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Woody Vegetation in the New York Metropolitan Region: Changes over Time, Taxonomic Keys, Maps, Ecological Descriptions, and Management Implications

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Illustrated by Bobbi Angell and Emma Skurnick



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Abstract

The New York metropolitan area has well over 500 woody plant species growing without cultivation in its wild flora, and the species composition and distributions of these species are changing. For example, numerous native species that were once common are today exceedingly rare. Conversely, many introduced, nonnative species are becoming increasingly common. A new manual was deemed necessary to document these and other changes in the New York Metropolitan Region, which encompasses 25 counties within a radius of 80.5 km of New York, NY. We used records developed by the New York Metropolitan Flora project (started in 1989 by Steve Clemants of the Brooklyn Botanic Garden) to organize a manual of woody plants for the region. The 370,000 plant species records used come from 3 main sources: collections made in the field, observations made in the field, and published data. We compared records from two time periods for each species: 1990 through 2013 and all years prior to 1990. Distribution maps highlight the decline or spread of species and species groups across the two time periods. In addition, species with 10 records or more have a detailed description of the species' identification, nativity, phenology, ecology, biology, change in distribution, cultivation and management (for native species), management (for invasive nonnative species), and economic and medicinal uses. Associated dichotomous keys are also included. This information provides taxonomic, biological, and ecological background that may help explain increasing or decreasing trends and shared patterns and histories with other species in the region. This manual covers 443 species in detail, with 362 distribution maps and 178 illustrations depicting 334 species. It briefly mentions 89 other woody species. The manual is available online at https://doi.org/10.2737/NRS-GTR-205.

KEY WORDS: boreal, distribution map, flora, invasive plant, native plant, trend analysis

Cover photo

Aerial photograph of a portion of the New York Metropolitan Region showing the boundaries of the five boroughs of New York, NY and select major cities, greenspaces, and bodies of water. Sources: Microsoft Bing© and Earthstar Geographics.

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Abbreviations used in this report

AK for Alaska
AL for Alabama
APHIS for
USDA Animal and Plant Health Inspection Service
AR for Arkansas
AZ for Arizona
CA for California
CT for Connecticut
DC for District of Columbia
DE for Delaware
f. sp. for forma specialis
FL for Florida
GA for Georgia
HI for Hawai'i
IA for Iowa
IL for Illinois
IN for Indiana
KY for Kentucky
LA for Louisiana
MA for Massachusetts
MB for Manitoba, Canada
MD for Maryland
ME for Maine
MI for Michigan
MN for Minnesota
MO for Missouri
MS for Mississippi
MT for Montana
NC for North Carolina
NRCS for
USDA Natural Resources Conservation Service
NE for Nebraska
NJ for New Jersey
NL for Newfoundland and Labrador, Canada
NS for Nova Scotia, Canada
NY for New York
NYC for New York City
OH for Ohio
OK for Oklahoma
ON for Ontario, Canada
OR for Oregon
PA for Pennsylvania
PE for Prince Edward Island, Canada
QC for Quebec, Canada
RI for Rhode Island
SC for South Carolina
SK for Saskatchewan, Canada
sp. for a single species
spp. for more than one species
subsp. for subspecies
TN for Tennessee
TX for Texas
U.K. for the United Kingdom
U.S. for the United States
UT for Utah
VA for Virginia
var. for variety
VT for Vermont
WI for Wisconsin
WV for West Virginia

Introduction

Review of Floristic Research in the New York Metropolitan Area

The flora of New York, NY and its environs has been studied for the past 250 years. Cadwallader Colden published one of the first accounts of the region's vegetation with his "Plantae Coldenghamiae" (1749, 1751). By the mid-18th century, much of the flora in the New York metropolitan area had been documented. Of the roughly 3,000 vascular plant species (including native and nonnative species) that now occur here, approximately 50 percent were accounted for in Carolus Linnaeus' 1753 compendium of the world's plants, "Species Plantarum" (1753). (The first two sections of this introduction are modified from Moore et al. 2003).

After a century of basic exploration in this region, botanists began to assemble the data into floras and checklists for publication (e.g., Mann 1872, Patterson 1892). Among the earliest of these floras were André Michaux's "Flora Boreali-Americana" (1803), Christiaan H. Persoon's "Synopsis Plantarum" (1805–1807), Frederick T. Pursh's "Flora Americae Septentrionalis" (1814), Thomas Nuttall's "Genera of North American Plants" (1818), and Torrey's "Catalogue of Plants Growing Spontaneously within Thirty Miles of the City of New York" (1819). The tradition of publishing regional floras has continued to the present. A center of regional floristic study developed in New York under John Torrey. In 1824, Torrey published "Flora of the Northern and Middle Sections of the United States." This was followed much later by Nathaniel Lord Britton and Addison Brown's "An Illustrated Flora of the Northern United States" (1896–1897) and the "Manual of the Flora of the Northern States and Canada" (1901). The most recent floristic treatments are Henry Allan Gleason and Arthur Cronquist's "Manual of Vascular Plants of Northeastern United States and Adjacent Canada" (1991) and Noel H. Holmgren's "The Illustrated Companion to Gleason and Cronquist's Manual" (1998), the standard texts for plant identification in the region today. (A revision of this manual is being prepared at the New York Botanical Garden by Robert Naczi and his collaborators; https://www.nybg.org/science-project/the-new-manual-of-vascular-plants-project-by-nybg/; Naczi 2016). (All internet links within this book are current as of the date of publication.)

Asa Gray, a student of Torrey's, founded a second center of northeastern U.S. floristics at Harvard University. In 1848, he published "A Manual of Botany of the Northern United States" (1848; see also Moore et al. 2010). The eighth edition of his book, now known as "Gray's Manual of Botany" (Fernald 1950), is still frequently used for the identification of plants in the northeastern United States.

In addition to regional floras, numerous studies of plants in the immediate area around New York City have been produced. Torrey published the first catalog of these plants in 1819. This was one of the earliest local floras in the Nation, preceded only by Jacob Bigelow's "Florula Bostoniensis" (1814) and William Barton's "Compendium Florae Philadelphicae" (1818). Torrey's catalog has been followed periodically by other floras, catalogs, and checklists pertaining to the metropolitan region, including Graves (1910) for CT; Anderson (1989), Britton (1881, 1889), Stone (1911), and Hough (1983) for NJ; Mitchell (1986), Mitchell and Tucker (1987) and Werier (2017) for NY; Jelliffe (1899) for Long Island; and Taylor (1915) for the vicinity of New York City, including parts of CT, PA, and NY, and all of NJ.

Torrey was influential in developing amateur botanical expertise in New York City. He and his colleagues founded the Torrey Botanical Club (now the Torrey Botanical Society; Moore 2020) in 1867. Botanical clubs were founded

in other areas in the Northeast as well, most notably the New England Botanical Club (1895), Philadelphia Botanical Club (1891), Connecticut Botanical Society (1903), and Long Island Botanical Society (1986). These clubs played, and continue to play, a very important role in the understanding of the local flora. They publish scholarly journals: "The Journal of the Torrey Botanical Society," "Bartonia," and "Rhodora." Each club has amassed and cared for extensive herbaria. The Torrey Botanical Society herbarium is now incorporated into the New York Botanical Garden; collections made by Philadelphia Botanical Club members are incorporated into the Academy of Natural Sciences, in Philadelphia; and the New England Botanical Club herbarium is housed within the Harvard University Herbaria collections. These clubs and their activities have been vital to the development of this manual.

New York Metropolitan Flora Project

In 1989, Steven Clemants (1954–2008), of the Brooklyn Botanic Garden, founded the New York Metropolitan Flora (NYMF) project. The project's purpose was to document all vascular plants that grow without cultivation in the metropolitan area. The NYMF range extends to all counties within a radius of 80.5 km of New York City, a total of 25 counties. It includes all of Long Island (Kings, Queens, Nassau, and Suffolk Counties), all of northern New Jersey (south to Mercer and Monmouth Counties), part of southeastern New York (Orange, Putnam, Rockland, and Westchester Counties), and Fairfield County in Connecticut. This area, the New York Metropolitan Region, encompasses approximately 19,813 km^2 and is the region covered in this manual (Fig. 1).

For collecting and surveying purposes, the project used a grid system based on the New York Transverse Mercator Grid (a variation of the Universal Transverse Mercator Grid). The same grid used in the "Atlas of Breeding Birds of New York State" (Andrle and Carroll 1988, McGowan and Corwin 2008), it breaks down the metropolitan region into 964 five-km × five-km cells or blocks. Each block is assigned a centroid. As far as possible, every record in the NYMF database corresponds to one of these blocks.

Data entered into the NYMF database are derived from three main sources: 1) collections made in the field, 2) observations made in the field, and 3) published data. To date, the NYMF database consists of more than 370,000 records taken from these 3 sources. All herbaria that have significant collections in the NYMF range were inventoried. These herbaria (followed by abbreviations according to Holmgren et al. 1990) are the Academy of Natural Sciences, Philadelphia (PH); the Brooklyn Botanic Garden (BKL); Cornell University (BH, CU); Harvard University (A, GH, NEBC); the New York Botanical Garden (NY); New York State Museum (NYS); Rutgers University (CHRB); Smithsonian Institution's National Museum of Natural History (US); Staten Island Institute of Arts and Sciences (SIM); University of Connecticut (CONN); and Yale University (Y). The field-collection data made by the NYMF staff are especially important because most records from herbaria were obtained before 1990.

In addition to compiling vouchered data, the NYMF staff made nonvouchered observations in the field, and these records are also entered into the database. Observations made by others are also entered; for example, the records of Stanley Smith, the first curator of the herbarium of the New York State Museum, are included. Some questions regarding species identity cannot be answered without a voucher specimen, so this approach could be criticized. However, a parallel may be drawn in the common use of observational data in bird studies. Furthermore, the presence of a detailed vouchered database for comparison lessens the risk of error in using nonvouchered data. Moreover, it is the only practical way to get a reasonably complete picture of distributions. The NYMF range is large, and it is not feasible to have collections for all species in each block. Because each block unit is small, most questions about records can be answered by physically visiting a block.

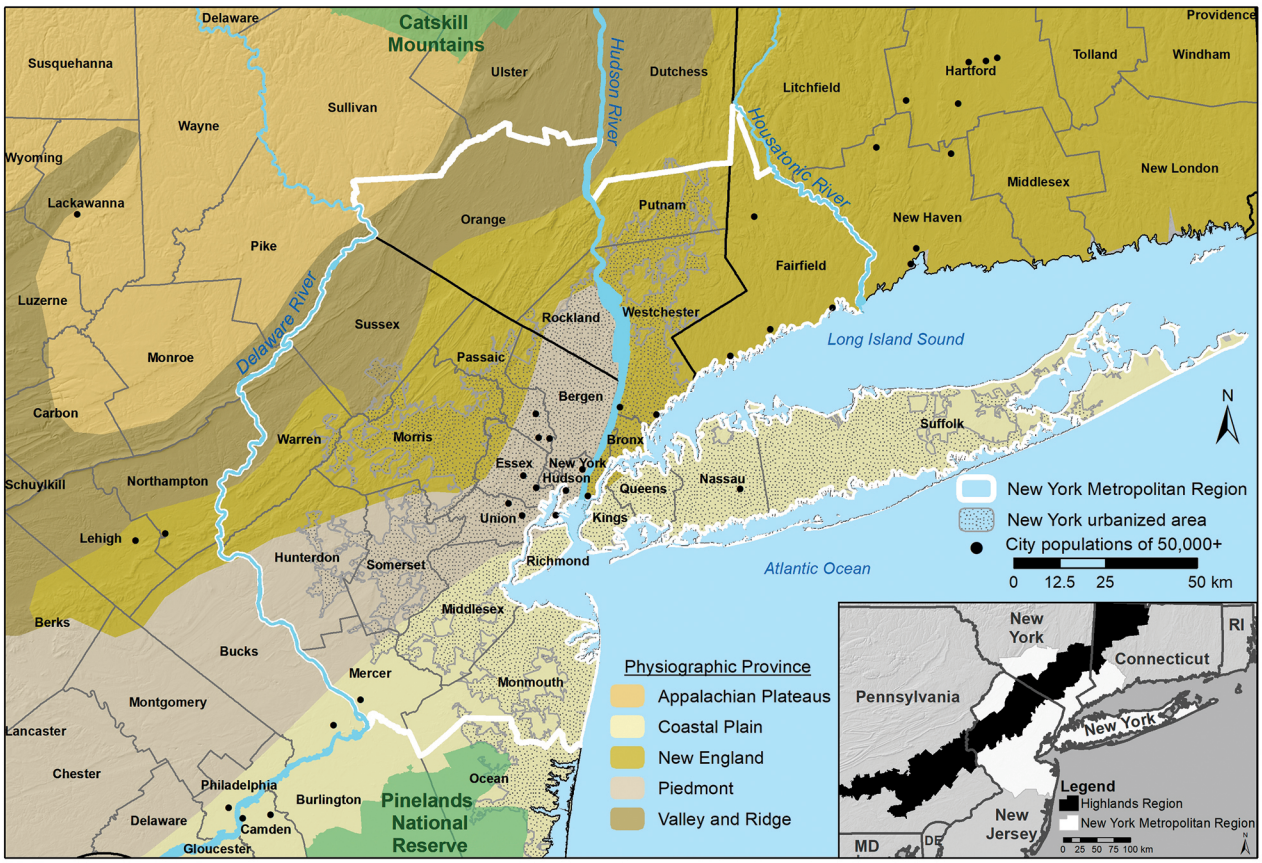

Figure 1.—The New York Metropolitan Region, showing extent of urbanization, physiographic provinces, and state and county boundaries. Inset shows the Highlands Region, a geographic region recognized as having distinctive features that may also affect vegetation patterns. Urbanized areas are defined here as those containing 50,000 or more people (U.S. Census Bureau, n.d.). Map information is derived from the following sources. Catskill Mountains: New York State Office of Cyber Security and Critical Infrastructure Coordination (2005); cities and towns: U.S. Geological Survey (2014); county boundaries: (Esri 2018a); Delaware River: Delaware River Basin Commission (2017); Highlands Region: USDA Forest Service, Northeastern Area State and Private Forestry (n.d.); hillshade: Esri (2017); Housatonic River: State of Connecticut (2018); Hudson River: Bell et al. (2005); New York urbanized area: U.S. Census Bureau (2012); physiographic provinces: U.S. Geological Survey (2018); Pinelands: New Jersey Department of Environmental Protection (1994); state boundaries: Esri (2018b).

Development and Use of this Manual

In the mid-2000s, researchers at the Brooklyn Botanic Garden and the USDA Forest Service began a collaborative effort to produce a manual of the woody plants of the New York Metropolitan Region for use by botanists, taxonomists, ecologists, and land managers. The goals of the manual were to provide information on the 1) identification, 2) nativity, 3) phenology, 4) ecology, 5) biology, 6) change in distribution through a comparison of distributions before 1990 and since 1990, 7) cultivation and management of native species, 8) management of invasive nonnative species, and 9) economic and medicinal uses of the woody plants in this region (Table 1). A glossary can be found on pp. 626–637.

Table 1.—Taxa described in this manual, with abundance trend analysis where available, presence of maps and illustrations noted, and any synonyms used recently (since about 1990). Please see Table 2 on p. 15 for explanation of symbols, and p. vi for abbreviations. Species (as listed under accepted names) for which neither an abundance trend, map, nor illustration is presented are uncommon species in the New York Metropolitan Region and are mentioned only briefly in the manual. In this table and the species keys within genera, an asterisk (*) denotes species not native to the region.

Scientific name	Trend	Map	Botanical illustration
Abies balsamea	Ø♥		
*Abies grandis**			
*Acer campestre**	↑↑	X	X
*Acer ginnala**	↑↑↑	X	X
Acer negundo	↑↑↑	X	X
Acer nigrum	↔	X	X
*Acer palmatum**	↑↑↑	X	X
Acer pensylvanicum	↑↑	X	X
*Acer platanoides**	↑↑↑	X	X
*Acer pseudoplatanus**	↑↑	X	X
Acer rubrum	↑	X	X
Acer saccharinum	↑↑↑	X	X
Acer saccharum	↑↑	X	X
Acer spicatum	↓↓↓	X	X
*Actinidia arguta**			
*Actinidia polygama**			
*Aesculus glabra**	Ø		
*Aesculus hippocastanum**	↑	X	X
*Aesculus parviflora**	Ø		
*Ailanthus altissima**	↑↑↑	X	X
*Akebia quinata**	↑	X	X
*Albizia julibrissin**	↑↑↑	X	X
*Alnus glutinosa**	↑	X	
Alnus incana subsp. *rugosa*	↑	X	X
Alnus serrulata	↑↑	X	X
Alnus viridis subsp. *crispa**			
*Amelanchier alnifolia**			
Amelanchier arborea	↑↑↑	X	X
Amelanchier canadensis	↑	X	X
Amelanchier canadensis var. *obovalis*: See *Amelanchier obovalis*			
Amelanchier humilis	Ø		
Amelanchier laevis	↑	X	
Amelanchier nantucketensis	↓	X	
Amelanchier obovalis	Ø		
Amelanchier sanguinea	Ø		
Amelanchier spicata	↔	X	X
Amelanchier stolonifera: See *Amelanchier spicata*			
*Amorpha fruticosa**	↑	X	X
Ampelopsis brevipedunculata: See *Ampelopsis glandulosa*			
*Ampelopsis glandulosa**	↑↑↑	X	X
Andromeda glaucophylla	↓↓↓	X	X
Andromeda polifolia var. *latifolia*: See *Andromeda glaucophylla*			
*Aralia elata**	↑↑↑	X	X
Arceuthobium pusillum	Ø♥		X
Arctostaphylos uva-ursi	↔	X	X
Aristolochia macrophylla			
Aristolochia tomentosa			
Aronia arbutifolia	↔	X	X
Aronia atropurpurea: *See Aronia prunifolia*			
Aronia floribunda: See *Aronia prunifolia*			
Aronia melanocarpa	↔	X	X
Aronia prunifolia	↔	X	
Ascyrum crux-andreae: See *Hypericum crux-andreae*			
Ascyrum hyperiicoides var. *multicaule*: See *Hypericum hyperioides* subsp. *multicaule*			
Ascyrum stans: See *Hypericum crux-andreae*			
Asimina triloba	Ø♥	X	X
Baccharis halimifolia	↔	X	X
*Berberis julianae**			
*Berberis ×ottawensis**			
*Berberis thunbergii**	↑↑↑	X	X

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
*Berberis vulgaris**	↓	X	
Betula alleghaniensis	↑↑	X	X
Betula cordifolia			
Betula lenta	↑↑	X	X
Betula nigra	↑	X	X
Betula papyrifera	↑↑	X	
*Betula pendula**	↔	X	
*Betula platyphylla**			
Betula populifolia	↑↑	X	X
Betula pumila	↓↓↓	X	
*Broussonetia papyrifera**	↔	X	X
*Buddleja davidii**	↑	X	X
*Calluna vulgaris**	Ø		X
*Campsis radicans**	↑↑↑	X	X
*Carpinus betulus**			
Carpinus caroliniana	↑↑	X	X
Carya cordiformis	↑↑↑	X	X
Carya glabra	↑↑↑	X	X
Carya laciniosa			
Carya ovalis	↔	X	
Carya ovata	↑↑↑	X	X
Carya tomentosa	↑↑	X	X
*Castanea crenata**			
Castanea dentata	↑	X	X
*Castanea mollissima**			
Castanea pumila	Ø		
*Castanea sativa**			
*Catalpa bignoniodes**	↑↑↑	X	X
*Catalpa ovata**			
*Catalpa speciosa**	↑↑	X	
Ceanothus americanus	↓↓	X	X
*Celastrus orbiculatus**	↑↑↑	X	X
Celastrus scandens	↓↓↓	X	X
Celtis occidentalis	↑	X	X
Celtis pumila	Ø		
*Cephalanthus occidentalis**	↑↑	X	X
Cercis canadensis	Ø♥	X	X
Chamaecyparis thyoides	↔	X	X
Chamaedaphne calyculata	↔	X	X
Chimaphila maculata	↑	X	X
Chimaphila umbellata	↓↓	X	X
Chionanthus virginicus	Ø		

Scientific name	Trend	Map	Botanical illustration
*Clematis ×jackmanii**			
Clematis occidentalis	↓↓↓	X	
*Clematis terniflora**	↑↑↑	X	
Clematis virginiana	↑↑	X	X
*Clematis viticella**			
Clethra alnifolia	↔	X	X
Comptonia peregrina	↔	X	X
Corema conradii	Ø		X
Cornus alternifolia	↑	X	X
Cornus amomum	↑↑	X	X
Cornus canadensis	↓↓↓	X	X
Cornus florida	↑↑	X	X
Cornus foemina	Ø		X
*Cornus kousa**	Ø		
*Cornus mas**			
Cornus racemosa	↑↑	X	
Cornus rugosa	↓	X	X
*Cornus sanguinea**			
Cornus sericea	↑	X	X
Corylus americana	↑↑	X	X
*Corylus avellana**			
Corylus cornuta	↑↑	X	X
Cotinus spp.			
Crataegus spp.	↑↑	X	
Crataegus calpodendron	Ø		X
Crataegus chrysocarpa	↓	X	X
Crataegus coccinea	↔	X	X
Crataegus coccinioides	Ø		
Crataegus crus-galli	↓	X	X
Crataegus dodgei	Ø		
Crataegus flabellata	Ø		X
Crataegus holmesiana	Ø		
Crataegus intricata	↔	X	X
Crataegus jesupii	Ø		
Crataegus levis	Ø		
Crataegus macrosperma	Ø		X
Crataegus mollis	Ø		X
*Crateagus monogyna**	↔	X	X
Crataegus pedicellata See *Crataegus coccinea*			
Crataegus pennsylvanica	Ø		

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
*Crataegus phaenopyrum**	Ø		
Crataegus populnea			
Crataegus pruinosa	↓	X	X
Crataegus punctata	↔	X	X
Crataegus schuettei			
Crataegus submollis	Ø		
Crataegus succulenta	Ø		
Crataegus uniflora	↓↓	X	X
*Cytisus scoparius**	↔	X	X
Dasiphora fruticosa subsp. *floribunda*	↓↓	X	X
Decodon verticillatus	↔	X	X
*Deutzia scabra**	↑↑	X	X
Diervilla lonicera	↔	X	X
Diospyros virginiana	↔	X	X
Dirca palustris	↓↓	X	X
*Elaeagnus angustifolia**	↑	X	X
*Elaeagnus commutata**			
*Elaeagnus multiflora**			
*Elaeagnus umbellata**	↑↑↑	X	X
Empetrum nigrum	Ø♥		X
Epigaea repens	↔	X	X
Eubotrys racemosus	↔	X	X
*Eubotrys recurvus**			
*Euonymus alatus**	↑↑↑	X	X
Euonymus americanus	↓↓	X	X
Euonymus atropurpureus	↓↓	X	X
*Euonymus europaeus**	↔	X	X
*Euonymus fortunei**	↑↑↑	X	X
Euonymus fortunei var. *radicans*: See *Euonymus fortunei*			
Fagus grandifolia	↑↑	X	X
*Fagus sylvatica**			X
*Ficus carica**	Ø		X
Forsythia spp*.			
*Frangula alnus**	↑↑	X	X
Fraxinus americana	↑↑	X	X
*Fraxinus excelsior**			
Fraxinus nigra	↑	X	X
Fraxinus pennsylvanica	↑↑↑	X	X
Fraxinus profunda	Ø		
Fraxinus tomentosa: See *Fraxinus profunda*			
Gaultheria hispidula	Ø		X
Gaultheria procumbens	↔	X	X
Gaylussacia baccata	↑	X	X
Gaylussacia bigeloviana	↓↓↓	X	X
Gaylussacia dumosa: See *Gaylussacia bigeloviana*			
Gaylussacia frondosa	↔	X	X
*Genista tinctoria**			
*Ginkgo biloba**	Ø♥	X	X
*Gleditsia triacanthos**	↑↑↑	X	X
*Gymnocladus dioicus**	↑↑	X	X
*Halesia tetraptera**			
Hamamelis virginiana	↑↑	X	X
*Hedera helix**	↑↑↑	X	X
Hedera helix var. *hibernica*: See *Hedera helix*			
*Hibiscus syriacus**	↑↑↑	X	X
Hudsonia ericoides	↔	X	X
Hudsonia tomentosa	↔	X	X
Hydrangea arborescens	↔	X	X
*Hydrangea paniculata**	↑↑↑	X	X
Hypericum crux-andreae	Ø		X
Hypericum densiflorum	↓↓↓	X	X
Hypericum hypericoides subsp. *multicaule*	↔	X	X
Hypericum stragulum: See *Hypericum hypericoides* subsp. *multicaule*			
Hypericum prolificum	↑	X	X
*Ilex crenata**	↑↑↑		X
Ilex glabra	↔	X	X
Ilex laevigata	↓	X	X
Ilex montana	Ø		X
Ilex mucronata: See *Nemopanthus mucronatus*			

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
Ilex opaca	↑↑↑	X	X
Ilex verticillata	↑↑	X	X
Itea virginica	Ø♥		X
Iva frutescens	↔	X	X
*Juglans ailantifolia**	Ø		
Juglans cinerea	↔	X	
Juglans nigra	↑↑↑	X	X
*Juglans regia**			
Juniperus communis: See *Juniperus communis* var. *depressa*			
Juniperus communis var. *depressa*	↓	X	X
Juniperus virginiana	↑↑	X	X
Kalmia angustifolia	↔	X	X
Kalmia buxifolia: See *Leiophyllum buxifolium*			
Kalmia latifolia	↑	X	X
Kalmia polifolia	↓↓↓	X	X
*Kerria japonica**	Ø		
*Koelreuteria paniculata**	↑↑↑	X	X
*Larix decidua**			
*Larix kaempferi**			
Larix laricina	↓↓	X	X
Leiophyllum buxifolium	Ø		
*Lespedeza bicolor**			
*Lespedeza thunbergii**			
*Leucothoe fontanesiana**	↑↑↑	X	X
Leucothoe racemosa: See *Eubotrys racemosus*			
Leucothoe recurvus: See *Eubotrys recurvus*			
Ledum groenlandicum: See *Rhododendron groenlandicum*			
*Ligustrum obtusifolium**	↑↑↑	X	X
*Ligustrum ovalifolium**	Ø		
*Ligustrum vulgare**	↑↑↑	X	X
Lindera benzoin	↑↑	X	X
Liquidambar styraciflua	↑	X	X
Liriodendron tulipifera	↑↑	X	X
Lonicera canadensis	Ø		X
Lonicera dioica	↓	X	X
*Lonicera fragrantissima**	↑	X	X
*Lonicera japonica**	↑↑↑	X	X
*Lonicera maackii**	↑↑↑	X	X
*Lonicera morrowii**	↑↑↑	X	X
Lonicera sempervirens	↓↓	X	X
*Lonicera tatarica**	↓↓↓	X	X
Lonicera villosa			
*Lonicera xylosteum**	↓↓↓	X	X
*Lycium barbarum**	↓	X	X
Lyonia ligustrina	↔	X	X
Lyonia mariana	↔	X	X
*Maclura pomifera**	↑	X	X
*Magnolia acuminata**	↔	X	
*Magnolia kobus**	Ø		
*Magnolia macrophylla**	Ø		
*Magnolia tripetala**	↑↑↑	X	X
Magnolia virginiana	↔	X	
Malus spp.	↑↑↑	X	
*Malus baccata**	↑↑	X	
Malus coronaria	↓↓	X	X
*Malus floribunda**	Ø		
*Malus prunifolia**	Ø		
*Malus pumila**	↑↑	X	X
Malus sieboldii: See *Malus toringo*			
Malus sylvestris: See *Malus pumila*			
*Malus toringo**	↑↑↑	X	
Melia azedarach			
Menispermum canadense	↑	X	X
Metasequoia glyptostrobioides			
Morella cerifera	Ø		X
Morella pensylvanica	↔	X	X
*Morus alba**	↑↑↑	X	X
Morus rubra	↓↓↓	X	
Myrica cerifera: See *Morella cerifera*			
Myrica gale	↓	X	X

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
Myrica pensylvanica: See *Morella pensylvanica*			
Nemopanthus mucronatus	↓↓	X	X
Nyssa sylvatica	↑↑	X	X
Ostrya virginiana	↑↑	X	X
*Oxydendrum arboreum**	Ø♥	X	X
Parthenocissus inserta	↔	X	X
Parthenocissus quinquefolia	↑↑	X	X
*Parthenocissus tricuspidata**	↑↑	X	X
Parthenocissus vitacea: See *Parthenocissus inserta*			
*Paulownia tomentosa**	↑↑	X	X
*Phellodendron amurense**	↑↑	X	X
*Philadelphus coronarius**	↑↑↑	X	X
*Philadelphus inodorus**	Ø		
*Philadelphus pubescens**	Ø		
Phoradendron flavescens: See *Phoradendron leucarpum*			
Phoradendron leucarpum	Ø		X
Phorodendron serotinum: See *Phorodendron leucarpum*			
Photinia floribunda: See *Aronia prunifolia*			
Photinia melanocarpa: See *Aronia melanocarpa*			
Photinia pyrifolia: See *Aronia arbutifolia*			
*Photinia villosa**	↑↑↑	X	X
Physocarpus opulifolius	↓	X	X
*Picea abies**	↑↑↑	X	
*Picea glauca**	Ø		
Picea mariana	↔	X	
*Picea pungens**	Ø		
Picea rubens	↔	X	X
*Pinus banksiana**	Ø		X
Pinus echinata	↔	X	X
*Pinus nigra**	Ø		
Pinus pungens	Ø		
Pinus resinosa	↑	X	
Pinus rigida	↔	X	X
Pinus strobus	↑↑↑	X	X
*Pinus sylvestris**	↑↑	X	
*Pinus thunbergii**	↑↑↑	X	X
Pinus virginiana	↓↓	X	X
*Platanus ×hispanica**	↑↑	X	X
Platanus ×hybrida: See *Platanus ×hispanica*			
Platanus occidentalis	↑↑↑	X	X
*Populus alba**	↔	X	X
Populus balsamifera	↔	X	X
*Populus ×canescens**			
Populus deltoides	↑↑↑	X	X
Populus grandidentata	↑↑	X	X
Populus heterophylla	↓↓	X	X
Populus ×jackii			
*Populus nigra**	↓↓	X	X
Populus tremuloides	↑↑	X	X
Prunus alleghaniensis	Ø♥	X	X
Prunus americana	↓↓	X	X
Prunus angustifolia			
*Prunus avium**	↑↑↑	X	X
*Prunus cerasifera**	Ø		
*Prunus cerasus**	↓↓↓	X	
*Prunus domestica**	↓↓↓	X	
*Prunus mahaleb**	Ø		
Prunus maritima	↔	X	X
Prunus nigra			
*Prunus padus**	Ø♥	X	
Prunus pensylvanica	↔	X	X
*Prunus persica**	↔	X	X
Prunus pumila	↔	X	X
Prunus pumila var. *depressa*	Ø		
Prunus pumila var. *susquehanae*	↓↓	X	
Prunus serotina	↑↑	X	X
*Prunus spinosa**	Ø		

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
Prunus virginiana	↑↑	X	X
*Pseudotsuga menziesii**	Ø		
Ptelea trifoliata	↔	X	X
Pueraria lobata: See *Pueraria montana* var. *lobata*			
Pueraria montana var. *lobata**	↔	X	X
*Pyracantha coccinea**			
*Pyrularia pubera**			
Pyrus arbutifolia: See *Aronia arbutifolia*			
Pyrus atropurea: See *Aronia prunifolia*			
Pyrus baccata: See *Malus baccata*			
*Pyrus calleryana**	↑↑↑	X	X
*Pyrus communis**	↔	X	X
Pyrus floribunda: See *Aronia prunifolia*			
Pyrus malus: See *Malus pumila*			
Pyrus melanocarpa: See *Aronia melanocarpa*			
Pyrus prunifolia: See *Malus prunifolia*			
*Pyrus pyrifolia**			
Pyrus seiboldii: See *Malus toringo*			
*Quercus acutissima**			
Quercus alba	↑↑	X	X
Quercus bicolor	↑↑	X	X
Quercus ×brittonii			
Quercus ×bushii			
Quercus coccinea	↑	X	X
Quercus falcata	↔	X	X
Quercus ×faxonii			
Quercus ×filialis			
Quercus ×giffordii			
Quercus ×hawkinsiae; See *Quercus ×porteri*			
Quercus ×heterophylla			
Quercus ilicifolia	↔	X	X
*Quercus imbricaria**			
Quercus ×jackiana			
Quercus macrocarpa	Ø♥		
Quercus marilandica	↔	X	
Quercus montana	↑↑	X	X
Quercus muehlenbergii	↔	X	X
Quercus palustris	↑↑	X	
Quercus phellos	↑	X	
Quercus ×porteri			
Quercus prinoides	↔	X	X
Quercus prinus: See *Quercus montana*			
Quercus ×rehderi			
Quercus ×robbinsii			
*Quercus robur**	Ø		
Quercus rubra	↑↑	X	X
Quercus ×rudkinii			
Quercus ×saulii			
Quercus stellata	↔	X	X
Quercus velutina	↑↑	X	X
Rhamnus alnifolia	↓↓↓	X	X
*Rhamnus cathartica**	↑↑↑	X	X
*Rhamnus davurica**			
Rhamnus frangula: See *Frangula alnus*			
Rhododendron arborescens			
*Rhododendron calendulaceum**			
Rhododendron canadense	↓↓↓	X	X
Rhododendron groelandicum	Ø		X
Rhododendron maximum	↔	X	X
*Rhododendron molle**			
Rhododendron nudiflorum: See *Rhododendron pericylmenoides*			
Rhododendron periclymenoides	↑	X	X
Rhododendron prinophyllum	↓↓↓	X	X
Rhododendron viscosum	↔	X	X
*Rhodotypos scandens**	↑↑↑	X	X
Rhus aromatica	↑↑↑	X	X

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
Rhus copallina	↑	X	X
Rhus glabra	↑↑	X	X
Rhus typhina	↑↑↑	X	X
Ribes americanum	↔	X	X
Ribes aureum var. *villosum**	Ø		X
Ribes cynosbati	↓	X	X
Ribes glandulosum	Ø		X
Ribes hirtellum	↔	X	X
Ribes lacustre	Ø		X
Ribes missouriense	Ø		X
*Ribes nigrum**	Ø		X
Ribes rotundifolium	↔	X	X
*Ribes rubrum**	↑	X	X
Ribes triste	↔	X	X
*Ribes uva-crispa**	↓↓↓	X	X
*Robinia hispida**	↔	X	X
*Robinia pseudoacacia**	↑↑↑	X	X
*Robinia viscosa**	↓↓	X	X
Rosa blanda	↓↓↓	X	
*Rosa canina**	↑	X	X
Rosa carolina	↑	X	X
*Rosa cinnamomea**	Ø		
Rosa eglanteria: See *Rosa rubiginosa*			
Rosa luciae var. *luciae**	↑↑↑	X	
*Rosa majalis**	Ø		
*Rosa micrantha**	↓↓↓	X	
*Rosa multiflora**	↑↑↑	X	X
Rosa nitida			
Rosa palustris	↑↑	X	X
*Rosa rubiginosa**	↓↓↓	X	
*Rosa rugosa**	↑	X	X
*Rosa setigera**	↓	X	
Rosa setigera var. *setigera*: See *Rosa setigera*			
Rosa virginiana	↔	X	X
Rosa wichuraiana: See *Rosa luciae* var. *luciae*			
Rubus allegheniensis	↑↑↑	X	X
Rubus argutus: See *Rubus pensilvanicus*			
Rubus arundelanus: See *Rubus flagellaris*			
*Rubus bifrons**	Ø		
Rubus canadensis	↓↓↓	X	X
Rubus cuneifolius	↓	X	X
Rubus enslenii: See *Rubus flagellaris*			
Rubus flagellaris	↑↑	X	X
Rubus hispidus	↑↑	X	X
Rubus idaeus	↓↓	X	X
Rubus idaeus subsp. *idaeus**	Ø	X	X
Rubus idaeus subsp. *strigosus*	↑↑↑	X	X
*Rubus illecebrosus**			
*Rubus laciniatus**	↔	X	X
Rubus longii: See *Rubus cuneifolius*			
Rubus ×neglectus			
Rubus occidentalis	↑↑↑	X	X
Rubus odoratus	↔	X	
Rubus pensilvanicus	↔	X	X
*Rubus phoenicolasius**	↑↑↑	X	
Rubus setosus	↓↓↓	X	X
*Salix alba**	↑	X	X
Salix amygdaloides			
*Salix atrocinerea**	↑↑↑	X	X
*Salix babylonica**			
Salix bebbiana	↔	X	X
Salix candida	↓↓↓	X	
*Salix cinerea**	↑↑↑	X	
Salix discolor	↑↑	X	X
*Salix elaeagnos**			
Salix eriocephala	↑	X	X
Salix exigua: See *Salix interior*			
*Salix ×fragilis**	↑↑	X	X
Salix humilis	↓↓↓	X	X
Salix humilis var. *humilis*			
Salix humilis var. *tristis*			
Salix interior	↓↓↓	X	X
Salix lucida	↓↓↓	X	X
Salix nigra	↑↑	X	X
Salix pedicellaris	↓↓↓	X	X
*Salix ×pendulina**	↑↑	X	X
*Salix pentandra**	↓↓↓	X	
Salix petiolaris	↓↓↓	X	

(continued on next page)

Scientific name	Trend	Map	Botanical illustration
*Salix purpurea**	↔	X	X
*Salix ×sepulcralis**	Ø		
Salix sericea	↔	X	X
Salix serissima	↓↓↓	X	X
Sambucus canadensis	↑↑	X	X
Sambucus racemosa	↔	X	X
Sassafras albidum	↑↑	X	X
Smilax glauca	↑	X	X
Smilax hispida: See *Smilax tamnoides*			
Smilax laurifolia	Ø		
Smilax rotundifolia	↑↑	X	X
Smilax tamnoides	↓↓	X	X
*Solanum dulcamara**	↑↑	X	X
*Sorbaria sorbifolia**	↔	X	X
Sorbus americana	Ø		X
*Sorbus aucuparia**	↑↑↑	X	X
Sorbus decora	Ø		
Spiraea alba var. *latifolia*	Ø	X	X
Spiraea corymbosa			
*Spiraea japonica**	Ø		
*Spiraea prunifolia**			
*Spiraea thunbergii**			
Spiraea tomentosa	↔	X	X
Staphylea trifolia	↑	X	X
*Styphnolobium japonicum**			
*Styrax japonicus**			
Symphoricarpos albus	↓↓↓		
Symphoricarpos albus: See *Symphoricarpos albus* var. *laevigatus*			
Symphoricarpos albus var. *laevigatus**	↓↓↓	X	X
*Symphoricarpos orbiculatus**	↑↑	X	X
*Symplocos paniculata**	Ø		
*Symplocos tinctoria**			
*Syringa vulgaris**	↑↑	X	X
*Taxodium distichum**	Ø		
Taxus spp.*	↑↑↑	X	
*Taxus baccata**	↑↑↑	X	
Taxus canadensis	↓↓↓	X	X
*Taxus cuspidata**	↑	X	
*Taxus ×media**			
Thuja occidentalis	↔	X	X
Tilia americana	↑↑↑	X	X
*Tilia cordata**	↑↑↑	X	X
*Tilia tomentosa**			
Toxicodendron radicans	↑↑	X	X
Toxicodendron radicans subsp. *radicans*: See *Toxicodendron radicans*			
Toxicodendron vernix	↑	X	X
Tsuga canadensis	↑↑	X	X
*Ulex europaeus**			
Ulmus americana	↑↑↑	X	X
*Ulmus glabra**			
*Ulmus ×hollandica**			
Ulmus minor: See *Ulmus procera*			
*Ulmus parvifolia**			
*Ulmus procera**			
*Ulmus pumila**	↑↑↑	X	X
Ulmus rubra	↑↑	X	X
Ulmus thomasii	Ø♥		
Vaccinium angustifolium	↔	X	X
Vaccinium atrococcum: See *Vaccinium corymbosum*			
Vaccinium caesariense: See *Vaccinium corymbosum*			
Vaccinium corymbosum	↑	X	X
Vaccinium macrocarpon	↓	X	X
Vaccinium myrtilloides	Ø		X
Vaccinium oxycoccos	↓↓↓	X	X
Vaccinium pallidum	↑	X	X
Vaccinium stamineum	↑	X	X
Vaccinium vacillans: See *Vaccinium pallidum*			
Viburnum acerifolium	↑	X	X
Viburnum alnifolium: See *Viburnum lantanoides*			

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Scientific name	Trend	Map	Botanical illustration
Viburnum dentatum	↑↑	X	
Viburnum dentatum var. *dentatum*	↑	X	X
Viburnum dentatum var. *lucidum*	↑↑	X	X
Viburnum dentatum var. *venosum*	↑	X	
*Viburnum dilatatum**	↑↑↑	X	X
*Viburnum lantana**	Ø♥	X	
Viburnum lantanoides	↓↓	X	X
Viburnum lentago	↑↑	X	X
Viburnum nudum	↔	X	X
Viburnum nudum var. *cassinoides*	↓	X	
Viburnum nudum var. *nudum*	↔	X	
*Viburnum opulus**	↑↑	X	
Viburnum opulus var. *americanum*	↓	X	
Viburnum opulus var. *opulus**	↑↑	X	X
*Viburnum plicatum**	↑↑↑	X	
Viburnum prunifolium	↑	X	X
Viburnum rafinesquianum	↔	X	X
Viburnum recognitum: See *Viburnum dentatum* var. *lucidum*			
*Viburnum setigerum**	↑↑↑	X	X
*Viburnum sieboldii**	↑↑↑	X	X
Vitis aestivalis	↑↑	X	X
Vitis labrusca	↑↑	X	X
Vitis ×novae-angliae	Ø		
*Vitis palmata**			
Vitis riparia	↑↑↑	X	
*Vitis vinifera**	Ø		
Vitis vulpina	↔	X	X
*Wisteria floribunda**	↑↑	X	
*Wisteria frutescens**	↑↑↑	X	X
*Wisteria sinensis**	↑↑↑	X	X
*Xanthorhiza simplicissima**	Ø		
*Yucca filamentosa**	↑↑↑	X	X
Zanthoxylum americanum	↔	X	X
*Zanthoxylum simulans**			
*Zelkova serrata**			

Keys

Keys are dichotomous and bracketed (i.e., not indented or yoked). Each lead of a couplet is numbered. The following dictate the sequence of the couplet: 1) if one lead goes to a species and the other lead takes the reader to another couplet, the lead that goes to a species is listed first; 2) if both leads go to a species, then the lead that goes to the species appearing first in the treatment is listed first; 3) if both leads take the reader to another couplet, then the sequence is determined by the couplet number (the lower one appearing first). The number in parentheses after a numbered lead in the genus key can guide the reader back to the immediately preceding relevant couplet. A few genera added later were more easily included in the key by using sub-couplets.

Genus entry

The entry for the genus has the following format: 1) genus name with authorship (abbreviations follow Brummitt and Powell 1992; also available from International Plant Names Index 2020) and common name on the same line; 2) synonyms, with basionyms appearing first and other synonyms following alphabetically; 3) family and alternate family placements; 4) growth habit for the genus world-wide (from trees down to vines); 5) worldwide native range and nonnative range (number of species world-wide); 6) brief statement on distinctive characters of the genus; 7) anything that is consistent across all members of the genus for the region that would otherwise be mentioned in the species treatment (e.g., cultivation, dispersal, pollination, uses); and 8) etymology of the genus name.

Species entry

Species are treated in one of three ways: 1) fully treated (i.e., keyed, discussed); 2) partially treated (keyed, briefly discussed); if rare and of particular interest in the region, species is marked with a heart symbol and a map or illustration [or both] may be included along with additional information); or 3) incidentally mentioned (possibly keyed for comparison only but generally not keyed; briefly mentioned under its most closely associated species and not numbered). This manual covers 443 species in detail and briefly mentions 89 other woody species.

The species entry has two sections: description and ecology. The description section follows this format: 1) species name with authorship (abbreviations follow Brummitt and Powell 1992; also available from International Plant Names Index 2020), common name, and symbols indicating change in abundance (see Table 2) all on the same line; 2) synonyms, with basionyms appearing first and other synonyms following alphabetically; 3) growth habit (when variable within genus); 4) phenology; 5) habitat; 6) a brief statement on distinctive characters of the species (optional); 7) a brief statement on the morphology of the species, such as variation (optional); 8) a brief statement on taxonomy of the species, such as alternative classifications and infraspecific taxa (optional); and 9) where known, etymology of epithet, if less than obvious. (For example, etymology is omitted for *Acer pensylvanicum* and *Rhododendron canadense*, Pennsylvania and Canada being obvious.) The more common species and species of special interest—those of particular interest because of their unique taxonomy, ecology, or distribution pattern (or combination thereof)—also have a drawing. This manual contains 178 illustrations depicting 334 species.

The ecology section follows this format: 1) native range (for nonnative species); 2) biology (size and age at maturity and seed set, where applicable; genetics and hybridization; habitat preferences or responses to changes in environmental conditions); 3) reproductive ecology (mating system, pollination and fruit or seed dispersal, expected germination rates, seed bank formation and longevity); 4) major pests and pathogens; 5) food uses; 6) toxicity or medicinal uses; 7) cultivation and management; 8) reasons for decline or spread, if known; 9) trends in distribution and abundance; and 10) conservation status (Snyder 2016, State of Connecticut 2015, Young 2019) or invasive status (Connecticut Invasive Plants Council 2018, New York State Departments of Environmental Conservation and Agriculture and Markets 2014, Snyder 2009), if any, for Connecticut, New Jersey, and New York (NatureServe S ranks in parentheses). NatureServe's conservation State status ranks (S ranks) are based on a scale of 1 to 5, from critically imperiled (S1) to demonstrably secure (S5) but with some doubt (e.g., S1?, S2?) (NatureServe 2020). Where notable decreases or increases (e.g., nonnative invasive species) are a concern, a management section that addresses all relevant species for each genus is provided after the last species is described. Species with 10 or more occurrences and select species with fewer than 10 records have a map showing pre-1990 distributions (orange circles), distributions from 1990 through 2013 (green circles), and distributions recorded during both timespans (circles with orange and green split vertically) within each 5 km × 5 km block described earlier. Species located in blocks falling on the boundary of the New York Metropolitan Region were counted if located anywhere in the block. Maps are provided for 362 taxa.

Changes to the Region's Landscape and Woody Flora over Time

Over the past three centuries, the landscape of the New York Metropolitan Region has undergone considerable changes. In the 1700s and 1800s, the landscape was much more open with less forested land, largely the result of fire and clearing of land for agriculture and fire breaks. With the decrease of fire (Nowacki and Abrams 2008), especially wildfire, and the decline of agriculture, forested land has increased (Houghton and Hackler 2000, Kauppi et al. 2006, Waisanen and Bliss 2002). At the same time the increase in human population in the region has resulted in the expansion of urban land into once forested and other areas. Although loss of agricultural land has continued to allow some forest recovery, urbanization and other land uses (e.g., mining) are changing this

trend such that forested areas are decreasing and may eventually show a loss (Drummond and Loveland 2010). This pattern is not yet reflected in our species data. The trend of increasing forested and urban land has continued over the past five decades, though at a decreasing rate. During this time, nonurban open lands, such as fields, grassland, and farmland, have decreased (Fig. 2).

Changes to the climate and wildlife populations (e.g., increase in populations of white-tailed deer [*Odocoileus virginianus*]), and the introduction of nonnative species, have also substantially altered the composition of the woody plant communities in the area. Many nonnative species that were rarely or never reported from the area are now widespread. Some of these can dominate habitats and are regarded as invasive. Conversely, many native species have declined considerably. Whether this decline is a direct or indirect result of nonnative species invasions depends on the species in question and the history of the invaded sites. Nonetheless, there is a correlation between increases in invasive plants in the New York Metropolitan Region and decreases in some native species; examples are *Celastrus orbiculatus* (nonnative) and *Celastrus scandens* (native), *Euonymus alatus* (nonnative) and *Euonymus americana* (native), *Lonicera japonica* (nonnative) and *Lonicera dioica* (native), and *Rosa multiflora* (nonnative) and *Rosa virginiana* (native). Another clear pattern is that boreal species (species that reach the southern limit of their range in the New York Metropolitan Region) have chiefly decreased (Fig. 3). Other less obvious patterns include an increase in some austral species (species reaching the northern limit of their range in the region), a decline in species (often fire adapted) that are adapted to open areas, a general increase in forest species, and a decrease in species exceptionally palatable to deer (most likely in response to increasing deer populations). In order to assess these changes, each species with 10 or more occurrences was assigned to 1 of 7 "change" categories (Table 2).

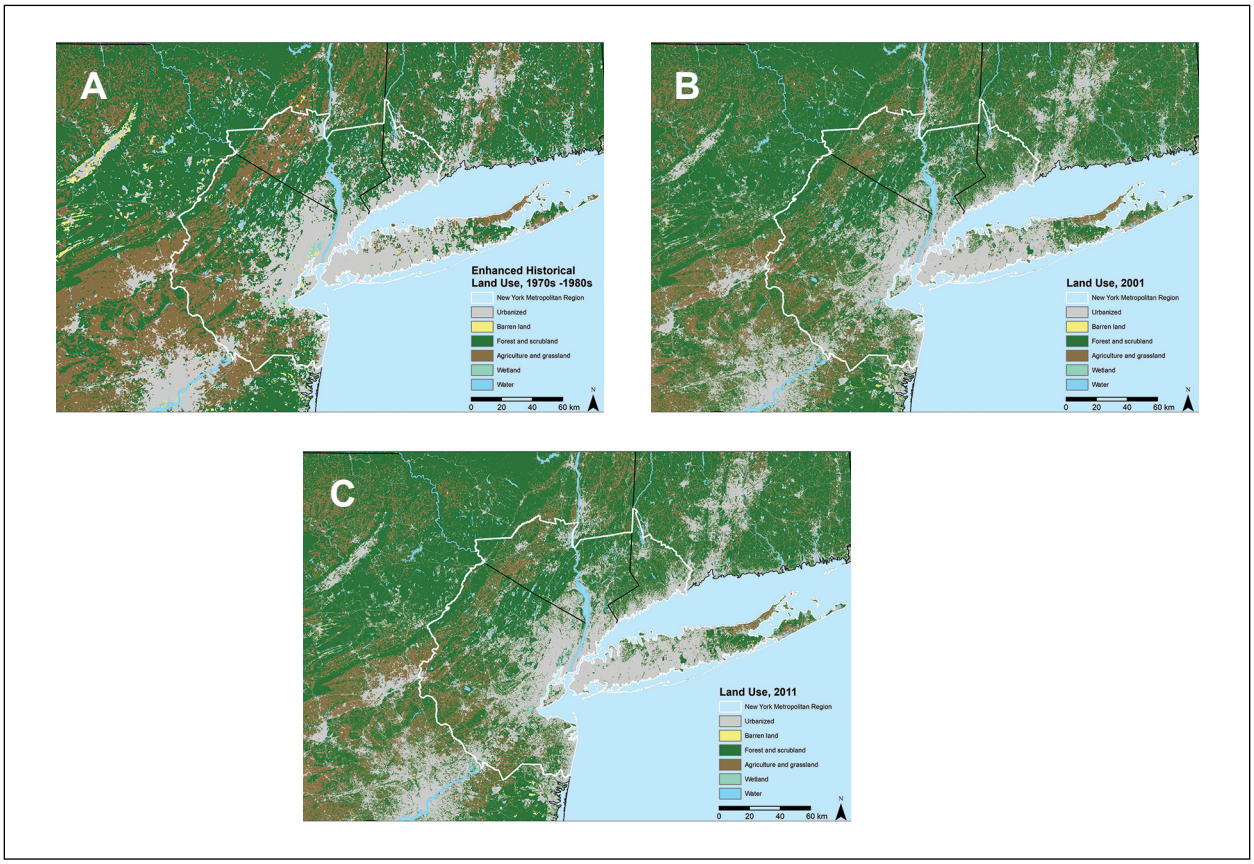

Figure 2.—Land use in the New York Metropolitan Region and environs for three time periods: A) 1970s through 1980s (Price et al. 2007), B) 2001 (Homer et al. 2007), and C) 2011 (Jin et al. 2013). Urbanized areas are defined here as those containing 50,000 or more people (U.S. Census Bureau 2012, n.d.). Note the increase through time of both forested and urban land.

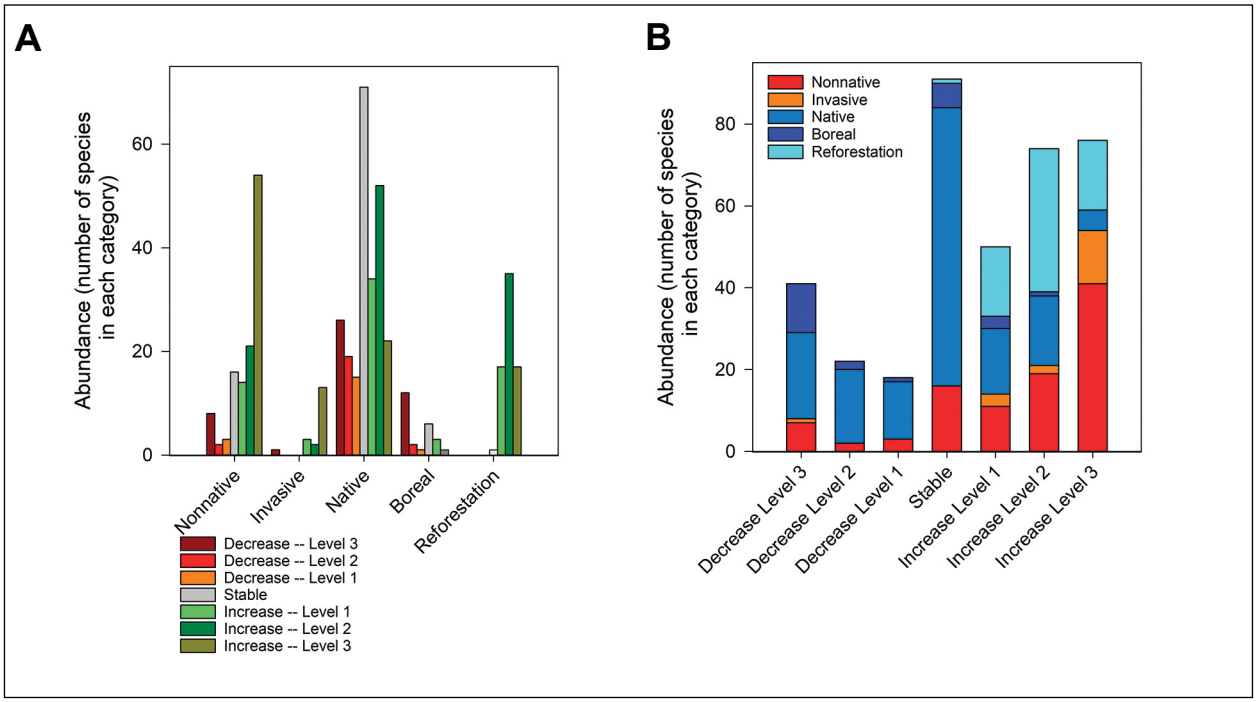

Figure 3.—Abundance of woody plant species in the New York Metropolitan Region by nativity type and change category between pre-1990 occurrences and 2013. See Table 2 for description of the seven change categories. A) Abundance patterns arranged by the five types. "Nonnative" includes the invasive species; "native" includes boreal and reforestation species. Invasive species are labeled as such because they have been included on an invasive species list for at least one of the states in the region. Boreal species are defined as species at the southernmost extent of their range in the region. Reforestation species are those species that appear to be increasing in response to the conversion of agricultural land to forested land. B) The five species types stacked within the two main categories: nonnative or native. Invasive species have been subtracted from the nonnative species total, and boreal and reforestation species have been subtracted from the native species total, to reflect the true total number of species present in each change category. The only invasive nonnative species that showed a decrease is *Lonicera tatarica*, which hybridizes with *L. morrowii* to form *L.* ×*bella*. This hybridization and the possibility that it is at the southernmost limit of its range in the eastern states may explain the decrease.

Table 2.—Categories of change in abundance of woody plant species in the New York Metropolitan Region for species with 10 or more records before 1990, and two special designations

Direction	Level	Definition	Symbol
Decrease	3	>80% of occurrences before 1990	↓↓↓
Decrease	2	70–79% of occurrences before 1990	↓↓
Decrease	1	60–69% of occurrences before 1990	↓
Stable	-	41–59% of occurrences in each of two time periods: before 1990 and from 1990 through 2013	↔
Increase	1	60–69% of occurrences from 1990 through 2013	↑
Increase	2	70–79% of occurrences from 1990 through 2013	↑↑
Increase	3	>80% of occurrences from 1990 through 2013	↑↑↑
Additional designations			
Rare	-	Fewer than 10 occurrences	Ø
Rare and of special interest	-	Fewer than 10 occurrences but of particular interest due to one or more of the following: unique taxonomy, ecology, distribution pattern	Ø♥

Genus Key (based on Clemants et al. 1999; note that a few genera added later were more easily included in this key by using sub-couplets)

1. Leaves linear (with parallel margins), needle-like, or scale-like; usually less than 0.5 cm wide 2
1. Leaves broad (with an expanded portion); usually 0.5 cm wide or more 3
2(1). Leaves linear 4
2. Leaves needle-like or scale-like. 5
3(1). Leaves whorled or opposite. 6
3. Leaves alternate 7
4(2). Trees 8
4. Shrubs 9
5(2). Leaves needle-like. 10
5. Leaves scale-like 11
6(3). Leaves whorled 12
6. Leaves opposite 13
7(3). Leaves compound 14
7. Leaves simple. 15
8(4). Branches roughened by the persistent leaf bases; bracts of cone exserted . . . . . ***Pseudotsuga***
8. Branches not roughened by the leaf bases; bracts of cone not exserted . . . . . ***Tsuga***
9(4). Leaves inrolled at margin . . . . . ***Andromeda***
9. Leaves not inrolled at margin. 16
10(5). Leaves in clusters of 2 or more 17
10. Leaves solitary 18
11(5). Shrubs 19
11. Trees. 20
12(6). Leaves rather thick, leathery (most likely evergreen) . . . . . ***Chimaphila***
12. Leaves thin, not leathery (most likely deciduous) 21
13(6). Leaves compound 22
13. Leaves simple. 23
14(7). Vines 24
14. Trees or shrubs 25
15(7). Vines 26
15. Trees or shrubs 27
16(9). Leaves with 2 yellowish or greenish bands on the lower surface; seeds visible in a fleshy cup (aril). . . . . ***Taxus***
16. Leaves without bands; seeds enclosed in fruits 28
17(10). Leaves in clusters of more than 5 . . . . . ***Larix***
17. Leaves in clusters of 2–5 . . . . . ***Pinus***
18(10). Leaves 2-sided or somewhat round. . . . . ***Abies/Juniperus/Metasequoia/Taxodium***
a. Seed cones cylindric, erect, with distinct bracts . . . . . ***Abies***
a. Seed cones globose without distinct bracts. . . . . b
b. Seed cones less than 15 mm diameter . . . . . ***Juniperus***
b. Seeds cones greater than 15 mm diameter c
c. Leaves opposite; seed cone scales persistent . . . . . ***Metasequoia***
c. Leaves alternate; seed cone scales deciduous. . . . . ***Taxodium***
18. Leaves 4-sided . . . . . ***Picea***
19(11). Parasitic on the branches of conifers. . . . . ***Arceuthobium***
19. Not parasitic. 29

20(11). Frequently with both needle-like and scalelike leaves;
female (seed-producing) cones berry-like . . . . . ***Juniperus***
20. Only scale-like leaves; female (seed-producing) cones not berry-like 30
21(12). Trees up to 30 m tall; leaves cordate . . . . . ***Catalpa***
21. Shrubs or small trees up to 3 m tall; leaves ovate or lanceolate 31
22(13). Vines 32
22. Shrubs or trees 33
23(13). Vines . . . . . ***Lonicera***
23. Shrubs or trees 34
24(14). Leaves palmately compound 35
24. Leaves pinnately compound 36
25(14). Trees 37
25. Shrubs 38
26(15). Tendrils present 39
26. Tendrils absent 40
27(15). Trees 41
27. Shrubs 42
28(16). Flowers in terminal heads . . . . . ***Corema***
28. Flowers in leaf axils . . . . . ***Empetrum***
29(19). Flowers not produced (gymnosperm) . . . . . ***Juniperus***
29. Flowers produced (angiosperm) 43
30(20). Terminal twigs somewhat round . . . . . ***Chamaecyparis***
30. Terminal twigs flattened . . . . . ***Thuja***
31(21). Leaves 3 cm wide or less 44
31. Leaves wider than 3 cm 45
32(22). Fruit capsules; flowers with both petals and sepals . . . . . ***Campsis***
32. Fruit long-tailed, plumose achenes; flowers without petals (sepals petaloid) . . . . . ***Clematis***
33(22). Shrubs 46
33. Trees 47
34(23). Trees 48
34. Shrubs 49
35(24). Fruit fleshy pods; flowers unisexual . . . . . ***Akebia***
35. Fruit berries; flowers bisexual . . . . . ***Parthenocissus***
36(24). Fruit legumes 50
36. Fruit aggregates of drupelets, achenes enclosed in hips, or drupes 51
37(25). Leaves twice- or thrice-compound 52
37. Leaves once-compound 53
38(25). Leaves twice- or thrice-compound . . . . . ***Aralia/Xanthorhiza***
38. Leaves once-compound 54
a. Leaflets serrate; flowers white in panicle of umbels;
fruit berry-like purplish-black multi-stoned drupe . . . . . ***Aralia***
a. Leaflets incisely toothed; flowers brownish-purple in panicle of racemes;
fruit 1-seeded follicle . . . . . ***Xanthorhiza***
39(26). Leaf venation parallel (at least main veins); inflorescences umbels . . . . . ***Smilax***
39. Leaf venation reticulate; inflorescences cymes or panicles 55
40(26). Climbing stems with aerial rootlets; inflorescences umbels . . . . . ***Hedera***
40. Climbing stems without aerial rootlets;
inflorescences panicles, racemes, cymes, or flowers 1 or 2 and axillary 56

41(27). Leaves entire or undulate 57
41. Leaves toothed or lobed, or both 58
42(27). Leaves strictly basal . . . . . ***Yucca***
42. Leaves not only basal. 59
43(29). Leaves opposite. . . . . ***Calluna***
43. Leaves alternate 60
44(31). Flowers campanulate. . . . . ***Decodon***
44. Flowers rotate; the anthers sunken in pouches in the corolla . . . . . ***Kalmia***
45(31). Leaves 4–6 per whorl; 10–20 cm tall . . . . . ***Cornus***
45. Leaves 3 per whorl; more than 1 m tall . . . . . ***Cephalanthus***
46(33). Leaves palmately compound. . . . . ***Aesculus***
46. Leaves pinnately compound 61
47(33). Leaves palmately compound. . . . . ***Aesculus***
47. Leaves pinnately compound 62
48(34). Fruit fleshy when mature. 63
48. Fruit dry when mature 64
49(34). Parasitic on the branches of trees 65
49. Not parasitic. 66
50(36). Leaflets 3 . . . . . ***Pueraria***
50. Leaflets 7 or more . . . . . ***Wisteria***
51(36). Fruit achenes enclosed in hips. . . . . ***Rosa***
51. Fruit clusters of drupelets or drupes. 67
52(37). Inflorescences umbels . . . . . ***Aralia***
52. Inflorescences panicles, racemes, or heads 68
53(37). Fruit pomes . . . . . ***Sorbus***
53. Fruit drupes, legumes, capsules, samaras, or follicles 69
54(38). Plants armed 70
54. Plants unarmed. 71
55(39). Bark with lenticels; pith white; inflorescences cymes . . . . . ***Ampelopsis***
55. Bark without lenticels; pith brown; inflorescences panicles . . . . . ***Vitis***
56(40). Fruit capsules. 72
56. Fruit drupes or berries 73
57(41). Leaves or twigs, or both, with a distinctive odor when crushed 74
57. Leaves and twigs not noticeably odoriferous when crushed 75
58(41). Leaves both toothed and lobed 76
58. Leaves only lobed or toothed, not both 77
59(42). Leaves linear, needle-like, or scale-like 78
59. Leaves broad 79
60(43). Fruit legumes. . . . . ***Cytisus***
60. Fruit 3-valved capsules . . . . . ***Hudsonia***
61(46). Leaflets 5 or more; fruit berries. . . . . ***Sambucus***
61. Leaflets 3; fruit winged capsules . . . . . ***Staphylea***
62(47). Fruit not winged 80
62. Fruit winged. 81
63(48). Branches (usually at least some) terminating in short thorns . . . . . ***Rhamnus***
63. Branches not terminating in short thorns. 82
64(48). Leaves lobed . . . . . ***Acer***
64. Leaves unlobed 83

65(49). Leaves scale-like . . . . . ***Arceuthobium***
65. Leaves flat . . . . . ***Phoradendron***
66(49). Upper leaves alternate . . . . . ***Iva***
66. Upper leaves opposite 84
67(51). Fruit clusters of drupelets; stems usually with prickles . . . . . ***Rubus***
67. Fruit drupes formed in raceme-like inflorescences; stems unarmed . . . . . ***Toxicodendron***
68(52). Inflorescences thin-peduncled heads; stamens numerous, far exceeding the corolla . . . . . ***Albizia***
68. Inflorescences panicles or racemes; stamens 6–10, shorter than the corolla 85
69(53). Plants armed 86
69. Plants unarmed. 87
70(54). Plants appearing armed, but actually densely hispid. . . . . ***Robinia***
70. Plants prickly or spiny . . . . . ***Zanthoxylum***
71(54). Leaflets 3 88
71. Leaflets more than 3. 89
72(56). Perianths U-shaped; flowers 1 or 2, axillary . . . . . ***Aristolochia***
72. Perianths not U-shaped; flowers in panicles or cymes, more than 2 per inflorescence . . . . . ***Celastrus***
73(56). Plants trailing or scrambling . . . . . ***Ribes***
73. Plants twining. 90
74(57). Twigs with slightly raised, circular stipule scars. . . . . ***Magnolia***
74. Twigs without circular stipule scars. 91
75(57). Twigs with slightly raised, circular stipule scars. . . . . ***Magnolia***
75. Twigs without circular stipule scars. 92
76(58). Leaves with lobing only at apex, obtriangular; venation dichotomous. . . . . ***Ginkgo***
76. Leaves with lobing not at apex, or only at apex, variously shaped; venation reticulate 93
77(58). Leaves lobed 94
77. Leaves toothed 95
78(59). Leaves linear 96
78. Leaves needle-like or scale-like. 97
79(59). Leaves rather thick, leathery (most likely evergreen) 98
79. Leaves thin, not leathery (most likely deciduous) 99
80(62). Leaves dotted with pellucid dots, densely long-hairy beneath; fruit drupes. . . . . ***Phellodendron***
80. Leaves not dotted, with short, appressed hairs on the abaxial side; fruit legumes . . . . . ***Styphnolobium***
81(62). Leaflets 3–5 (rarely 7, 9); fruit 2 joined samaras . . . . . ***Acer***
81. Leaflets 5 or more; fruit single samara . . . . . ***Fraxinus***
82(63). Leaf margins toothed (minutely in some species). . . . . ***Viburnum***
82. Leaf margins entire 100
83(64). Fruit nutlets . . . . . ***Cephalanthus***
83. Fruit capsules 101
84(66). Leaves lobed 102
84. Leaves unlobed 103
85(68). Leaflets crenulate; inflorescences racemes . . . . . ***Gleditsia***
85. Leaflets entire; inflorescences panicles . . . . . ***Gymnocladus***
86(69). Leaflets entire . . . . . ***Robinia***
86. Leaflets crenulate 104
87(69). Fruit winged 105
87. Fruit not winged. 106
88(71). Fruit winged . . . . . ***Ptelea***
88. Fruit not winged. 107

89(71). Fruit pomes . . . . . ***Sorbus***
89. Fruit legumes or follicles 108
90(73). Leaves peltate (at least partially); flowers unisexual . . . . . ***Menispermum***
90. Leaves not peltate; flowers bisexual . . . . . ***Actinidia/Solanum***
a. Leaves serrate; flowers unisexual (plants dioecious), petals white, separate, stamens many (20 or more); fruit green, 2–3 cm long . . . . . ***Actinidia***
a. Leaves entire; flowers bisexual, petals violet (rarely white), fused towards base, stamens 5; fruit scarlet, up to 1 cm long . . . . . ***Solanum***
91(74). Leaves with an unpleasant odor; widest above middle . . . . . ***Asimina***
91. Leaves with a pleasant, spicy odor; widest near middle . . . . . ***Sassafras***
92(75). Leaves cordate . . . . . ***Cercis***
92. Leaves variously shaped, but not cordate 109
93(76). Leaves star-shaped 110
93. Leaves not star-shaped 111
94(77). Leaves with a pleasant, spicy odor . . . . . ***Sassafras***
94. Leaves without odor 112
95(77). Leaves obtriangular, venation dichotomous . . . . . ***Ginkgo***
95. Leaves variously shaped, not obtriangular, venation reticulate 113
96(78). Leaves inrolled at margin . . . . . ***Andromeda***
96. Leaves not inrolled at margin 114
97(78). Leaves needle-like . . . . . ***Cytisus***
97. Leaves scale-like 115
98(79). Fruit berries, pomes, or berry-like drupes 116
98. Fruit capsules 117
99(79). Leaves entire or undulate 118
99. Leaves toothed or lobed, or both 119
100(82). Leaves (at least some) 15 cm or longer; leaf scars U-shaped; stamens 2 . . . . . ***Chionanthus***
100. Leaves less than 15 cm long; leaf scars narrowly crescent-shaped; stamens 4 . . . . . ***Cornus***
101(83). Leaves rather thick, leathery (most likely evergreen) . . . . . ***Kalmia***
101. Leaves thin, not leathery (most likely deciduous) 120
102(84). Fruit winged . . . . . ***Acer***
102. Fruit not winged . . . . . ***Viburnum***
103(84). Leaf margins toothed 121
103. Leaf margins entire or undulate 122
104(86). Leaves not strongly aromatic; fruit legumes . . . . . ***Gleditsia***
104. Leaves strongly aromatic; fruit follicles . . . . . ***Zanthoxylum***
105(87). Leaflets 11 or more . . . . . ***Ailanthus***
105. Leaflets 3 . . . . . ***Ptelea***
106(87). Inflorescences panicles or racemes; fruit drupes, legumes, or capsules 123
106. Inflorescences catkins; fruit nut-like drupes 124
107(88). Fruit drupes 125
107. Fruit legumes 126
108(89). Fruit drupes 127
108. Fruit legumes or follicles 128
109(92). Leaves spine-tipped (rarely nearly entire) . . . . . ***Ilex***
109. Leaves not spine-tipped 129
110(93). Leaves regularly serrate; bark not exfoliating . . . . . ***Liquidambar***
110. Leaves irregularly dentate; bark exfoliating . . . . . ***Platanus***

111(93). Fruit pomes . . . . . ***Crataegus***
111. Fruit capsules or fleshy syncarp 130
112(94). Bark not exfoliating; stipules not foliaceous; flowers with showy petals . . . . . ***Liriodendron***
112. Bark exfoliating; stipules foliaceous; flowers minute . . . . . ***Platanus***
113(95). Inflorescences various, not catkins 131
113. Inflorescences catkins 132
114(96). Flowers in terminal heads . . . . . ***Corema***
114. Flowers in leaf axils . . . . . ***Empetrum***
115(97). Parasitic on the branches of trees . . . . . ***Arceuthobium***
115. Not parasitic 133
116(98). Ovaries inferior . . . . . ***Vaccinium***
116. Ovaries superior 134
117(98). Leaves inrolled at margin . . . . . ***Andromeda***
117. Leaves not inrolled at margin. 135
118(99). Leaves or twigs, or both, with a distinctive odor when crushed 136
118. Leaves and twigs not noticeably odoriferous when crushed 137
119(99). Leaves lobed 138
119. Leaves not lobed or only shallowly lobed 139
120(101). Fruit 20 cm or longer. . . . . ***Catalpa***
120. Fruit less than 4 cm long . . . . . ***Paulownia***
121(103). Fruit fleshy. 140
121. Fruit dry 141
122(103). Fruit black . . . . . ***Rhodotypos***
122. Fruit not black 142
123(106). Leaflets entire . . . . . ***Robinia***
123. Leaflets toothed 143
124(106). Terminal twigs with continuous pith. . . . . ***Carya***
124. Terminal twigs with chambered pith . . . . . ***Juglans***
125(107). Inflorescences terminal; fruit red. . . . . ***Rhus***
125. Inflorescences axillary; fruit white or yellow . . . . . ***Toxicodendron***
126(107). Anthers polymorphic; filaments monadelphous . . . . . ***Cytisus***
126. Anthers monomorphic; filaments diadelphous. 144
127(108). Inflorescences terminal; fruit red. . . . . ***Rhus***
127. Inflorescences axillary; fruit white or yellow . . . . . ***Toxicodendron***
128(108). Fruit legumes. . . . . ***Amorpha***
128. Fruit follicles . . . . . ***Dasiphora/Sorbaria/Xanthorhiza***
a. Leaflets more than 5, usually 11–21, serrate; flowers white;
fruit follicle 4- to 8-seeded . . . . . ***Sorbaria***
a. Leaflets 5 (rarely 3 or 7), incisely toothed or margins entire and revolute;
flowers brownish-purple in panicle of racemes or yellow and solitary
or in few-flowered cymes; fruit 1-seeded follicle or achene . . . . . b
b. Leaflet margins entire and revolute; flowers yellow and solitary
or in few-flowered cymes; achene . . . . . ***Dasiphora***
b. Leaflet margins incisely toothed; flowers brownish-purple in panicle of racemes;
fruit 1-seeded follicle. . . . . ***Xanthorhiza***
129(109). Fruit acorns . . . . . ***Quercus***
129. Fruit berries, drupes, capsules, or syncarpous achenes 145

130(111). Leaf-lobing pattern somewhat symmetric; seeds covered with long hairs . . . . . ***Populus***
130. Leaf-lobing pattern asymmetric; seeds not covered with long hairs 146
131(113). Inflorescence subtended by a leaf-like bract . . . . . ***Tilia***
131. Inflorescence not subtended by a leaf-like bract 147
132(113). Fruit winged 148
132. Fruit not winged. 149
133(115). Producing flowers (angiosperm) . . . . . ***Hudsonia***
133. Not producing flowers (gymnosperm). . . . . ***Juniperus***
134(116). Fruit black . . . . . ***Ilex***
134. Fruit red, white, blue, or orange. 150
135(117). Leaves whorled or nearly so 151
135. Leaves not appearing whorled 152
136(118). Twigs without circular stipule scars . . . . . ***Lindera***
136. Twigs with slightly raised, circular stipule scars . . . . . ***Magnolia***
137(118). Fruit acorns . . . . . ***Quercus***
137. Fruit achenes, berries, drupes, capsules, or legumes 153
138(119). Leaves pinnatifid, fragrant. . . . . ***Comptonia***
138. Leaves various, not pinnatifid, not fragrant 154
139(119). Fruit follicles . . . . . ***Spiraea***
139. Fruit various, not follicles 155
140(121). Petals separate . . . . . ***Rhamnus***
140. Petals united towards base . . . . . ***Viburnum***
141(121). Leaves punctate, with translucent glands . . . . . ***Hypericum***
141. Leaves not punctate, without translucent glands 156
142(122). Stem internodes hollow. . . . . ***Deutzia***
142. Stem internodes solid. 157
143(123). Leaflets deeply lobed, some lobes almost reaching the midvein;
fruit large, bladder-like capsules. . . . . ***Koelreuteria***
143. Leaflets not lobed; fruit red drupes . . . . . ***Rhus***
144(126). Fruit 1-seeded . . . . . ***Lespedeza***
144. Fruit several-seeded . . . . . ***Pueraria***
145(129). Inflorescences catkins or catkin-like 158
145. Inflorescences various, not catkins 159
146(130). Flowers in hollow receptacles. . . . . ***Ficus***
146. Flowers in catkins 160
147(131). Flowers borne in hollow receptacles. . . . . ***Ficus***
147. Flowers not borne in hollow receptacles 161
148(132). Leaf bases oblique. . . . . ***Ulmus***
148. Leaf bases not oblique 162
149(132). Sap milky. 163
149. Sap not milky 164
150(134). Stems with thorns . . . . . ***Pyracantha***
150. Stems without thorns 165
151(135). Leaves sharply toothed, at least distally;
anthers not nestled in pockets in the corolla. . . . . ***Chimaphila***
151. Leaves revolute or entire; anthers nestled in pockets in the corolla . . . . . ***Kalmia***
152(135). Plants trailing. . . . . ***Epigaea***
152. Plants upright 166

153(137). Fruit achenes . . . . . ***Baccharis***
153. Fruit berries, drupes, capsules, or legumes 167
154(138). Leaves distinctly 3-nerved at base; fruit capsules . . . . . ***Hibiscus***
154. Leaves not distinctly 3-nerved at base; fruit drupelets, follicles, or berries 168
155(139). Fruit achenes . . . . . ***Baccharis***
155. Fruit various, not achenes 169
156(141). Anthers nestled in pockets in the corolla. . . . . ***Kalmia***
156. Anthers not nestled in corolla pockets 170
157(142). Seeds enclosed in arils (usually orange or red) . . . . . ***Euonymus***
157. Seeds not enclosed in arils 171
158(145). Leaves covered with scales (at least when young); seeds without long hairs. . . . . ***Elaeagnus***
158. Leaves without scales; seeds covered with long hairs . . . . . ***Salix***
159(145). Stems usually thorny;
fruit syncarp of achenes (forming a 6- to 12-cm-wide, fissured "ball"). . . . . ***Maclura***
159. Stems without thorns; fruit capsules, berries, or drupes 172
160(146). Pistillate catkins and fruit globose . . . . . ***Broussonetia***
160. Pistillate catkins and fruit cylindric . . . . . ***Morus***
161(147). Fruit capsules. 173
161. Fruit drupes or pomes 174
162(148). Petioles 2–4 mm long . . . . . ***Ulmus***
162. Petioles 10 mm or longer 175
163(149). Pith at nodes with thin plates. . . . . ***Broussonetia***
163. Pith at nodes without thin plates . . . . . ***Morus***
164(149). Fruit drupes 176
164. Fruit capsules, nuts, or nutlets 177
165(150). Stems more than 1 m tall. . . . . ***Symplocos***
165. Stems less than 20 cm tall 178
166(152). Corollas of distinct petals 179
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167(153). Inflorescences catkins or catkin-like 181
167. Inflorescences various, not catkins 182
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169(155). Inflorescences various, not catkins 184
169. Inflorescences catkins 185
170(156). Leaves less than 3 cm long 186
170. Leaves 3 cm or longer 187
171(157). Leaves 4 cm wide or less; purple petals . . . . . ***Decodon***
171. Leaves 2 cm wide or more; purple, greenish, bluish, white or yellow to reddish petals. 188
172(159). Fruit capsules. 189
172. Fruit berries or drupes 190
173(161). Leaves serrulate; corollas 6–7 mm long; capsules loculicidal . . . . . ***Oxydendrum***
173. Leaves entire; corollas much longer; capsules septicidal . . . . . ***Rhododendron***
174(161). Fruit drupes 191
174. Fruit pomes 192
175(162). Scales of fruiting catkins 5-lobed, persistent; stamens 4 . . . . . ***Alnus***
175. Scales of fruiting catkins 3-lobed, deciduous; stamens 2 . . . . . ***Betula***

176(164). Leaf blades with 3 distinct veins at base . . . . . ***Celtis***
176. Leaf blades only with a distinct midrib 193
177(164). Fruit capsules. 194
177. Fruit nuts or nutlets 195
178(165). Flowers 5-merous; pedicels without bracteoles . . . . . ***Arctostaphylos***
178. Flowers 4-merous; pedicels with 2 bracteoles . . . . . ***Gaultheria***
179(166). Leaves 0.6–1.2 cm, glabrous . . . . . ***Leiophyllum***
179. Leaves 2–5 cm, hairy beneath . . . . . ***Rhododendron***
180(166). Capsules septicidal 196
180. Capsules loculicidal 197
181(167). Leaves covered with scales (at least when young); seeds without long hairs . . . . . ***Elaeagnus***
181. Leaves without scales; seeds covered with long hairs . . . . . ***Salix***
182(167). Plants spiny . . . . . ***Berberis***
182. Plants not spiny 198
183(168). Fruit follicles . . . . . ***Physocarpus***
183. Fruit berries . . . . . ***Ribes***
184(169). Fruit capsules. 199
184. Fruit berries, drupes, or pomes 200
185(169). Fruit winged 201
185. Fruit not winged. 202
186(170). Leaves scale-like . . . . . ***Calluna***
186. Leaves not scale-like 203
187(170). Stamens 2 204
187. Stamens 4, 5, or more 205
188(171). Leaves entire . . . . . ***Chionanthus***
188. Leaves toothed 206
189(172). Corollas rotate (frequently broadly so); anthers nestled in pockets in the corolla . . . . . ***Kalmia***
189. Corollas campanulate to funnel-shaped; anthers not nestled in corolla pockets . . . . . ***Rhododendron***
190(172). Fruit berries, 2–4 cm wide. . . . . ***Diospyros***
190. Fruit drupes, 0.6–1.2 cm wide 207
191(174). Drupes winged. . . . . ***Halesia***
191. Drupes not winged 208
192(174). Carpels hard, bony at maturity . . . . . ***Crataegus***
192. Carpels papery or leathery at maturity. 209
193(176). Pistillate bracts 4–6, not enlarging or adnate to fruit;
fruit drupe-like, a globose nutlet coated with a grayish to whitish wax . . . . . ***Morella***
193. Pistillate bracts 2, persistent, enlarging, adnate to fruit;
fruit nutlet dotted with shining, resinous dots . . . . . ***Myrica***
194(177). Seeds not covered with long hairs. . . . . ***Hamamelis***
194. Seeds covered with long hairs 210
195(177). Flowers without calyx 211
195. Flowers of at least one sex with calyx 212
196(180). Skip to 213 213
196. Skip to 213 213
197(180). Pedicels with 2 bracteoles at base . . . . . ***Leucothoe***
197. Pedicels with 2 bracteoles near apex 214
198(182). Leaf apices mucronate. . . . . ***Nemopanthus***
198. Leaf apices various, not mucronate 215

199(184). Leaves distinctly 3-nerved at base . . . . . ***Ceanothus***
199. Leaves not distinctly 3-nerved at base 216
200(184). Fruit berries 217
200. Fruit drupes or pomes 218
201(185). Scales of fruiting catkins 5-lobed, persistent; stamens 4 . . . . . ***Alnus***
201. Scales of fruiting catkins 3-lobed, deciduous; stamens 2 . . . . . ***Betula***
202(185). Fruit drupes 219
202. Fruit capsules, nuts, or nutlets 220
203(186). Stamens 2 221
203. Stamens 4, 5, or 10. 222
204(187). Fruit berry-like drupes. . . . . ***Ligustrum***
204. Fruit capsules . . . . . ***Syringa***
205(187). Stamens numerous. . . . . ***Philadelphus***
205. Stamens 4 or 5 223
206(188). Leaves finely toothed, teeth about 0.5 mm long; flowers yellow . . . . . ***Diervilla***
206. Leaves coarsely toothed, teeth about 2 mm long; flowers white to purplish. . . . . ***Hydrangea***
207(190). Inflorescences terminal . . . . . ***Cornus***
207. Inflorescences axillary 224
208(191). Young trunks and branches with elongated, horizontal lenticels . . . . . ***Prunus***
208. Young trunks and branches variable, but without elongated, horizontal lenticels. 225
209(192). Inflorescences corymbs . . . . . ***Photinia***
209. Inflorescences racemes. 226
210(194). Bud scales more than 1; scales of catkins laciniate (rarely entire) . . . . . ***Populus***
210. Bud scale 1; scales of catkins entire . . . . . ***Salix***
211(195). Involucre not sac-like and not enclosing the nutlet. . . . . ***Carpinus***
211. Involucre sac-like and enclosing the nutlet . . . . . ***Ostrya***
212(195). Winter buds 2–2.5 cm long; staminate flowers in long-peduncled heads . . . . . ***Fagus***
212. Winter buds to 0.8 cm long; staminate flowers in catkins 227
213(196). Corollas broadly rotate; anthers nestled in pockets in the corolla. . . . . ***Kalmia***
213. Corollas campanulate; anthers not nestled in corolla pockets . . . . . ***Rhododendron***
214(197). Flowers solitary . . . . . ***Chamaedaphne***
214. Flowers in racemes . . . . . ***Eubotrys***
215(198). Fruit legumes or capsules 228
215. Fruit berries or drupes 229
216(199). Capsules 3-locular; inflorescences dense, elongated racemes . . . . . ***Clethra***
216. Capsules 5-locular; inflorescences umbels or loose racemes 230
217(200). Plants spiny . . . . . ***Berberis***
217. Plants without spines . . . . . ***Vaccinium***
a. Climbing, twining; petals separate, berry ellipsoid, green 2–3 cm. . . . . ***Actinidia***
a. Erect or trailing, petals fused; berry globose red, blue, or bluish-black (rarely green) up to 2 cm . . . . . ***Actinidia/Vaccinium***
218(200). Fruit drupes 231
218. Fruit pomes 232
219(202). Leaf blades with 3 distinct veins at base. . . . . ***Celtis***
219. Leaf blades only with a distinct midrib 233
220(202). Fruit capsules. 234
220. Fruit nuts or nutlets 235
221(203). Flowers yellow; fruit capsules. . . . . ***Forsythia***
221. Flowers white; fruit drupes . . . . . ***Ligustrum***

222(203). Stamens 10 . . . . . ***Leiophyllum***
222. Stamens 4 or 5 236
223(205). Flowers in panicles; leaves blue-green, and white and tomentose beneath . . . . . ***Buddleja***
223. Flowers otherwise; leaves green, glabrous 237
224(207). Flowers mostly unisexual . . . . . ***Nyssa***
224. Flowers bisexual . . . . . ***Frangula***
225(208). Pith of second-year branches with diaphragms;
branches at mid-trunk diverging at a 90-degree angle . . . . . ***Nyssa***
225. Pith of second-year branches without diaphragms;
branches at mid-trunk diverging at various angles (not strictly 90 degrees) 238
226(209). Ovaries and fruit partly 6- to 10-celled . . . . . ***Amelanchier***
226. Ovaries and fruit 2- to 5-celled 239
227(212). Mature involucre spiny; staminate catkins upright . . . . . ***Castanea***
227. Mature involucre scaly; staminate catkins pendulous . . . . . ***Quercus***
228(215). Fruit legumes . . . . . ***Genista***
228. Fruit capsules 240
229(215). Ovaries superior; nodes swollen 241
229. Ovaries inferior; nodes not swollen 242
230(216). Buds oblong; anthers spurred . . . . . ***Lyonia***
230. Buds globose or ovoid; anthers without spurs 243
231(218). Drupes winged . . . . . ***Halesia***
231. Drupes not winged 244
232(218). Carpels “bony” at maturity . . . . . ***Crataegus***
232. Carpels papery or leathery at maturity 245
233(219). Leaves pinnatifid, stipulate . . . . . ***Comptonia***
233. Leaves toothed, estipulate 246
234(220). Seeds not covered with long hairs . . . . . ***Hamamelis***
234. Seeds covered with long hairs . . . . . ***Salix***
235(220). Flowers without calyces 247
235. Flowers of at least one sex with calyces 248
236(222). Corollas less than 8 mm long . . . . . ***Symphoricarpos***
236. Corollas 15 mm or longer . . . . . ***Lonicera***
237(223). Flowers in axillary heads; fruit splitting into 2 nutlets . . . . . ***Cephalanthus***
237. Flowers in pairs, axillary clusters, terminal spikes, terminal cymes, or terminal heads;
fruit not splitting into nutlets 249
238(225). Axillary buds more than 1 per node . . . . . ***Ilex***
238. Axillary bud 1 per node . . . . . ***Rhamnus***
239(226). Leaves plicate or revolute in bud; styles basally connate; fruit lacking grit cells . . . . . ***Malus***
239. Leaves involute in bud; styles free; fruit with grit cells . . . . . ***Pyrus***
240(228). Capsules loculicidal . . . . . ***Lyonia***
240. Capsules septicidal . . . . . ***Rhododendron***
241(229). Leaf apices rounded; inflorescences terminal plumose panicles . . . . . ***Cotinus***
241. Leaf apices acute; inflorescences axillary pairs of flowers . . . . . ***Dirca /Frangula***
a. Flowering March–April before leaves appear; stamens 8;
fruit green to reddish, ellipsoid 1-seeded drupe . . . . . ***Dirca***
a. Flowering May–July after leaves appear; stamens 5;
fruit black, globose 1-seeded drupe . . . . . ***Frangula***

242(229). Calyces and corollas indistinct . . . . . ***Pyrularia***
242. Calyces and corollas distinct 250
243(230). Seeds not reticulate . . . . . ***Eubotrys***
243. Seeds reticulate . . . . . ***Leucothoe***
244(231). Leaves with 3 distinct veins from the base . . . . . ***Ceanothus***
244. Leaves not distinctly 3-nerved 251
245(232). Inflorescences corymbs 252
245. Inflorescences racemes. 253
246(233). Pistillate bracts 4–6, not enlarging or adnate to fruit;
fruit drupe-like, a globose nutlet coated with a grayish to whitish wax . . . . . ***Morella***
246. Pistillate bracts 2, persistent, enlarging, adnate to fruit;
fruit nutlet dotted with shining, resinous dots . . . . . ***Myrica***
247(235). Fruit in pendulous spikes; leaves with 9 or more pairs of veins . . . . . ***Carpinus***
247. Fruit in clusters; leaves usually with 5–8 pairs of veins . . . . . ***Corylus***
248(235). Mature involucre spiny; staminate catkins upright . . . . . ***Castanea***
248. Mature involucre scaly; staminate catkins pendulous . . . . . ***Quercus***
249(237). Flowers in terminal cymes or heads; fruit drupes . . . . . ***Cornus***
249. Flowers in pairs, axillary clusters, or terminal spikes 254
250(242). Leaves resinous-dotted beneath . . . . . ***Gaylussacia***
250. Leaves not resinous-dotted beneath 255
251(244). Leaves with glands at the junction of the petiole and the blade . . . . . ***Prunus***
251. Leaves without glands 256
252(245). Pedicels and inflorescences not warty; glands present on upper surfaces of leaves . . . . . ***Aronia***
252. Pedicels and inflorescences warty; glands absent on upper surfaces of leaves . . . . . ***Photinia***
253(245). Ovaries and fruit partly 6- to 10-celled . . . . . ***Amelanchier***
253. Ovaries and fruit 2- to 5-celled . . . . . ***Malus***
254(249). Corollas 15 mm or longer . . . . . ***Lonicera***
254. Corollas less than 8 mm long. . . . . ***Symphoricarpos***
255(250). Fruit drupes . . . . . ***Cornus***
255. Fruit berries 257
256(251). Leaves obovate or obovate to oblong . . . . . ***Symplocos***
256. Leaves elliptic 258
257(255). Stamens inserted on the corolla. . . . . ***Lycium***
257. Stamens not inserted on the corolla . . . . . ***Vaccinium***
258(256). Veins running unbranched to the margin or nearly so. . . . . ***Rhamnus***
258. Veins branching before the margin 259
259(258). Bark stringy; fruit 1.2–1.4 cm diameter . . . . . ***Styrax***
259. Bark not stringy; fruit less than 1 cm diameter 260
260(259). Leaves not mucronate; pedicels of female flowers less than 5 mm long . . . . . ***Ilex***
260. Leaves mucronate; pedicels of female flowers and fruit more than 1 cm long . . . . . ***Nemopanthus***

Species Treatments

In these species treatments, "the region" refers to the New York Metropolitan Region (Figs. 1, 4) and abbreviations are used for some common words or names (see list on p. vi). Taxa that are not native to the region are indicated with an asterisk (*) in the species keys within genera.

Abies Mill. – fir

Pinaceae. Coniferous trees. Species 46 in northern Africa, Asia, Europe, and North America. Genus readily distinguished from other members of the Pinaceae by its erect seed cones, which rarely fall intact, the scales usually falling individually at maturity. Generally grows best in cool humid climates. Some species (including *Abies balsamea*) grown for pulpwood, lumber, and ornament, including Christmas trees (leaves persisting longer than *Picea* but not as long as *Pinus*). Foliage and oils provide the aroma in many "pine scented" products (Hunt 1993). "Abies" is the ancient Latin name for the silver fir (*A. alba* Mill.).

Native Species

1. *Abies balsamea* (L.) Mill. – balsam fir Ø♥

Pinus balsamea L.

Male (pollen-producing) cones maturing late Apr.–early June from previous year's foliage; female (seed-bearing) cones developing late Apr.–early June. Seeds dispersed Aug. onward. Populations restricted to swamps or bogs at elevations over 300 m. Native material from the area referable to *Abies balsamea* (L.) Mill. var. *balsamea*, the



Figure 4—Aerial photograph of a portion of the New York Metropolitan Region showing boundaries of the five New York City boroughs. Sources: Microsoft Bing© and Earthstar Geographics.

awned membranaceous bracts shorter than the cone scales (in the more boreal *A. balsamea* var. *phanerolepis* Fernald, the membranaceous bracts exserted from the cone scales giving a "whitish, misty appearance"; Fernald 1909). Epithet from Latin refers to the aromatic balsam (also in other *Abies* spp.) present in the wood vesicles (Hunt 2003).

Cones produced every 2 years; may mast 2–5 times every 8 years. Fewer cones and fewer mast years occur with fewer growing degree-days (days during the year when the species is able to grow, calculated by summing the number of days when the average minimum and maximum temperatures divided by a baseline temperature that is empirically determined for each species is above zero) and lower maximum temperature of the warmest month prior to cone production. Fewer cones and fewer mast years are also associated with *A. balsamea* found in coniferous forests compared to *A. balsamea* found in mixed conifer and hardwood forests (Messaoud et al. 2007). May produce a transient winter seed bank (Houle 1992). Reported tolerant of salt spray but not pollution (Dirr 1998). Once cultivated in plantations (including in Europe) for wood and other products, but less so today (Chater 1964, Sargent 1922). More often cultivated is *A. balsamea* Hudson Group, a series of cultivars exhibiting a low growing (less than 1 m tall), spreading habit. Used in some cough syrups, Canada balsam (a turpentine used in microscopy), and some oil paints (Mills and White 1977, Royer et al. 2013); the third most popular Christmas tree (Frank 1990). A boreal species reaching southern limit of its range in VA and WV. Native populations listed as endangered (S1) in NJ and CT; currently known only in the area from NJ in Sussex and Warren Counties. Other records from the region most likely represent remnants from cultivation.

Nonnative Species

***Abies grandis* (Douglas ex D.Don) Lindl. – grand fir, giant fir**

Pinus grandis Douglas ex D.Don

Native to the Pacific Northwest and Northern California. Reported from Orange County (NY), but it is not clear whether material is escaped or cultivated remnant.

Acer L. – maple

Aceraceae (Sapindaceae s.l.). Trees, shrubs. Species 110+ in Asia, Europe, and North America. Pollinated by wind and insects. Distinguished by opposite leaves (simple and usually palmately lobed, except *Acer negundo*, which has compound leaves) and double samaras. An ecologically and economically important genus. "Acer" is the Latin word for maple. The word is derived from a proto-Indo-European word and most likely refers to the pointed lobes present in many species.

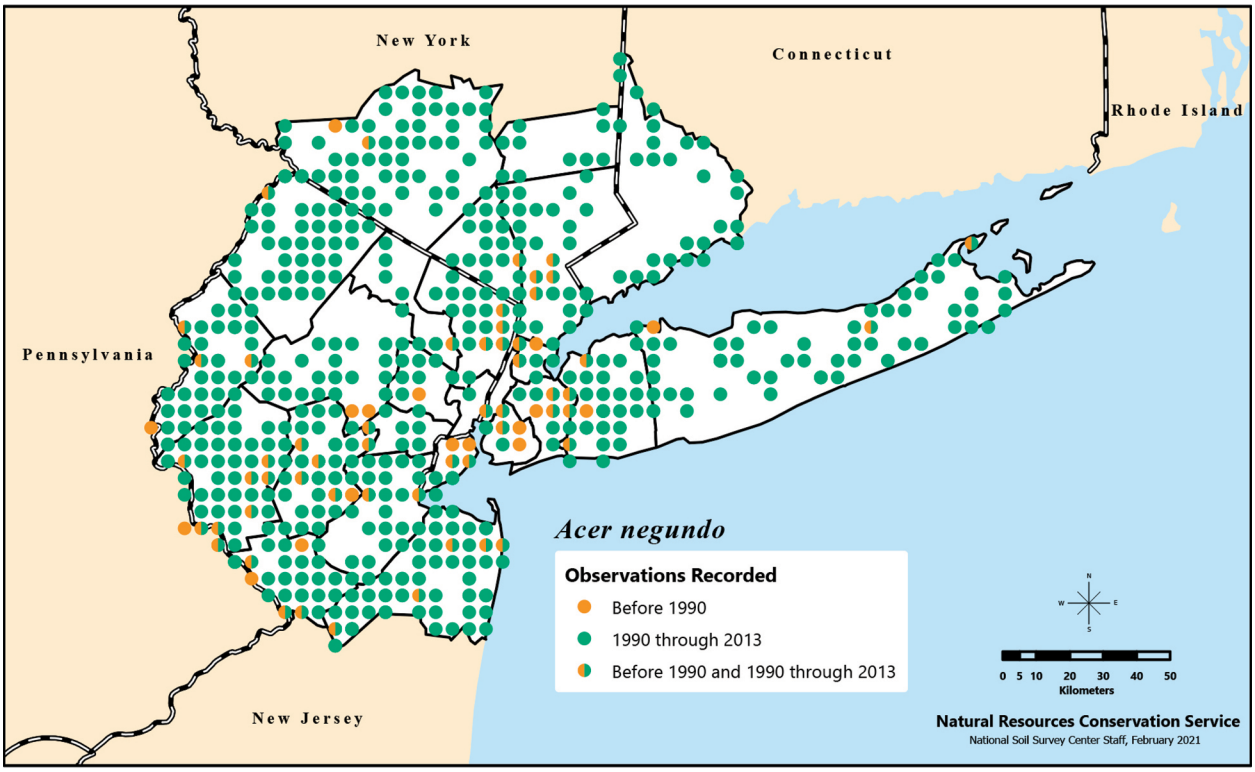
Native Species

1. *Acer negundo* L. – box-elder ↑↑↑

Tree. Flowering early Apr.–May. Typically in floodplains but also in drier areas, often in disturbed areas; common throughout the region. All material examined has glabrous twigs and would be *Acer negundo* L. var. *negundo*. Widely cultivated and naturalized in Asia (Xu et al. 2008) and Europe (Walters 1968). Fernald (1950) stated that the epithet was an aboriginal name. Linnaeus (1753) also described *Vitex negundo* (five-leaved chaste tree) from Africa and Asia. The Sanskrit name for this species is "nirgundī" and perhaps Linnaeus applied the epithet "negundo" to this maple species because of the leaves' superficial similarity to those of *Vitex negundo*.

Height at maturity 23 m (Zasada and Strong 2008). Grows rapidly and can become weedy; its wood breaks easily in wind and ice. Dioecious (Dirr 1998). Female trees have higher growth rates than male trees in response to increased water availability (Ward et al. 2002b), and males appear to withstand water stress better than female trees (Dawson et al. 2004). Males often associated with drier, nonstreamside habitats; females more often found along streams or in wetter habitats (Dawson and Ehleringer 1993). Male trees have higher growth rates and suffer greater herbivory than females, suggesting a possible tradeoff between growth and herbivory (Jing and Coley 1990). Cultivated since 1688, with at least 9 cultivars, of which the variegated forms are popular in Europe (Dirr 1998).

A B



Distribution of *Acer negundo*, or box-elder, recorded in the New York Metropolitan Region during three time categories.

Acer Key

1. Leaves compound . . . . . ***Acer negundo***
1. Leaves simple. 2
2. Leaf lobes rounded; petioles with milky juice. . . . . ***Acer campestre****
2. Leaf lobes acute or acuminate; petioles without milky juice (except *Acer platanoides*) 3
3. Leaves silvery-white beneath. 4
3. Leaves not silvery-white beneath. 5
4. Lobes of leaves crenate to serrate . . . . . ***Acer pseudoplatanus****
4. Lobes of leaves sharply serrate 6
5. Leaves with 5–9 lobes . . . . . ***Acer palmatum****
5. Leaves with 5 (only for *A. platanoides* and *A. spicatum*) or 3 (all others in this line) lobes. 7
6. Buds pointed, not reddish 8
6. Buds blunt, reddish 9
7. Leaves generally with 5 lobes, with entire or coarsely dentate margins; petioles with milky juice. . . . . ***Acer platanoides****
7. Leaves generally with 3 lobes, with serrate margins; petioles without milky juice 10
8. Leaf blades with drooping margins . . . . . ***Acer nigrum***
8. Leaf blades flat. . . . . ***Acer saccharum***
9. Terminal leaf lobe less to slightly more than half the length of the blade. . . . . ***Acer rubrum***
9. Terminal leaf lobe well over half the length of the blade . . . . . ***Acer saccharinum***
10. Buds with several pairs of imbricate scales, sessile. . . . . ***Acer ginnala****
10. Buds with 1 pair of valvate scales visible, stalked. 11
11. Twigs and buds glabrous; bark of older branches white-striped . . . . . ***Acer pensylvanicum***
11. Twigs and buds pubescent; bark not striped . . . . . ***Acer spicatum***

2. *Acer nigrum* Michx. f. – black maple ↔

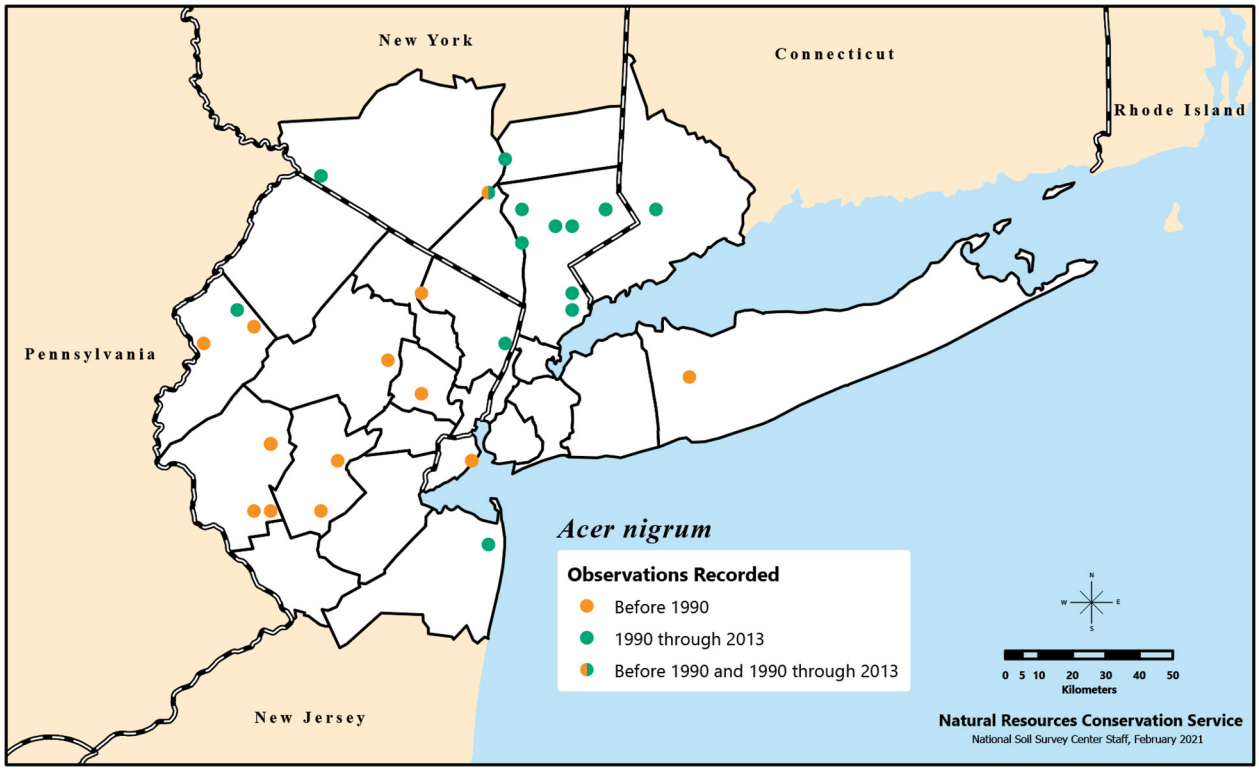
Tree. Flowering late Apr.–May. Dry to mesic woodlands. *Acer nigrum* is morphologically similar to *A. saccharum* and is relegated to a varietal status of *A. saccharum* by some authors; therefore, *A. nigrum* may be underreported and undercollected. Epithet (and common name) from Latin refers to the dark bark of the species relative to the gray bark of *A. saccharum*.

Acer nigrum and *A. saccharum* are genetically similar (Skepner and Krane 1998). The two species hybridize readily, with some indication that *A. saccharum* genes may tend to dominate. Despite this, *A. nigrum* maintains a distinct morphology (more pubescent leaf undersides, droopy leaf lobes, and evident leaf stipules; Skepner and Krane 1998). Slower growing and more drought-tolerant than *A. saccharum* (Graves 1994). Cultivated since 1812, but not extensively compared to many other *Acer* spp. (Dirr 1998).

3. *Acer pensylvanicum* L. – striped maple, moosewood ↑↑

Tree. Flowering early May–June. Rich, rocky woodlands often along slopes. Distinguished from other maples by its inflorescences of pendulous racemes and striped bark.

A small understory, shade-tolerant tree. Height at maturity 11 m. Can form a short-term seed bank of 1–2 years (Zasada and Strong 2008). Functionally dioecious. Individual trees tend to be either of staminate inflorescences or of pistillate inflorescences; hence tree primarily dioecious, though trees with both genders have been found. Pollination via insects predominates; wind pollination may occur (Sullivan 1983). Flowering and basal sprouting are initiated in response to a decline in plant growth related to canopy crown closure (Hibbs and Fischer 1979). Matures best within canopy gaps; can spread vegetatively by sprouting into nearby gaps. Monolayer leaf display



Distribution of *Acer nigrum*, or black maple, recorded in the New York Metropolitan Region during three time categories.

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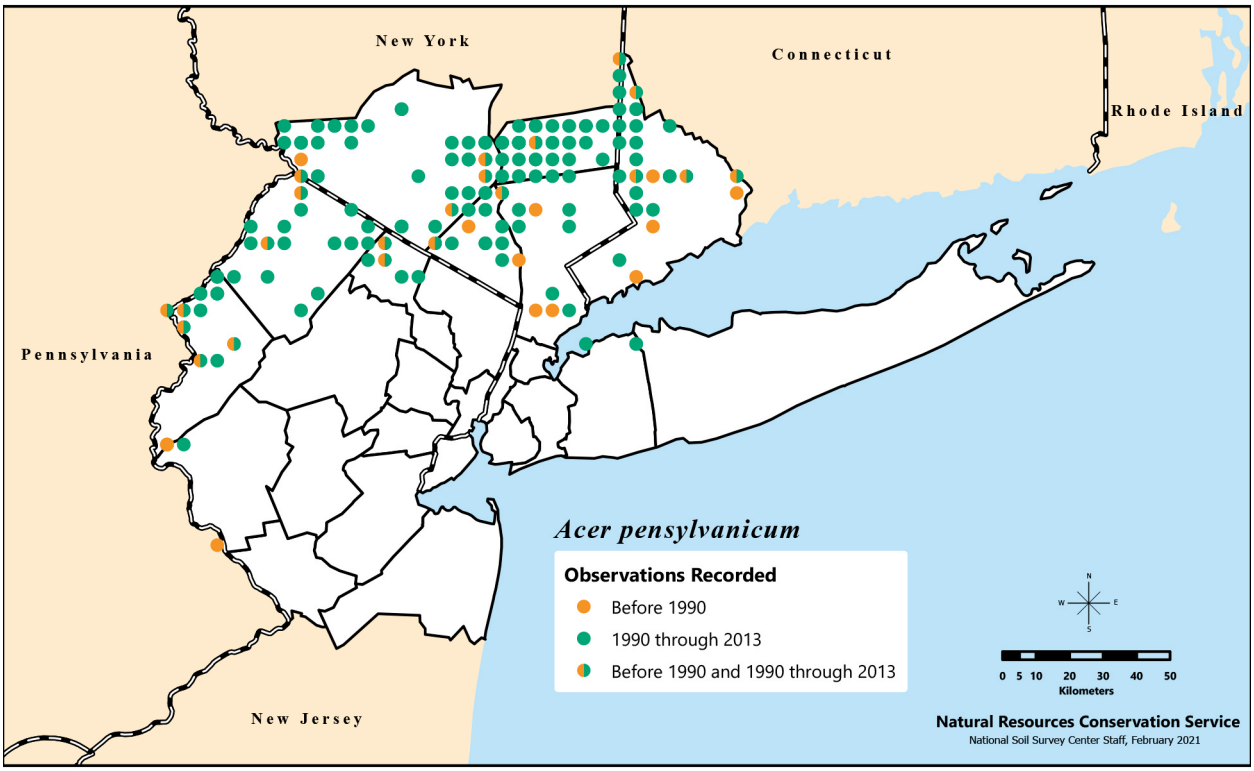


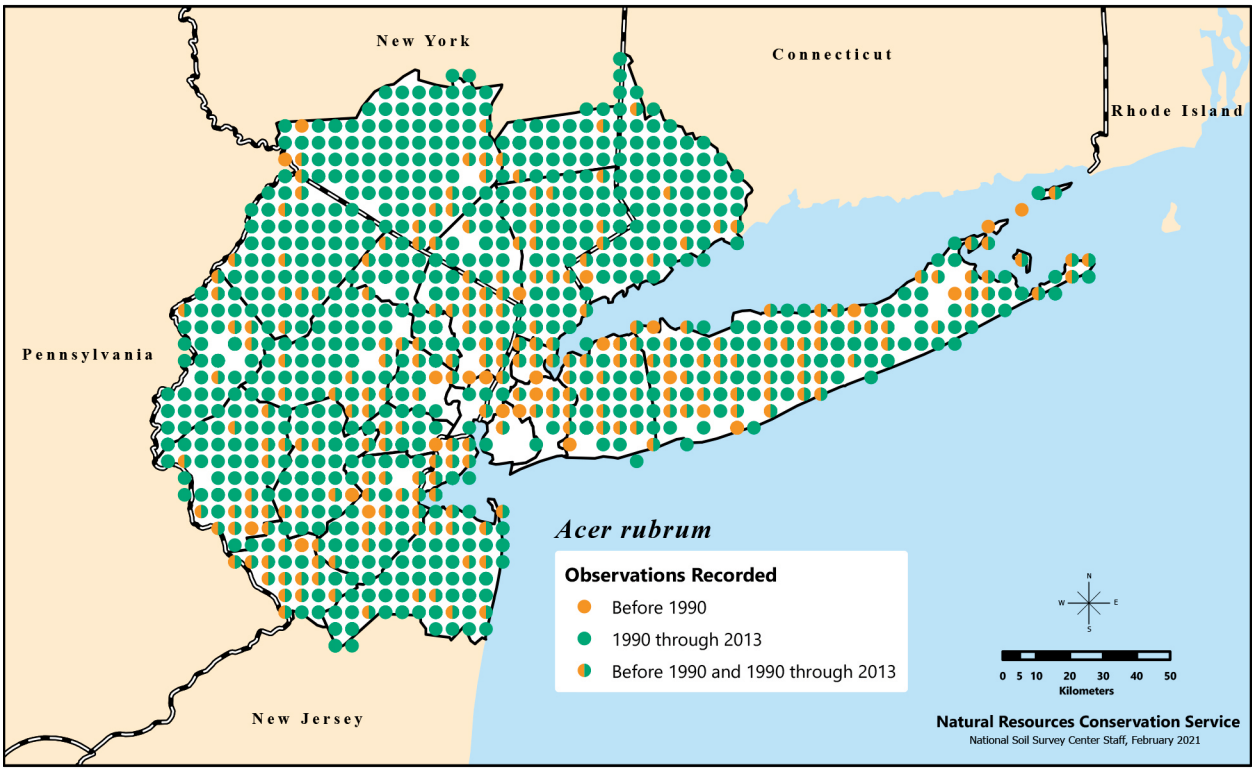
Distribution of *Acer pensylvanicum*, called striped maple or moosewood, recorded in the New York Metropolitan Region during three time categories.

also makes this species adept at using sunflecks (Lei and Lechowicz 1990, Sipe and Bazzaz 1995). Poor growth conditions (e.g., lower light levels) can lead to gender switching; males switch to females, possibly resulting in greater sexual reproduction. Sex ratios usually favor males (81 male to 15 female in one study area) (Hibbs and Fischer 1979). Vegetative reproduction apparently a mechanism for surviving suppression rather than increasing its numbers. Can vegetatively propagate, but majority of reproduction is sexual (Gabriel and Walters 1990). Most serious pest is the ascomycete fungus *Verticillium albo-atrum*, which kills the trees (Hibben 1959). Cultivated since 1755, with at least 3 cultivars (Dirr 1998).

4. *Acer rubrum* L. – red maple ↑

Tree. Flowering late Feb.–late Apr. Wide variety of upland and wetland habitats. Most common native maple in the region. Exceptional cytological and morphological variation has led some to recognize numerous intraspecific taxa. In the region, material with large leaves, commonly found in rich woodlands off the Coastal Plain, has been referred to as *Acer rubrum* L. var. *rubrum*. In swamps chiefly on the Coastal Plain, material with smaller leaves and reduced lobes is referable to *A. rubrum* var. *trilobum* K.Koch. and material with leaves permanently pubescent beneath is referable to *A. rubrum* var. *drummondii* Hook. & Arn. ex Nutt. Although extensively and increasingly planted in urban areas, *A. rubrum* is not particularly urban-tolerant. Shade-tolerant; prefers low, wet areas with slightly acidic, moist soils, though it can grow in a variety of soil types (Dirr 1998).

Cytologically (reported numbers include 2n=65, 78, 91, 97, 98, and 104, though these numbers are not specific to the region; Saeki et al. 2011), morphologically, and ecologically variable, but remains surprisingly distinct. Functionally dioecious, though monoecious plants and hermaphrodites are found; male trees tend to outnumber female trees (Primack and McCall 1986). Male bias apparently not correlated with site age or environmental conditions (Sakai



Distribution of *Acer rubrum*, or red maple, recorded in the New York Metropolitan Region during three time categories.

1990a). Female trees produce fewer seeds in xeric sites compared to more mesic sites; those on drier sites depend more on vegetative reproduction (Sakai 1990b). May suffer from chlorosis caused by manganese deficiency if grown in soils with high pH (Dirr 1998). Suffers from leaf hoppers (family Cicadellidae), which may cause considerable leaf damage, as well as leaf and petiole borers (family Tortricidae). Less resistant than other maples to arthropod pests (Seagraves et al. 2013). Cultivated since 1860, with at least 58 cultivars. Many of these cultivars are products of the *A. rubrum* and A. *saccharinum* hybrid: *A. ×freemanii* or Freeman's maple (Dirr 1998, Freeman 1941). Freeman maple is morphologically intermediate between its two-parent species (Jensen et al. 2002). Reproductive barriers, including asynchronous flowering phenology, cytological variation, and different habitats, exist but apparently do not prevent some natural hybridization (Saeki et al. 2011). Seeds may remain dormant in seed bank for 1–2 growing seasons (Houle 1994, Peroni 1995). Ability to produce a seed bank, even for a short period, may explain the increasing abundance of *A. rubrum* in eastern deciduous forests (Hille Ris Lambers and Clark 2005). Success in eastern forests may also be attributed to early emergence of tree seedlings, which gives them a significant survival advantage over other plants in understory (Jones et al. 1997). Lack of *Quercus* (oak) regeneration in eastern deciduous forests is strongly correlated with increase in *A. rubrum* stems in mid-story (McDonald et al. 2003). May start producing seed as early as 4 years of age (Zasada and Strong 2008). Height at maturity 28 m. Important component of late successional forests, but can be an aggressive colonizer of old fields and early successional forests (Rankin and Pickett 1989). Other studies show successful establishment of *A. rubrum* not likely until 6–9 years after old field abandonment (Peroni 1994). Close association with arbuscular mycorrhizal fungi apparently stronger in forested systems than disturbed systems (Wiseman and Wells 2005). Planted as a plantation tree in Poland; expansion beyond plantations has been observed (Wojterska et al. 2012). Known as soft maple in

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the lumber industry. Tapped for syrup but once the buds break, which tends to occur earlier than for the hard maples, syrup develops a bad flavor (Walters and Yawney 1990). Most of this species' occurrences since 1990 coincided with its pre-1990 occurrences; hence only a single increase arrow.

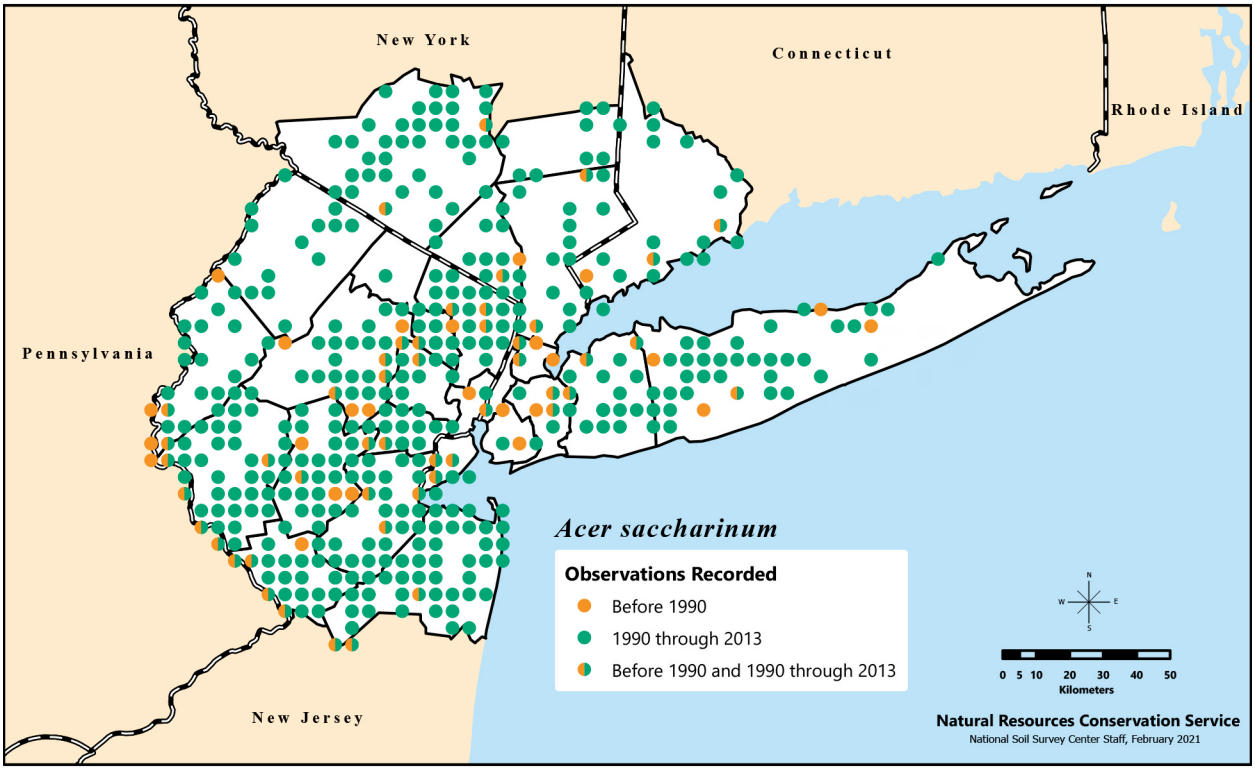
5. *Acer saccharinum* L. – silver maple ↑↑↑

Tree. lowering late Feb.–Apr. Wet to mesic woodlands. Though native to the region, it is also planted and some material may be naturalized. Epithet from Latin refers to the sugary sap; however, sugar content of sap is lowest of the maple spp. used for syrup production (Koelling and Heiligmann 1996).

Functionally dioecious, but hermaphrodites also present (Dirr 1998). Tends to have more females than males, and both males and female trees in smaller size classes, with more hermaphrodites in the largest size classes. Males and females do not differ significantly in size. Trees of similar size and sex tend to clump spatially, but male and female trees are randomly distributed within each size class, resulting in females being pollinated by males and hermaphrodites being pollinated by themselves or each other (Sakai and Oden 1983). Earliest seed-bearing age 11 years. Seeds not dormant; no seed bank likely (Zasada and Strong 2008). Height at maturity 28 m. Overplanted because it grows rapidly, producing a large shade tree. However, its brittle wood makes it a hazard. Affected by several different pests and not very hardy in urban environments. Cultivated since 1725, with at least 12 cultivars not including those associated with *A.* ×*freemanii* (its hybrid with *A. rubrum*) (Dirr 1998).

6. *Acer saccharum* Marshall – sugar maple ↑↑

Tree. Flowering mid-Apr.–May. Well-drained uplands in rich soils. Shade-tolerant even as a seedling (Dirr 1998). Leaves superficially resemble those of the nonnative *Acer platanoides*. Readily distinguished from this species by lack of milky juice in petioles (petioles of *A. platanoides* exude milky juice when leaves are picked). A hard



Distribution of *Acer saccharinum*, or silver maple, recorded in the New York Metropolitan Region during three time categories.

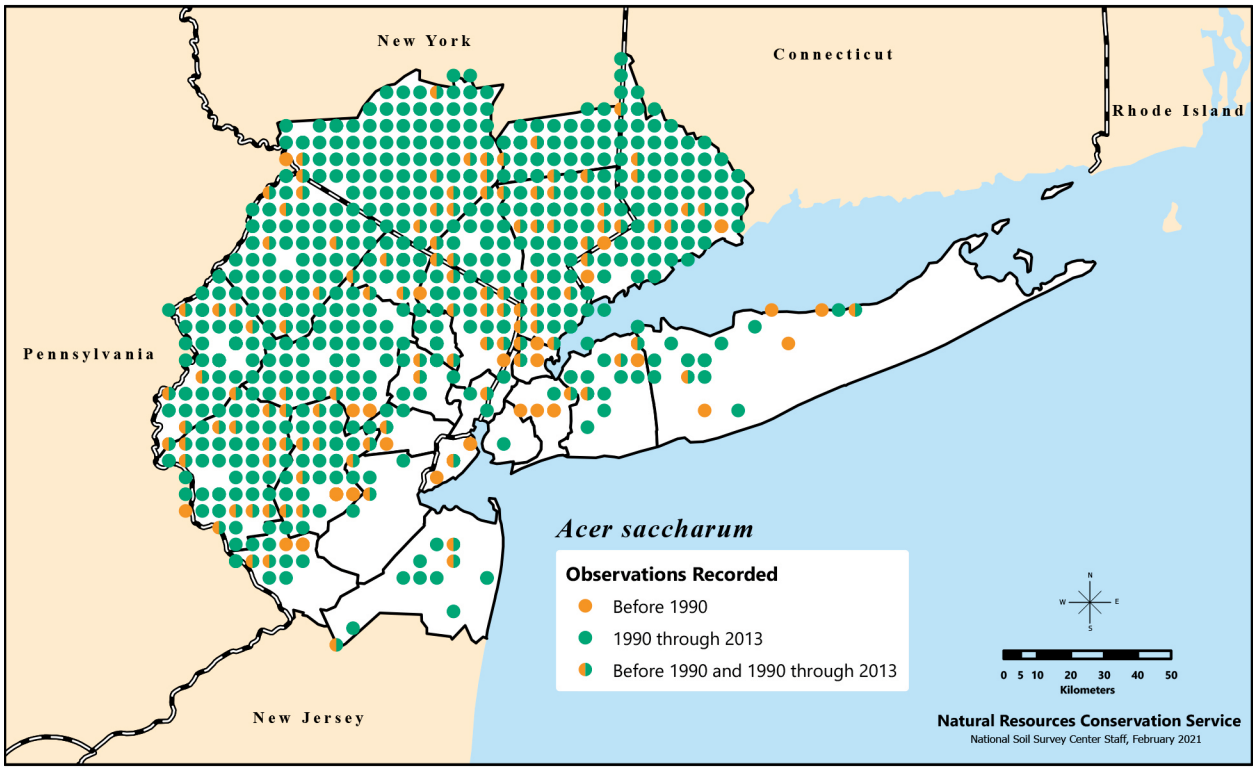
maple species common in the region. Generally absent in urban areas and infrequent on the Coastal Plain. Epithet from Latin refers to the sugary sap.

Monoecious with the male and female flowers maturing at different times on a plant (a form of dichogamy). Trees differ in the timing of each gender's maturity, allowing for synchronization of flowering time of male and female flowers of separate trees, ensuring outcrossing (Gabriel 1968). Earliest seed-bearing age 22 years. One of the few masting maples; produces large seed crops once every 3–7 years. Seeds that will germinate usually do so the spring and summer after dispersal, showing no tendency to form even a short-term seed bank (Houle 1992). Species used more than any other maple species for syrup production; limited syrup production, but a few commercial producers, in the region. An important commercial hardwood tree; provides about 6 percent of the hardwood sawtimber volume in the U.S. (Godman et al. 1990). Under cultivation since 1753, with at least 31 cultivars (Dirr 1998). Recent national declines of species in eastern forests attributed to magnesium and calcium deficiency or soil acidification, or both (Burke and Raynal 1998, Cleavitt et al. 2011, Horsley et al. 2000). Declines in the 1960s thought to be from combined effect of drought conditions and insects; drought weakens the trees, making them more susceptible to disease and insects (Dirr 1998). Increases may be attributed to passive reforestation.

7. *Acer spicatum* Lam. – mountain maple ↓↓↓

Shrub, small tree. Flowering late May–Aug. Rocky, upland woodlands. Northern, boreal species (Aubin et al. 2000) that prefers cool, shady, acidic soils and is found at higher elevations in the southern Appalachian Mountains. Shrubs to small trees (Dirr 1998). Epithet from Greek "spica," possibly referring to erect inflorescences, which can look like ears of corn.

Apomixis may be important for some seed production (Sullivan 1983). Most closely related to *Acer pensylvanicum*. Functionally dioecious with some hermaphrodites present. Inflorescences bloom staminate first, then pistillate, then



Distribution of *Acer saccharum*, or sugar maple, recorded in the New York Metropolitan Region during three time categories.

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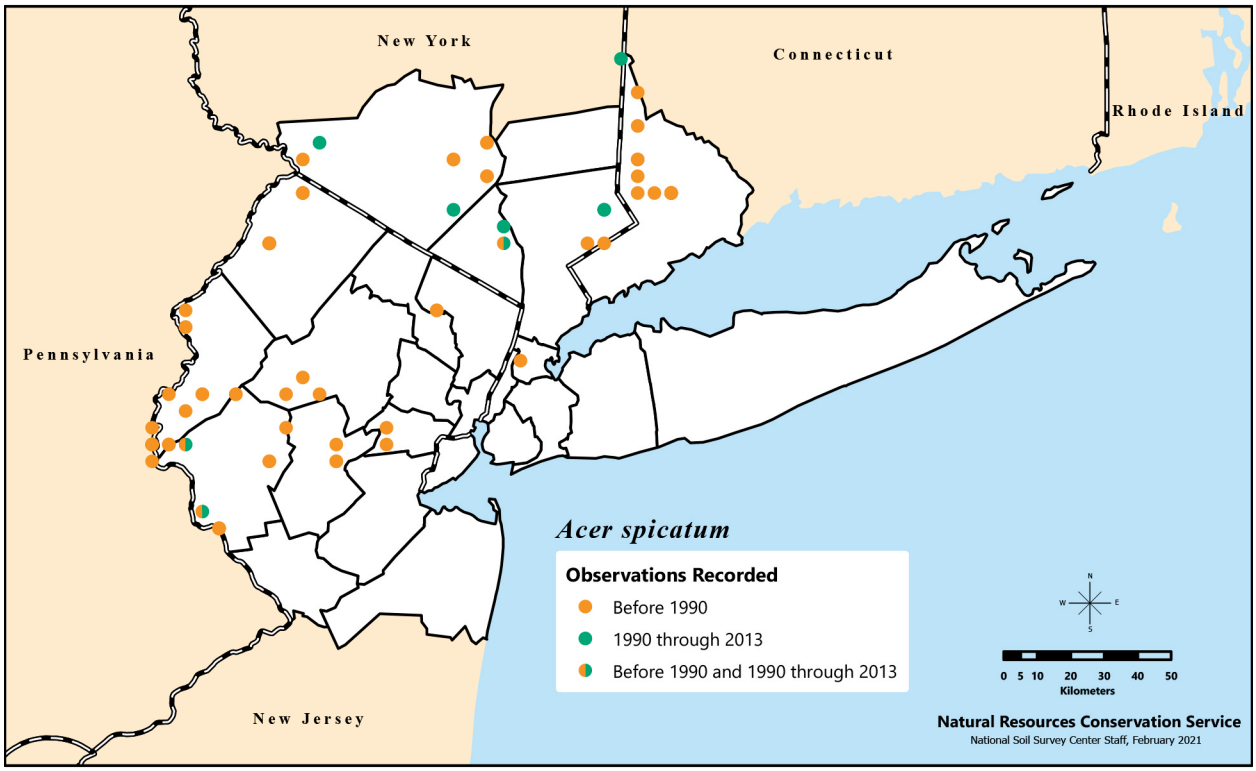


Distribution of *Acer spicatum*, or mountain maple, recorded in the New York Metropolitan Region during three time categories.

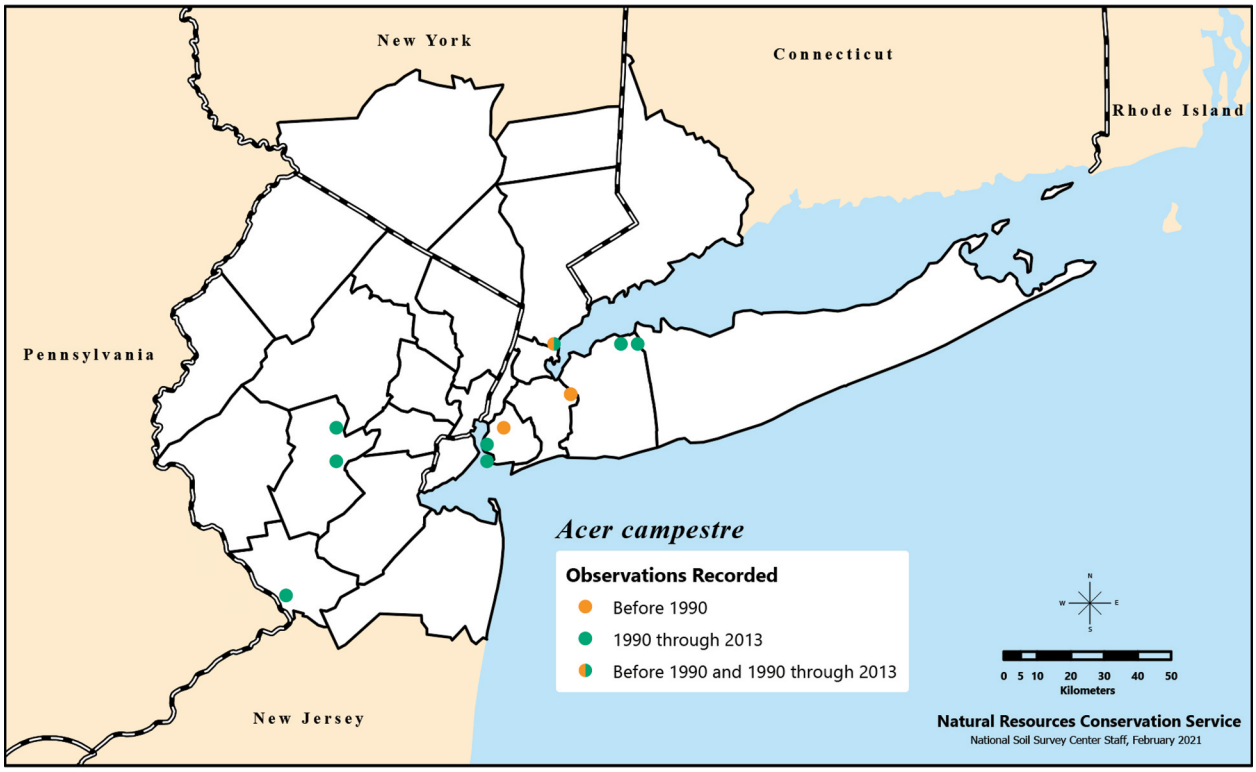
staminate again; asynchronous flowering. At any given time, both receptive staminate and pistillate flowers can be found on different trees in a population, ensuring cross-pollination (Sullivan 1983). Height at maturity 9 m. Seeds form a short-term seed bank of 1–2 years (Zasada and Strong 2008). Cultivated since 1750, but no known cultivars. Planted only rarely as a landscape shrub (Dirr 1998).

Nonnative Species

8. *Acer campestre* L. – hedge maple ↑↑

Shrub, small tree. Flowering Apr.–May. Native to Asia and Europe. Occasionally planted and only rarely naturalized in the region. Wing angle and milky juice exuded by leaf petioles make it similar to *Acer platanoides*, but its rounded leaf lobes are distinctive. Epithet from Latin refers to fields, one of its habitats.

Monoecious with heterodichogamous (separation in time and space of anther dehiscence and stigma receptivity) flowering (Renner et al. 2007). Round and dense habit. Slow growing, to 25 m tall. Originally from Europe, the Near East, and Africa. Brought to the U.S. in colonial times. Prefers rich, well-drained soils; performs best in alkaline and some acidic soils (pH 5.5 or above; Coudun et al. 2006, Dirr 1998). Tolerant of dry soils, compaction, and air pollution (Dirr 1998). Drought tolerance may be due in part to its being hypostomatous (having stomates only on the underside of its leaves) (Burghardt and Riederer 2003). Grows in both full sun and light shade; essentially pest- and disease-free. At least 8 known cultivars. A very durable species, but not commonly planted in North America. Heavily browsed by the Muntjac deer (nonnative ungulates from South Asia; *Muntiacus reevesi*) in its native England and Scotland, which may suggest it could serve as forage for North American deer (*Odocoileus* spp.) (Cooke and Farrell 2001).



Distribution of *Acer campestre*, or hedge maple, recorded in the New York Metropolitan Region during three time categories.

9. *Acer ginnala* Maxim. – Amur maple ↑↑↑

Shrub, tree. Flowering late Apr.–May. Native to northeastern Asia. Occasionally planted and naturalized in disturbed areas. Taxon is sometimes recognized as subspecies of *Acer tataricum* L., *A. tataricum* subsp. *ginnala* (Maxim.) Wesm. Epithet is from the Chinese vernacular for this species.

Functionally dioecious (Barwinsky 1995). Can start bearing samaras at 5 years, with 1 year between large seed crops (Zasada and Strong 2008). Relatively slow-growing (4 m in 10 years). Height at maturity 6 m. Easy to transplant and adaptable to wide range of soil pHs, but grows best in moist, well-drained soils. Cultivated since 1860. Can grow in full sun or light shade. Virtually disease-free except for susceptibility to some of the same ascomycete fungal diseases of *A. saccharinum* (Verticillium wilt) (Dirr 1998).

Listed as potentially invasive in CT (not prohibited).

10. *Acer palmatum* Thunb. – Japanese maple ↑↑↑

Shrub, small tree. Flowering May–June. Native to Asia. Frequently planted; can become naturalized, usually as an understory tree in disturbed woodlands. Epithet from Latin means “like the palm of a hand.”

Tends to leaf out early and, consequently, may be impacted by late frosts. Mature trees can tolerate short-term droughts and heat. Incomplete information about sexual system; existing literature indicates primarily monoecious species with occasional pure male trees (Renner et al. 2007). Seed collected directly off tree before drying and browning may germinate the following spring without any pretreatment. Dry seeds will require a hot and cold stratification (Dirr 1998). A short-term seed bank of 1–2 growing seasons has been documented, but for a relatively low percentage of seed (Tanaka 1995). Long cultivated

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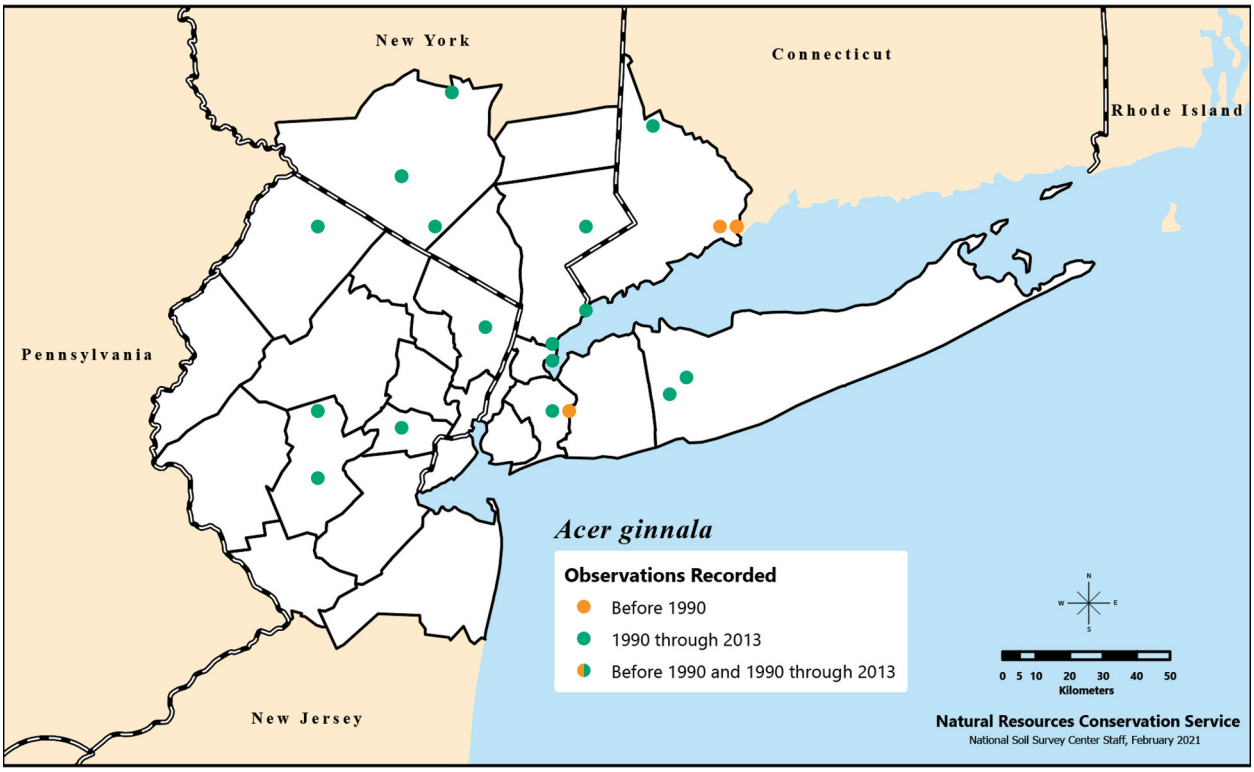
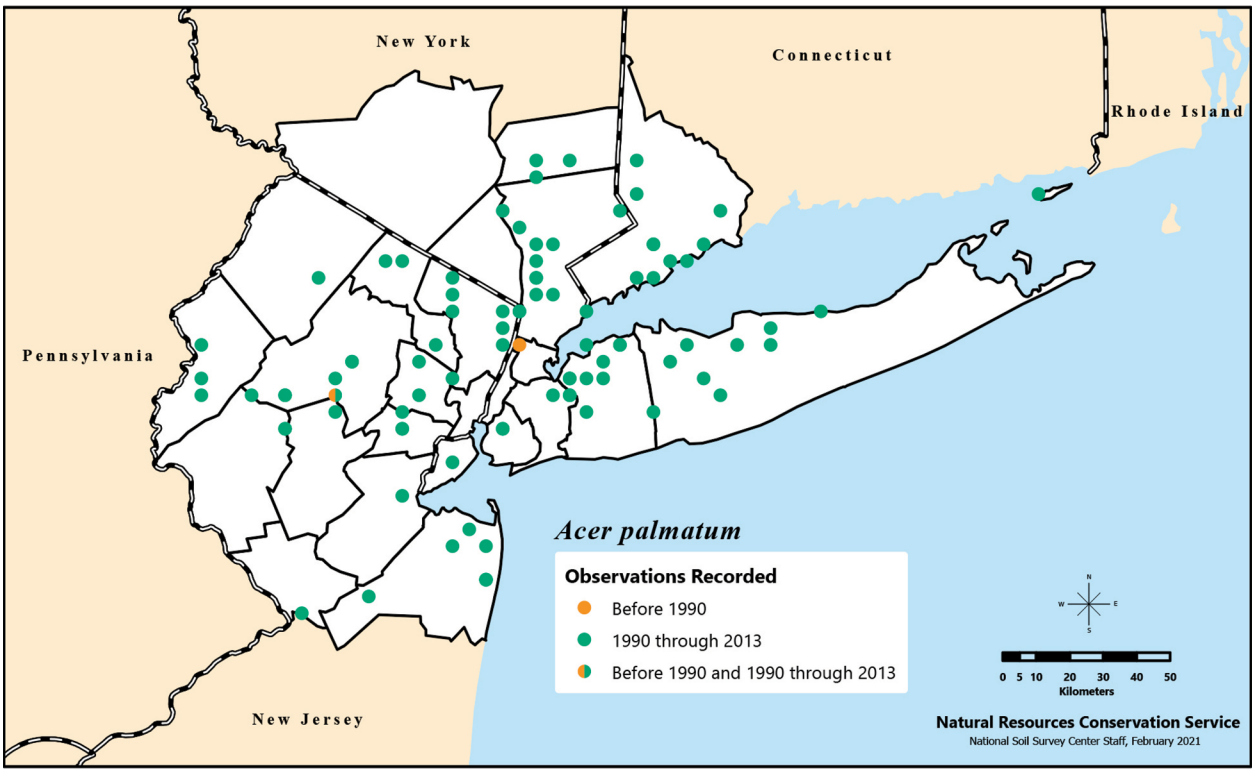


Distribution of *Acer ginnala*, or Amur maple, recorded in the New York Metropolitan Region during three time categories.



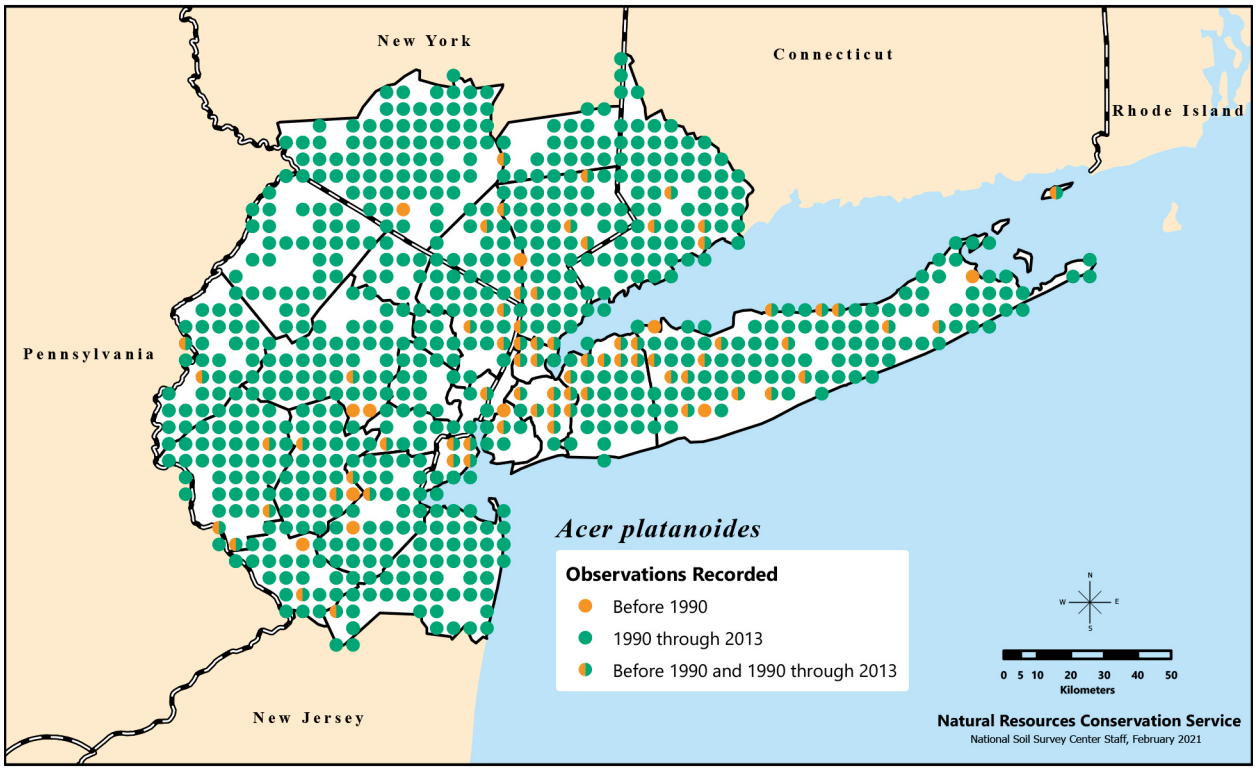
Distribution of *Acer palmatum*, or Japanese maple, recorded in the New York Metropolitan Region during three time categories.

with no documented introduction date; over 158 cultivars. Sixteen cultivars in nondissected-leaves group and 14 cultivars in dissected-leaves group are likely to be among the most popular for landscaping in the U.S. (Dirr 1998).

11. *Acer platanoides* L. – Norway maple ↑↑↑

Tree. Flowering Mar.–May. Native to Europe; widely planted and now commonly naturalized in dry to mesic disturbed areas. Leaves superficially resemble those of the native *Acer saccharum*. Readily distinguished from this species by milky juice exuded from petioles when leaves are picked. Epithet refers to similarity of leaves to those of the plane tree (sycamore; Platanus).

Introduced into the U.S. around 1756 (Dirr 1998). Extensively cultivated since at least 1683 (Nowak and Rowntree 1990), with 36 more frequently used cultivars and 89 accepted cultivars (Santamour and McArdle 1982). Today considered invasive; plantings have decreased. Height at maturity 31 m (Zasada and Strong 2008). Monoecious with heterodichogamous flowering. Some trees protogynous (male flowers open at anthesis); others protandrous (male flowers open before anthesis) (Renner et al. 2007). Earliest seed-bearing age unknown. Does not appear to mast; instead produces large seed crops annually. Seed are wind-dispersed with estimated dispersal distances of 50 m (Matlack 1987). Though both *A. pseudoplatanus* and *A. platanoides* may have a seed bank, *A. platanoides*' tolerance of dessication during storage (Hong and Ellis 1990) may result in longer-lived seed banks than those of *A. pseudoplatanus*, especially in drier environments. Tolerant of air pollution and relatively dry conditions; planted extensively as an urban street tree, under stressful soil conditions, including low soil fertility due to high or low pH and too little or too much soil moisture due to excessive (high sand content) or poor (high clay content) drainage. Less tolerant of warm summer nights and less vigorous in colder conditions (Dirr 1998). Shown to be physiologically more efficient at utilizing resources than *A. saccharum* (Kloeppel and Abrams 1995), in part explaining its invasiveness in addition to its popularity.



Distribution of *Acer platanoides*, or Norway maple, recorded in the New York Metropolitan Region during three time categories.

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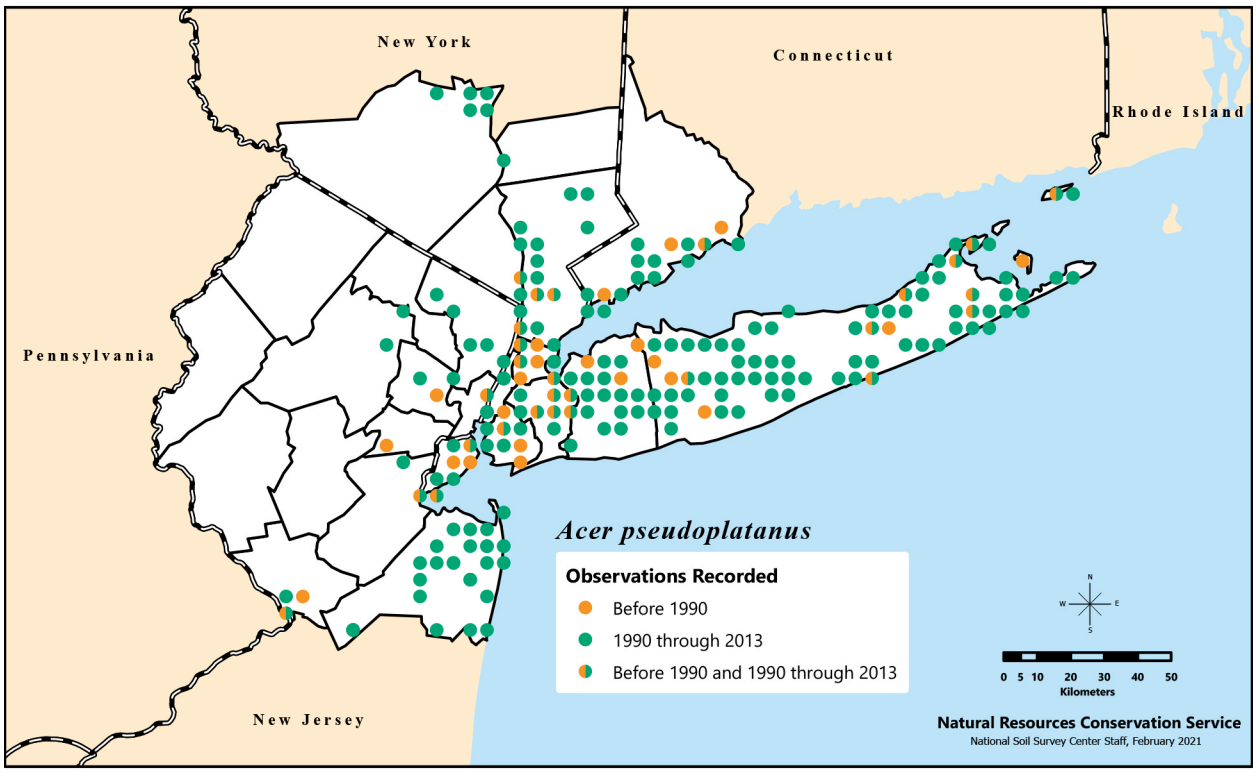
Listed as invasive in CT (not prohibited), NJ (category 1), and NY (regulated).

12. *Acer pseudoplatanus* L. – sycamore maple ↑↑

Tree. Flowering late Apr.–May. Uplands in disturbed areas. Native to central and southern Europe. Occasionally planted and now frequently naturalized in dry to mesic disturbed areas, especially in NYC and Long Island. Prefers colder climates (Dirr 1998). Observations in NYC parks indicate it is displacing *Acer platanoides*. Salt-tolerant (even salt-laden winds); competes well in coastal areas. Tolerates a wide range of soil pH, but prefers well-drained soils (Dirr 1998). Naturalized in northern Europe; considered invasive in England, Norway, Sweden, Australia, New Zealand, Ireland, Canada, and the U.S. Though native to Denmark, it and potentially different cultivars have also been extensively planted in Denmark. First noted presence in New England was in 1870 in NJ and NY. Epithet from Greek refers to similarity of leaves to those of the plane tree (sycamore; *Platanus*).

Height at maturity 31 m (Zasada and Strong 2008). Has heterodichogamous reproductive system with most individuals being protandrous (male flowers flower before anthesis), a smaller portion being protogynous (male flowers flower at anthesis), and a few trees being strictly male. Flowers in three separate gender phases, during the first 10 days of which protogynous trees are female and protandrous trees are male. In the following 2 weeks protogynous trees are male and protandrous trees are female. In the last phase most trees are male. Pollination appears primarily by insects (e.g., thrips; family Thripidae), but wind may still play a role (Tal 2009). Protandrous trees have been documented to suffer less from herbivory than protogynous trees; herbivory may increase flowering in general as stress response (Leather 2000). Earliest seed-bearing age 25 years (Hein et al. 2009). Producing seed Aug.–Oct.; seed dispersed Sept.–Nov. Does not mast; produces large seed crops annually. Can produce 30 fruits per inflorescence and more than 800 inflorescences per tree (Jones 1944). Seeds have a very thick



Distribution of *Acer pseudoplatanus*, or sycamore maple, recorded in the New York Metropolitan Region during three time categories.

pericarp, which protects them from freezing and desiccation (Hong and Ellis 1990, Pukacka and Pukacki 1997). Seeds are dormant (intermediate physiological dormancy; removal of the seed coat is likely to break dormancy), suggesting a short-lived seed bank is possible (Gleiser et al. 2004).

First cultivation of unknown origin (Zasada and Strong 2008); has been cultivated for centuries, with at least 70 cultivars (Dirr 1998). Able to acclimate to decreasing soil moisture by increasing root biomass (Khalil and Grace 1992). Litter has a relatively high pH and a greater likelihood of being associated with earthworms (order Lumbriculida) (Neirynck et al. 2000). Responding to climate change (2100 predictions for southeast England: winter temperature rise of 3.5 °C; spring, summer, and fall temperature rise of 3.0 °C; 10 percent increase in rainfall) by leafing out 21 days earlier than present day (Sparks and Carey 1995).

Listed as potentially invasive in CT (prohibited) and invasive in NY (prohibited).

Management

Acer platanoides is shade-tolerant, regenerates under its own shade (Reinhart et al. 2006, Webster et al. 2005), and is documented to displace associated native species including *A. rubrum*, *A. saccharum*, and *Quercus rubra* (Fang 2005, Paquette et al. 2012). In comparison, there is less evidence of impacts of *A. pseudoplatanus* on native vegetation, though there is evidence that it is replacing *A. platanoides* in the region, possibly due to preferential planting. *Acer pseudoplatanus* may have only limited establishment in dry environments because its seeds are vulnerable to desiccation (Hong and Ellis 1990), though adult plants may be able to acclimate to dry and saline conditions (Dirr 1998, Khalil and Grace 1992). The ability of *A. pseudoplatanus* to adapt to saline conditions may make it more of a threat under climate change, in which sea level is rising and waters are spreading inland. Prolific seed and seedling production will also help this species prosper in environments with enough water. However, it lacks a substantial seed bank (recalcitrant seeds; Gleiser et al. 2004), so it can be controlled relatively easily by removing it and not continuing to plant it as a landscape tree. It is still somewhat attractive as a street tree because of its tolerance to salt and pollution, though other *Acer* spp. produce much more vibrant foliage. Despite the prolific seed production of both *A. platanoides* and *A. pseudoplatanus*, the dispersal range is relatively small, within 50 m. A combined herbicide application following stem removal, because of possible resprouting, is recommended as the most likely treatment to effectively kill these species. More information is also needed on the invasive potential of individual cultivars for both *A. platanoides* and *A. pseudoplatanus*. There is some evidence that *A. platanoides* cultivars with reddish foliage may be indicative of nitrogen deficiency (Sinkkonen 2008) and potentially less invasive. The *A. platanoides* cultivars ‘Crimson King,’ ‘Globosum,’ ‘Faasen’s Black,’ and ‘Rubrum’ have been shown to produce fewer flowers and seeds than other cultivars, especially ‘Columnare’ and ‘Emerald Queen’ (Conklin and Sellmer 2009). Cultivars of the native *A. rubrum* may be used to replace these street trees. To our knowledge, there is no current evidence that any *A. rubrum* cultivar is escaping or hybridizing with others to produce an invasive species, but the number of available cultivars, the difficulty of telling them apart morphologically (Tobolski and Kemery 1992), and the apparent increasing use of *A. rubrum* cultivars (Fare et al. 1990, Galvin 1999, Iles and Vold 2003, Ruter and Sibley 2000) warrant attention to the potential for invasion. Large increase in *A. ginnala* and *A. palmata* indicates a need for more research on these species as well.

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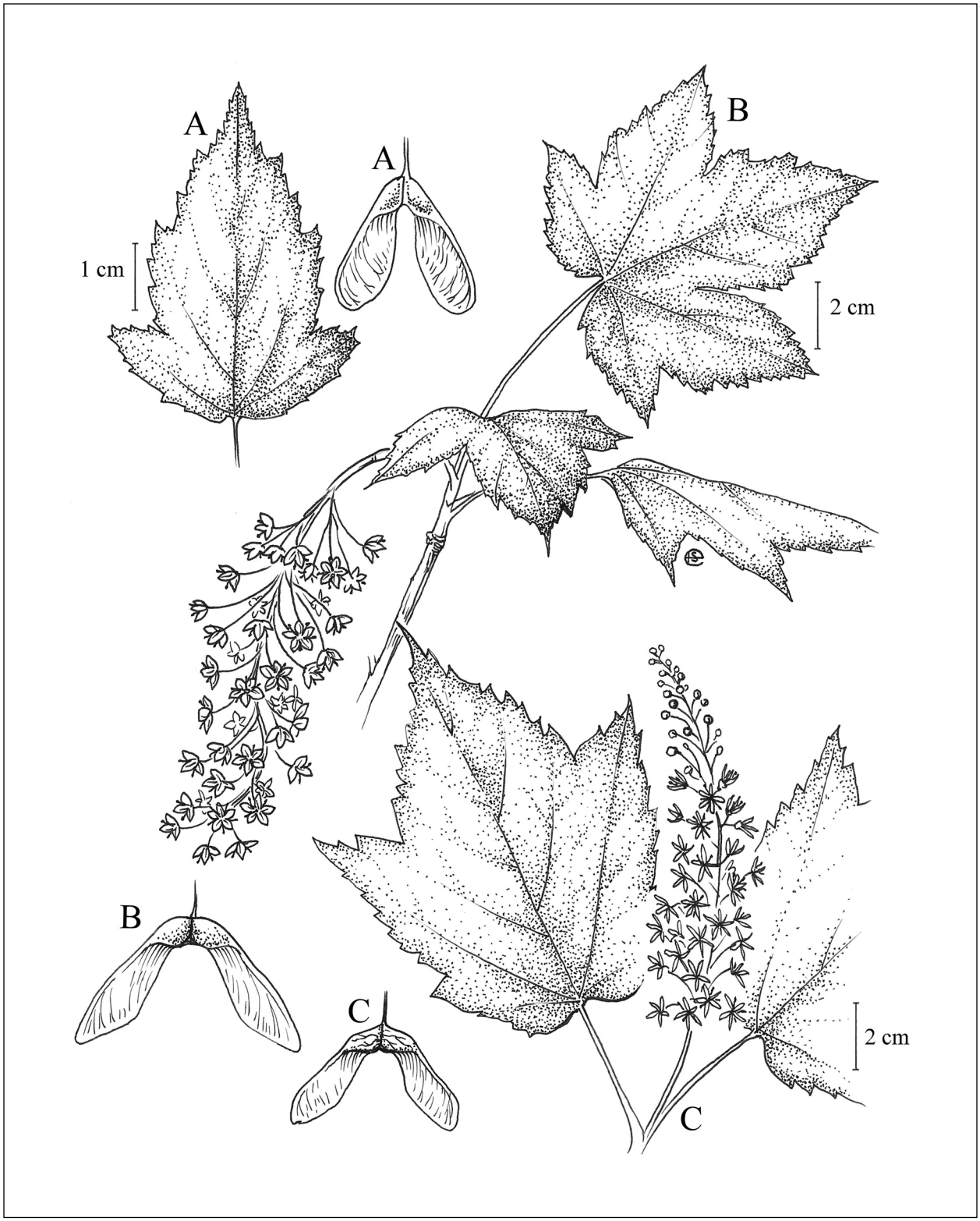
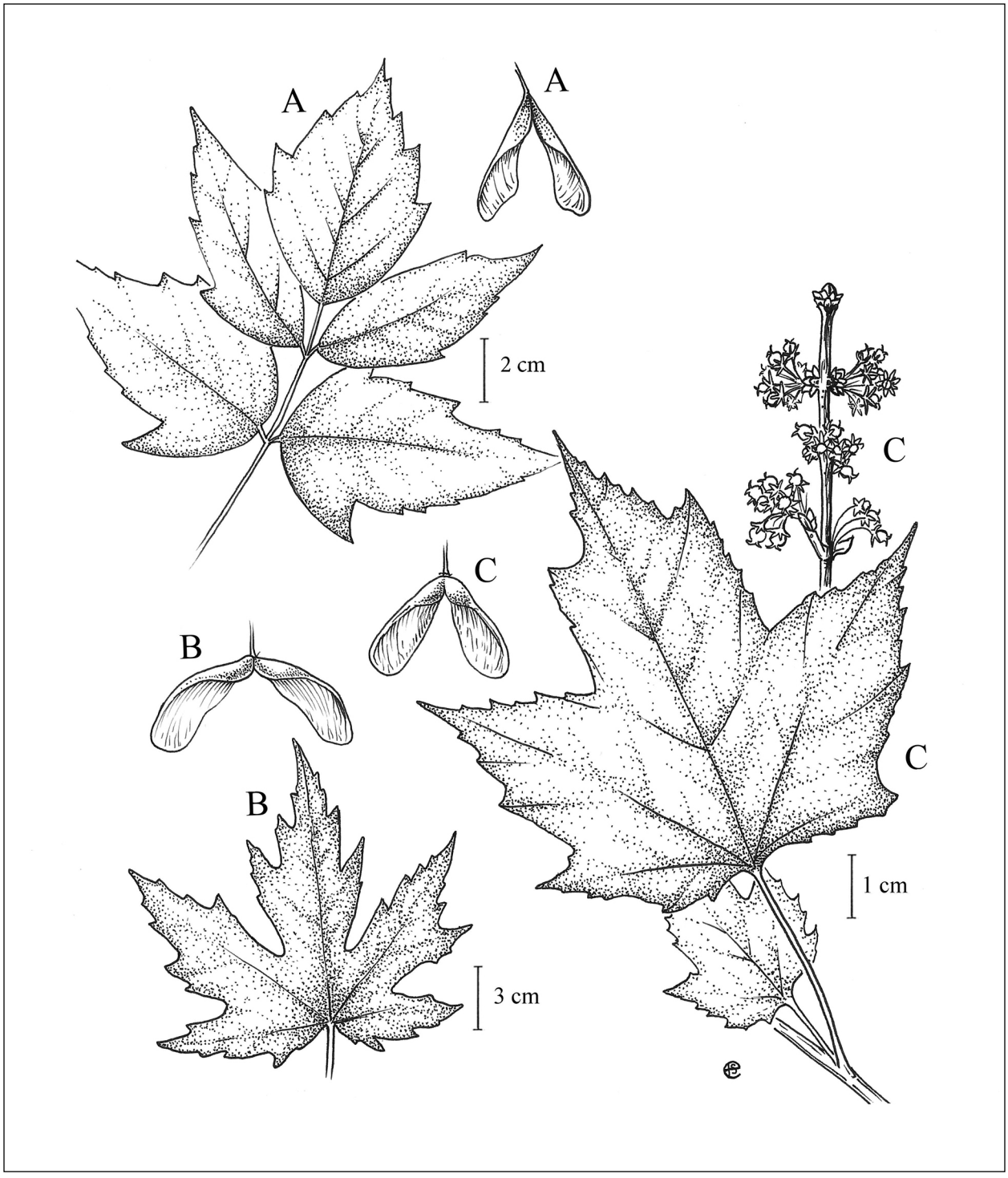


A) Leaf and fruit of *Acer ginnala*; flowering leafy twig and fruit of B) *Acer pseudoplatanus* and C) *Acer spicatum*. Illustration by Emma Skurnick.



A) Leaves and fruit of *Acer negundo* and B) *Acer saccharinum*; C) fruit, leafy twig, and flowering twig of *Acer rubrum*. Illustration by Emma Skurnick.

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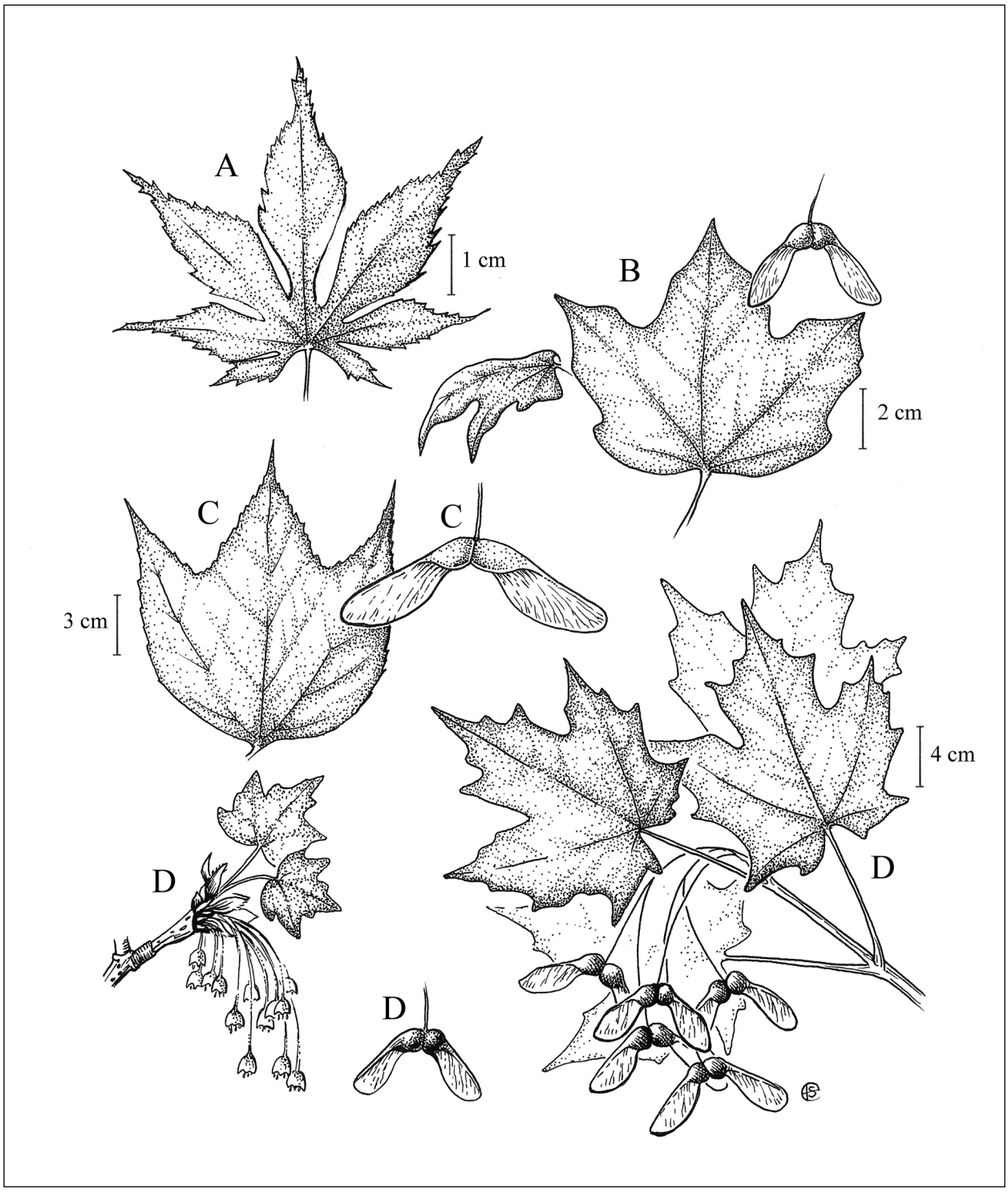
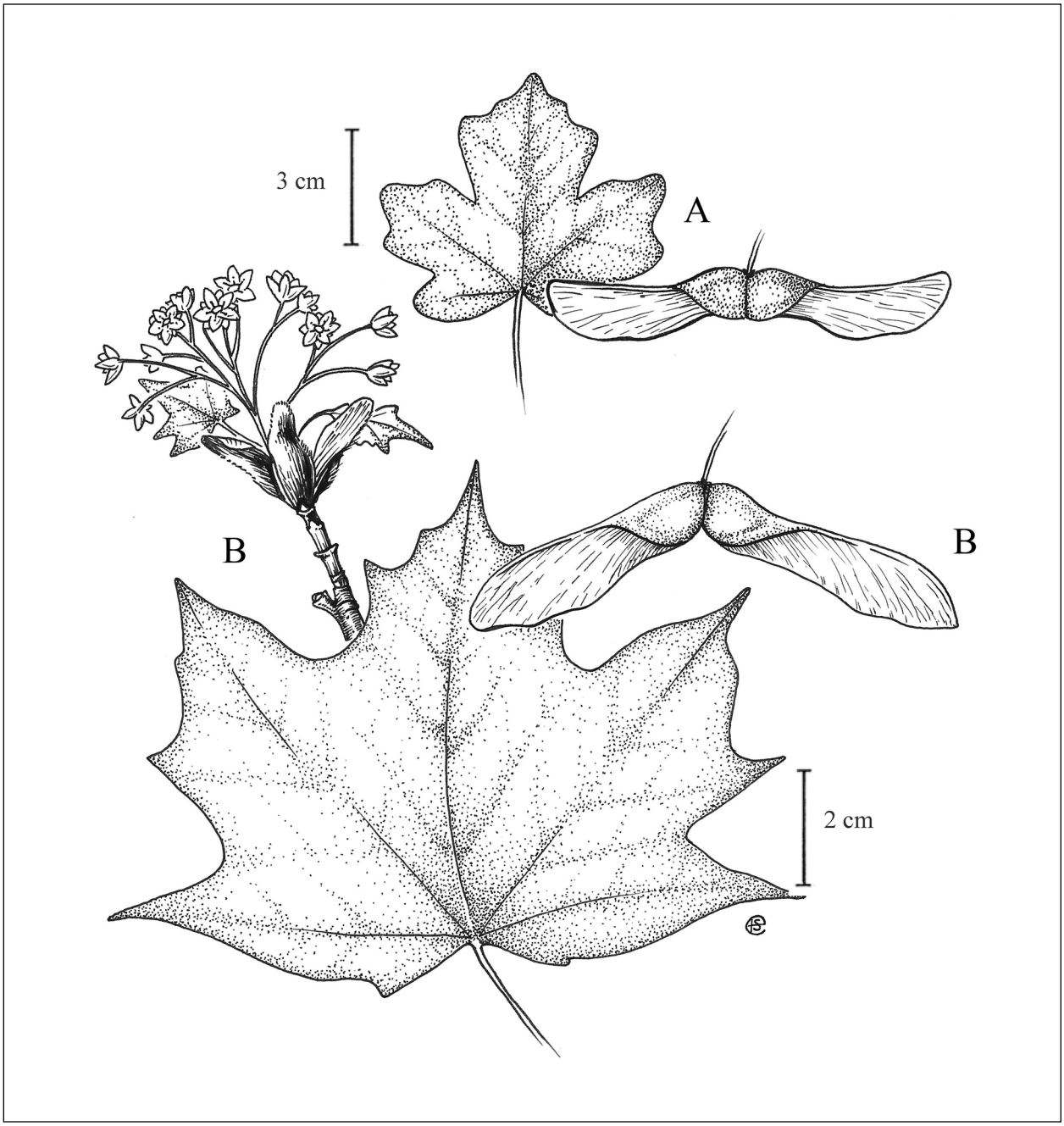


A) Leaf of *Acer palmatum*; leaf and fruit of B) *Acer nigrum* and C) *Acer pensylvanicum*; D) flowering twig, fruit, and leafy twig of *Acer saccharum*. Illustration by Emma Skurnick.



A) Leaf and fruit of *Acer campestre*; B) flowers, leaf, and fruit of *Acer platanoides*. Illustration by Emma Skurnick.

A B

Actinidia Lindl. – kiwi

Actinidiaceae. Climbing shrubs. Species 55–60 in eastern and southern Asia. Species include kiwifruit (also called kiwi or Chinese gooseberry; *Actinidia chinensis* Planch., *A. deliciosus* (A.Chev.) C.F.Liang & R.Z.Wang) and kiwi berry (*A. arguta* (Sieb. & Zucc.) Planch. ex Miq.). The kiwifruit commonly sold in the U.S., fuzzy kiwifruit (*A. deliciosus*), has a pubescent dark brown skin and bright green flesh. Cultivars were developed from material introduced into New Zealand in the early 1900s (Ferguson and Bollard 1990). Golden kiwifruit (*A. chinensis*), has a smooth (glabrescent) light brown skin and yellow flesh; its fruit is sweeter than fuzzy kiwifruit but not as widely available due to a much shorter shelf life. The two keyed species, kiwi berry or tara vine (*A. arguta*) and silver vine (*A. polygama* (Seib. & Zucc.) Maxim.), rarely escape or persist from cultivation in the region. Leaves of some species induce in cats a reaction similar to catnip, the chemical actinidine believed to be the cause (Bol et al. 2017); sometimes used by zoos to calm big cats (Sakan et al. 1959). Genus name is derived from the Greek "actis," and refers to the radiating styles.

These species have only a rare occurrence in the region and those occurrences are most likely plantings or cultivated remnants (a 2,000-m^2 population of *A. arguta* was recently eradicated on Long Island in Nassau County [NY]; Lindberg 2017).

Aesculus L. – buckeye, horse-chestnut

Hippocastanaceae (Sapindaceae s.l.). Trees, shrubs. Species 13 in the Northern Hemisphere in Asia, Europe, and North America. Distinguished by opposite palmately compound leaves, showy flowers in terminal panicles, and leathery capsules. "Aesculus" is the ancient Latin name for an oak or other mast-producing tree.

Nonnative Species

1. *Aesculus glabra* Willd. – Ohio buckeye Ø

Flowering May. Native to the U.S. south and west of the region; occasionally planted and rarely naturalizes in mesic woodlands. Recent and historical records scattered throughout the region.

Actinidia Key

1. Leaves never variegated; pith lamellate, white to brown; petals 5; anthers dark purple-black . . . . . ***Actinidia arguta****
1. Leaves often variegated; pith solid, white; petals 5–12; anthers yellow . . . . . ***Actinidia polygama****

Aesculus Key

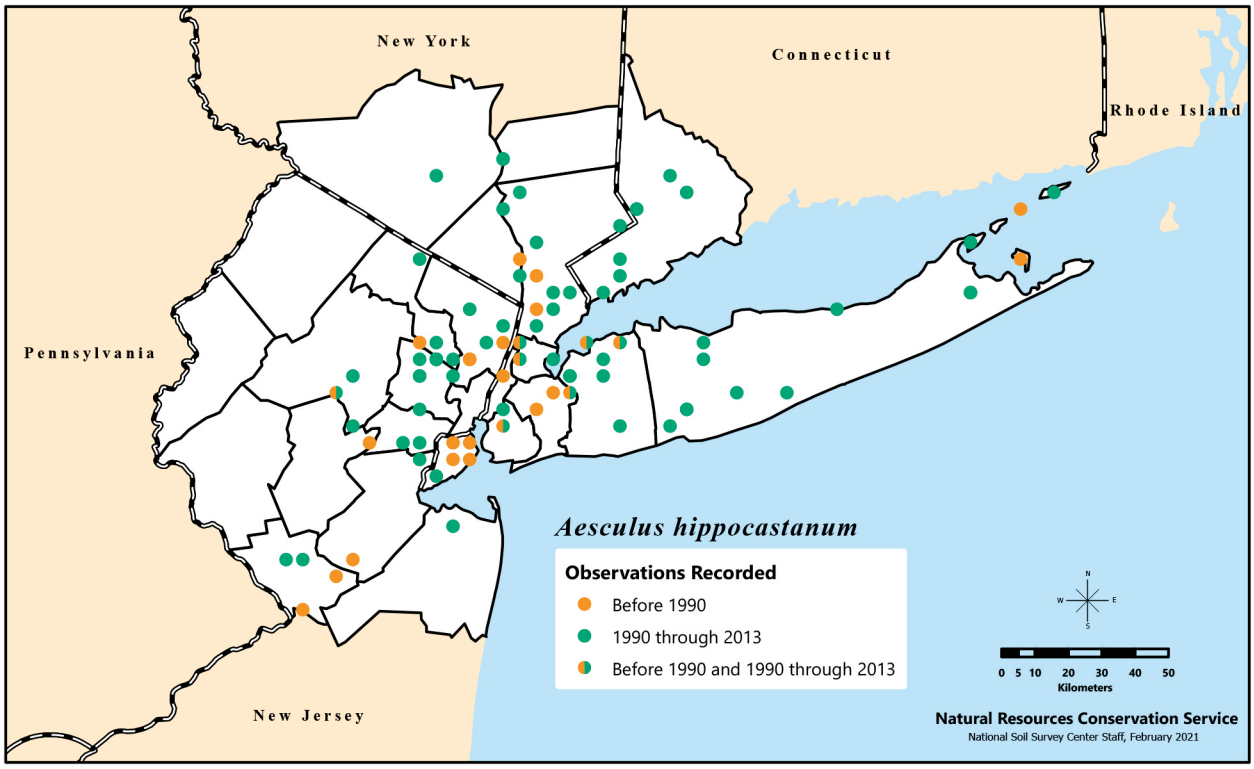
1. Winter buds resinous, sticky; petals 5, flowers about 2 cm across; leaflets 7–9 . . . . . ***Aesculus hippocastanum****
1. Winter buds not resinous or sticky; petals 4; flowers about 1 cm across; leaflets usually 5 2
2. Petals greenish-yellow, stamens 2 times as long as petals; fruit with prickles . . . . . ***Aesculus glabra****
2. Petals white, stamens 2–4 times as long as the petals; a stoloniferious shrub; fruit smooth . . . . . ***Aesculus parviflora****

2. *Aesculus hippocastanum* L. – horse-chestnut ↑

Flowering late Apr.–May. Native to Europe. Occasionally planted and rarely naturalizes (usually close to planted material). More commonly encountered as a remnant from cultivation. Epithet is an old genus name from Greek meaning horse chestnut.

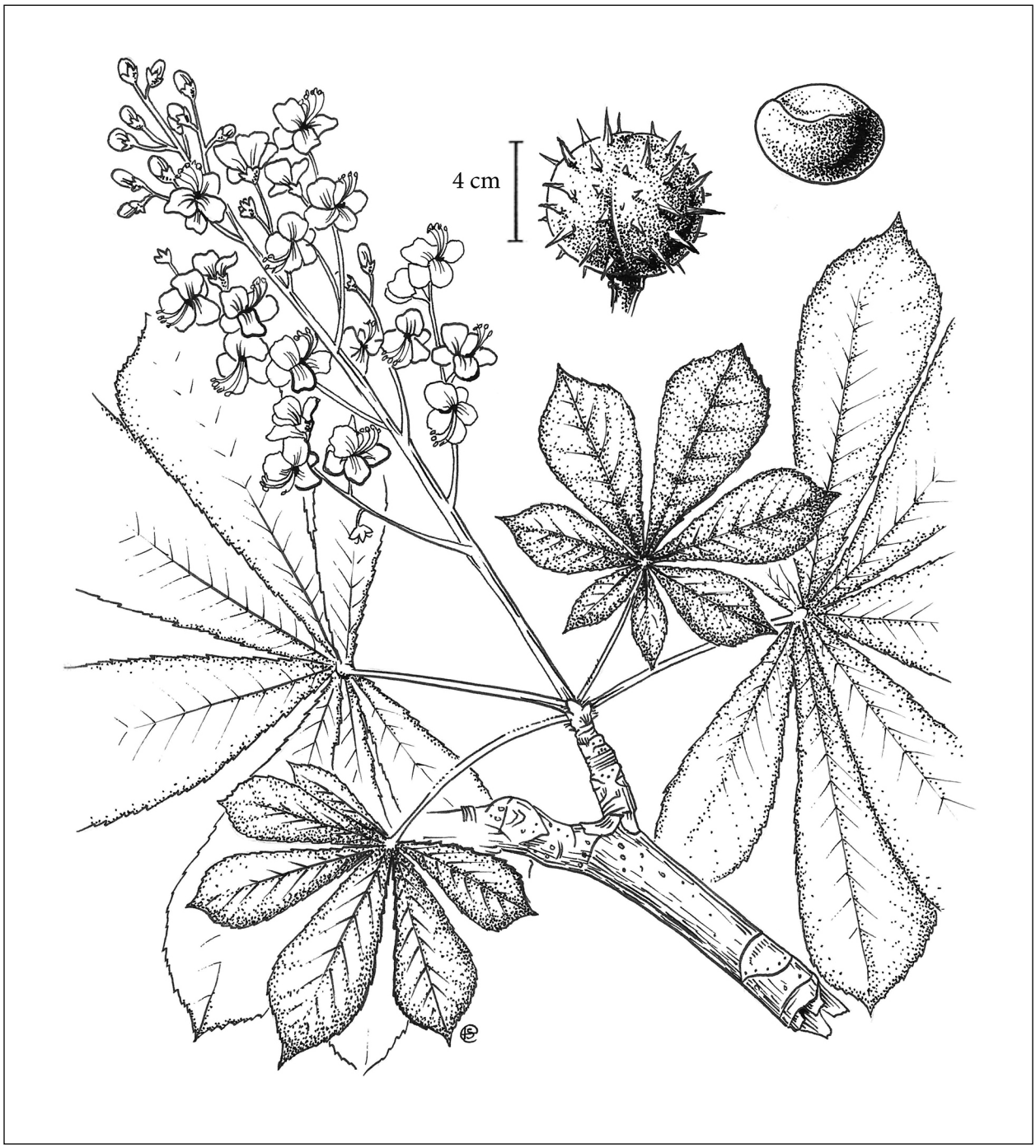
3. *Aesculus parviflora* Walt. – bottlebrush buckeye Ø

Flowering June–July. Native to the southeastern U.S. (GA, MS, SC). Occasionally planted and possibly naturalizing in the region in mesic woodlands.



Distribution of *Aesculus hippocastanum*, or horse-chestnut, recorded in the New York Metropolitan Region during three time categories.

A B



Flowering leafy twig, prickled fruit, and seed of *Aesculus hippocastanum*. Illustration by Emma Skurnick.

Ailanthus Desf. – ailanthus

Simaroubaceae. Trees. Species 5–10, native to Asia and northern Australia. Distinguished by smooth bark, large compound leaves, and samaras. *Ailanthus altissima* is the only species that can survive in temperate regions (Hu 1979). Genus name is derived from an Ambonese (South Mollucan) name meaning "tree-of-heaven," an allusion to the tree's height.

Nonnative Species

1. *Ailanthus altissima* (Mill.) Swingle – tree-of-heaven ↑↑↑

Toxicodendron altissimum Mill.

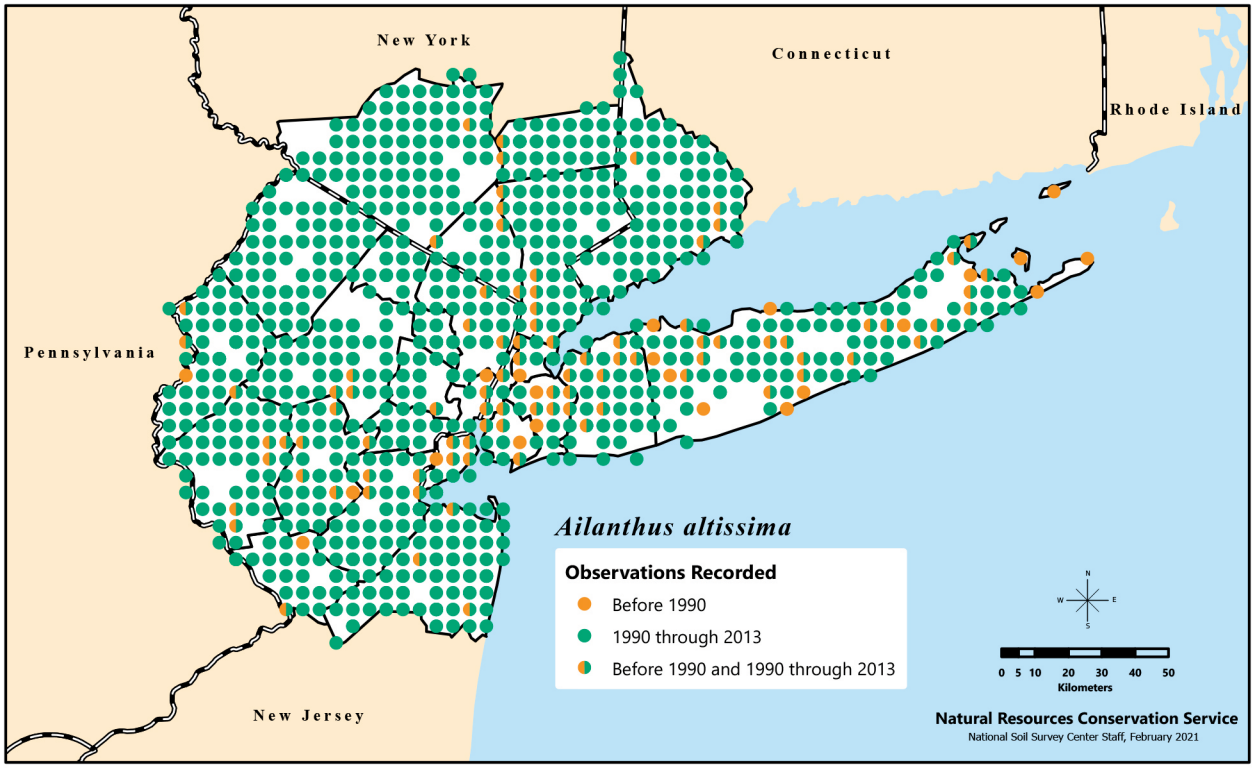
Flowering early June–early July. Male trees often flower a few days earlier than female trees within a local area. Often found in urban areas in fields, woodland edges, disturbed forests, and vacant lots, though it can survive under closed-canopy forest conditions (Knapp and Canham 2000). The Scottish horticulturist and botanist Philip Miller (1691–1771) originally misclassified this species, placing it in the poison ivy genus, *Toxicodendron* (Anacardiaceae). He did not have flowering or fruiting material for examination; in his original description he noted he was "at a loss where to place it" taxonomically (Miller 1768: TOX-TRA).

Escaped from cultivation and naturalized in Africa, Asia (beyond its native range), Europe, North America, and South America. Exhibits significant variation, especially in the leaves and fruits, resulting in numerous recognized varieties and forms (Hu 1979). Like the genus name, epithet "altissima" ("tallest" in Latin) refers to the tall heights that individuals can attain.

Large seed crops produced annually (Zasada and Little 2008). Primarily dioecious, though hermaphrodites also present with a few monoecious individuals (Dirr 1998). Pollinated by insects (ants [family Formicidae], bees [order Hymenoptera], beetles [order Coleoptera], flies [order Diptera]; Aldrich al. 2008) and wind (Maxia and Maxia 2003). Samaras travel as far as 100 m (and more rarely up to 200 m; Landenberger et al. 2007) by wind and possibly longer distances by water (Kaproth and McGraw 2008, Kowarik and Säumel 2008), although often staying on the trees through winter and into the next spring. No seed pretreatment required, but cold stratification for 30–60 days improves germination rate (Zasada and Little 2008). Seed banks unlikely due to the high germination rate, but they have been documented in a NY urban forest (Kostel-Hughes et al. 1998), and dormancy has been documented (Redwood et al. 2019). Seed longevity documented as long as 5 years in the laboratory or when buried 10 cm in field soil, but 60–70 percent of the germination occurs within the first year for seeds just under the litter layer (Rebbeck and Jolliff 2018). Prolific root sprouting and suckering with an extensive root system ensure successful asexual reproduction (Dirr 1998). Height at maturity 12–25 m.

Produces the allelopathic compounds ailanthone, ailanthinone, chaparrine, and ailanthinol B (De Feo et al. 2003). Allelopathic effects on associated species vary with species (Gomez-Aparicio and Canham 2008, Small et al. 2010) and may decrease with exposure time (Lawrence et al. 1991). Verticillium wilt caused by *Verticillium nonalfalfae* (previously identified as *V. albo-atrum*) infects and kills *Ailanthus altissima* (Schall and Davis 2009). This pathogen occurs naturally and has been documented in OH, PA, and VA (Rebbeck et al. 2013; Snyder et al. 2013, 2014). There are several hosts including native plants and crop species, such as *Aralia spinosa* (devil's walking stick), *Acer pensylvanicum* (striped maple), *Solanum tuberosum* (potato), *Spinacia oleracea* (spinach) (Inderbitzin et al. 2011, Kasson et al. 2014), *Robinia pseudoacacia* (black locust), and *Rhus typhina* (staghorn sumac) (Kasson et al. 2015), but this agent most effectively kills *A. altissima* (Kasson et al. 2015). Several insects infest *A. altissima* but do not tend to kill it, including ailanthus web worm moth, a complex of two species (*Atteva aurea* and *A. pustulella*; Wilson et al. 2010), and brown marmorated stink bug (*Halyomorpha halys*). This stink bug is an invasive species as well and *A. altissima* may be facilitating its invasion to some extent (Venugopal et al. 2014). *Ailanthus altissima* is negatively impacted by the nonnative spotted lantern fly (*Lycorma delicatula*), which may result in death; *A. altissima* may also facilitate the spread of this insect, which has many other hosts (Dara et al. 2015).

A B



Distribution of *Ailanthus altissima*, or tree-of heaven, recorded in the New York Metropolitan Region during three time categories.

Pollen is allergenic (Lewis and Elvin-Lewis 2003, Maxia and Maxia 2003) and rarely can cause contact dermatitis (Whiticar and Harvey 2009). Sap can cause myocarditis; extracts have been used to slow heart rates (Bisognano et al. 2005). Its quassinoids (biologically active compounds) have been used to treat malaria (Okunade et al. 2003), Esptein-Barr (Tamura et al. 2003), and human immunodeficiency virus (Chang and Woo 2003). Central metaphor in Betty Smith's (1943) novel "A Tree Grows in Brooklyn," due to its ability to grow well in difficult conditions.

Listed as invasive in CT (prohibited) and NJ (category 1).

Management

Increased light results in rapid growth and root suckering of *Ailanthus altissima*. Damage to existing stems (e.g., by cutting, fire, inadequate herbicide application) also tends to stimulate root suckering. Propagation from roots (as small as 1 mm diameter and 10 mm long) and, less often, stems, is likely; mechanical removal may help spread this species to new locations if plant parts remain on machinery or tools or if soil containing remnants of root or stem is moved. Living root or stem material remaining after any type of treatment may resprout. Successful removal can be difficult and may require waiting 1 growing season to determine its effectiveness. Focusing control on the seed-producing female tree may be a preferred approach, especially when funding or time is limited. Use of the naturally occurring *Verticillium nonalfalfae* as a biocontrol may be a viable option. Care should be taken to minimize the impact on native and crop species; potentially impacted native species may be among the few that could colonize the disturbed area previously invaded by *A. altissima*, and *A. altissima* populations are often adjacent to agricultural crops. The natural spread of this pathogen from inoculated *A. altissima* trees to nearby *Aralia spinosa* and *Rhus typina* has been documented at a mortality rate of 38 percent, and 29 percent of the total stems present, respectively (though some of this could be natural mortality) (Kasson et al. 2015).



Flowering leafy twig and fruit of *Ailanthus altissima*. Illustration by Emma Skurnick.

A B

Akebia Decne. – akebia

Lardizabalaceae. Vines. Species 5 native to Asia. Distinguished by alternate palmately compound leaves. Genus is unusual morphologically in that the carpels are not completely closed; closed carpels enclosing the ovule are the common condition in angiosperms (flowering plants). Genus name is derived from the Japanese word used for *Akebia quinata*.

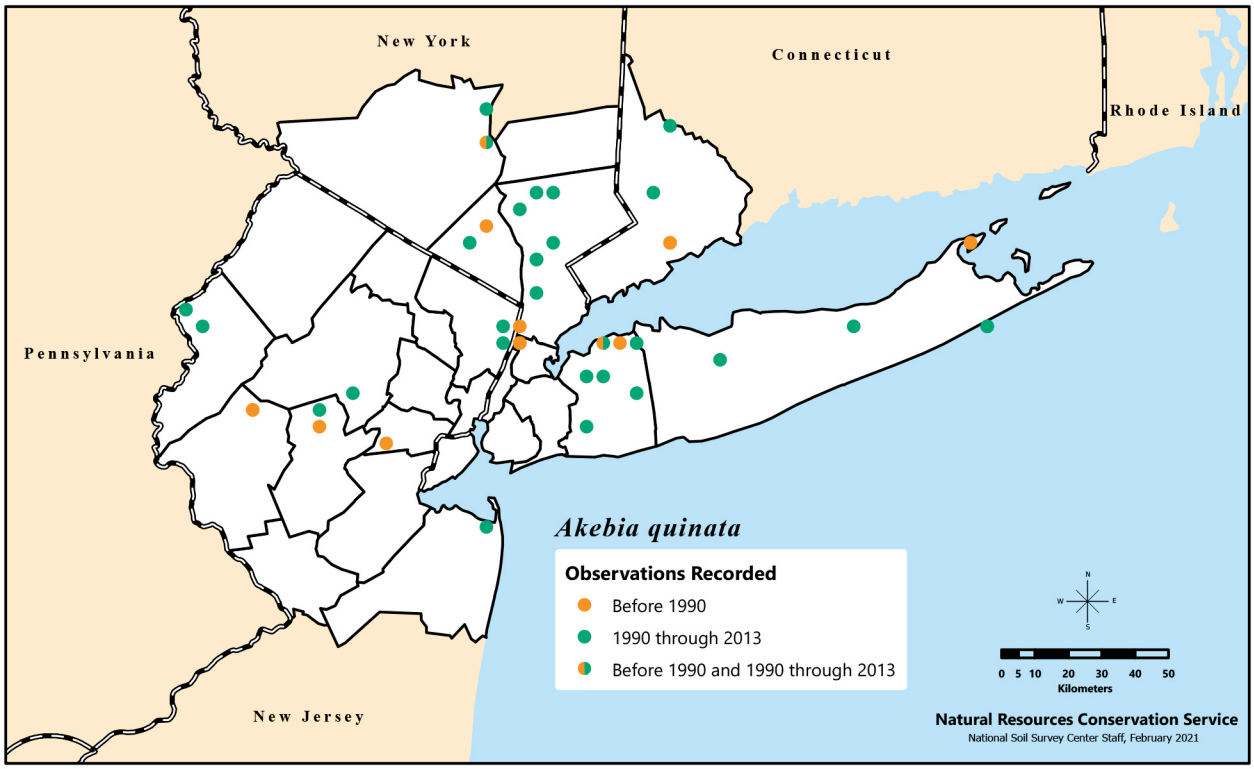
Nonnative Species

1. *Akebia quinata* (Houtt.) Dcne. – five leaf akebia ↑

Rajania quinata Houtt.

Flowering Apr.–May. Occasionally planted; sometimes spreads extensively from the original planting. May cover large areas, the vines draping over other woody vegetation much like *Pueraria montana* (kudzu). Has not been documented to spread from seed; viable seed not observed from any material in the region. In the "Flora of China" treatment (Chen and Shimizu 2001), *Akebia longeracemosa* Matsum. is recognized as distinct from *A. quinata*, and distinguished from the latter based on its subleathery, subevergreen leaves (papery and deciduous in *A. quinata*) with pale green beneath (glaucous in *A. quinata*) and large racemes to 18 cm with 20+ flowers (to 12 cm with fewer than 11 flowers in *A. quinata*). Further examination of material in the region is warranted to determine whether both species are present. Some material examined has subleathery, subevergreen leaves (see also Rhodes and Block 2007). This twining, woody vine can also serve as groundcover (Dirr 1998, Gleason and Conquist 1993). Shade- and drought-tolerant, but prefers sunny to partially shaded sites with well-drained soils (Brunel et al. 2010). Epithet from Latin refers to the five leaflets.

Monoecious. In its native China, Japan, and Korea, female flowers, which are larger than the male flowers, open 1–2 days before male flowers. Floral sex ratios in inflorescences vary within and among plants: female flowers 0–2 and male flowers 4–10. Though flowers have a sweet scent, there are no

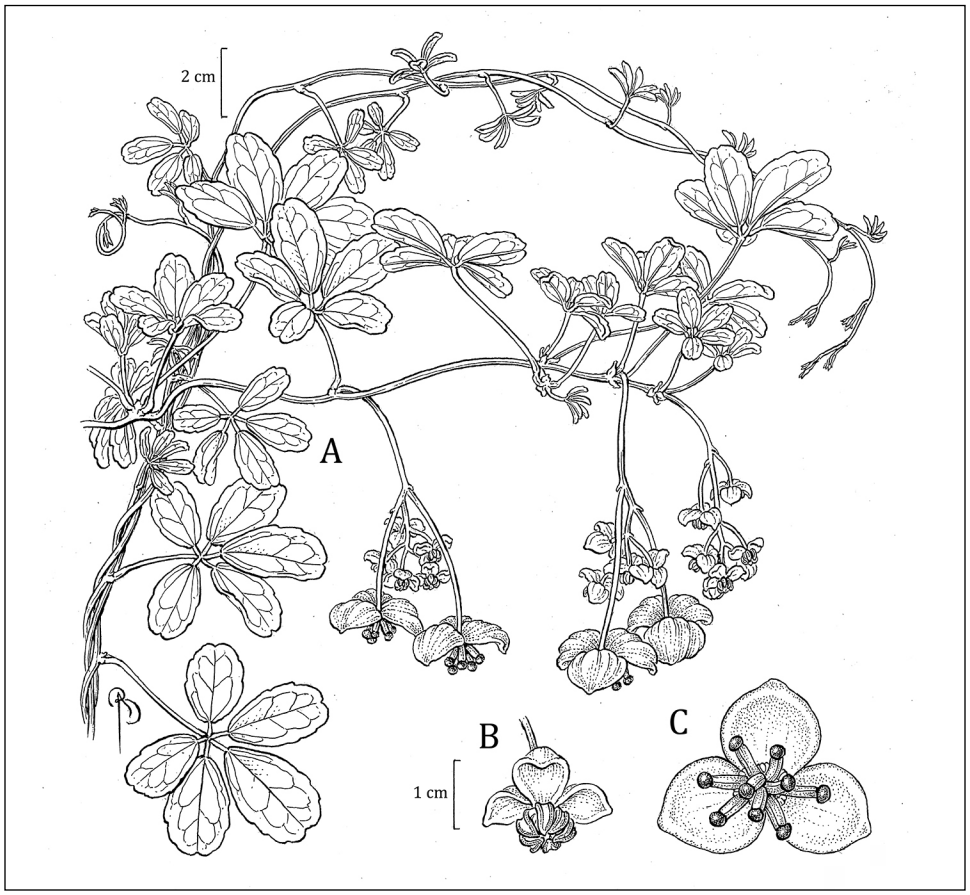


Distribution of *Akebia quinata*, or five-leaf akebia, recorded in the New York Metropolitan Region during three time categories.

nectaries; thus, pollen from the male flowers is the only reward for would-be pollinators. Flower color may be sexually dimorphic. Female flowers have deep-purple sepals and males, white sepals; plants also exist in which both sexes have white sepals. Solitary bees (*Adrena* spp.) are the primary pollinators. Pollinators usually visit the female flower of an inflorescence first and appear to distinguish the sexes based on size, though color differentiation may help. Visiting the female flower first in each inflorescence ensures outcrossing (Kawagoe and Suzuki 2002). Artificially self-pollinated flowers do not produce seed, suggesting self-incompatibility and making this species pollinator limited. Fruit contain about 200 seeds that mature Sept.–Oct. (Kawagoe and Suzuki 2005) and are dispersed by mammals, birds, and ants (family Formicidae) (Nakanishi 1988). Though species spreads by seed, limitations in seed production indicate dependence on vegetative reproduction, with which it spreads primarily by stolons (Dirr 1998). Cultivated since 1845, with at least 3 cultivars (Dirr 1998).

Management

Though *Akebia quinata* is on several State invasive plant lists and worldwide lists, its relative invasiveness needs further study. This species is also known to invade riparian areas in France (Brunel et al. 2012), is a new invasive to Slovenia (Glasnović and Pečnikar 2010), and is problematic enough to be placed on an observation list for the entire Mediterranean region (Brunel et al. 2012). In the NY Metropolitan Region, there is a huge, persisting population covering several hectares of a forested slope in Worthington State Forest. Species should be watched as an invasive and removed when resources permit. Cutting stems near ground level and applying a herbicide to prevent resprouting has been effective. If herbicide cannot be applied, repeated cutting often weakens the plants.



A) Flowering leafy stem, B) male flowers, and C) female flower of *Akebia quinata*. Illustration by Bobbi Angell.

A B

Albizia Durazz. – mimosa

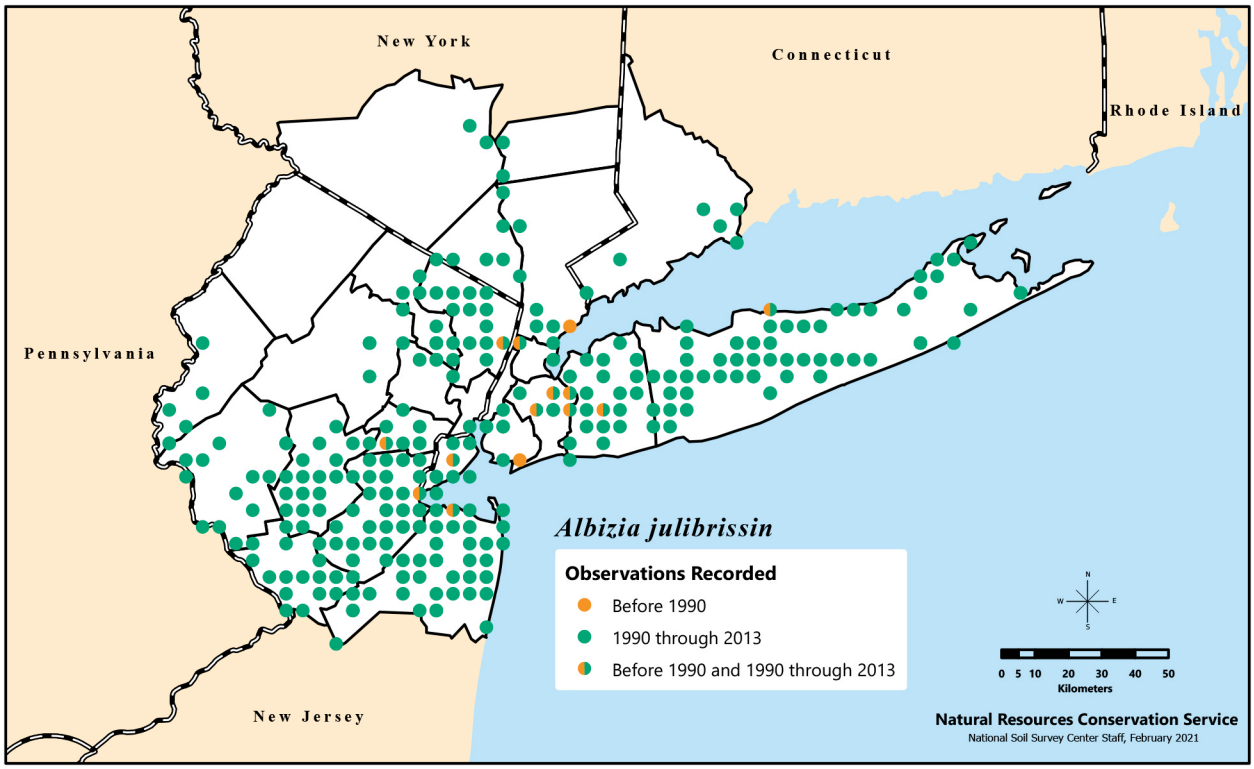
Fabaceae s.l. (Mimosaceae). Trees, shrubs. Species approximately 150 in chiefly tropical and subtropical areas of Africa, Asia, Australia, Madagascar, North America, and South America; greatest diversity in the Eastern Hemisphere tropics. Distinguished by bipinnate leaves and showy globose clusters of small flowers. Genus named after the Florentine nobleman Sig. Filippo degl'Albizzi, who introduced it into cultivation in the 1700s. As a result, the name is sometimes corrected from the Italian botanist Antonio Durazzini's (1740–1810) original spelling to Albizzia; however, doing so is considered an incorrect spelling (Barneby and Grimes 1996, Brummitt and Taylor 1990).

Nonnative Species

1. *Albizia julibrissin* Durazz. – mimosa ↑↑↑

Flowering June–Aug. Native to tropical Asia. Reaches northern limit of its nonnative range in the eastern U.S. in southern NY (generally unable to withstand temperatures below -21 °C). Occasionally planted and naturalized in disturbed uplands under a variety of soil conditions. Epithet is a modification of a Persian name for the species.

Introduced into the U.S. in 1745 (Dirr 1998). André Michaux of France brought seeds from Persia (now Iran) and gave them to William Bartram of Philadelphia, PA, who shared them with Thomas Jefferson. Michaux also planted the tree in his botanic gardens in Charleston, SC (Cothran 2004). Remains a popular tree of the southern states, but there is extensive mortality, and survival is primarily as root sprouts (Dirr 1998). Fixes nitrogen via nodule-forming rhizobia, with evidence that some of the associated rhizobia spp. may be novel (Wang et al. 2006). Pollinated by insects or birds. Matures and senesces within 10–20 years (Irwin et al. 2003). Seeds have physical dormancy; may form a seed bank that may last as long as 67 years (Fordham 1965). Cultivated in the northeastern U.S. since 1918 (DeWolf 1968), with at least 4 cultivars (Dirr 1998).

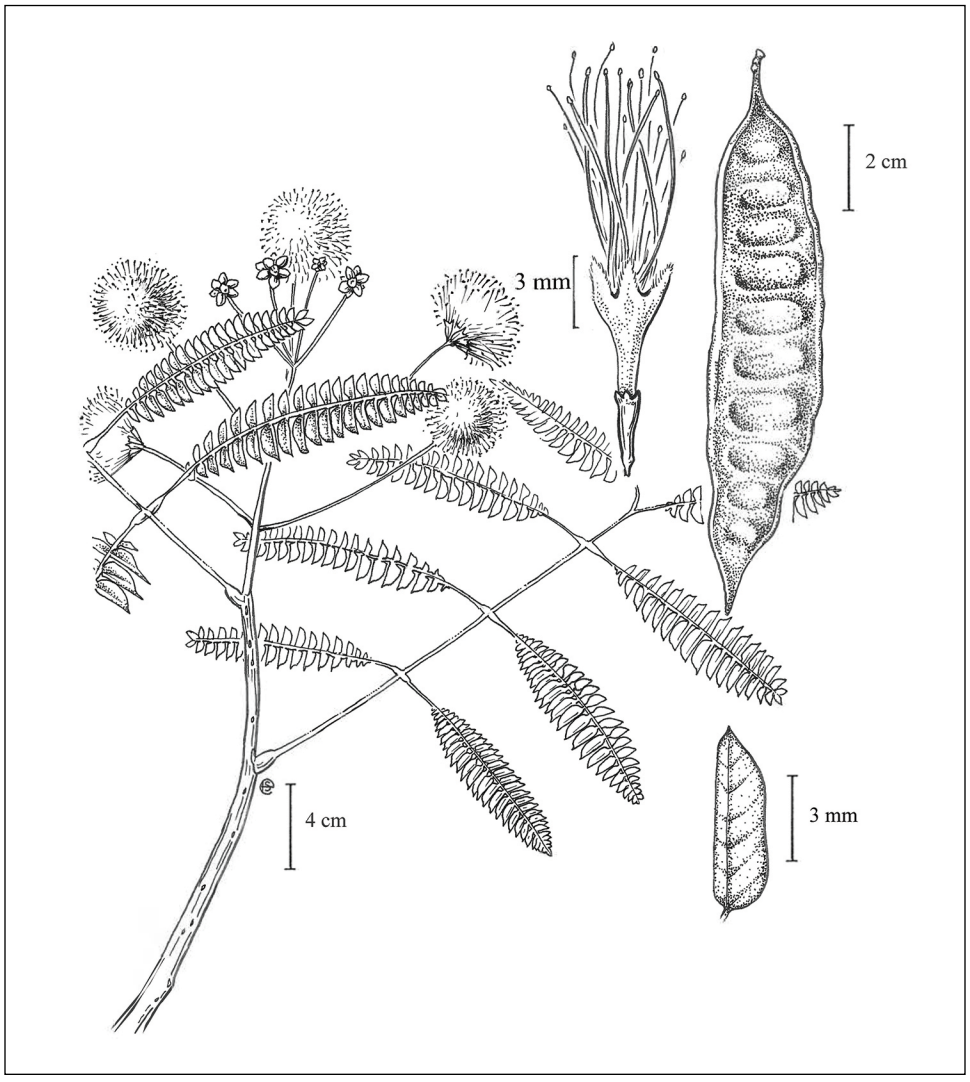


Distribution of *Albizia julibrissin*, or mimosa, recorded in the New York Metropolitan Region during three time categories.

Susceptible to the fungus *Fusarium* or wilt disease. In 1940, mimosa webworm (*Homadaula anisocentra*) was the first generalist immigrant insect found to feed on *Albizia julibrissin* (Clarke 1943, Hoebeke and Wheeler 2011). The first detection of a nonnative specialist predator, east palearctic seed beetle (*Bruchidius terrenus*), on *A. julibrissin* seed was reported in 2009 (Hoebeke et al. 2009). This is considered a "reassociation" of a predator with its host: an accidental introduction of a potential biocontrol of *A. julibrissin* 225 years after the introduction of this invasive plant (Chang et al. 2011). This beetle is also being reported as a reassociation with the nonnative *A. julibrissin* in Bulgaria (Stojanova 2014). Another specialized reassociation has been documented for the buprestid beetle (*Agrilus subrobustus*), of which *A. julibrissin* is its only known host (Hoebeke and Wheeler 2011, Westcott 2007).

Management

Because of *Albizia julibrissin*'s vulnerability to disease and now reassociations with predators, its invasive capacity may be limited. In addition, cold temperatures could further limit its expansion into the region, though the noted increase in the abundance over our measured time-period does not support this. Moreover, this species may continue to be promoted as a forage species for livestock, meaning disease- and predator-resistant cultivars may persist, be developed by plant breeders, or develop naturally over time. If trees are allowed to attain maturity as forage crops, the invasive potential could spread. However, its use as a forage crop in more northern regions is very uncommon or may not occur. This species resprouts vigorously after a fire, but herbicide can be an effective control (Koepke-Hill et al. 2012).



Flowering twig with leaves, flower, fruit, and leaf of *Albizia julibrissin*. Illustration by Emma Skurnick.

Alnus Mill. – alder

Betulaceae. Trees, shrubs. Species 25–40, boreal in Northern Hemisphere, primarily higher elevations elsewhere; Asia, Europe, North America, and South America. Readily recognized in the field by its infructescences composed of woody scales (superficially resembling some female cones of gymnosperms) persisting long after dispersal of the small samaras. Roots associate with an actinobacterium (*Frankia alni*) leading to nitrogen fixation (Weber et al. 1987). "Alnus" is the ancient Latin name for the genus.

Native Species

1. *Alnus incana* subsp. *rugosa* (DuRoi) R.T.Clausen – speckled alder ↑

Betula alnus var. *rugosa* DuRoi; *Alnus rugosa* (DuRoi) Spreng.; *Alnus rugosa* (DuRoi) Spreng. var. *americana* (Regel) Fernald

Shrub. Flowering Mar.–Apr. Numerous wetland habitats, usually not in dense shade. Prefers cooler climates (Mandák et al. 2016). Not commonly found on the Coastal Plain. In cultivation since 1769, but rarely cultivated (Dirr 1998). See next entry for discussion of hybridization with *Alnus serrulata*. Species epithet is Latin for "gray" or "gray-haired."

2. *Alnus serrulata* (Dryand. ex Aiton) Willd. – smooth alder, hazel alder ↑↑

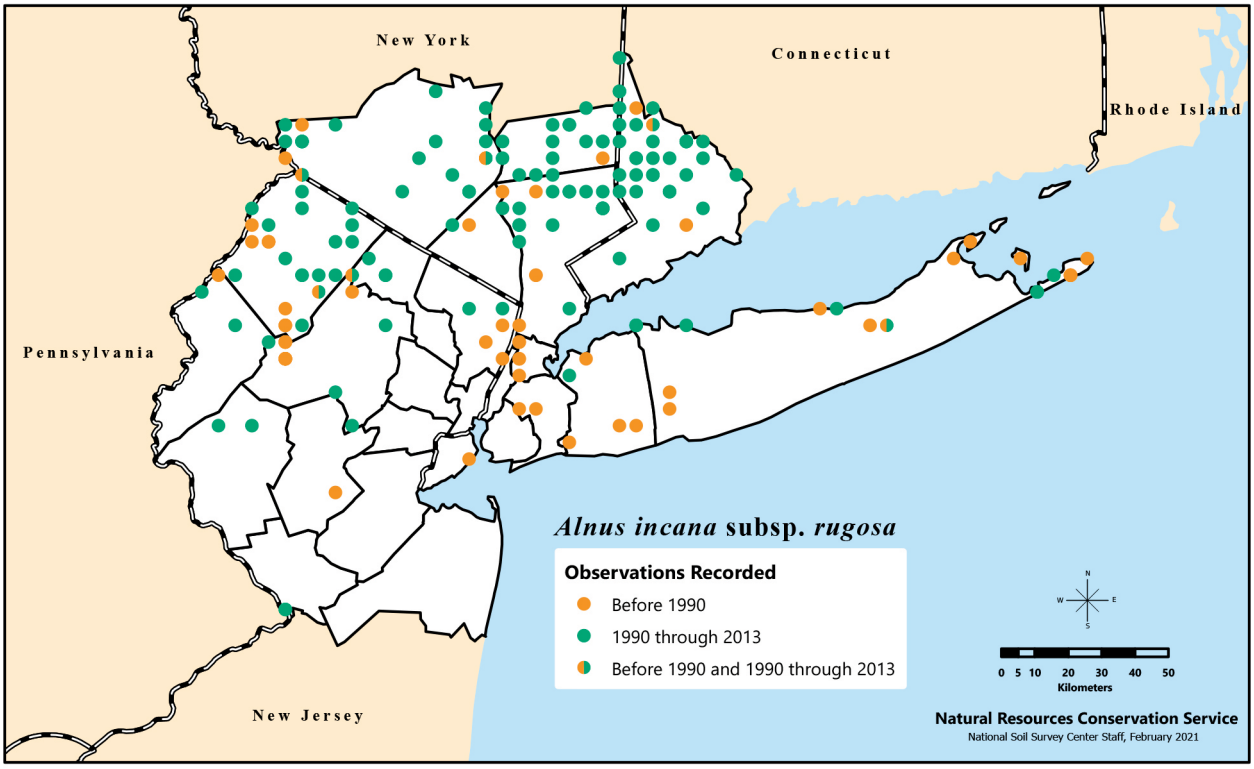
Betula serrulata Dryand. ex Aiton; *Alnus noveboracensis* Britton; *Alnus serrulata* f. *noveboracensis* (Britton) Fernald

Shrub. Flowering Mar.–Apr. Common throughout the region in many habitats similar to the preceding entry; unlike the preceding species, it is common on the Coastal Plain. Boreal, but can inhabit warmer areas than preceding species (Mayle et al. 1993). Not typically cultivated, though it can colonize wet areas quickly (Dirr 1998).

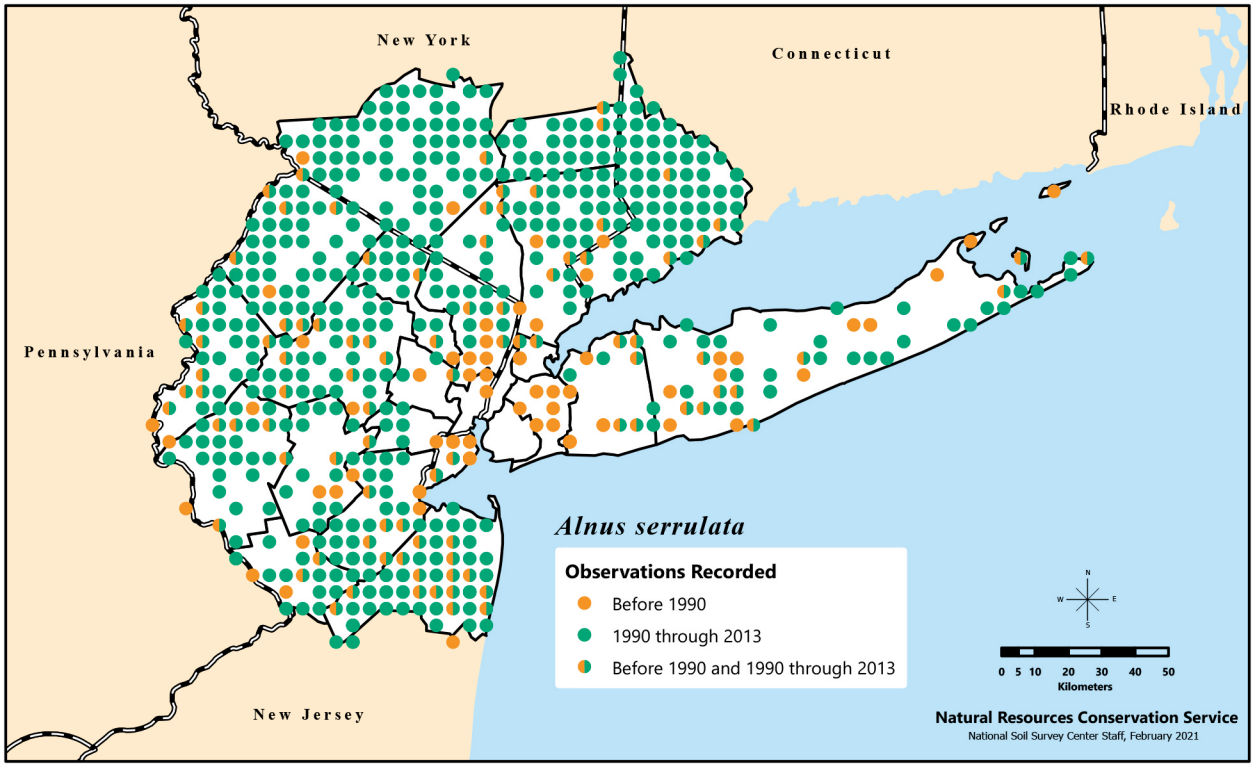
Can hybridize with *Alnus incana* subsp. *rugosa*. Some believe *A. serrulata* var. *subelliptica* Fernald represents this hybrid, although Fernald (1945) did not include this hybrid in his treatment. Callier (1911) directly described the hybrid as *A. ×fallacina*. *Alnus noveboracensis* Britton (1904), a striking variant originally described from material on Staten Island, has leaves that are densely and permanently pubescent beneath (typically the leaves are glabrous or glabrescent). Substantial increases of *A. serrulata* may be due to deforestation in wetland areas.

Alnus Key

1. Single-trunked tree . . . . . ***Alnus glutinosa****
1. Multistemmed shrub 2
2. Leaves doubly serrate, undersides not resin-coated;
   bark dark grayish to reddish-brown, with prominent whitish lenticels . . ***Alnus incana* subsp. *rugosa***
2. Leaves simply serrate or serrulate, undersides resin-coated;
   bark light gray, without prominent lenticels 3
3. Winter buds stalked (this condition also present in *A. incana* and *A. glutinosa*);
   leaves serrulate, mostly obovate, apices rounded . . . . . ***Alnus serrulata***
3. Winter buds sessile or subsessile;
   leaves serrate, mostly ovate, apices acute . . . . . ***Alnus viridis* subsp. *crispa****

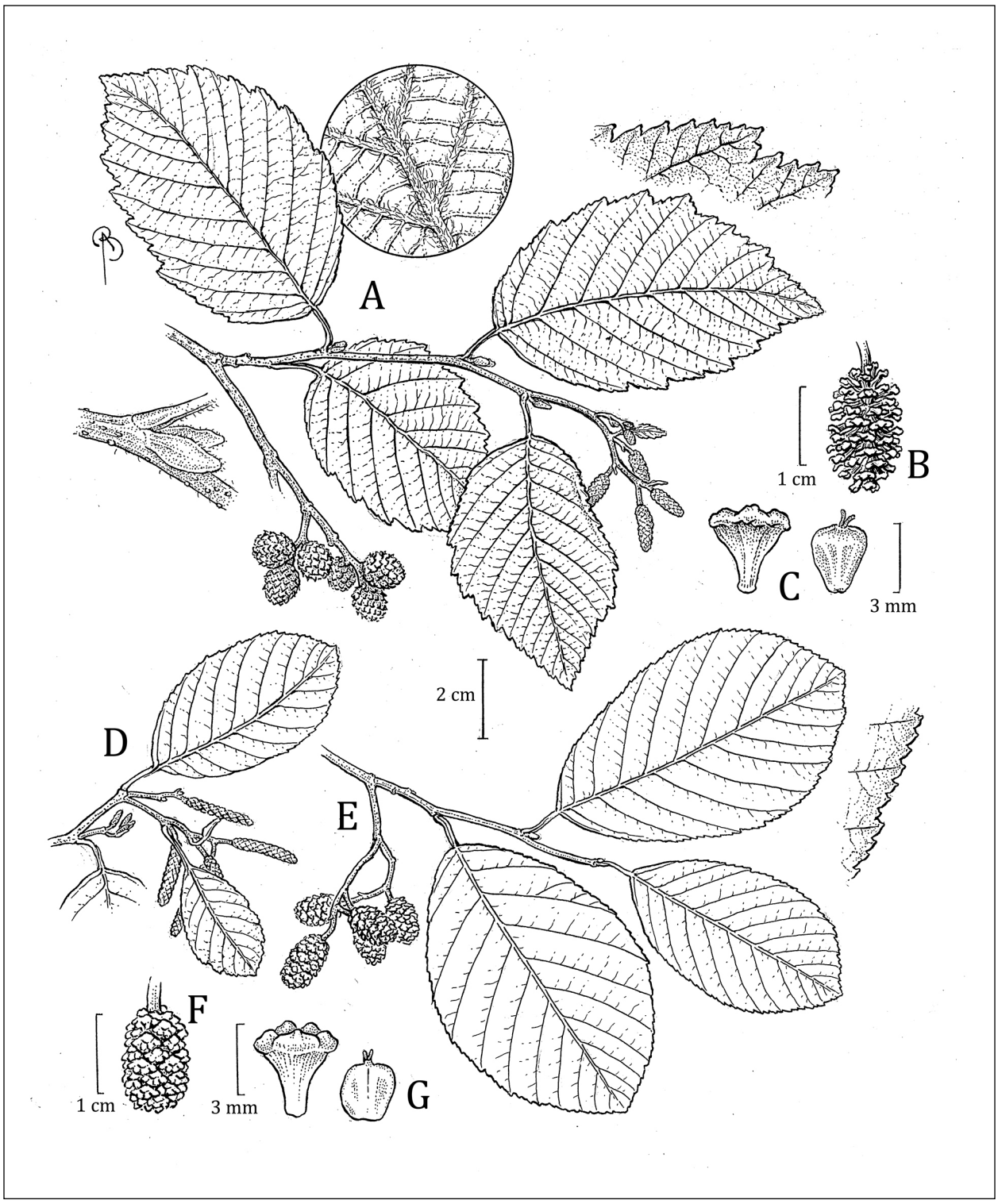


Distribution of *Alnus incana* subsp. *rugosa*, or speckled alder, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Alnus serrulata*, called smooth or hazel alder, recorded in the New York Metropolitan Region during three time categories.

A B



A) Leafy twig with enlarged views of winter buds, underside, and margin; staminate and pistillate catkins; B) mature fruiting catkin (“cone”); and C) floral bract and nutlet of *Alnus incana* subsp. *rugosa*; D) leafy twig with staminate catkins; E) leafy twig with pistillate catkins and enlarged view of leaf margin; F) mature fruiting catkin (“cone”); and G) floral bract and nutlet of *Alnus serrulata*. Illustration by Bobbi Angell.

Nonnative Species

3. *Alnus glutinosa* (L.) Gaertn. – black alder ↑

Betula alnus var. *glutinosa* L.

Tree. Flowering Mar.–Apr. Open wetlands and borders of wetlands. Boreal (Heide 2003). Epithet from Latin refers to gumminess of young branchlets and expanding leaves. Native to Europe. Cultivated since 1860, with at least 5 cultivars (Dirr 1997). Those found in the region are new and most likely planted for landscaping purposes.

***Alnus viridis* subsp. *crispa* (Aiton) Turrill – green alder, mountain alder**

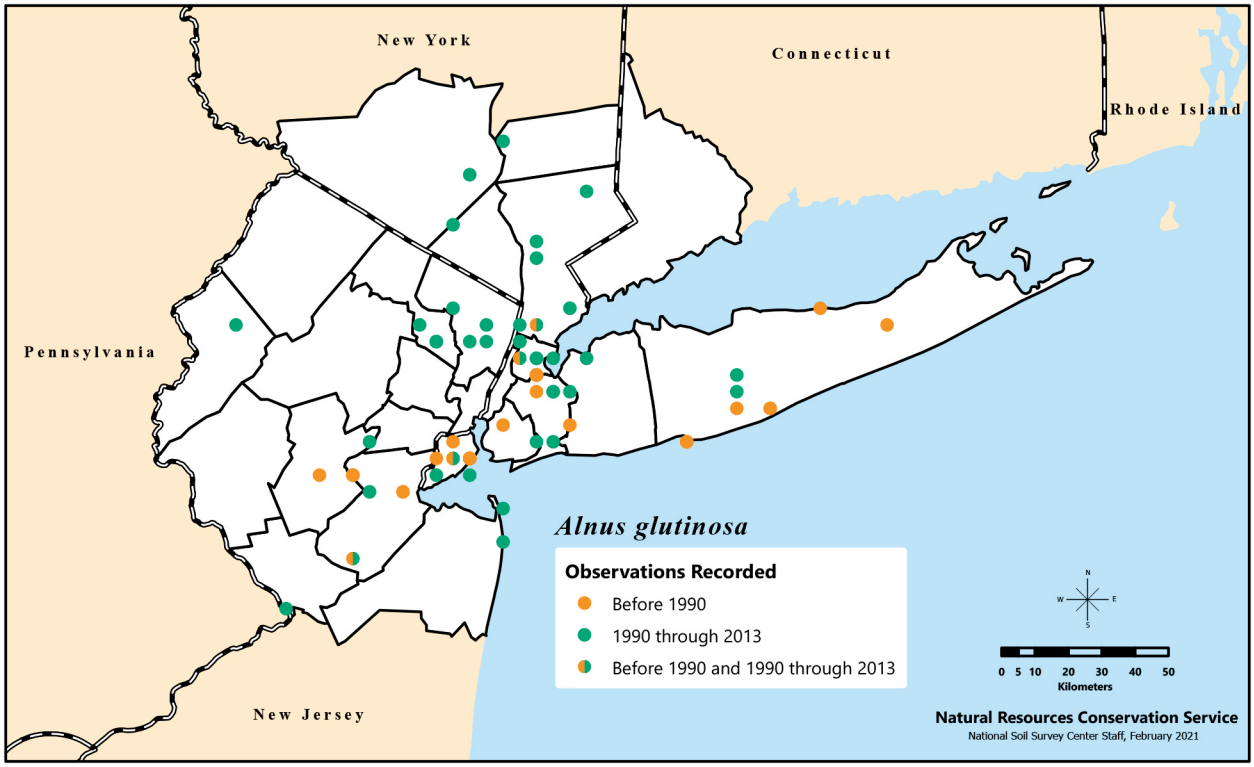
Betula viridis Aiton

Another nonnative in the region, but native north of this region; reported once as an escape or persistent from cultivation on Long Island in Nassau County (NY).

Amelanchier Medik. – Juneberry, shadbush, serviceberry

Rosaceae. Small trees, shrubs. Species approximately 20 in Europe and North America. Distinguished by showy white flowers appearing in spring (often before or concurrent with the leaves) and blue to purple juicy pome fruits. “Amelanchier” is a Provençal name for a European species.

Species identification can be exceedingly difficult, due to cytological variability and apomixis (Campbell et al. 2014). Flowering material is essential for proper identification and the species are usually in bloom for only 1–2 weeks during the spring. Some species produce excellent palatable fruit, whereas others do not, and some species vary from population to population. Genus is also vulnerable to infection from rust species in the genus *Gymnosporangium*, especially in areas where there is *Juniperus*, the alternate host of



Distribution of *Alnus glutinosa*, or black alder, recorded in the New York Metropolitan Region during three time categories.

A B

Amelanchier Key

1. Inflorescence erect 2
1. Inflorescence drooping 3
2. Ovary summit glabrous 4
2. Ovary summit pubescent 5
3. Stems less than 2 m tall . . . . . ***Amelanchier nantucketensis***
3. Stems 2 m or taller 6
4. Clumped shrub or small tree; stem height 2 m or more; petals 5–12 mm . . . . . ***Amelanchier canadensis***
4. Colonial shrub; stem height less than 2 m tall; petals 3–7 mm . . . . . ***Amelanchier obovalis***
5. Veins not ending in teeth . . . . . ***Amelanchier spicata***
5. Veins ending in teeth 7
6. Ovary summit pubescent; young branchlets reddish . . . . . ***Amelanchier sanguinea***
6. Ovary summit glabrous; young branchlets grayish 8
7. Pedicels more than 1 cm at anthesis; native species . . . . . ***Amelanchier humilis***
7. Pedicels less than 1 cm at anthesis; planted species . . . . . ***Amelanchier alnifolia****
8. Leaves at anthesis tomentose beneath, green . . . . . ***Amelanchier arborea***
8. Leaves at anthesis tomentose beneath, with a coppery hue; fruit juicy . . . . . ***Amelanchier laevis***

the rust. Fruits infected with the rust have orange protrusions and are not palatable. By far the most common species in the region are *Amelanchier arborea* and *A. canadensis*; the former is more frequent off the Coastal Plain and the latter more common on the Coastal Plain. The other species (spp. 3–8) are much less often encountered. Another species, *A. bartramiana* (Tausch) M.Roem. (oblong serviceberry), although not reported from the NY Metropolitan Region, has been reported in nearby Monroe (PA), Sullivan (NY), and Ulster (NY) Counties; it differs from all other *Amelanchier* spp. in the region by having flowers not in racemes but in few-flowered (1–4) bracteate fascicles.

Native Species

1. *Amelanchier arborea* (F.Michx.) Fernald – downy shadbush ↑↑↑

Mespilus arborea F.Michx.

Shrub, small tree. Flowering Apr.–May; fruiting June–July. Upland to mesic woodlands; more common off the Coastal Plain. Prefers moist, well-drained acidic soils. Tolerates full sun and partial shade (Dirr 1998). Species includes diploid (2n=34) and tetraploid individuals (2n=68) (Campbell et al. 2014).

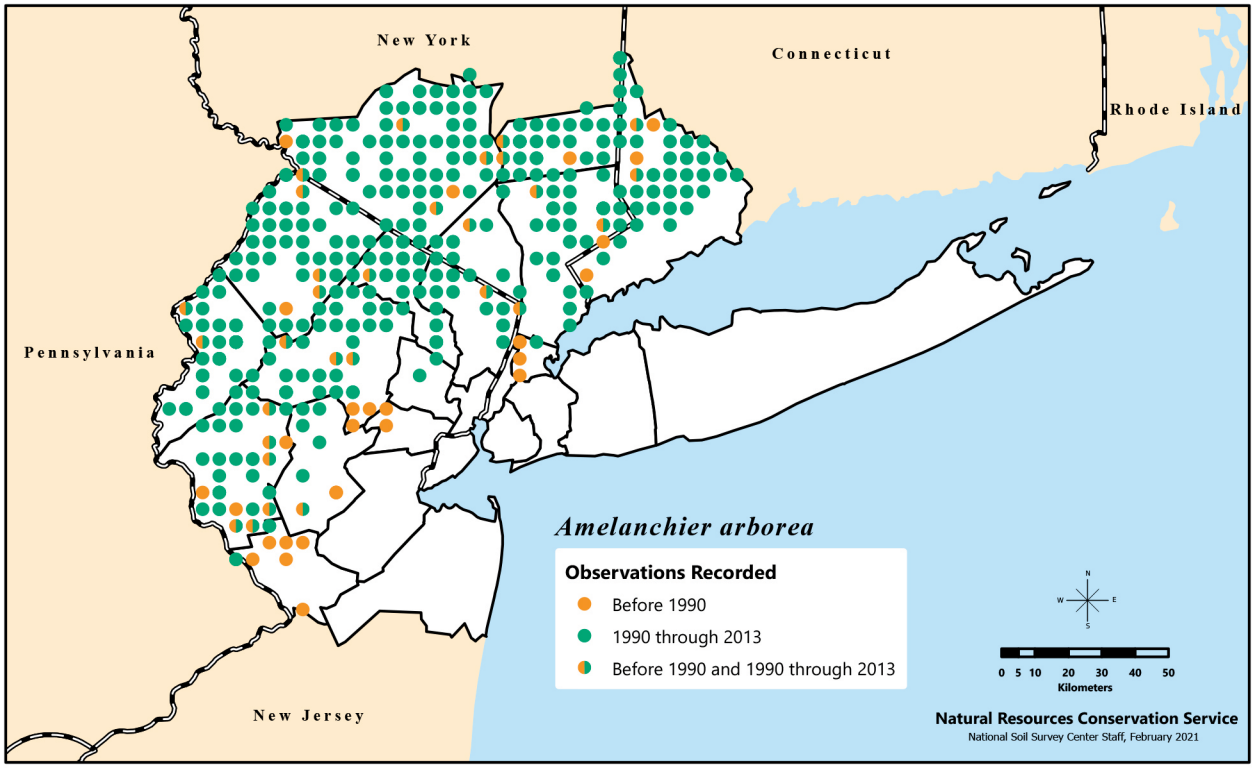
One of the first small trees to flower in spring. Flowers are perfect (Dirr 1998). Mostly self-incompatible (Gorchov 1985). Fruits are black and sweet and make a tasty pie, but are difficult to collect before birds consume them (Dirr 1998). Height at maturity 18 m (Brinkman and Strong 2008). Not likely to be found in seed banks (Hall et al. 2010). Cold stratification for 90–120 days recommended for germination. Cultivated since 1746 (Dirr 1998), with at least 13 cultivars. May hybridize with *Amelanchier canadensis*, *A. humilis*, and *A. laevis* (Campbell et al. 2014). Increases may be associated with increases in forest area.

2. *Amelanchier canadensis* (L.) Medik. – eastern serviceberry ↑

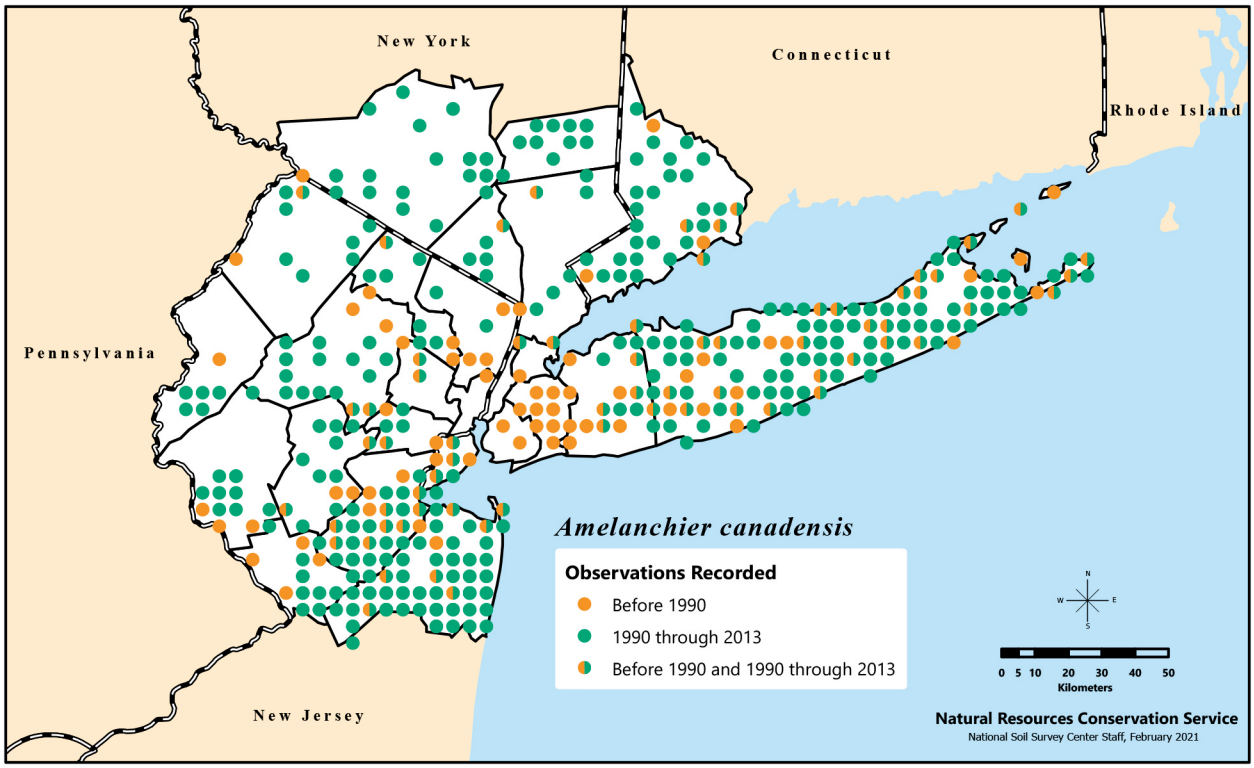
Mespilus canadensis L.

Shrub, small tree. Flowering Apr.–May; fruiting May–June. Mesic woodlands and woodland edges; more common on the Coastal Plain. Species includes diploid (2n=34) and tetraploid individuals (2n=68) (Campbell et al. 2014).

Self-compatible and capable of apomixis (Campbell et al. 1987). Although much shrubbier due to its tendency to root sucker, it is often confused with *Amelanchier arborea*. *Amelanchier*



Distribution of *Amelanchier arborea*, or downy shadbush, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Amelanchier canadensis*, or eastern serviceberry, recorded in the New York Metropolitan Region during three time categories.

A B

canadensis flowers about 1 week after *A. arborea*; fruit black, juicy, and sweet (Dirr 1998). Height at maturity 8 m (Brinkman and Strong 2008).

Amelanchier intermedia Spach, which has been reported from the region, has been treated as a synonym of *A. canadensis*, as a hybrid between *A. arborea* or *A. laevis* and *A. canadensis* (Gleason and Cronquist 1993, Landry 1975), or as a distinct species (Campbell et al. 2014, Fernald 1950). Amelanchier intermedia is similar to *A. canadensis* in having the racemes ascending, and it differs from both *A. arborea* and *A. canadensis* in having the leaves somewhat well developed at anthesis (somewhat similar to *A. laevis*) and purple-tinged.

3. *Amelanchier humilis* Wieg. – bush Juneberry Ø

Shrub, small tree. Flowering Apr.–May; fruiting May–July. Open, often calcareous, woodlands. Exceptionally rare in the region; currently known only from Bergen (NJ), Orange (NY), Sussex (NJ), and Warren Counties (NJ). Species includes diploid (2n=34) and tetraploid individuals (2n=68) (Campbell et al. 2014). Epithet from Latin refers to the species' low-growing nature (less than 1 m).

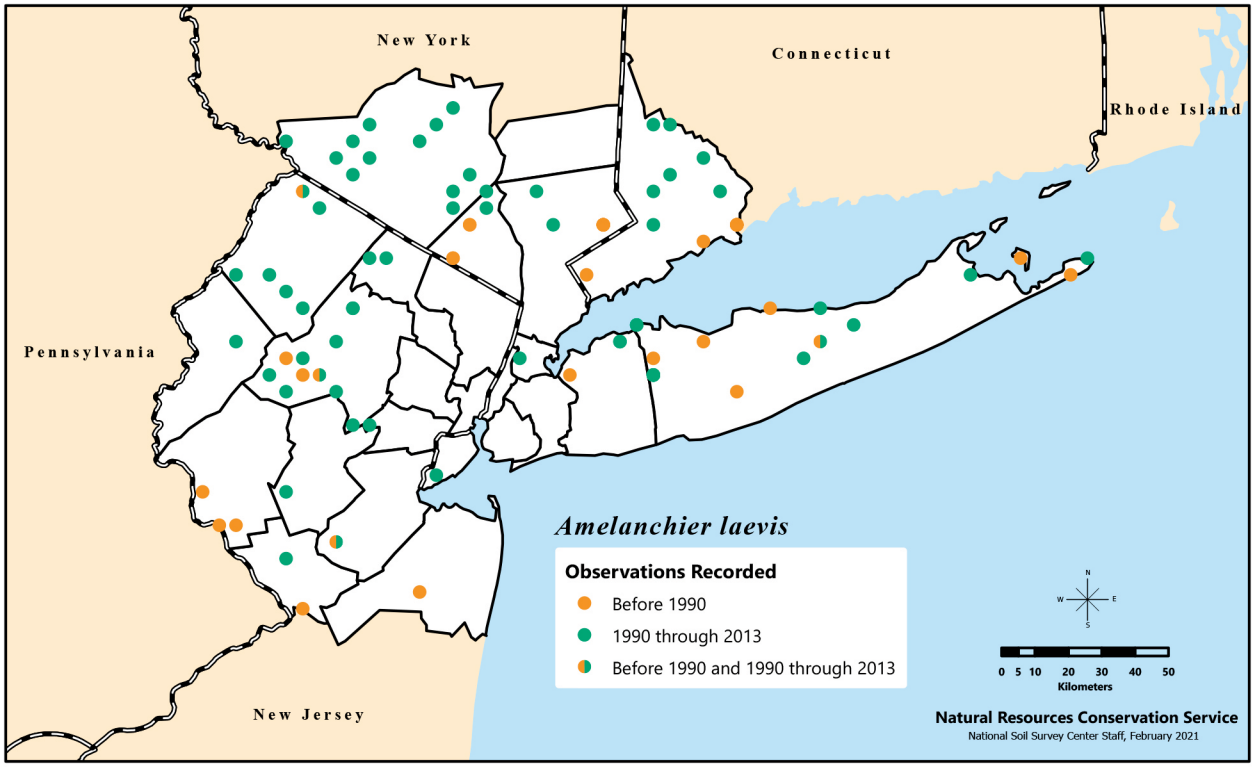
Strongly rhizomatous with root suckering (Campbell et al. 2014). May hybridize with *Amelanchier arborea* and *A. spicata* (Fernald 1950).

Tracked as imperiled in NJ (S1S2).

4. *Amelanchier laevis* Wieg. – smooth shadbush ↑

Shrub, small tree. Flowering Apr.–May; fruiting May–June. Dry to mesic upland woodlands. Species includes diploid (2n=34) and tetraploid individuals (2n=68) (Campbell et al. 2014). Epithet from Greek refers to the plant's glabrous nature.

Self-compatible with some apomixis (Campbell et al. 1987). Fruit also black and sweet (Dirr 1998). When co-occurring with *Amelanchier arborea*, *A. laevis* consistently flowers earlier. Height at maturity 9 m (Brinkman and Strong 2008).



Distribution of *Amelanchier laevis*, or smooth shadbush, recorded in the New York Metropolitan Region during three time categories.

5. *Amelanchier nantucketensis* Bicknell – Nantucket shadbush ↓

Amelanchier oblongifolia var. *micropetala* B.L.Rob.; *Amelanchier stolonifera* f. *micropetala* (B.L.Rob) Rehd.

Shrub. Flowering Apr.–May; fruiting May–June. Rare on the Coastal Plain in pine barren woodlands and woodland edges. Known from scattered locations in ME, MA, MD, NJ, and NY. Epithet refers to Nantucket Island, where the species was first discovered.

Some have suggested that *Amelanchier nantucketensis* represents a hybrid between *A. canadensis* and *A. spicata*. One most unusual character that is generally observed in this species is andropetaly, the presence of microsporangia on micropetals. The petal-borne pollen is viable and is taken by a group of native bees (order Hymenoptera) (Dibble and Drummond 1997). Species can also be self-compatible and apomictic (Campbell et al. 1987). Species is tetraploid (2n=68) (Campbell et al. 2014).

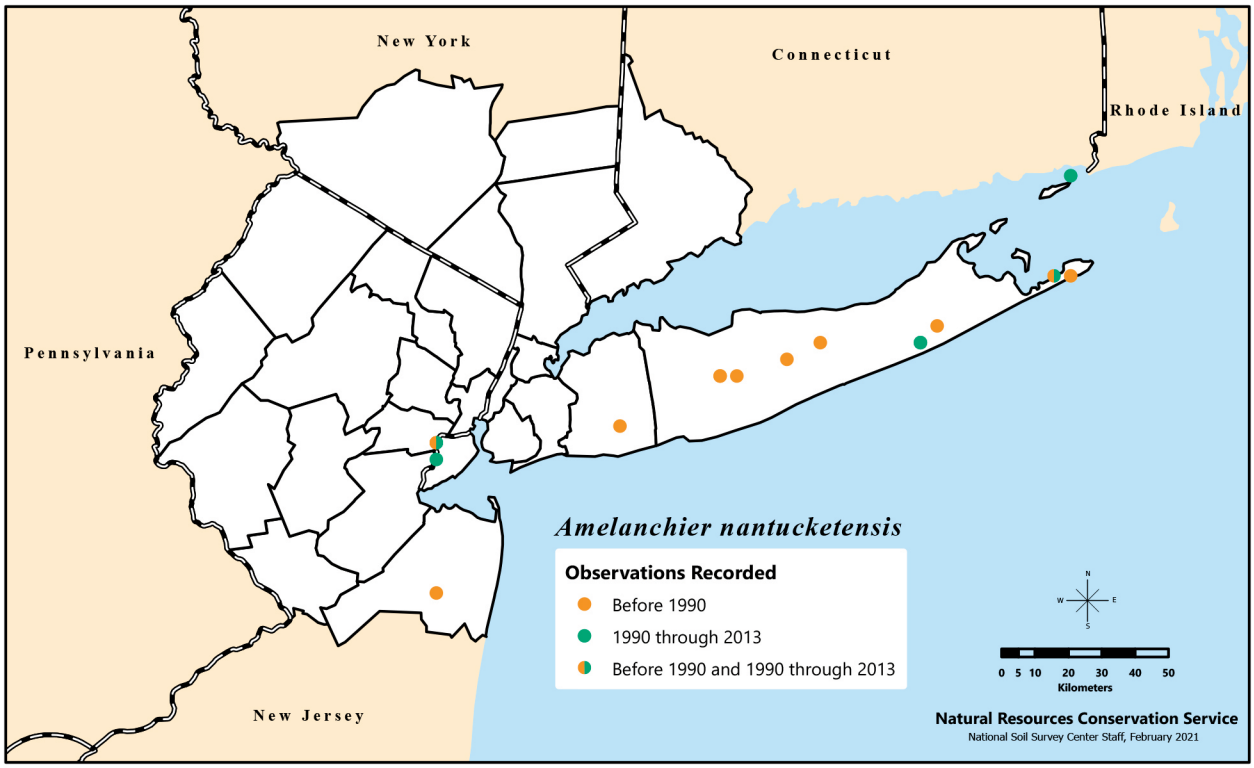
Listed as endangered in NY (S1); tracked as possibly globally rare (G3?) and critically imperiled in NJ (S1).

6. *Amelanchier obovalis* (Michx.) Ashe – coastal Juneberry Ø

Mespilus canadensis var. *obovalis* Michx.; *Amelanchier botryapium* var. *obovalis* (Michx.) Farw.; *Amelanchier canadensis* subsp. *obovalis* (Michx.) P.Landry; *Amelanchier canadensis* var. *obovalis* (Michx.) Britton et al.

Shrub. Flowering Apr.–May; fruiting May–June. Rare on the Coastal Plain of NJ in dry, open pine barren woodlands. Historically and currently known from Middlesex and Monmouth Counties.

The species is chiefly diploid (2n=34) but some material of 3n=51 has also been reported (Campbell et al. 2014). When co-occurring with



Distribution of *Amelanchier nantucketensis*, or Nantucket shadbush, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Mercer and Passaic Counties (NJ).

A B

Amelanchier canadensis, *A. obovalis* consistently flowers later than *A. canadensis*. May hybridize with *A. canadensis* (Frye 2006), and Campbell et al. (2014) treated *A. obovalis* as a variety of *A.* canadensis.

7. *Amelanchier sanguinea* (Pursh) DC. – New England serviceberry Ø

Pyrus sanguinea Pursh

Shrub, small tree. Flowering Apr.–May; fruiting May–June. Exceptionally rare in the region in open, rocky woodlands; may be a boreal or high-elevation species that is declining in the region. Epithet from Latin means "blood red," a reference to the reddish young branchlets.

Species includes diploid (2n=34) and tetraploid individuals (2n=68), as well as triploid material (3n=51) (Campbell et al. 2014). Fruit black and very sweet at maturity (Nielsen 1939). Height at maturity 3 m (Brinkman and Strong 2008).

Confirmed from Orange and Rockland Counties (NY) and Sussex County (NJ). Reports from Long Island require further study.

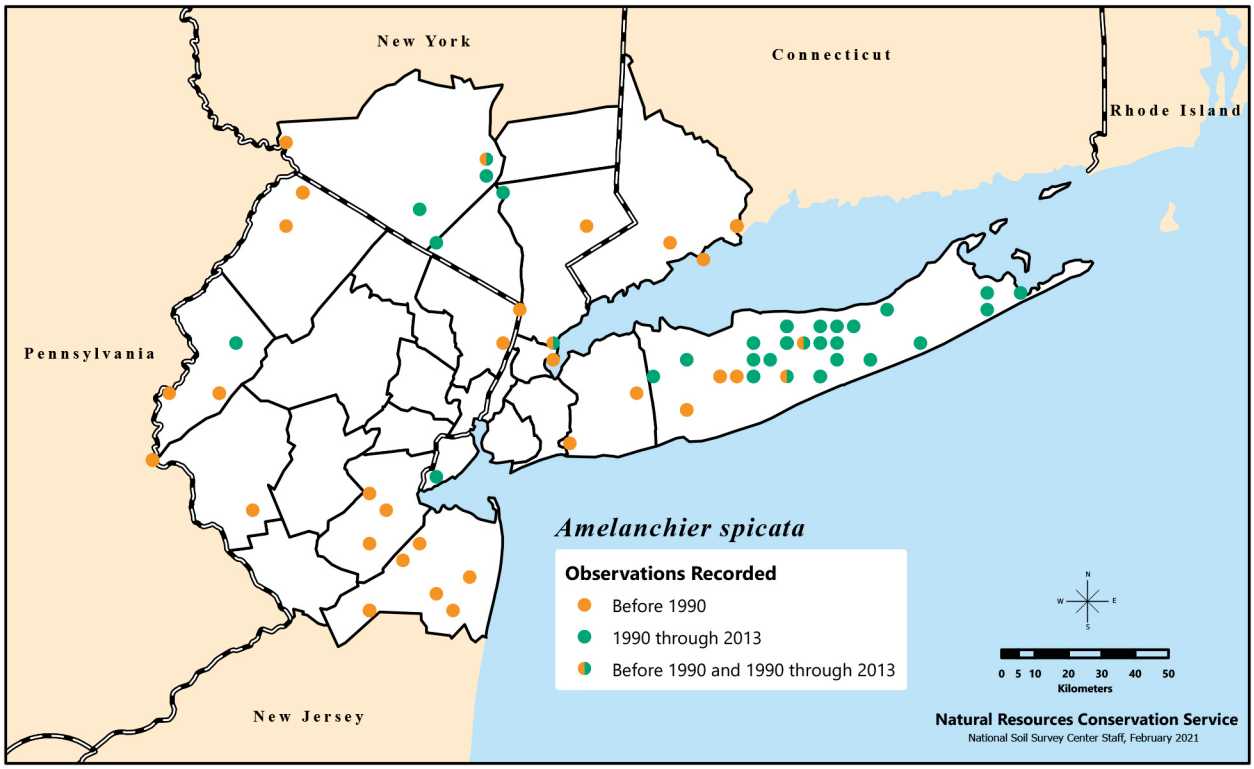
Listed as endangered in NJ (S1.1), with only one known record from Sussex County.

8. *Amelanchier spicata* (Lam.) K.Koch – running Juneberry ↔

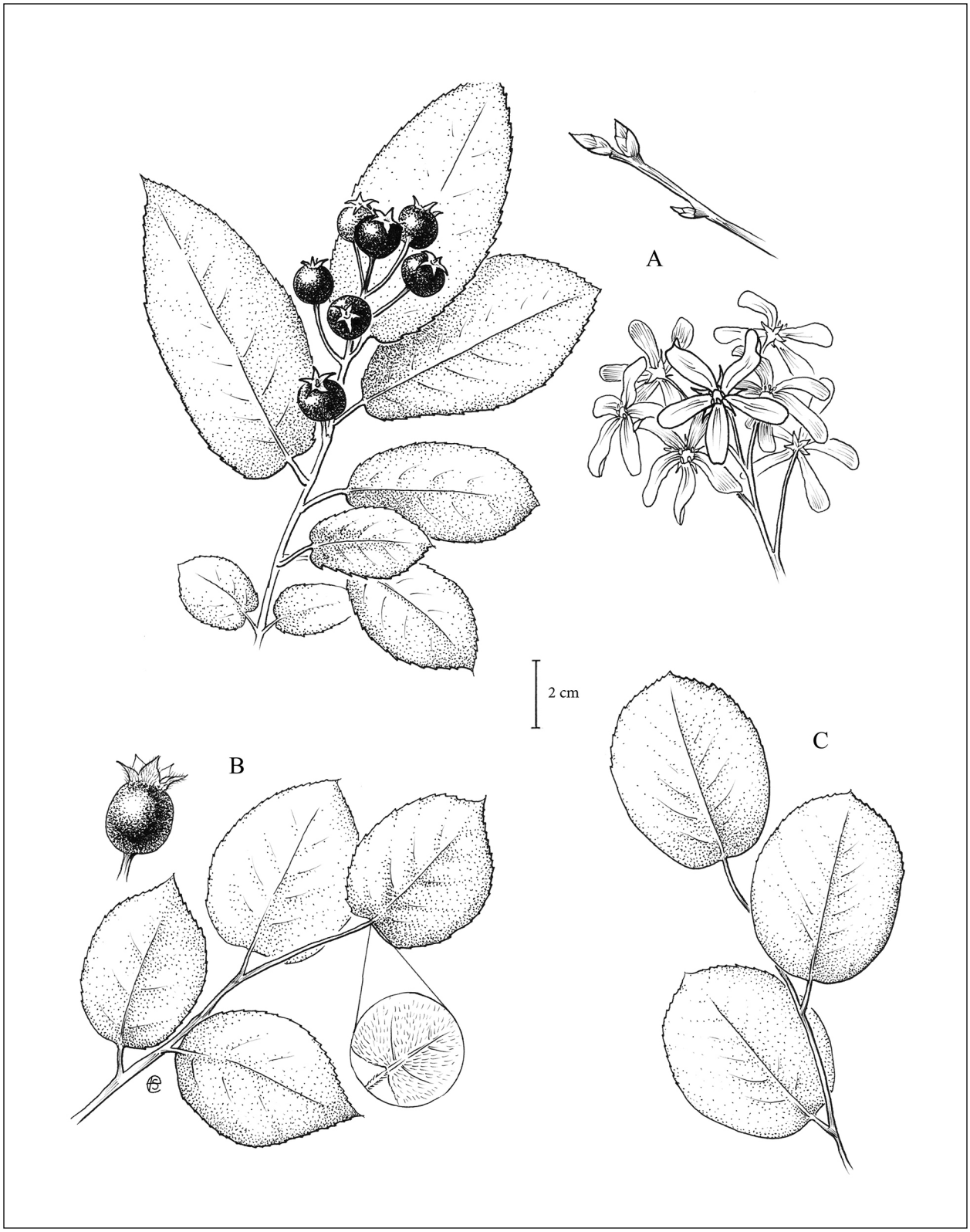
Crataegus spicata Lam.; *Amelanchier canadensis* subsp. *spicata* (Lam.) Á.Löve & D.Löve; *Amelanchier stolonifera* Wieg.

Shrub. Flowering Apr.–May; fruiting May–June. Woodlands, woodland edges, roadsides, and fields; usually in acid soils. Epithet from Greek "spica," possibly referring to upright short racemes, which can look like ears of corn.

When growing with *Amelanchier canadensis*, this species consistently flowers 1–2 weeks later. Usually has leathery and lustrous leaves. Whereas



Distribution of *Amelanchier spicata,* or running Juneberry, recorded in the New York Metropolitan Region during three time categories.



A) Twig with leaves and fruit, leaf buds, and flowers of *Amelanchier arborea*; B) fruit, twig with leaves, and enlarged view of leaf underside, becoming glabrous, of *Amelanchier canadensis*; C) twig with more-sharply toothed leaves of *Amelanchier spicata*. Illustration by Emma Skurnick.

much material is colonial, some plants that key to this species are not colonial and typically grow much taller than the colonial material. Species includes diploid (2n=34) and tetraploid individuals (2n=68), as well as triploid material (3n=51) (Campbell et al. 2014).

Tracked as vulnerable in NJ (S3) under the name *Amelanchier stolonifera*.

Nonnative Species

***Amelanchier alnifolia* (Nutt.) Nutt. ex M.Roem. – saskatoon berry**

Aronia alnifolia Nutt.

Shrub, small tree. Flowering Apr.–May; fruiting May–June. Not native to the region; native range is north and west of the region. Native to the Great Plains ranging from MB and SK to NE. However, this species has been targeted for cultivation as a landscape plant (Stushnoff 1991), horticultural crop, and fruit crop (McGarry et al. 1998, 2001; Nesom 2017); is becoming much more commonly planted as a small street tree (or shrub) in urban areas. Therefore, it might be expected to escape in the region, though not documented in our dataset. Of all the North American species of Amelanchier, this species produces some of the best-tasting fruit. No known documentation that it has become invasive in the U.S. yet, but it and *A. spicata* have become invasive in parts of Russia, spreading by seed (Kuklina 2011). Cultivated since 1918, with at least 9 cultivars commonly planted (Dirr 1998) and at least 16 available (Zatylny et al. 2005). Entomosporium leaf and berry spot are serious diseases of *A. alnifolia* caused by the fungus *Entomosporium mespili* in its native region, but effect differs with cultivar (Ronald and St-Pierre 2002).

Management

Abundance of each species may not be accurate due to the difficulty in distinguishing some of the species, but efforts to restore some of the many rare as well as more common *Amelanchier* spp. in the region should be pursued. Indeed, *A. canadensis*' sweet fruit could rival that of *A. alnifolia*. Use of the nonnative *A. alnifolia* for horticultural (landscaping or fruit production) purposes should be reevaluated, given its potential to invade and the lack of information on the likelihood of hybridization with the native species. The fungus *Entomosporium* that causes leaf spot may possibly also occur beyond *A. alnifolia*'s native range and may serve to reduce the plant's ability to spread. We do not know whether this fungus could also negatively impact the native *Amelanchier* spp., especially the rare ones, in the region, but the possibility should be noted. *Entomosporium mespili* has been reported from *Amelanchier* in MA (Farr et al. 1989).

Amorpha L. – false indigo

Fabaceae. Shrubs, herbs. Species 15 in North America. Genus name is derived from the Greek "amorphos," meaning "deformed," a reference to the corolla consisting of just a single petal (instead of five) that is wrapped around the stamens and style.

Nonnative Species

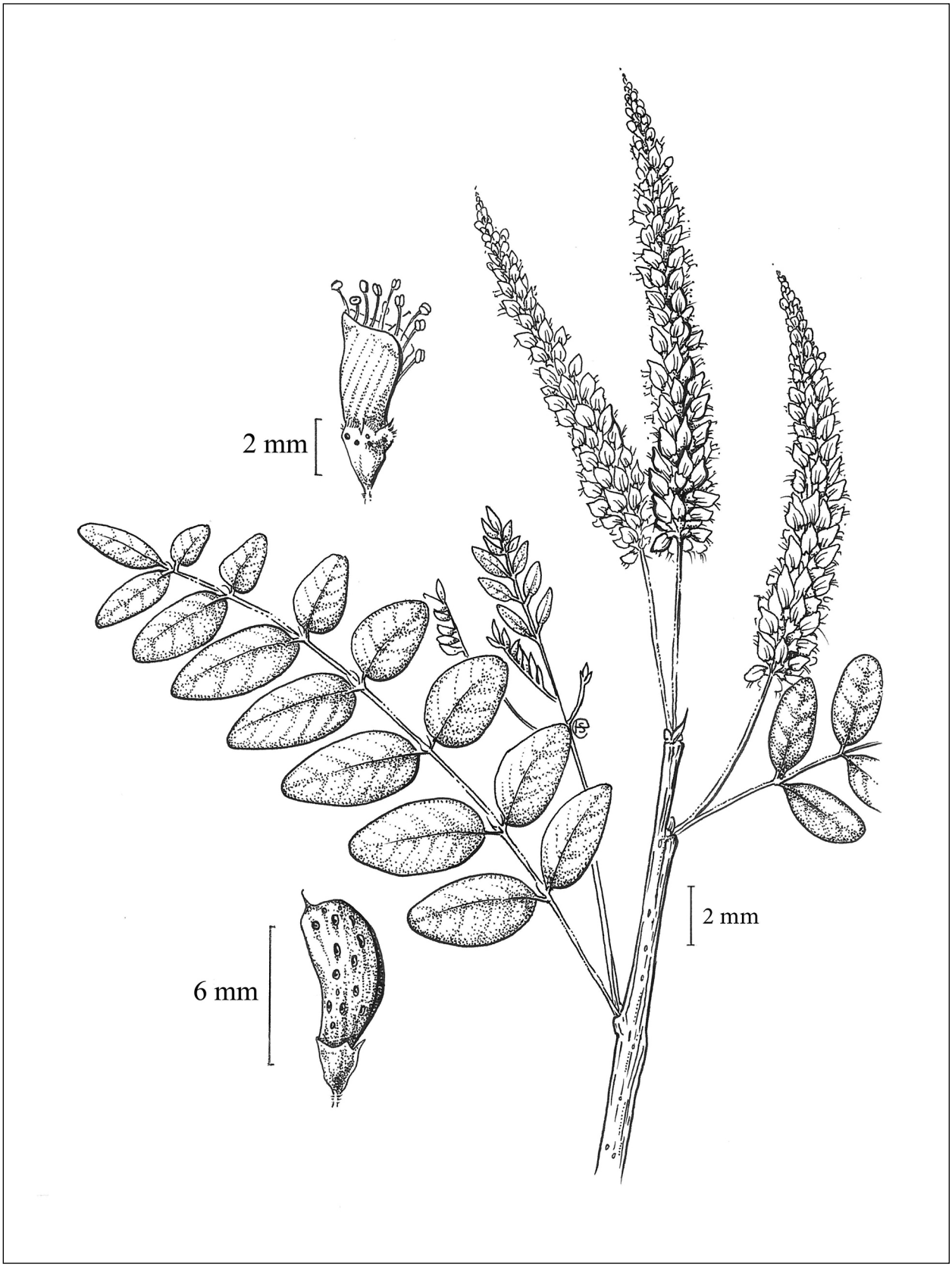
1. *Amorpha fruticosa* L. – false indigo ↑

Shrub. Flowering May–June. Moist open areas, especially edges of streams (including freshwater tidal zone) and lakes. Epithet from Latin refers to its fruticose (shrubby) habit. One of the most common shrubs along the Hudson River banks. Seeds dispersed by water; may potentially form seed bank (Blagojević et al. 2015).

Numerous varieties sometimes recognized based on pubescence and leaf size; all local material referable to *Amorpha fruticosa* var. *fruticosa*. Nativity status questionable. Reported as native throughout the northeastern U.S., including the NY Metropolitan Region, by Gleason and Cronquist (1993) but reported as cultivated and escaped by Fernald (1950). Britton (1889 but not 1881) reported it from northern NJ and regarded it a "fugitive of the West." Reported as nonnative in CT (Connecticut Botanical Society 2015a), DE (Tatnall 1946), and NY (Weldy et al. 2020) but native in PA (Rhoads and Klein 1993).

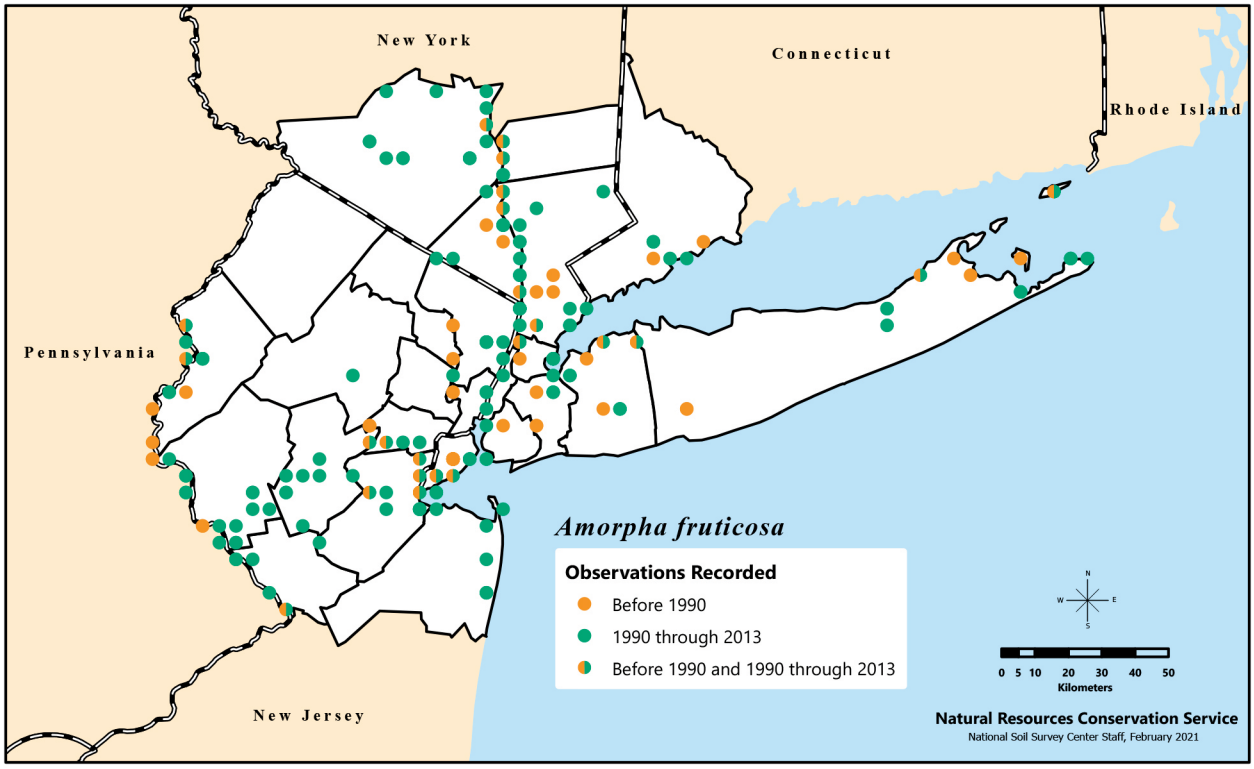
Cultivated since 1724, with at least 6 cultivars (Dirr 1997). Invasive in eastern and southern Europe (Mabberley 2008).

Listed as potentially invasive in CT (prohibited) and tracked as potentially invasive in NJ (category 2).



Flower, fruit, and flowering twig with leaves of *Amorpha fruticosa*. Illustration by Emma Skurnick.

A B



Distribution of *Amorpha fruticosa*, or false indigo, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Essex County (NJ).

Ampelopsis Michx. – porcelain berry

Vitaceae. Vines. Species 25 native to eastern Asia, Central America, and North America. Distinguished from other genera in the grape family by close (not peeling) bark covered with lenticels and blue (to black) berry fruit largely lacking in pulp. Genus name is derived from the Greek "ampelos" (vine) and "opsis" (resembling), the shrubs often climbing and thus vine-like.

Nonnative Species

1. *Ampelopsis glandulosa* (Wall.) Momiy – porcelain berry ↑↑↑

Vitis glandulosa Wall.; *Ampelopsis brevipedunculata* (Maxim.) Trautv., *Cissus brevipedunculata* Maxim.

Flowering June–Aug.; fruiting Aug.–Sept. Common in disturbed open areas. Native to China, Japan, Korea, and Russia. Epithet from Latin refers to the short ("brevi-") peduncles of the inflorescence.

Tolerates several soil types, except consistently wet soils. The best fruiting occurs in open sun. Fruiting increases when root growth is restricted. Two other species, *Ampelopsis aconitifolia* Bunge (native to Asia) and *A. cordata* Michx. (native to the U.S., south and west of the region), have been reported from the northeastern U.S. and may occur in the region. Unlike *A. glandulosa* and *A. cordata*, *A. aconitifolia* has compound (5-foliate) leaves with the leaflets being lobed, and *A. cordata* differs from *A. glandulosa* in having glabrous twigs, petioles, and leaf undersides (pubescent in *A. glandulosa*) and leaves that are usually unlobed (consistently lobed in *A. glandulosa*).

Flowers are perfect (Dirr 1998), but species is protandrous (Gerrath and Posluszny 1989), suggesting that it is functionally self-incompatible. Flowers are green, small, and generally inconspicuous (Dirr 1998) though they produce copious amounts of nectar which is available along with the pollen before the stigma is receptive (Gerrath and Posluszny 1989). Fruits are grape-

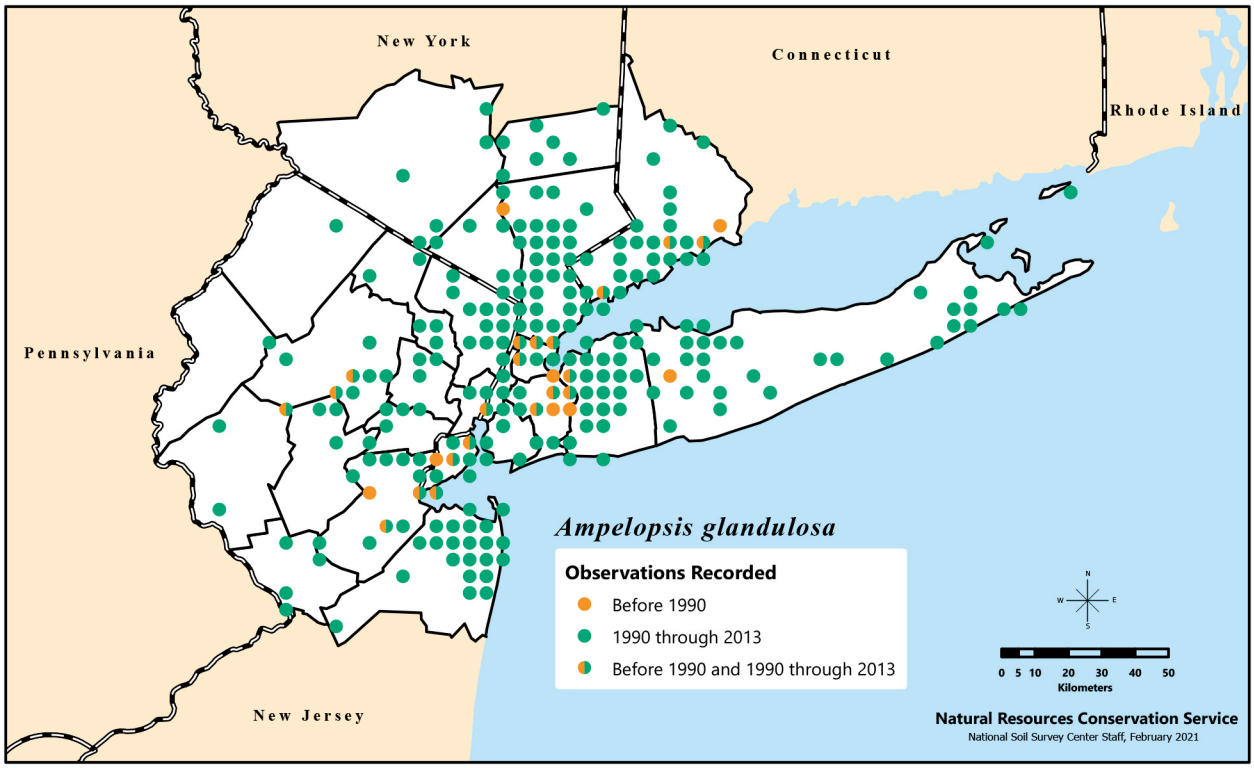
like berries that start off yellow and change to pale lilac and purple and then to bright blue. Primarily planted for its unusual fruit, which contain one to four seeds each (Gerrath and Posluszny 1989) and are dispersed by birds (Dirr 1998) and possibly deer (*Odocoileus* spp.) (Williams et al. 2008). Seeds have physiological dormancy (Baskin and Baskin 2001). Forms seed banks in its native habitat, in both mature and clear-cut forests (Sakai et al. 2010). A cold period may not be required for germination, but it does improve it (Dirr 1998). Unlike the temperate members but like the tropical members of Vitaceae, this species continues to flower and fruit throughout the growing season (Gerrath and Posluszny 1989). Invasion success of this vine is not explained by differential resistance to herbivory, because it experiences similar levels of herbivory as associated native species. Deer browse may suppress its growth (Aston and Lerdau 2008). In addition to being able to reproduce by seed, this species can effectively be propagated using cuttings (Dirr 1998); leafier stems have greater success (Emerine 2011).

Japanese beetles (*Popillia japonica*) can remove all leaf tissue in very little time (Dirr 1998). In one study, *A. glandulosa* was not able to outcompete *Parthenocissus quinquefolia* (Emerine 2011), suggesting it may be more of an opportunist invader of disturbed sites than an aggressive competitor. Cultivated since 1870, with at least 2 cultivars and 1 variety, all of which differ in leaf shape (lobing) and fall color.

Listed as invasive in CT (not prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

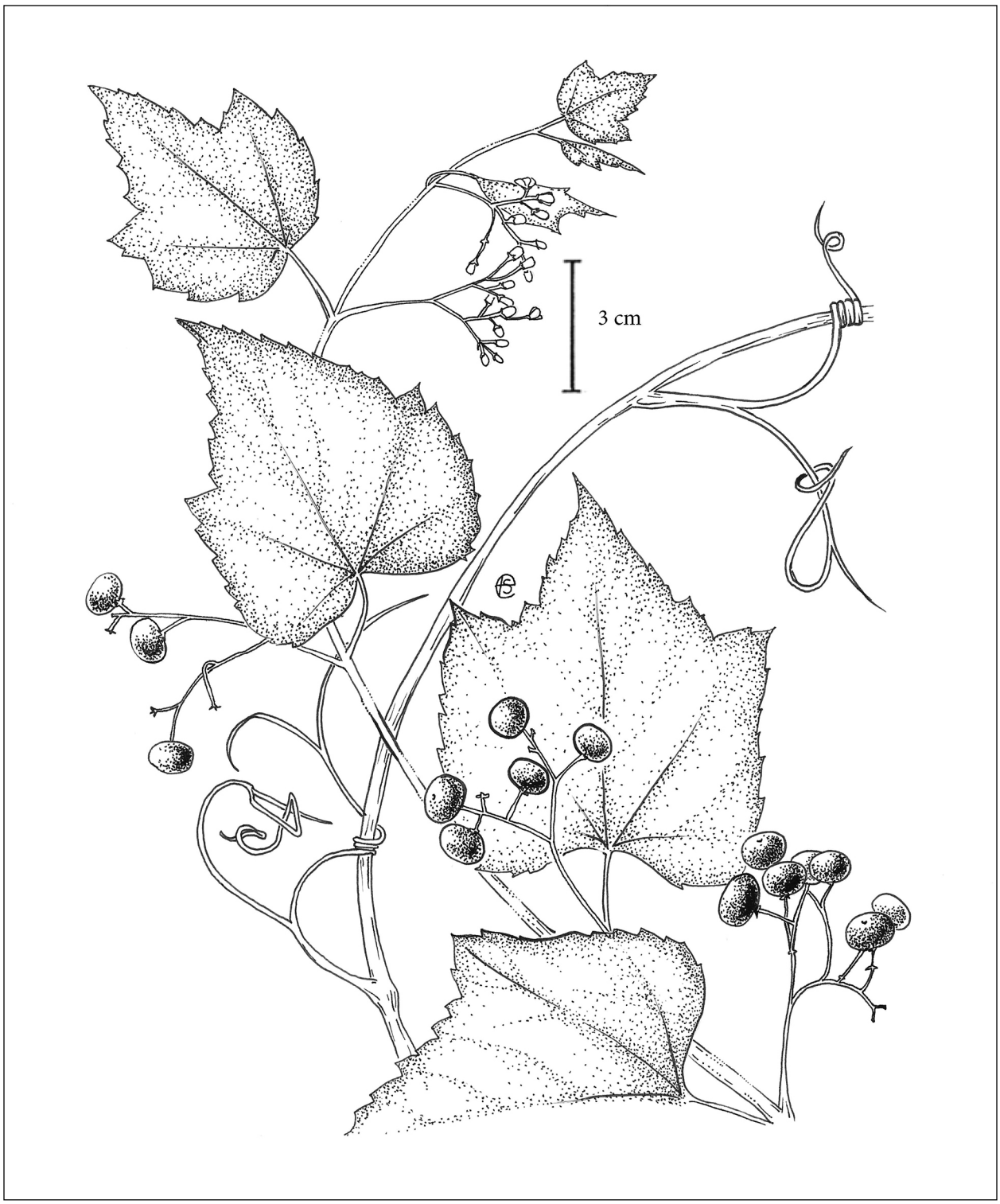
Management

If seed production is not limited in some way, such as by low-light conditions, subsequent seed dispersal by birds and other animals, such as deer, will make management of *Ampelopsis glandulosa* very difficult. We may be inadvertently benefiting from the presence of another nonnative species, the Japanese beetle, which can rapidly remove foliage from *A. glandulosa*, though negative impacts on *A. glandulosa* populations are not yet



Distribution of *Ampelopsis glandulosa*, or porcelain berry, recorded in the New York Metropolitan Region during three time categories.

A B



Twining stem with leaves, flowers, and fruit of *Ampelopsis glandulosa*. Illustration by Emma Skurnick.

evident. This species' somewhat less aggressive nature (Emerine 2011) and possible shade-intolerance (Robertson et al. 1994) may explain its relatively limited expansion compared to other invasive vines. Successful control of this species is achieved with a combined stem cut followed by herbicide application to new foliage growth. A simple foliar application may also be effective, especially if done prior to fruiting (Emerine 2011).

Andromeda L. – bog rosemary

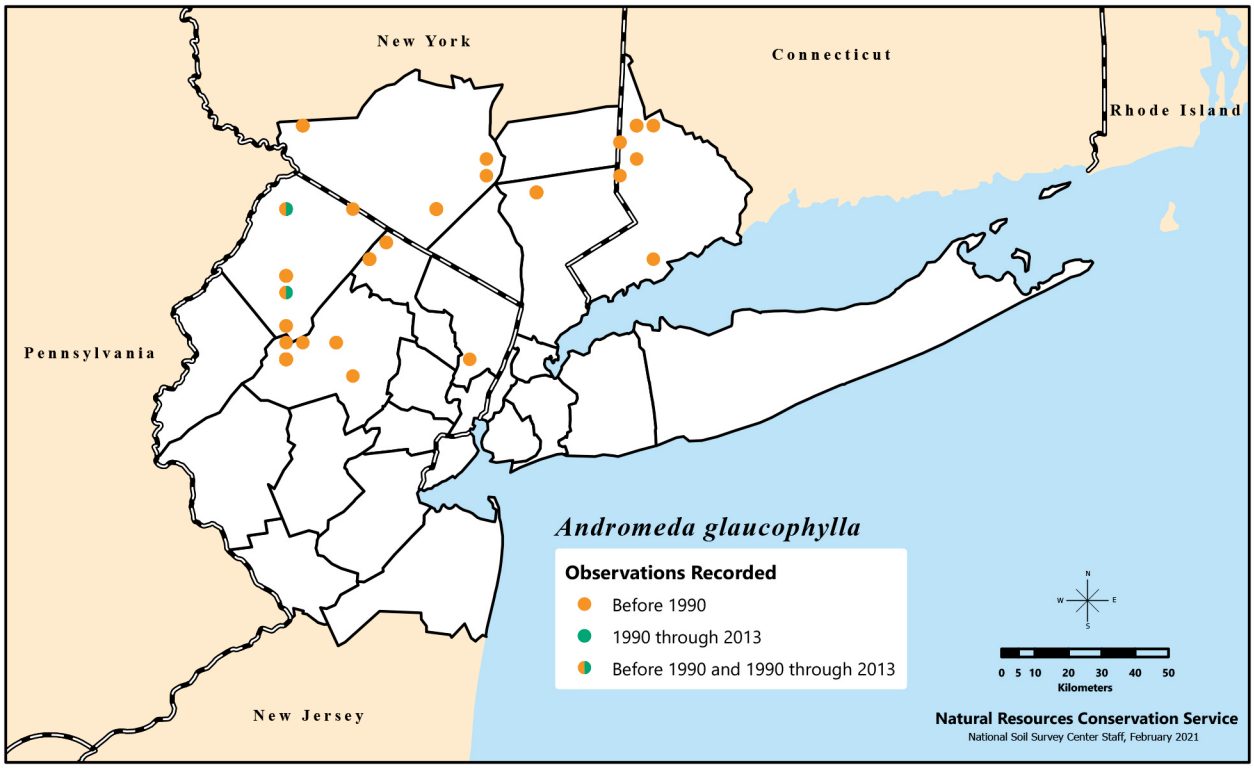
Ericaceae. Shrubs. Species 2 (the other: *Andromeda polifolia*) native to Asia, Europe, and North America; circumboreal. Distinguished from other shrubs in the heath family by alternate twigs with whitish surface, evergreen leaves strongly whitened beneath, and flowers in umbellate clusters, pedicels lacking leaf-like bracts (bracts present in the related *Chamaedaphne*). Some treat the genus as monospecific, the species consisting of 2 varieties, *A. polifolia* L. var. *polifolia* (northern Asia, northern Europe, northwestern North America) and *A. polifolia* var. *latifolia* Ait. (northeastern North America) or 2 subspecies, *Andromeda polifolia* subsp. *polifolia* and *Andromeda polifolia* subsp. *glaucophylla* (Link) Hultén. Linnaeus named the genus after Andromeda of Greek mythology.

Native Species

1. *Andromeda glaucophylla* Link – bog rosemary ↓↓↓

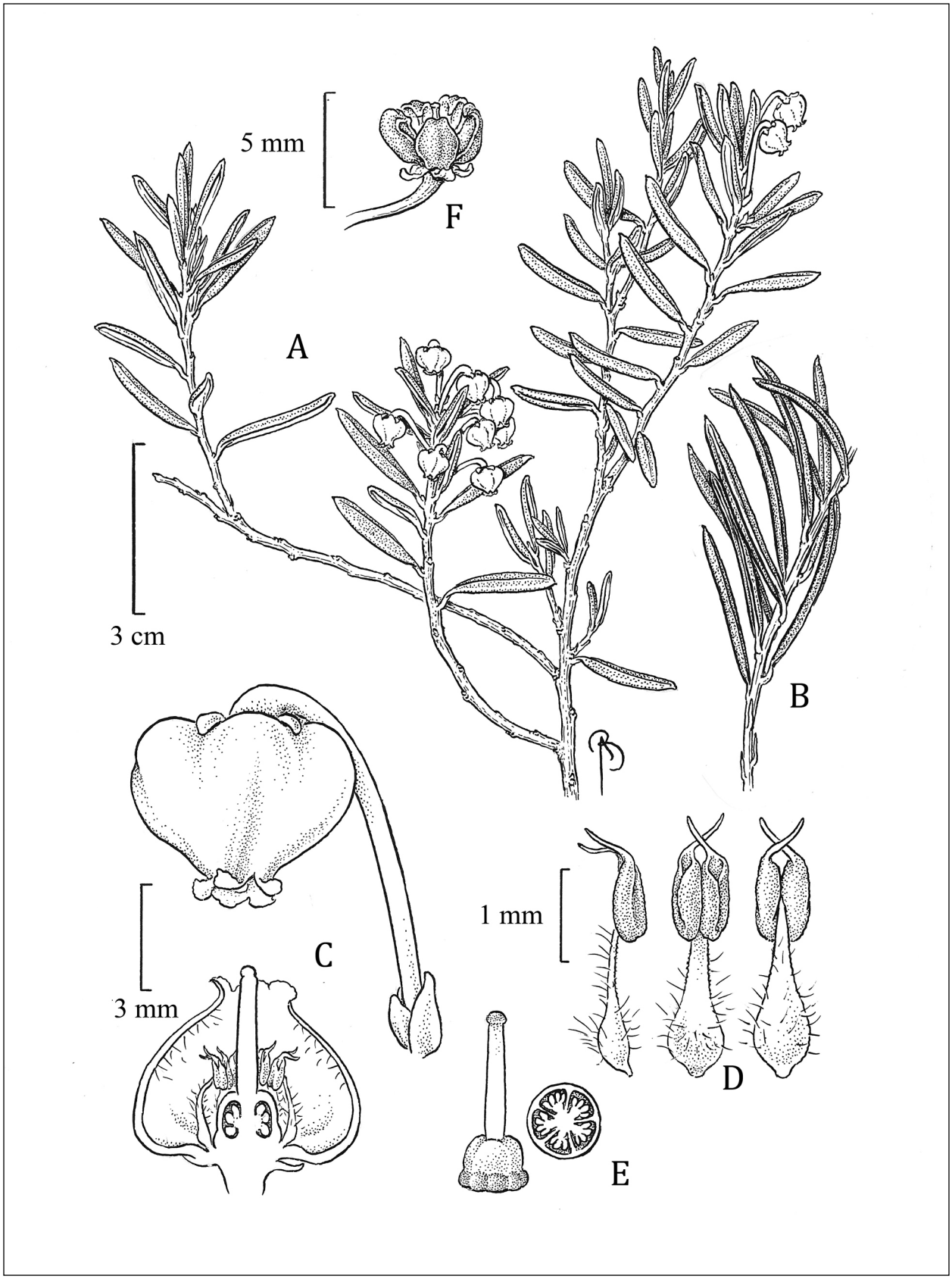
Andromeda canescens Small; *Andromeda glaucophylla* var. *iodandra* Fernald; *Andromeda polifolia* subsp. *glaucophylla* (Link) Hultén; *Andromeda polifolia* var. *glaucophylla* (Link) DC.; *Andromeda polifolia* var. *latifolia* Ait.

Flowering May–June. Dwarf shrub bogs and inland poor fens, often associated with *Chamaedaphne calyculata*, *Kalmia polifolia*, *Rhododendron groenlandicum*, and *Vaccinium oxycoccus*. Occurs in soils with a pH of 4.5–5. Epithet from Latin means "leaves with a bluish cast."



Distribution of *Andromeda glaucophylla*, or bog rosemary, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Warren County (NJ) and Putnam County (NY).

A B



A) Twig with leaves and flowers; B) twig with only leaves; C) flower and cross-section of flower showing stamens, pistil, and ovary with ovules; D) stamens; E) ovary and its cross-section showing five locules and ovule; and F) fruit of *Andromeda glaucophylla*. Illustration by Bobbi Angell.

Flowers are visited by a number of insects (but often few individuals), most commonly by *Apis mellifera*, *Bombus affinis*, *B. fervida*, *B. impatiens*, *B. terricola*, *B. vagans*, and *Andrena* spp. (Hagerup 1954; Reader 1975, 1977; Small 1976). Flies (order Diptera) and butterflies (order Lepidoptera) are reported as floral visitors but probably do not pollinate the flowers. A boreal or high-elevation species (Weder 2006) that may be declining in the region.

Listed as endangered in CT (S1) and NJ (S1) under the name *Andromeda polifolia* var. *glaucophylla*.

Aralia L. – sarsaparilla, spikenard, Hercules' club

Araliaceae. Small trees, shrubs, herbs. Species 65+ native to eastern Asia, Malaysia, and North America. Distinguished by prickly stems, decompound prickly leaves, and large compound panicles of white flowers. Three herbaceous species, *Aralia hispida*, *A. nudicaulis*, and *A. spinosa*, are also present in the region. Genus name is derived from the French-Canadian word "Aralie," the name given to it on the original specimens sent to the pre-Linnean botanist Joseph Pitton de Tournefort (1656–1708) by Michel Sarrazin (1659–1734), a Quebec physician.

Nonnative Species

1. *Aralia elata* (Miq.) Seem. – Chinese angelica tree ↑↑↑

Dimorphanthus elatus Miq.

Flowering July–Aug.; fruiting Sept.–Oct. Frequent in open disturbed thickets, woodlands, and woodland edges. Native to Asia; invasive in the NY Metropolitan Region and spreading rapidly. In the past, material often misidentified as *Aralia spinosa*, which is native to the southeastern U.S. and reaches the northern limit of its native range in central PA, DE, and (possibly) southern NJ. The two species can be distinguished based on leaf venation (lateral veins running to the tips of the leaf teeth at the margin in *A. elata*; lateral veins not extending to the teeth in *A. spinosa*), inflorescence or infructescence central axis (absent or less than 12 cm in *A. elata*, the inflorescence therefore a cyme or corymb; extended up to 1 m in *A. spinosa*, the inflorescence a panicle), and fruit size with some slight overlap (dry fruits: 3.0–3.5 mm in *A. elata*; 3.5–5.0 mm in *A. spinosa*). All differences are important to distinguish the two species, especially the leaf vein character and the inflorescence type. Epithet is Latin for "elevated" or "tall." Further research is needed to determine whether *A. spinosa* is present in the region; reports from the region remain unconfirmed. *Aralia spinosa* is tracked as critically imperiled in NY (S1).

Fruit primarily dispersed by birds; species may also asexually spread by root suckering (Moore et al. 2009), but not as prolifically as its native congener *A. spinosa* (Dirr 1998). *Aralia elata* was introduced into the U.S. in 1830 and is native to Asia and Russia (Dirr 1998). Cultivars of *A. elata* include a thornless form, a variegated form (most from Dutch nurseries), a form with leaflets having a golden-yellow border, a variegated form with white margins, and a form with small leaflets (Dirr 1998). *Aralia elata* is an early successional species in its native regions (Shimoda et al. 1994) and is often left behind after a harvest for use of the fruit as a food crop, though this species is rarely planted as a crop, garden, or street tree in its native regions (Kobayashi and Koike 2010). *Aralia elata* has a survival rate of only 20 percent in response to herbivory by Sika deer (*Cervus nippon*) (Shimoda et al. 1994). No known findings of impacts of white-tailed deer (*Odocoileus virginianus*) in the U.S. on introduced *A. elata*. Increase of *A. elata* in areas with high deer pressure (e.g., the Mid-Atlantic states; Moore et al. 2009) suggests that white-tailed deer may find *A. elata* to be less palatable than the native *A. spinosa*, which is browsed by deer in summer but does not appear to be a preferred food (Healy 1971, Johnson et al. 1995). Based on native material, Wen (1994) recognized four varieties in *Aralia elata*. The introduced material in the region is *Aralia elata* var. *elata* and also possibly *A. elata* var. *mandshurica* (Rupr. & Maxim.) J.Wen.

Tracked or listed as potentially invasive in NJ (category 2?) and NY (prohibited).

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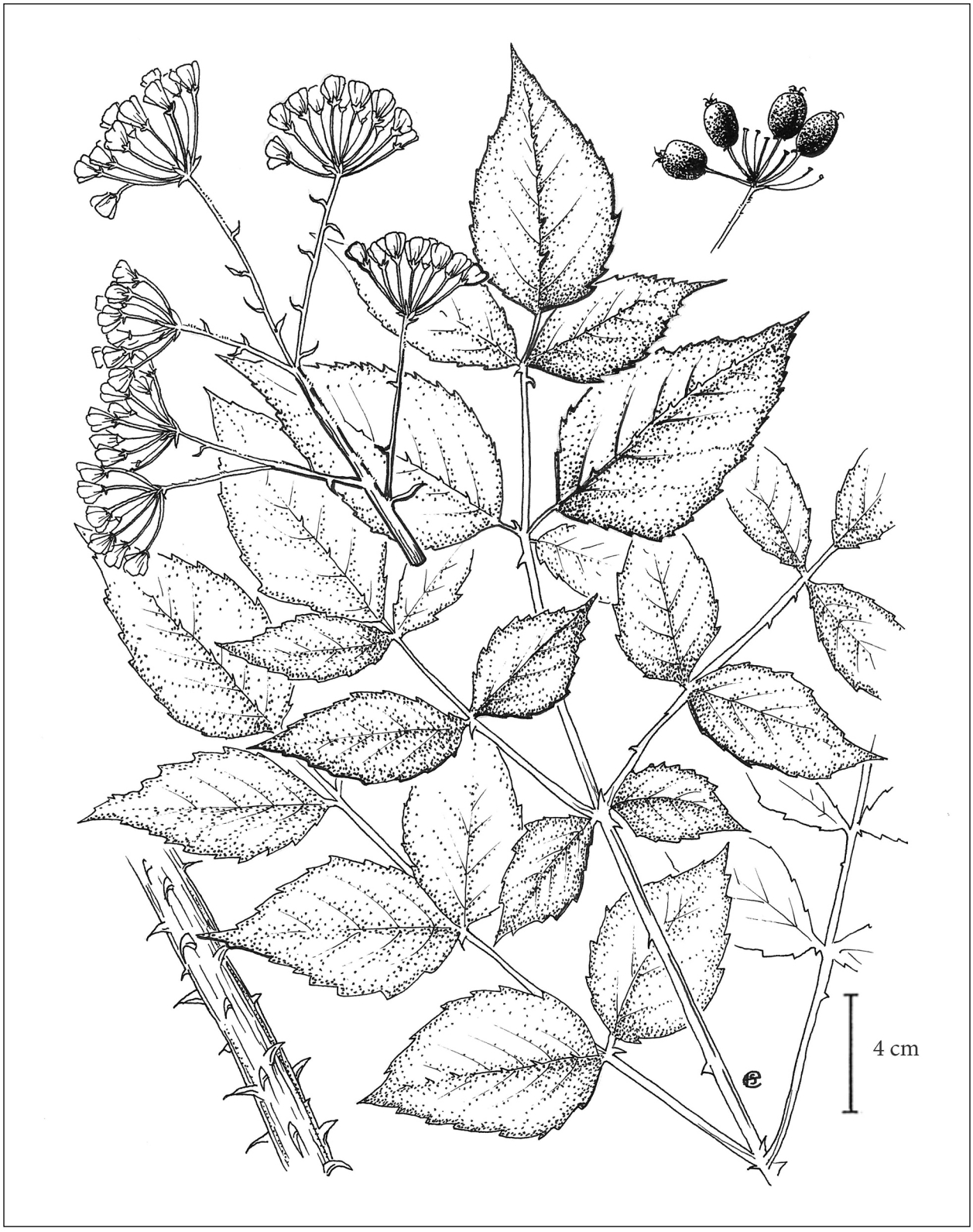
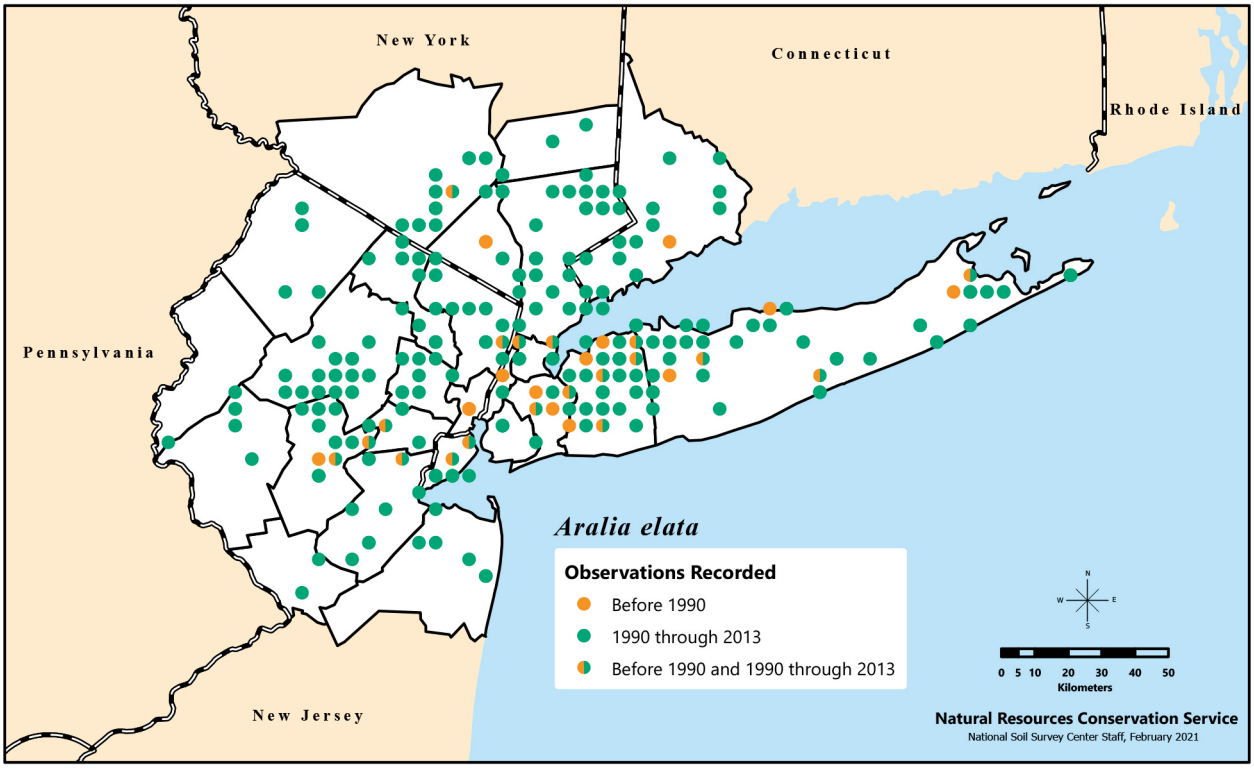


Stem with prickles, leaves, flowers, and fruit of *Aralia elata*. Illustration by Emma Skurnick.



Distribution of *Aralia elata*, or Chinese angelica tree, recorded in the New York Metropolitan Region during three time categories.

Management

It is somewhat surprising that *Aralia elata* is spreading; it is not among the more popular trees to be planted because of its thorny nature and it is not as prolific a spreader as *Aralia spinosa*. However, several bird species consume its fruit readily, which may have contributed greatly to its successful long-distance dispersal. Moreover, it may not register as a problem to many land managers because it looks so similar to *A. spinosa*. Many questions need to be addressed with further research. For example, can the two species function the same in a particular ecosystem? If so, could we potentially see the decline of *A. spinosa*, or is *A. spinosa* more competitive? Can the two species hybridize? If so, is a superweed the result? Given evidence of its ability to spread inconspicuously and the many unknowns associated with this species, the best management strategy may be to simply stop planting it and to remove it where it is planted as an ornamental tree. Removing it from natural areas in which it has spread will be more problematic; great care would have to be taken to not inadvertently remove the native or mistake the nonnative for the native.

Arceuthobium M.Bieb. – dwarf mistletoe

Santalaceae s.l. (inclusive of Viscaceae; earlier treatments placed this genus in the Loranthaceae, which also includes many hemiparasites with the mistletoe habit). Parasitic subtree. Species 40+ in Africa, Asia, Central America, and North America, all parasitic on conifers. Genus name is derived from the Greek “arceuthos,” referring to *Juniperus* spp. (junipers) and “bios,” meaning “life,” in reference to the plants living on junipers (and other conifers).

Native Species

1. *Arceuthobium pusillum* C.Peck – dwarf mistletoe Ø♥

Flowering Apr.–June. Historically and currently known only from *Picea mariana* (black spruce) in Warren and Sussex Counties (NJ). Elsewhere reported on other *Picea* spp., *Larix* spp., and *Pinus strobus* (Fernald 1950). Can result in abnormal growth of the host, a condition called witch’s broom. First person to document this parasitic

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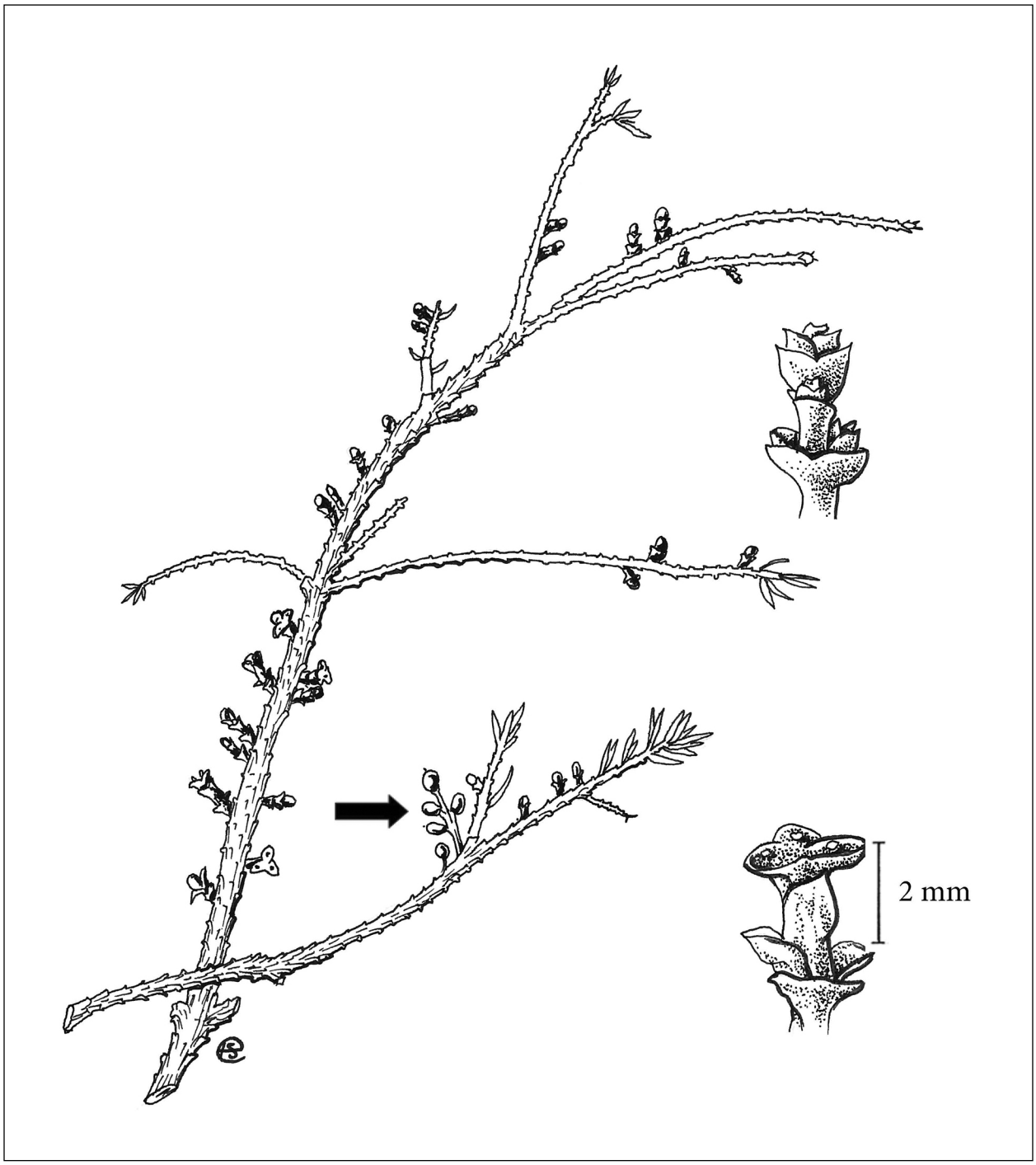
plant wreaking havoc on black spruce was a self-taught botanist, Lucy Millington (1825–1900). Explaining that she thought it was a mistletoe, she sent the first specimens in 1871, from pine barrens in Warrensburg, NY, to the editors of the Bulletin of the Torrey Botanical Club, who sent them to Asa Gray (1810–1888) at Harvard. She had also sent specimens to the state botanist, Charles Horton Peck (1833–1917). Peck claimed authorship within weeks, but much later confirmed in writing that Millington had documented the species first. A protegée of Millington's, Liberty Hyde Bailey, helped bring Millington's discovery to light (Tolley 2003). Epithet means "tiny," a reference to the plant's diminutive habit. The species may be overlooked and therefore undercollected or underreported because of its tiny stature.

Listed as endangered in NJ (S1).



Nearly needleless twig of *Picea mariana* showing *Arceuthobium pusillum* and female (top) and male (bottom) flowers of *A. pusillum*. Arrow indicates fruiting specimen with maturing berries. Illustration by Emma Skurnick.

Arctostaphylos Adans. – bearberry

Ericaceae. Shrubs. Species about 60 mainly in North America, but also in Asia and Europe. Distinguished from other shrubs in the heath family by its small, thick, evergreen leaves and mealy berry-like drupe. Genus name is based on the Greek "arctos" ("bear") and "staphyle" ("bunch of grapes," "fruit"), which refer to the common name.

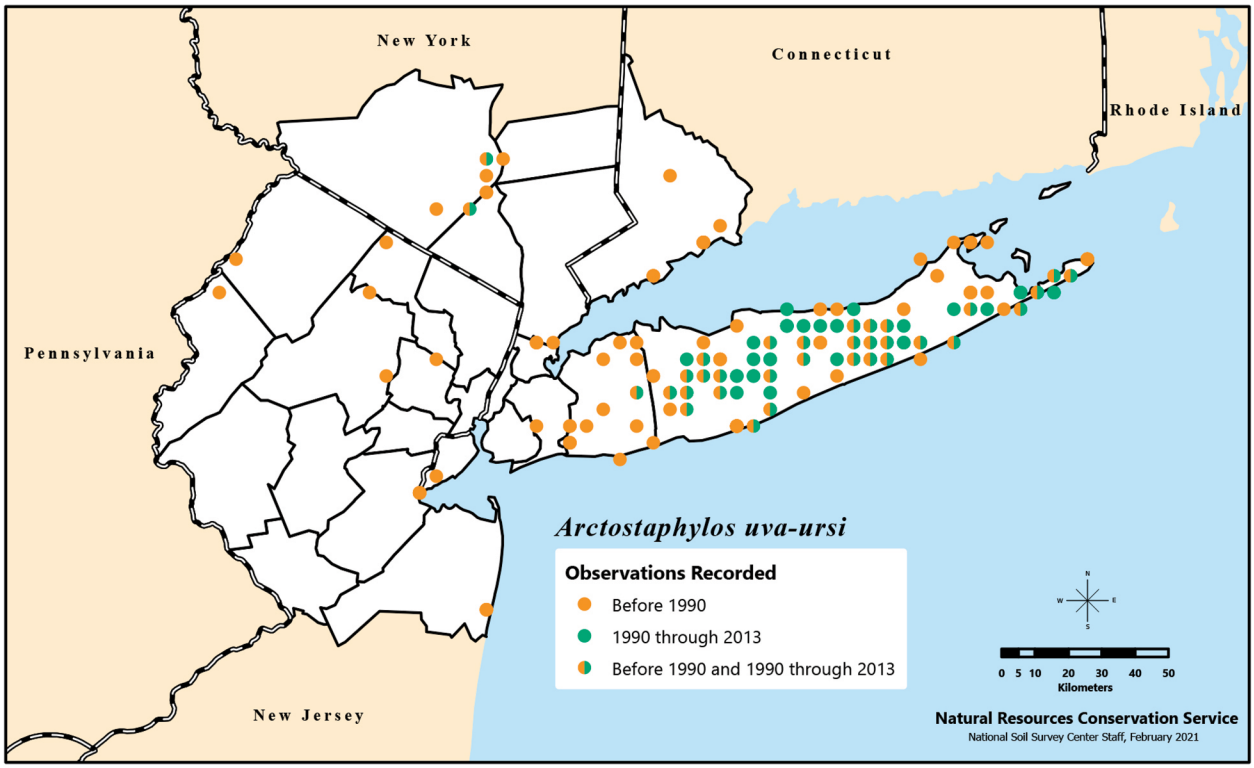
Native Species

1. *Arctostaphylos uva-ursi* (L.) Spreng. – bearberry ↔

Arbutus uva-ursi L.

Flowering Apr.–May; fruiting June–Sept. (Meyer 2008a). Dwarf pine plains, pitch pine-oak-heath woodlands and occasionally on cliffs or hills inland. Dry sand or stony soils with a pH of 4.5–5. Species never common in the region off the Coastal Plain but apparently has declined from this area. Epithet is an old genus name meaning "bear's grape," and, thus, like the genus name, is a reference to the common name.

Somewhat salt-tolerant (Martin 1959). Without wind, little seed set occurs. Some bumble bee (*Bombus*) spp. visit but usually too late to affect pollination (Grevillius and Kirchner 1923, Hagerup 1954, Warming 1908). Drupes eaten by several birds, including wild turkey (*Meleagris gallopavo*) and ruffed grouse (*Bonasa umbellus*), and white-tailed deer (*Odocoileus virginianus*) (Vines 1960). Embryos are dormant and surrounded by a hard seed coat with a micropyle that is plugged at maturity. They can remain viable for 3 years. Scarification with acid followed by warm and cold stratification is usually necessary for germination; amount of time is variable (Berg 1974, Giersbach 1937a, Peseckiené 1972, Young and Young 1992). Nodular root structures appear to be latent buds (Tiffney et al. 1978).



Distribution of *Arctostaphylos uva-ursi*, or bearberry, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Bergen County (NJ).

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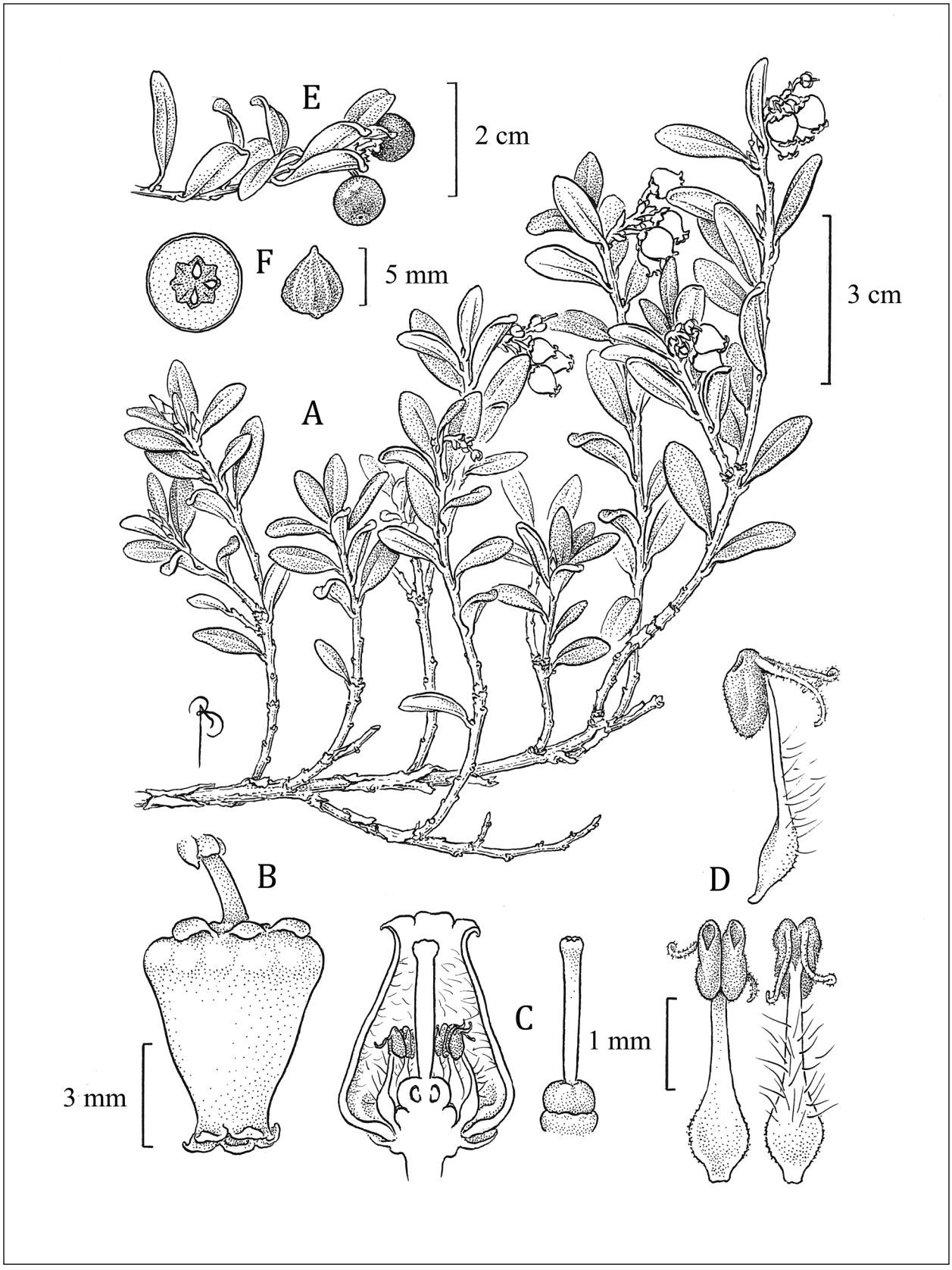

Twigs with leaves and A) flowers and E) fruit; B) flower and cross-section of flower; C) pistil and D) stamens; F) cross-section of a fruit showing seed, and seed of *Arctostaphylos uva-ursi*. Illustration by Bobbi Angell.

Aristolochia L. – birthwort

Aristolochiaceae. Herbs and woody vines. Species 350–400, nearly world-wide (when circumscribed broadly to include *Endodeca* Raf., *Einomeia* Raf., *Howardia* Klotsch, *Isotrema* Raf., and *Pararistolochia* Hutch. & Dalziel). Unusual pollination biology in some species, the brown fetid flowers attracting flies, which become trapped in the flower until after the anthers dehisce (Solereder 1888, 1889a, 1889b) and pollen is deposited on them. The two keyed species (one native to Cumberland and Blue Ridge Mountains, two native to the southeastern and south-central U.S.) occasionally escape from cultivation in the region. Two other species present in the region, *Aristolochia clematitis* L. (native to Europe) and *A. serpentaria* L. (native, rare in the region; = *Endodeca sepentaria* (L.) Raf.), are herbs. Genus name is Greek for "childbirth," in reference to its once being thought to be effective against infections during childbirth.

These species only rarely occur in the region as escapes from cultivation.

Aronia Medik. – chokeberry

Rosaceae. Shrubs. Species 3, native to North America. Genus is sometimes included within a broadly circumscribed *Photinia* Lindl. or *Pyrus* L. Genus name is the ancient name for the Medlar tree (*Mespilus germanica*), possibly applied by the German physician and botanist Friedrich Medikus (1736–1808) to the chokeberries because of the similarity of the fruits.

Native Species

1. *Aronia arbutifolia* (L.) Pers. – red chokeberry ↔

Mespilus arbutifolia L.; *Adenorachis arbutifolia* (L.) Nieuwl.; *Aronia pyrifolia* (Lam.) Pers.; *Crataegus pyrifolia* Lam.; *Photinia pyrifolia* (Lam.) K.R.Robertson & J.B.Phipps; *Pyrus arbutifolia* (L.) L.f.; *Sorbus arbutifolia* (L.) Heynh.

Flowering Apr.–June; fruiting Oct.–Nov. Mesic woodlands, swamps, and bogs. Also found in low wet forests, savannas, the Coastal Plain and Piedmont, and mountains (Rossell and Kesgen 2003). Epithet refers to the leaves being similar in shape to leaves of *Arbutus*.

Species capable of self-pollination or cross-pollination with insects as the main vector (Hardin 1973, Persson Hovmalm et al. 2004). The fruits, which are red, remain firm and on the plant, often lasting into spring. Seeds are dispersed by

Aristolochia Key

1. Stems and leaves glabrous-puberulent; peduncle with bracteoles . . . . . ***Aristolochia macrophylla*** Lam. (=***Isotrema macrophyllum*** (Lam.) C.F.Reed)
1. Stems and leaves (abaxial surface) tomentose; peduncle without bracteoles. . . . . .***Aristolochia tomentosa*** Sims (=***Isotrema tomentosum*** (Sims) H.Huber)

Aronia Key

1. Lower leaf surface, young shoots, and rachis glabrous . . . . . ***Aronia melanocarpa***
1. Lower leaf surface, young shoots, and rachis pubescent 2
2. Sepals stipitate glandular; fruit red; lower leaf surfaces densely tomentose . . . . . ***Aronia arbutifolia***
2. Sepals glandless or nearly so; fruit purple to purple-black; lower leaf surface scarcely tomentose . . . . . .***Aronia prunifolia***

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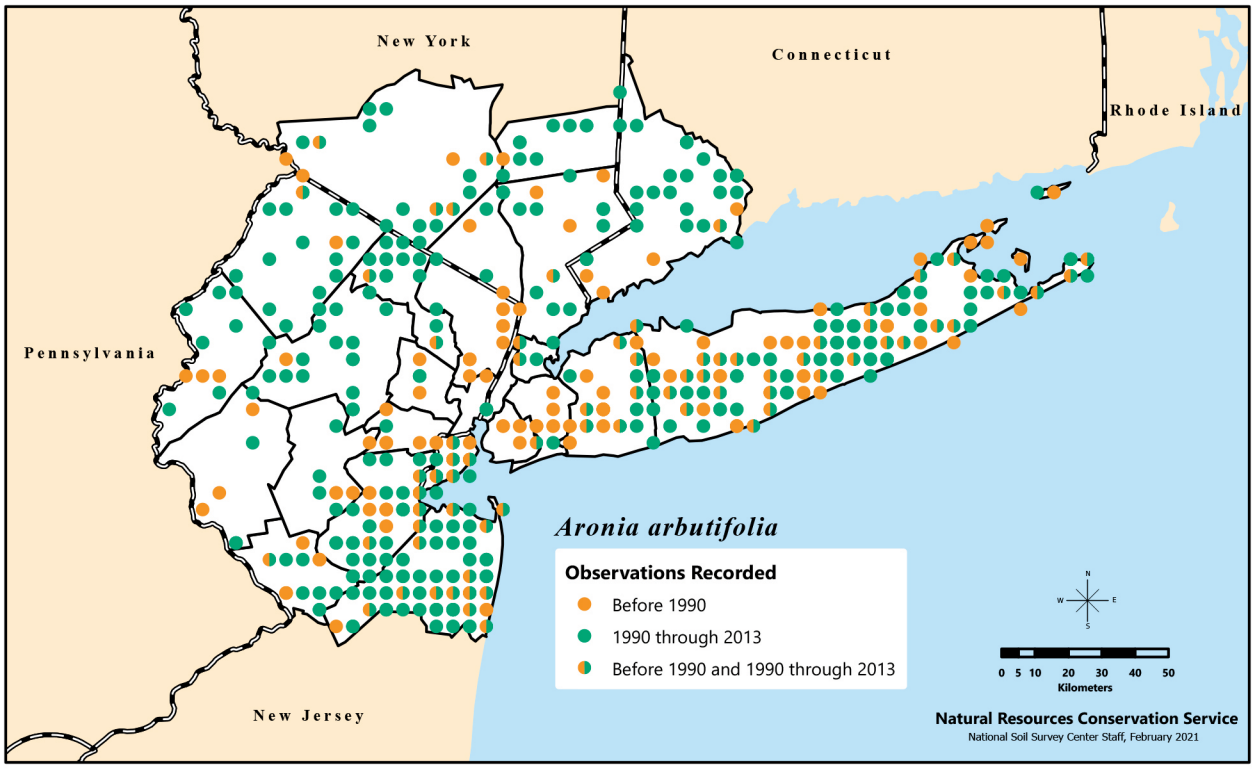


Distribution of *Aronia arbutifolia*, or red chokeberry, recorded in the New York Metropolitan Region during three time categories.

birds and other animals. Moist cold stratification required for germination with relatively high germination rates. This species is the tallest of the three; height at maturity 3–4 m (Gill et al. 2008). Though the fruit color is the only reliable way to distinguish these three species, the abaxial side of the leaves of *A. arbutifolia* tends to be the most pubescent of the three species. However, glabrous forms of *A. arbutifolia* do exist (Hardin 1973).

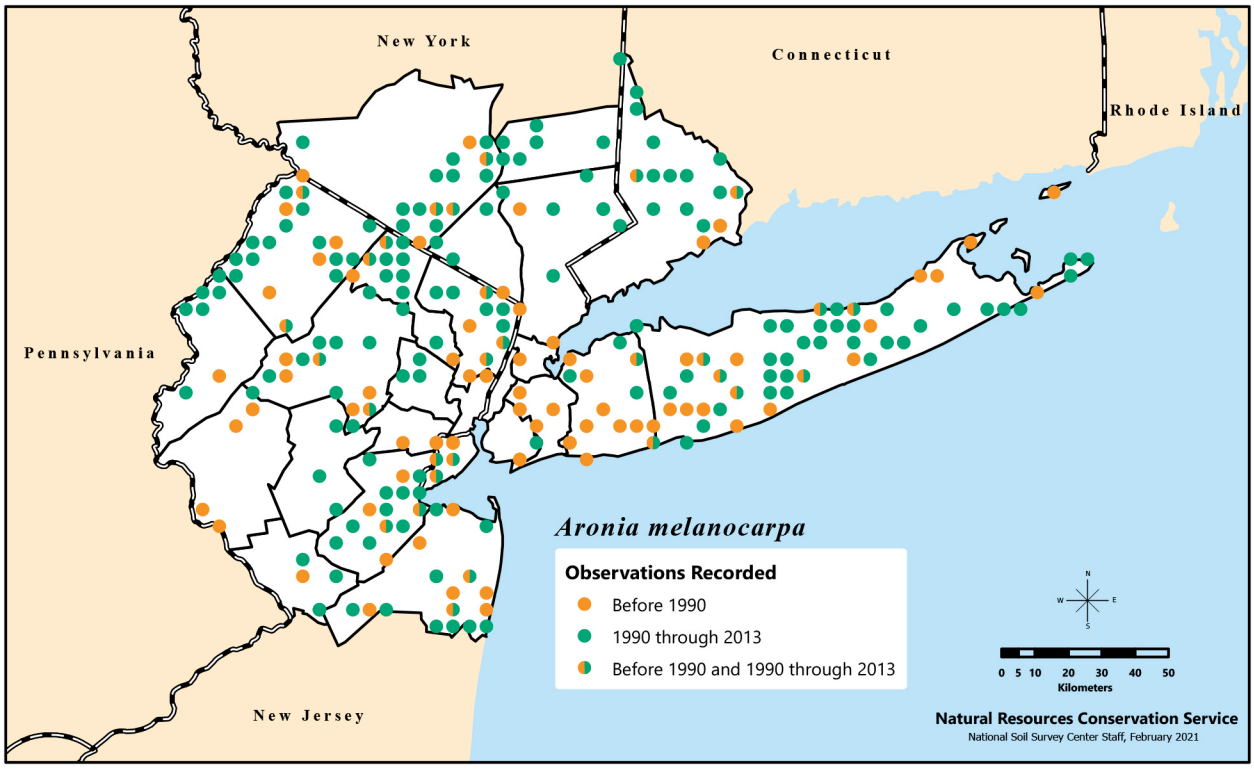
2. *Aronia melanocarpa* (Michx.) Elliott – black chokeberry ↔

Mespilus arbutifolia var. *melanocarpa* Michx.; *Adenorachis melanocarpa* (Michx.) Nieuwl.; *Photinia melanocarpa* (Michx.) K.R.Robertson & J.B.Phipps; *Pyrus arbutifolia* var. *melanocarpa* (Michx.) Hook.; *Pyrus melanocarpa* (Michx.) Willd.; *Sorbus melanocarpa* (Michx.) Heynh.

Flowering Apr.–June; fruiting Sept.–Oct. Similar habitats to *Aronia arbutifolia* but also occurring in drier conditions, including dry sandy areas and bluffs. Has been found in sand dunes, dry rocky slopes, and grassy areas (Brand 2010, Dirr 1998). Epithet from Greek refers to its black seeds.

The black fruit shrivel and drop from the plants shortly after ripening. Seeds dispersed by birds and other animals. Moist cold stratification required for germination. This species compared with *A. arbutifolia* and *A. ×prunifolia* has a relatively low germination rate. Shortest of the three species; height at maturity 0.5–1 m (Gill et al. 2008). Leaves tend to be glabrous (Hardin 1973). Seeds intended for home gardening in Germany were also introduced into Russia in the 19th century. Extensively cultivated in Siberia, Russia since the 1940s. Seed propagation of this species most likely results in largely homogeneous progenies (Persson Hovmalm et al. 2004).

Several Russian cultivars of *A. melanocarpa*; most popular are ‘Aron,’ ‘Nero,’ and ‘Viking.’ Such Russian cultivars appear to be genetically identical and are tetraploids. Native plants of *A. melanocarpa* (which could include hybrids because the hybrid and *A. melanocarpa* are morphologically difficult to distinguish with certainty) consist of two types of mother plants: diploid plants that produce heterogeneous offspring, and tetraploids that produce



Distribution of *Aronia melanocarpa*, or black chokeberry, recorded in the New York Metropolitan Region during three time categories.

homogeneous offspring. Tetraploid plants tend to produce tetraploid offspring that are identical, indicating apomixis. Offspring of diploid plants are diploid or triploid and are genetically heterogeneous, indicating outcrossing. All *A.* ×*prunifolia* plants may possibly be tetraploid and apomictic (Perrsson Hovmalm et al. 2004). This is supported by the fact that bagged, emasculated, and nonpollinated flowers of *A.* ×*prunifolia*, but not *A. melanocarpa* or *A. arbutifolia*, produced offspring (Hardin 1973). Lack of genetic diversity of the cultivated *A. melanocarpa* may be improved by incorporating more native plant material. Despite virtually identical genetic make-up, the cultivars can vary in terms of chemical content such as anthocyanins. Such differences may be the result of somatic mutations that do not affect DNA profiles (Persson Hovmalm et al. 2004).

Has been documented to have antioxidative, antidiabetic, anti-inflammatory, antibacterial, and antiviral properties; may promote heart, liver, and digestive and immune system health; may also reduce the likelihood of genetic mutations and protect against radiation injury (Kokotkiewicz et al. 2010). True *A. melanocarpa* does not form the red or purplish fall color; doing the latter is a sign that it has been crossed to some degree with *A. arbutifolia* (Dirr 1998, Hardin 1973).

3. *Aronia prunifolia* (Marshall) Rehder – purple chokeberry ↔

Mespilus prunifolia Marshall; *Adenorachis atropurpurea* (Britton) Nieuwl.; *Aronia atropurpurea* Britton; *Aronia floribunda* (Lindl.) Sweet; *Crataegus prunifolia* (Marshall) Baumg.; *Photinia floribunda* (Lindl.) K.R.Robertson & J.B.Phipps; *Pyrus arbutifolia* var. *atropurpurea* (Britton) B.L.Rob.; *Pyrus atropurpurea* (Britton) L.H.Bailey; *Pyrus floribunda* Lindl.; *Pyrus melanocarpa* var. *atropurpurea* (Britton) Farw.; *Sorbus arbutifolia* var. *atropurpurea* (Britton) C.K.Schneid.

Flowering Apr.–June; fruiting Aug.–Oct. Various wetland habitats; most often found in acidic wetlands, such as bogs. Epithet is Latin meaning "leaves like those on a plum tree."

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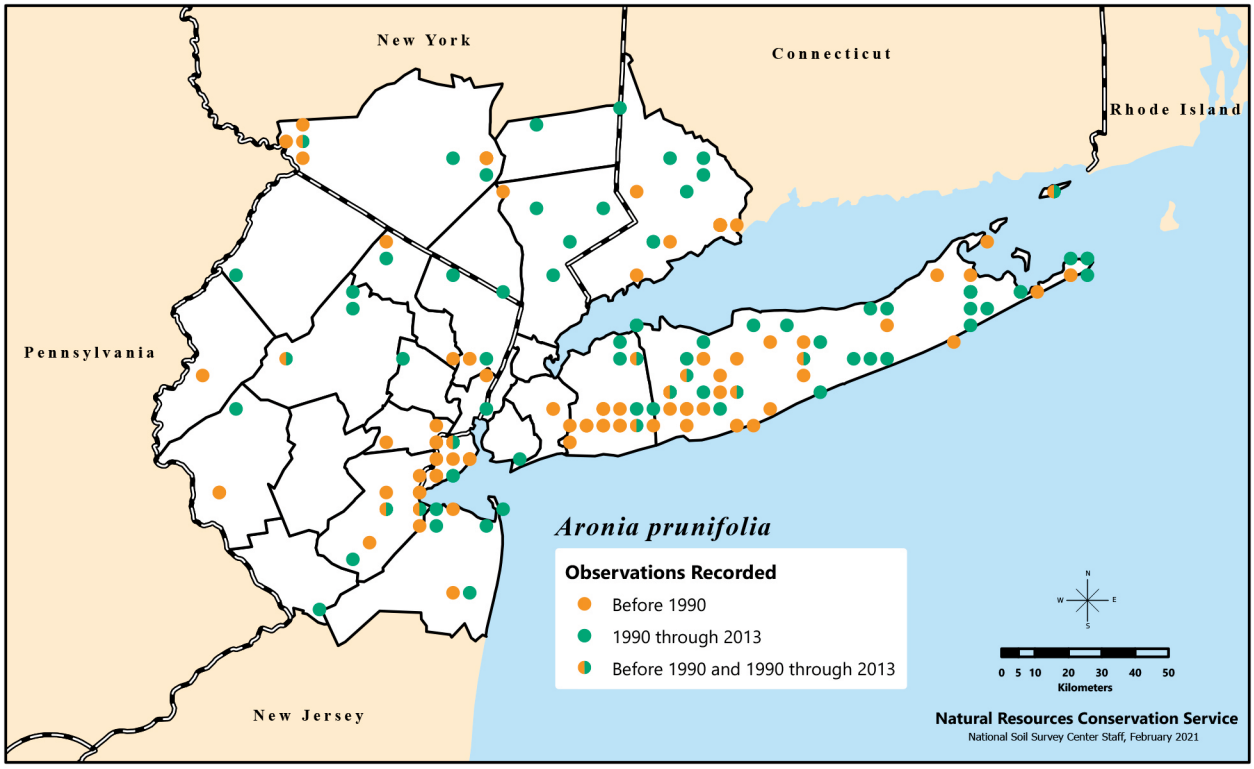
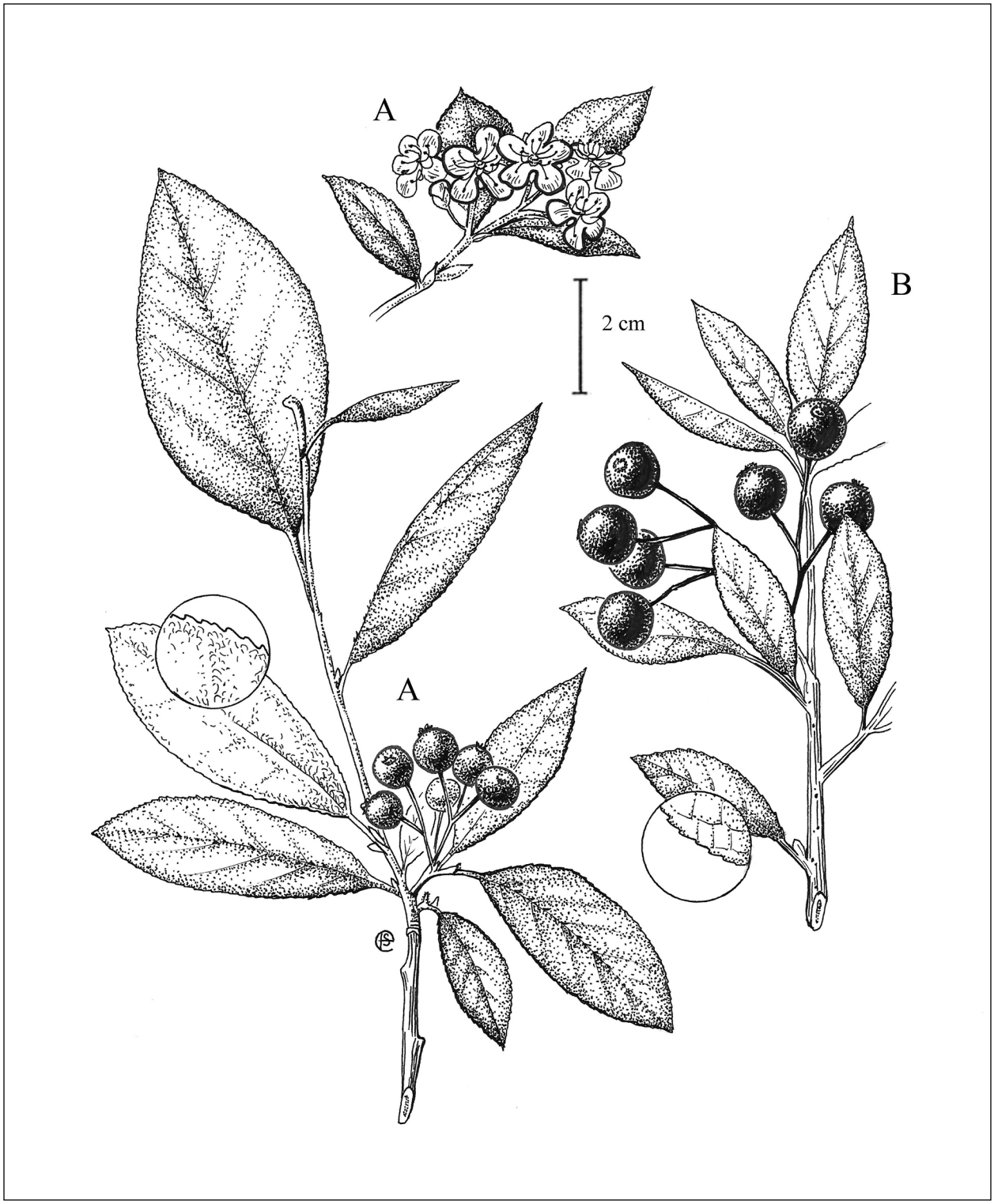


Distribution of *Aronia prunifolia*, or purple chokeberry, recorded in the New York Metropolitan Region during three time categories.

Fruit is purple and drops from the plants shortly after ripening. Moist cold stratification required for germination, with relatively high germination rates. Height at maturity 1–4 m (Gill et al. 2008). Considered an intermediate between *Aronia arbutifolia* and *A. melanocarpa* and is thought to be a hybrid of these two species (Hardin 1973).

Management

Using species of *Aronia* in its native range as a landscape species and potentially beyond its native eastern range in North America to places such as Oregon is being considered (Strik et al. 2003). This species could also be utilized in restoration and rehabilitation projects of disturbed natural areas. Moreover, *Aronia*'s colorful fall foliage and berries and its many medicinal uses would make this genus an ideal candidate as a landscape or garden species, at least in partial-shade and full-sun environments with adequate moisture (Brand 2010). These species may be able to tolerate a broad range of environmental conditions. However, it is important to discern whether the individuals occurring in the drier range are not cultivars. Though use of native species in landscaping, over nonnative potentially invasive species, is highly desirable, doing so requires great care and knowledge of exactly what forms are being planted. This is especially important because many (possibly most) cultivars of *Aronia* are genetically identical (Perrsson Hovmalm 2004), possibly making them more vulnerable to disease and eventual mass dieback. *Aronia* can be successfully crossed outside its genus with several *Sorbus* spp. (Connolly 2009). These cultivars may result in species with inferior quality fruit (Jeppsson 2000), but there is a potential for the development of a cultivar with invasive tendencies; more research on such cultivars should be mandatory prior to their general use.



A) Leaves, showing pubscence; fruit; and flowers of *Aronia arbutifolia*, B) glabrous leaves, and fruit of *Aronia melanocarpa*. Illustration by Emma Skurnick.

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Asimina Adans. – pawpaw

Annonaceae. Shrubs. Species about 10 in North America. The French naturalist Michel Adanson (1727–1806) based the genus name on the name used for the pawpaw by French colonists; the French term for the plant was derived from a Native American name for the plant.

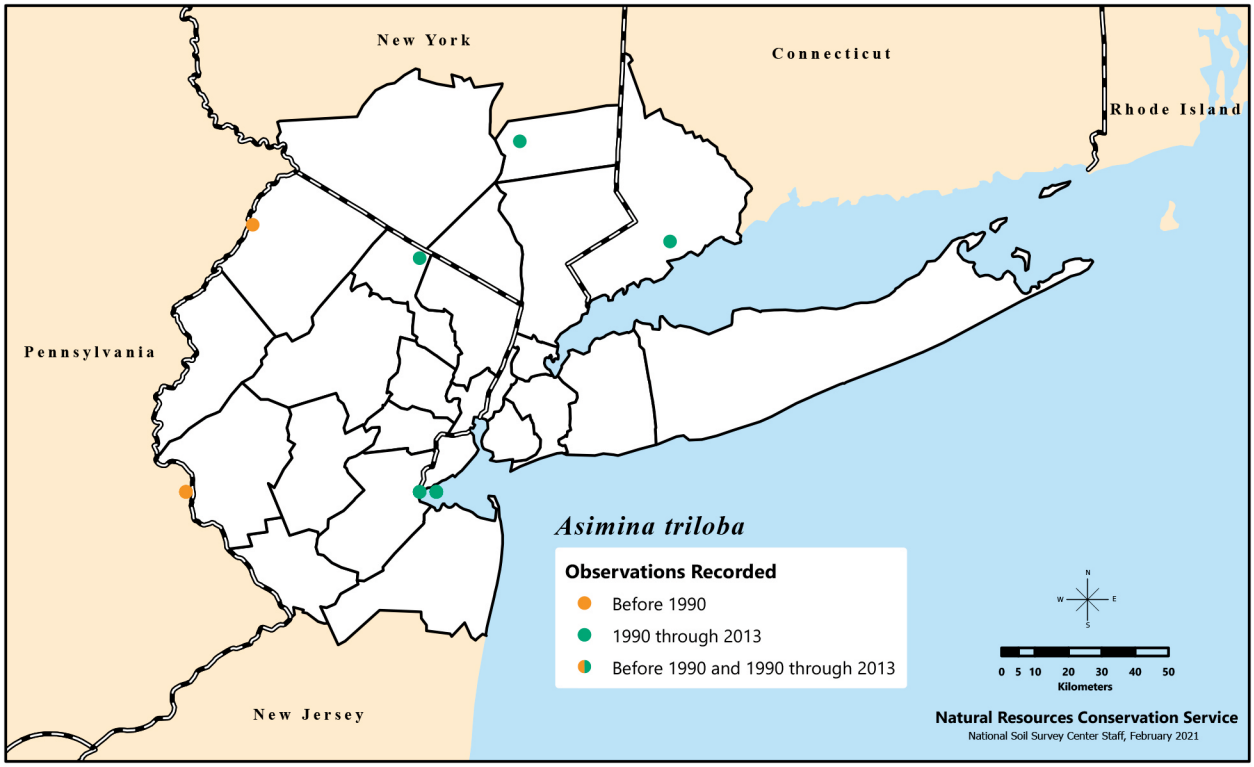
Native Species

1. *Asimina triloba* (L.) Dunal – pawpaw Ø♥

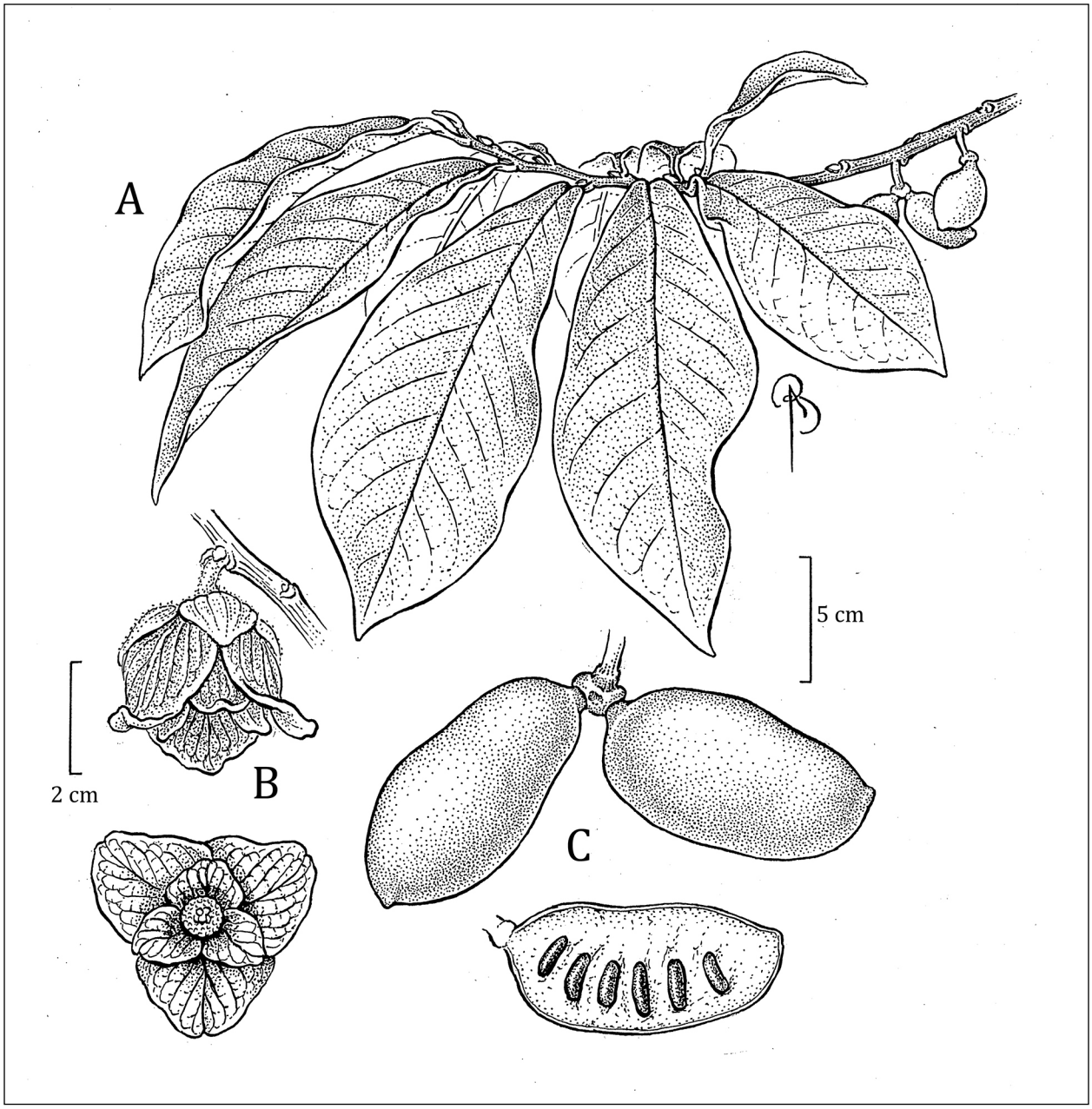
Annona triloba L.

Flowering May; fruiting June–July. Rich mesic hardwood forests and river bottoms. Reaches the northern limit of its range in the region (Dirr 1998). Current records known from Fairfield County (CT); Hunterdon, Monmouth, Passaic, and Sussex Counties (NJ); and Richmond and Putnam Counties (NY). Epithet is curious in that nothing in the plant's morphology (leaves, flowers, fruit) appears trilobed. Linnaeus (1753) originally described the fruit as being "trifidus" and the English naturalist and artist Mark Catesby's (1683–1749) plate of the species (Catesby 1743: 85), which is the lectotype for the name (Dandy 1958) that Linnaeus consulted, shows the fruits from the three separate pistils cohering towards the base, thus appearing as a trilobed fruit. Dirr (1998) indicated that the epithet is a reference to the trilobed calyx. However, Linnaeus in his original description of *Annona triloba* did not describe the calyx, and a 3-lobed calyx is not diagnostic for this species; it is the common condition in *Annona* and *Asimina*.

Some material may represent remnants from cultivation or naturalized material. Potential pollinators are flesh flies (family Sarcophagidae) and beetles (order Coleoptera), but the exact pollinating agents of *Asimina* are not known. Many flies observed on flowers of plants studied in cultivation in Italy (Kral 1960, Roberston 1896, Willson and Schemske 1980, Zimmerman 1941). Fruiting not abundant in nature, and experiments show that fruit set is pollen limited. Hand



Distribution of *Asimina triloba*, or pawpaw, recorded in the New York Metropolitan Region during three time categories.



A) Twig with leaves and fruit; B) flower; C) fruit and cross-section of fruit of *Asimina triloba*. Illustration by Bobbi Angell.

pollination necessary to produce fruit on trees in cultivation. Pawpaw fruit consumed by many birds and mammals, including raccoons (*Procyon lotor*), gray foxes (*Urocyon cinereoargenteus*), opossums (*Didelphis* spp.), squirrels (family Sciuridae), and black bears (*Ursus americanus*). Both fruit and seeds float, so water dispersal is also possible (Bowden and Miller 1951, Cypher and Cypher 1999, Willson and Schemske 1980). Germination is recalcitrant; prechilling required. Germination is slow; can be accelerated by cold stratification, after which development of the hypocotyl and epicotyl still requires several weeks. Seeds should not be allowed to dry out before planting (Brett and Callaway 1992). *Asimina triloba* is clonal; ability to spread vegetatively appears to insure its survival, though it does not spread extensively from such growth (Hosaka et al. 2005). Very shade-tolerant, but flowering stems occur more often in canopy gaps, suggesting that some level

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of canopy disturbance, in addition to pollinators, is necessary to increase sexual reproduction (Hosaka et al. 2008).

This species may also deter invasive plants, including shade-tolerant species like *Microstegium viminuem* (Japanese stiltgrass), which notably cannot grow under a pawpaw canopy. This inability to grow under a pawpaw canopy appears to be due solely to the lack of light and the reduction of sunflecks, because no differences in allelopathic compounds, soil moisture, or soil nutrients could be found between areas under and outside a pawpaw canopy (Cole and Weltzin 2005). *Asimina triloba*'s shady canopy also prevents the growth of some native tree species but not all (Baumer and Runkle 2010).

Under consideration for planting as a crop to help finance the restoration of riparian buffer strips in the Chesapeake Bay Watershed (Robles-Diaz-de-Léon and Nava-Tudela 1998). Domestication of pawpaw requires adequate genetic variation within the germplasm collections (stored at the National Clonal Germplasm Repository). Genetic diversity of pawpaw populations varies; one study showed very low diversity (Rogstad et al. 1991) and other studies show high genetic diversity within each population (Huang et al. 1998, Pomper et al. 2003), which may suggest that pollination and germination limitations also vary greatly with location. However, NY populations differ in genetic composition from the populations in GA, KY, VA, WV, IN, IL, MD, and PA (Huang et al. 1998). Some of the genetic diversity of the NY populations possibly associated with escapees from cultivation (Greller et al. 1992). Not commonly cultivated, but at least 3 cultivars available that vary in fruit size. In cultivation since 1736 (Dirr 1998).

Listed as endangered in NJ (S1) and tracked as rare in NY (S2). Further research is needed to better understand the native and nonnative ranges for this species in the region. Early floras of the region treated the species' native range in the region as restricted to near the Delaware River in Mercer and Hunterdon Counties in NJ (Britton 1889: 41, Stone 1911: 448, Taylor 1915: 315).

Management

A lack of *Asiminia triloba* in the region may be explained by a lack of genetic diversity, which could be attributed to being limited by pollinators. Alternatively, its rarity may be related to a loss of habitat or a loss of rich mesic woods and undisturbed riparian areas. Further domestication could be strategically planned in conjunction with restoration of riparian sites within the region. Ideally, this species could potentially help prevent increases in invasive plant species, such as Japanese stiltgrass, in those riparian areas.

Baccharis L. – baccharis

Asteraceae. Shrubs, herbs. Species 350 in North America and South America. One of only 2 woody representatives (the other, *Iva frutescens*) of this family in the NY Metropolitan Region. Genus name is an ancient name for a shrub, in reference to Bacchus, the Roman name for Dionysus, the Greek god of wine.

Native Species

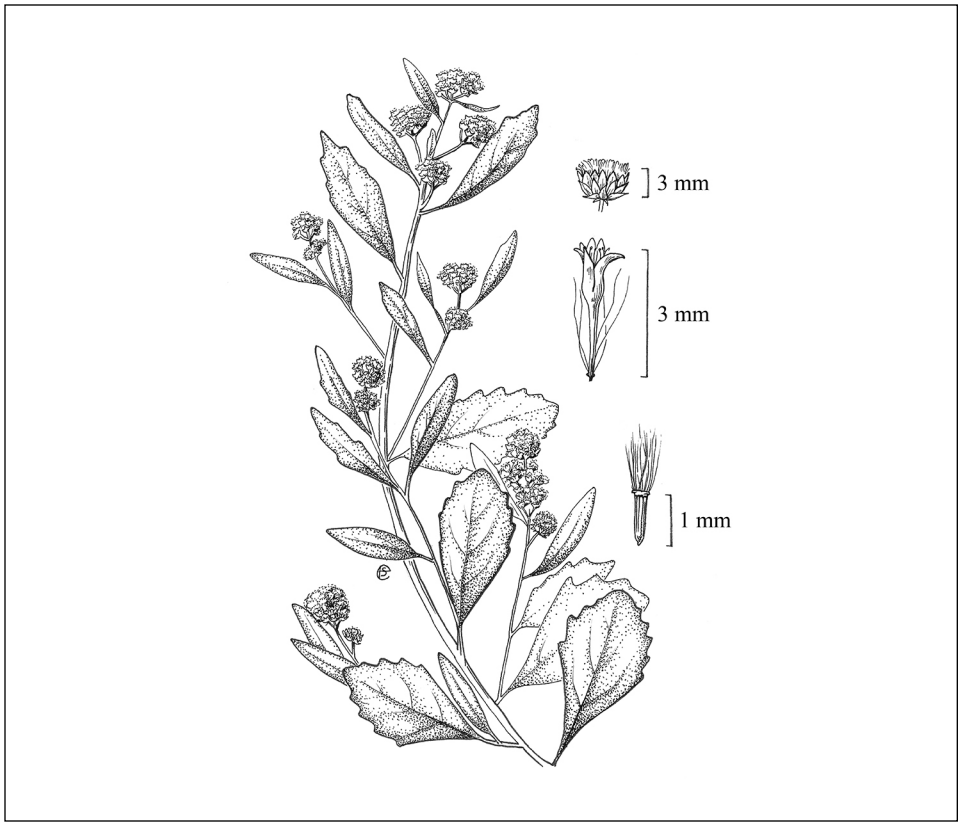
1. *Baccharis halimifolia* L. – groundsel-tree ↔

Flowering mid-Aug.–late Sept. Edges of marshes, chiefly along the coast (occasionally inland). Pistillate plants with their silvery white pappus a conspicuous part of coastal marshes in fall. Introduced in Australia and France (Sundberg and Bogler 2006); invasive in Australia (Westman et al. 1975). Epithet refers to the similarity of the leaves to those of *Atriplex halimus* L., native to northern Africa and Europe. Cultivated since 1683 (Dirr 1997).

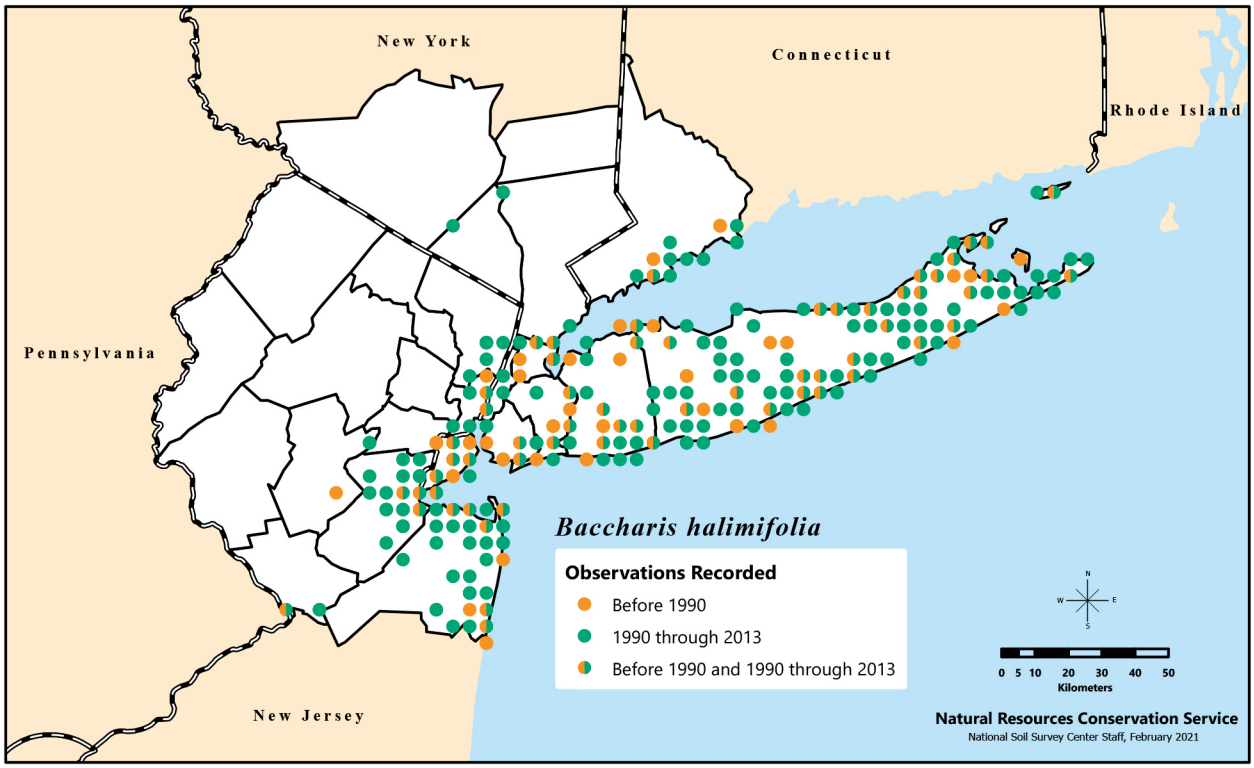
Dioecious (Krishchick and Denno 1990). Found in many soil types; prefers moist soils high in organic matter but is adapted to poorly drained, saline soils (Fried 2016). Seed bank documented (Crawford and Young 1998).

Berberis L. – barberry

Berberidaceae. Shrubs. Species about 500 in temperate and tropical regions in Africa, Asia, Europe, North America, and South America. Self-fertile and mostly autogamous, helping



Twig with leaves and flowers; single composite flowering head; male flower showing corolla and pappus of capillary bristles; and fruit (achene) with pappus of *Baccharis halimifolia*. Illustration by Emma Skurnick.



Distribution of *Baccharis halimifolia*, or groundsel-tree, recorded in the New York Metropolitan Region during three time categories.

A B

Berberis Key

1. Leaves evergreen . . . . . ***Berberis julianae****
1. Leaves deciduous 2
2. Leaf margins spinulose-toothed; leaves 1.5–9 cm; twigs gray; thorns often with 2 side branches as long as the center spine; flowers racemose . . ***Berberis vulgaris****
2. Leaf margins smooth; leaves 1–4 cm; twigs brown; thorns often solitary, or with 2 small side branches; flowers in small clusters or solitary . . . . . ***Berberis thunbergii****

to ensure reproduction (Cadic 1992). *Berberis* spp. have several medicinal compounds; the most common one is berberine, used to treat several ailments including those associated with the cardiovascular, gastrointestinal, immune, and central nervous system (Imanshahidi and Hosseinzadeh 2008). Genus name is derived from "berbêrys," the Arabic name for the fruit.

Nonnative Species

***Berberis julianae* C.K.Schneid. – wintergreen barberry**

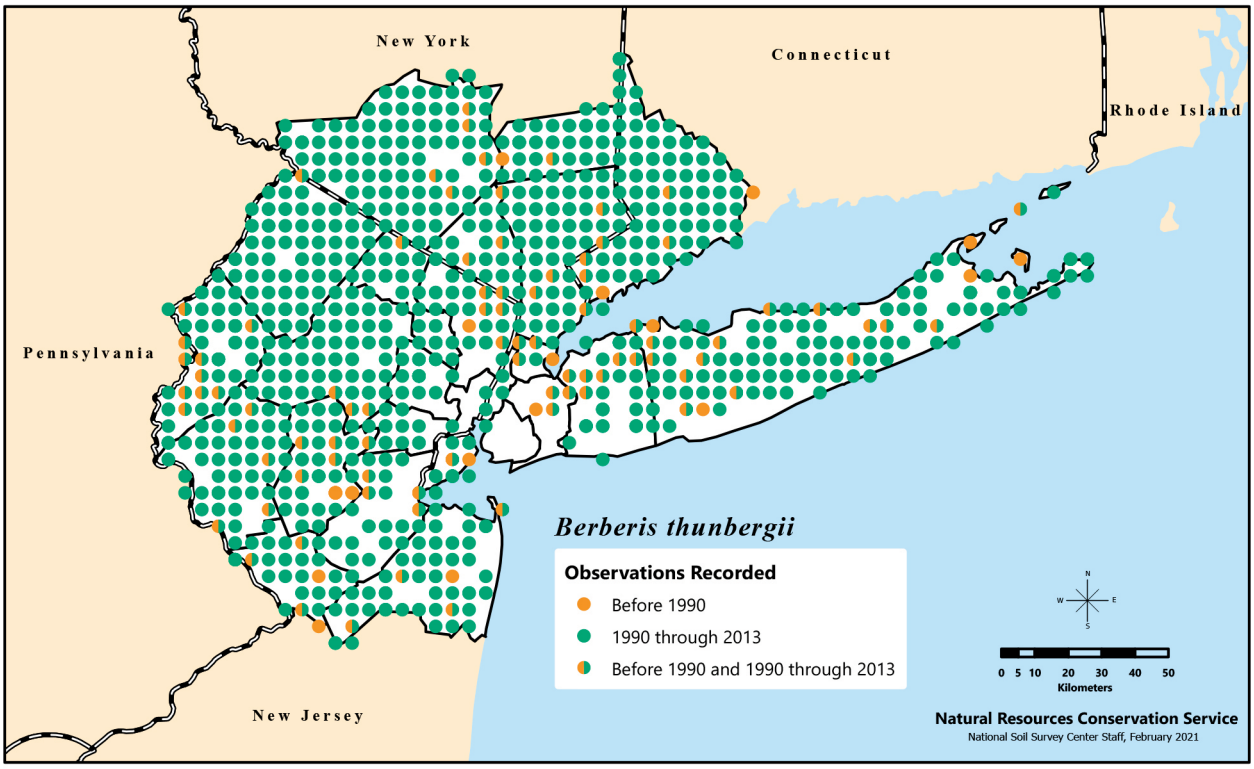
Flowering May. Occasionally cultivated; once reported as possibly naturalized on Long Island in Suffolk County (NY). Epithet honors C.K. Schneider's wife. Evergreen leaves are sharply toothed; three-branched spines at the nodes. Yellow flowers plus a tinge of red; berries blue to black with a bloom. Escapes are noted in several states, suggesting an invasive tendency (Keet et al. 2016). Those with red to purple leaves in the winter are likely to be the 'Spring Glory' cultivar (Dirr 1998). Possibly the most cold-tolerant of the barberries; shade-tolerant (Keet et al. 2016). Evergreen nature may increase treatment window times for this species.

1. *Berberis thunbergii* DC. – Japanese barberry ↑↑↑

Flowering May–early June; fruiting Sept.–Nov. (Minore and Rudolf 2008). Leaves turn red in fall (Dirr 1998). Dry to mesic uplands (rarely in wetter situations) along roadsides, thickets, woodlands, and closed-canopy forests. Native to Japan (Minore and Rudolf 2008); introduced into the U.S. in about 1864 (Dirr 1998). Epithet honors Swedish botanist Carl Peter Thunberg (1743–1828).

Deciduous. Fruit bright red berries containing 1–2 seeds. Moist cold stratification for 90 days required for germination. No apparent seed bank formed (D'Appollonio 2006). Seeds are bird and animal dispersed (Silander and Klepeis 1999). This species is one of the first shrubs to leaf out in spring (Xu et al. 2007a, 2007b) which may be true of all the deciduous barberries. Height at maturity typically less than 1.8 m. Well over 20 popular cultivars, which can be divided into the purple leaf types (or cultivars of *Berberis thunbergii* var. *atropurpurea*) and the green, yellow-variegated leaf types (Dirr 1998). Several cultivars are tetraploids (Rounsaville and Ranney 2010). The *B. thunbergii* var. *atropurpurea* accessions were essentially identical and most likely derived from a highly inbred seed (Lubell et al. 2008a). Tetraploidy can be induced in *B. thunbergii* var. *atropurpurea* using colchicine and oryzalin. Doing so may lead to sterile cultivars after crossing these tetraploids with a diploid to produce a triploid, which is often sterile. However, reversal to the diploid state does occur for both types of tetraploids (Lehrer et al. 2008).

Significant correlation between abundance of *B. thunbergii* and abundance of the blacklegged tick (*Ixodes scopularis*), the white-footed mouse (*Peromyscus leucopus*), and Lyme disease (caused by the bacteria *Borrelia* spp.). This correlation is not due to the possibility that the canopy of this shrub provides protection for the mouse. Instead, this species serves as good habitat for questing ticks in terms of providing protection, adequate stem area, and relatively high humidity. Mice in barberry-infested areas tend to have more ticks, which carry Lyme disease. Thus, controlling *B. thunbergii* may help reduce the occurrence of Lyme disease (Williams et al. 2009).



Distribution of *Berberis thunbergii*, or Japanese barberry, recorded in the New York Metropolitan Region during three time categories.

Listed as invasive in CT (not prohibited) and NY (prohibited); tracked as invasive in NJ (category 1). Exceptionally common throughout the region and one of the region's most invasive plants.

2. *Berberis vulgaris* L. – common barberry ↓

Flowering late Apr.–early June; fruiting Sept.–Oct. (Minore and Rudolf 2008). Dry to mesic uplands; along roadsides; thickets and woodlands. Much less common than *B. thunbergii*, but recently much more frequently encountered off the Coastal Plain. Native to northern Africa, Europe (Minore and Rudolf 2008), and temperate Asia.

Deciduous. Fruits scarlet or purple berries containing 1–2 seeds. Fruit palatable and commonly used in cuisine of the Middle East and as a food additive (Akbulut et al. 2008). Fruit has antioxidant properties but also contains tannins (but lower concentrations than the antioxidants) that may prevent any nutrients from being absorbed (Hanachi and Golkho 2009).

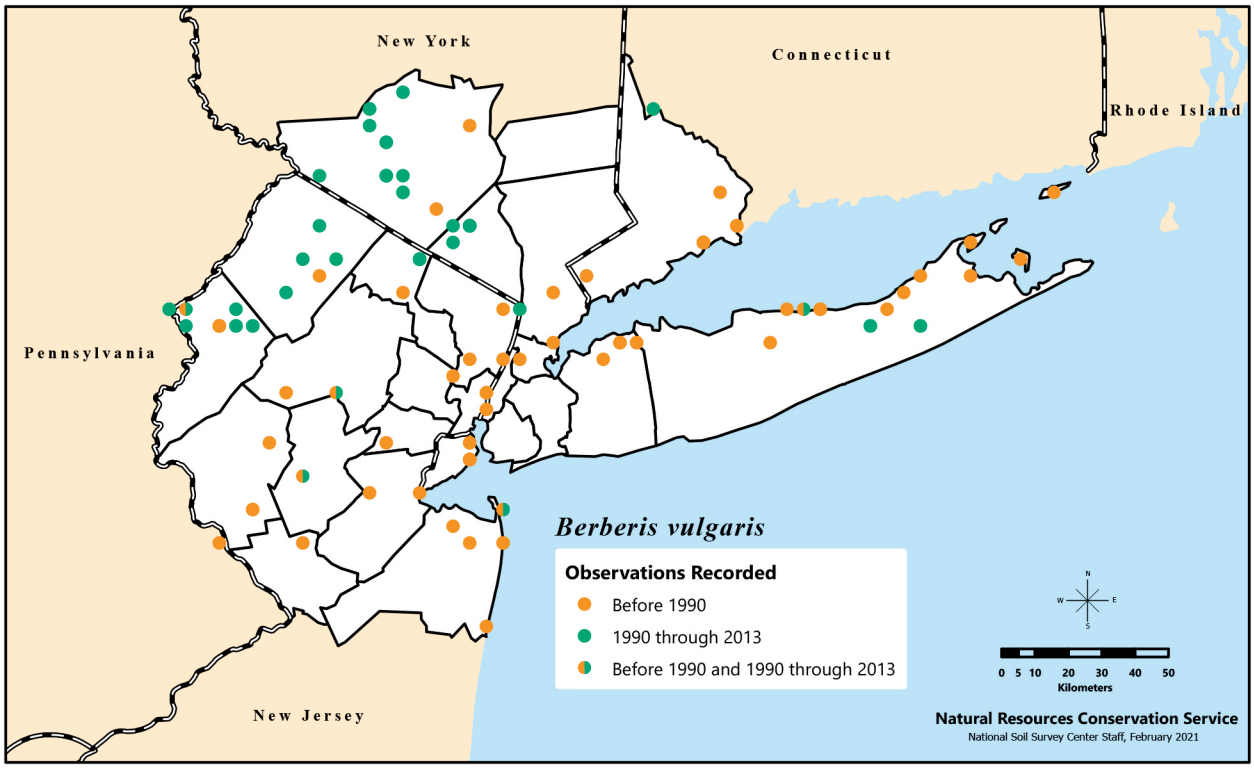
Seeds are bird and animal dispersed. Appears to form a transient seed bank (Bakker et al. 1996). Moist cold stratification for 40 days required for germination. Height at maturity typically 1.8–3 m. An aggressive shrub. Most common cultivar is 'Purpurea.' An alternate host for the wheat rust *Puccinia graminis*; destruction of this species required in some states (Dirr 1998). Also an alternate host for *Puccinia striiformis* (wheat stripe rust pathogen) (Jin et al. 2010).

Listed as invasive in CT (prohibited).

***Berberis* ×*ottawensis* C.K.Schneid.**

The hybrid between *Berberis thunbergii* and *B. vulgaris* occasionally reported from the region. Common in Europe and Canada (Dirr 1998). This hybrid is a diploid (Rounsaville and Ranney 2010). *Berberis thunbergii* cultivars 'Concorde' and 'Criruzam' Crimsom Ruby are likely genotypes of this hybrid, because they form a cluster with known *B.* ×*ottawensis* cultivars (Lubell et al.

A B

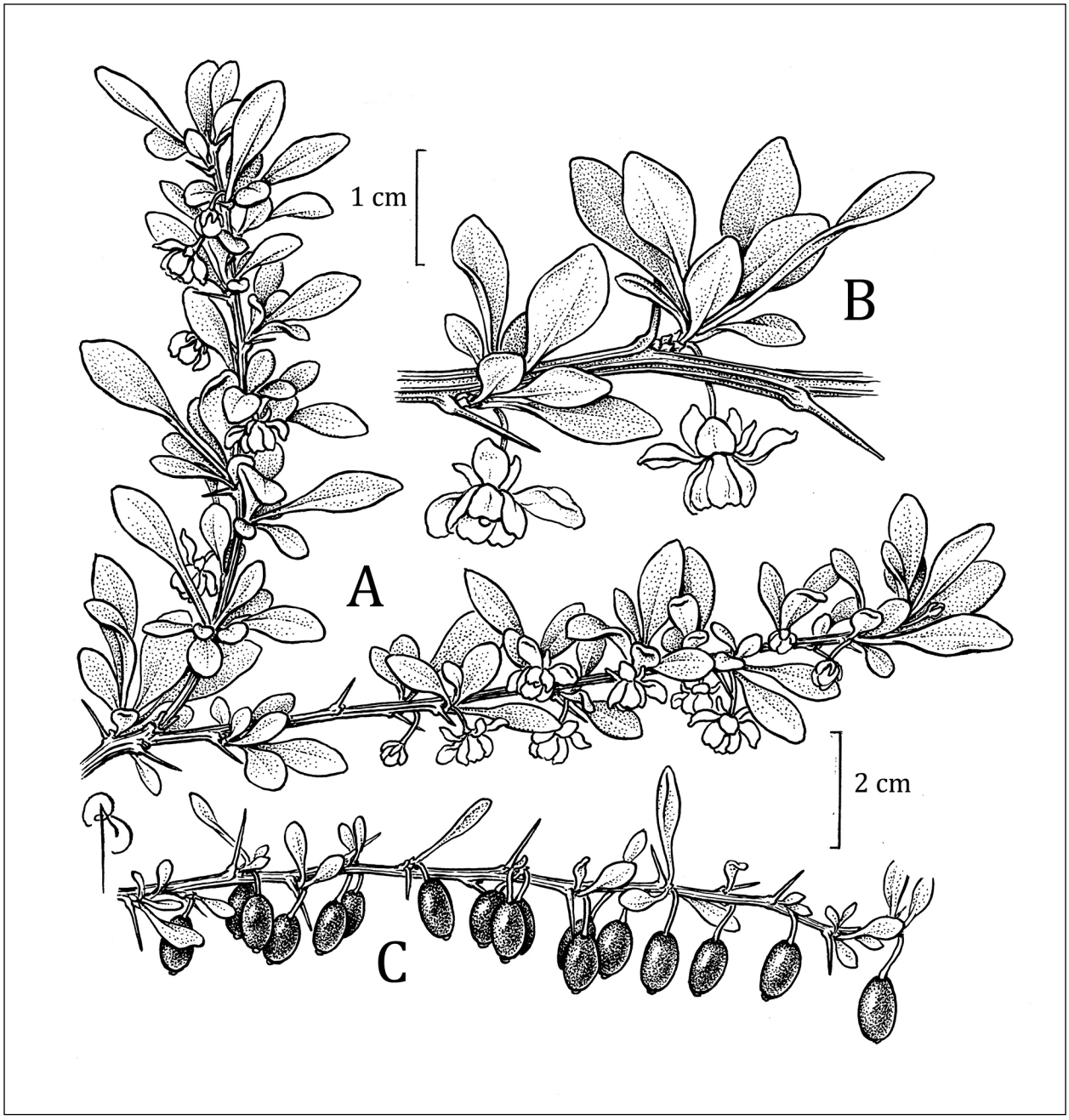


Distribution of *Berberis vulgaris*, or common barberry, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Kings County (NY).

2008b).

Management

One of the most successful control methods of *Berberis thunbergii* starts with pretreatment: prescribed burn or cutting or mowing to reduce the size of the plants. Once the plants have leafed out again, the second step is to apply herbicide or to scorch with a propane torch. The latter may be reasonable when plants are small and herbicide application is not a possibility (Ward et al. 2009). The bird-dispersed seeds make control of these nonnatives more of a challenge, but not having a seed bank improves the likelihood of successful control. *Berberis* is more likely to be found in sites that were historically abandoned agricultural sites, though it can also invade forests with no history of agricultural land use (DeGasperis and Motzkin 2007). *Berberis* cultivars do not all have the same invasive potential. A key for 42 *B. thunbergii* cultivars and hybrids and *B. vulgaris* 'Atropurpurea' using 23 markers is available. This key may help ensure only legal cultivars are sold, if cultivar-specific bans are enacted (Lubell et al. 2008b). The green-leaved shrubs found invading natural or disturbed areas are likely to be the progeny of *B. thunbergii* first introduced in 1889 and not the more recent popular *B. thunbergii* var. *atropurpurea* (Lubell et al. 2008a). Unfortunately, the invasive potential in terms of seed production is high for *B. thunbergii* var. *atropurpurea* and the cultivar 'Rose Glow.' 'Aurea' and 'Crimson Pygmy' are similar cultivars with much lower seed production values than *B. thunbergii* var. *atropurpurea* and 'Rose Glow.' Thus, selection of cultivar is important if the goal is to reduce the likelihood of future invasions (Lehrer et al. 2006). The invasive tendencies of *B. julianae* and invasive potential of *B. ×ottawensis* are noted here as concerns for the NY Metropolitan Region.



A) Twig with leaves, flowers, and prickles; B) portion of a twig with leaves, flowers, and prickles; and C) twig with leaves, fruit, and prickles of *Berberis thunbergii*. Illustration by Bobbi Angell.

A B

Betula L. – birch

Betulaceae. Trees, shrubs. Species 50, chiefly in the Northern Hemisphere in Asia, Europe, and North America; also South America. Genus name is the ancient Latin name for the plant.

Native Species

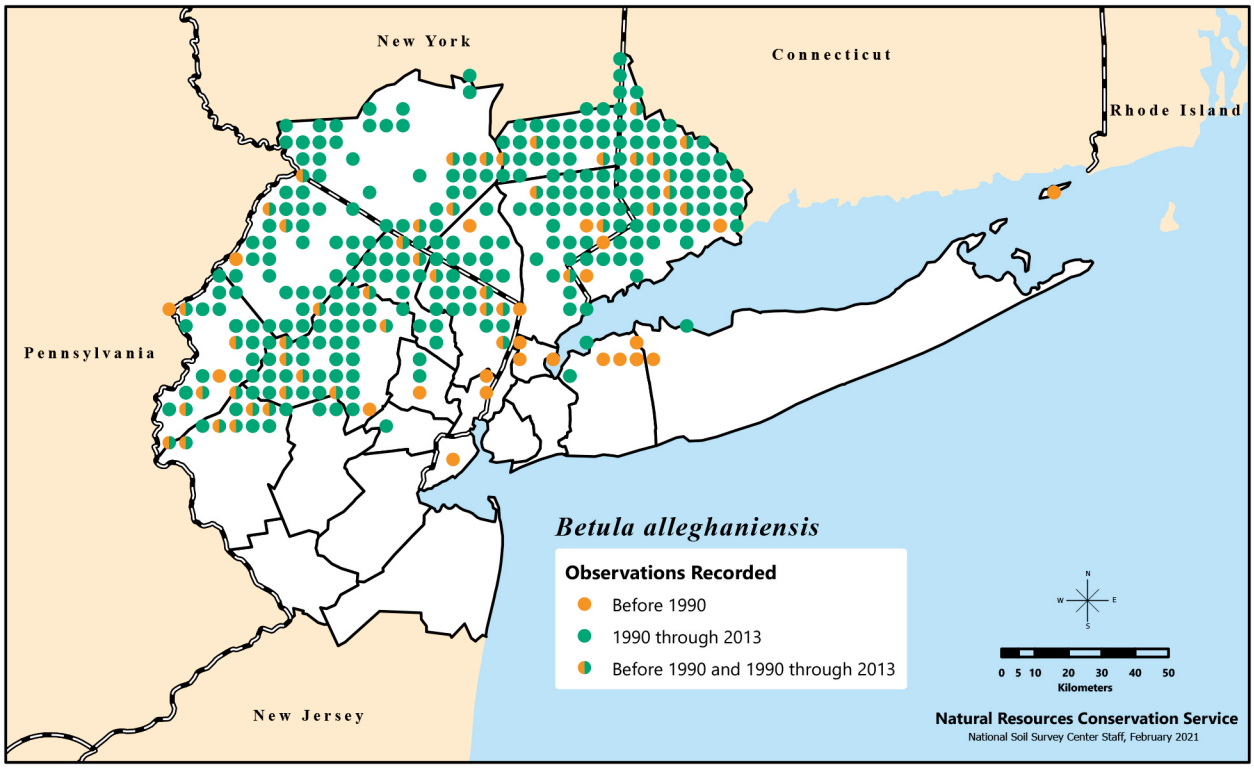
1. *Betula alleghaniensis* Britton – yellow birch ↑↑

Tree. Flowering late May–early June (Erdmann 1990). Rich mesic woodlands. Prefers moist cool soils and cool summer temperatures. Does not grow well in hot, dry climates. (Dirr 1998). Common name refers to its yellowish bronze bark (Erdmann 1990).

Monoecious. Because female flowers are receptive 2–5 days before the pollen from the male flowers is shed from the same tree, this species is primarily outcrossed (Erdmann 1990). Earliest seed-bearing age 40 years, with 2 years between large seed crops (Karrfalt 2008). Seeds generally have low viability; light required to germinate. Seeds are wind pollinated. Ability to mast may improve fitness of this species susceptible to high seed predation (Kelly et al. 2001) and may be related to pollination efficiency (Houle 1999). Young seedlings browsed by deer (*Odocoileus* spp.) (Horsley and Marquis 1983). Fire can kill most saplings and resprouting is vigorous (Erdmann 1990, Perala and Alm 1990). Height at maturity 30 m. Wood used extensively for cabinets, furniture, doors, and flooring; species is thus a commercially important tree (Dirr 1998). Though a shade-intolerant tree, seedlings grow best at about 45 percent full sunlight (Logan 1965). Shaded seedlings produce more shoot dry biomass, while unshaded seedlings produce more root dry biomass (Gordon 1969). *Acer saccharum* can suppress *B. alleghaniensis* root growth with allelopathic compounds (Tubbs 1973). Forms a persistent seed bank if buried in mineral soil and not exposed to predators, pathogens, and suitable germination conditions (Houle 1994, Houle and Payette 1990). Hybridizes naturally with *B. papyrifera* (Barnes et al. 1974).

Betula Key

1. Multistemmed shrub . . . . . ***Betula pumila***
1. Single- or multi-trunked tree 2
2. Bark on mature trunks whitish 3
2. Bark on mature trunks yellowish-gray to dark reddish-brown or blackish-brown 4
3. Bark on mature trunks tight, not exfoliating . . . . . ***Betula populifolia***
3. Bark on mature trunks exfoliating into thin strips 5
4. Leaf blades ovate to elliptic, base rounded; twigs with a wintergreen taste or odor 6
4. Leaf blades rhombic to ovate, base broadly cuneate to truncate; twigs without a wintergreen taste or odor . . . . . ***Betula nigra***
5. Leaf undersides pubescent at least along veins 7
5. Leaf undersides glabrous 8
6. Bark of mature trunks exfoliating; leaf undersides without shiny resin dots . . . . . ***Betula alleghaniensis***
6. Bark of mature trunks not exfoliating; leaf undersides with shiny resin dots . . . . . ***Betula lenta***
7. Leaves subcordate at the base . . . . . ***Betula cordifolia***
7. Leaves cuneate or acute at the base . . . . . ***Betula papyrifera***
8. Leaf apices acuminate without long drawn tip . . . . . ***Betula platyphylla****
8. Leaf apices with a long tapering tip 9
9. Leaves ovate, bases mostly truncate; axillary buds 5–7 mm long, apices obtuse to acute . . . . . ***Betula ×caerulea***
9. Leaves triangular or rhombic, bases mostly cuneate; axillary buds 4–5 mm long, apices acute or acuminate . . . . . ***Betula pendula****



Distribution of *Betula alleghaniensis*, or yellow birch, recorded in the New York Metropolitan Region during three time categories.

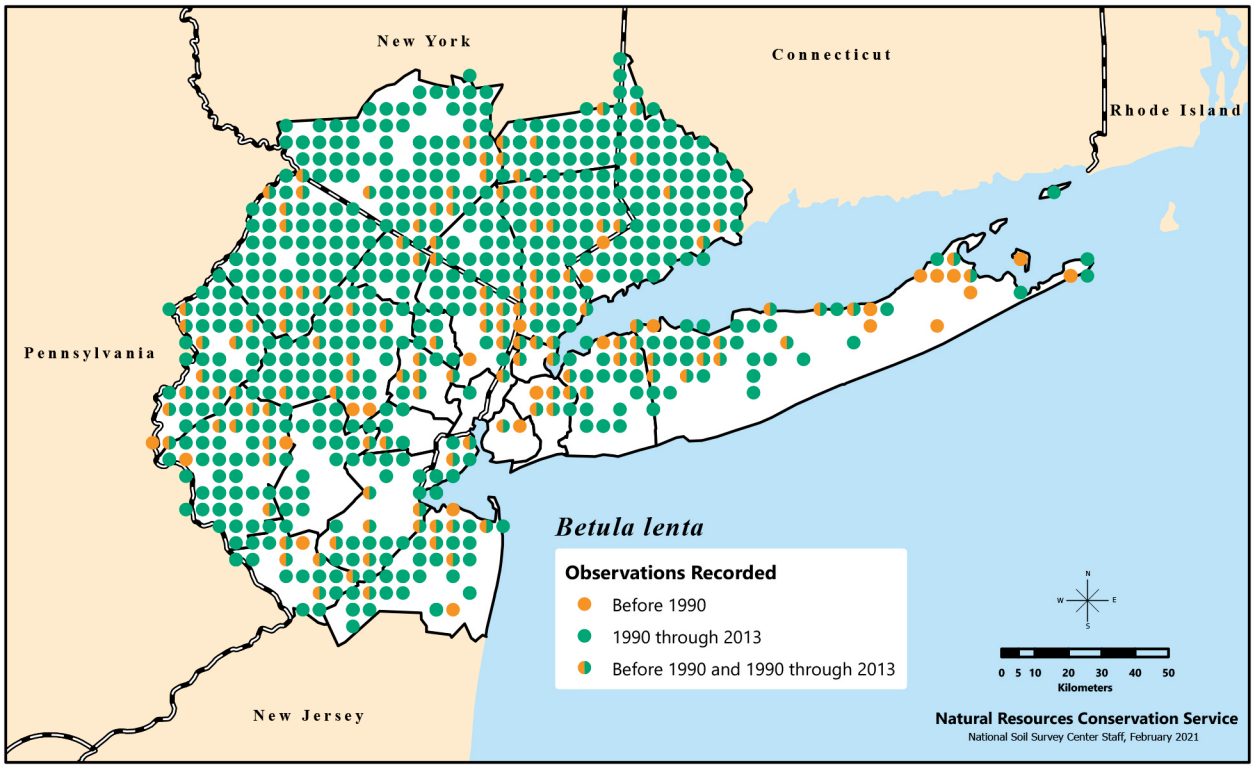
2. *Betula lenta* L. – sweet birch, black birch ↑↑

Tree. Flowering late Apr.–mid-May. Mesic, usually rich, woodlands. Prefers deep, rich, moist, slightly acidic, well-drained soils, but can be found on more xeric and rocky sites (Dirr 1998). Epithet means "flexible," a reference to the pliant twigs.

Monoecious. Earliest seed-bearing age 40 years, with 1–2 years between large seed crops. Month-long cold stratification may compensate for a lack of light for germination. Seed banks of 17 years may be possible (Karrfalt 2008). Seeds are wind dispersed and are dispersed in both fall and winter (January and February). A winter dispersal phenology (after the leaves fall) provides higher wind speeds and snow cover that result in unimpeded seed movement; seeds travel farther than those dispersed in fall. About 95 percent of the seed fall within an area of 19 m^2 (Matlack 1989). May sprout from the base even as a sapling, though it cannot root sucker (Del Tredici 2001).

Height at maturity 24 m. It makes an excellent landscape tree with the best fall color among the birches, though many prefer the birch spp. with light bark. As with most birches, it suffers from several diseases, such as leaf spots (caused by the fungi *Tubakia* spp.), canker (caused by the fungus *Nectria nigrescens*), wood decay (caused by fungi in class Agaricomycetes), and mildew (order Erysiphales). Wood darkens to a color resembling mahogany and was historically used as a substitute for mahogany wood. Wood is used to make cabinets and woodenware; its pulp is used in book paper, paper towels, and corrugated paper. *Betula lenta* and *B. alleghaniensis* can hybridize (but do not appear to do so naturally); hybrids have low vigor (Sharik and Barnes 1971). At least one natural hybrid of *B. lenta* and *B. pumila* has been documented. Shade-intolerant (Lamson 1990); typically colonizes forest gaps (Hibbs 1982). Cultivated since 1759 (Dirr 1998).

A B



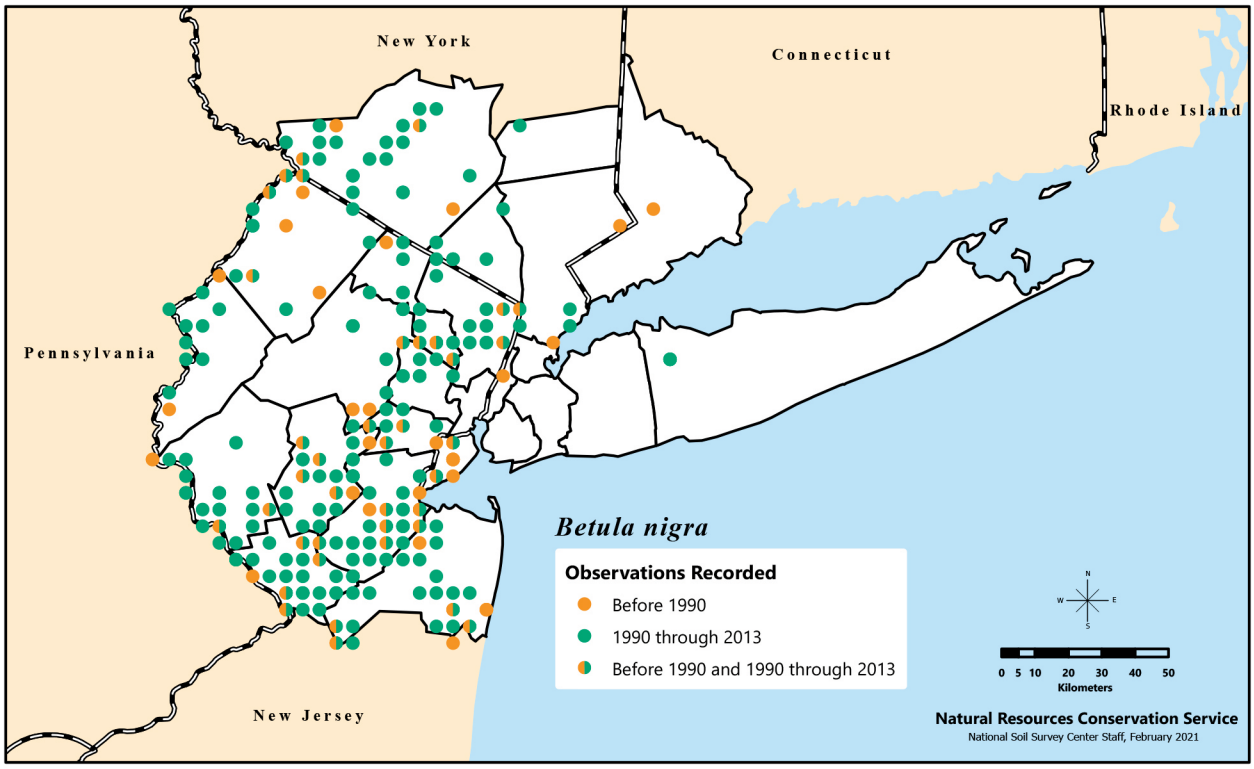
Distribution of *Betula lenta*, called sweet birch or black birch, recorded in the New York Metropolitan Region during three time categories.

3. *Betula nigra* L. – river birch ↑

Tree. Flowering mid-Apr.–mid-May. Swampy woodlands, riversides, and lakesides. On the Coastal Plain, this species can be found in open wetlands in the freshwater tidal zone. Prefers acidic (pH less than 6.5), moist soils, though it can survive but not thrive in drier soils. Tolerates heat well but is not drought-tolerant (Dirr 1998, Wolfe and Pittillo 1977). Etymology unclear.

Monoecious. It is the only spring-fruiting birch; seeds dispersed May–June. Seeds are the largest among the native North American birches (Grelen 1990). Seeds may germinate after 30–60 days of cold stratification, but light is more important (Karrfalt 2008). Good seed groups generally occur every year (Grelen 1990). Height at maturity 30 m. May be one of the few bottomland trees that can grow well in very acidic conditions, such as those caused by acid mine drainage. A poor competitor against other species in soils with a more moderate pH (McClelland and Ungar 1970). Its lower competitive ability may be due to shade-intolerance (Grelen 1990). Can form a persistent seed bank, even in mine spoil (Carter and Ungar 2002). Probably the most adaptable birch used in landscaping, a use likely to increase. Planted for its bark, which exfoliates into papery sheets, exposing an inner bark color that varies from salmon-brown, gray-brown, or cinnamon-brown to reddish-brown. Relatively pathogen-free though it may experience leaf spot, especially in wet years. Likely to develop iron chlorosis if the soil pH is too high (Dirr 1998). Though the wood is not generally considered of commercial value, it has been used locally for furniture, artificial limbs (wood is light in weight), and children's toys. Cultivated since 1736, with at least seven cultivars. Natural hybrids with *Betula papyrifera* have been reported but not verified. Other cross attempts have resulted in low viability, though crosses with *B. nigra* as the maternal source were more likely to survive (Clausen 1970).

Tracked as vulnerable (S3) in NY.



Distribution of *Betula nigra*, or river birch, recorded in the New York Metropolitan Region during three time categories.

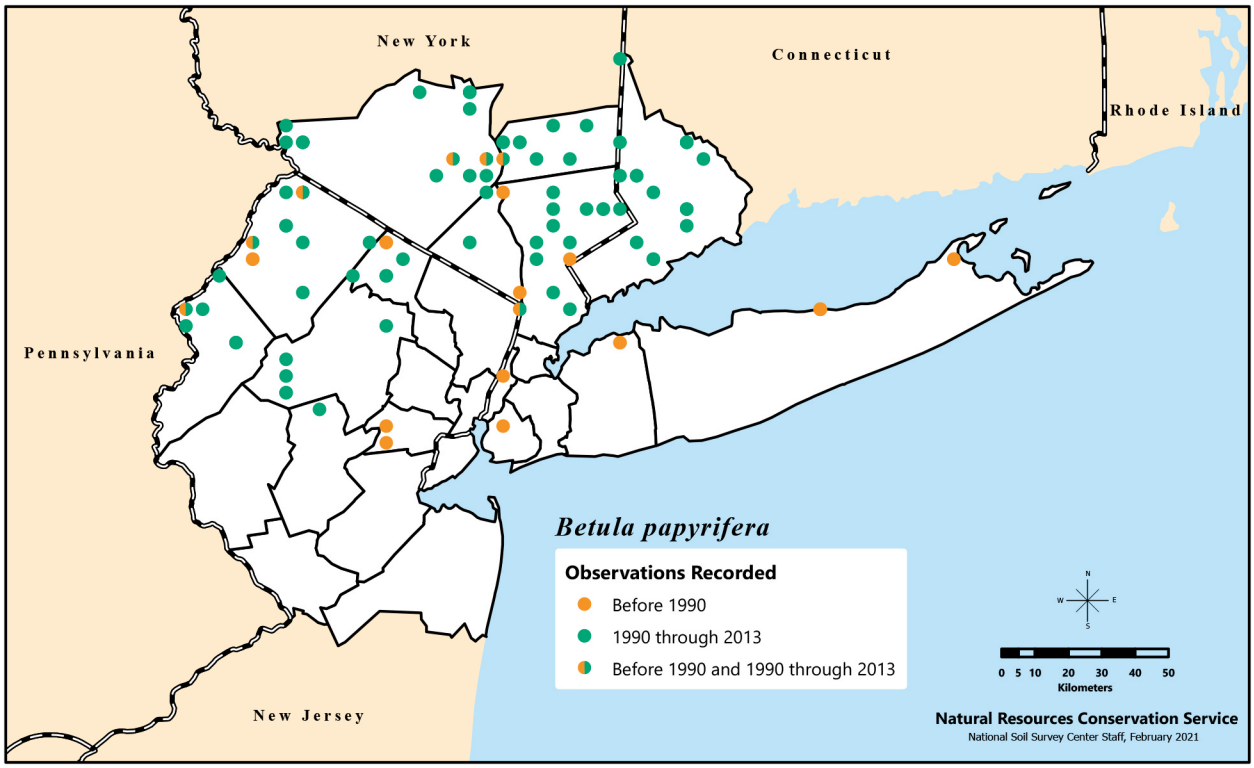
4. *Betula papyrifera* Marshall – canoe birch, paper birch, white birch ↑↑

Tree. Flowering late Apr.–early June. Rich, mesic woodlands, often on slopes. Best adapted to colder climates; well-drained, acidic, moist, sandy or silty soils; and full sun. More tolerant of higher pH soils than Betula nigra (Dirr 1998). The NY Metropolitan Region is most likely within the southernmost limit of its range. Epithet from Latin refers to the thin papery exfoliating bark present on mature trees.

Male inflorescences are on long shoots while female inflorescences are on short shoots (Caesar and Macdonald 1983, 1984). No cold stratification required for germination, but it may substitute for a lack of light, of which 9 or more hours is advised (Bevington 1986, Dirr 1998). Forms a persistent seed bank (Leckie et al. 2000). Earliest seed-bearing age is 15 years, with 2 years between large seed crops (Karrfalt 2008). Height at maturity 21 m. Second only to *B. lenta* in the beautiful yellow leaf color produced in fall. Much less susceptible to bronze birch borer (*Agrilus anxius*) than the nonnative *B. pendula* (which is often planted instead of *B. papyrifera*). Indeed, there is evidence that the native *B. papyrifera*, which also has white bark, is the superior landscape tree compared to *B. pendula*. The European species have white bark at earlier ages than *B. papyrifera*, which may be why they have been planted more frequently than *B. papyrifera* as ornamentals. Susceptible to dieback from air pollution. Browsed by deer and other animals (Safford et al. 1990). Cultivated since 1750 (Dirr 1998), with at least 2 cultivars (Dirr 1998) and 6 recognized varieties (Safford et al. 1990). Can hybridize naturally with almost every other native birch, including *B. alleghaniensis*, *B. lenta*, *B. nigra*, and *B. pumila*, but hybrids are not named (perhaps because they are viable only via backcrosses due to sterile pollen) (Clausen 1962). *Betula cordifolia*, only rarely found in the region, is thought to be a hybrid of *B. papyrifera* and *B. lenta*. Can sprout prolifically after cutting or fire. Wood is used commercially for veneer and pulpwood. Sap is tapped and used as a syrup that contains less sugar than maple syrup (Safford et al. 1990).

Tracked as imperiled in NJ (S2).

A B



Distribution of *Betula papyrifera*, variously called canoe birch, paper birch, or white birch, recorded in the New York Metropolitan Region during three time categories.

5. *Betula populifolia* Marshall – gray birch ↑↑

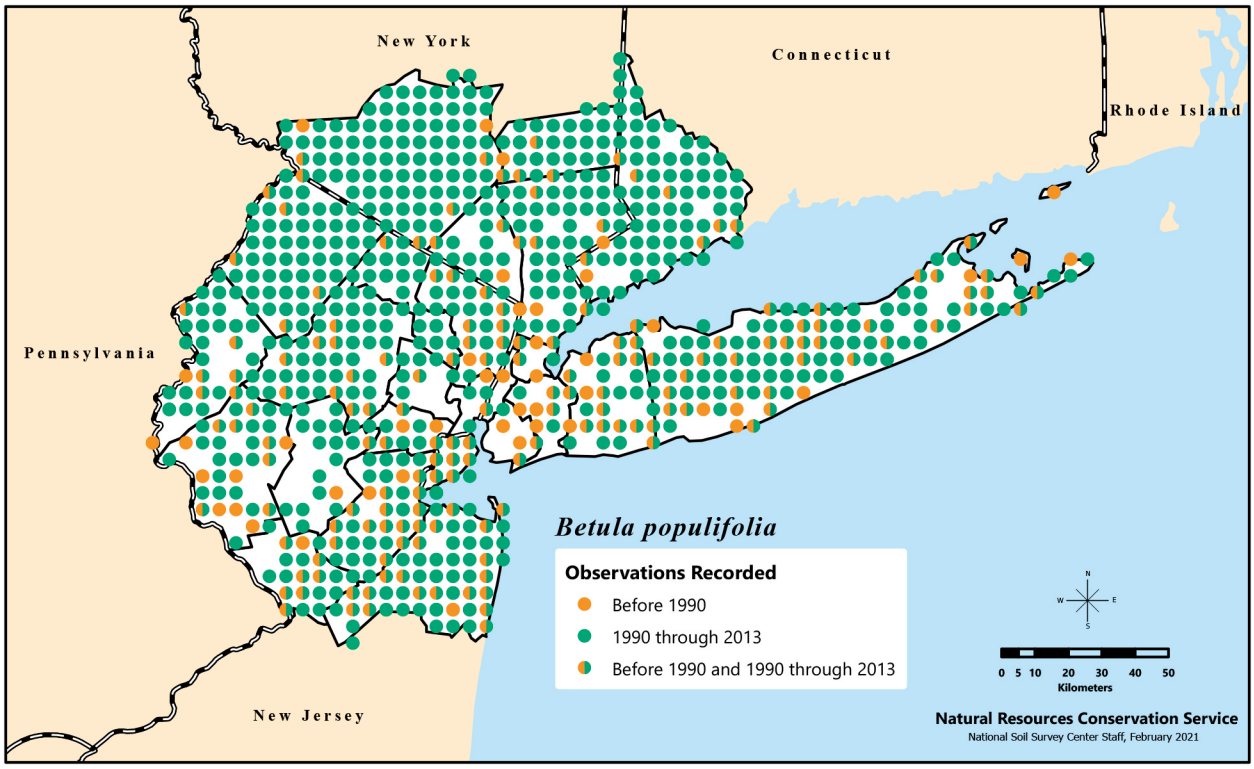
Tree. Flowering mid-Apr.–early May. Dry to sometimes mesic woodlands and open areas. Species often appears after disturbance. Grows well in very nutrient-poor soils, including sandy, rocky, and gravelly sites. Can tolerate both wet and dry conditions, but prefers full sun. Develops chlorosis in response to soils with high pH (Dirr 1998). Epithet refers to the leaves, which are similar in outline to those of some *Populus* (poplar) spp.

Leafs out early. Of no commercial value. Can start bearing seeds annually at 8 years of age. Seeds are dispersed into mid-winter. Appears to lack innate seed dormancy, so if conditions are right for germination, seeds germinate almost immediately (Weiss 1926). In winter and early spring, lack of moisture or temperature fluctuations may hinder germination (Pratt 1986). Ectomycorrhizal diversity rather than abundance can improve plant growth and nutrient uptake for this species (Baxter and Dighton 2001). Cold stratification of 60–90 days appears to help germination, but at least 8 hours of light is also required (Karrfelt 2008).

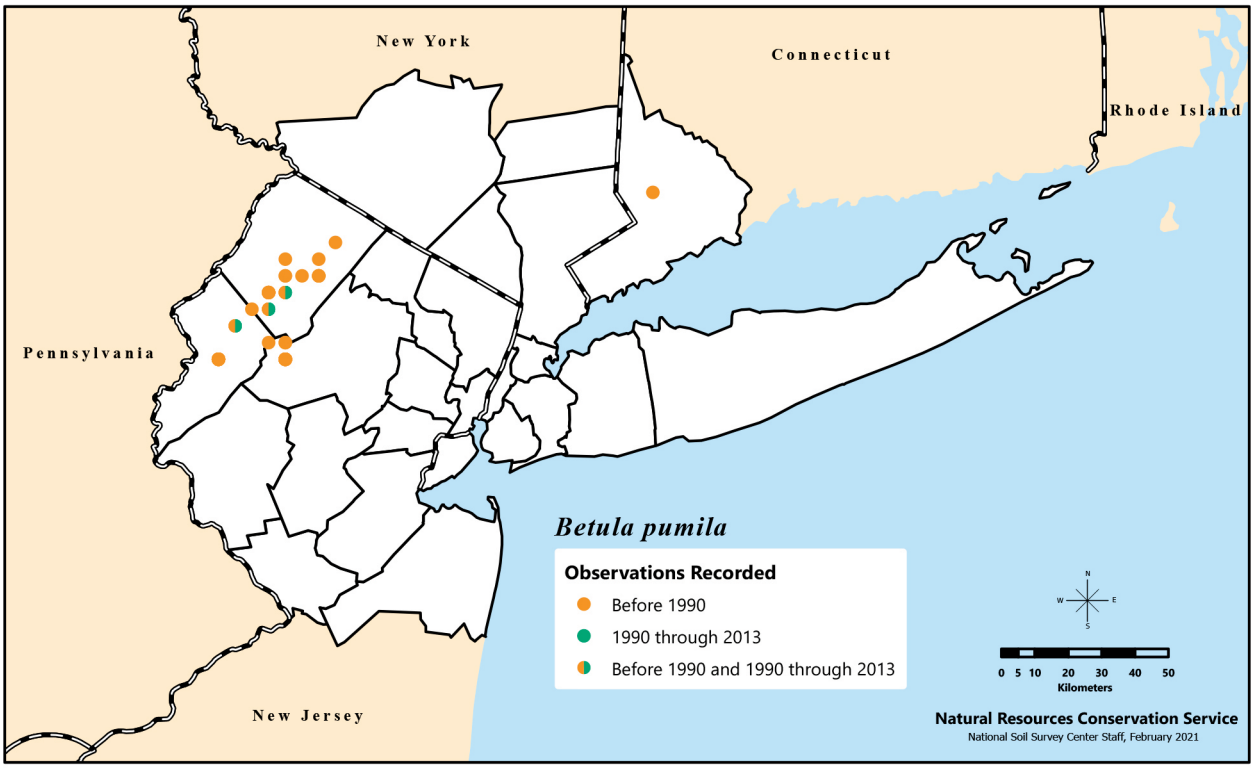
Height at maturity 12 m. Can rapidly colonize disturbed waste lands, making it a good nurse tree for subsequent species following a typical successional trajectory (Weiss 1926). This species has invasive tendencies and invades peat mines in great numbers, which could impede restoration of these bogs, because of their negative effect on the water table (Lavoie and Saint-Louis 1999). Cultivated since 1780 but with no apparent cultivars (Dirr 1998). *Betula* ×*caerulea*, a cross between *B. cordifolia* and *B. populifolia*, was present historically in the region (one record) but has no current records.

6. *Betula pumila* L. – swamp birch ↓↓↓

Shrub. Flowering May. Bogs and open swamps, usually calcareous. Two varieties are sometimes recognized and have been reported from the region, *Betula pumila* var. *pumila*, with branches and leaf surfaces eglandular (but pubescent), and *B. pumila* var. *glandulifera* Regel, with glandular branches and leaf undersides (Fernald 1950; not recognized by Furlow 1997). Epithet from Latin means “dwarf,” a reference to the species’ low habit, a shrub.



Distribution of *Betula populifolia*, or gray birch, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Betula pumila*, or swamp birch, recorded in the New York Metropolitan Region during three time categories.

A B

Seeds are dispersed through winter into March; 1–2 years between large seed crops. Height at maturity 3 m. Cultivated since 1762. The variety *B. pumila* var. *glandulifera* Regel hybridizes introgressively with *B. papyrifera*. The higher number of backcrosses into *B. papyrifera* suggest a loss of *B. pumila* genetic information. These hybrids resemble *B. papyrifera*, but do contain a compound in the inner bark known only from *B. pumila*. Two of these backcrosses have viable pollen and thus could potentially perpetuate themselves (Clausen 1962).

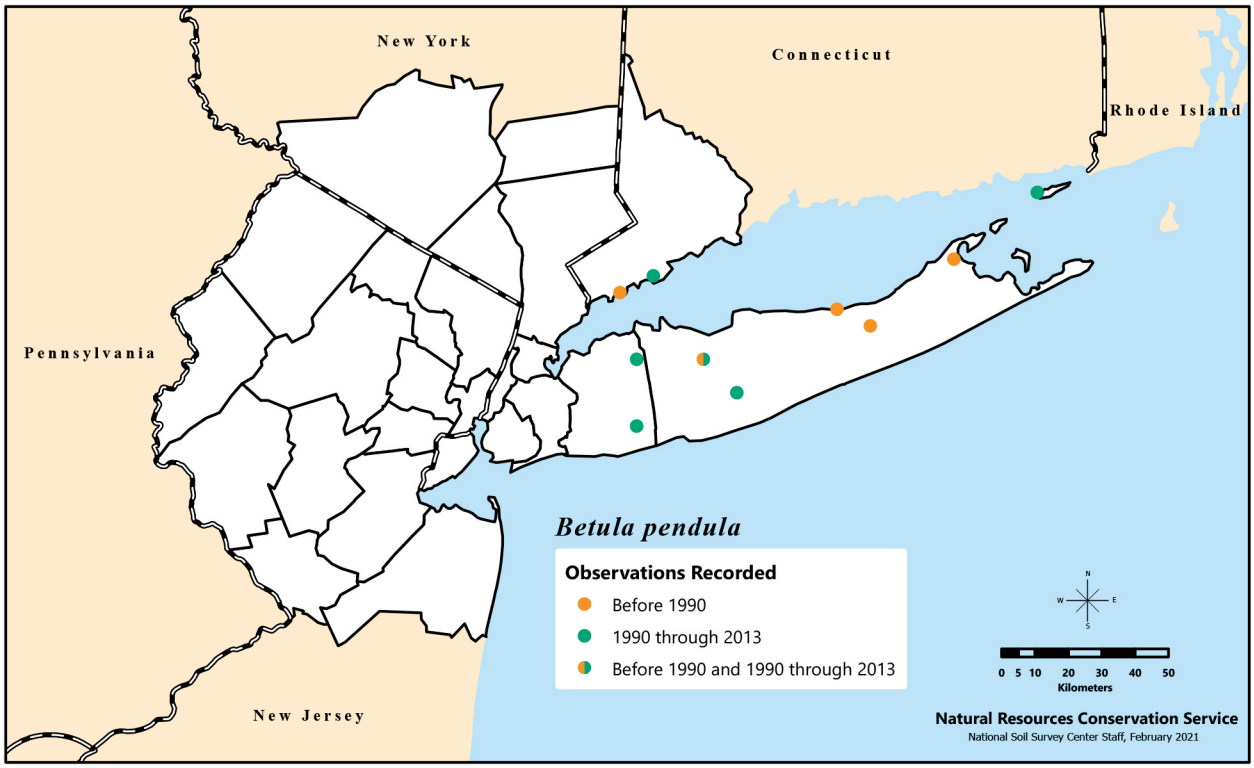
Listed as threatened in CT (S2) and tracked as imperiled in NJ (S2).

Nonnative Species

7. *Betula pendula* Roth – weeping birch ↔

Flowering May. Thickets and open woods scattered on the Coastal Plain. Prefers well-drained moist sandy or loamy soils. Can tolerate wet and dry conditions and is more pH-tolerant than species native to the region, such as *B. nigra* (Dirr 1998). Native to Asia and Europe. Epithet from Latin refers to the species' drooping (pendulous) branches.

Seeds are dispersed July–Sept. Earliest seed-bearing age 15 years of age; large seed crops every 2–3 years. At least 8 hours of light necessary for germination but can be compensated with 30–40 days of cold stratification (Karrfalt 2008). Height at maturity 19.5 m (Karrfalt 2008), but can grow to 30 m (Atkinson 1992). This species is very susceptible to leaf miners and birch borers, so much so that a once very popular landscape tree is now much less likely to be planted. A persistent seed bank is possible. In one study only 6 percent of the seed remained viable after 1 year, but the rate of decline slowed after 2 years, so some seed may be relatively long-lived in the seed bank (Atkinson 1992). However, another study in Sweden showed that this species was found abundantly within the seed bank (soil was collected after germination and before seed dispersal, so the seed found were not from current seed rain) (Milberg 1995). Long cultivated, with at least 18 cultivars (Dirr 1998).



Distribution of *Betula pendula*, or weeping birch, recorded in the New York Metropolitan Region during three time categories.

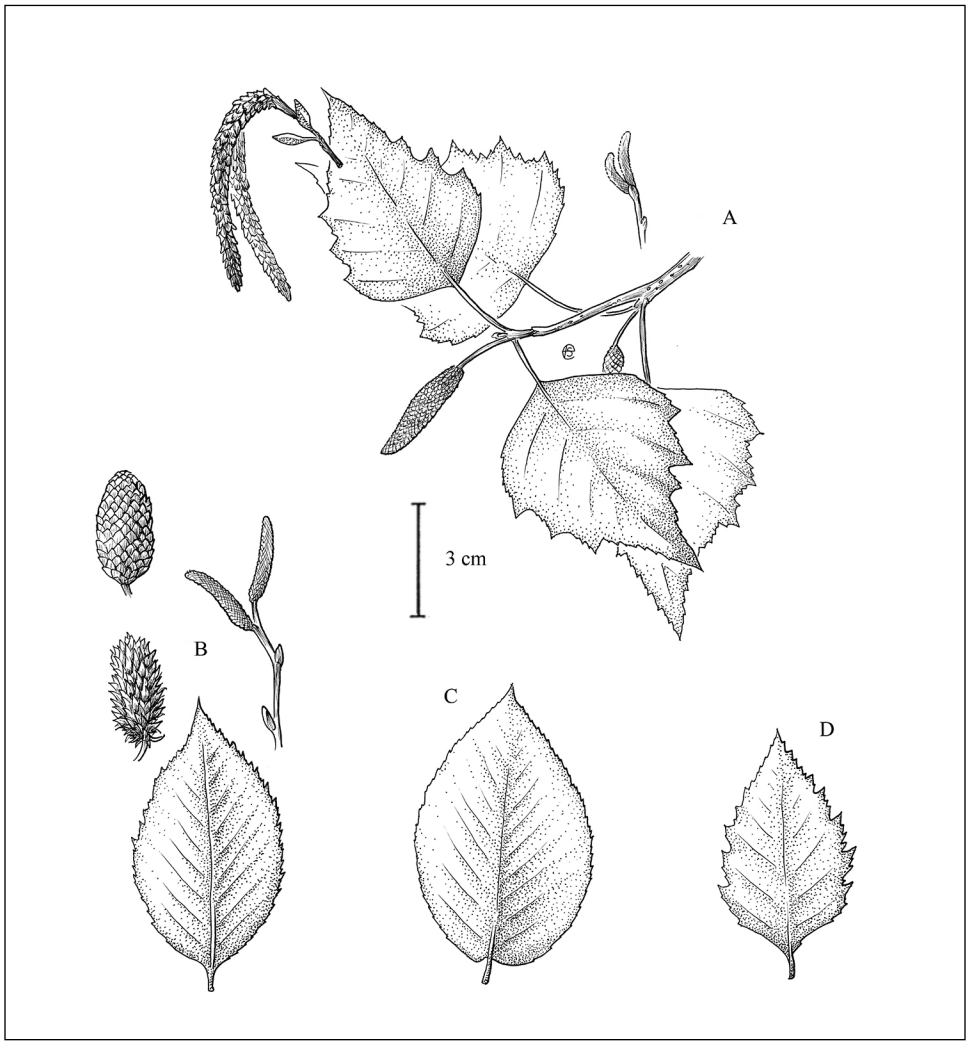
***Betula platyphylla* Sukachev – Asian white birch**

Native to Asia. This species has been anecdotally reported from NY (Mitchell and Tucker 1997). However, no specimen has been seen that is clearly this species (see also Werier 2017: 316–317, 413). It is morphologically close to *Betula pendula*.

Probably represented in cultivation by the varieties *japonica* or *szechuanica*, which are both highly susceptible to the birch borer. Only the cultivar 'Whitespire' appears to be borer-free (Dirr 1998).

Management

Many of the native *Betula* spp. have shown substantial increases in abundance in the region, possibly due to increases in young forest cover or disturbance. Indeed, *B. populifolia*, a native to the region, appears to be more of a concern as a native invader of disturbed bogs than any potential invasive tendencies of the nonnative *B. pendula*. The increases of the other native species are not of great concern because they are noncompetitive due to their extreme shade-intolerance and give way to successional changes in species composition. The potential loss of the rare native *B. pumila* either due to decreasing habitat or hybrid introgression is of much concern. Planting this species in appropriate locations is encouraged, taking care that there are no nearby populations of *B. papyrifera*.



A) Leaves and staminate (narrower) and pistillate catkins of *Betula populifolia*; B) staminate catkins and leaves of *Betula alleghaniensis*; and leaf of C) *Betula lenta* and D) *Betula nigra*. Illustration by Emma Skurnick.

A B

Broussonetia L'Hér. – mulberry

Moraceae. Trees, shrubs. Species 4 native to eastern Asia. Genus name honors French physician and naturalist Auguste Broussonet (1761–1807).

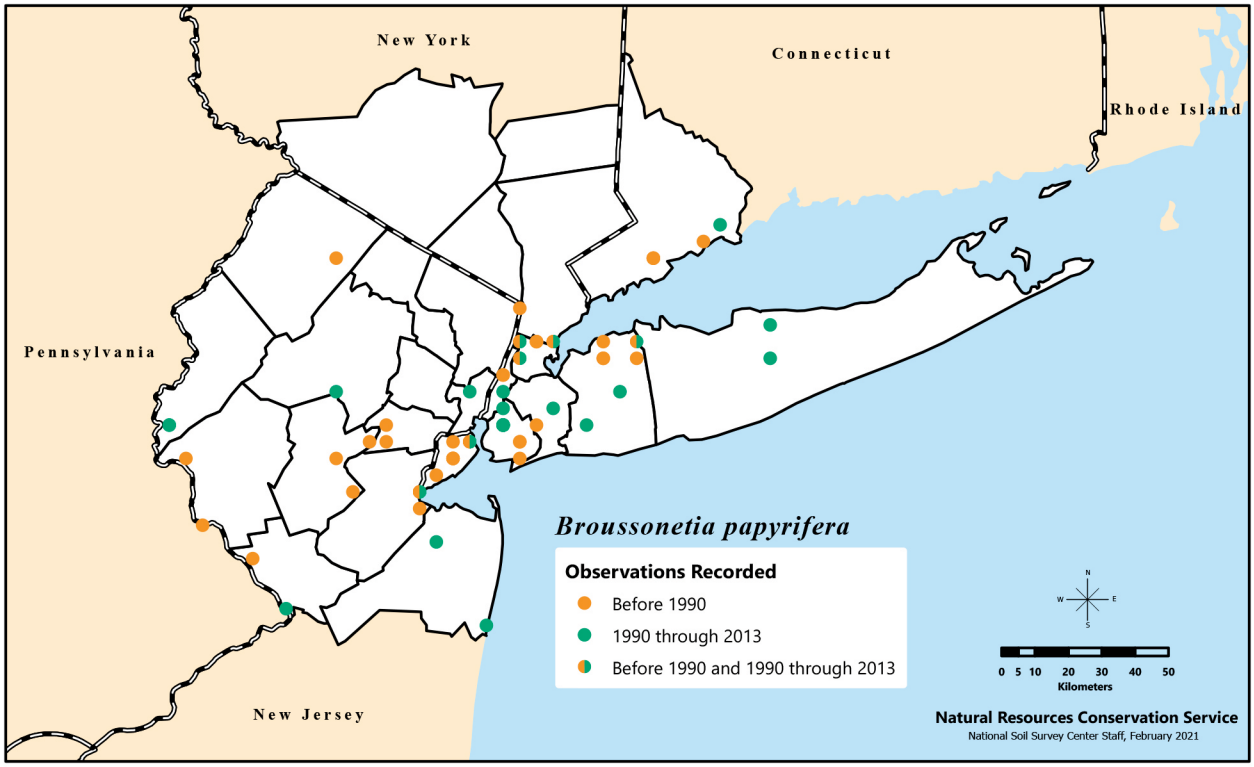
Nonnative Species

1. *Broussonetia papyrifera* (L.) Vent. – paper mulberry ↔

Morus papyrifera L.

Flowering late May–mid-June. Common in moist areas near streams, in open and forested upland areas, and in disturbed urban areas. Exceptionally adaptable; thrives in any soil (including soils with high pH; Wu et al. 2009b) and in urban areas. Tolerates heat and drought (Dirr 1998); prefers full sun (Dirr 1998, Miyazawa et al. 2014). Native to China and Japan (Dirr 1998). As indicated by the epithet from Latin, in Asia the species has been used to make paper.

Dioecious. No pretreatment required for germination (Dirr 1998). Forms a seed bank in its native China (Min Cao et al. 2000) and, thus, possibly areas in which it has been introduced. Seeds germinate better with light (Kyereh et al. 2014). May top-kill and never flower in areas with cold winters, such as Chicago, IL, where it resprouts each year. Once planted as an ornamental tree and can make an effective street tree for casting heavy shade, but sprouts from the roots. Considered a category 2 (spreading but not yet displacing native plants) (Morgan and Overholt 2005) invasive plant in FL; primary means of spread is seed dispersal by local wildlife (Morgan and Overholt 2019). Also considered one of the worst invasive plants in other countries, including Pakistan and Ghana (Kyereh et al. 2014, Marwat et al. 2010). In Ghana, it bears fruit twice a year (Jan.–Mar. and July–Aug.; Kyereh et al. 2014) and has been shown to negatively impact regeneration of native species (Bosu et al. 2013). In its native range, it is used for making paper and rope, as cattle fodder, and for medicinal and ornamental purposes (Matthews 1996). Its spread in the Pacific and Polynesian Triangle is thought to be

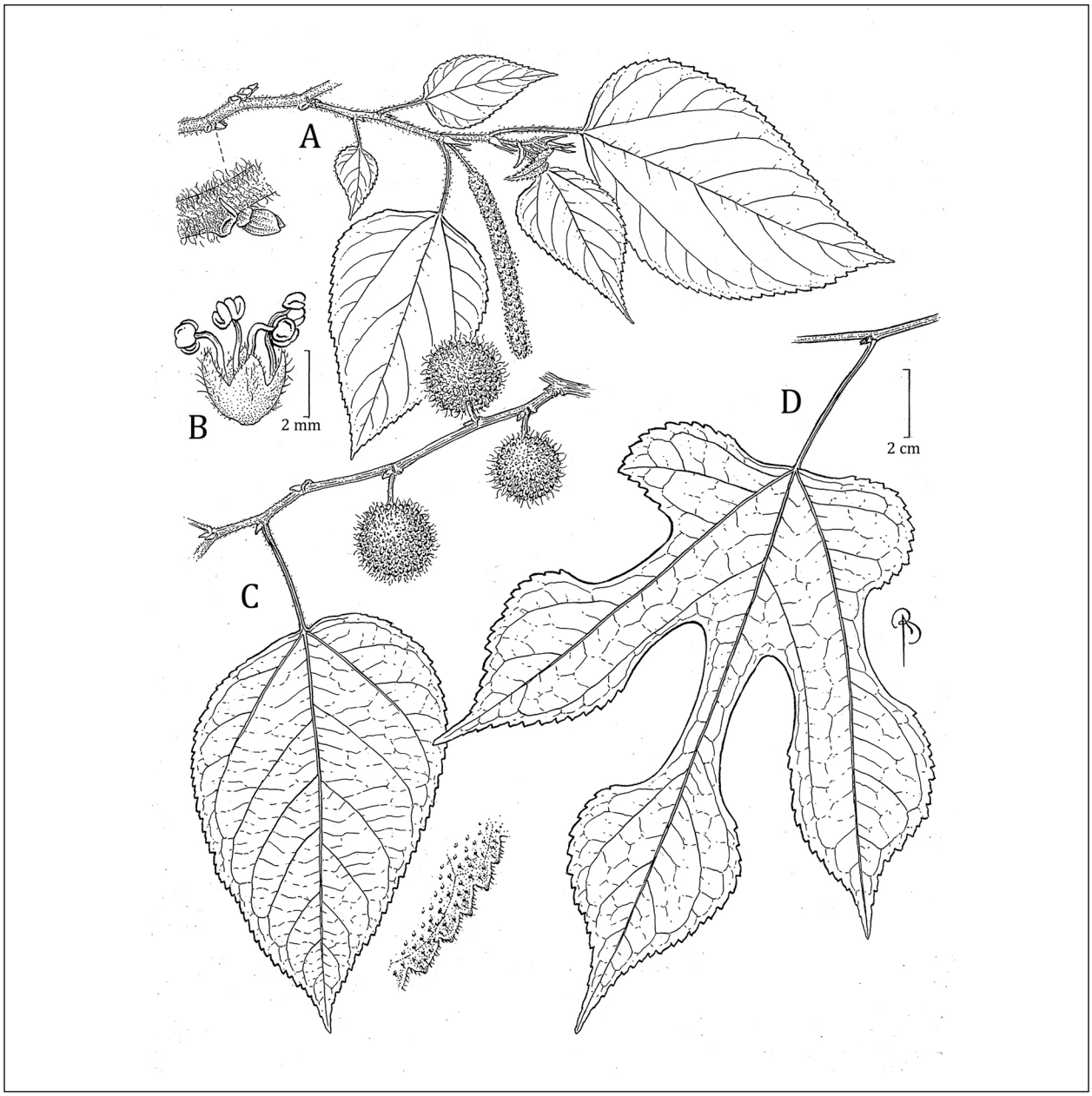


Distribution of *Broussonetia papyrifera*, or paper mulberry, recorded in the New York Metropolitan Region during three time categories.

due in part to the Lapita culture; these prehistoric people colonized new areas by transporting native vegetation to the new landscapes in order to maximize their survival. This history may make *Broussonetia papyrifera* an ideal candidate plant species for tracking historic human expansion in Polynesia (Seelenfreund et al. 2010). Cultivated since 1750 (Dirr 1998), with at least 4 cultivars.

Management

Because of its invasive potential, we advise against planting *Broussonetia papyrifera* and would suggest removing it where possible. Cold winters may successfully reduce its ability to spread in some areas and planting only male trees may also help limit future invasions. However, there is little economic or ornamental value compared to other similar species that could be planted.



A) Twig with leaves and male catkin, and enlarged view of portion of stem showing pubescence; B) male flower; C) twig with leaf and female catkins, and enlarged view of underside leaf margin showing dense pubescence; and D) example of lobed leaf of *Broussonetia papyrifera*. Illustration by Bobbi Angell.

A B

Buddleja L. – buddleja, butterfly bush

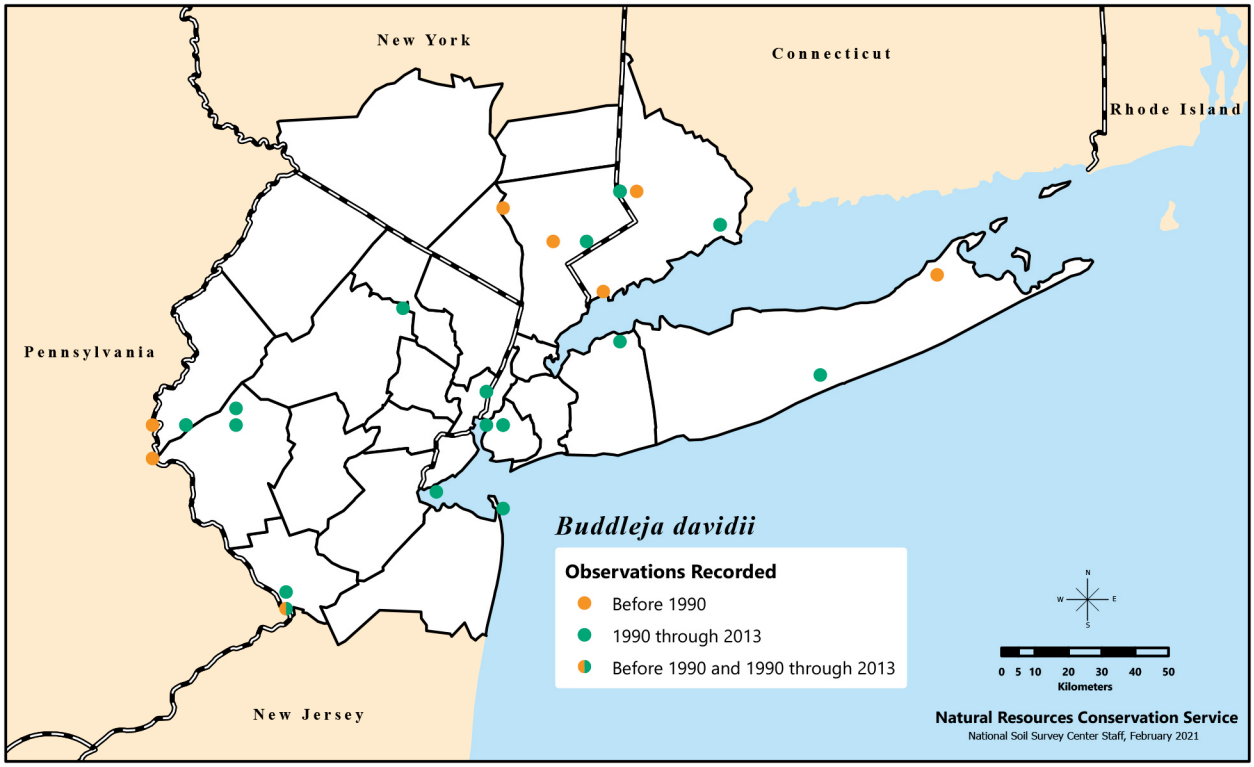
Scrophulariaceae (sometimes placed in Loganaceae or the monogeric family Buddlejaceae). Shrubs; rarely trees, herbs. Species approximately 100 in Africa, Asia, North America, and South America, chiefly tropical and subtropical. Genus name honors Adam Buddle (1662–1715), an English cleric. Genus name is also occasionally spelled *Buddleia* and *Buddlea*, the latter the suggested spelling under the current rules of nomenclature (Turland et al. 2018). However, Linnaeus' original spelling was *Buddleja* and, even though this is contrary to the current rules for the formation of generic names, it is to be maintained.

Nonnative Species

1. *Buddleja davidii* Franch. – buddleja, butterfly bush ↑

Flowering July–Oct. Reported from a wide variety of habitats; usually found in open, disturbed areas in the NY Metropolitan Region. Native to China. Epithet honors Armand David (1826–1900), botanical collector in China (1862–1874) and member of the French Lazarist missionary at Peking (now Beijing).

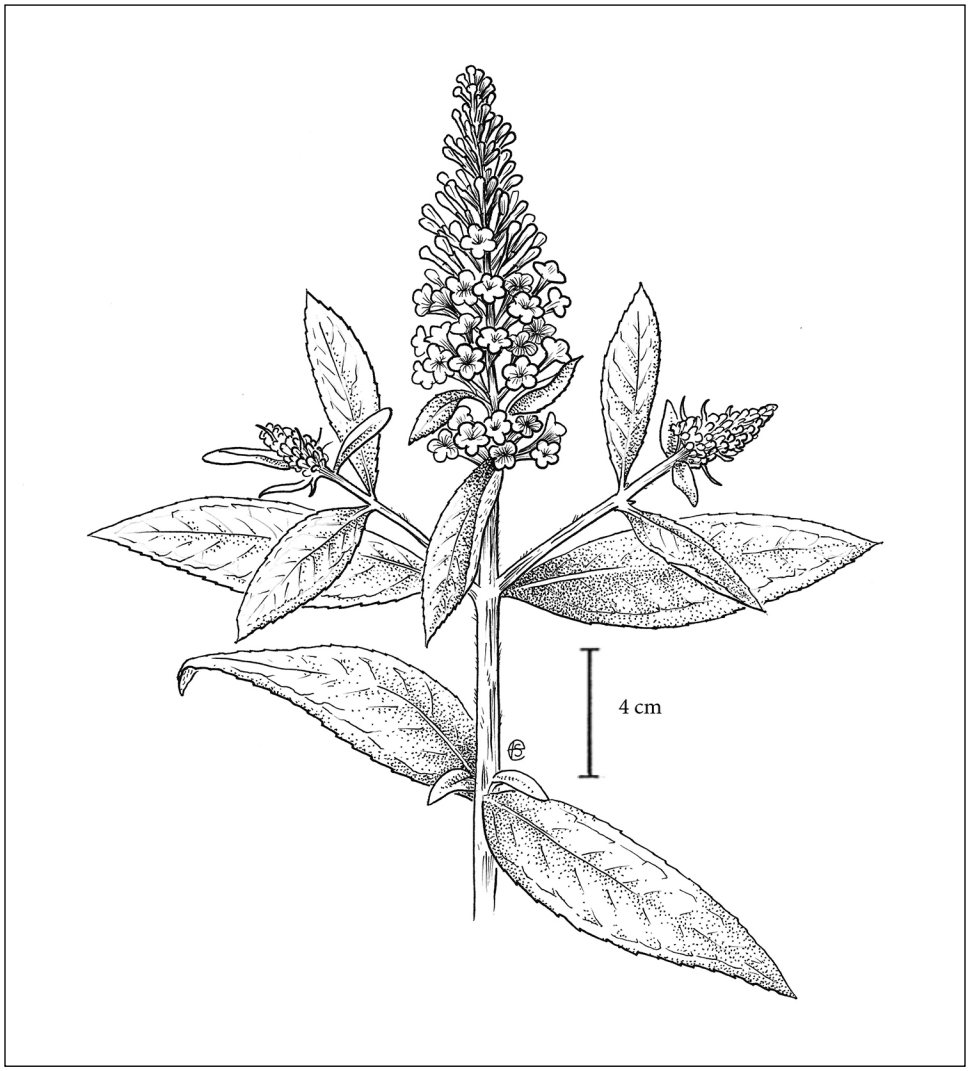
Flower color of cultivars ranges from white to yellow and red, but the common lilac and purple varieties are the ones that typically occur in the wild. Flowering normally does not take place until the plant is 2 years old or older. Flowering is asynchronous, maturing at the base of the panicle first. Individual flowers last 1–3 days and the panicle about 2 weeks. Cannot self-pollinate; pollinated by insects. Invests much of its reproductive effort in insect attractants such as large, colorful flowers, abundant nectar, and a strong scent (Tallent-Halsell and Watt 2009). Pruning before growth begins in spring results in more vigorous growth and larger panicles (Dirr 1998). Lifespan between 20 and 30 years. A mature plant can produce millions of seeds, but seed production does vary with the cultivar. Seeds are chiefly wind dispersed but can also be



Distribution of *Buddleja davidii*, called butterfly bush or buddleja, recorded in the New York Metropolitan Region during three time categories.

dispersed by water and transportation vectors such as automobiles and trains. The plants may also reproduce asexually from stem and root fragments. Seed banks are likely to be short-lived, 2.5 years or less. Germination occurs within 24 hours of the seed being sufficiently hydrated. The seeds will not germinate at a temperature below 6 °C. Optimal germination temperature 25 °C (Tallent-Halsell and Watt 2009).

An opportunistic invader; successfully invades a variety of different disturbed areas. Can colonize soils across a wide range of pHs (Tallent-Halsell and Watt 2009), though it may perform better on alkaline soils (Dirr 1998). Shade-intolerant. Self-thins, with several million stems per ha decreasing to 13,000 stems per ha over 3–5 years, reaching an average of 2,500 stems per ha after 10 years (Tallent-Halsell and Watt 2009). If stressed (especially drought stressed), the plant may suffer from mite infestations (Dirr 1998). For the most part, highly resistant to most insects and disease, and appears to perform better in its introduced range due to a lack of natural enemies (Ebeling et al. 2008). Resistance to herbivory may be due to the presence of toxic shikimate-derived and sesquiterpenen compounds. However, cattle (*Bos taurus*) and goats (*Capra hircus*) find it palatable. Slugs (class Gastropoda) and snails (order Achatinoidea) also consume *Buddleja davidii*, as do aphids (superfamily Aphidoideae), red spider



Flowering twig with leaves of *Buddleja davidii*. Illustration by Emma Skurnick.

mites (*Tetranychus urticae*), whiteflies (family Aleyrodidae), and some specialized weevils (superfamily Curculionoidea) and leaf miners (the dipteran *Amauromyza verbasci*) (Tallent-Halsell and Watt 2009). Some people may develop contact dermatitis from working directly with the vegetation of this species (Dirr 1998).

Cultivated in the U.S. since 1890 (Dirr 1998); a popular garden plant of important economic value to the horticultural industry (Tallent-Halsell and Watt 2009). Some butterflies (order Lepidoptera), moths (order Lepidoptera), and hummingbirds (family Trochilidae) may have become dependent on this species and may show a preference for it (Giuliano et al. 2004). Indeed, *B. davidii* and its cultivars, despite acknowledged invasiveness, are protected in some areas of the U.K., preventing any removal control efforts. Though it is sold extensively in OR, it is listed as one of the most invasive plants in the state. Unfortunately, the individual cultivars of this species were not included in the invasive list, and such cultivars are still sold (Tallent-Halsell and Watt 2009).

Species' impact on successional trajectories of the disturbed sites it invades is variable. Apparently little impact in some cases, but evidence at some sites of native species (especially native early-successional species) displacement (Tallent-Halsell and Watt 2009). Such species displacement, in one case, resulted in an acceleration of the reforestation process and the consequent loss of *B. davidii* from the system as well (Smale 1990).

Tracked as potentially invasive in NJ (category 2).

Management

Small *Buddleja davidii* shrubs with less pubescence on their leaves can be controlled with a foliar spray, but larger shrubs (often with more pubescent leaves and many stems) will be more effectively killed if they are cut at ground level and herbicide is applied to the cut stump. Planting cover grasses after a disturbance does help prevent colonization of the disturbed site by *B. davidii*. The weevil *Cleopus japonicas* may be a potential biocontrol agent (Brockerhoff et al. 1999, Tallent-Halsell and Watt 2009). Perhaps the best way to control spread of this species is not to continue to plant it.

This species may be difficult to control because of its popularity in gardens and the horticultural trade, in addition to its measurable ecosystem services (preferred food source for several pollinators). Such a food source may not have been previously present in some disturbed locations and urban areas, but it is also possible that *B. davidii* displaced previous food sources of the pollinators. Nonetheless, it may be performing an equal or superior function to these displaced species—at least in terms of pollinator services (but other possible ecosystem services should be considered). While the apparent ecosystem services and general benefits to urban socioeconomics may be arguments for simply containing this species with no planned eradication, it is also being considered seriously for use as a biofuel (Hallac et al. 2009, 2010) and, consequently, could be planted as a crop. Given the invasive potential of most cultivars and the likelihood of northern spread in the U.S. based on climate change models (Ebeling et al. 2008, Kriticos et al. 2011), planting this species over a large area for potential use as a biofuel could lead to unwanted spread of this species.

Calluna Salisb. — heather

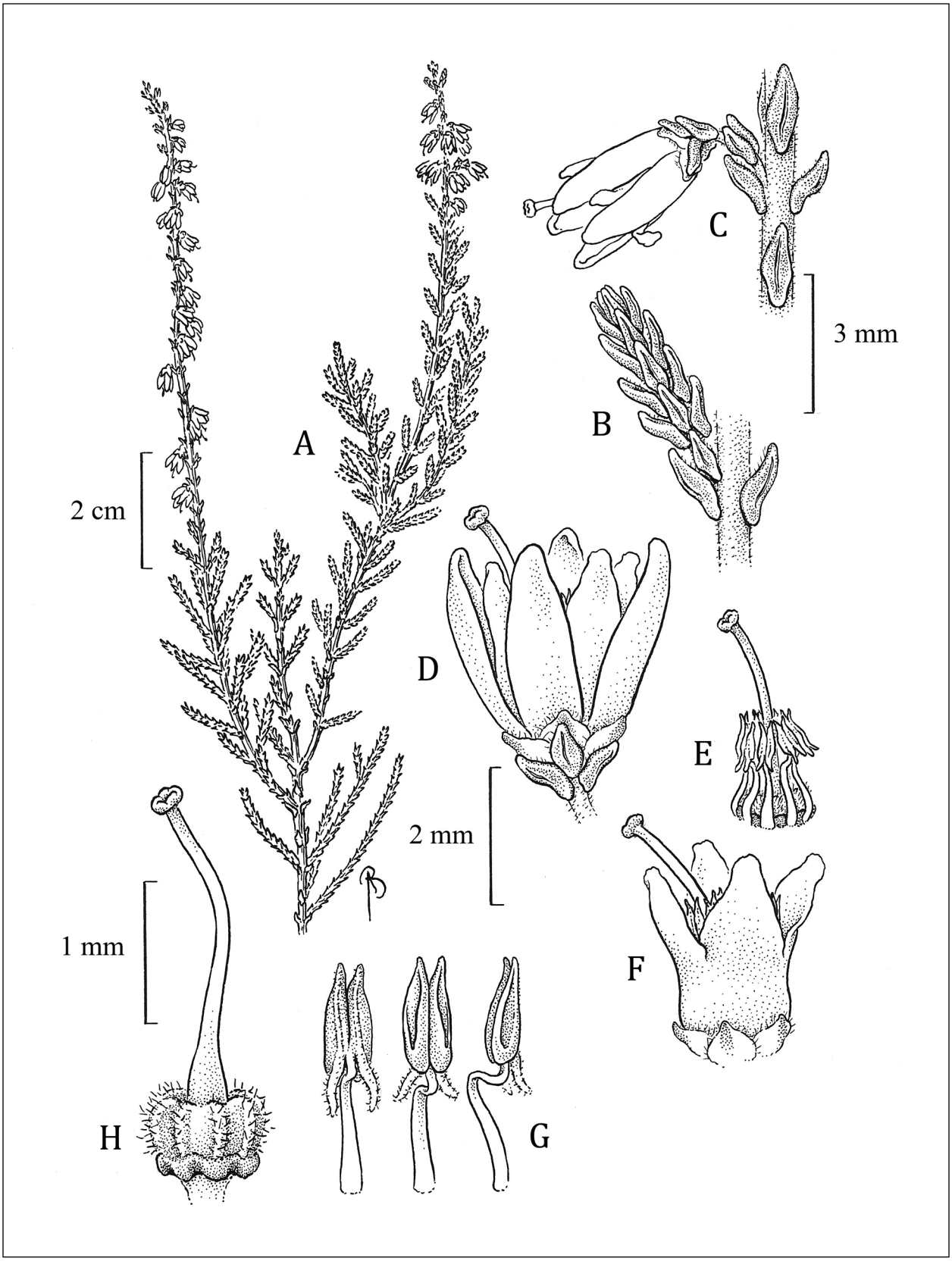
Ericaceae. Shrubs. Monospecific; native to western Asia and Europe. Genus name is derived from the Greek "kallyno," meaning "to brush or sweep," a reference to the twigs of the plant historically being used to make brooms.

Nonnative Species

1. *Calluna vulgaris* (L.) Hull. – heather Ø

Erica vulgaris L.

Flowering late July–Sept. (possibly later). Damp, sandy areas. Characteristic heath of moorlands in Europe. Historically reported as introduced on Long Island in Suffolk County (NY) and in Passaic County (NJ), but no longer documented in the NY Metropolitan Region. Also reported just south of the region in the NJ Pine Barrens (Atlantic and Burlington Counties) (Hough 1983). Cultivated for centuries, with over 1,000 cultivars reported, but its strict soil requirements (acidic, well drained, moist, organic, and sandy) make it an unlikely candidate for commercial landscaping (Dirr 1997).



A) Flowering twig with leaves; B) leaves; C, D) flower; E) stamens and pistil together; F) flower without outer petaloids; G) stamens; and H) pistil of *Calluna vulgaris*. Illustration by Bobbi Angell.

C

Campsis Lour. – trumpet creeper

Bignoniaceae. Vines. Species 2. Native status in the region questionable; the other species native to Asia. Genus name is from the Greek "campsis," meaning "curvature," a reference to the stamens.

Nonnative Species

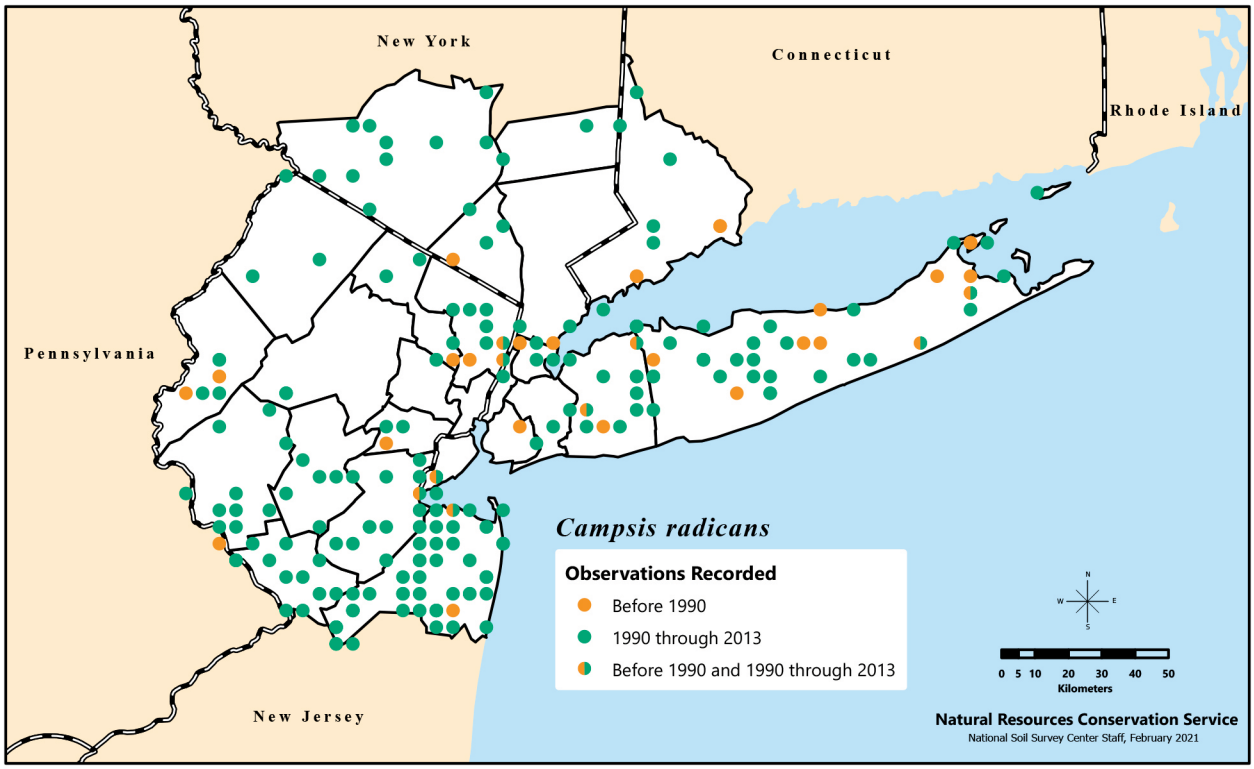
1. *Campsis radicans* (L.) Seem. – trumpet creeper, trumpet vine, cow-itch ↑↑↑

Bignonia radicans L.; *Tecoma radicans* (L.) DC.

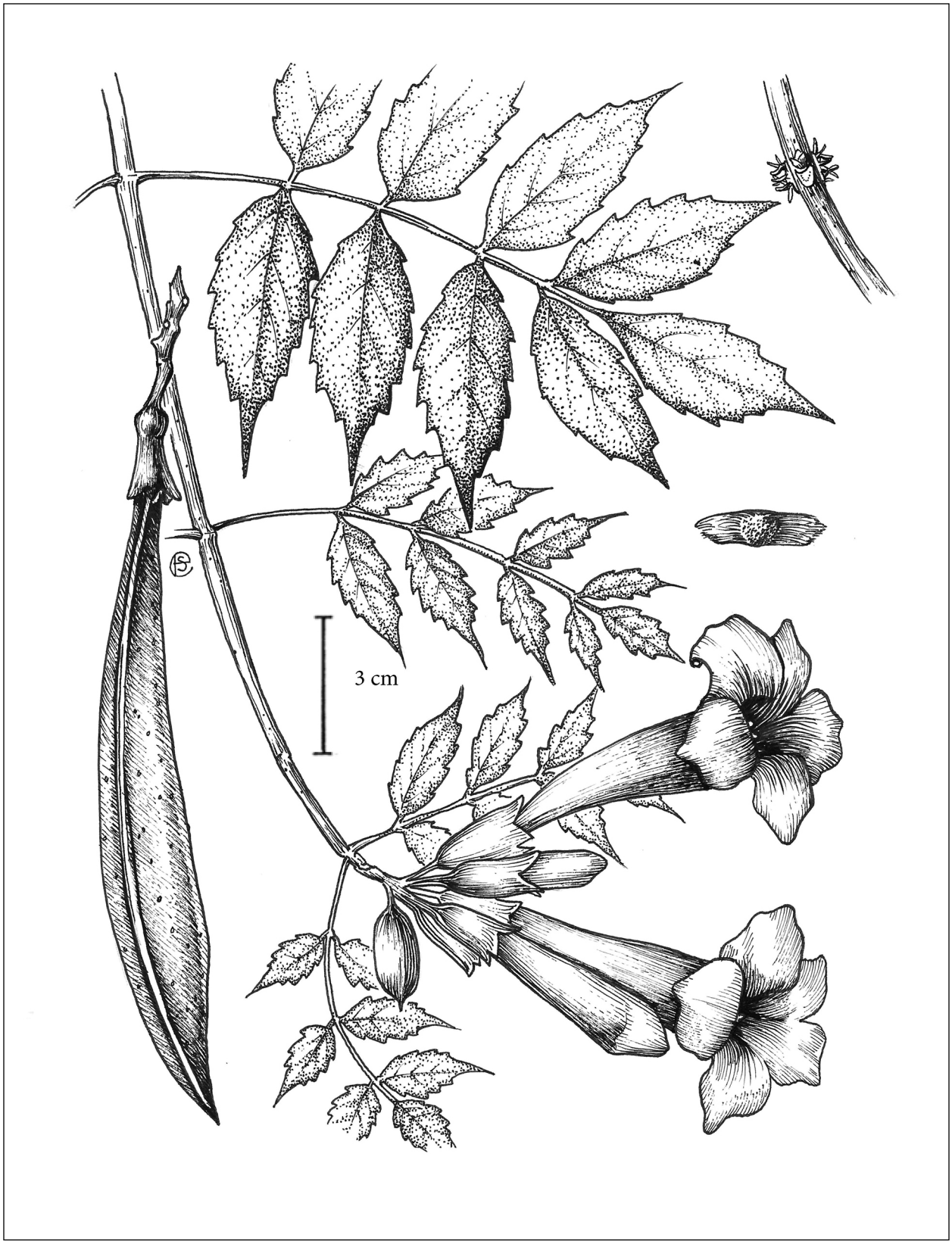
Flowering mid-July–early Sept. Fields and thickets, often in lowlands. Epithet from Latin refers to the aerial roots.

Often a high climber; aerial roots present (as in *Hedera helix* and *Toxicodendron radicans*). Flowers frequently visited by ruby-throated hummingbirds (*Archilochus colubris*), seeking the nectar, which is rich in sucrose. Corolla orange to scarlet, rarely orange-yellow. Implicated in causing contact dermatitis, although the compounds responsible have not been identified (Lewis and Elvin-Lewis 2003). Native status in the region questionable. Fernald (1950) and Gleason and Cronquist (1993) treated the species as native to NJ, and naturalized farther north. Stone (1911) and Taylor (1915) treated the species as native to southern NJ, but an escape from cultivation farther north. Britton (1881, 1889) treated it as nonnative in NJ. Treated as nonnative in NY by Weldy et al. (2020) but native in CT by the Connecticut Botanical Society (2015b). Cultivated since 1640, with at least 5 commonly used cultivars (Dirr 1997).

The other species, *Campsis grandiflora* (Thunb.) K.Schum. (native to Asia; leaves glabrous, calyx deeply 5-lobed, corolla with a shorter tube), and the hybrid *C.* ×*tagliabuana* (Vis.) Rehder (*C. grandiflora* × *C. radicans*), are also occasionally cultivated but are not known to escape.



Distribution of *Campsis radicans*, variously called trumpet creeper, trumpet vine, or cow-itch, recorded in the New York Metropolitan Region during three time categories.



Flowering stem with leaves, stem node with rootlets, pod-like fruit capsule, and winged seed of *Campsis radicans*. Illustration by Emma Skurnick.

C

Carpinus L. – hornbeam

Betulaceae. Trees. Species 25–50 in Asia, Europe, North America, and South America, with greatest diversity in Asia, especially China. Wood is used in handles and items where exceptionally hard wood is required, such as chopping blocks, mallet heads, and piano actions. The common name is derived from horn (a reference to the wood's hardness) and "beam," an Old English term for tree. Genus name is the ancient name for hornbeam.

Native Species

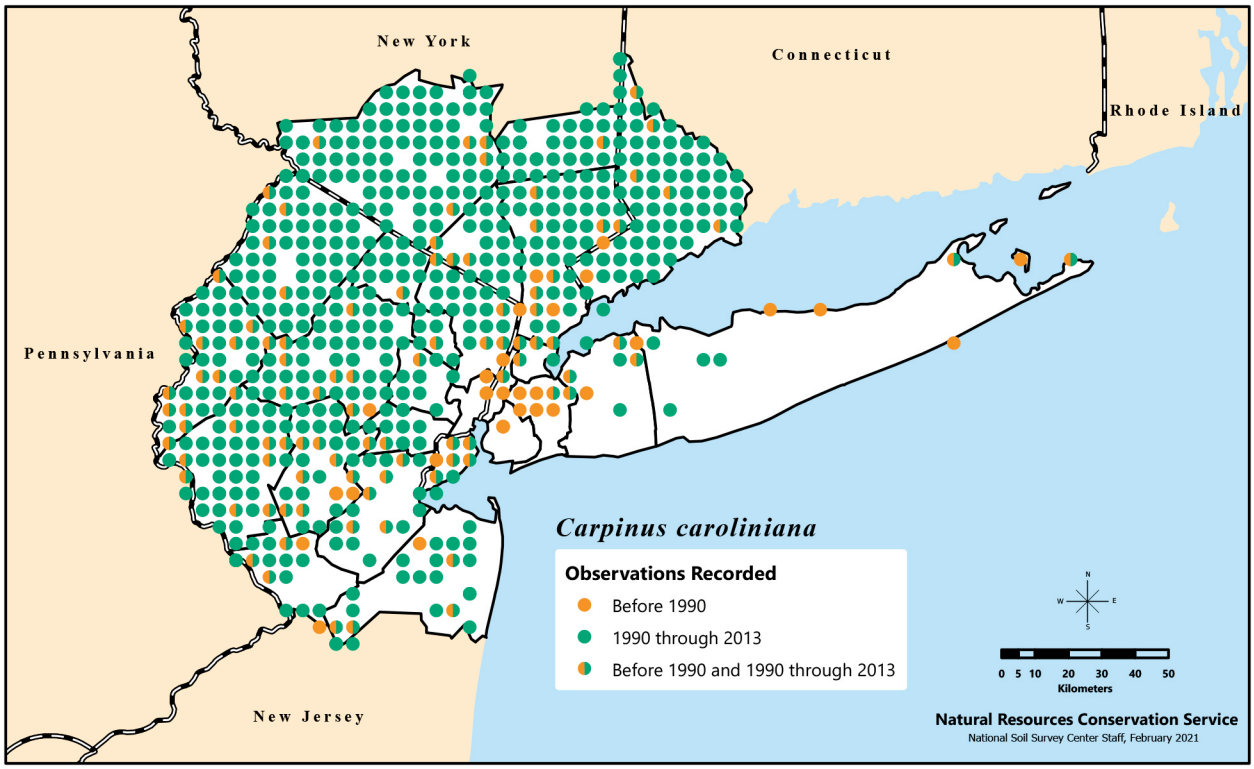
1. *Carpinus caroliniana* Walt. – American hornbeam, ironwood, musclewood ↑↑

Flowering mid-Apr.–early May. Rich deciduous woodlands and swamps. Only species in this genus in North America. If subspecies are recognized, all material from the region would be referable to *Carpinus caroliniana* subsp. *virginiana* (Marshall) Furlow. The more southern *C. caroliniana* subsp. *caroliniana*, reaching the northern limit of its range in southern NJ (Furlow 1997), has longer (to 12 cm) leaves with acuminate apices, well-developed secondary teeth on the margins, and dark glands on the abaxial surfaces. Map shows species-level records combined with subspecies records because there are relatively few records (13) of *C. caroliniana* subsp. *virginiana*, the subspecies shares the same trend, and it is possible that some records identified to species only may be this subspecies. Cultivated since 1812, with 2 cultivars (Dirr 1997). Increases may be due to reforestation.

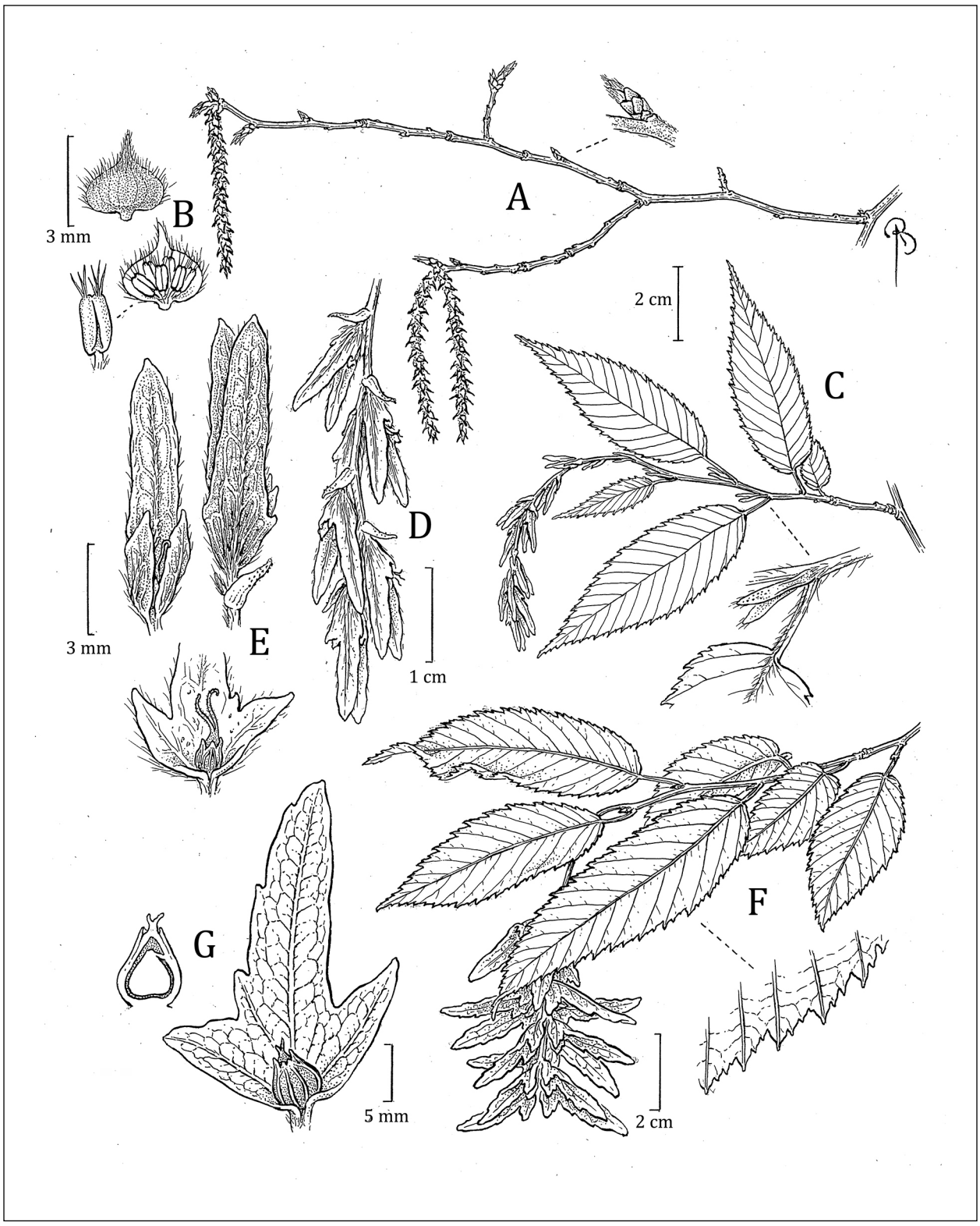
Nonnative Species

***Carpinus betulus* L. – European hornbeam**

Native to western Asia and Europe; rarely persists after cultivation. Readily distinguished from the native species by its larger (to 5 mm), glabrous buds and fewer nerved (3–5) fruiting bracts.



Distribution of *Carpinus caroliniana*, variously called American hornbeam, ironwood, or musclewood, recorded in the New York Metropolitan Region during three time categories.



A) Twig with male catkins and enlarged view of leaf bud; B) view of male flower, its cross-section, and stamens; C) leafy twig with female catkins and enlarged view of leaf node; D) female catkin; E) a female flower and its cross-section; F) fruiting leafy twig and enlarged view of leaf margin; and G) fruit and its cross-section of *Carpinus caroliniana*. Illustration by Bobbi Angell.

C

Carya Nutt. – hickory

Juglandaceae. Trees. Species 15 in eastern Asia and eastern North America. Genus name comes from the Greek "karyon," meaning "nut" or "kernel." Genus first described as Hicoria by Constantine Samuel Rafinesque (1783–1840), a Turkish naturalist, traveler, and writer who made major and often controversial contributions to botany and zoology.

Monoecious and wind pollinated with shade tolerance and slow growth in immaturity. Also displays a degree of dichogamy (protogyny and protandry) which affect pollination and fruit set (McCarthy and Quinn 1990). Average *Carya* catkin produces 2.5 million pollen grains (Madden et al. 1969); has already leafed out by the time pollen is shed. The overwhelming surface area of nontarget tissues relative to stigmatic surface area associated with a tree and its nearest neighbors suggests that, in the absence of strong turbulence, horizontal and vertical pollen movement out of canopy may be minimal (McCarthy and Quinn 1990). Number of years between seed crops varies with species. Given *Carya*'s high degree of self-pollination and difficulty of effective pollen dispersal, dichogamous plasticity helps ensure some degree of outcrossing and species fidelity (McCarthy and Quinn 1990). However, overlapping phenology can lead to hybridization (McCarthy and Quinn 1990).

Carya spp. economically important; besides the cultivated pecan, the wood is grown extensively for timber and tool handles. The nuts are an important, high quality food source for wildlife because they are high in proteins and particularly high in lipids (Bonner 2008a). Hickory nuts also make up 1–91 percent of the diet of feral hogs (*Sus scrofa*), depending on the availability of acorns, which are a preferred food (Henry and Conley 1972). Though acorns are a more efficient food source in winter, hickory nuts may be the most efficient food source in fall and spring due to their high lipid content (Smith and Follmer 1972). Hickories affected by elm spanworm (*Ennomos subsignaria*) and possibly other similar defoliators have been documented not to produce crops for at least 3 years after the defoliation year (Henry and Conley 1972). Feeding on the husks and cotyledons within by moth larvae may result in nut abortion or a reduction in size of the nut. Early season feeding of nuts by sucking insects usually kills the nut. Insects often serve as vectors for microbes, fungi or viruses, which may all result in rotten nuts (Vander Wall 2001). Low early survival of *Carya* seedlings in the Northeast (e.g., NJ) most likely the result of herbivory by vertebrates (Myster and McCarthy 1989).

Native Species

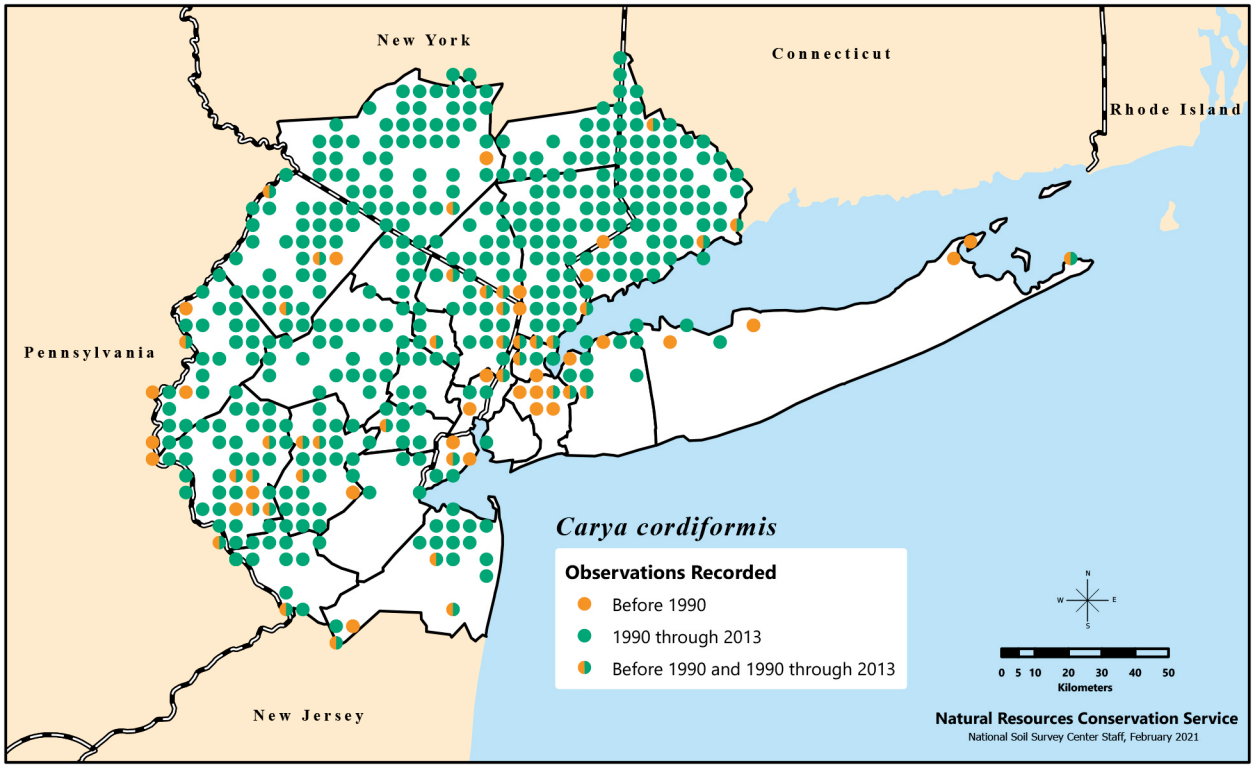
1. *Carya cordiformis* (Wangenh.) K.Koch – bitternut hickory ↑↑↑

Juglans cordiformis Wangenh.

Flowering May–early June; nuts ripening and falling in Oct. Woods and wet woods, swamps,

Carya Key

1. Terminal bud scales 4–6, valvate, bright orange yellow . . . . . ***Carya cordiformis***
1. Terminal bud scales more than 6, imbricate 2
2. Fruit 3.5–7 cm, terminal buds 10–25 mm, with straight appressed hairs 3
2. Fruit 2–4 cm, terminal buds rarely over 10 mm, resinous, lacking straight appressed hairs. 4
3. Leaflets 7–9 5
3. Leaflets most often 5 . . . . . ***Carya ovata***
4. Bark rough and furrowed, nut not strongly angled . . . . . ***Carya glabra***
4. Bark separating into long plates, nut angled above the middle . . . . . ***Carya ovalis***
5. Bark shaggy, husk separating to the base. . . . . ***Carya laciniosa***
5. Bark close, husk not separating quite to base . . . . . ***Carya tomentosa***



Distribution of *Carya cordiformis*, or bitternut hickory, recorded in the New York Metropolitan Region during three time categories.

and streambanks. Epithet from "cord," meaning "heart," refers to the somewhat heart-shaped nut.

Earliest seed-bearing age 30 years, with 3–5 years between large seed crops. Cold stratification for 90 days recommended for germination (Bonner 2008a). Seeds are bitter and are ignored by squirrels. Height at maturity 15–30 m. Cultivated since 1689 (Dirr 1998). Increases may be due to reforestation.

2. *Carya glabra* (Mill.) Sweet. – pignut hickory ↑↑↑

Juglans glabra Mill.

Flowering May; nuts ripening and falling in Oct. Upland and dry woods and slopes. Epithet refers to the glabrous nature of the petioles, rachises, and leaflets.

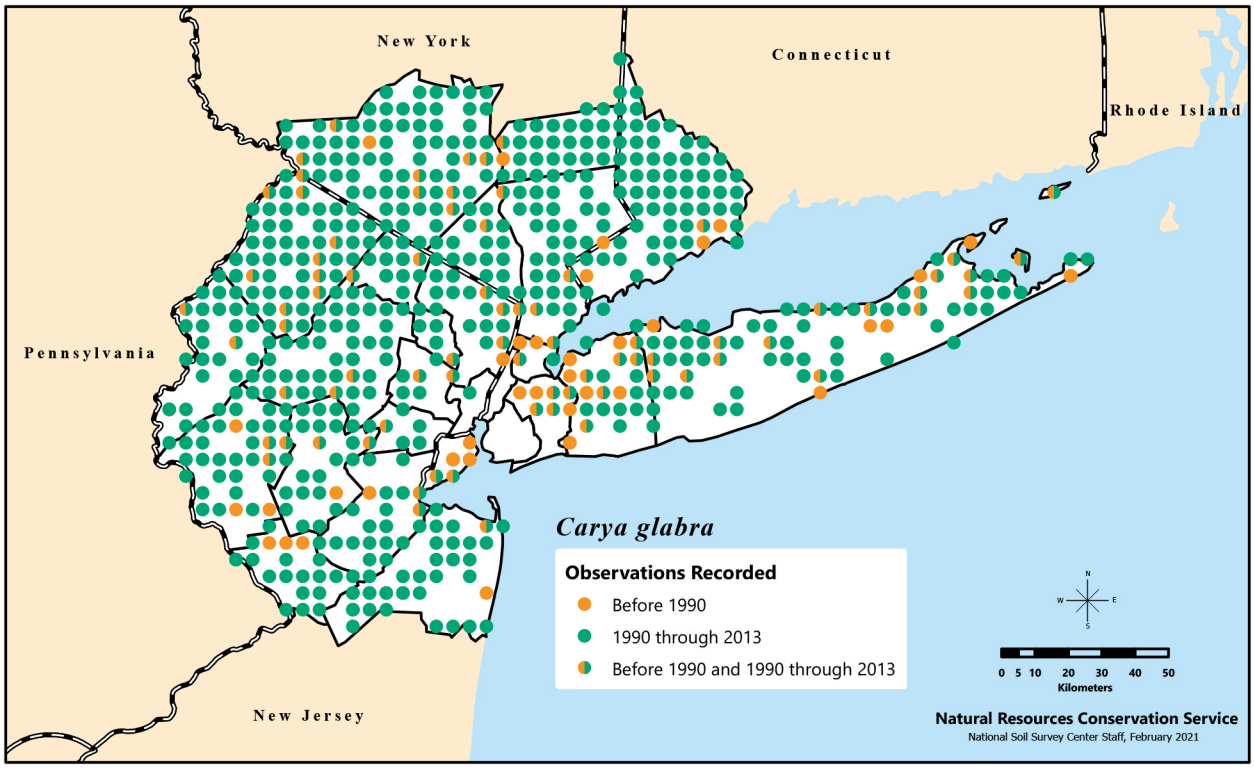
Earliest seed-bearing age 30 years, with 1–2 years between large seed crops. Cold stratification for 90–120 days recommended for germination (Bonner 2008a). Seeds bitter and astringent. Height at maturity 24–27 m. Important timber tree with enormous tap roots and strong wood. Used for tool handles and fuel. Cultivated since 1750 (Dirr 1998). Increases may be due to reforestation, though *C. glabra* may be overestimated compared with *C. ovalis*, which may have been grouped with *C. glabra*.

Another species, *Carya pallida* (Ashe) Engl. & Graebn. (pale hickory) would key here. Though not reported from the NY Metropolitan Region, it has been reported just south of the area in Burlington County (NJ), where it reaches the northern limit of its range. It differs from *C. glabra* in having silvery scales on the leaflet blades (especially when young) and pubescent (but sometimes glabrescent) petioles and rachises.

***Carya laciniosa* (F.Michx.) Loud. – big shellbark hickory, kingnut**

Juglans laciniosa F.Michx.

Flowering May–early June; nuts ripening and falling in Oct. Floodplains and bottomlands. Epithet refers to the strips or flaps (lacinia) of bark



Distribution of *Carya glabra*, or pignut hickory, recorded in the New York Metropolitan Region during three time categories. This map may contain records of what is now called *Carya ovalis*.

that separate from the trunk with age. Species most likely does not occur naturally in the NY Metropolitan Region; recent records may represent misidentifications of *Carya ovata* or specimens persistent from cultivation. Listed as threatened in NY; all confirmed reports are from central and western NY, with two unconfirmed reports in the region from Orange and Rockland Counties (Young 2019).

3. *Carya ovalis* (Wangenh.) Sarg. – sweet pignut hickory ↔

Juglans ovalis Wangenh.

Flowering May–early June; nuts ripening and falling in Oct. Upland woods. Epithet refers to the shape of the nut, which can be ovate. Buds tend to be more resinous than those of its most similar relative, *Carya glabra*. Seed sweet and edible (Gleason and Cronquist 1993). Presence of *C. ovalis* in the region may have been underestimated because it was grouped with *C. glabra*.

4. *Carya ovata* (Mill.) K.Koch – shagbark hickory ↑↑↑

Juglans ovata Mill.

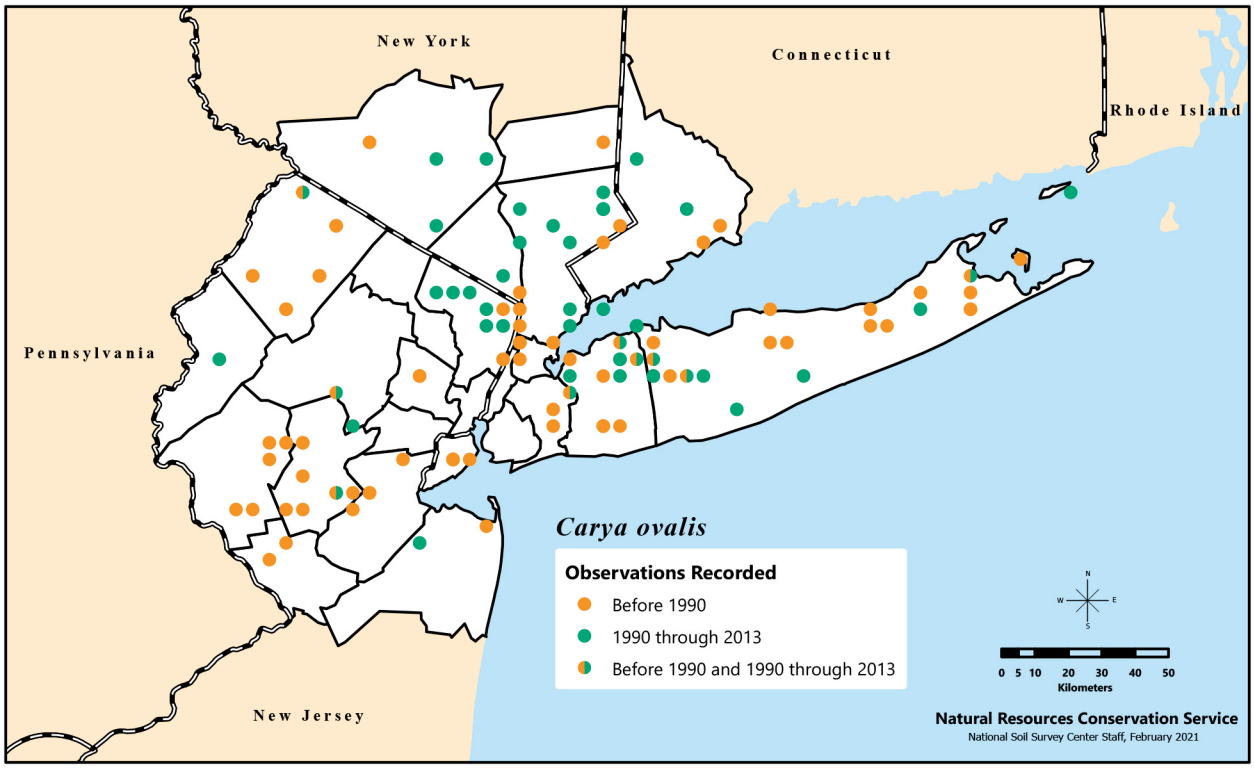
Flowering May–early June; nuts ripening and falling in Oct. Rich mesic woods. Epithet from Latin refers to the shape of the nut, which can be ovate.

Earliest seed-bearing age 40 years, with 1–3 years between large seed crops (Bonner 2008a). Height at maturity 21–30 m. Seed edible and sweet. Cultivated since 1629 (Dirr 1998). Increases may be due to reforestation.

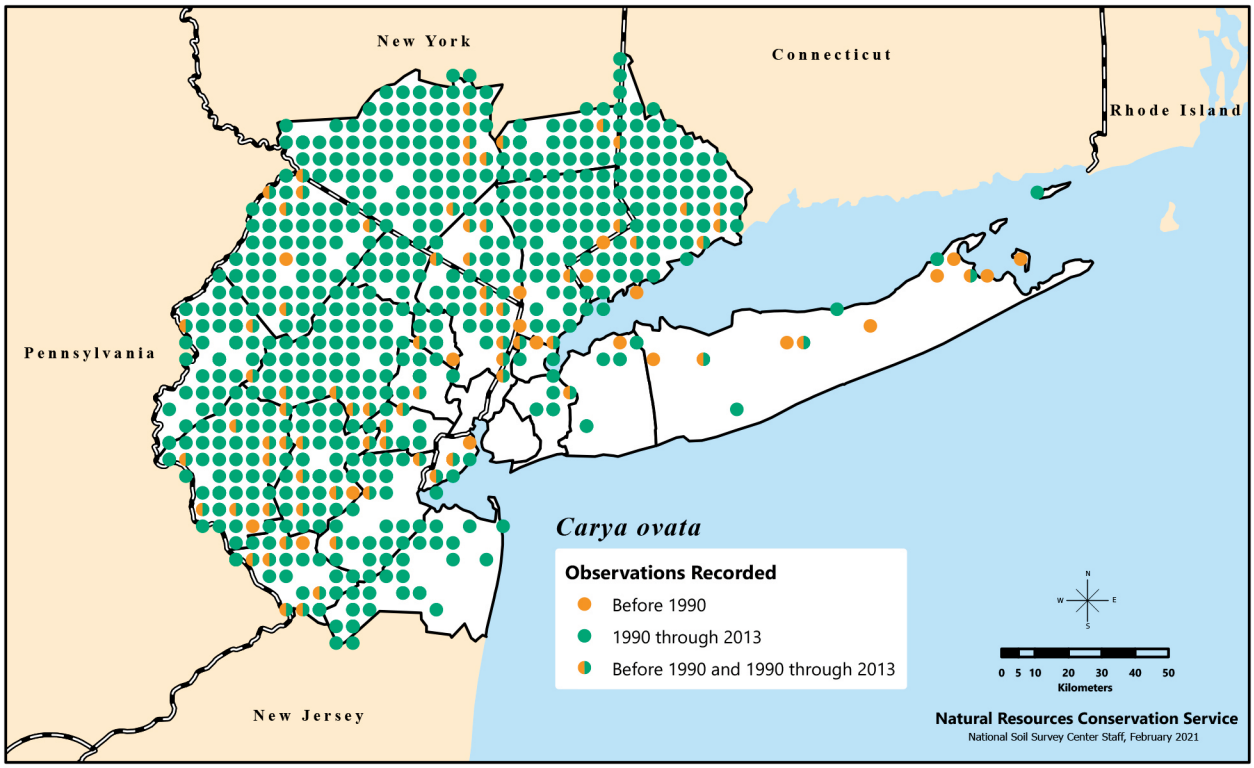
5. *Carya tomentosa* (Lam.) Nutt. – mockernut hickory ↑↑

Juglans tomentosa Lam.

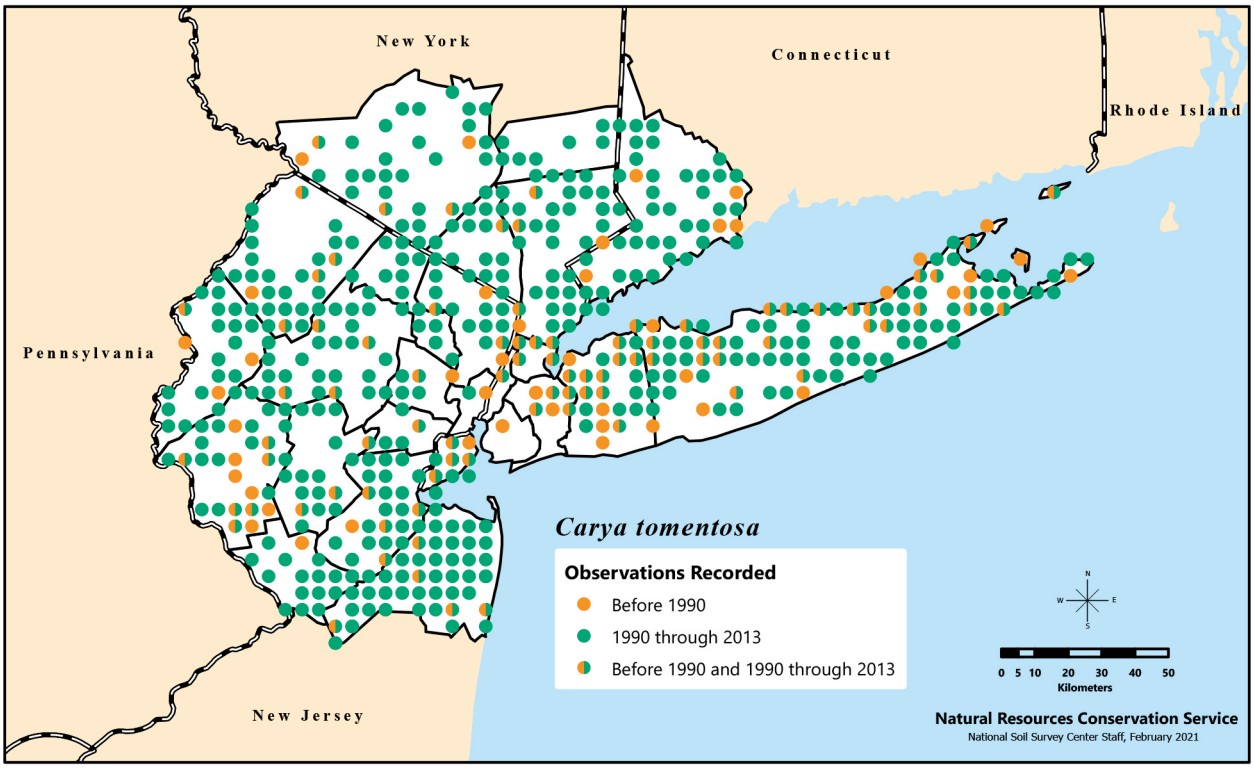
Flowering May; nuts ripening and falling in Oct. Dry woods. Common name stems from early New York Dutch “mokernoot” or “heavy hammer nut,”



Distribution of *Carya ovalis*, or sweet pignut hickory, recorded in the New York Metropolitan Region during three time categories. This species and *Carya glabra* previously were treated as one species; this map may be missing many records.



Distribution of *Carya ovata*, or shagbark hickory, recorded in the New York Metropolitan Region during three time categories.



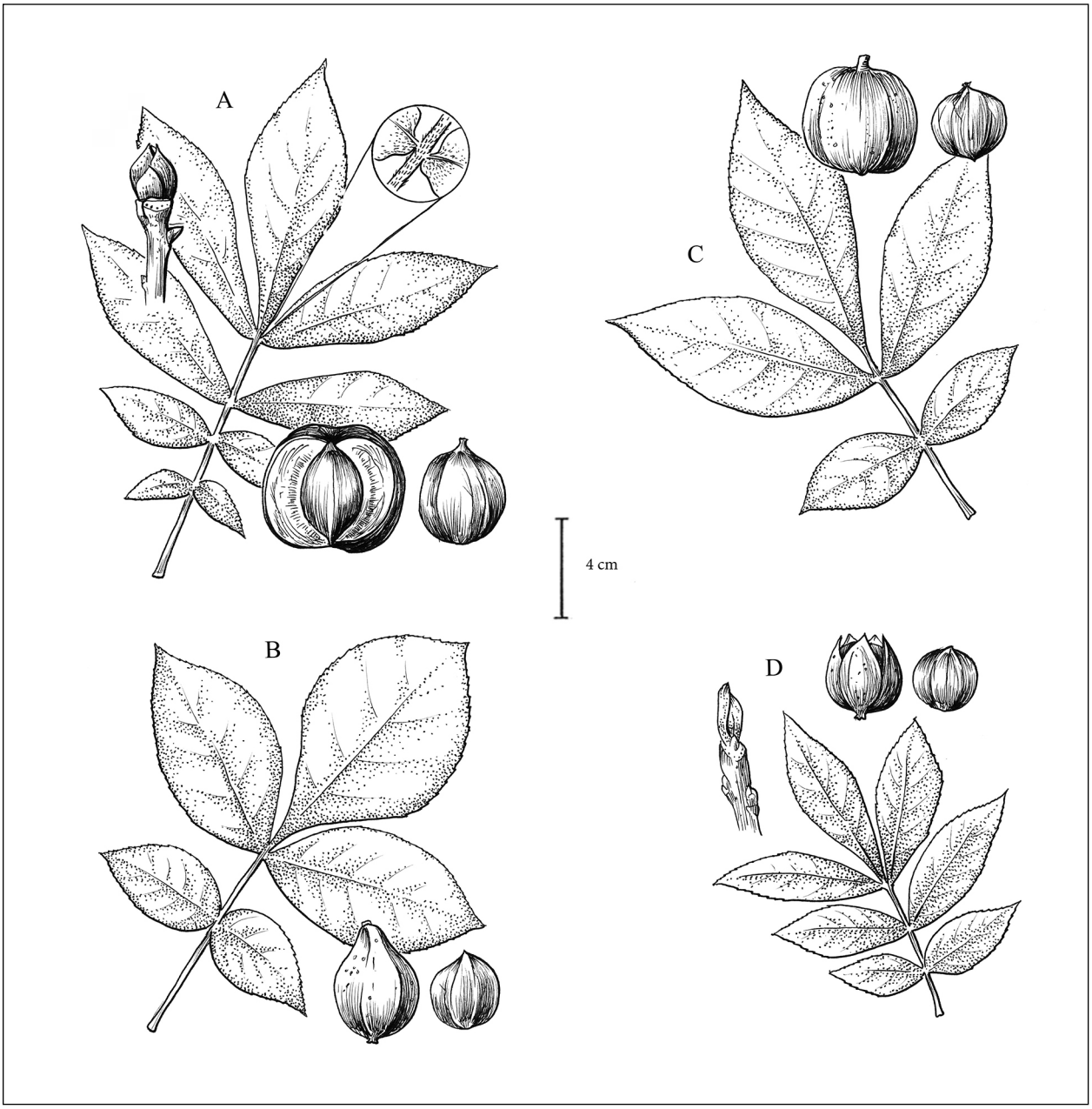
Distribution of *Carya tomentosa*, or mockernut, recorded in the New York Metropolitan Region during three time categories.

an allusion to its thick shell. Epithet refers to the abundant pubescence present on the terminal buds, branchlets, and leaves.

Height at maturity about 20 m; trees may grow to more than 35 m (Dirr 1998). Differs from *Carya glabra* in that leaf undersides are pubescent with fascicled hairs (Gleason and Cronquist 1993). Edible seed. In cultivation since 1766 but rare to find any sold commercially, though it is relatively common (Dirr 1998).

Management

Because identification can be challenging among some of the species within *Carya*, correct identification to species is often not completed prior to harvesting of the wood, which can prevent the development of accurate patterns of species removal and distribution. Inaccurate or incomplete information could lead to incorrect rarity assessments. See previous comment on *C. ovalis* and *C. glabra*. We encourage taking the time to know which hickory species are present and keeping such trees for their beauty and for their importance to wildlife. Replacement of such individuals with commercially available *Carya* is unlikely.



A) Leaves and nuts of *Carya tomentosa*; B) leaves with enlarged view of node with pair of leaves, terminal bud, and nuts of *Carya glabra*; C) leaves and nuts of *Carya ovata*; D) terminal bud, leaves, and nuts of *Carya cordiformis*. Illustration by Emma Skurnick.

Castanea Mill. — chestnut

Fagaceae. Trees, shrubs. Species 12 in temperate Asia, Europe, and North America. Genus name is derived from the Greek "castana," the name for the genus.

Native Species

1. *Castanea dentata* (Marshall) Borkh. – American chestnut ↑

Fagus-Castanea dentata Marshall

Tree. Flowering June–July; nuts maturing Sept.–Oct. Upland woods, now occurring strictly as stump sprouts due to blight, but not uncommon.

An intermediate shade-tolerant tree; shows an ability to survive in low light conditions but responds rapidly to increases in light (Joesting et al. 2007, McCament and McCarthy 2005, Wang et al. 2006). While the demise of the American chestnut is due to chestnut blight (*Cryphonectria parasitica*), *Castanea dentata* is also highly susceptible to other pathogens and insects, including *Phytophthora cinnamomi*, which causes root rot (Rhoades et al. 2003, Wang et al. 2013), and spongy moth (*Lymantria dispar*), though the Chinese-American hybrid is much more susceptible to spongy moth infestation than pure American chestnut trees (Rieske et al. 2003). One study shows that *C. dentata* is somewhat competitive against other gap species such as *Liriodendron tulipifera* on dry field sites, but is not likely to outcompete *L. tulipifera* under more mesic conditions. In contrast, greenhouse experiments show *C. dentata* as the superior competitor to *L. tulipifera* and *Quercus prinus*. The latter suggests substantial herbivory or resource limitations (or both) in the field for *C. dentata* (Griscom and Griscom 2012). Many other field studies show *C. dentata* as the superior competitor to several other hardwood species including *Juglans nigra* and *Q. rubra* in both dry and relatively mesic sites, but many of these involve plantings of *C. dentata* outside its native range (i.e., in southwestern Wisconsin) (Jacobs and Severeid 2004, Jacobs et al. 2009, Paillet and Rutter 1989). Resistant hybrid proposed for reintroduction is 93.75 percent native genetic material, so hypothesis is hybrid will respond like the native species to environmental conditions, disease pathogens, and insects. However, based on hybrid's response to *Phytophthora* and spongy moth noted previously, this assumption is potentially faulty.

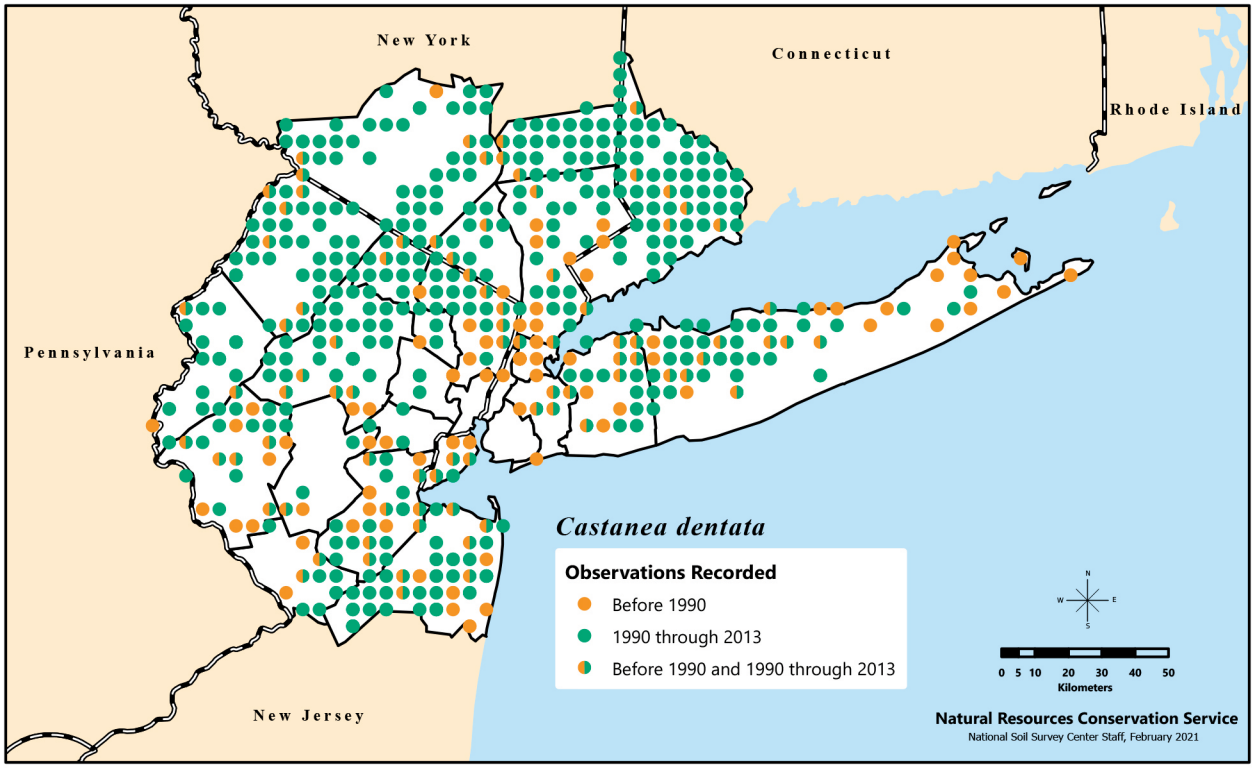
2. *Castanea pumila* (L.) Mill. – chinquapin Ø

Fagus pumila L.

Shrub, small tree. Flowering June–July; nuts maturing Sept. Upland woods. Historically, the northern limit of the species' range has been taken as Mercer County (NJ) (Britton 1889); also reported from adjacent Hunterdon County (NJ). Population from Suffolk County (NY) of unknown nativity (Werier 2017). Populations from MA (Dow Cullina et al. 2011) also taken as introduced. Epithet means "dwarf," a reference to the species being a shrub or small tree.

Castanea Key

1. Leaves and branches glabrous . . . . . ***Castanea dentata***
1. Leaves and branches pubescent 2
2. Lower leaf surface with conspicuous glands; nuts 2–3 cm across. 3
2. Lower leaf surface without conspicuous glands; nuts about 1 cm across 4
3. Leaves coarsely serrate . . . . . ***Castanea sativa****
3. Leaves crenately serrate . . . . . ***Castanea crenata****
4. Nut solitary in an involucre (prickly covering surrounding nut) . . . . . ***Castanea pumila***
4. Nuts 2 or 3 in an involucre. . . . . ***Castanea mollissima****



Distribution of *Castanea dentata*, or American chestnut, recorded in the New York Metropolitan Region during three time categories.

Height at maturity 15 m (Bonner 2008b); most often found as a shrub (Dirr 1998), possibly in response to the blight. Somewhat resistant to chestnut blight. Appears to respond to the blight by sprouting prolifically and maintaining a shrub habit (Bonner 2008b, Dirr 1998). Cultivated since 1699 (Dirr 1998).

Listed as endangered in NJ (S1). Not reported from CT.

Nonnative Species

Castanea crenata Siebold & Zucc. – Japanese chestnut

Flowering June–July; nuts maturing Sept. Native to Asia. Occasionally planted and may naturalize; possible naturalized site reported from Suffolk County (NY).

Height at maturity 10 m. Resistant to chestnut blight. Cultivated since 1876 (Bonner 2008b).

Castanea mollissima Blume – Chinese chestnut

Flowering June–July; nuts maturing Sept. Native to Asia; occasionally planted and may naturalize. Epithet refers to the soft pubescence present on the twigs, leaves, and involucres, “mollis” meaning “soft” in Latin.

Height at maturity 21 m. Resistant to chestnut blight and is the species currently used to develop resistant varieties of *Castanea dentata* (Bonner 2008b). Cultivated since 1800 (Dirr 1998).

Castanea sativa Mill. – Spanish chestnut

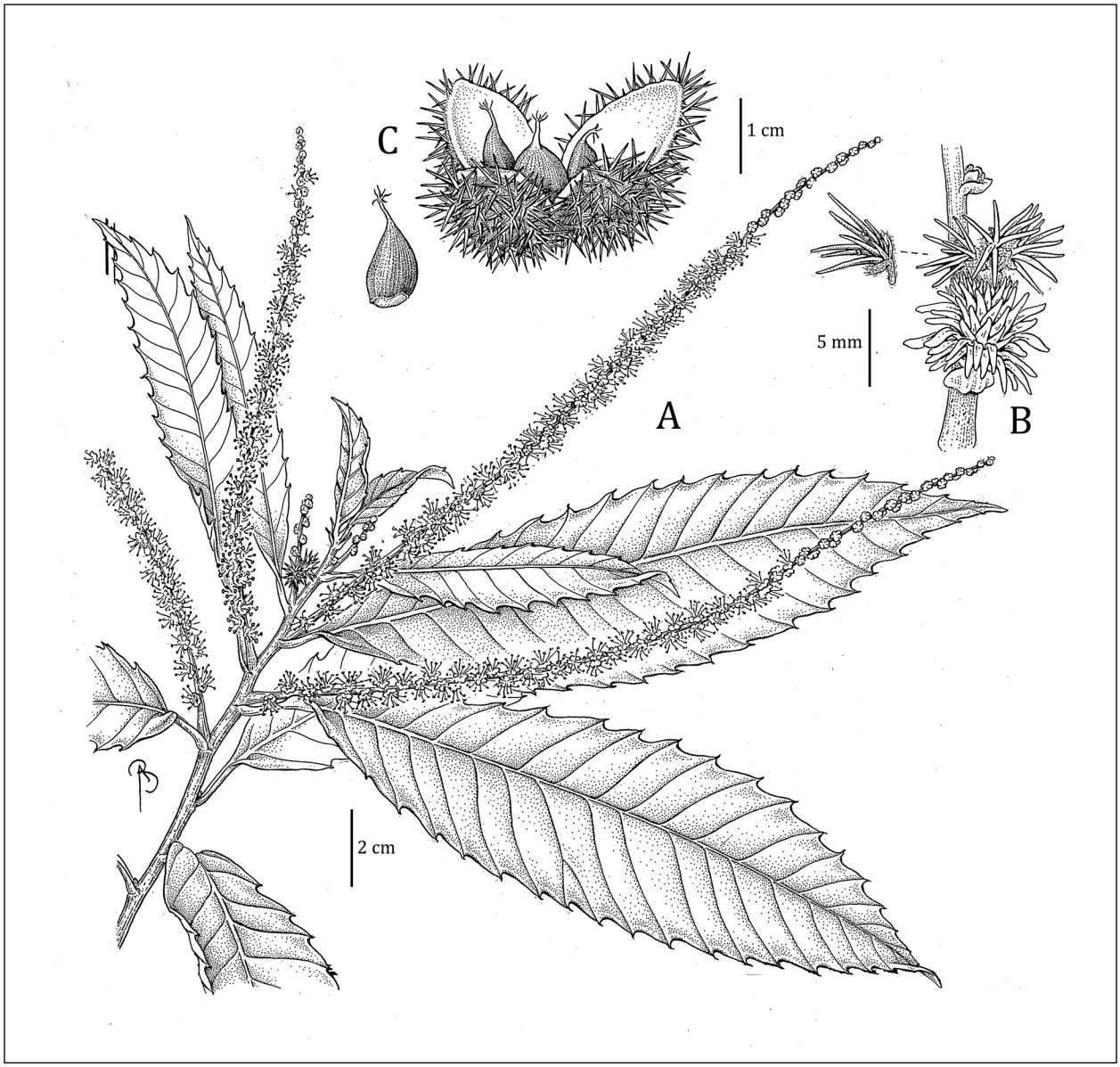
Flowering June–July; nuts maturing Sept. Native to northern Africa, western Asia, and Europe; occasionally planted and may naturalize. Epithet refers to the cultivation of this plant, “sativus” meaning “cultivated” in Latin.

Height at maturity 21 m. Susceptible to chestnut blight and restricted in the U.S. (Dirr 1998), but apparently planted in some areas such as MA (Haines 2011). Cultivated for centuries (Dirr 1998).

Management

There are three possible methods of reintroducing *Castanea dentata* to U.S. forests: 1) use of hypovirulent strains of *Cryphonectria parasitica*, 2) breeding and planting resistant native *C. dentata*, and 3) hybridization of Chinese and American chestnuts. Because dissemination of the hypovirus has proven to be very slow and because too few naturally resistant trees have been found, the third method is considered by many as the most promising (McCament and McCarthy 2005). Because of its intermediate shade-tolerant response to light, *C. dentata* reintroduction may be best achieved using an underplanting and releasing silvicultural strategy instead of an intensive harvest and planting strategy (Wang et al. 2006).

Of concern is *C. dentata*'s apparent superior competitiveness to existing native species that have since filled its niche after the blight. Indeed, some still see the hybrid as nonnative despite its 93.75 percent native genetic composition.



A) Twig with leaves and male and female catkins; B) enlarged female flowers; and C) nut, and nuts in an involucre of *Castanea dentata*. Illustration by Bobbi Angell.

Unintended consequences of reintroduction, including disruption of relatively stable ecosystems and displacement of other native species, are a concern. In addition, while the threat of blight is unlikely for the hybrid, there are threats from other nonnative insects and pathogens. In addition to spongy moth and *Phytophthora cinnamomi*, the Oriental chestnut gall wasp (*Dryocosmus kuriphilus*) and ambrosia beetles (subfamily Scolytiane and Platypodinae) may also negatively affect the hybrid (Jacobs 2007). Introduction of the hybrid may also have cascading effects on other trophic levels, in particular rodent (order Rodentia) populations in response to an increasing changing mast production (Dalgleish et al. 2012).

Catalpa Scop. – catalpa, catawba

Bignoniaceae. Trees. Species 10 in eastern Asia, the southeastern U.S., and the West Indies. Genus name is based on "catawba," the name given to the tree by the Catawba, who used *Catalpa bignonioides* for their totem. Name is an uncorrectable spelling error by Austrian physician and naturalist Giovani Antonio Scopali (1723–1788; "Linnaeus of the Austrian Empire"); misspelling originated with Linnaeus when he described *Bignonia catalpa*.

Nonnative Species

1. *Catalpa bignonioides* Walt. – southern catalpa ↑↑↑

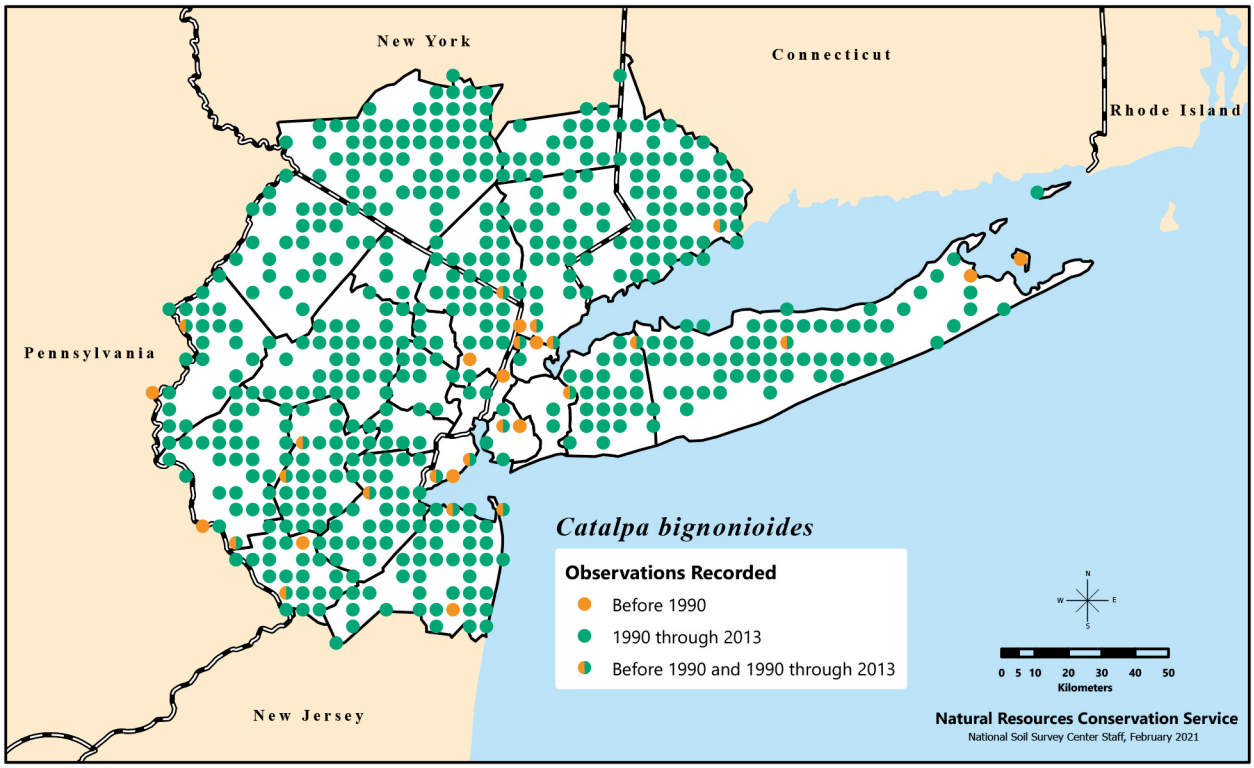
Bignonia catalpa L.

Flowering May–June (usually after *Catalpa speciosa*). Frequently escaped from cultivation throughout the region in disturbed dry to moist areas. While Linnaeus' *Bignonia catalpa* is the earliest name, the combination "*Catalpa catalpa*" based on this earlier name, as proposed by Karsten (1880–1883) and Sudworth (1891), cannot be used because the rules of botanical nomenclature do not allow tautonyms. Species native to the southeastern U.S., including southwest GA and FL to LA, though precise native range is uncertain due to cultivation and naturalization. Considered naturalized in other U.S. locations, including New England, OH, MI, and TX (Bonner and Graney 2008). Epithet refers to the similarity of this species to members of the genus *Bignonia*, the genus in which Linnaeus originally placed the species. *Catalpa ×hybrida* Späth, a hybrid between this species and *C. ovata*, is in cultivation.

Flowers usually about 2 weeks after *C. speciosa* (Bonner and Graney 2008, Dirr 1997). Fruits maturing Oct. and producing winged, wind-dispersed seeds. Pretreatment and light not required for germination. Seeds of *C. bignonioides* are slightly larger than seeds of *C. speciosa* (Bonner and Graney 2008). Height at maturity 9–12 m (Dirr 1997). Very tolerant of poor soil conditions. Cultivated since 1726 (Dirr 1998), with at least 2 cultivars, 1 with dark yellow fall leaves and another dwarf cultivar (Dirr 1997). Indigenous cultures in South America use this species for medicinal reasons. Has anti-inflammatory and antinociceptive (pain receptors) properties, possibly the result of saponins, sterols, or phenols found in the leaves and pods (Muñoz-Mingarro et al. 2003). North American powdery mildew (*Erysiphe elevata*), commonly infects this species, and was found for the first time on planted *C. bignonioides* trees in Europe in 2004 (Vajna et

Catalpa Key

1. Leaves glabrous below; flowers chiefly yellow . . . . . ***Catalpa ovata****
1. Leaves pubescent below; flowers chiefly white 2
2. Leaves abruptly acuminate; panicles many-flowered; flowers about 3 cm across at the mouth . . . . . ***Catalpa bignonioides****
2. Leaves long-acuminate; panicles few-flowered; flowers about 4 cm across at the mouth . . . . . ***Catalpa speciosa****



Distribution of *Catalpa bignonioides*, or southern catalpa, recorded in the New York Metropolitan Region during three time categories.

al. 2004). The native ant *Forelius pruinosus* has a mutualistic interaction with *C. bignonioides* in that it preys on *C. bignonioides* herbivores but also utilizes the extrafloral nectaries (Ness 2003a). The nonnative ant *Solenopsis invicta* has more of a commensalist interaction than a mutualistic interaction. Though the nonnative ant is a better pupal predator than the native ant, the nonnative ant also does harm to other mutualists (parisitoids) of *C. bignonioides*, and feeds less frequently on the nectaries (Ness 2003b).

Tracked as potentially invasive in NJ (category 2).

Catalpa ovata G.Don – Chinese catalpa

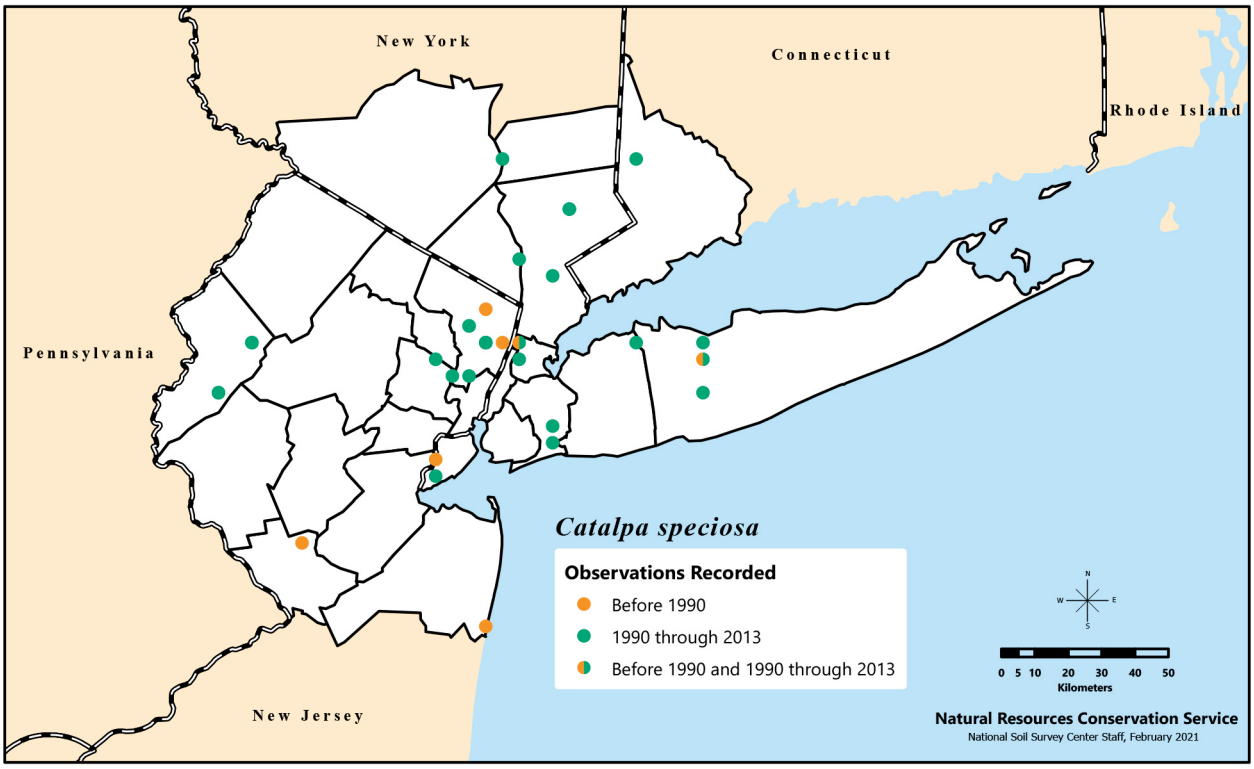
Flowering June–July. Native to eastern Asia. Occasionally cultivated and rarely naturalized in open upland areas. Fruit and seeds smaller than those of *C. bignonioides* and *C. speciosa*. Cultivated since 1849 (Dirr 1998). Can hybridize with both *C. bignonioides* and *C. speciosa* (Olsen and Kirkbride 2017).

2. *Catalpa speciosa* (Meehan) Engelm. – northern catalpa ↑↑

Catalpa bignonioides var. *speciosa* Meehan

Flowering May–June (usually before *C. bignonioides*). Occasionally escaped from cultivation throughout the region in disturbed dry to moist areas. Much less common in the region than the closely related *C. bignonioides*. Species likely native to bottomlands in AR, IL, IN, KY, MO, and TN. However, like *C. bignonioides*, its precise native range is uncertain due to cultivation and naturalization (see following discussion). Epithet means “showy,” a reference to the flowers.

Flowers are perfect but self-incompatible. If a flower is pollinated with its own pollen, it cannot be outcrossed later (Bonner and Graney 2008). Individual flowers last a maximum of 2 days. Inflorescences last 5–6 days and tree flowers 8–12 days. Number of outcrossed flowers increases over time, even though the peak



Distribution of *Catalpa speciosa*, or northern catalpa, recorded in the New York Metropolitan Region during three time categories.

flowering period occurs about midway during the flowering period. Peak flowering period serves to keep the pollinators active and appears to help ensure their presence beyond the peak period. Pollinators include large bees (diurnal; *Adena* spp.) and large moths (nocturnal; order Lepidoptera) (Stephenson 1982). Honey bees (*Apis* spp.) are not effective pollinators of this species. Mast matures in Oct. and produces winged wind-dispersed seeds. Pretreatment and light not required for germination. The seeds of *C. speciosa* are slightly smaller than the seeds of *C. bignonioides* (Bonner and Graney 2008). Height at maturity 13–20 m (Dirr 1998). *Catalpa speciosa* is considered naturalized in the northeastern and southeastern U.S. (Bonner and Graney 2008), and there was a "catalpa craze" in the 19th century during which plantations of *C. speciosa* (mixed with some *C. bignonioides* and *C. ovata*) were planted and the wood was marketed for fence and telegraph posts (Olsen and Kirkbride 2017).

However, fossils of *C. speciosa* have been found in archaeological remains estimated to date back to A.D. 1500–1700 from the vicinity of Neale's Landing in WV, suggesting it may have had a larger native distribution historically (Hemmings and Core 1972). Cultivated since 1754 (Dirr 1998).

Catalpa sphinx moth (*Ceratomia catalpa*) feeds on both *C. bignonioides* and *C. speciosa* and can be a destructive herbivore. Larvae utilize glycosides to deter predators by regurgitating in response to being attacked (Bowers 2003). *Catalpa speciosa* apparently was replacing *C. bignonioides* in the late 1800s in the Mississippi Valley (Engelmann 1880), suggesting that *C. speciosa* may have been favored as a cultivated tree at one time, possibly due to its taller habit and inodorous leaves. Leaves of *C. bignonioides* produce an unpleasant smell that is not shared by *C. speciosa* (Engelmann 1880).



Twig with leaves and flowers, thin pod-like fruit capsule, and winged seed of *Catalpa bignonioides*. Illustration by Emma Skurnick.

Management

Because of the naturalized status of *Catalpa bignonioides* and *C. speciosa* (both of which are native elsewhere in the U.S.) in the NY Metropolitan Region, it is difficult to describe these species as nonnative. Moreover, the limited seed production and the evident negative impact of natural predators and pathogens make it difficult to classify these species as invasive, but MD does include *C. speciosa* as a potential invader (University of Georgia 2018). Though the trees appear to be a nuisance or an environmental weed, there is no documented evidence of native species displacement, spreading over large areas, or economic losses associated with these two species in the U.S. Nonetheless, the Czech Republic lists it as an invader equal to *Ailanthus altissima* and *Robinia pseudoacacia* (Kelbel 2000). In contrast, England considers it a treasured urban tree (Del Tredici 1986, Wearn 2010). Indeed, these two *Catalpa* spp. are being promoted as urban trees even in the U.S. (Olsen and Kirkbride 2017).

These species may not be ideal for urban trees because they are susceptible to several herbivores, pathogens, and diseases, such as powdery mildew. Their fruits are also considered messy, and each tree produces a large amount of leaf and flower litter. Consequently, some see a need to breed for a more desirable *Catalpa* cultivar or hybrid that has reduced fruit, leaf, and flower litter and that is less susceptible to herbivory and disease.

Two sources of resistance to powdery mildew have been found: the four eastern Asian *Catalpa* spp. and the two West Indian *Catalpa* spp. This hybrid or cultivar has been crossed with the related *Chilopsis linearis* (desert willow, native to California; family Bignoniaceae). The bigeneric hybrid or ×*Chitalpa* has been successfully produced (Olsen 2008). It is already possible to purchase ×*Chitalpa tashkentensis* (sold as a hybrid between *Catalpa bignonioides* and *Chilopsis linearis*). The advertised characteristics include narrow leaves and tolerance to both drought and cold; it does not produce fruit, but it does produce showy flowers (Mountain Valley Growers 2019). Landscapers and breeders of these species should take great care when weighing the importance of breeding a new urban tree against the potential for unleashing a nonnative invasive that contains genetic material from eastern Asia or the West Indies (or both). Such crosses are not yet documented to lead to invasive species, but it may be only a matter of time if they become popular landscape or urban trees.

Hybridization between *C. speciosa* and *C. bignonioides* has not been documented with certainty, though there is evidence of intermediate flowering times in regions where the species now overlap (Del Tredici 1986). Given that these two species do hybridize with *C. ovata* (Olsen and Kirkbride 2017) and are likely to overlap more with continued use as landscape trees, the likelihood for a hybrid to develop increases as well. Such a hybrid could have a broader climatic range than the individual species, making it more prone to invasion.

Ceanothus L. – New Jersey tea

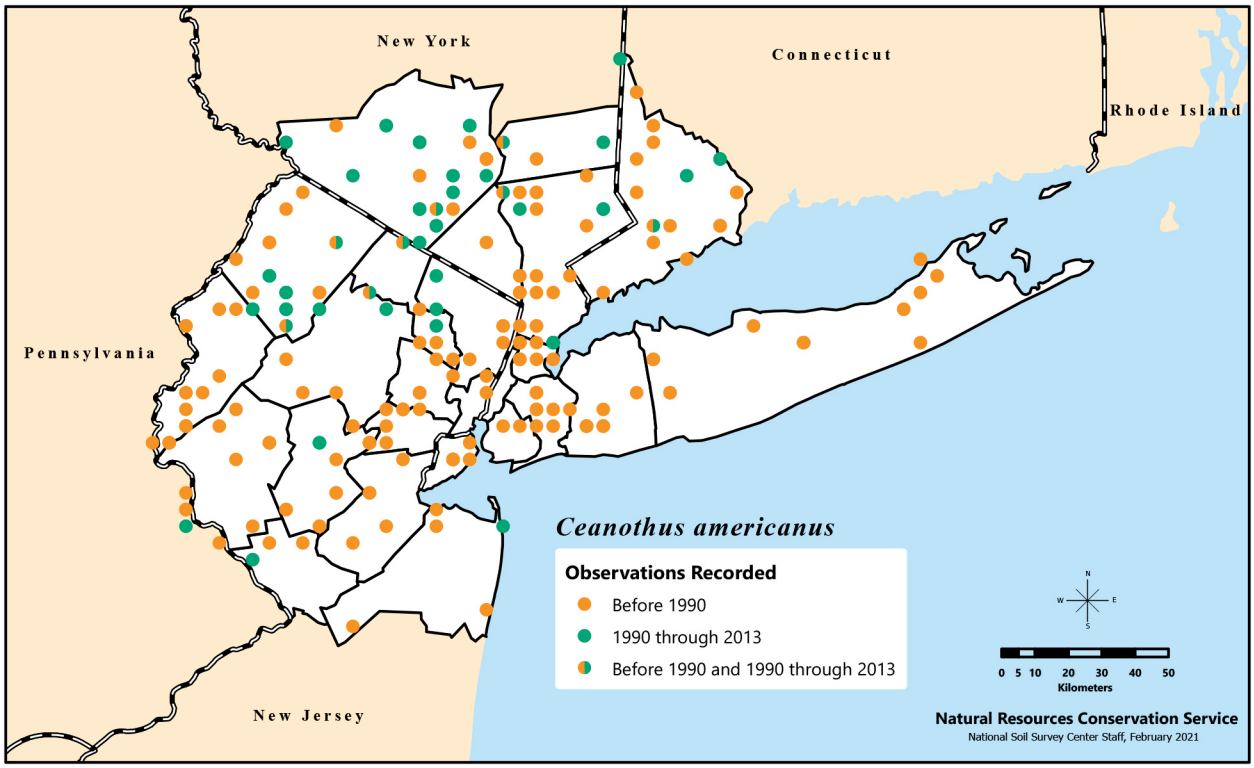
Rhamnaceae. Shrubs, small trees. Species 55 in North America. Genus name is derived from the Greek “keanothos,” but this name must have been applied by Theophrastus (ca. 371–287 B.C.; “father of botany,” early classifier of plants, and Greek philosopher who studied under Aristotle and took over the Lyceum when Aristotle fled Athens), from whom Linnaeus got the name, to a different group of plants than this genus, which is limited to North America.

Native Species

1. *Ceanothus americanus* L. – New Jersey tea ↓↓

Flowering June–early Aug. Usually dry to somewhat mesic woods, hillsides, rock cliffs, ravines, and fields.

Pollination biology is not known. Seeds may be dispersed by finches (such as *Hesperiphona vespertina*); however, observations indicate the birds split most of the seeds (Ridley 1930). Seeds have impermeable seed coats as well as dormant embryos. Best germination results have

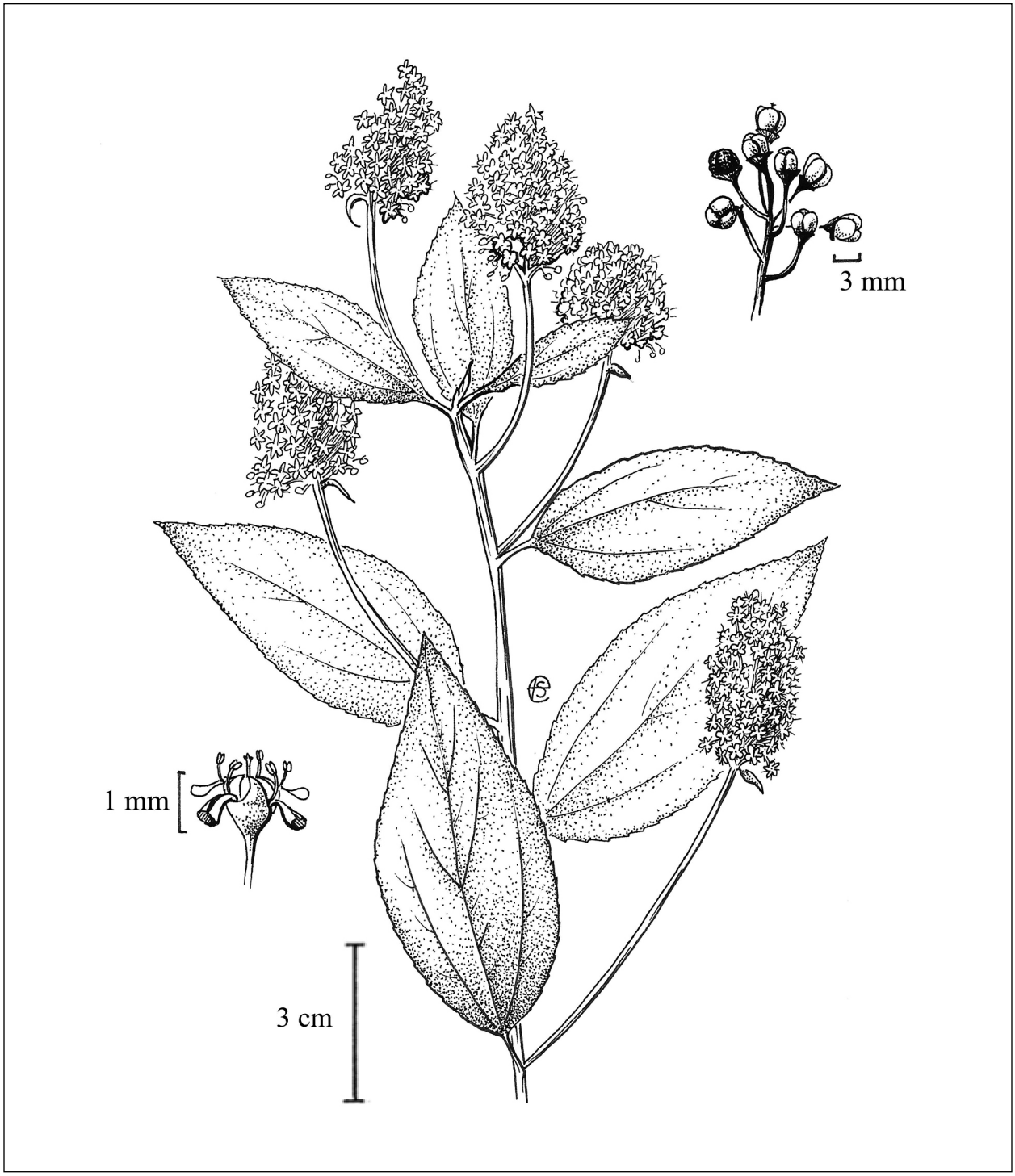


Distribution of *Ceanothus americanus*, or New Jersey tea, recorded in the New York Metropolitan Region during three time categories.

been obtained by first soaking seeds in hot water, allowing the water to gradually cool overnight, followed by cold stratification in moist sand for 60 days. Germination is epigeal. Seed stored dry in sealed containers at 5 °C showed no appreciable loss of viability after 2 years (Quick and Quick 1961). Cultivated since 1713 (Conard and Reed 2008). Was a commercially important species used for tea, especially during the Revolutionary War era (Warnhoff et al. 1965).

Recent survey work indicates severe population decrease in the region and beyond. Species readily eaten year-round by deer (Coladonato 1993); increasing deer populations may partly explain species' decline in the region. Decline has affected moths and the mottled duskywing skipper (*Erynnis martialis*), a globally rare (G3) species of conservation concern (S1) in NY. Primary food source for larvae of this skipper and of two moths is foliage of *C. americanus*; loss of plant has led to skipper and moths' apparent disappearance from NJ and much of the East. The few remaining colonies include those in NY and Canada; Albany Pine Bush probably the only northeastern location for all three lepidopterans. In addition to deer browse, loss of brushy and barrens habitats has contributed to decline of *C. americanus* (New York Department of Environmental Conservation 2012).

Despite decline in the region, not tracked as rare in CT, NJ, or NY.



Flowering twig with leaves, and flower (at left) and fruit of *Ceanothus americanus*. Illustration by Emma Skurnick.

C

Celastrus L. – bittersweet

Celastraceae. Shrubs, vines. Species 30+ in Asia, Australia, and North America. Flowers are pollinated by insects or wind (Brizicky 1964). Fruit and seeds of *Celastrus* are dispersed by humans (Dirr 1998), birds, and small mammals (Dreyer et al. 1987). No seed bank apparent (Van Clef and Stiles 2001). Moist cold stratification for 6 months required for germination (Wendel et al. 2008). Primary seed dispersers are several common bird species, such as the American robin (*Turdus migratorius*), which has been shown to transport seeds as far as 500 m (Bartuszevige and Gorchov 2006, Vittoz and Engler 2007). Able to grow thinner and taller in response to greater stem densities if under higher light levels (Leicht-Young et al. 2011). Genus name is derived from "elastros," an ancient Greek name probably for the tree now known as *Phyllrea* (Rehder 1949).

Native Species

1. *Celastrus scandens* L. – American bittersweet ↓↓↓

Flowering late May–late June. Woods, dune thickets, riverbanks, and fencerows. Epithet from Latin means "climbing," a reference to the plant's typical habit.

Propagation possible by seed as well as vegetatively by root suckering (Dreyer et al. 1987). Cultivated since 1736 (Wendel et al. 2008). Has declined dramatically over the past 50 years (Steward et al. 2003), possibly due to competition (Steward et al. 2003) and hybridization (Dreyer et al. 1987, Pooler et al. 2002) with Chinese or Asian bittersweet (*Celastrus orbiculatus*; see next entry). Loses its ability to forage for light or other resources under high density conditions when shaded (Leicht and Silander 2006).

Listed as a species of special concern in CT (S3) and rare in NY (S4).

Nonnative Species

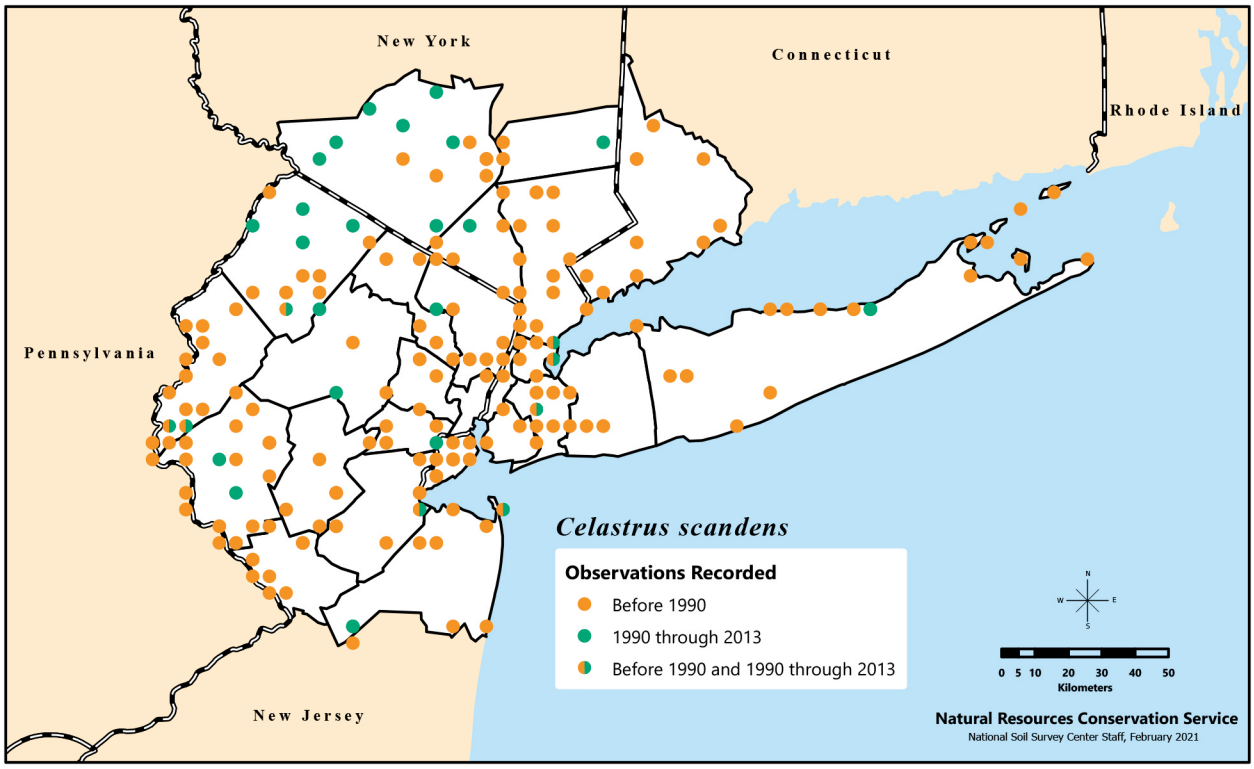
2. *Celastrus orbiculatus* Thunb. – Chinese or Asian bittersweet ↑↑↑

Flowering late May–early June. Woods, thickets, fencerows, and disturbed areas. Epithet from Latin refers to the leaves, which may be somewhat round in outline.

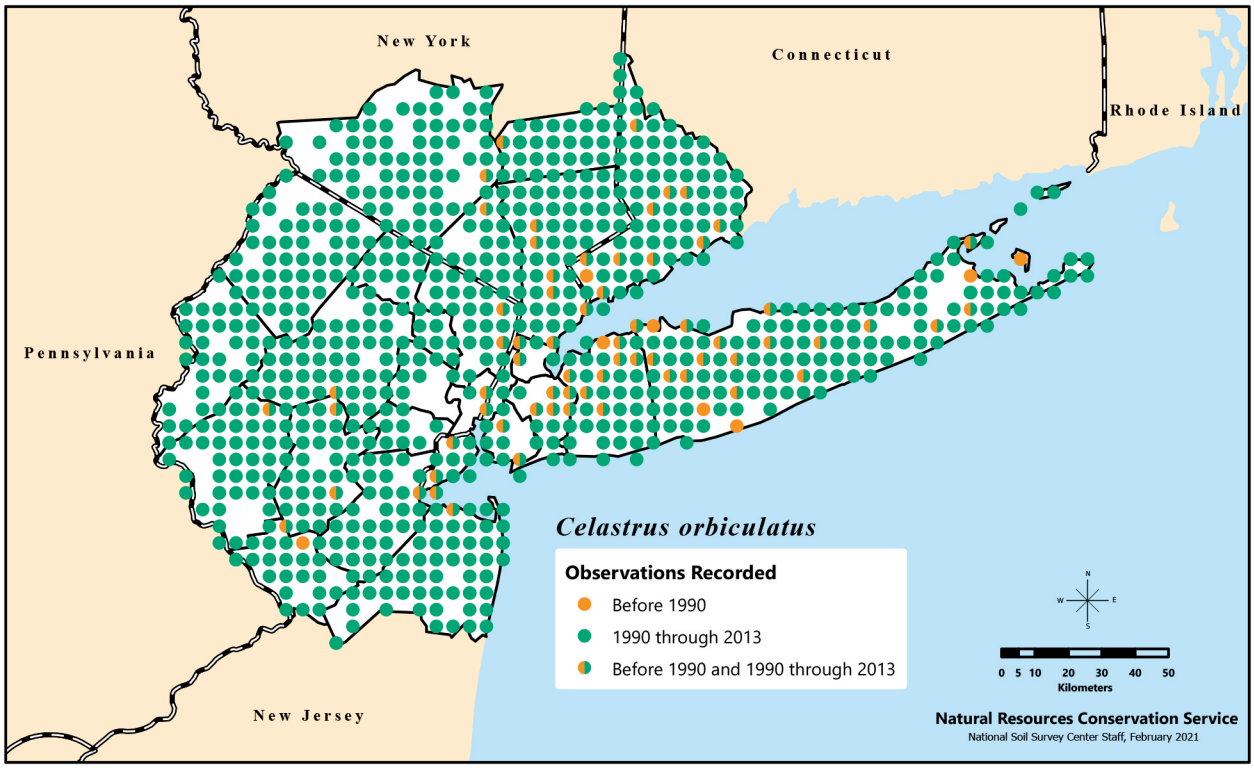
Native to eastern Asia (Japan, China). First seen escaping from cultivation in the NY Metropolitan Region in 1919. Has increased dramatically in distribution in the past 50 years. Capable of girdling trees (also occasionally reported in *Celastrus scandens*). More competitive than *C. scandens* because it is more shade-tolerant (Robertson et al. 1994), grows more rapidly (Leicht-Young 2011, McNab and Meeker 1987) with a higher survival rate (Leicht-Young et al. 2011) in variable environments (Leicht-Young et al. 2007b), photosynthesizes at a faster rate (Clement et al. 1991), and produces more viable seeds (Dreyer et al. 1987). Hybridizes with the native *C. scandens*, producing a sparingly fertile hybrid that is more vigorous than the native; hybridization unidirectional with pollen flow from male introduced plants to female native plants. Result is poor seed set and offspring with infertile pollen; both are a waste of native female reproductive effort (Zaya et al. 2015). Utilizes a "sit and wait" strategy of invasion in that it germinates best in shade but does not grow prolifically until there is a canopy opening (Greenberg et al. 2001). Able to obtain light and other resources even in the shade (Leicht and Silander 2006). Possible medicinal uses against rheumatoid arthritis (Min et al. 1999) and

Celastrus Key

1. Leaves about twice as long as wide, serrulate; leafing out with new leaves involute-folded; many-flowered terminal panicles; pollen yellow; fruits 0–1 seed . . . . . ***Celastrus scandens***
1. Leaves broader, crenulate (-serrulate); leafing out with new leaves conduplicate; few-flowered axillary cymes; pollen white; fruits with 5 or more seeds . . . . . ***Celastrus orbiculatus****



Distribution of *Celastrus scandens*, or American bittersweet, recorded in the New York Metropolitan Region during three time categories.



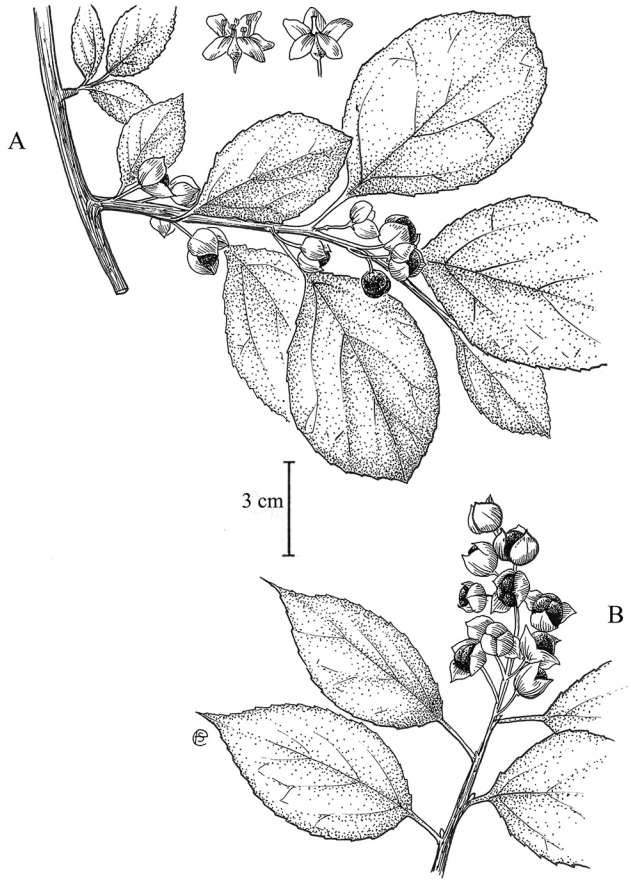
Distribution of *Celastrus orbiculatus*, called Chinese or Asian bittersweet, recorded in the New York Metropolitan Region during three time categories.

reversing cancer cell resistance to treatment drugs (Kim et al. 1998).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

Management

The ability to distinguish the native and nonnative *Celastrus* spp. morphologically is important for successful management. Leicht-Young et al. (2007a) have produced a detailed key with some of the more reliable characters, which have been incorporated into the preceding descriptions. Successful removal of *C. orbiculatus* when young is possible by pulling or digging it out of the ground with most of its roots. If nontarget species are not a concern, foliar application of herbicide may be most effective. Some stems are likely to be too high for foliar sprays, in which case stems may be cut or injected with a herbicide. Though a seed bank may not be a concern, any remaining living root material is likely to produce new stems, making multiple treatments necessary. Large infestations may be best handled by treating from the invasion front inward for at least 500 m (based on seed dispersal distances via birds) as well as treating any relatively small satellite populations beyond this invasion front. Many birds tend to utilize forested corridors between patches of habitat (Machtan et al. 1996); knowledge and possible manipulation of a given landscape where this invader is found may help reduce the movement of seeds.



A) Leaves, fruit, and male and female flowers of *Celastrus orbiculatus*; B) leaves and fruit of *Celastrus scandens*. Illustration by Emma Skurnick.

Celtis L. – hackberry

Cannabaceae (Celtidaceae; Ulmaceae s.l.). Trees, shrubs. Species about 60 in mostly tropical Africa, Asia, Europe, North America, and South America. One species (*Celtis sinensis*) introduced and invasive in Australia. Genus name is the name given by the Roman scholar Pliny the Elder (A.D. 23–79) to a tree species, but probably not from *Celtis*, with sweet berries or drupes.

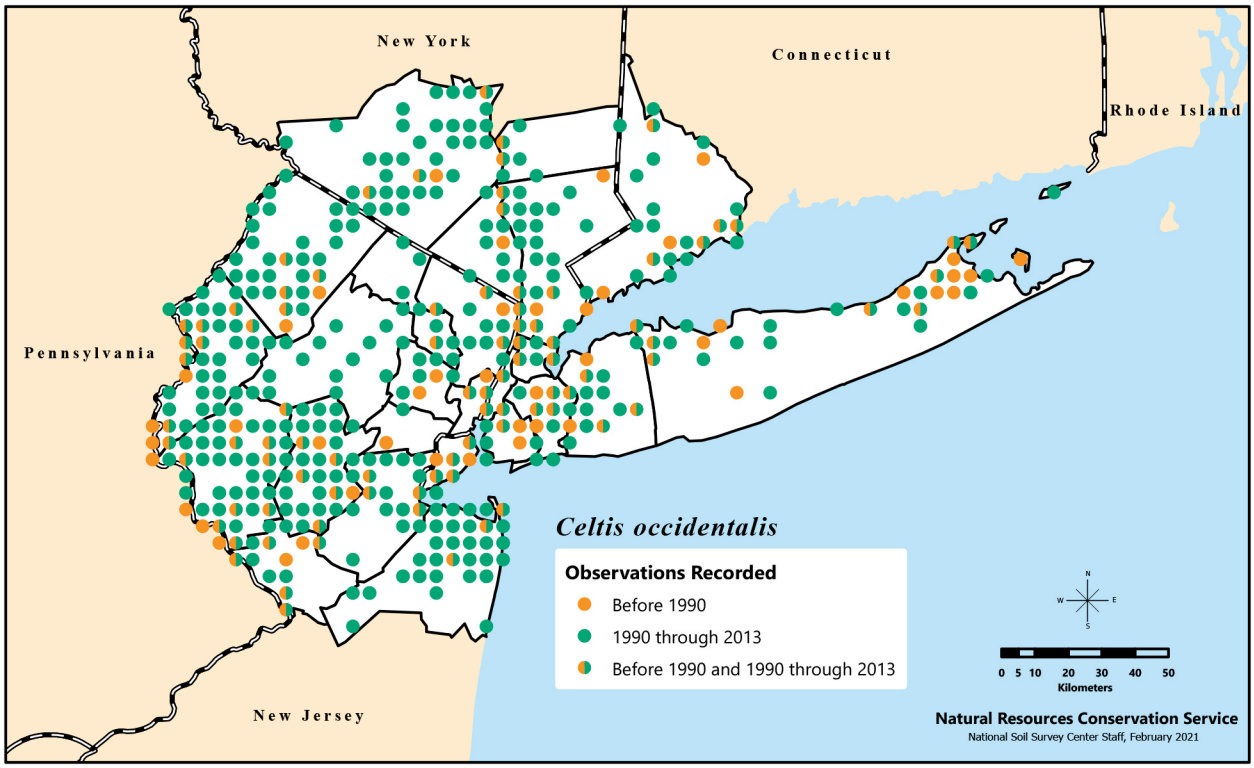
Native Species

1. *Celtis occidentalis* L. – hackberry ↑

Tree. Flowering Apr.–May; fruit ripening in Aug.–Oct. Occurs in a wide variety of habitats, including dry to mesic woodlands, bottomlands, riverbanks, open rocky areas, fencerows, and old fields. Does well in dry soils and windy conditions and thus may make a good urban landscape tree (Dirr 1998). Epithet from Latin means "western,"

Celtis Key

1. Tree (rarely shrubby); leaves serrate below the middle, yellowish-green beneath; fruiting pedicels longer than the petiole . . . . . ***Celtis occidentalis***
1. Shrub or small tree; leaves entire or with some teeth above the middle, gray-green beneath; pedicels shorter or about as long as the petioles . . . . . ***Celtis pumila***



Distribution of *Celtis occidentalis*, or hackberry, recorded in the New York Metropolitan Region during three time categories.

referring to the Western Hemisphere. “Hackberry” is a misnomer from the Scottish “hagberry”’ (referring to *Prunus avium*) (Dirr 1998).

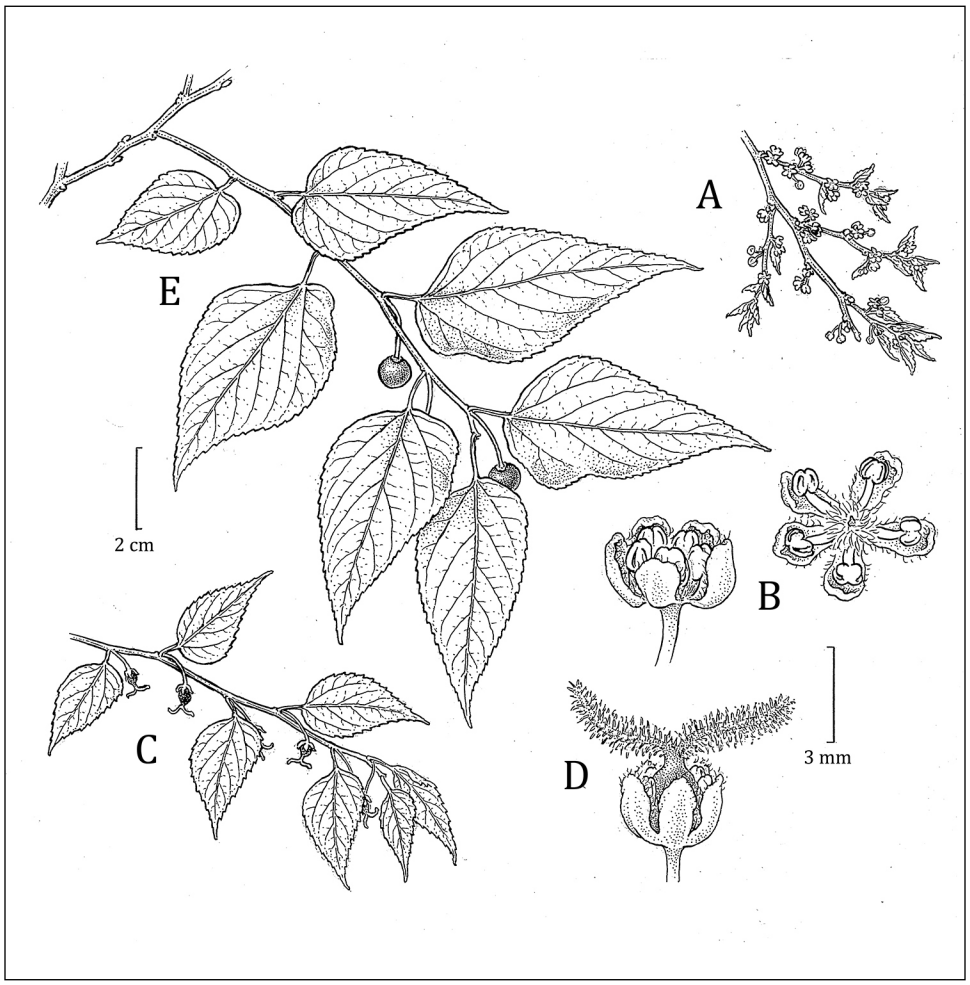
Moist cold stratification for 60–90 days required for germination (Dirr 1998). Height at maturity 9–40 m (Bonner 2008c). Cultivated since 1636, with at least 4 cultivars (Dirr 1998). Increases may be due to reforestation.

2. *Celtis pumila* Pursh – dwarf hackberry Ø

Celtis georgiana Small; *Celtis occidentalis* var. *pumila* (Pursh) A.Gray; *Celtis pumila* var. *georgiana* (Small) Sarg.; *Celtis tenuifolia* Nutt.; *Celtis tenuifolia* var. *georgiana* (Small) Fernald & B.G.Schub.

Shrub. Flowering May; fruit ripening in Aug. Open rocky areas, often on slopes. Often associated with calcareous soils and limestone outcrops, though it is found in sandy soil as well (Cusick 1986). Species is at the northernmost limit of its range in the NY Metropolitan Region (Broyels et al. 1997) and is exceptionally rare in NJ; reported only from Essex, Hunterdon, Sussex, and Warren Counties. Epithet refers to the species’ short stature, “pumila” meaning “short” in Latin. Triploid and apomictic; pollen reported to be mostly aborted (Whittemore 2013). In the region near the coast there are populations of *Celtis* that, like *Celtis pumila*, are shrubs. These populations are usually found in sandy, open woodlands. This shrubby coastal *Celtis* material has usually been identified as diminutive examples of *C. occidentalis*. However, these populations should perhaps be included in *Celtis pumila*. This coastal shrubby *Celtis* material has been excluded from either species treated here pending further study.

Tracked as imperiled (S2) in NJ.



A) Twig with staminate flowers, B) staminate flowers, C) leafy twig with pistillate flowers, D) pistillate flower, and E) twig with leaves and fruit of *Celtis occidentalis*. Illustration by Bobbi Angell.

Cephalanthus L. – buttonbush

Rubiaceae. Shrubs, rarely small trees. Species about 6 in Africa, Asia, North America, South America, and the West Indies. Genus name is derived from the Greek words "cephale," meaning "head," and "anthos," meaning "flower," in reference to the striking spherical inflorescences.

Native Species

1. *Cephalanthus occidentalis* L. – buttonbush ↑↑

Shrubs, rarely small trees. Flowering July–Aug. Marshes, swamps, and streambanks. Epithet from Latin refers to the plant being native to the Western Hemisphere; the other species described by Linnaeus (1753) is *Cephalanthus orientalis* (=*Nauclea orientalis* (L.) L.).

Protandrous, with low seed viability of self-fertilized seed compared to outcrossed seed (Imbert and Richards 1993), suggesting dependence on pollinators. Bumble bees (*Bombus* spp.) and butterflies (order Lepidoptera) are common pollinators of this shrub (Andersson et al. 2002, Bhattacharya et al. 2003). Cultivated since 1735 (Dirr 1997). Increases may be due to increases in wetland habitats.

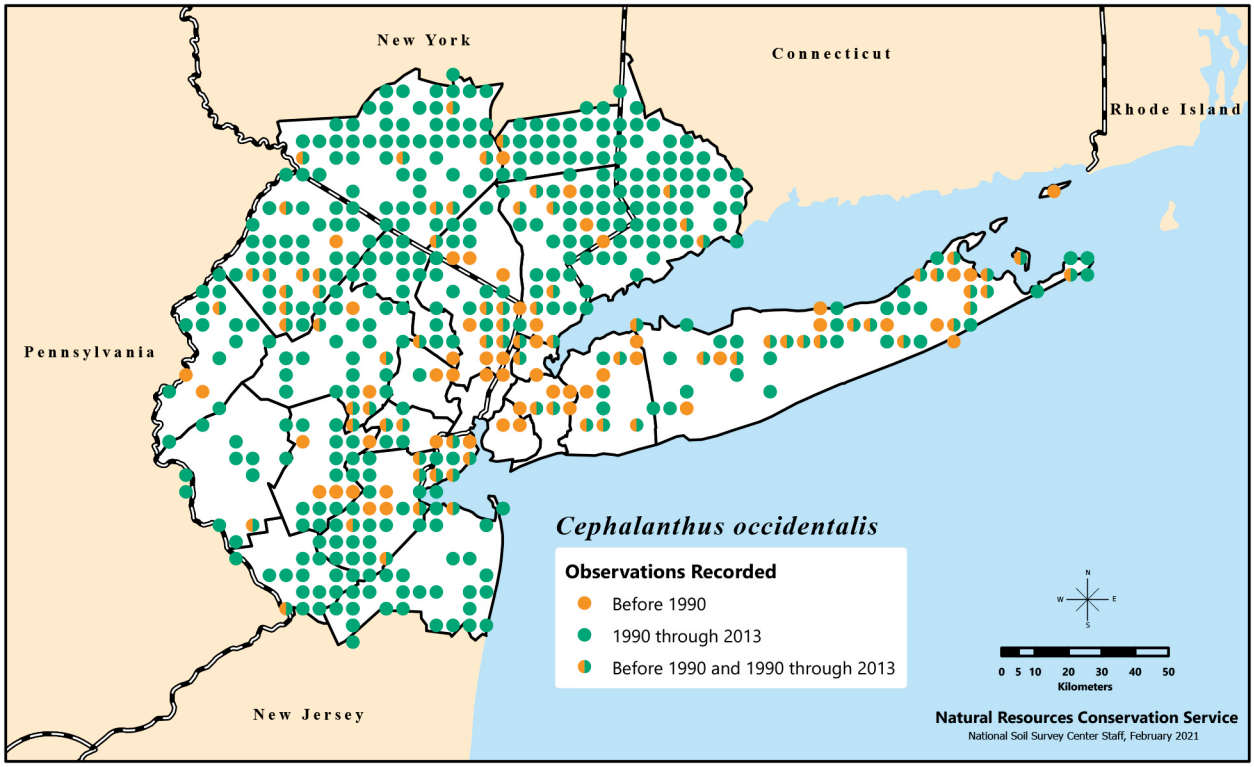
Cercis L. – redbud

Fabaceae s.l. (Cesalpiniaceae). Trees, shrubs. Species 11 in northern temperate areas: 6 in Asia, 5 native to China; 1 in Europe; 4 in North America. Genus name is derived from "kerkis," the ancient Greek name for the Judas-tree (*Cercis siliquastrum* L.), native to Europe and cultivated since ancient times.

Native Species

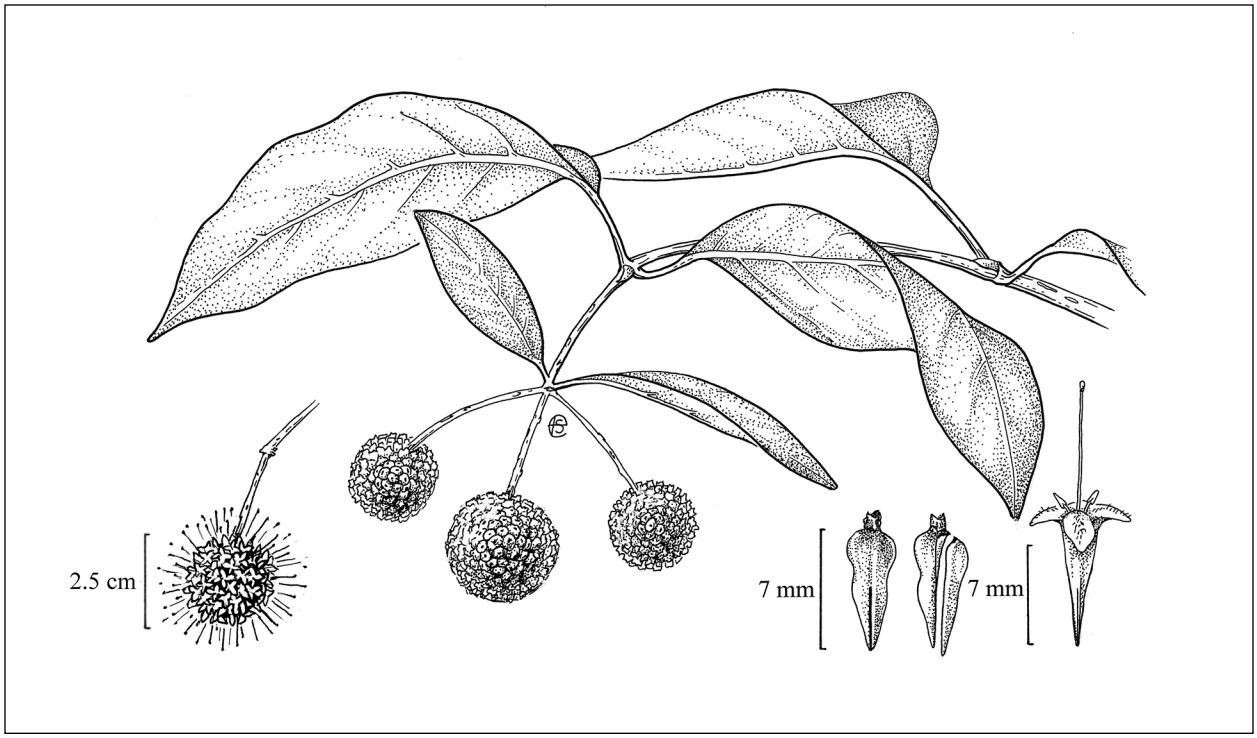
1. *Cercis canadensis* L. – redbud Ø♥

Trees, shrubs. Flowering late Apr.–May. Rich mesic woodlands and ravines. Also most likely naturalized along roadsides and in thickets, woodland edges, fields, and waste places. Material reported from NY is not native (Werier 2017). Material in CT and NJ consists of native and naturalized populations. Native populations listed

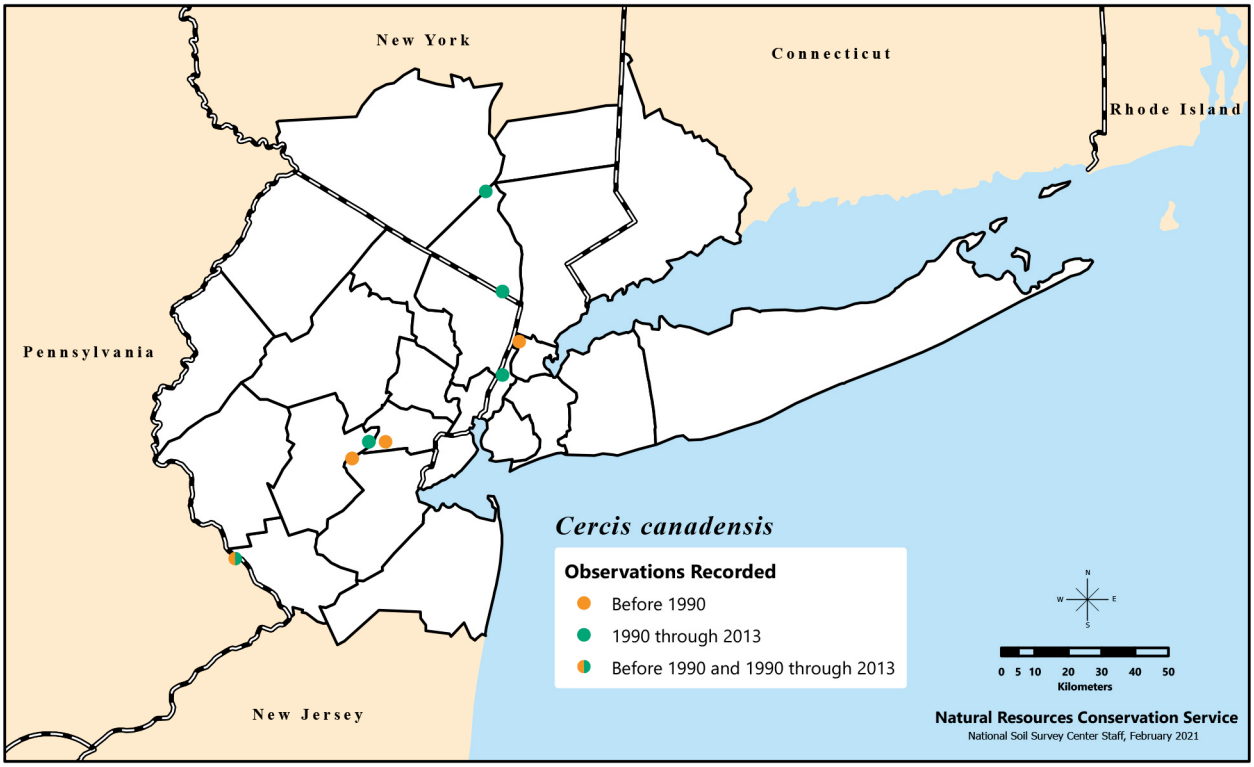


Distribution of *Cephalanthus occidentalis*, or buttonbush, recorded in the New York Metropolitan Region during three time categories.

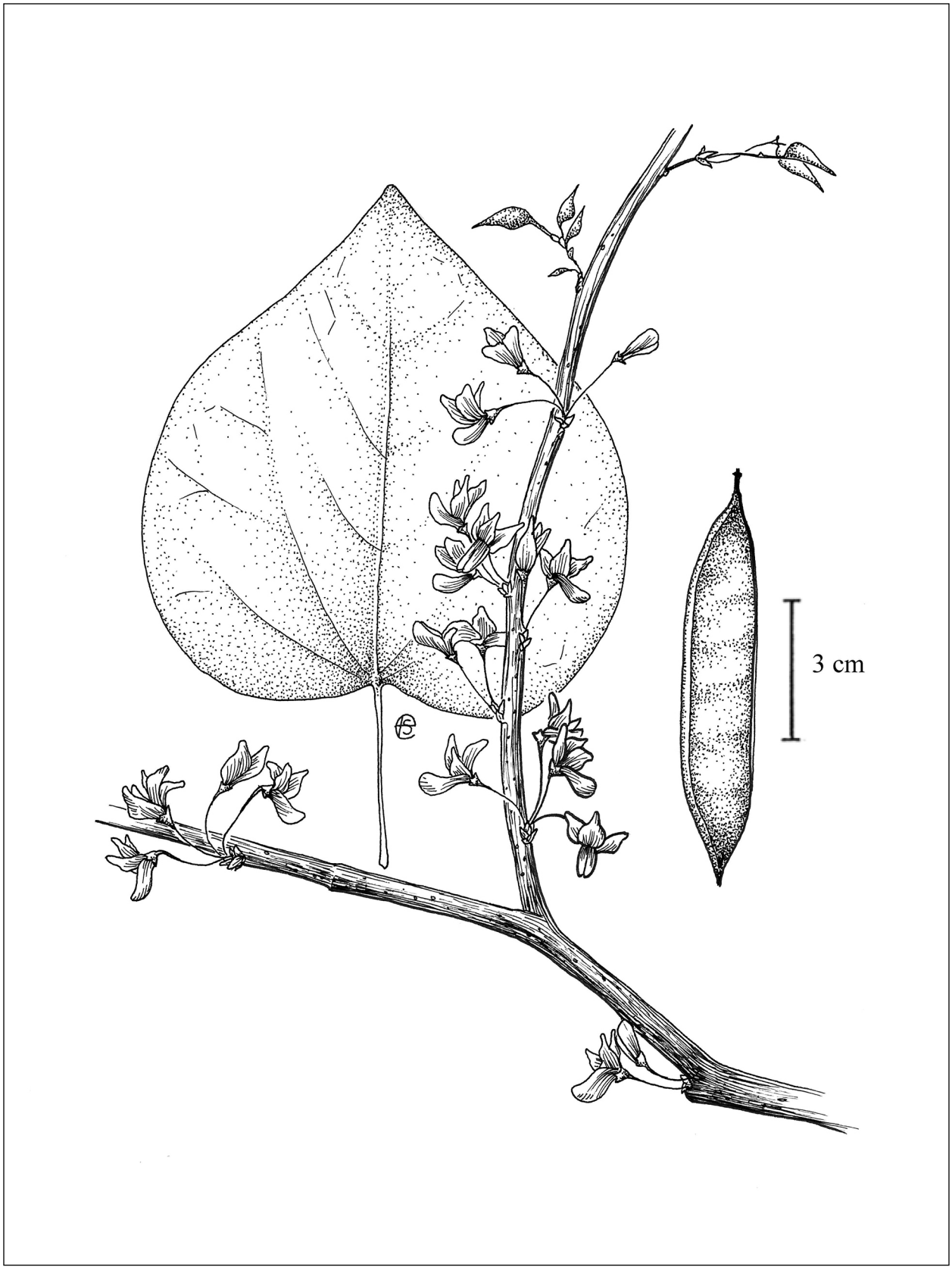
C



Twig with leaves and fruiting heads; flowering head; two fruits, one splitting into nutlets; and flower of *Cephalanthus occidentalis*. Illustration by Emma Skurnick.



Distribution of *Cercis canadensis*, or redbud, recorded in the New York Metropolitan Region during three time categories.



Flowering twig, leaf, and fruit (legume) of *Cercis canadensis*. Illustration by Emma Skurnick.

as endangered (S1) in NJ, with possible native occurrences reported from all northern counties except Sussex and Warren. Tracked as historical (SH) in CT, with reports from just outside the region in Litchfield and New Haven Counties. Graves (1910) did not take the species as native to CT. Stone (1911) regarded the populations in NJ along the Delaware River as representing the northern limit of this species' native range east of the Allegheny Mountains. Naturalized populations recently reported in NY from Bronx, New York, Orange, and Rockland Counties. Though Linnaeus used the *canadensis* epithet for this species, he did not report it from Canada as currently understood, instead applying the term "Canada" to an area of northeastern North America, partly in Canada but mostly in the U.S. (Stearn 1957). Indeed, the only report of a native population of this species for Canada is an 1892 record from Pelee Island, ON in Lake Erie (Scoggan 1978).

Height at maturity 7–12 m. Earliest seed-bearing age 3–4 years; individuals in open or semi-open areas produce the most flowers and seeds (Banner and Stein 2008). Due to the hard seed coat, germination requires scarification (possibly with sulfuric acid) followed by 5–8 weeks of moist cold stratification. Occurs naturally over an extended range; plants from farther south do not tend to do well farther north and vice versa. Cultivated since 1641, with at least 14 cultivars and 2 subspecies. There are several even showier *Cercis* spp. from China, including *C. chinensis*, *C. chingii*, and *C. yunnanensis*, as well as from Europe, *C. siliquastrum*, all of which can look similar to *C. canadensis* (Dirr 1998). Though there is no evidence that any of these species has invasive tendencies, care should be taken to confirm the species and perhaps evaluate the cultivars if the intent is to plant native material.

Chamaecyparis Spach – white cedar

Cupressaceae. Trees. Species 5 in eastern Asia and North America. Genus name is derived from the Greek for "ground cedar," "chamai" meaning "ground."

Native Species

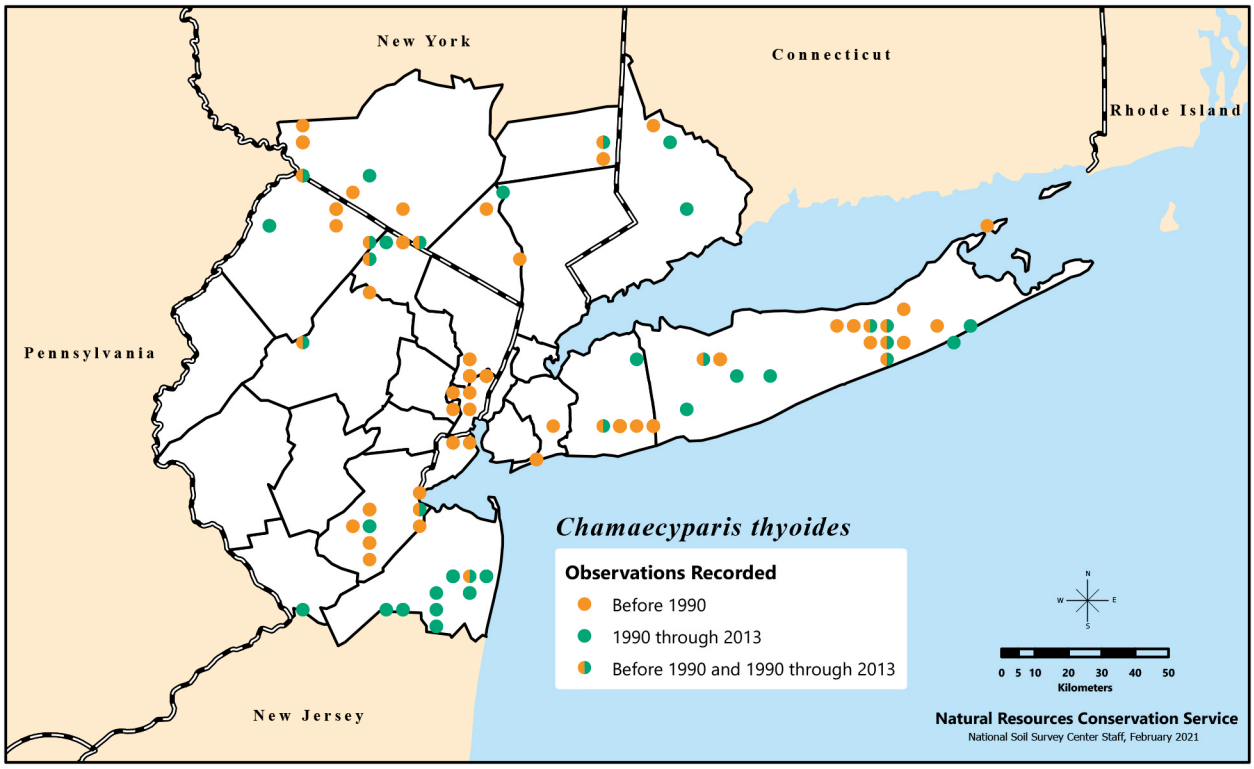
1. *Chamaecyparis thyoides* (L.) BSP – Atlantic white cedar ↔

Cupressus thyoides L.

(See *Juniperus* plate on p. 263 for illustration)

Pollen produced in Apr.–early May; cones maturing at end of season and persisting on tree into the next season. Swamps and bogs. Historically, the species was more frequently dominant in the Meadowlands. The "juniper" of Juniper Swamp in Maspeth, Queens was also this species. This bog and swamp were a popular place to pick wild blueberries (*Vaccinium* spp.) in the 1800s. Epithet from Greek means "thya-like," a reference to *Thuja*.

Native to U.S. eastern swamps and the coast. Prefers full sun in lowlands, boggy sites, and streambanks. More than 43 cultivars. Promoted as a native evergreen hedge or screening (Dirr 1998). Though capable of growing on acidic, nutrient-deficient sites, it responds positively to nutrient addition, growing as much as 21 times more with increased nutrients (Haas and Kuser 2003). May live as long as 1,000 years, but the age of individuals growing in stands is usually closer to 200 years. Wind-thrown trees are relatively common due to its shallow root system. Canopy openings caused by the loss of a few trees via windthrow or fire may lead to displacement of this species by hardwood trees, which are more competitive in partial shade. Clearcutting, at least at one time, may have ensured better regeneration (Little 1959). However, as early as 1965, the lack of regeneration of this species after a major disturbance such as an intense fire or harvesting was linked with excessive browsing by rabbits (family Leporidae) and deer (*Odocoileus* spp.) (Little and Somes 1965). Recent interest in its restoration has led to studies on how best to control hardwood species, invasive plant encroachment, and deer and other herbivory to improve regeneration. Some evidence that the



Distribution of *Chamaecyparis thyoides*, or Atlantic white cedar, recorded in the New York Metropolitan Region during three time categories.

cedar populations have stabilized and are no longer in decline, perhaps due to the reduction in harvesting (Zampella and Lathrop 1997), but other studies refute this, reporting low regeneration, due to a lack of severe disturbances (Motzkin et al. 1993) or excessive deer browsing (Zimmermann and Mylecraine 2005), or both.

Valued for its timber and used for boats, furniture, and utility poles (Kuser and Zimmermann 1995). However, better or cheaper materials (including plastics) have replaced much of the market. The higher cost was due to overharvesting and the general depletion of the population (Ward 1989). In 1989, its wholesale value was estimated at $10 million–$11.5 million with an annual production of 45,000 m^3 and about 400,000–420,000 m^3 inventoried (Ward 1989).

There are thought to be 2 geographic varieties: var. *henryae* in GA, FL, AL, and MS and var. *thyoides* in the area from SC to ME (Little 1966). Significant provenance differences exist even within the northern variety; populations from NC grow almost twice as fast as populations from NJ (Mylecraine et al. 2005).

Earliest cone-bearing age 3 years. Cones contain approximately 8 seeds, but fewer than one-third may be viable (Bonner 2008d).

Listed as threatened in NY (S2).

Management

Sustainability of *Chamaecyparis thyoides* populations may depend on the ability to provide periodic and adequate canopy removal to allow enough light in for seedlings of this species to compete against more shade-tolerant hardwood species. However, if browse by deer or other animals is likely, regeneration may be minimal for this species and for many hardwood species. Moreover, if propagules of invasive plants are nearby, especially after a disturbance, the invasives could potentially directly or indirectly displace *C. thyoides*. Thus, knowledge of the surrounding landscape is important before using disturbance as a regeneration tool for this species.

C

Chamaedaphne Moench – leatherleaf

Ericaceae. Shrub. Species 1 in Asia, Europe, and North America. Genus name is derived from the Greek for "ground" ("chamai") and "laurel" ("daphne").

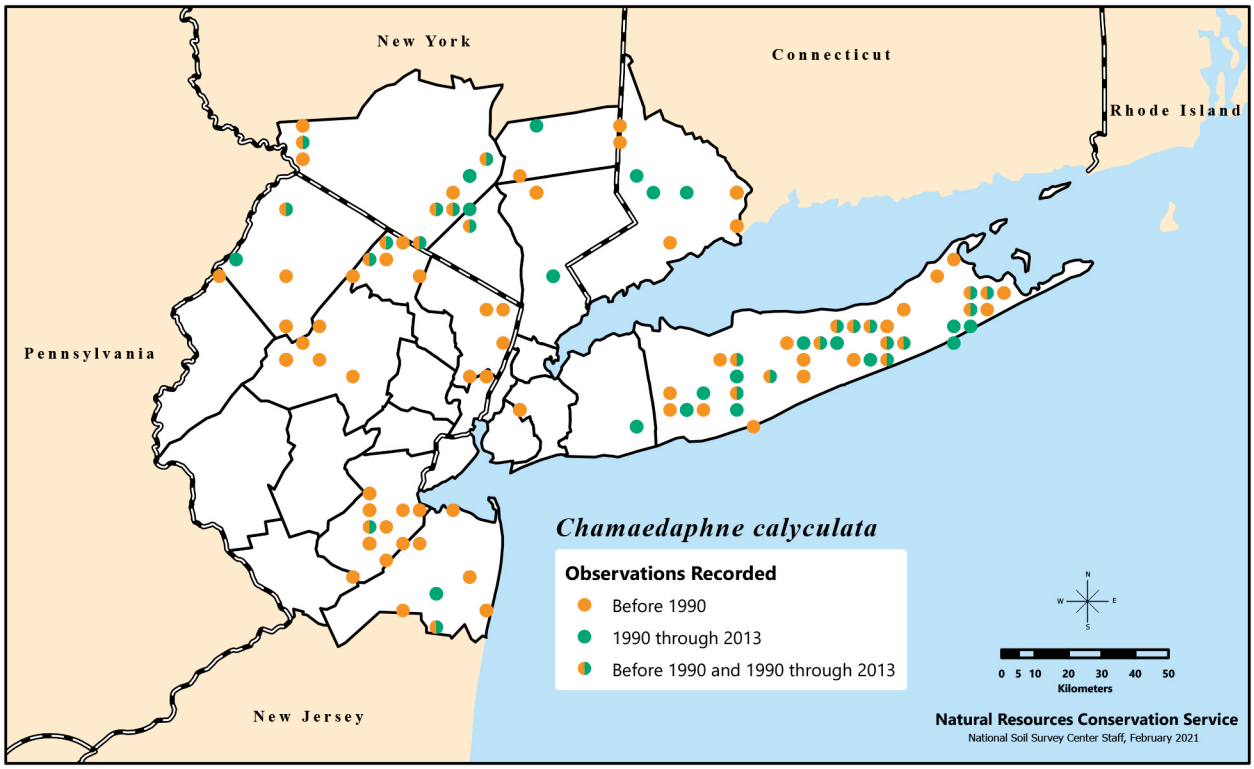
Native Species

1. *Chamaedaphne calyculata* (L.) Moench – leatherleaf ↔

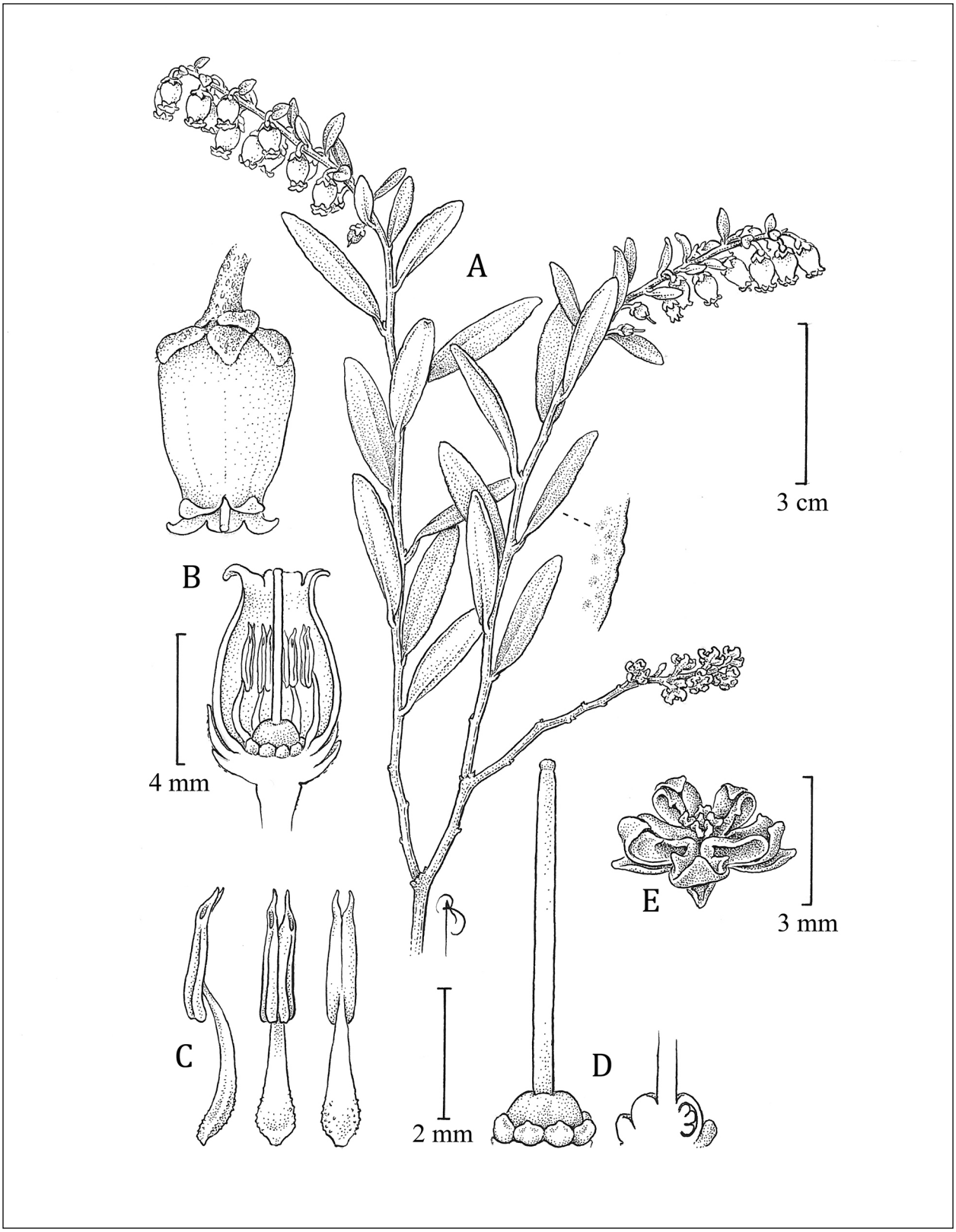
Andromeda calyculata L.

Flowering Apr.–June. Bogs, swamps, and lake and stream margins; pine barrens, vernal ponds, shrub swamps, inland poor fens, and dwarf shrub bogs. *Chamaedaphne calyculata* is the dominant species in shrub associations on some bogs. Usually grows on wet sphagnum mats over water with a pH of 4.5–6. Epithet is Latin for a cup-like structure below the calyx and may refer to the 2 bracts beneath the persistent calyx of this species.

Potentially a good plant for wetland mitigation or restoration. In cultivation since 1748, with at least 2 cultivars (Dirr 1998) and possibly 3 varieties (Fabijan 2009). Several bee spp., including *Andrena bradleyi*, *Bombus affinis*, and *Colletes inaequalis*, have been reported to visit the flowers (Grevillius and Kirchner 1923, Heinrich 1976, Lovell and Lovell 1935, Reader 1977, Small 1976, Warming 1908). The flowers are also visited by many other insects including flies (order Diptera), butterflies (order Lepidoptera), and beetles (order Coleoptera). Plants contain a toxic substance called andromedotoxin (Kingsbury 1964), which can be fatal and probably keeps deer (*Odocoileus* spp.) from browsing it (Pellerin et al. 2006). Reductions in its habitat (e.g., bogs) may explain its declining abundance in sections of the region, though it appears to be maintaining its presence.



Distribution of *Chamaedaphne calyculata*, or leatherleaf, recorded in the New York Metropolitan Region during three time categories.



A) Flowering twig with leaves, enlarged view of leaf underside, flowers, and previous year's fruit; B) flower and cross-section of flower; C) stamens; D) pistil with cross-section showing ovules; and E) dehisced fruit (capsule) of *Chamaedaphne calyculata*. Illustration by Bobbi Angell.

C

Chimaphila Pursh – pipsissewa, wintergreen, wax flower

Ericaceae. Half shrubs (low-growing shrubs). Species 4 in Asia, Central America, Europe, North America, and the West Indies. Fire-intolerant; generally found in mid- to late successional forests. Abundance highest when canopy cover is light to moderate. In *Chimaphila maculata*, bumble bees (*Bombus* spp.) are the most important pollinators, but the flowers are also visited by staphylinid beetles (family Staphylinidae) (Barrett and Helenurm 1987, Knudsen and Olesen 1993), and there is a small amount of self-pollination (Barrett and Helenurm 1987). Capsules have large numbers of tiny seeds (Barrett and Helenurm 1987, Copeland 1947) that are wind dispersed. Leaves reported to have antibacterial properties (Copeland 1947). The plants have also been used as diuretics and to treat rheumatism and fever (Krüssmann 1984). Widely used by Native American tribes for food and medicinal purposes (Moerman 1998, Sheth et al. 1967). Genus name is derived from the Greek "cheima" ("winter") and "philien" ("loving"), in reference to its evergreen habit.

Native Species

1. *Chimaphila maculata* (L.) Pursh – spotted wintergreen, waxflower ↑

Pyrola maculata L.

Flowering June–July. Common in xeric coniferous, deciduous, or mixed woods, usually in sandy soils. Epithet refers to the variegated leaves, "macula" meaning "blotch" in Latin.

2. *Chimaphila umbellata* (L.) W.P.C.Barton – prince's pine, pipsissewa ↓↓

Pyrola umbellata L.

Flowering June–July. Xeric, usually coniferous, forests; in sandy soils.

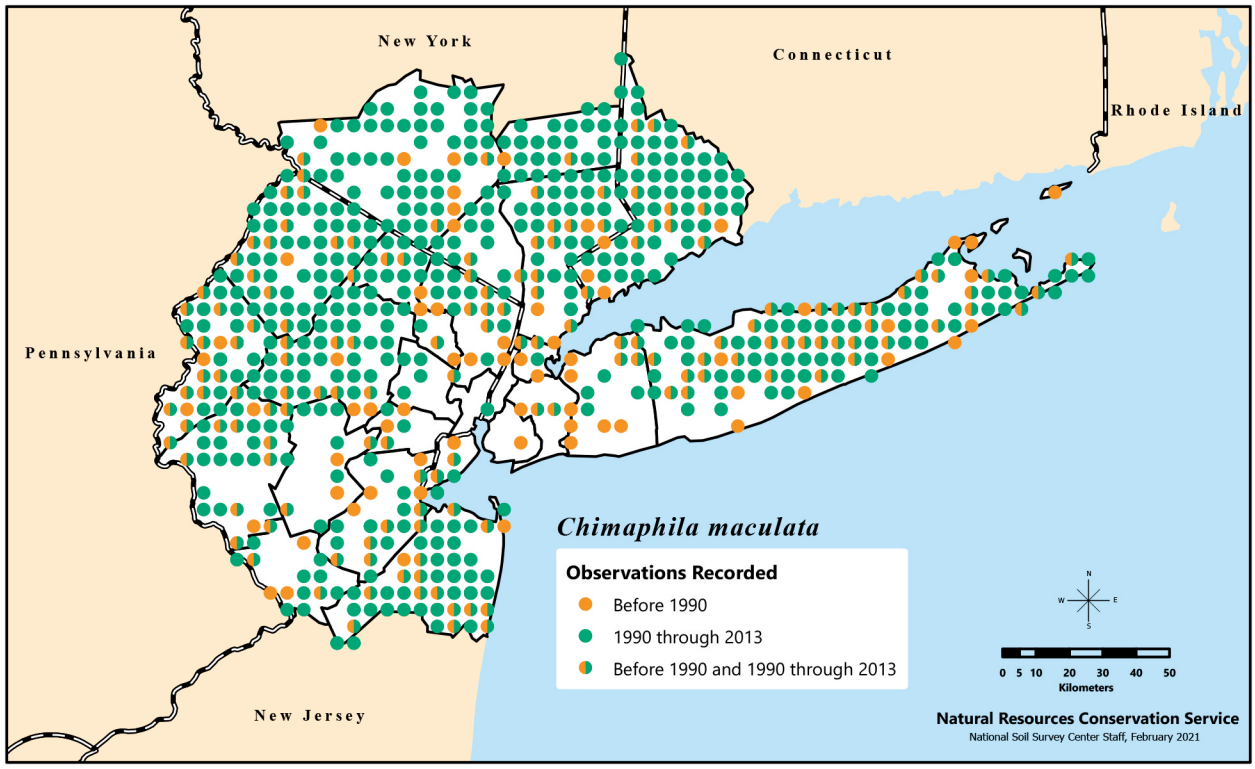
Based on Freeman's (2009; see also Takahashi 1986, 1987) infraspecific treatment, which recognizes only 2 subspecies, material in the region would be referable to *Chimaphila umbellata* (L.) W.P.C.Barton subsp. *umbellata*. Local material differs from the other recognized subspecies, *C. umbellata* subsp. *domingensis* (S.F.Blake) Dorr from the West Indies (Hispaniola; see Dorr 1995), in having ciliate filaments and larger leaves. Earlier studies (Blake 1917) have recognized up to 5 subspecies (or varieties) of *C. umbellata* in the southwestern U.S. and eastern North America, and *C. umbellata* subsp. *umbellata* in Asia and Europe. In these finer treatments, our local material (*C. umbellata* var. *cisatlantica*) is distinguished from the other subspecies on the basis of its taller habit (to 30 cm); strongly veined abaxial blade surfaces; flowers in racemose corymbs, sepal lobes being broader than long; and shorter capsules (only to 6 mm).

Management

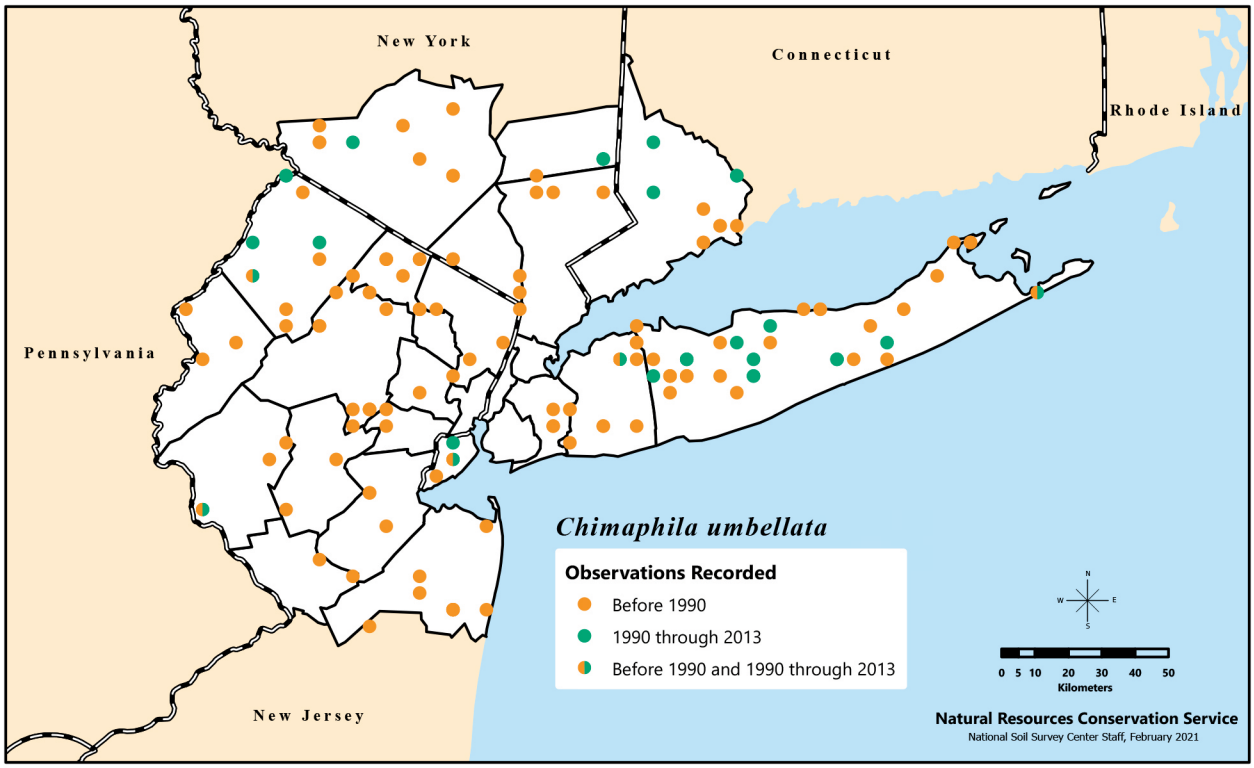
Currently, *Chimaphila maculata* is common, whereas *C. umbellata* is rather rare, even though earlier manuals (e.g., Britton 1889, Stone 1911, Taylor 1915) regarded both species as common in the region. The recent decline of *C. umbellata* compared to *C. maculata* may be due to more extensive deer browse. Deer appear to avoid *C. maculata* (Rawinski 2014), which is often found in woodlands that show heavy deer browse. In contrast, *C. umbellata* is found most commonly in areas with less deer browse or in areas where

Chimaphila Key

1. Blades lanceolate, adaxial surface variegated with white; base rounded (cuneate); dilated portion of filament villous . . . . . ***Chimaphila maculata***
1. Blades oblanceolate, not variegated with white, base cuneate; dilated portion of filament ciliate . . . . . ***Chimaphila umbellata***



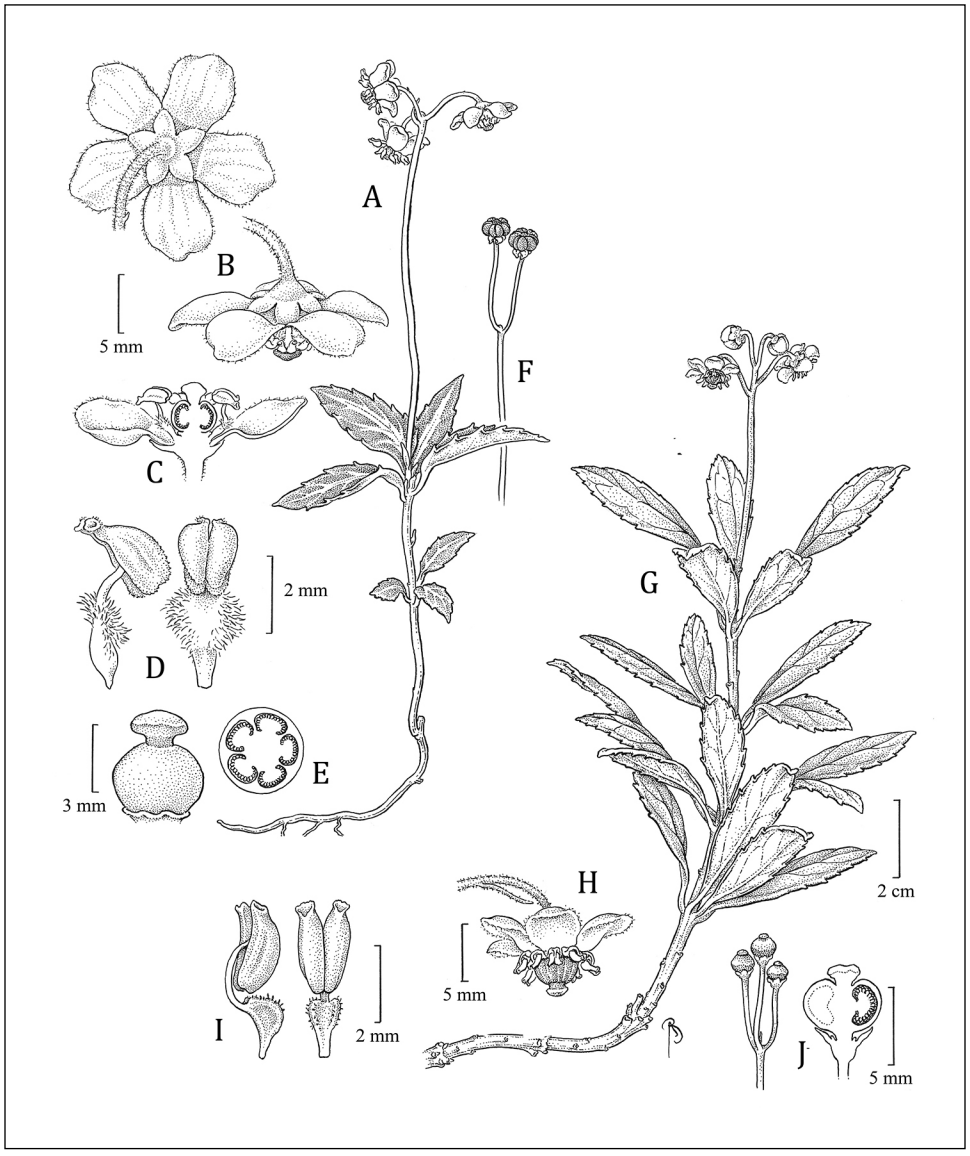
Distribution of *Chimaphila maculata*, called spotted wintergreen or waxflower, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Chimaphila umbellata*, called prince's pine or pipsissewa, recorded in the New York Metropolitan Region during three time categories.

deer may not be able to reach it (e.g., cellar holes). *Chimaphila maculata* has thicker leaves and may have higher concentrations of several chemical components (i.e., salicylate compounds) than *C. umbellata*. These chemical compounds may serve as a deer deterrent and provide medicinal uses, including taraxerol, ursolic acid, hyperoside, and chimaphilin (Minore 2008). The third North American species, *C. menziesii* (R.Br.) Spreng., is also affected by deer browse (Daufresne and Martin 1997, Stockton and Bobechko 2002, Stockton and Buttler 2000).

Due to their small size, seeds are difficult to collect when mature and optimal storage conditions are not known. Furthermore, *Chimaphila* seedlings are seldom found in nature (Holm 1927); therefore, much regeneration must be accomplished through the growth of underground rhizomes. *Chimaphila* spp. may be partial root parasites (Kruckeberg 1982).



A) Plant with leaves and flowers, B) flowers, C) cross-section of flower, D) stamens, E) pistil and cross-section of pistil, and F) separate fruiting twig of *Chimaphila maculata*; G) plant with leaves and flowers, H) flower, I) stamens, and J) pistil and cross-section of pistil of *Chimaphila umbellata*. Illustration by Bobbi Angell.

Chionanthus L. – fringe-tree

Oleaceae. Shrubs, small trees. Species 150 mainly from the subtropics and tropics; a few temperate species, including one in North America. Flowers perfect (but with minute calyx), conspicuous, and white in drooping panicles (Gleason and Cronquist 1991). Genus name is derived from the Greek "chion" ("snow") and "anthos" ("flower"), a reference to the white flowers.

Native Species

1. *Chionanthus virginicus* L. – white fringe-tree Ø

Flowering May. Height at maturity up to 10 m. Rich upland woods and along streams. Native to central and eastern U.S. as far south as FL, but grows well in cold climates, including as far north as ME and MN; USDA Hardiness Zones 3–9 (Gilman and Watson 1993). Native in mesic and wetland habitats in southern NJ adjacent to the region; confirmed escaped population in the region from Somerset County (NJ). In NY, historical possibly naturalized population reported from Nassau (1976) and Queens (1903) Counties; recent possibly naturalized populations reported from Rockland (1990) and Orange Counties (1990). Not reported from CT. Functionally dioecious; pistils of infertile flowers much smaller than those of the fertile flowers, with the infertile flowers functioning as males. Fruit a dark-blue drupe that matures in the fall but may remain on the tree through winter (Gleason and Cronquist 1993, Gilman and Watson 1993, Peterson and Cipollini 2017). Susceptible to the invasive emerald ash borer (EAB; *Agrilus planipennis*) (Peterson and Cipollini 2017).

Clematis L. – clematis

Atragene L.; *Viticella* Moench; *Viorna* Spach non (Persoon) Reichenb.

Ranunculaceae. Mostly vines; some shrubs and herbs. Species 300–325 worldwide; greatest diversity in Asia. Flowers lack true petals, the sepals (and in some cases staminodes) being petaloid. Plumose style persistent on achene, aiding in wind dispersal (Grey-Wilson 2000). Likely to be pollinated by bumble bees (*Bombus* spp.) and hover flies (family Syrphidae); though outcrossing is more common, many species may reproduce by geitonogamy (fertilization from pollen from a different flower on the same plant) or autonomous (without a vector pollinator) self-fertilization (Redmond and Stout 2018). Genus name (derived from the Greek "clema," meaning "shoot") first used by the Greek physician Pedanius Dioscorides (A.D. ca. 40–ca. 90) for a climbing plant; later applied to this genus by Linnaeus (1753). The herbaceous *Clematis ochroleuca* historically reported (1800s, 1900s) from Staten Island and Long Island; last known reports were from the 1950s (Moore 2020).

Native Species

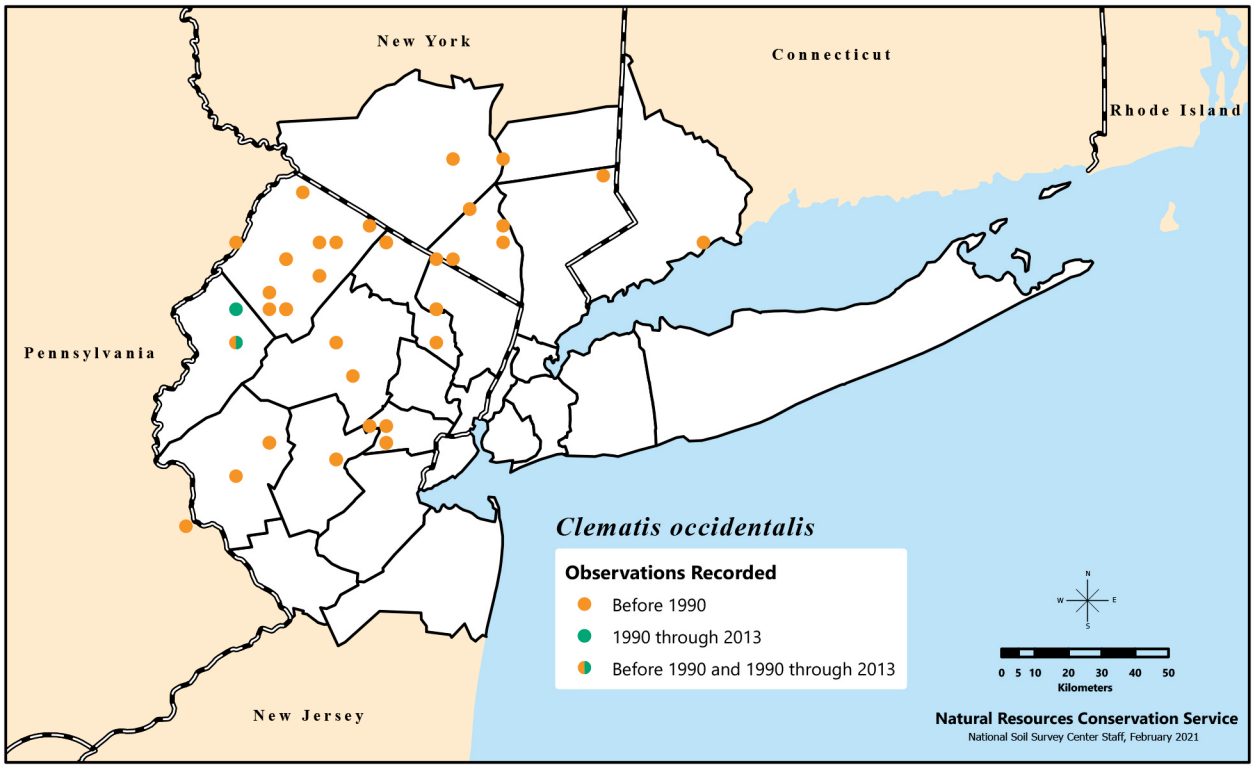
1. *Clematis occidentalis* (Hornem.) DC. – mountain clematis ↓↓↓

Atragene occidentalis Hornem.; *Clematis verticillaris* DC.

Flowering May–June. Rocky woodlands and woodland edges, ledges, and slopes, often on limestone. Material in the region referable to *Clematis occidentalis* var. *occidentalis*.

Clematis Key

1. Perianth campanulate; petaloid staminodes present between sepals and stamens (*Clematis* subg. *Atragene* (L.) Torrey & A.Gray) . . . . . ***Clematis occidentalis***
1. Perianth rotate; petaloid staminodes absent 2
2. Infloresence (3)5-many flowered; sepals white-cream (*C.* subg. *Clematis*) 3
2. Infloresence 1-3-flowered; sepals blue-violet (*C.* subg. *Viticella* (Dill. ex Moench) Kenner & W.M.Dennis) . . . . . ***Clematis viticella****
3. Leaflets 3, margins dentate to serrate; flowers unisexual. . . . . ***Clematis virginiana***
3. Leaflets 5 (sometimes 3), margins mostly entire; flowers bisexual . . . . . ***Clematis terniflora****



Distribution of *Clematis occidentalis*, or mountain clematis, recorded in the New York Metropolitan Region during three time categories.

Flowers are solitary (Gleason and Cronquist 1993). A northern and high-elevation species showing considerable decline in the region. Though widespread, it has never been abundant. Extreme decline may be because of its preference for alkaline soils, which may decrease habitat availability, and because all *Clematis* spp. are a preferred food of deer (*Odocoileus* spp.) (Masters et al. 2012). Not known to be cultivated.

Tracked as imperiled in NJ (S2).

2. *Clematis virginiana* L. – virgin's-bower ↑↑

Flowering late July–early Sept. Streambanks and mesic open areas. Although *C. virginiana* has mostly five leaflets and *C. terniflora* has three or even just one, *C. virginiana* can also have three leaflets. However, *C. virginiana*'s anthers are less than 1.5 mm; those of *C. terniflora* are between 1.5 and 3 mm long (Gleason and Cronquist 1993). Cultivated since 1720 (Dirr 1997). Though this species suffers from deer browse like most *Clematis* spp. (Fargione et al. 1991), it may not be a preferred food (Mosbacher and Williams 2009), which may explain its apparent increase compared to *C. occidentalis*.

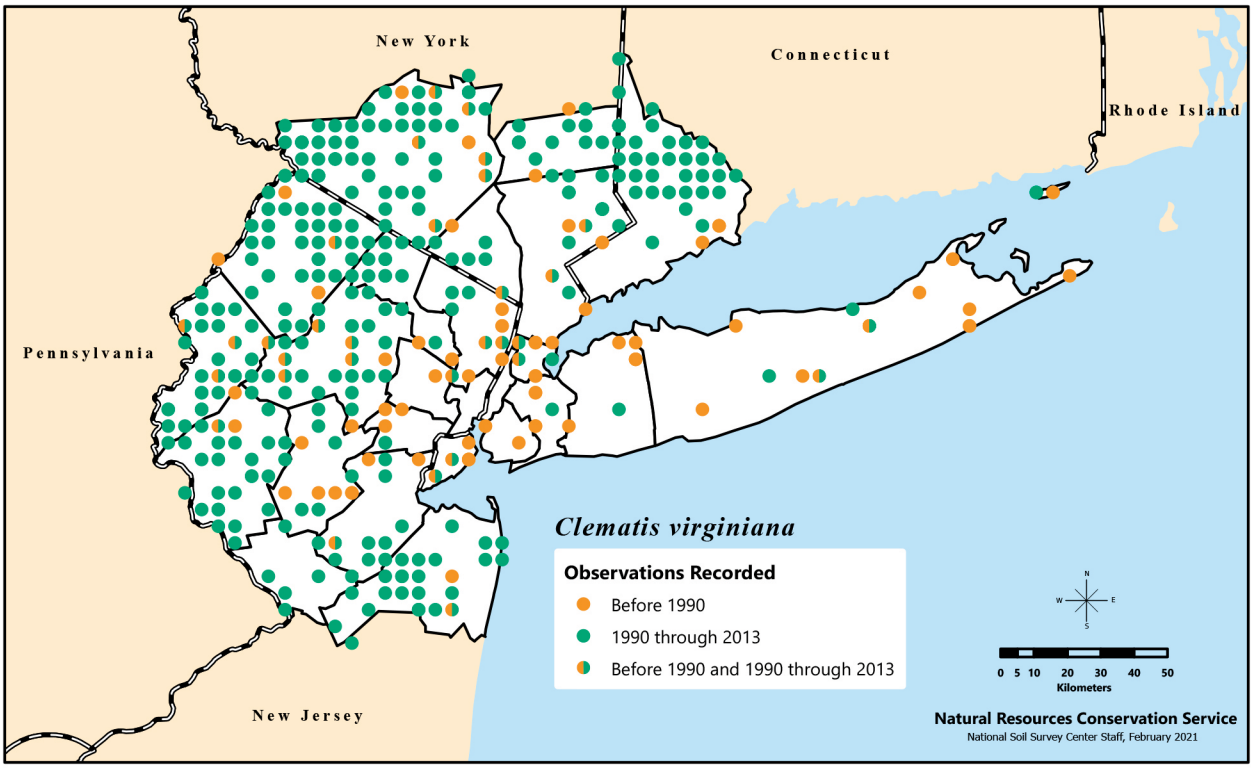
Nonnative Species

3. *Clematis terniflora* DC. – sweet autumn clematis ↑↑↑

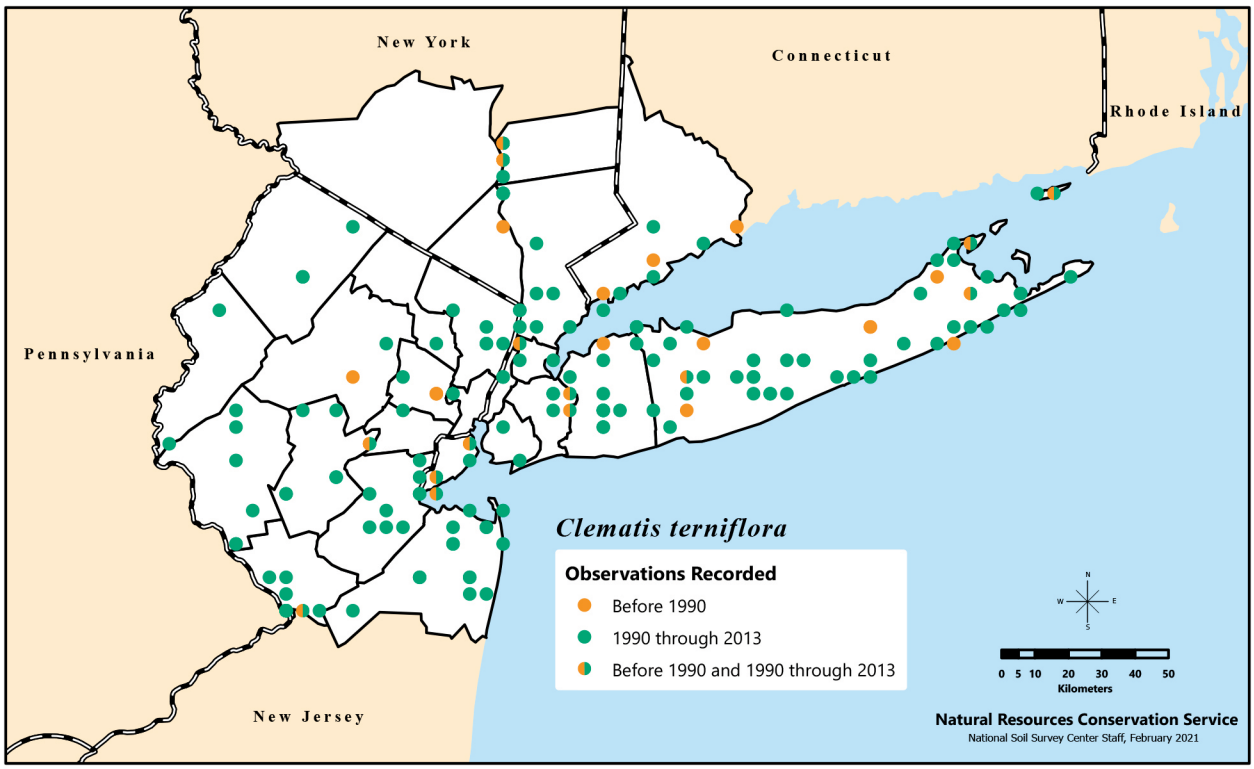
Clematis dioscoreifolia H.Lév. & Vaniot; *Clematis maximowicziana* Franch. & Sav.; *Clematis paniculata* Thunb. non J.F.Gmel.

Flowering July–Sept. Dry to mesic woodlands, roadsides, and disturbed open areas. Species similar in appearance to native *Clematis virginiana*. Native to Asia (e.g., Japan).

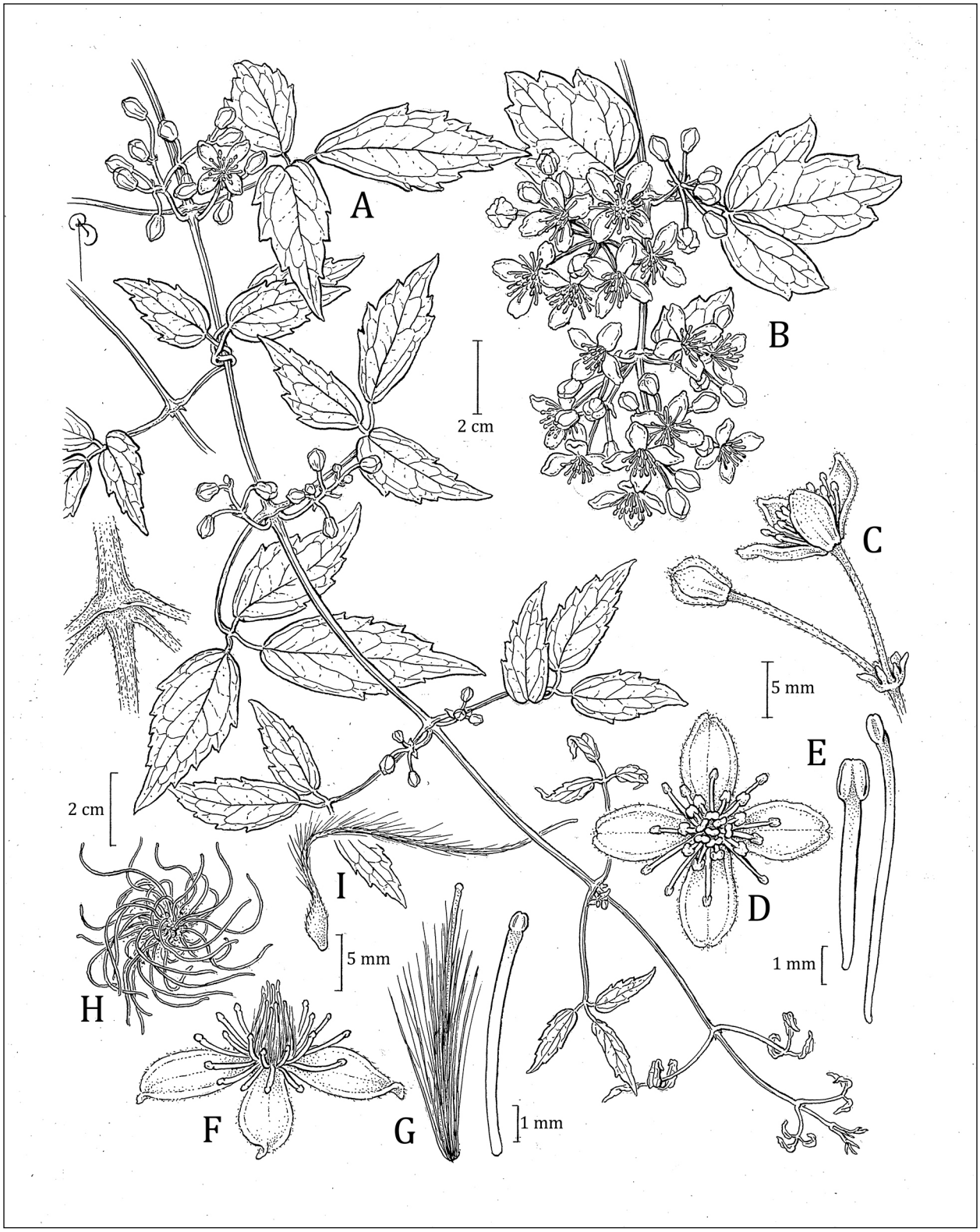
A semi-evergreen vine (Bensley 2006) that was first introduced into the U.S. in 1864 (Dirr 1998) or in 1877 (Spingarn 1935). Most closely related to members of the subgenus *Flammula*, which also contains species originating from the Mediterranean coast (Miikeda et al. 2006). May be differentiated from native species in that some of its flowers are bisexual and its leaves are entire (Gleason and Cronquist 1993, Haines



Distribution of *Clematis virginiana*, or virgin's-bower, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Clematis terniflora*, or sweet autumn clematis, recorded in the New York Metropolitan Region during three time categories.



A) Stem with leaves and buds; B) stem with leaves and male flowers; C) male flower and bud; D) male flower; E) stamens; F) female flower; G) styles, one mature and plumose; H) cluster of pistils in fruit; and I) achene with attached pistil of *Clematis virginiana*. Illustration by Bobbi Angell.

2011). Used for medicinal purposes, including treatment of rheumatoid arthritis (Zhang et al. 2007a). However, though many other *Clematis* spp.'s ethnopharmacological compounds have been documented and *C. terniflora* is traditionally used as a medicinal plant, medicinal claims have not been evaluated for this species (Chawla et al. 2012). Can be very aggressive and capable of engulfing structures (Dirr 1998). Prefers full sun to partial shade but may thrive and flower in very shady conditions, in contrast to many other *Clematis* spp. (Missouri Botanical Garden, n.d.). Sporadic flowering may occur all year (Langeland and Meisenburg 2009). Best propagated by seeds, which are relatively large with a plume. Seeds dispersed by wind, though the large seed size may limit long-distance dispersal. Found as far west as NE and as far south as FL (Langeland and Meisenburg 2009). There is evidence of the spread of this species in the region (Clemants and Moore 2005). Information on the seed bank and potential hybridization with other *Clematis* spp. is lacking. The variety *terniflora*, sometimes called var. *robusta*, is more vigorous (Bensley 2006). This variety may be the noted invasive species, while other varieties may be less aggressive, possibly explaining why some people seemingly have trouble growing this species (i.e., getting it to flower) and others cannot control its growth (Internet Brands 2014).

Tracked as invasive in NJ (category 1) and listed as invasive in NY (category 1 and regulated).

Two other nonnative *C.* subg. *Clematis* spp., *C. recta* L. (native to Asia and Europe) and *C. vitalba* (native to northern Africa and Europe; keyed), have been reported outside the region and could be encountered. *Clematis recta* is herbaceous and is ascending (not a vine).

Clematis viticella L. (native to Europe; keyed) and *C.* ×*jackmanii* T.Moor (*C. lanuginosa* Lindl. × *C. viticella*) are cultivated and may escape. They are readily distinguished by their large flowers (to 5 cm across in *C. viticella*, 14 cm in *C.* ×*jackmanii*).

Management

Successful management of *Clematis terniflora* has been achieved using herbicide treatment with limited control after only one treatment; multiple treatments are likely to be required (Langeland and Meisenburg 2009). The relatively short-distance dispersal (though long-distance dispersal has been documented via the movement of mulch infested with *C. terniflora* seed [Langeland and Meisenburg 2009]) suggests that it may also be possible to control this species by simply cutting it back as it attempts to spread beyond an area where it is locally abundant (Dirr 1998). Given the potential rapid rate of growth of this species and the need for multiple herbicide treatments or relatively constant pruning to keep it from spreading, it is advisable not to purchase and plant *C. terniflora*. There are several other less problematic *Clematis* spp., including native species, that would produce equally desirable garden plants.

C

Clethra L. – pepperbush

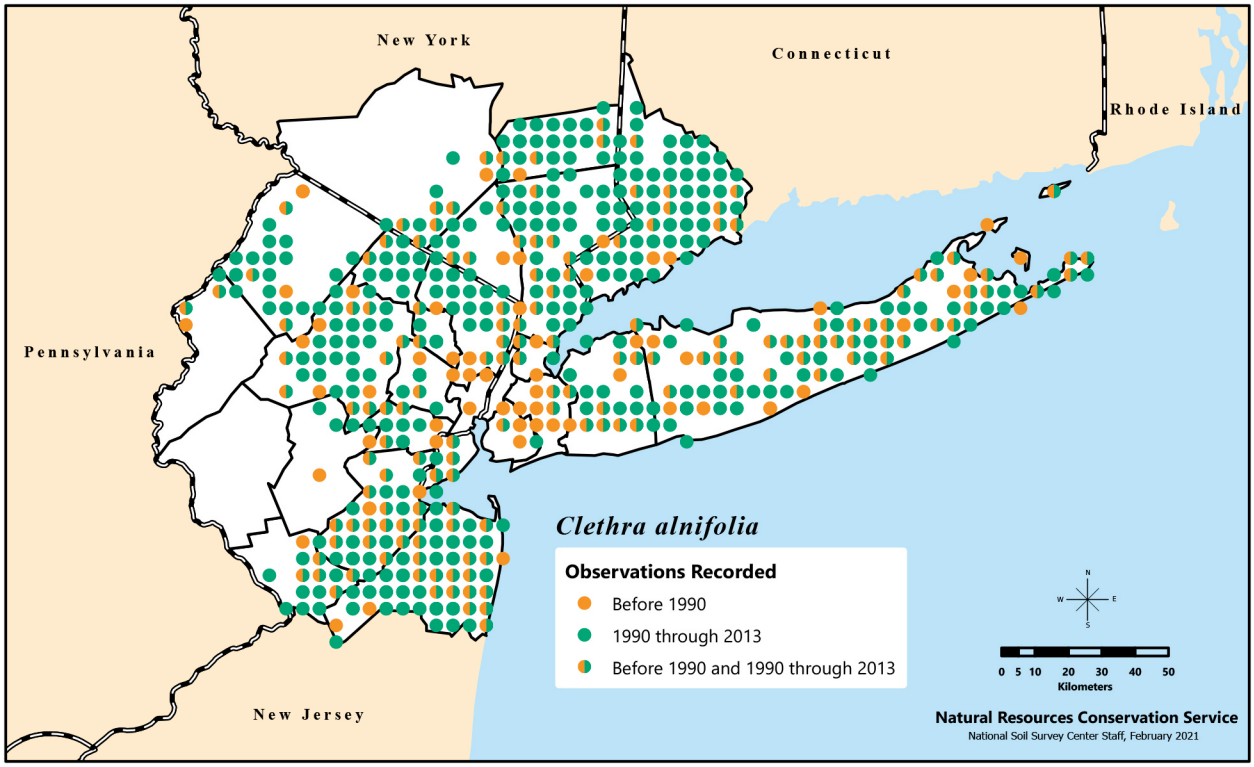
Clethraceae (Cyrillaceae s.l.). Shrubs, small trees. Species 80+, mostly tropical, in Asia, Madeira, North America (1), and South America. Genus name is the ancient Greek name for alder (*Alnus*), later applied to this genus due to the similar leaves.

Native Species

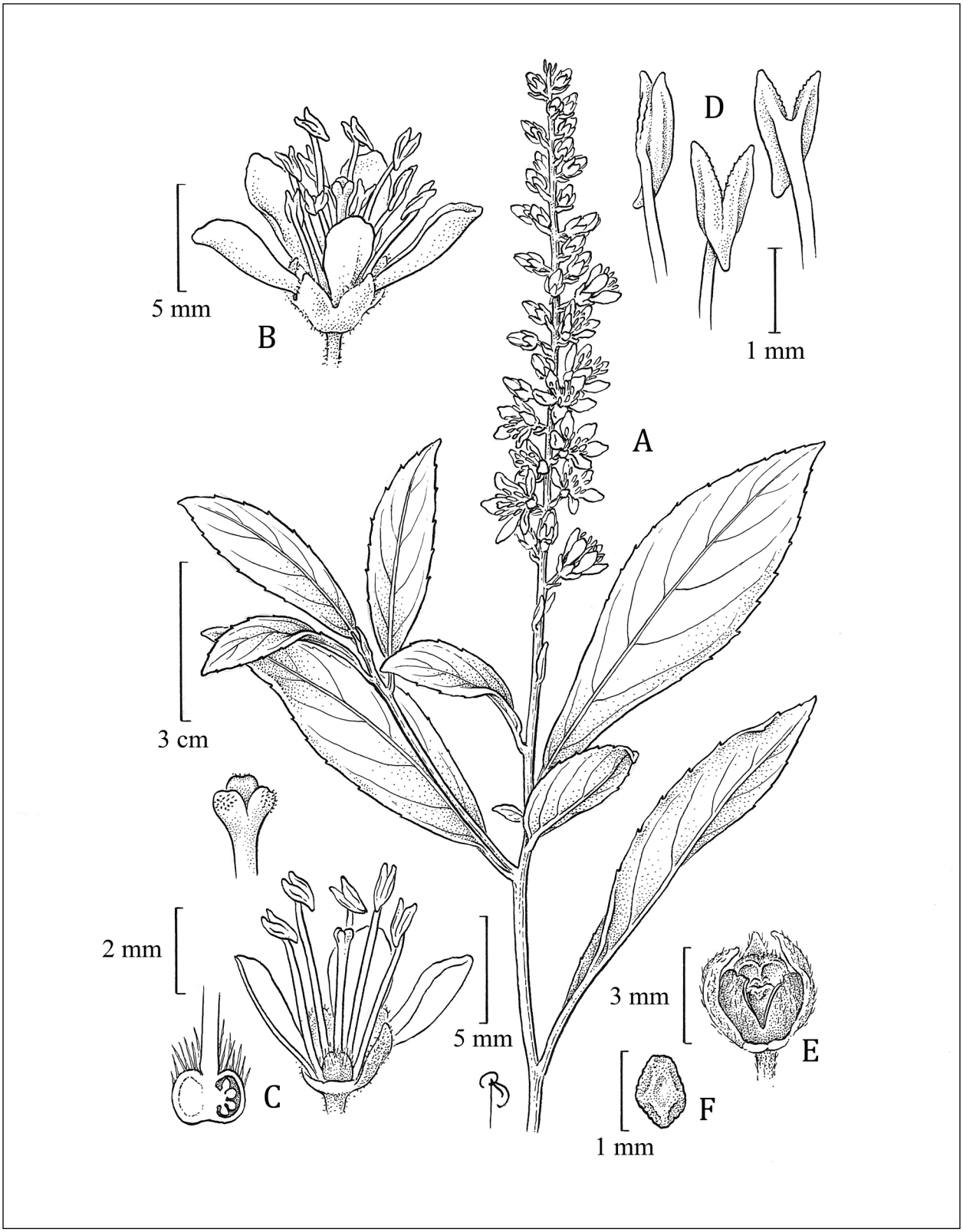
1. *Clethra alnifolia* L. – sweet pepperbush ↔

Flowering late June–early Sept. Wet woods, swamps, thickets, marshes, swales and bogs, lake shores, stream edges, rocks in water, pine-barren shrub swamps, coastal plain poor fens, red maple-hardwood swamps, inland Atlantic white cedar swamps, and coastal plain Atlantic white cedar swamps. Grows in wet sphagnum peat and occasionally dry upland peat at swamp margins; optimal soil is very acidic (pH about 4.5) (Edinger et al. 2014, Wherry 1920). Good plant for shady and wet areas with acidic soil, though it can grow in full sun. Can withstand salty conditions (Dirr 1998). Epithet from Latin refers to similarity of the leaves to those of *Alnus* (alder).

One of the most characteristic shrubs of the region. The sweet-smelling flowers are visited by over 100 insect species; most common visitors are *Apis mellifera*, *Bombus impatiens*, and *Cantharis nigricans* (a beetle), though the beetle is probably not a pollinator. Roads and similar corridors may serve as barriers to bumble bee movement for this species (Bhattacharya et al. 2003). Despite both high seed production and germination rates, high seedling mortality in one NJ wetland forest study made this species rely on clonal growth (Jordan and Harman 1995). Saponins produced by this species are often the cause of the occasionally large amounts of foam floating on streams and rivers, especially below dams, where this species is located. Cultivated since 1731, with at least 15 cultivars. Honey made from *Clethra* flowers is considered of high quality (Stricker 1946). Virtually pest-free (Dirr 1998). Much overlap between newer and older populations; hence its apparent stability.



Distribution of *Clethra alnifolia*, or sweet pepperbush, recorded in the New York Metropolitan Region during three time categories.



A) Twig with leaves and flowers; B) flower; C) flower with some petals removed showing stamens and pistil; cross-section of ovary showing ovules; and stigma; D) top portion of stamens showing anthers and upper portion of filaments; E) capsule; and F) seed of *Clethra alnifolia*. Illustration by Bobbi Angell.

C

Comptonia L'Hér. – sweet fern

Myricaceae. Shrub. Species 1 in North America. Many other species present in Europe and North America during Eocene (Berry 1906, Chourey 1974). Distinguished from *Myrica* L., within which it was sometimes included, by its pinnatifid leaves with stipules and bracteoles much exceeding the waxless fruit. Like *Alnus*, *Morella*, and *Myrica*, nitrogen fixation occurs through an association of the roots with the actinobacteria *Frankia* spp. (Callaham et al. 1978). Genus name honors Henry Compton (1632–1713), horticulturist and Bishop of Oxford and London.

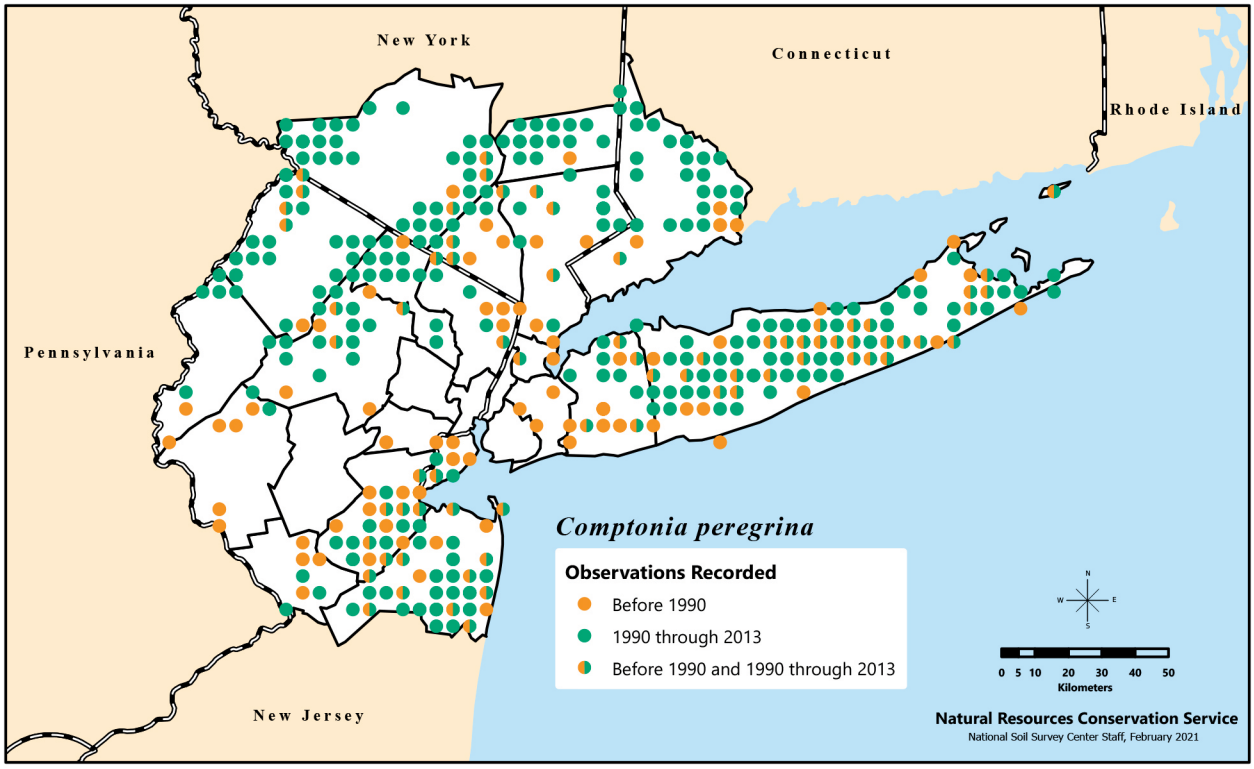
Native Species

1. *Comptonia peregrina* (L.) J.M.Coult. – sweet fern ↔

Liquidambar peregrina L.; *Liquidambar aspleniifolia* (L.) L.; *Myrica aspleniifolia* L.; *Myrica peregrina* (L.) Kuntze; *Myrica peregrina* var. *aspleniifolia* (L.) Fernald

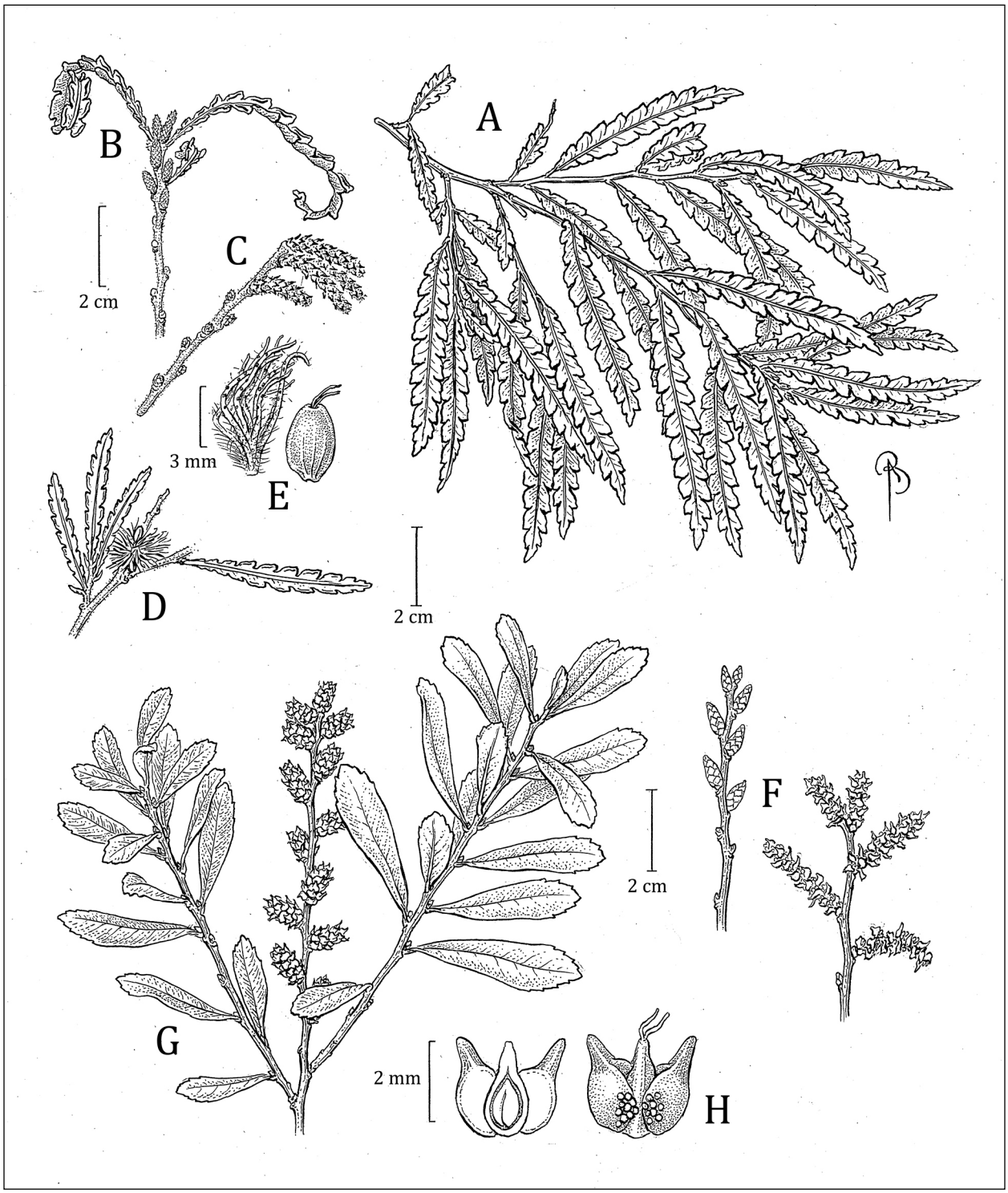
Flowering Apr.–May. Open woodlands, often pinelands, on dry, sandy to rocky soils. Epithet means "foreign" or "strange," an indication the species was unusual to Linnaeus, and no doubt why he struggled with its generic placement (see discussion below).

Usually dioecious; rarely monecious. Aromatic; used by Native Americans for tea, incense, and various medicinal purposes (Lewis and Epstein-Lewis 2003, Moerman 1986). Curiously, Linnaeus (1753) placed this species under two genera, *Liquidambar* L. and *Myrica* L. (under the names *L. peregrina* and *M. aspleniifolia*), later (1759) recognizing them both not in *Myrica* but in *Liquidambar*. Linnaeus' two entities are sometimes recognized as distinct varieties of this species, *C. peregrina* var. *peregrina* and *C. peregrina* var. *aspleniifolia* (L.) Fernald, the latter with less pubescence; smaller leaves, female catkins (less than 1.5 cm diameter), and nutlets (less than 4 mm); and limited to the Coastal Plain from VA to Long Island (Fernald 1938). Forms extensive colonies; seeds may remain viable in a seed bank for up to 70 years (Del Tredici 1977). Alternate host of sweetfern blister rust (*Cronartium comptoniae*), which harms some



Distribution of *Comptonia peregrina*, or sweet fern, recorded in the New York Metropolitan Region during three time categories.

Pinus spp. (Del Tredici 1996). Increases appear to be related to elevation differences; this species is more likely to increase at elevations greater than 20 m and where sandy, gravelly, infertile soils may be more common. However, this species has decreased similarly in other locations. Cultivated since 1714 (Dirr 1997).



A) Twig with leaves, B) twig with female catkins, C) twig with male catkins, D) fruiting twig, and E) bur and seed of *Comptonia peregrina*; F) male and female catkins, G) fruiting twig, and H) fruit in cross-section, showing the seed and two thickened bracts, and fruit with resin-dots of *Myrica gale*. Illustration by Bobbi Angell.

C

Corema D.Don – broom crowberry

Ericaceae s.l. (Empetraceae). Dwarf shrubs. Species 2: Europe 1 (Azores, Iberia) and North America 1. Genus name from Greek means "broom," a reference to the bushy appearance of the plant.

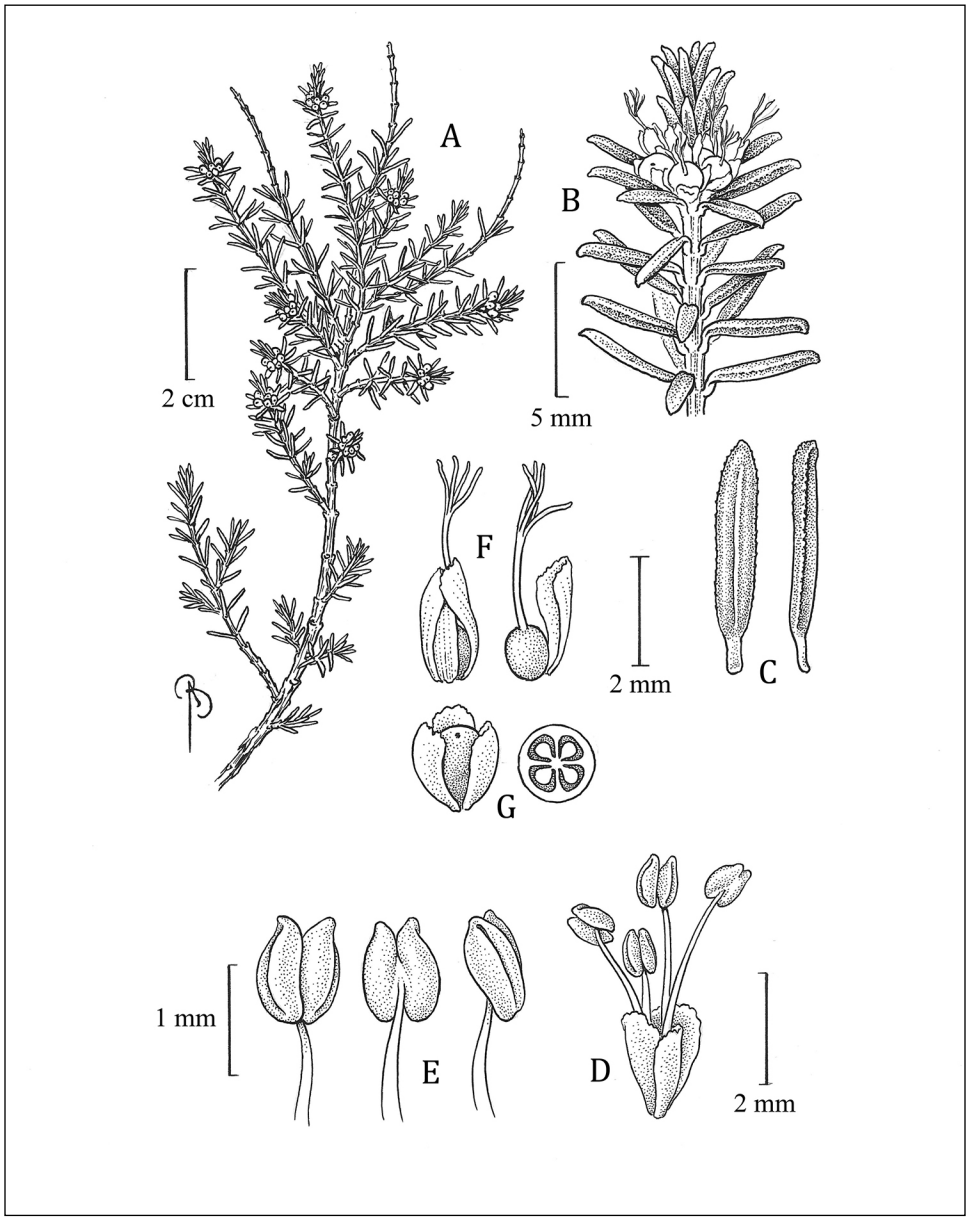
Native Species

1. *Corema conradii* (Torr.) Torr. – broom crowberry Ø

Empetrum conradii Torr.

Flowering late Feb.–mid-Apr. Sandy dry open areas. Extant farther south in the NJ Pine Barrens in adjacent Burlington and Ocean Counties. Epithet honors Solomon White Conrad (1779–1831), botany professor at the University of Pennsylvania, whom John Torrey credited with the discovery of the species.

Listed as endangered in NJ (S1) and NY (S1). Known only historically from the region from Nassau and Suffolk Counties (NY); Stone (1911) also reported it from Monmouth County (NJ).



A) Fruiting leafy twig, B) tip of fruiting leafy twig, C) leaves, D) male flower, E) stamens, F) female flower showing pistil, and G) ovary (inside sepals) and cross-section of ovary showing ovules of *Corema conradii*. Illustration by Bobbi Angell.

Cornus L. – dogwood

Arctocrania (Endl.) Nikai *Benthamidia* Spach; *Cynoxylon* (Raf.) Small; *Bothrocaryum* (Koehne) Pojark.; *Chamaepericlymenum* Hill; *Dendrobenthamia* Hutch.; *Swida* Opiz; *Thelycrania* (Dumortier) Fourreau

Cornaceae. Trees, shrubs. Species 45–60 in Africa, Australia, Europe, North America, and South America. Many species cultivated for their showy flowers or fruit (or both). Considerable diversity in the flowers and fruits, the subgenera here (see also Murrell and Poindexter 2006) sometimes recognized as distinct genera. Flowers visited by numerous insects including *Andrena*, *Apis*, and *Bombus* spp. (Gunatilleke and Gunatilleke 1984, Hall and Sibley 1976, Lovell 1898). Seeds dispersed primarily by birds (Borowicz 1988, Borowicz and Stephenson 1985, Burger 1987, Drummond 2005, Hoyt 1957, Johnson et al. 1985) although one study found *Cornus* seeds had considerable injury and poorer germination after passage through birds (Krefting and Roe 1949). Genus name is derived from Latin "cornu," meaning "horn," a reference to the hard wood. The following hybrids have been reported: *C.* ×*acadiensis* Fernald (*C. alternifolia* × *C. sericea*); *C.* ×*arnoldiana* Rehd. (*C. amomum* var. *schuetzeana* × *C. racemosa*); *C.* ×*friedlanderi* W.H.Wagner (*C. rugosa* Lam. × *C. racemosa*

Cornus Key

1. Short shrubs, less than 3 m tall; cymes subtended by 4 showy petaloid bracts (*C.* subg. *Arctocrania* (Endl.) Reichb.; *Chamaepericlymenum*). . . . . ***Cornus canadensis***
1. Shrubs 3 m or taller; cymes with or without showy petaloid bracts 2
2. Cymes subtended by 4 showy-petaloid bracts; fruit red (rarely yellow in *Cornus florida*) 3
2. Cymes not subtended by showy bracts; fruit white, blue, blackish, or red 4
3. Bracts apices rounded; fruit simple 1- or 2-seeded drupes (*C.* subg. *Cynoxolon* (Raf.) Raf.; *Benthamidia*) . . . . . ***Cornus florida***
3. Bract apices acuminate; fruit multiple, each cyme's drupes fused together (*C.* subg. *Syncarpea* (Nakai) Q.Y.Yang; *Dendrobenthamia*) . . . . . ***Cornus kousa****
4. Leaves alternate; fruit elliptical, blackish, with a waxy bloom; stones pitted at apex (*C.* subg. *Mesomora* Raf.; *Bothrocaryum* (Koehne) Pojark.). . . . . ***Cornus alternifolia***
4. Leaves opposite; fruit elliptical or globose, white, blue, blackish, or red; stones not pitted at apex 5
5. Cymes axillary, subtended by yellowish-green bracts; fruit elliptical, red (*C.* subg. *Cornus*) . . . . . ***Cornus mas****
5. Cymes terminal, ebracteate; fruit globose, white or blue (*C.* subg. *Kraniopsis* Raf. [=*C.* subg. *Thelycrania* (Dumort.) C.K.Schneid.; *Swida*; *Thelycrania*]) 6
6. Fruit black (rarely green) . . . . . ***Cornus sanguinea***
6. Fruit white or blue 7
7. Cymes elongated, convex, paniculate; fruit white . . . . . ***Cornus racemosa***
7. Cymes not elongated, flat or rounded; fruit white or blue 8
8. Pith brown; sepals 1–2 mm, styles dilated distally; fruit blue . . . . . ***Cornus amomum***
8. Pith white; sepals to 1 mm, styles not dilated distally; fruit white or blue 9
9. Twigs greenish (sometimes streaked with purple); leaves ovate to rotund, larger ones with 6–8 lateral veins on each side, abaxial surface; fruit blue . . . . . ***Cornus rugosa***
9. Twigs bright red to purplish; leaves ovate to lanceolate, larger ones with 3–4(5) lateral veins on each side, abaxial surface glabrous to finely pubescent; fruit blue 10
10. Leaves glaucous and finely pubescent beneath; cymes flat, axes pubescent, anthers cream; fruit white. . . . . ***Cornus sericea***
10. Leaves not glaucous, glabrous beneath; cymes rounded, axes glabrous, anthers blue; fruit blue . . . . . ***Cornus foemina***

Lam.); *C.* ×*slavinii* (*C. rugosa* × *C. sericea*); *C. amomum* × *C. foemina*; *C. foemina* × *C. racemosa*.

Native Species

1. *Cornus alternifolia* L.f. – pagoda dogwood ↑

Shrub, rarely small tree. Flowering May–June. Rich upland woodlands, woodland edges. Taxonomically close to *Cornus controversa* Hemsl. (occasionally cultivated but not known to escape) from Asia; the two species differ only in leaf bases (cuneate in C. *alternifolia*, rounded in *C. controversa*) and pubescence of abaxial leaf surfaces (diverging hairs in *C. alternifolia*, parallel in *C. controversa*). These two species are the only two grouped in *C.* subg. *Mesomora* and represent the only *Cornus* sp. with alternate leaves.

Height at maturity 5–8 m (Brinkman and Vankus 2008). Introduced in 1760, with at least 1 cultivar in the U.S. and at least 4 others not likely to be found in the U.S. (Dirr 1997). Increases may be related to reforestation.

2. *Cornus amomum* Mill. – silky dogwood ↑↑

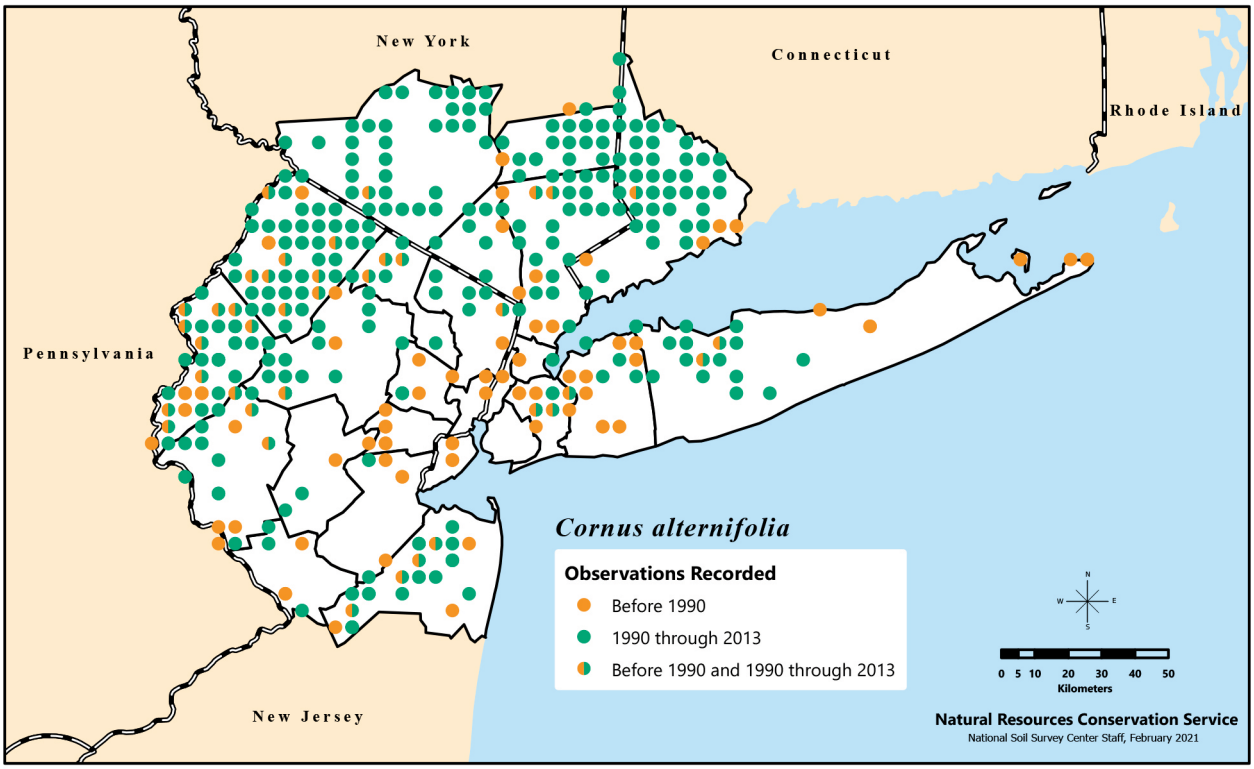
Shrub. Flowering late May–July. Wet woodlands, woodland edges, marshes, and meadows. Epithet was the Latin for odoriferous shrubs (such as black cardamom), which does not apply to this species. Two varieties.

Earliest seed-bearing age 4–5 years (Brinkman and Vankus 2008). Height at maturity 3 m. Cultivated since 1658 (Dirr 1997). Increases may reflect increases in wet habitat types. Most material in the region referable to typical variety.

Cornus amomum var. *scheutzeana* reported only from NJ, where it is listed as endangered (S1), from Sussex and Warren Counties (Snyder 2000: 16–17).

3. *Cornus canadensis* L. – bunch berry ↓↓↓

Half shrub (low-growing shrub). Flowering late May–July. Mesic woodlands, woodland edges, and boggy areas on acid soils. Besides North America, also native to Asia (China, Japan, Korea, Myanmar, Russia's Far East). Very shade-tolerant.



Distribution of *Cornus alternifolia*, or pagoda dogwood, recorded in the New York Metropolitan Region during three time categories.

Cornus amomum Mill. Key

1. Leaves rounded at base,
   green beneath with russet pubescence . . . . . .***Cornus amomum* Mill. var. *amomum***
1. Leaves cuneate at base, glaucous beneath
   with white pubescence . . . . . .***Cornus amomum* var. *scheutzeana* (C.A.Meyer) Rickett**

C

Germination is enhanced by stratification for 30–60 days at 25 °C followed by 120–150 days at 0.5 °C. In Canada, considered a weedy pest in *Vaccinium angustifolium* (lowbush blueberry) fields (Hall and Sibley 1976). One cultivar has been produced and is said to perform well in gardens (Dirr 1997).

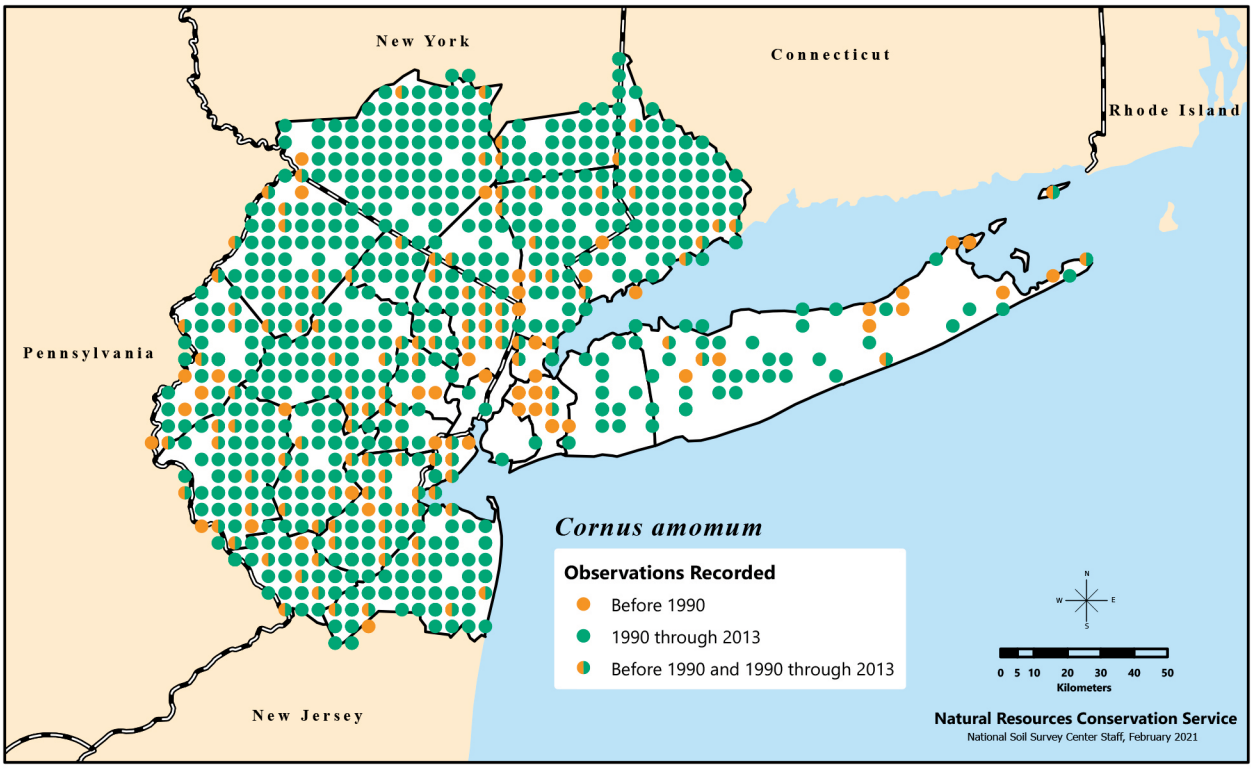
Height at maturity 0.3 m (Brinkman and Vankus 2008). Found in boreal habitats, which may explain its decline.

Tracked as critically imperiled in NJ (S1).

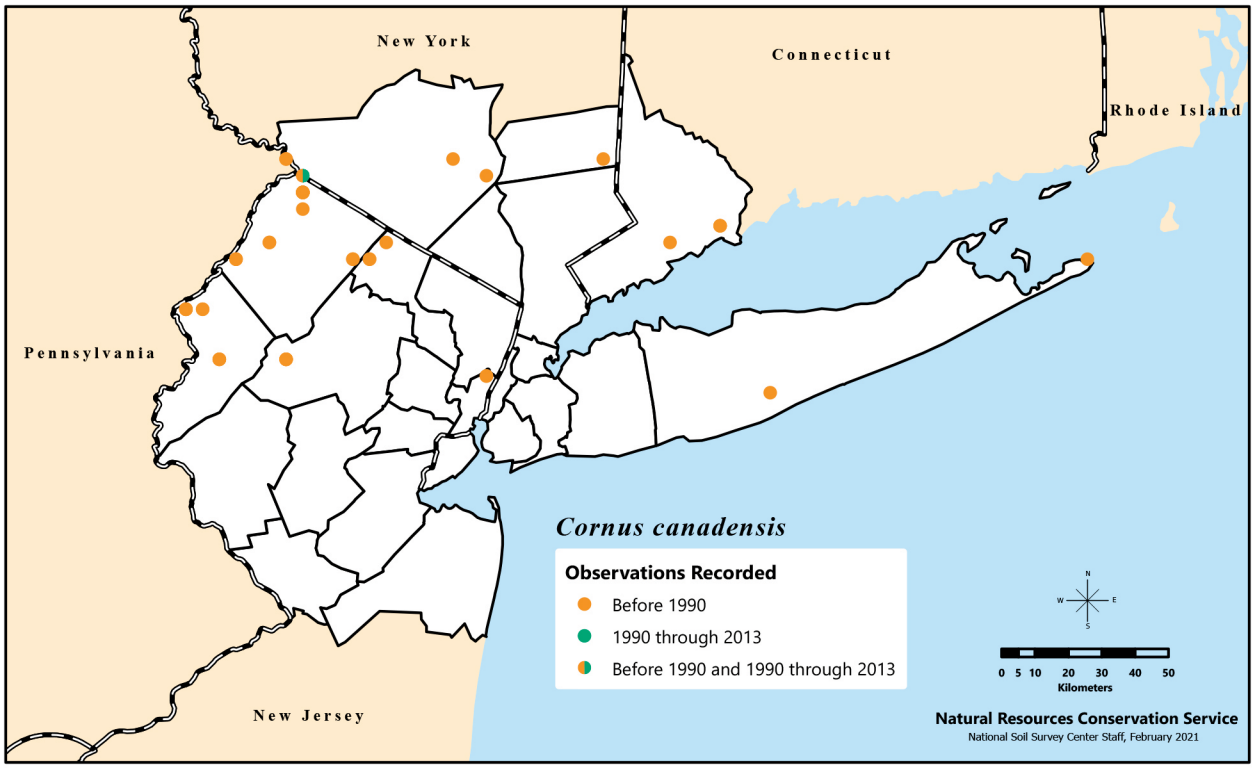
4. *Cornus florida* L. – flowering dogwood ↑↑

Tree, shrub. Flowering mid-Apr.–early June. Upland woods and woodland edges. Commonly cultivated in the region, including the form (rare in the wild) with pink bracts (*Cornus florida* f. *rubra* (Weston) Palmer).

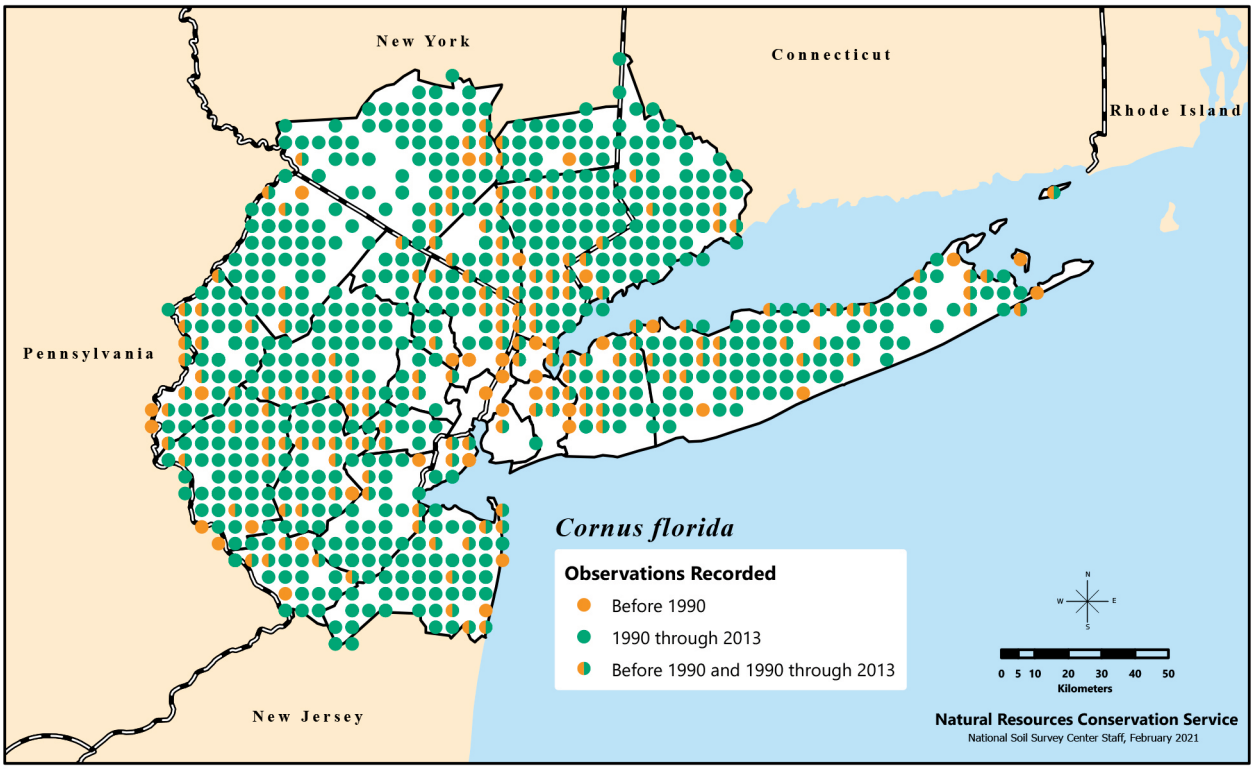
Height at maturity 6–12 m. Earliest seed-bearing age 6 years, with 1–2 years between large seed crops (Brinkman and Vankus 2008). Yellow-fruited material (*C. florida* f. *xanthocarpa* Rehd.) rarely encountered. Suffers from several diseases including dogwood anthracnose (*Discula destructiva*); trees growing in mesic, shady conditions are the most susceptible (Dirr 1997). Anthracnose does not appear to have impacted its abundance in the region. In cultivation since 1731, with at least 90 cultivars. Increases may be due in part to reforestation.



Distribution of *Cornus amomum*, or silky dogwood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Cornus canadensis*, or bunch berry, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Bergen and Mercer Counties (NJ) and Kings County (NY).



Distribution of *Cornus florida*, or flowering dogwood, recorded in the New York Metropolitan Region during three time categories.

5. *Cornus foemina* Mill. – stiff dogwood Ø

Cornus stricta Lam.

Shrub. Flowering May–June. Wet to mesic woodlands.

Cultivated since 1785, though rarely planted. Could make a good urban tree (Dirr 1997).

Known only from Morris and Passaic Counties (NJ). Tracked as imperiled in NJ (S2).

6. *Cornus racemosa* Lam. – gray dogwood ↑↑

Cornus foemina subsp. *racemosa* (Lam.) J.S.Wilson

Flowering May–July. Dry to mesic open woodlands and woodland edges. Sometimes merged with *Cornus foemina.*

Shrub. Height at maturity 4 m (Brinkman and Vankus 2008). Possible candidate for urban areas or other areas with poor soil. Cultivated since 1758, with at least 4 cultivars (Dirr 1997). Increases may be due in part to reforestation.

7. *Cornus rugosa* Lam. – round-leaf dogwood ↓

Flowering May–Aug. Dry to mesic woodlands, woodland edges, and slopes; often on rocky soils. May prefer more alkaline substrates (Davidson 2004).

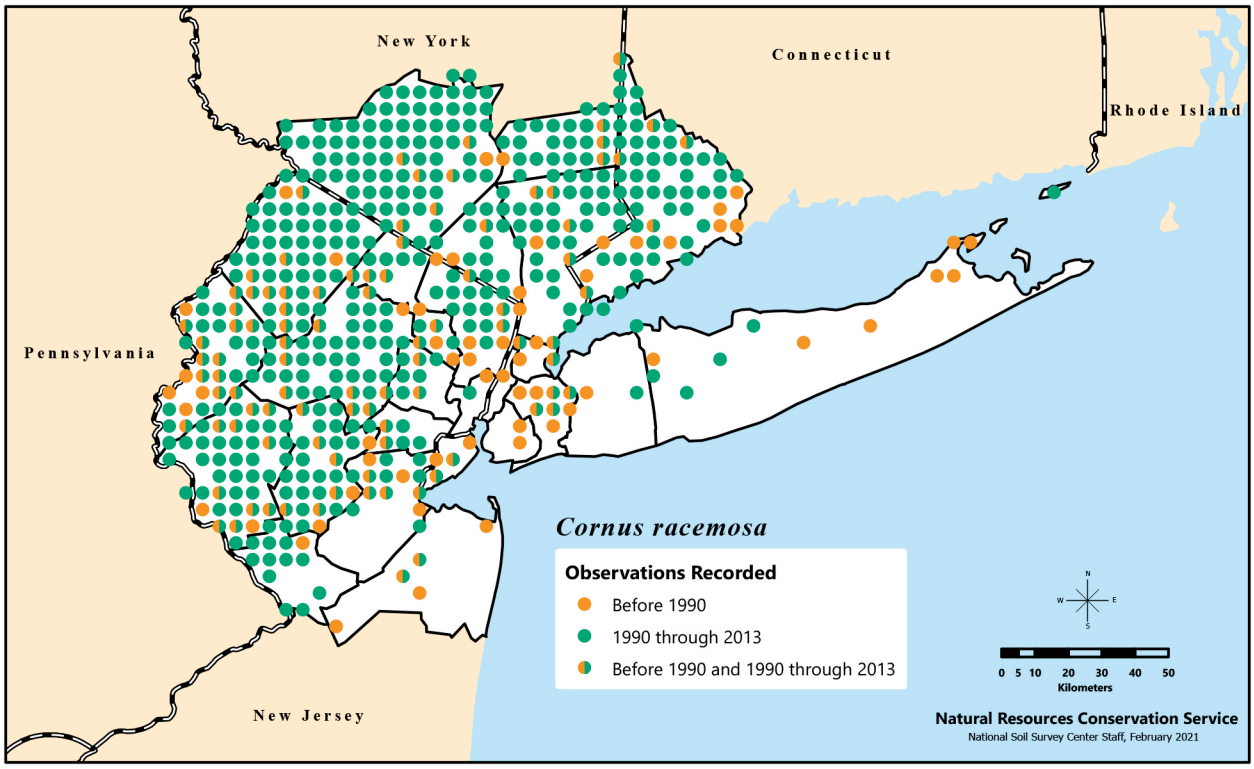
Shrub. Height at maturity 3 m (Brinkman and Vankus 2008). Not typically cultivated. Considered a boreal relic (Welch 1935), which may explain its decline.

8. *Cornus sericea* L. – red-osier dogwood ↑

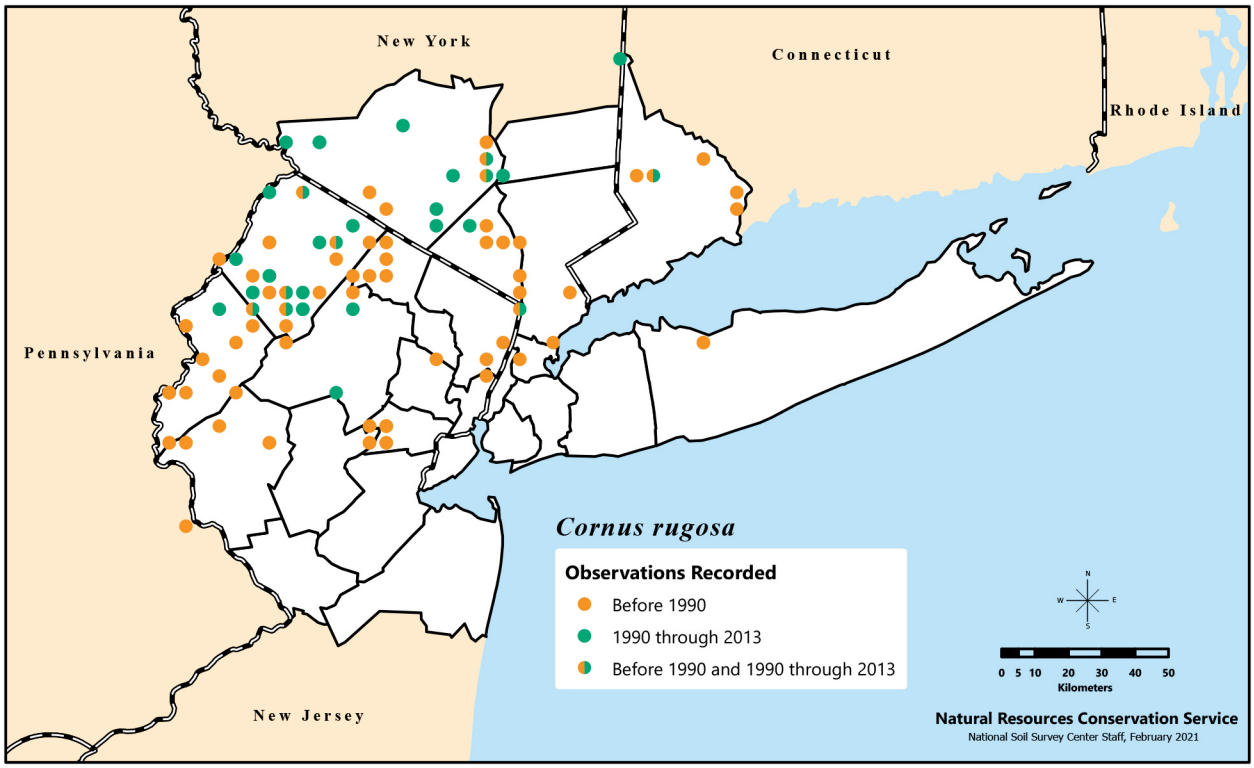
Cornus stolonifera Michx.

Shrub. Flowering May–Aug. Mesic woodlands and woodland edges. Material in the region is referable to *Cornus sericea* subsp. *sericea*. Naturalized in Europe.

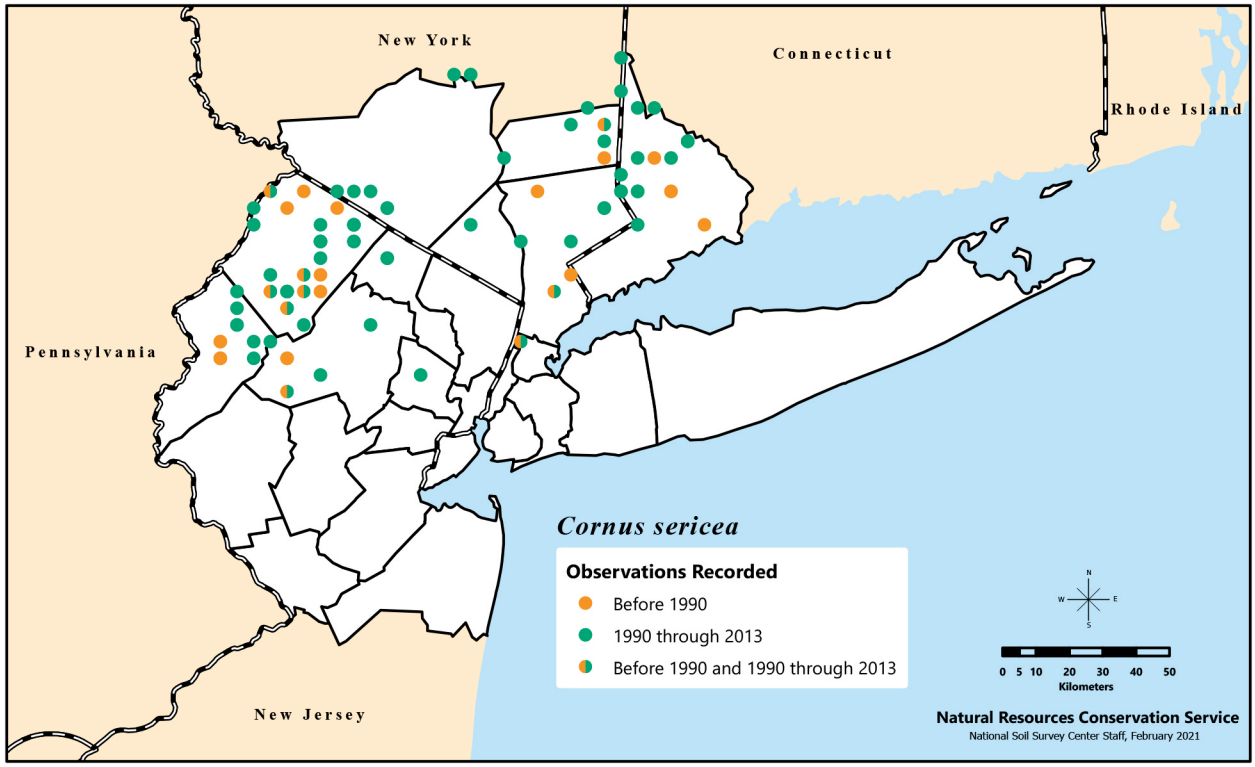
Similar to *C. canadensis* in that it is found naturally in high mountain areas and, thus, can be found across the U.S., including on Mount Lemon, outside of Tucson, AZ (Dirr 1997). Height at maturity 3–6 m (Brinkman and Vankus 2008). Cultivated since 1656, with at least 12 cultivars (Dirr 1997).



Distribution of *Cornus racemosa*, or gray dogwood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Cornus rugosa*, or round-leaf dogwood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Cornus sericea*, or red-osier dogwood, recorded in the New York Metropolitan Region during three time categories.

Nonnative Species

9. *Cornus kousa* Bürger ex Hance – kousa dogwood Ø

Tree, shrub. Flowering May–June. Superficially similar to *Cornus florida*; readily distinguished from the native species by its acuminate bracts and multiple fruits. Material examined is *C. kousa* subsp. *chinensis* (Osborn) Q.Y.Xiang. Widely used in the region for landscaping. No definitive escapes have been detected in the region. Native to Asia. Epithet is the name for this species in Japan.

Large seed crops every 2 years (Brinkman and Vankus 2008). Height at maturity 8 m. Introduced into the U.S. in 1875, with at least 88 cultivars (Dirr 1997).

***Cornus mas* L. – cornelian cherry**

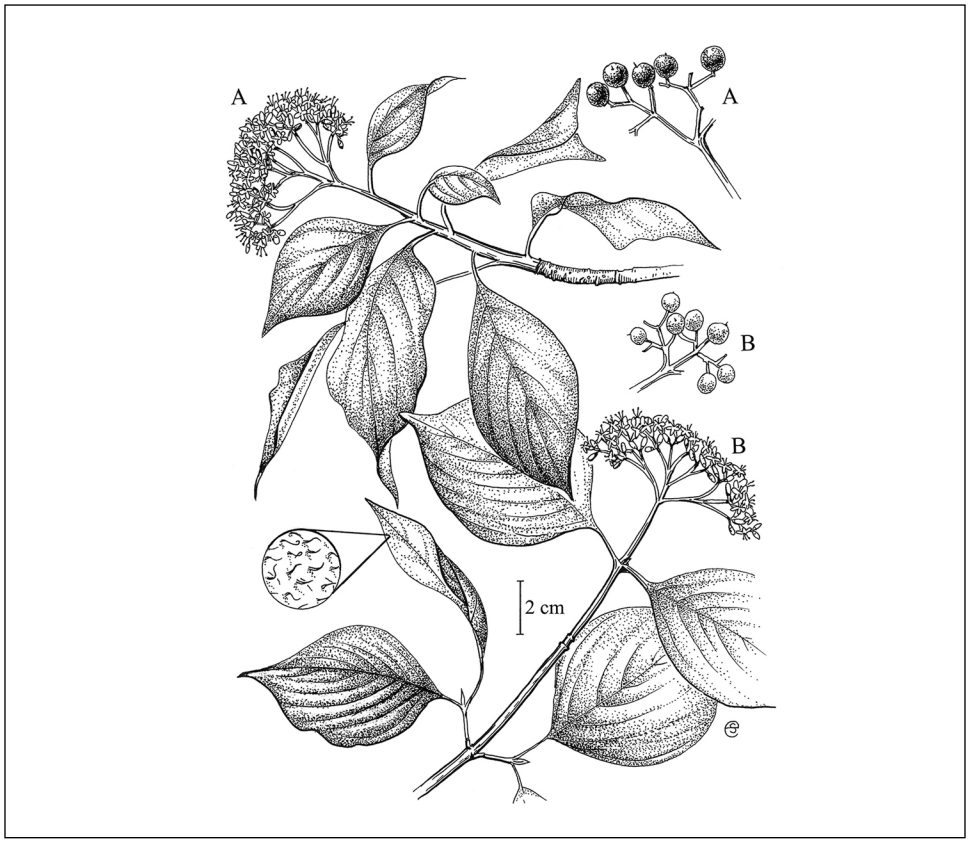
Tree, shrub. Flowering Mar.–Apr. May persist from cultivation. Native to Asia and Europe.

Height at maturity 8 m (Brinkman and Varkus 2008). The closely related and similar *Cornus chinensis* Wangerin and *C. officinalis* Sieb. & Zucc., native to Asia, differ from *C. mas* by the presence of hairs in the vein axils on the abaxial leaf surface (gray in *C. chinensis*, brown in *C. officinalis*). All three species are occasionally cultivated for ornament and edible fruits (cornelian cherry) rich in vitamin C and used in medicine. These three species along with *C. sessilis* Torrey from CA are grouped as *Cornus* subg. *Cornus*. Cultivated for centuries, with at least 13 cultivars (Dirr 1997).

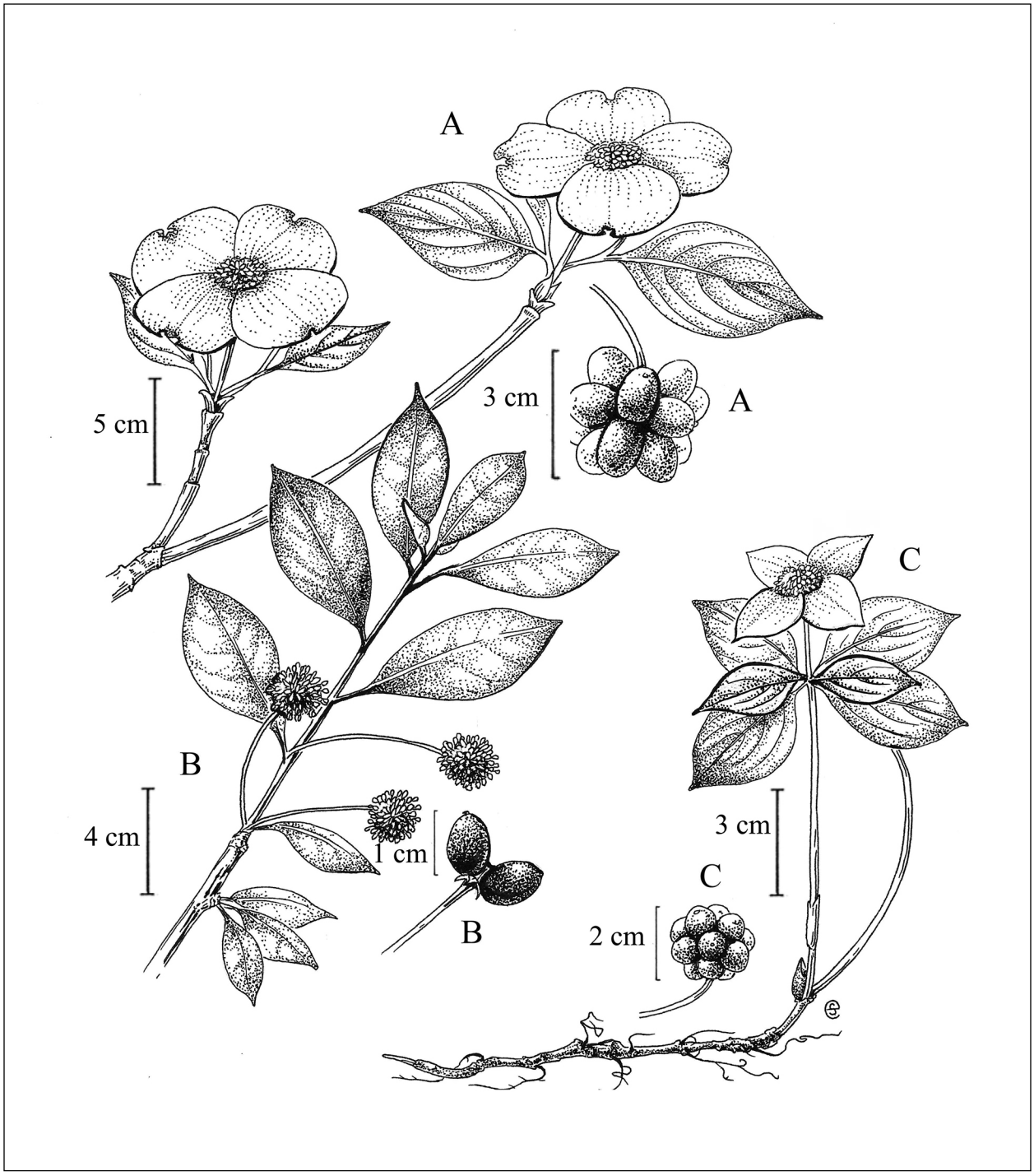
***Cornus sanguinea* L. – blood twig dogwood**

Shrub. Flowering May–June. Cultivated occasionally for ornament, especially for its dark red twigs. May persist from cultivation; not yet known to escape in the region. Native to Europe.

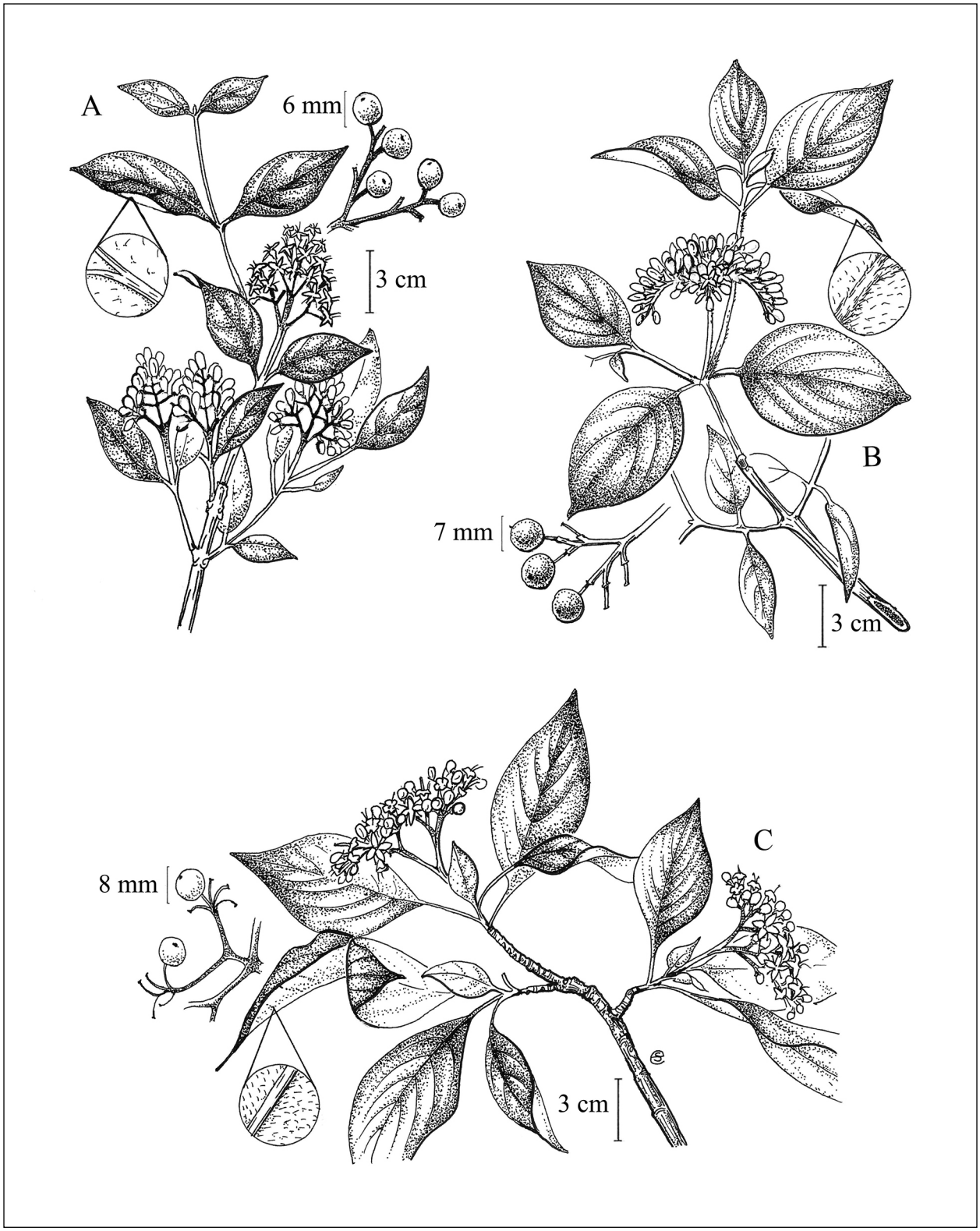
Height at maturity 1–5 m (Brinkman and Vankus 2008). Cultivated for centuries, with at least 5 cultivars (Dirr 1997).



Flowering leafy twig and fruit of A) *Cornus alternifolia* and B) *Cornus rugosa*, with enlarged view of leaf underside showing pubescence. Illustration by Emma Skurnick.



A) Flowering leafy twig and fruit of *Cornus florida*; B) leaves, male flowers, and fruit of *Nyssa sylvatica*; C) fruit and flowering leafy twig of *Cornus canadensis*. Illustration by Emma Skurnick.



Leaves with enlarged view of underside, flowering leafy twig, and fruit of A) *Cornus foemina*, B) *Cornus amomum*, and C) *Cornus sericea*. Illustration by Emma Skurnick.

C

Corylus L. – hazel, filbert

Betulaceae. Shrubs, small trees. Species 18–20 in northern temperate Asia, Europe, and North America. The smaller nuts of the wild *Corylus* similar in flavor to the commercial filberts (*C. colurna* L., *C. maxima* Mill.). Hybridization known between *C. americana* and *C. cornuta* (Fryer 2007). Genus name is the ancient name for the plant, probably derived from the Greek "corys" (helmet), a reference to the involucre.

Native Species

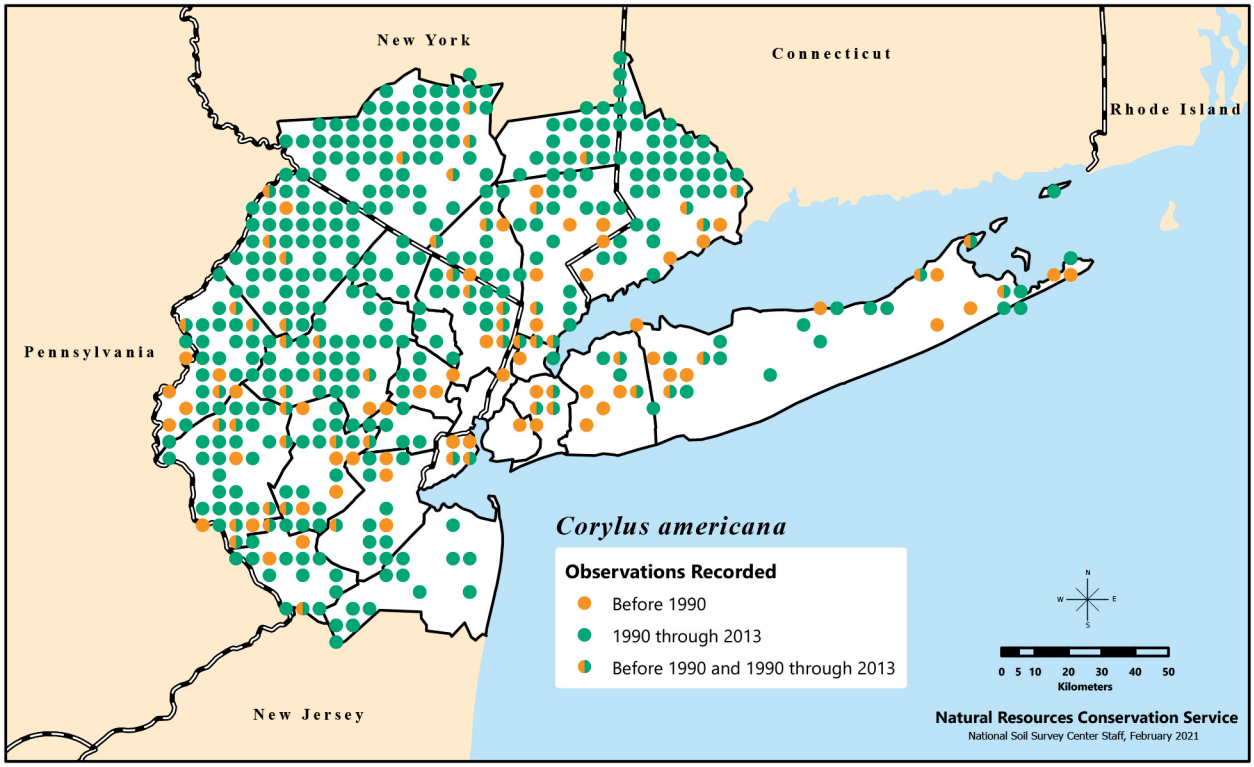
1. *Corylus americana* Walt. – American filbert ↑↑

Flowering Mar.–Apr.; fruit maturing Sept.–Oct. Rich woodlands and woodland edges.

Cultivated since 1798; considered too large a shrub for contemporary landscapes. Hybrids between *Corylus americana* and *C. avellana* result in 4 cultivars; the hybrid cultivars are hardier than *C. avellana* and have the best characteristics of each species. Squirrels (family Sciuridae) consume the nuts (Dirr 1997). Increases may be associated with reforestation.

Corylus Key

1. Petioles glabrous or with eglandular hairs; mature involucre 4–7 cm, with a long beak . . . . . ***Corylus cornuta***
1. Petioles with glandular hairs; mature involucre 1.5–3 cm, without a long beak 2
2. Involucre nearly twice as long as nut, with laciniate lobes . . . . . ***Corylus americana***
2. Involucre shorter or slightly longer than nut, with shallow lobes . . . . . ***Corylus avellana****



Distribution of *Corylus americana*, or American filbert, recorded in the New York Metropolitan Region during three time categories.

2. *Corylus cornuta* Marshall – beaked hazel ↑↑

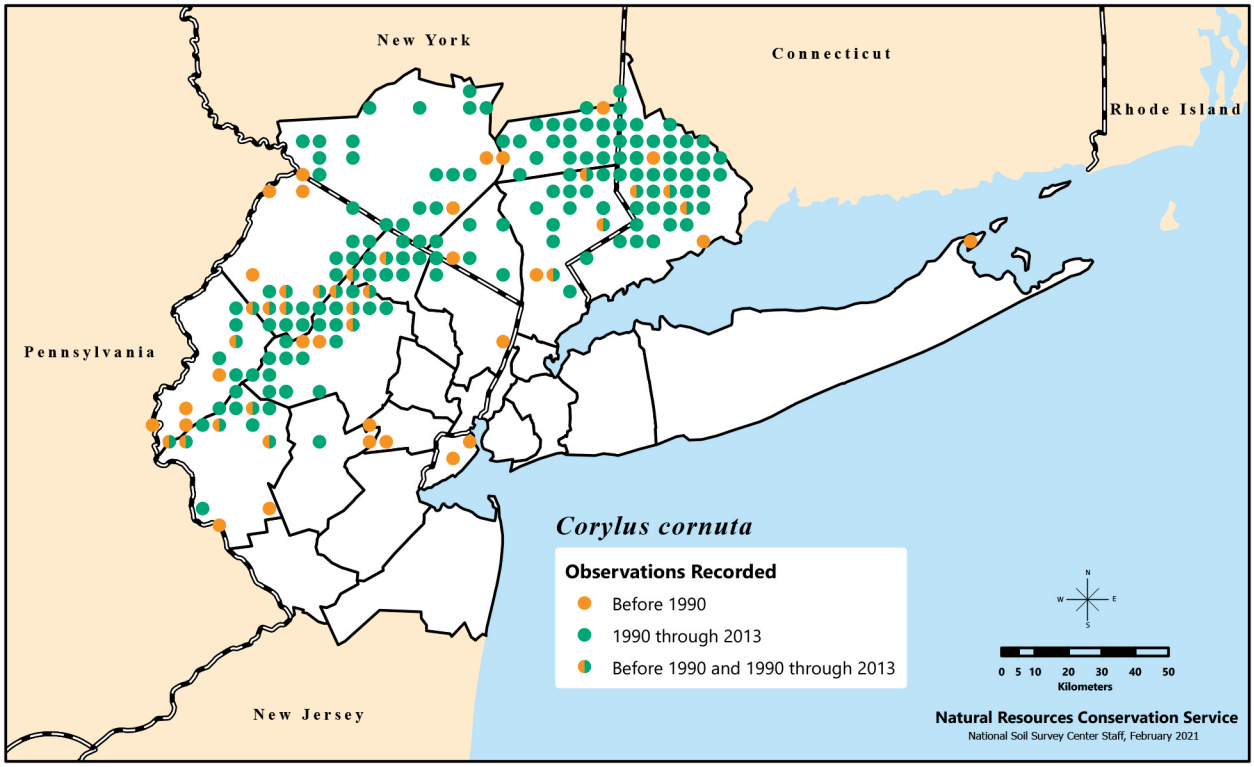
Flowering Mar.–Apr.; fruit maturing Sept.–Oct. Rich woodlands and woodland edges, often on rocky soils; most abundant in the Highlands. Epithet in Latin means "horned," a reference to the beak on the nut.

Like *Corylus americana*, *C. cornuta* hybridizes with *C. avellena*, producing 2 cultivars with large, early maturing nuts; these hybrids are known as filazels. Cultivated since 1745 (Dirr 1997). Increases may be due to reforestation.

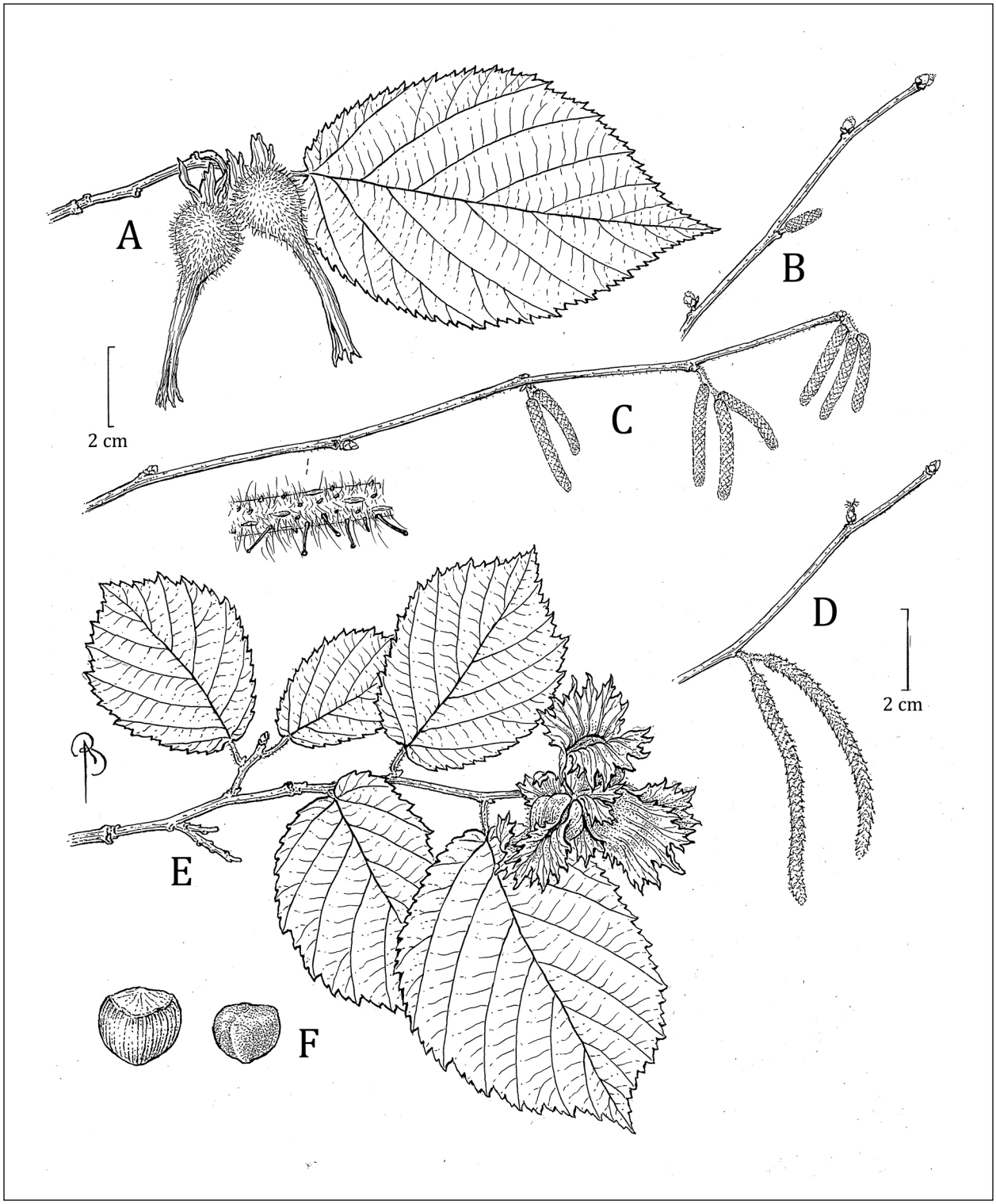
Nonnative Species

***Corylus avellana* L. – European hazel**

Flowering Mar.–Apr.; fruit maturing Sept.–Oct. Native to Europe; occasionally cultivated and persistent from cultivation. Important food cache species for the native red squirrels (*Sciurius vulgaris*) in Great Britain; the introduction of the gray squirrel (*Sciurius carolinensis*) has reduced all red squirrel food sources, making the red squirrels a threatened species. Commercially grown for its nut production in Europe as well as the U.S., with OR being the primary location of filbert production. Cultivated for centuries, with at least 6 cultivars (Dirr 1998).



Distribution of *Corylus cornuta*, or beaked hazel, recorded in the New York Metropolitan Region during three time categories



A) Fruiting twig with leaf, B) twig with female catkin and short male catkin, C) twig with male catkins and stem section showing stipitate glands of *Corylus cornuta*; D) twig with male and female catkins, E) fruiting twig, and F) nut and seed of *Corylus americana*. Illustration by Bobbi Angell.

Cotinus Adans. – smoke tree

Anacardiaceae. Small trees, shrubs. Species 2; *Cotinus coggygria* Scop, native to Asia and Europe, and *C. obovatus* Raf., native to southern U.S., are occasionally planted (especially *C. coggygria*) and may be encountered as remnants from cultivation.

Crataegus L. – hawthorn

Rosaceae. Shrubs, small trees. Species 200+ in northern Africa, Asia, Europe, and North America (including Mexico); introduced in southern Africa, Australia, Pacific Islands, and South America. Leaves on extension (usually sterile) shoots often much larger and much more variable in shape than the leaves on short (usually flowering) shoots (unless noted otherwise, key is based on leaves of short shoots). Distinguished from other genera with pome fruits (Rosaceae subf. Amygdaloideae tribe Maleae) by its deciduous (or nearly so) leaves, presence of short shoots, and mature carpels being hard and bony (referred to as pyrenes). Taxonomy made difficult by ploidy (diploids, triploids, tetraploids, aneuploidy), apomixis, and hybridization; some earlier treatments recognized almost 1,000 species for North America. Encountered usually without flowers or fruits, making identification impossible for many species. Most closely related to monospecific *Mespilus* L. (*M. germanica* L., native to Asia and Europe, cultivated and escaped elsewhere) from which it is distinguished by the presence of short shoots (absent in *Mespilus*) and flowers less than 25 mm across (25 mm or more in *Mespilus*). Intergeneric hybrids are placed in the nothogenus ×*Crataemespilus*. Interspecific hybrids are reviewed in Gleason and Cronquist (1993) and Phipps (2014). When abundant, can be a valuable source of food (pomes), nectar, and pollen to wildlife. Flower fragrance ranges from sweet to fetid; pollinators are chiefly flies (order Diptera) and bees (order Hymenoptera). Some species (none local) grown commercially for their fruits. Leaves and fruit can be infected by rust fungi (*Gymnosporangium* spp.); the genus serves as the secondary host, and *Juniperus* spp. are the primary host. Genus name is derived from Krataigon, ancient name for the genus, very likely derived from the Greek “kratos” (strength), which possibly refers to the genus’ hard wood or sharp thorns present in some species. The taxonomy used here, including the sections and series identified in the keys, is largely based on Phipps (2014).

Cotinus Key

1. Leaf base contracted abruptly; blades oval, glabrous . . . . . ***Cotinus coggygria***
1. Leaf base cuneate; blades obovate, pubescent beneath when young. . . . . ***Cotinus obovatus***

C

Crataegus Key

1. Leaves lobed, veins running to the tips of the lobes or teeth, as well as the sinuses (at least the deeper sinuses); pyrene sides grooved or plane (*C.* sect. *Crataegus*) 2
1. Leaves lobed or unlobed, veins running to the tips of the lobes or teeth but not the sinuses; pyrene sides pitted or plane. 3
2. Leaves thick (tardily deciduous), veins running to all sinuses, apex rounded or acute, base cuneate, not cordate; thorns generally shorter than 1.5 cm; calyx persistent on fruit; styles 3; pyrenes 3, sides grooved (*C.* ser. *Crataegus*) . . . . . ***Crataegus monogyna****
2. Leaves thin (early deciduous), veins running to only the deeper sinuses, apex sharply acute or acuminate, base truncate to cordate; thorns generally longer than 2.5 cm; calyx not persistent on fruit; styles 3–5; pyrenes 3–5, sides plane (*C.* ser. *Cordatae* (Beadle) Rehder) . . . . . ***Crataegus phaenopyrum****
3. Mature pomes, soft, flesh pulpy, succulent (not mealy); pyrene dorsally with deep pit, sides eroded (pitted in *C. macracantha* discussed under *C. succulenta*) (*C.* sect. *Macracanthae* Loudon ser. *Macracanthae* (Loudon) Rehder). 4
3. Mature pomes firm, flesh usually mealy (not succulent); pyrene dorsally lacking pit (*C. macrosperma*, *C. schuettii* can have dorsal grooves and ridges), sides plane (*C.* sect. *Coccineae* Loudon) 5
4. Leaves dull yellow-green, abaxial leaf surfaces (and new growth) pubescent; sepal margins entire to slightly glandular serrate; when co-occurring, flowering 1–2 weeks after *C. succulenta*; fruit ellipsoid, oblong, or obovoid . . . . . ***Crataegus calpodendron***
4. Leaves lustrous, dark green, abaxial leaf surfaces (and new growth) glabrous; sepal margins entire glandular serrate to glandular laciniate; when co-occurring, flowering 1–2 weeks before *C. calpodendron*; fruit globose or subglobose. . . . . ***Crataegus succulenta***
5. Leaves small (usually less than 1.5 cm long), base cuneate, crenate or serrate above middle, usually unlobed or slightly lobed for leaves on extension (sterile) shoots; inflorescence flowers single (sometimes in clusters of 2–5); sepals foliaceous with glandular pectinate or deeply serrate margins (*C.* ser. *Parvifoliae* Loud.) . . . . ***Crataegus uniflora***
5. Leaves longer (usually more than 1.5 cm long); sepals not foliaceous, entire or glandular serrate margins 6
6. Leaves and inflorescence glandular; inflorescence 3- to 8-flowered simple (rarely slightly branched) corymbs (*C.* ser. *Intricatae* (Sarg.) Rehder) . . . . . ***Crataegus intricata***
6. Leaves and inflorescence eglandular (rarely a few scattered glands present); inflorescence many-flowered (usually 8+) branched corymbs or corymbose panicles 7
7. Leaves somewhat thick, leathery, obovate to oblong, broadest above the middle (rarely elliptic, broadest near the middle) 8
7. Leaves thin, papery (rarely somewhat thick), generally not obovate to oblong, broadest at or below the middle. 9
8. Leaves unlobed (rarely lobed on extension shoots), adaxial surface glossy, veins not impressed, petioles less than ¼ as long as the blade; inflorescence branches glabrous; ripe fruit hard, dry, inedible with 1–3(–5) pyrenes (*C.* ser. *Crus-galli* (Loud.) Rehder) . . . . . ***Crataegus crus-galli***
8. Leaves usually lobed (more deeply so on extension shoots), adaxial surface dull, veins strongly impressed, petioles more than ¼ as long as the blade; inflorescence branches pubescent; ripe fruit soft, somewhat edible with (2–)3–5 pyrenes (*C.* ser. *Punctatae* (Loud.) Rehder) . . . . . ***Crataegus punctata***

9. Leaves rhombic or elliptic, broadest near the middle,
bases cuneate or abruptly narrowed (*C.* ser. *Rotundifoliae* (Eggl.) Rehder) 10
9. Leaves ovate, oblong to ovate, or deltoid, broadest below the middle,
bases cuneate or abruptly narrowed, bases various but not cuneate or abruptly narrowed 11
10. Leaves with distinct spreading, sharp lobes, longer than wide;
sepals glandular serrate; fruit usually pubescent . . . . . ***Crataegus chryscocarpa***
10. Leaves with shallow, rounded lobes or lobes absent,
as wide or wider than long; sepals entire or glandular denticulate;
fruit usually glabrous . . . . . ***Crataegus dodgei***
11. Adaxial surfaces of young leaves with short appressed hairs,
surface rough; calyx on fruit diminutive, not covering top of fruit 12
11. Adaxial surfaces of young leaves glabrous or pubescent, surface smooth;
calyx on fruit prominent, covering top of fruit 13
12. Leaves thin, acuminate, tips of the lobes often reflexed;
fruit bright red, soft at maturity (*C.* ser. *Tenuifoliae* (Sarg.) Rehder) 14
12. Leaves somewhat thick, acute, tips of the lobes not reflexed;
fruit greenish to dull red, hard or firm at maturity (*C.* ser. *Populnae* J.B.Phipps) 15
13. Foliage and inflorescence branches pubescent to tomentose;
young fruit pubescent, pyrenes usually 5 (*C.* ser. *Molles* (Sarg.) Rehder) 16
13. Foliage and inflorescence branches glabrous to slightly pubescent;
young fruit glabrous, pyrenes 3–5 17
14. Leaves glossy on adaxial surface; inflorescence branches pubescent;
stamens 5 or 10 . . . . . ***Crataegus flabellata***
14. Leaves dull on adaxial surface; inflorescence branches glabrous;
stamens 10 (or fewer) or 20 18
15. Leaves somewhat thick, dark green, lobes shallow . . . . . ***Crataegus populnea***
15. Leaves, thin, green, lobes deep 19
16. Foliage and inflorescence branches copiously tomentose . . . . . ***Crataegus mollis***
16. Foliage and inflorescence branches pubescent,
pubescence on abaxial surface of leaves chiefly limited to the veins 20
17. Leaves chiefly oblong to ovate, margins serrate nearly to the base;
stamens usually 10 (*C.* ser. *Coccineae* (Loud.) Rehder). 21
17. Leaves chiefly ovate or deltoid, margins serrate but not toward the base; stamens 10 or 20 22
18. Stamens 10 or fewer; fruit obovoid or oblong;
pyrenes plane or with shallow dorsal grooves and ridges . . . . . ***Crataegus macrosperma***
18. Stamens 20; fruit oblong or subglobose;
pyrenes with deep dorsal grooves and ridges . . . . . ***Crataegus schuettei***
19. Fruit obovoid or oblong, 1.0–1.4 cm thick,
not or only slightly pruinose (strongly glaucous) . . . . . ***Crataegus jesupii***
19. Fruit obovoid or pyriform, 0.7–1.0 cm thick, conspicuously pruinose . . . . . ***Crataegus levis***
20. Thorns absent or few, older ones brown; leaf bases
broadly cuneate to truncate; stamens 5 or 10, cream to salmon . . . . . ***Crataegus pennsylvanica***
20. Thorns numerous, older ones blackish; leaf bases broadly cuneate;
stamens 5 or 10, cream to salmon. . . . . ***Crataegus submollis***
21. Leaves oblong to ovate or oval;
fruit globose, not or only slightly longer than wide . . . . . ***Crataegus coccinea***
21. Leaves elliptic or oblong to ovate; fruit obovoid or oblong, longer than thick . . ***Crataegus holmesiana***
22. Flowers 2.0–2.5 cm across, stamens 20; fruit with sessile calyx,
soft, edible (*Crataegus* ser. *Dilatatae* (Sarg.) Rehder) . . . . . ***Crataegus coccinioides***
22. Flowers 1.5–2.0 cm across, stamens 20; fruit with elevated calyx, green-dull red,
firm to hard, inedible (*Crataegus* ser. *Pruinosae* (Sarg.) Rehder) . . . . . ***Crataegus pruinosa***

C

Native Species

1. *Crataegus calpodendron* (Ehrh.) Medik. – late or pear hawthorn Ø

Mespilus calpodendron Ehrh.

Flowering late May–June; fruiting Aug.–Oct. Rare in open woodlands and thickets. Epithet from Greek means "urn-tree," a reference to the urn-like shape of the fruit.

Name *Crataegus tomentosa* L. sometimes misapplied to this species in early literature (e.g., Britton 1889); *C. tomentosa* is a nomen dubium, its proper application uncertain. See *C. succulenta* for discussion of *C. macracantha*.

Species is apparently declining in the region. Once reported from all NJ counties except Bergen, Essex, and Hudson, but now listed as endangered in NJ (S1). There is also an unconfirmed report from Suffolk County (NY).

2. *Crataegus chrysocarpa* Ashe – round-leaf hawthorn ↓

Flowering May–June; fruiting Sept.–Oct. Infrequent in open upland mesic habitats, including woodland edges, and thickets. Our material is referable to *Crataegus chrysocarpa* var. *chrysocarpa*. Phipps (2014) recognized several other varieties, and some of these are reported from upstate NY. Epithet from Greek means "golden fruit," in reference to the yellow color of the fruit in early maturation; fully ripe fruit is red (although some individuals have fully ripened fruit that is yellow).

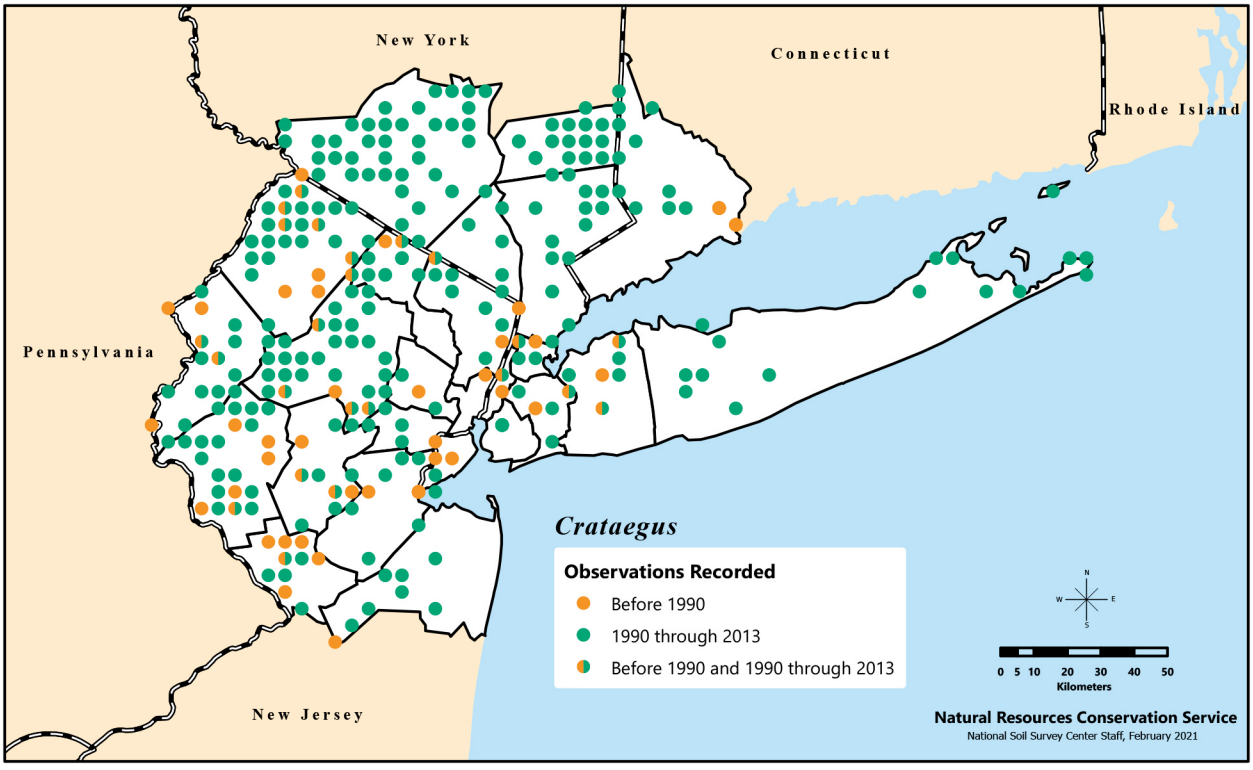
Tracked as imperiled in NJ (S2).

3. *Crataegus coccinea* L. – scarlet hawthorn ↔

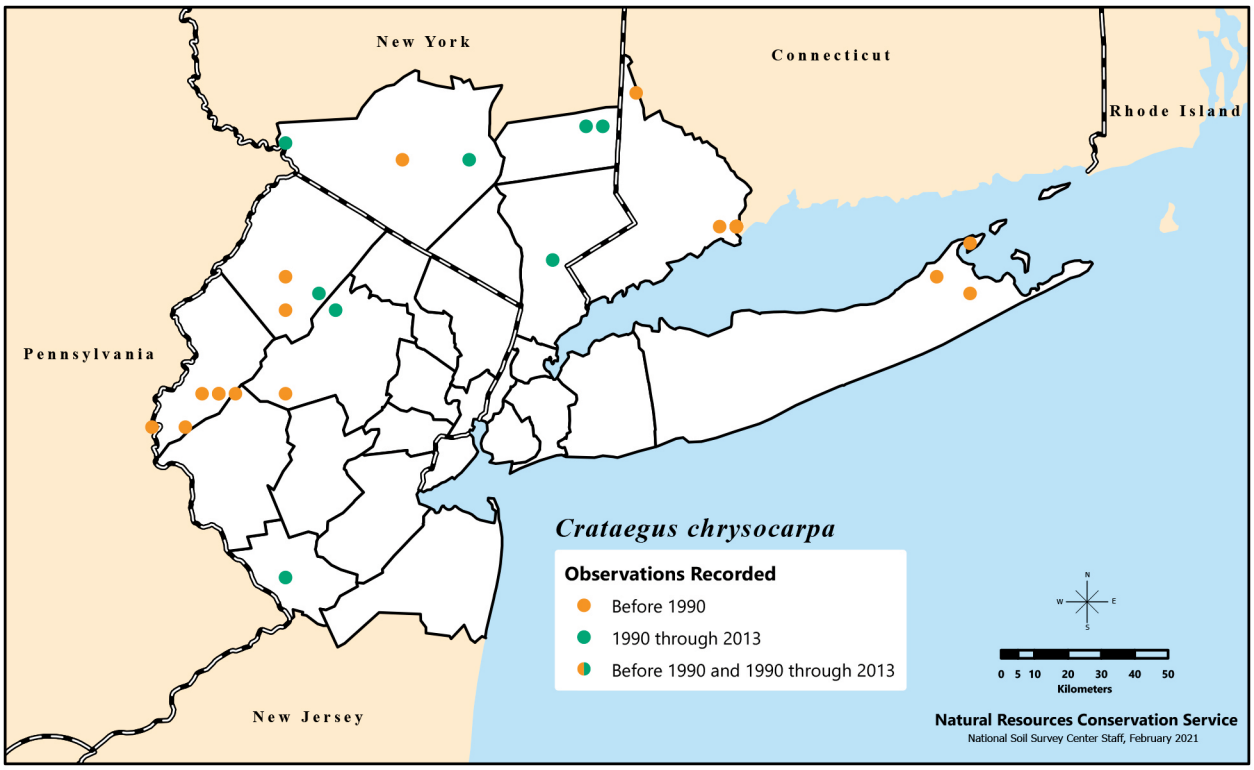
Crataegus pedicellata Sarg.

Flowering May; fruiting Sept.–Oct. Infrequent in open upland mesic habitats, including woodland edges, and thickets. Epithet is Greek for "red," a reference to the color of the ripe fruit.

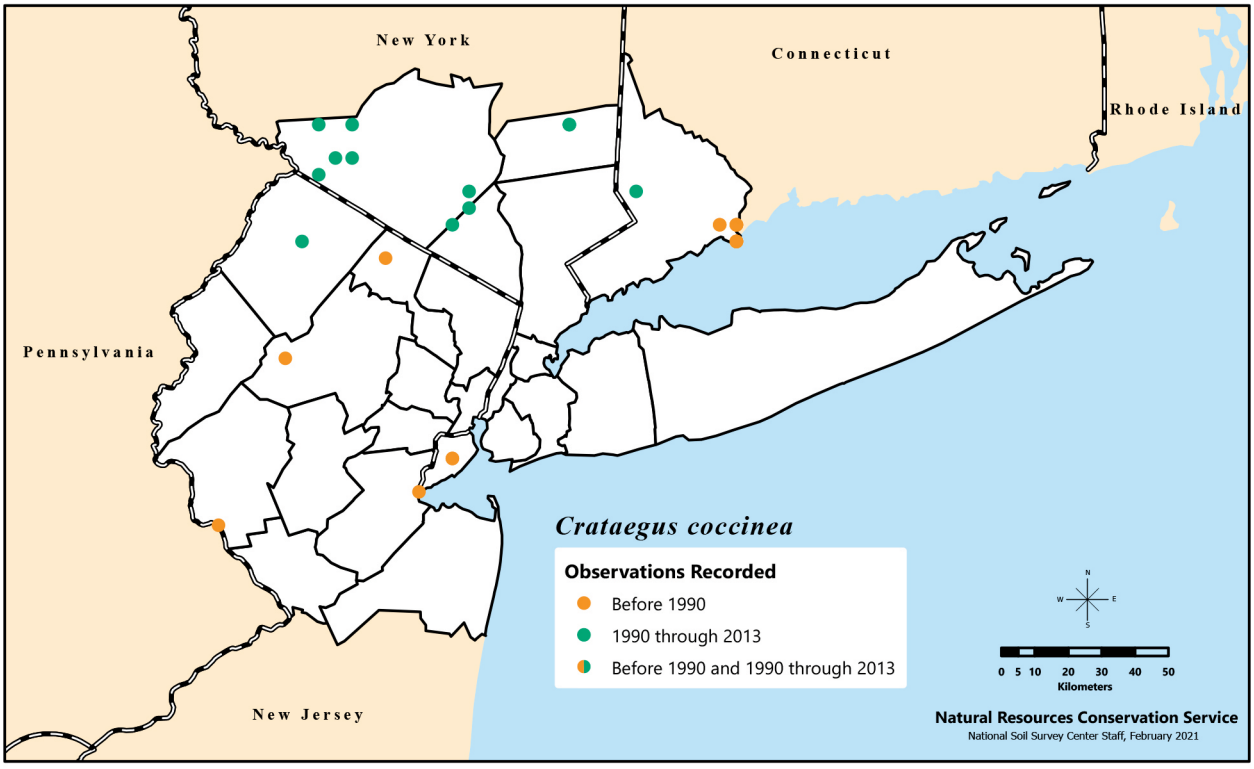
Long known as *Crataegus pedicellata*. However, the lectotypification of the name *C. coccinea* (Phipps et al. 2003) clarified the application of this name, making it synonymous with the later *C. pedicellata*. All material examined from the region is *C. coccinea* var. *coccinea*. *Crataegus coccinea* var. *pringlei* (Sarg.) A.J. Macklin & J.B. Phipps



Distribution of all native *Crataegus*, or hawthorn, species, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Crataegus chrysocarpa*, or round-leaf hawthorn, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Crataegus coccinea*, or scarlet hawthorn, recorded in the New York Metropolitan Region during three time categories.

has been reported from CT and NY (Phipps 2014); leaves are ovate in *C. coccinea* var. *coccinea* (leaves broadly elliptic to elliptic-ovate in *C. coccinea* var. *pringlei* (Sarg)). Another species from *C.* (sect. Coccineae) ser. *Coccineae* that has been reported from CT and NY but not reported from the NY Metropolitan Region is *C. magniflora* Sarg.; local material of *C. coccinea* has ovate leaves with cuneate bases and stamens 5 or fewer (deltoid to ovate leaves with rounded, cordate, or truncate bases, and stamens 20 in *C. magniflora* Sarg.).

Tracked as critically imperiled in NJ (S1) under the name *Crataegus pedicellata*.

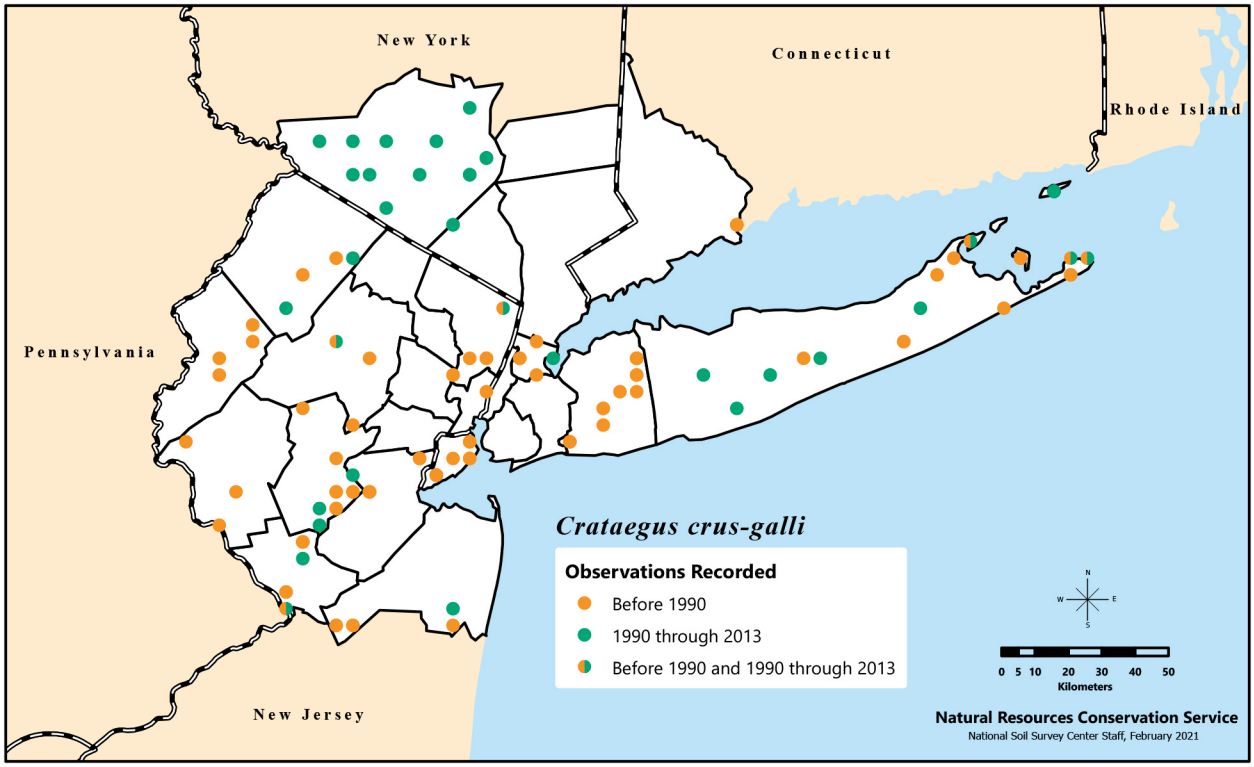
4. *Crataegus coccinioides* Ashe – Kansas hawthorn Ø

The only species from *Crataegus* ser. *Dilatatae*. Epithet refers to the species' similarity to *C. coccinea* (*C.* ser. *Coccineae*). Indeed, reports of this species from the region may represent misidentifications of *C. coccinea* (or possibly *C. holmesiana*). The distributions reported in Fernald (1950), Gleason and Cronquist (1993), and Phipps (2014) do not include the NY Metropolitan Region; the species occur north and west of the region. Dreyer et al. (2014) reported it from CT, although Phipps (2014) did not. Being reviewed as possibly rare, with records in the region from New York, Putnam, and Suffolk Counties (Weldy et al. 2020, Young 2019). Further field and herbarium work are needed to determine the status of *C. coccinioides* for the region.

5. *Crataegus crus-galli* L. – cockspur hawthorn ↓

Flowering mid-May–June; fruiting Sept.–Oct. Frequent in open to shady upland habitats in rocky to sandy soils. Epithet from Latin means "spur of a cock," a reference to the thorns. Material in the region is referable to *Craetagus crus-galli* var. *crus-galli*.

Crataegus crus-galli is very similar to a more rare species in the region, *C. berberifolia* Torr. & A.Gray (barberry hawthorn). *Crataegus berberifolia* has been reported from NY from Suffolk County (Weldy et al. 2020), and is listed as endangered (S1) for NY. However, Phipps (2014) reported the species only from the southeastern U.S., with a northern range limit of NC or VA. The young leaves and inflorescence branches of



Distribution of *Crataegus crus-galli*, or cockspur hawthorn, recorded in the New York Metropolitan Region during three time categories.

C. crus-galli are mostly glabrous; those of *C. berberifolia* are pubescent. *Crataegus berberifolia* may be little differentiated from some forms of *C. crus-galli* (Phipps 2014). Further field and herbarium work are needed to determine the status of *C. berberifolia* from the region.

6. *Crataegus dodgei* Ashe – Dodge's hawthorn Ø

Crataegus chrysocarpa var. *dodgei* (Ashe) E.J.Palmer; *Craetagus dodgei* var. *flava* (Sargent) P.G.Smith & J.B.Phipps; *Craetagus flavida* Sargent

Flowering May; fruiting Sept.–Oct. Rare in open habitats, including fields, thickets, and woodland edges. Species named for its discoverer, Charles Keene Dodge (1844–1918), a Michigan botanist and attorney.

Tracked as critically imperiled in NJ (S1), with reports from from Hunterdon, Morris, Sussex, and Warren Counties. Also reported from CT and NY but not from the region.

7. *Crataegus flabellata* (Bosc ex Spach) Koch – fan-leaved hawthorn Ø

Mespilus flabellata Bosc ex Spach; *Crataegus grayana* Eggl.; *Crataegus* var. *grayana* (Eggl.) E.J.Palmer

Flowering May–mid-June; fruiting Sept–Oct. Occasional in open to slightly shady uplands including fields, fencerows, open woodlands, woodland edges, and pastures, often on rocky soils; sometimes also found on streambanks but not in wet soils. Epithet from Latin means "fan-shaped," in reference to the shape of the leaves.

Earlier floras (e.g., Gleason and Cronquist 1993) often treated this species much more broadly to include *Crataegus macrosperma* and *C. schuettei*, which are here treated as distinct species according to Phipps (2014). Reported from Fairfield County (CT); Bergen, Hunterdon, Morris, Orange, and Passaic Counties (NJ); and Orange and Suffolk Counties (NY).

8. *Crataegus holmesiana* Ashe – Holmes hawthorn Ø

Flowering May; fruiting Sept.–Oct. Rare in open habitats, including pastures, woodland edges, thickets, and streambanks. Sometimes treated as a synonym of *Crataegus coccinea* (e.g., Gleason and Cronquist 1993). Epithet honors Joseph Austin Holmes (1859–1915), geology and natural history professor at the University of North Carolina.

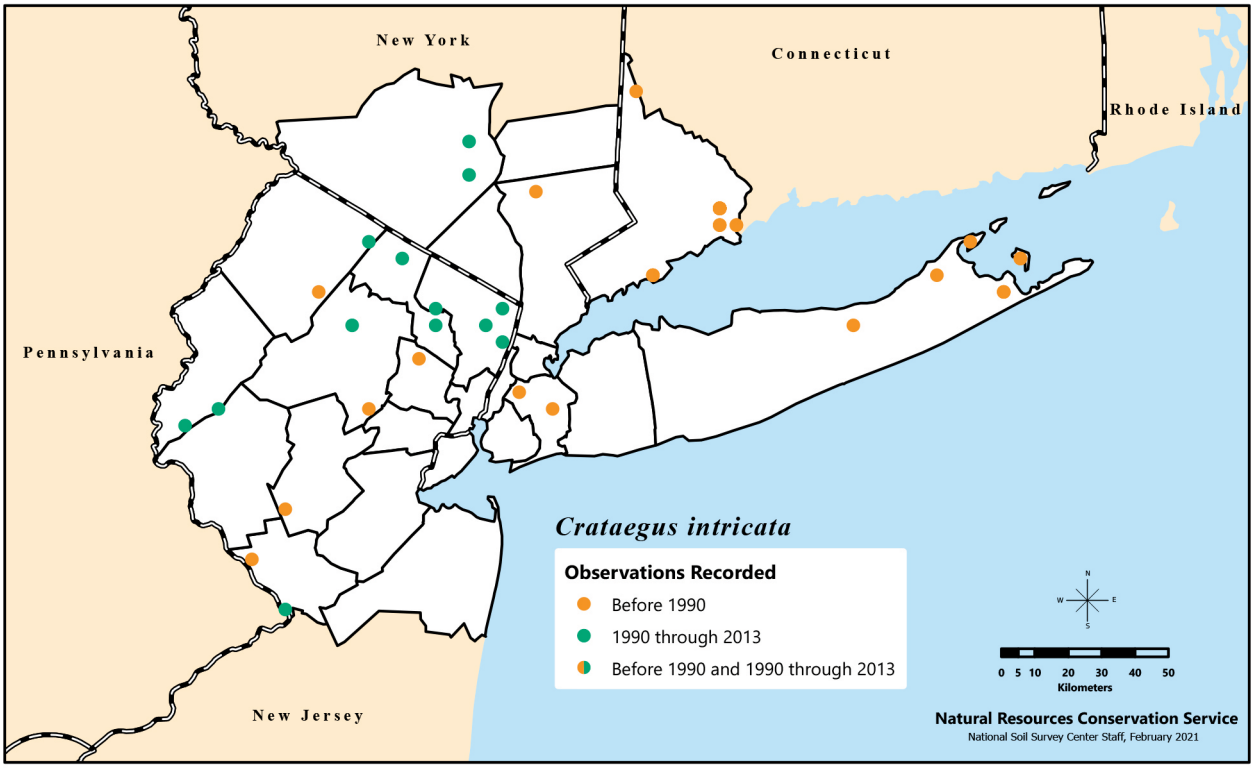
Listed as endangered in NJ (S1); reported from Hunterdon County (NJ). Also reported from Fairfield County (CT). In NY tracked as imperiled and reported only from outside the region.

9. *Crataegus intricata* Lange – intricate hawthorn ↔

Crataegus boyntonii Beadle

Flowering May; fruiting Sept.–Oct. Infrequent in open woodlands and woodland edges. Epithet from Latin may refer to the frequent and irregular branching of the shrub.

Crataegus biltmoreana Beadle (Biltmore hawthorn; named in honor of Biltmore, NC, the type locality) and *C. stonei* Sarg. (Stone's hawthorn; named in honor of American botanist George Edward Stone, 1861–1941) have often been treated as synonyms of *C. intricata* (e.g., Gleason and Cronquist 1993). However, Phipps (2014) recognized them as distinct species and reported the former from CT and NY and the latter from NY. *Crataegus biltmoreana* and *C. stonei* differ from *C. intricata* in their pubescent mature foliage, inflorescence, and young fruit (glabrous or nearly so in *C. intricata*). They can be distinguished from each other by their leaves (blades with 3–5 lobes per side, with deep sinuses in *C. biltmoreana*; unlobed or 1- to 3-lobed with shallow sinuses, *C. stonei*) and anther color (cream, *C. biltmoreana*; pink, *C. stonei*). Fernald (1950) and Dreyer et al. (2014) reported *C. intricata* var. *straminea* (Beadle) E.J. Palmer from CT, Fernald distinguishing it from typical *C. intricata* on the basis of its oblong to ovate or elliptic leaves, glabrous even when young (ovate or oblong to ovate, pubescent when young in *C. succulenta* var. *succulenta*), and pink to purple anthers (ivory or cream in *C. intricata* var. *intricata*). However, Phipps (2014: 590), treating the taxon as *C. rubella* Beadle (with *C. intricata* var. *straminea* placed "somewhat arbitrarily" in synonymy), indicated it as a southeastern species with DE being the northern limit of its range.



Distribution of *Crataegus intricata*, or intricate hawthorn, recorded in the New York Metropolitan Region during three time categories.

Crataegus biltmoreana is under review as possibly being rare in NY (Young 2019). Further field and herbarium work are needed to determine the status of *C. biltmoreana*, *C. stonei*, and *C. intricata* var. *straminea* (*C. rubella*) from the region.

10. *Crataegus jesupii* Ashe – Jesup's hawthorn Ø

The only report for the region is an unconfirmed record from Fairfield County (CT); there are also reports from upstate NY and PA (Phipps 2014, Weldy et al. 2020). Epithet honors Henry Criswold Jesup (1826–1903), botany professor at Dartmouth University.

Tracked as historical in NY (SH), with an unconfirmed record from Long Island in Bronx County. Also reported from Fairfield County (CT); not reported from NJ. See discussion under *Crataegus populnea*.

11. *Crataegus levis* Sarg. – smooth hawthorn Ø

Reported from CT (Dreyer et al. 2014) and NY and PA (Phipps 2014), but records for the NY Metropolitan Region are unconfirmed. Epithet from Greek means "smooth," a reference to the species' light armature. See discussion under *Crataegus populnea*.

12. *Crataegus macrosperma* Ashe – eastern hawthorn Ø

Flowering May–mid-June; fruiting Sept.–Oct. Open uplands including open woodlands, thickets, fencerows, and slopes; often on rocky soils. Earlier floras of the region often treated this species as a synonym of *Crataegus flabellata* (e.g., Gleason and Cronquist 1993). Epithet refers to the seeds, which are large, at least relative to the other species being described at the time by William Willard Ashe (1872–1932), forester and botanist from the southern U.S. and prolific plant collector and conservationist.

Reported from Fairfield County (CT); Sussex County (NJ); and Bronx, Orange, Putnam, Suffolk, and Westchester Counties (NY).

13. *Crataegus mollis* (Torr. & A.Gray) Scheele – downy hawthorn Ø

Crataegus coccinea var. *mollis* Torr. & A.Gray

Epithet from Latin means "soft," a reference to the feel of the leaves due to the copious pubescence.

See discussion under *Crataegus pennsylvanica*.

14. *Crataegus pennsylvanica* Ashe – Pennsylvania hawthorn Ø

Flowering May; fruiting Sept.–Oct. Open uplands including fields, fencerows, and woodland edges.

Three species of *Crataegus* ser. *Molles* (as circumscribed by Phipps 2014) have been reported from the region, *C. mollis*, *C. pennsylvanica*, and *C. submollis*. Fernald (1950) recognized all three species, but placed *C. pennsylvanica* in *C.* ser. *Coccineae*. Gleason and Cronquist (1993) recognized only *C. mollis*, treating *C. submollis* as a synonym of *C. mollis* and *C. pennsylvanica* as a synonym of *C. coccinea*. Phipps (2014) recognized all three species, but, based on his distribution maps, *C. mollis* and *C. submollis* would not be likely to occur in the NY Metropolitan Region; *C. mollis* occurs east of OH and *C. submollis* occurs west and north of the region. If so, then records from the region of *C. mollis* and *C. submollis* may represent misidentifications of *C. pennsylvanica*. Further field and herbarium work are needed to determine the status of *C. mollis*, *C. pennsylvanica*, and *C. submollis* from the region.

Tracked as critically imperiled in NJ (S1.1), with one record from Sussex County. Also historically reported from Suffolk County (NY).

***Crataegus populnea* Ashe – poplar hawthorn**

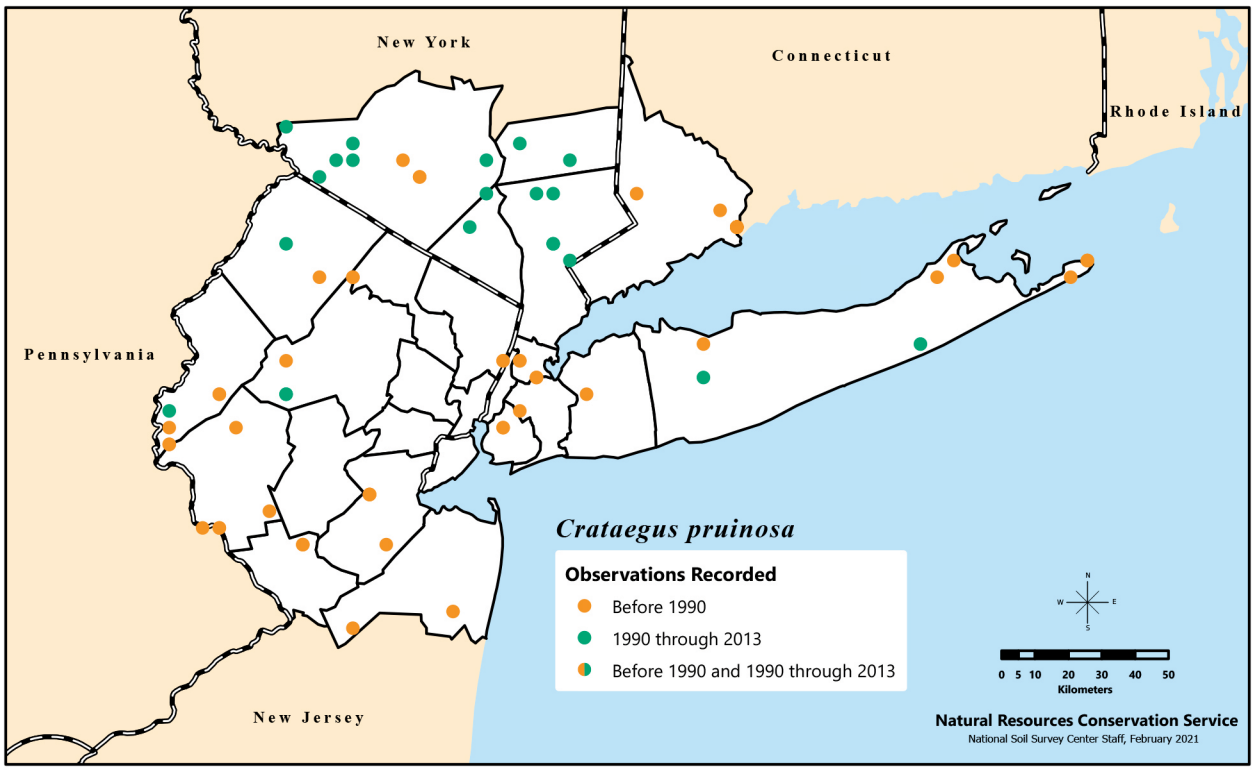
Species has been reported from CT (Dreyer et al. 2014) and NY and PA (Phipps 2014), but records for NY Metropolitan Region are unconfirmed. Epithet from Latin means "poplar-like," a reference to the shape of the leaves.

Three species included by Phipps (2014) in *Crataegus* (sect. *Coccineae*) ser. *Populneae* (*C. jesupii*, *C. levis*, *C. populnea*) are included in the genus key. Although these species have been reported from the general area, records from the region remain unconfirmed for all three species. Gleason and Cronquist (1993) treated *C. jesupii* as a synonym of *C. pruinosa*, and *C. levis* and *C. populnea* as synonyms of *C. flabellata*. Further field and herbarium work are needed to determine the status of *C. jesupii*, *C. levis*, and *C. populnea* from the region.

15. *Crataegus pruinosa* (H.L.Wendl.) K.Koch – frosted hawthorn ↓

Mespilus pruinosa H.L.Wendl.

Flowering mid-May–June; fruiting Sept.–Oct. Open uplands, including pastures, fencerows, successional fields, thickets, and woodland edges. The only species distributed throughout the region. Epithet refers to the whitish-blue waxy bloom



Distribution of *Crataegus pruinosa*, or frosted hawthorn, recorded in the New York Metropolitan Region during three time categories.

(pruinose) that is present on the fruit. While many *Crataegus* spp. can have pruinose fruits, this is best developed in this species. All material examined from the region is *C. pruinosa* var. *pruinosa*. Other varieties recognized by Phipps (2014) that, based on the reported range, may occur in the region are *dissona* (Sarg.) Eggl., *parvula* (Sarg.) J.B.Phipps, and *rugosa* (Ashe) Kruschke.

16. *Crataegus punctata* Jacq. – dotted hawthorn ↔

Flowering mid-May–June; fruiting Sept.–Nov. Rare in open uplands, including pastures, fencerows, successional fields, and woodland edges, often on rocky soils. Epithet from Latin means "dotted" (punctate), probably a reference to the dots of lighter color that can be present on the fruit, which are usually scarlet.

Tracked as imperiled in NJ (S2).

***Crataegus schuettei* Ashe – royal hawthorn, Schuette hawthorn**

Crataegus basilica Beadle

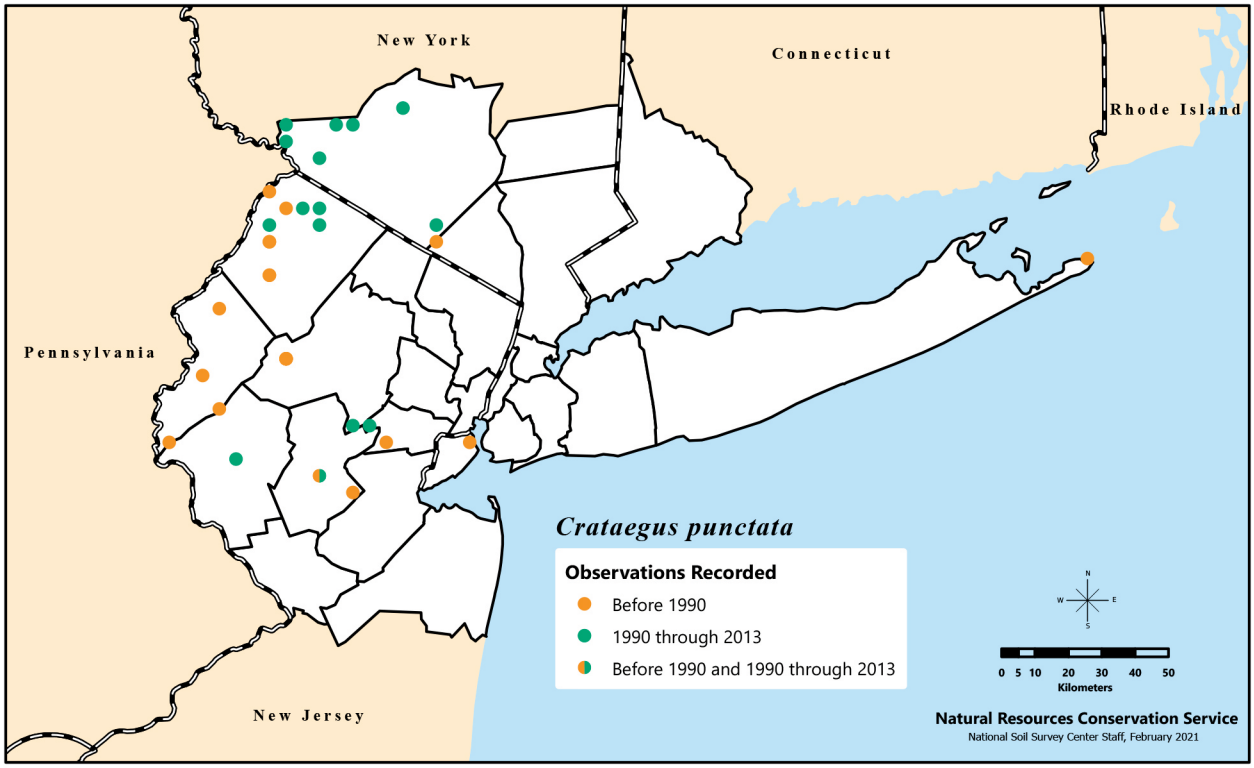
Flowering late Apr.–mid-June; fruiting Sept.–Oct. Open uplands including open woodlands, thickets, fencerows, and fields. Epithet refers to Wisconsin botanist John H. Schuette (1821–1908), who collected the material from Green Bay, WI, on which William Willard Ashe based his original description in 1901.

Crataegus schuettei was not included in most floras of the northeastern U.S.; the material either was included in a broadly circumscribed *C. flabellata* (e.g., Gleason and Cronquist 1993) or treated under *C. basilica*, which is a slightly older name, published in 1902. Further field and herbarium work are needed to determine the status of *C. schuettei* from the region.

17. *Crataegus submollis* Sarg. – northern downy hawthorn, Quebec hawthorn Ø

Epithet from Latin means "rather soft," a reference to the feel of the leaves due to the pubescence (but not as soft as the more pubescent *Craetagus mollis*).

See discussion under *Crataegus pennsylvanica*.



Distribution of *Crataegus punctata*, or dotted hawthorn, recorded in the New York Metropolitan Region during three time categories.

18. *Crataegus succulenta* Schrad. ex Link – fleshy hawthorn Ø

Flowering late Apr.–early May; fruiting Aug.–Sept. Open woodlands, woodland edges, and field edges. Material in the region is *Crataegus succulenta* var. *succulenta*. Epithet refers to the succulent nature of the fruit, a characteristic of species in *C.* sect. *Macracanthae*.

Crataegus macracantha Lodd. ex Loudon (large-thorn hawthorn), including *C. macracantha* var. *occidentalis* (Ashe) E.J.Palmer (reported from CT by Dreyer et al. 2014; not recognized by Phipps 2014), differs from *C. succulenta* (and *C. calpodendron*) in that its stamens are consistently 10 in number (20 in *C. succulenta* and *C. calpodendron*) and pyrene sides pitted (eroded in *C. succulenta* and *C. calpodendron*). Earlier floras of the region did not report this species; it either was not known from the region or was treated as a synonym of *C. succulenta*. Phipps (2014) reported it as the most widespread North American hawthorn and reported it from CT and NY. Further field work and review of the local herbarium material of *C.* sect. *Macracanthae* (likely originally identified as either *C. calpodendron* or *C. succulenta*) are needed to determine the status of *C. macracantha* from the region.

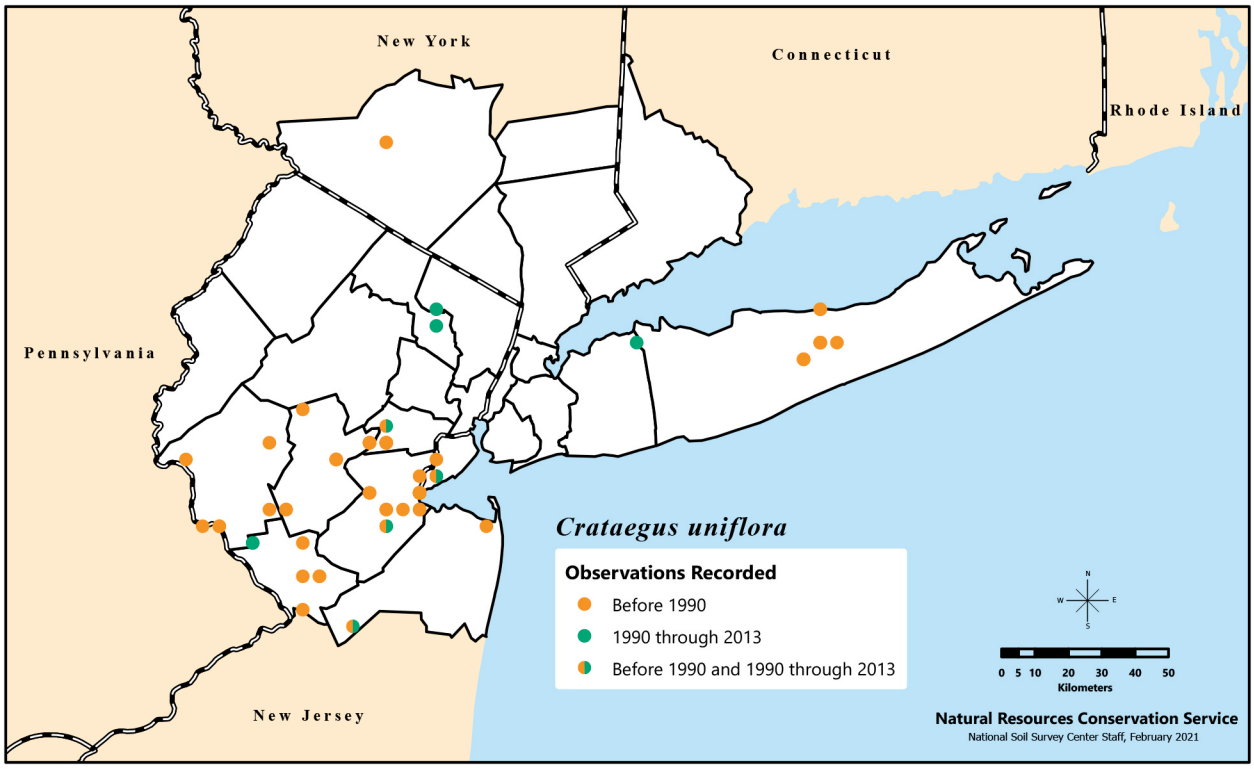
Listed as endangered in NJ (S1), with confirmed reports from Hunterdon, Monmouth, and Warren Counties (NJ). Other reports from NJ and NY are unconfirmed. Dreyer et al. (2014) reported all records from CT to be based on misidentifications.

19. *Crataegus uniflora* Muenchh. – dwarf hawthorn, one-flowered hawthorn ↓↓

Crataegus parvifolia Aiton

Flowering mid-May–mid-June; fruiting Aug.–Oct. Sandy or rocky open areas and woodland edges. Northern limit of species' range is Long Island. Though rare in the region, it is more frequent in southern NJ. Name *Crataegus tomentosa* L. was sometimes misapplied to this species in early literature (e.g., Stone 1911); proper application of this name is uncertain.

Listed as endangered in NY (S1).



Distribution of *Crataegus uniflora*, called dwarf or one-flowered hawthorn, recorded in the New York Metropolitan Region during three time categories.

C

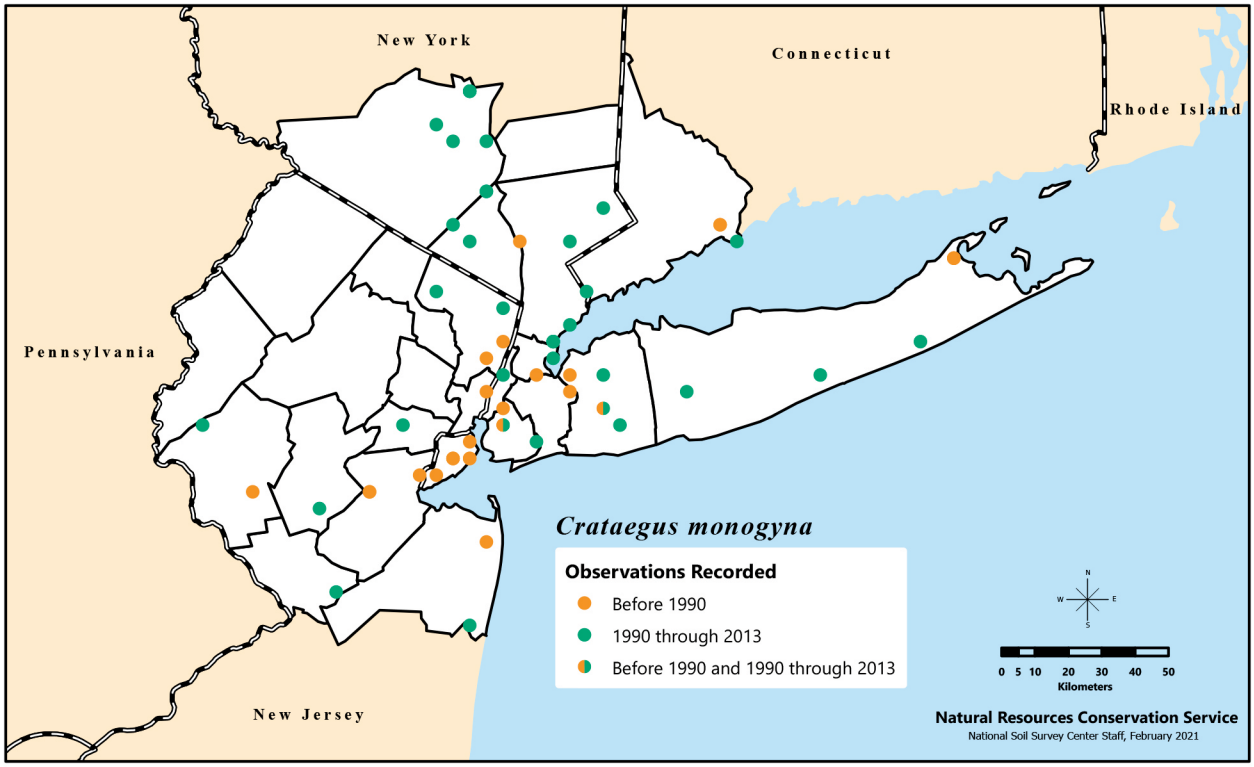
Nonnative Species

20. *Crataegus monogyna* Jacq. – English hawthorn, one-seeded hawthorn ↔

Flowering May; fruiting Sept.–Oct. Occasional in open upland habitats, including roadsides, woodland edges, and fencerows. Native to northern Africa, Southwest Asia, and Europe. Introduced material is *Crataegus monogyna* var. *monogyna*. Epithet refers to the ovary, which usually has only a single seed.

Considered invasive in much of North America (Sallabanks 1993) and Australia (Bass 1990); most information about its invasiveness in North America is from OR and CA (Sallabanks 1993, USDA NRCS 2019). May be able to hybridize with some native *Crataegus* spp. (Love and Feigen 1978) as well as species in a related genus (*Mespilus* spp.) (Byatt et al. 1977). Difficulties identifying *Crataegus* spp. vegetatively and the large number of native hawthorns may explain why it is not on State invasive species lists in the region. However, the lobing of the leaves helps distinguish it from most native hawthorns in the region and perhaps a greater effort should be made to document any spread of this nonnative *Crataegus* on the basis of this character. Its potential to hybridize with native species in the region should be researched further.

The name *Crataegus oxyacantha* L. (a formally rejected name; =*C. rhypidophylla* Gand.) has occasionally been misapplied to material of *C. monogyna*. *Crataegus rhypidophylla*, native to northern Africa and Europe, is occasionally planted but has not been reported to escape. *Crataegus monogyna* differs from *C. rhypidophylla* in its deeply 3- to 7-lobed leaves with margins entire or nearly so (shallowly 3- to 5-lobed leaves with serrulate margins in *C. rhypidlophylla*), and flowers usually with 1 style and fruit with 1 pyrene (flowers with 2 styles, and fruit with 2 pyrenes in *C. rhypidophylla*).



Distribution of *Crataegus monogyna*, called English or one-seeded hawthorn, recorded in the New York Metropolitan Region during three time categories.

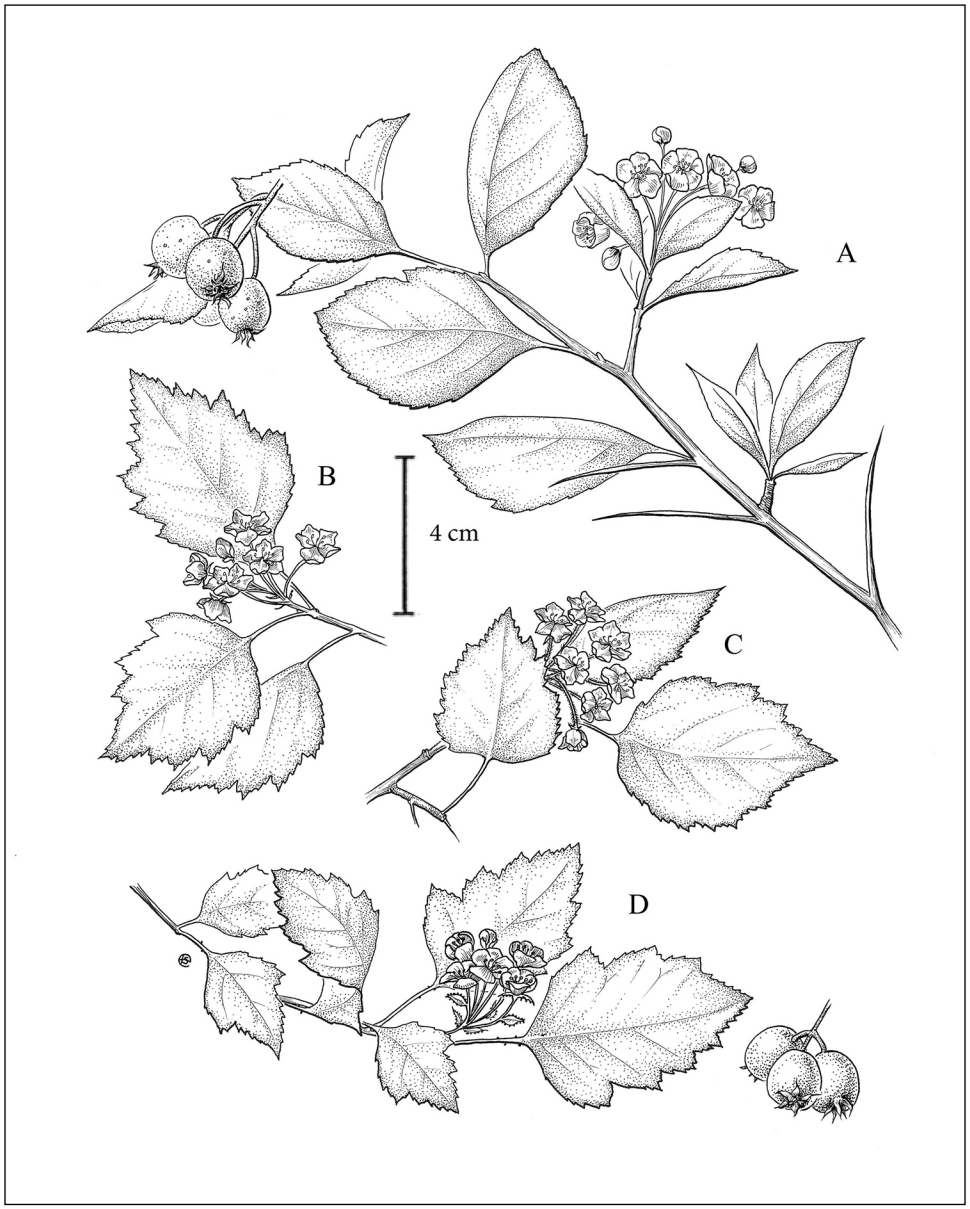
21. *Crataegus phaenopyrum* (L.f.) Medik. – Washington hawthorn Ø

Mespilus cordata L.f.

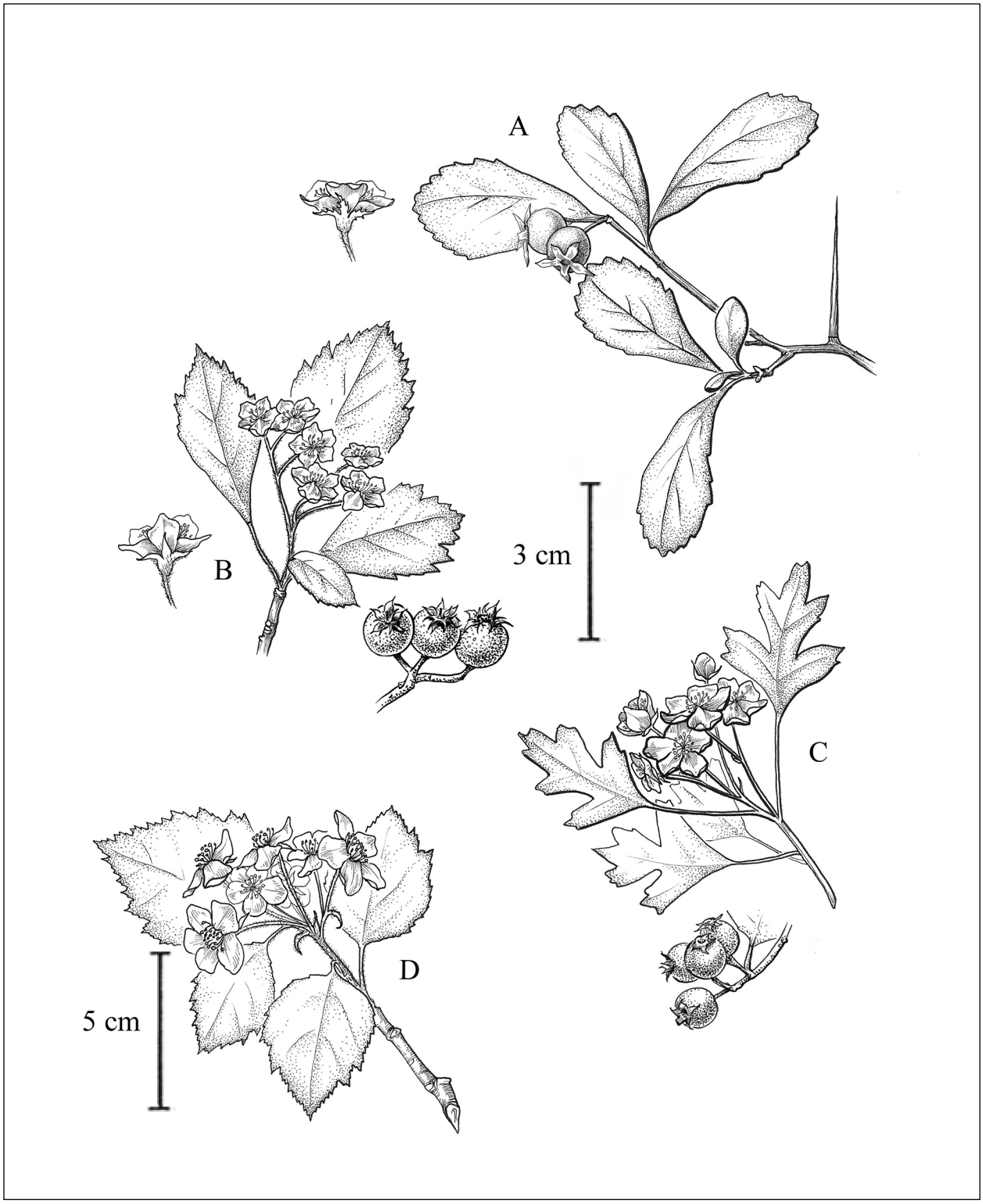
Flowering May; fruiting Sept.–Oct. Rare in open to slightly shaded disturbed areas, such as woodland edges; tolerant of moist soils. Native to the southeastern U.S., perhaps as far north as PA (Rhoads and Block 2007). Given that Britton (1889: 99) in his catalog of NJ plants referred to it as "adventive from further South," the species is best taken as not native to the region. Epithet refers to the pear-like appearance of the fruit.

In early literature, the names *Crataegus cordifolia* (Mill.) Aiton (=*Mespilus cordata* Aiton) and *C. populifolia* Walter were applied to this species. These two names are now considered nomina dubia, their proper applications not certain, and the former name has been formally rejected.

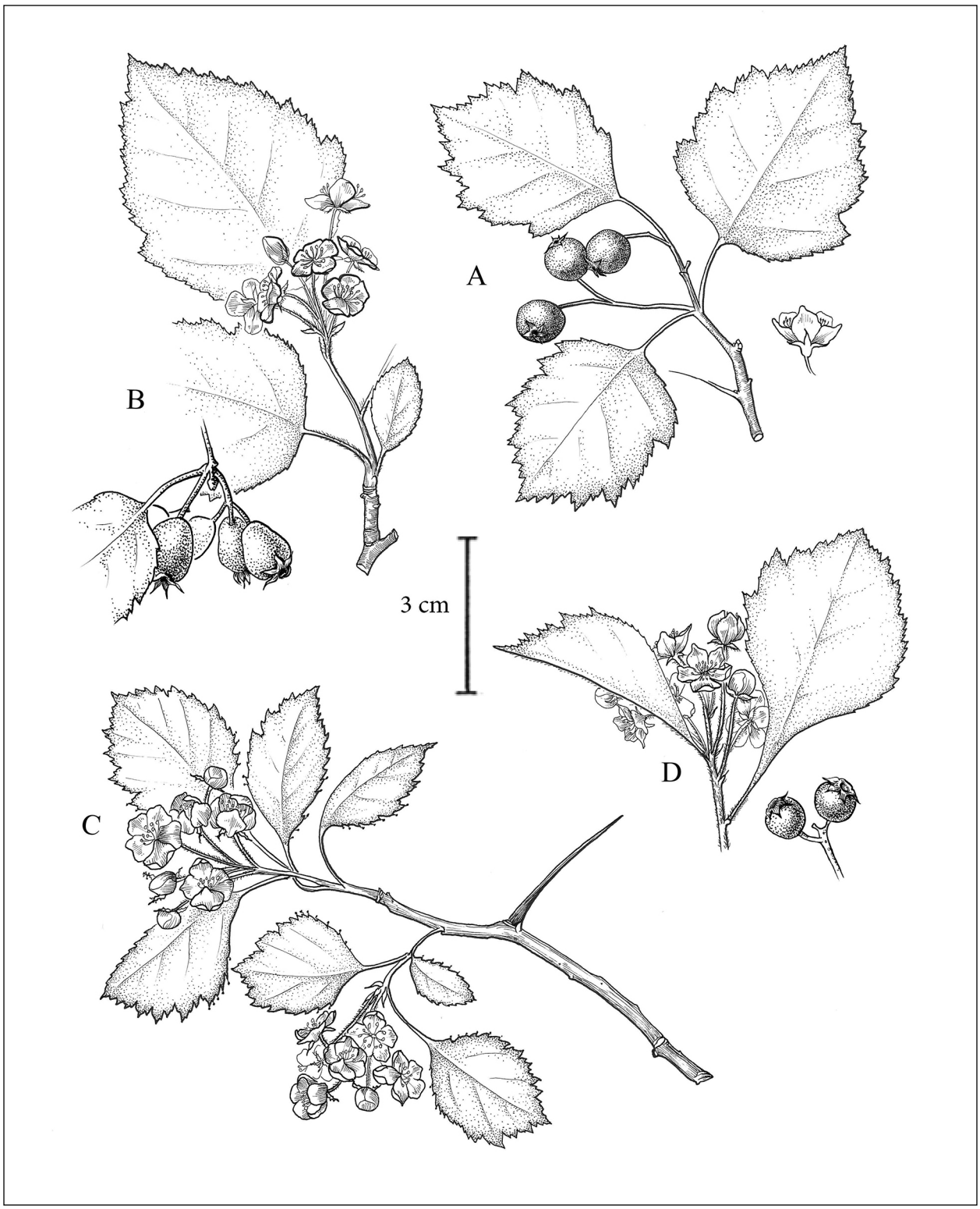
Historically reported from Hunterdon and Somerset Counties (NJ) and Queens County (NY); recently reported from Middlesex and Somerset Counties (NJ) and Nassau, Orange, and Westchester Counties (NY).



A) Flowering twig with leaves and thorns, and fruit of *Crataegus crus-galli*; flowering twig with leaves of B) *Crataegus macrosperma* and C) *Crataegus flabellata*; and D) flowering twig with leaves, and fruit of *Crataegus intricata*. Illustration by Emma Skurnick.



A) Side view of flower, and fruiting twig with leaves and thorn of *Crataegus uniflora*; B) side view of flower, flowering leafy twig, and fruit of *Crataegus punctata*; C) flowering leafy twig and fruit of *Crataegus monogyna*; and D) flowering leafy twig of *Crataegus mollis*. Illustration by Emma Skurnick.



A) Leafy twig with fruit, and side view of flower of *Crataegus pruinosa*; B) fruit and flowering leafy twig of *Crataegus coccinea;* C) twig with leaves, flowers, and thorn of *Crataegus chrysocarpa*; and D) flowering leafy twig and fruit of *Crataegus calpodendron*. Illustration by Emma Skurnick.

C

Cytisus L. – broom

Fabaceae. Shrubs, rarely small trees. Species 60 in northern Africa, the Canary Islands, and Europe.

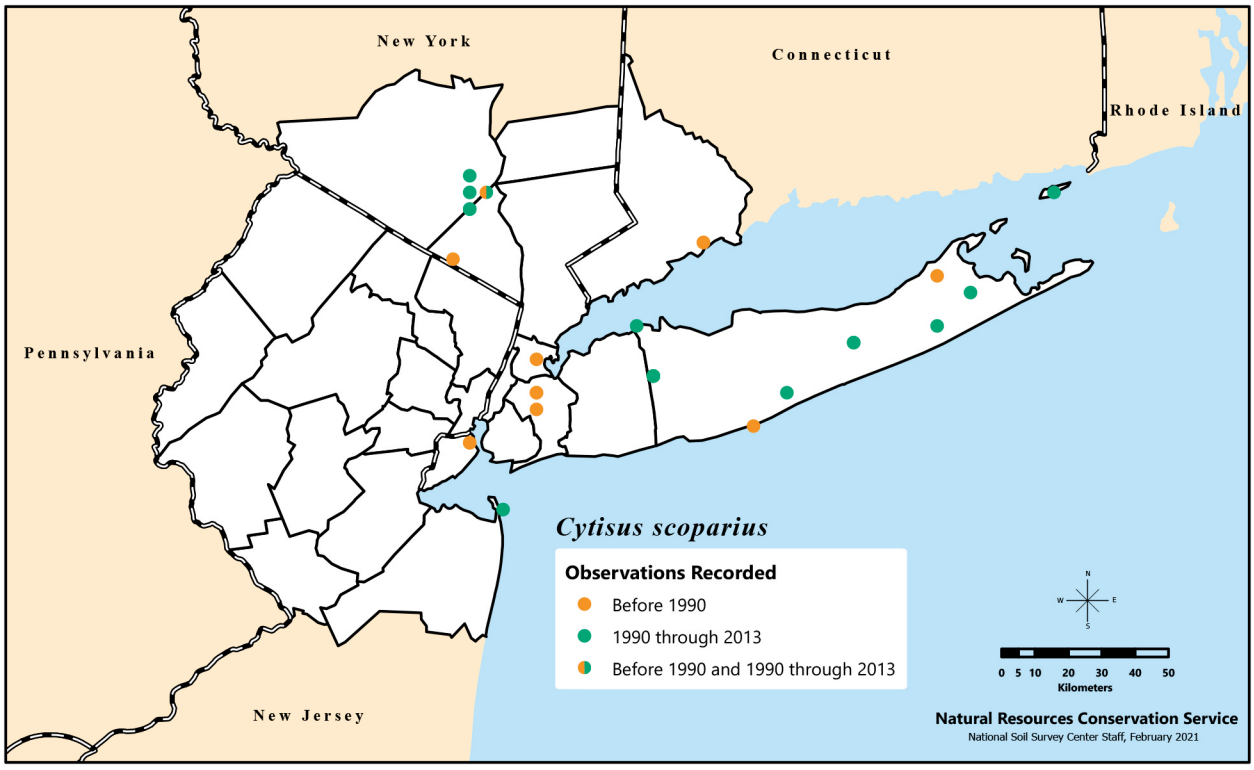
Nonnative Species

1. *Cytisus scoparius* (L.) Link – Scotch-broom ↔

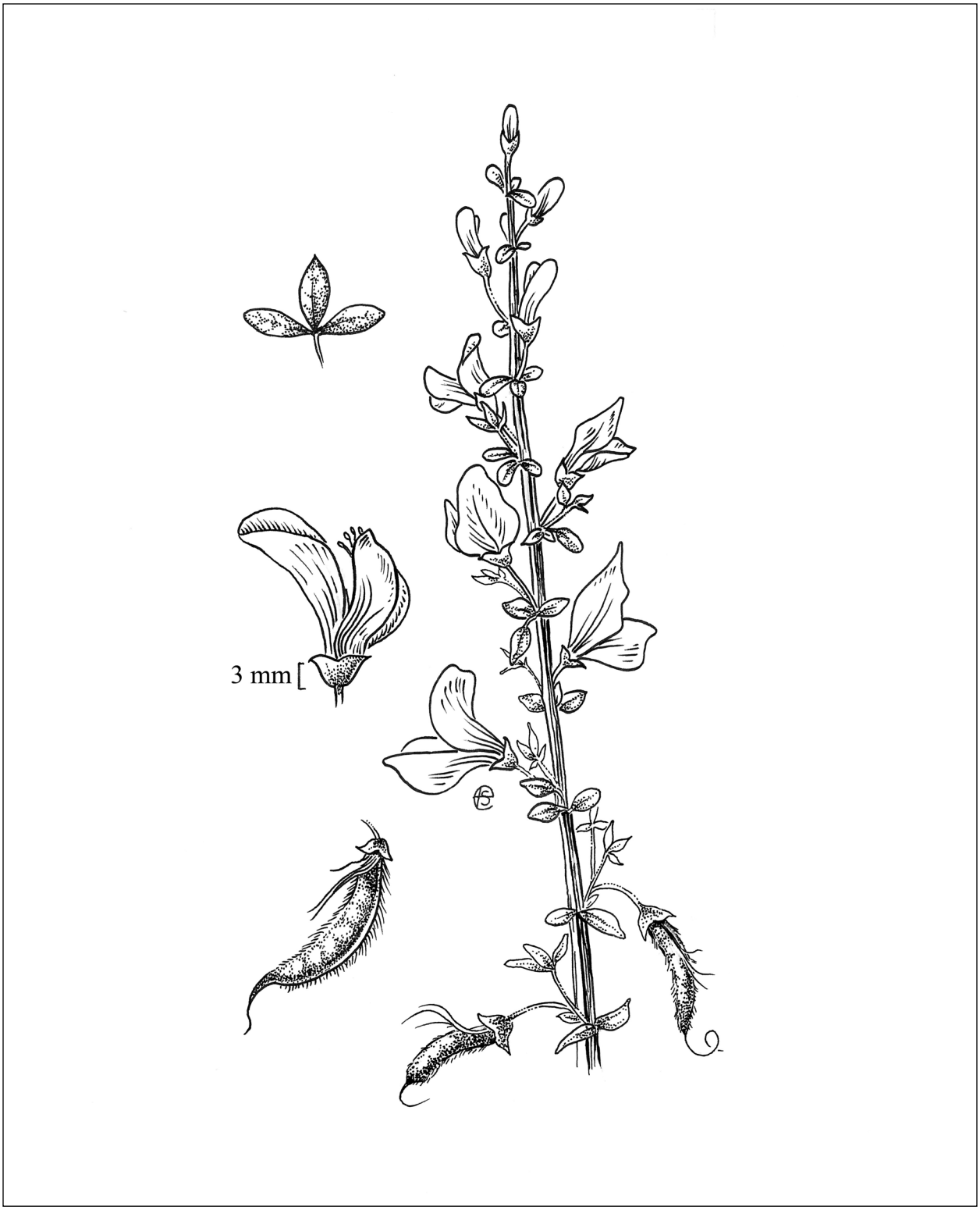
Spartium scoparium L.; *Sarothamnus scoparius* (L.) W.D.J.Koch

Shrub. Flowering May–June. Dry open, usually sandy, areas. Native of Europe; cultivated for its showy yellow flowers and occasionally escaped. The *planta genista* of the Plantagenet kings (Henry II–Richard III; 1154–1485).

Thrives on a range of soil types; fixes nitrogen in association with *Rhizobium* spp. Drought-tolerant (Peterson and Prasad 1998). Reaches reproductive maturity at 4 years (Meyer 2008b). Flowers must be "tripped" open for pollination by a large-enough pollinator to push the keel down and split the fused petals. Doing so releases the style and anthers, both of which spring up to touch the back of the pollinators, usually bumble bees (*Bombus* spp.). Self-pollination results in significantly fewer viable seed. Cannot reproduce vegetatively and is thus pollinator limited (Parker 1997). Prolific seed producer and invasive in Canada and the western U.S. and several other countries.Cultivated for centuries, with at least 35 cultivars (Dirr 1998).



Distribution of C*ytisus scoparius*, or Scotch-broom, recorded in the New York Metropolitan Region during three time categories.



Flowering and fruiting leafy twig; and leaf, flower, and fruit of *Cytisus scoparius*. Illustration by Emma Skurnick.

Dasiphora Raf. – cinquefoil

Rosaceae. Shrubs. Species about 5 in northern temperate Asia, Europe, and North America. Genus sometimes treated as a section, in *Potentilla*, P. sect. *Rhopalostylae* (Th.Wolf) Gusuleac.

Native Species

1. *Dasiphora fruticosa* subsp. *floribunda* (Pursh) Kartesz – shrubby cinquefoil ↓↓

Potentilla floribunda Pursh

Flowering late May–Sept. Open, usually mesic (sometimes dry) areas. Species wide-ranging in Asia, Europe, and North America; many infraspecific taxa recognized elsewhere in range. Prefers calcareous soils. Cultivated for centuries, with more than 130 cultivars (Dirr 1998). Loss of habitat may explain decreases in abundance.

Decodon J.F.Gmel. – water-willow

Lythraceae. Aquatic shrubs. Species 1 in eastern North America. Genus name is derived from the Greek “deca” (10) and “odous” (tooth), in reference to the multiple (5–7) teeth and horn-like projection in the sinuses of the calyx.

Native Species

1. *Decodon verticillatus* (L.) Elliott – water-willow ↔

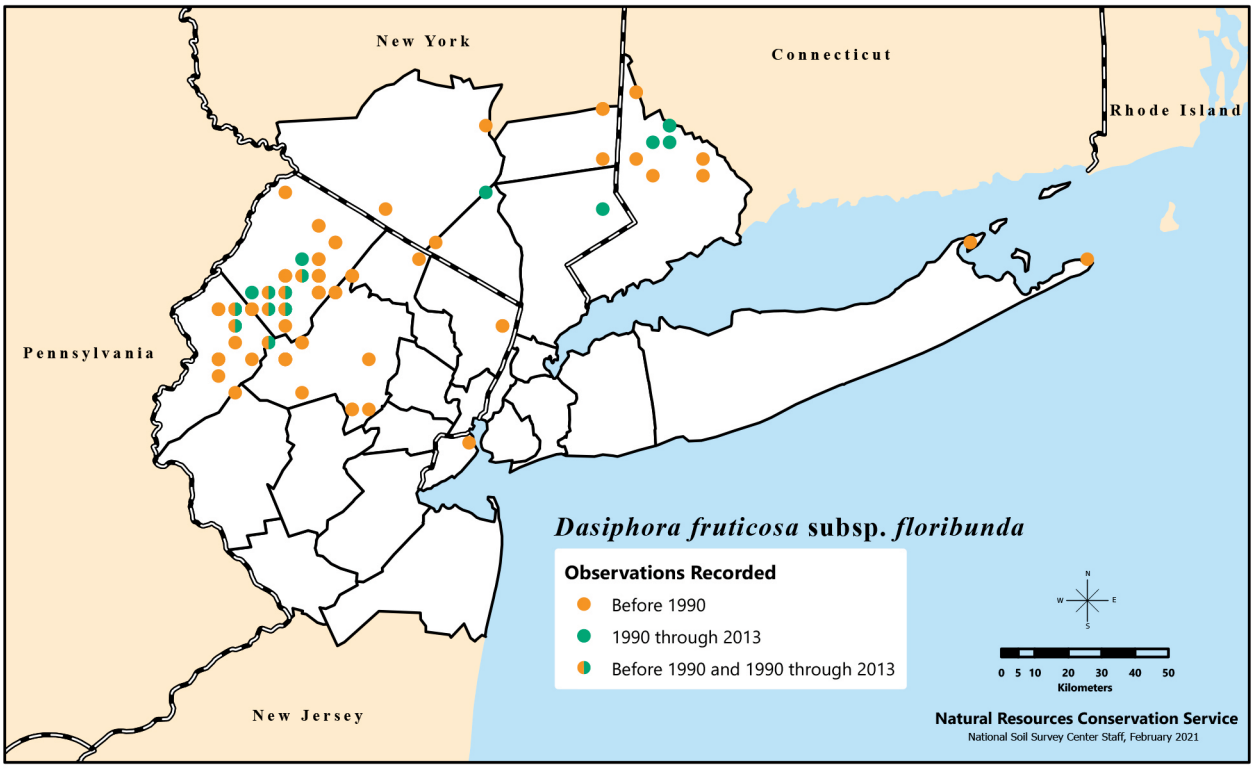
Lythrum verticillatum L.

Flowering Aug.–Sept. Swamps and marshes, usually open, sometimes in shallow standing water. Epithet from Latin refers to the whorled leaves of the species.

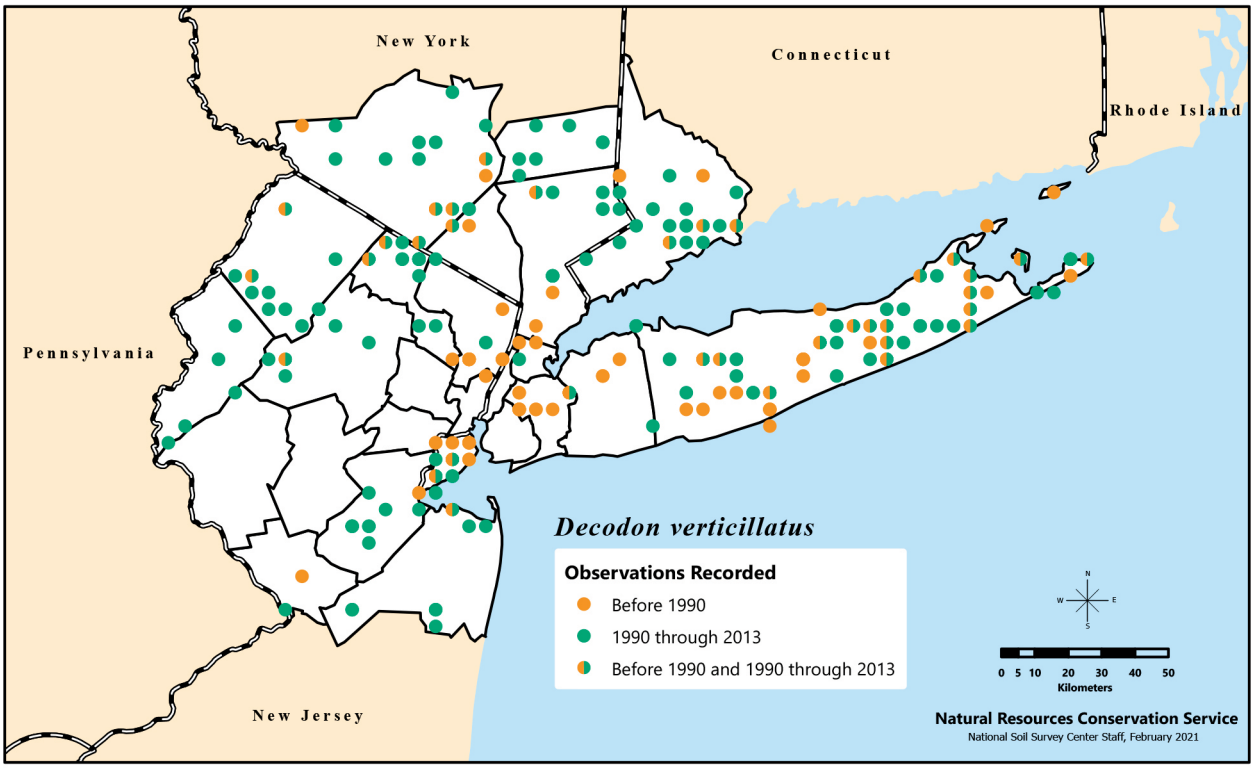
When plant is submerged, the bark of the submerged portion becomes exceptionally spongy



Flowering leafy twig of *Dasiphora fruticosa* subsp. *floribunda*. Illustration by Emma Skurnick.



Distribution of *Dasiphora fruticosa* subsp. *floribunda*, or shrubby cinquefoil, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Decodon verticillatus*, or water-willow, recorded in the New York Metropolitan Region during three time categories.

and thickened. Plant produces arching branches, which can root at the tips, often allowing it to spread and dominate an area. Clonal, self-compatible, and tristylous. The short-style morphs are most likely to outcross (Eckert and Barrett 1994b). High inbreeding depression appears to be a selective force that maintains outcrossing in this species (Eckert and Barrett 1994a). Northern populations (i.e., in ME) mostly reproduce only vegetatively due to a lack of pollinators and poor seed maturation. Because traits involved in sexual reproduction contribute little to fitness in these populations, the ability to reproduce sexually has been lost in these populations (Eckert et al. 1999). Populations in the region (southern range) are likely to still be able to reproduce sexually. Co-flowering stems with the invasive *Lythrum salicaria* (purple loosestrife, of the same family) may result in mixed pollen loads and reduced seed set (Da Silva and Sargent 2011).



Side and top views of flower, and flowering leafy twig of *Decodon verticillatus*. Illustration by Emma Skurnick.

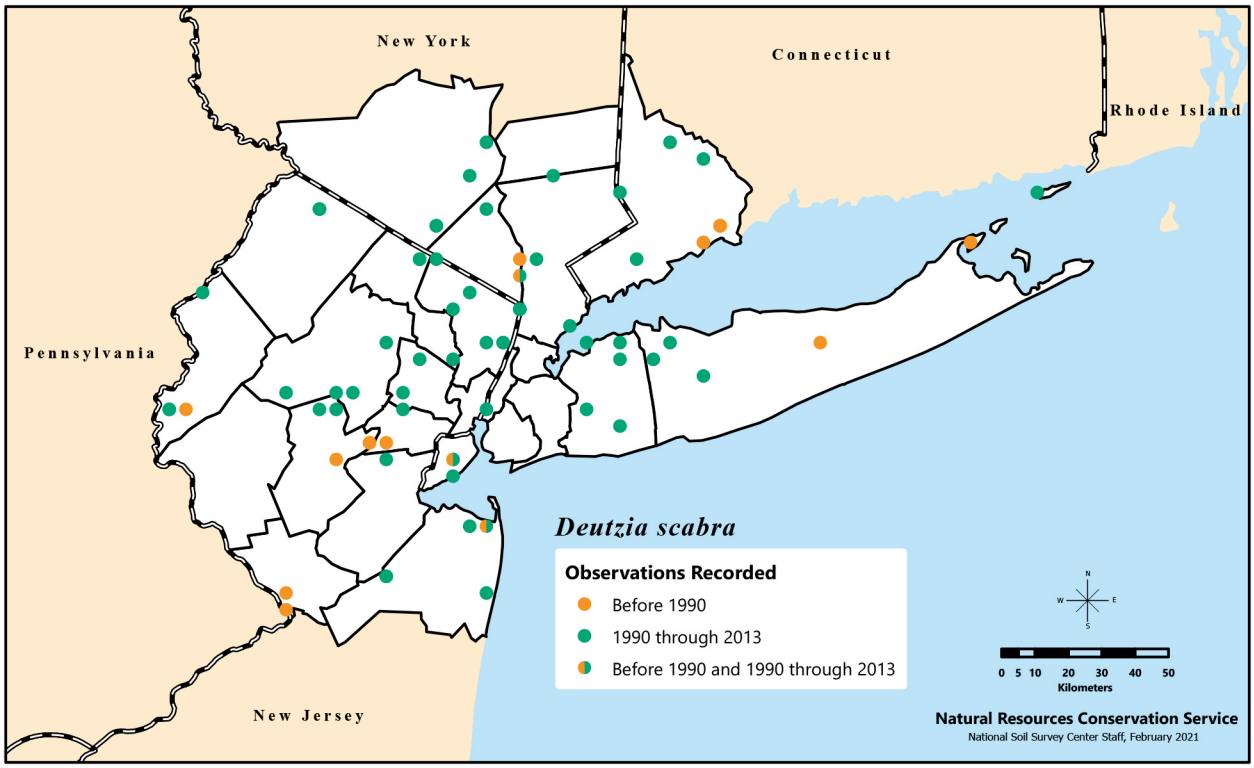
Deutzia Thunb. – deutzia, pride of Rochester

Hydrangeaceae. Shrubs. Species approximately 60 in Asia, Central America, and Europe, with the greatest diversity in China. Differs from *Hydrangea* and *Philadelphus* (also in the Hydrangeaceae) by its opposite leaves (alternate in *Hydrangea*), toothed calyces, 5-petaled perianth, and paniculate inflorescences (entire calyces, 4-petaled flowers, racemose inflorescences in *Philadelphus*). Some advocate the planting of species of this genus outside its native range as it is a good nectar plant for many insect species: "Deutzia flowers attracted numerous insects, mainly honey bees, bumble bees and solitary bees. The species and cultivars investigated are highly valuable honey plants. Increased use of these shrubs in gardens and parks should be encouraged in order to enrich nectar and pollen pasture for honey bees and wild Apoidea" (Masierowska 2006). However, others (see following species entry) report some species to be invasive. Genus name honors Johann van der Deutz, an attorney from Amsterdam, the Netherlands, who financially supported research by Carl Peter Thunberg (1743–1828; Swedish naturalist who studied under Linnaeus). The hybrid white double-flowered cultivar, 'Pride of Rochester,' was developed by Rochester, NY, nurserymen Patrick Barry (1816–1890) and George Ellwanger (1816–1906) (Coats and Creech 1992).

Nonnative Species

1. *Deutzia scabra* Thunb. – fuzzy deutzia, fuzzy pride of Rochester ↑↑

Flowering late May–early June. Occasional escape from cultivation along roadsides and in thickets. Native to Asia. The State Arboretum of Virginia identified the species as possibly invasive (State Arboretum of Virginia at Blandy Experimental Farm 2013). Epithet from Latin refers to the leaves, which are scabrous on the undersides.



Distribution of *Deutzia scabra*, called fuzzy deutzia or fuzzy pride of Rochester, recorded in the New York Metropolitan Region during three time categories.

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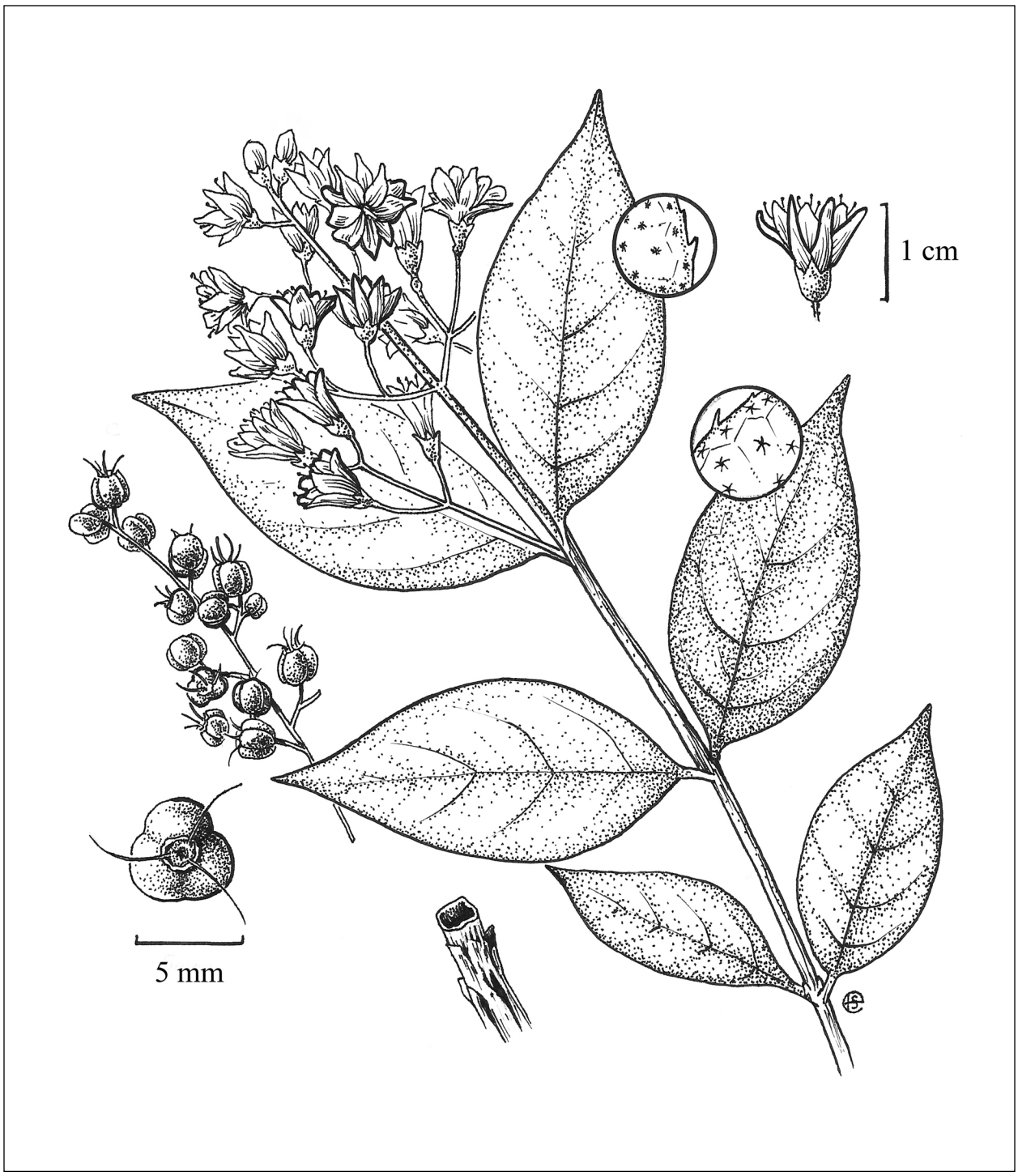


Flowering twig with leaves, infructescence (fruiting stem section), flower, fruit, stem cross-section, and enlarged underside and upperside of leaves showing stellate hairs of *Deutzia scabra*. Illustration by Emma Skurnick.

Diervilla Mill. – bush honeysuckle

Caprifoliaceae. Shrubs. Species 3 in eastern North America. Genus name honors Marin Dièreville (ca. 1670–ca. 1711), a French botanist and surgeon who introduced the plant to Europe in the late 1600s.

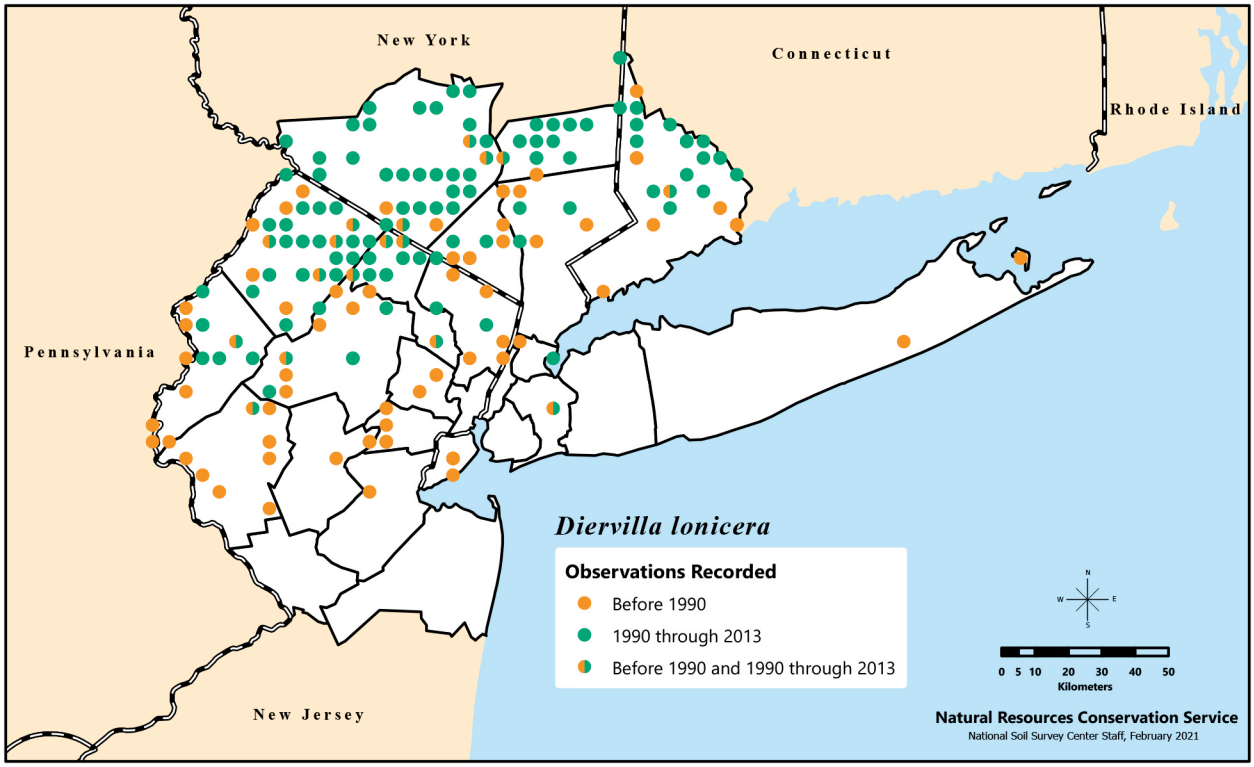
Native Species

1. *Diervilla lonicera* Mill. – bush honeysuckle ↔

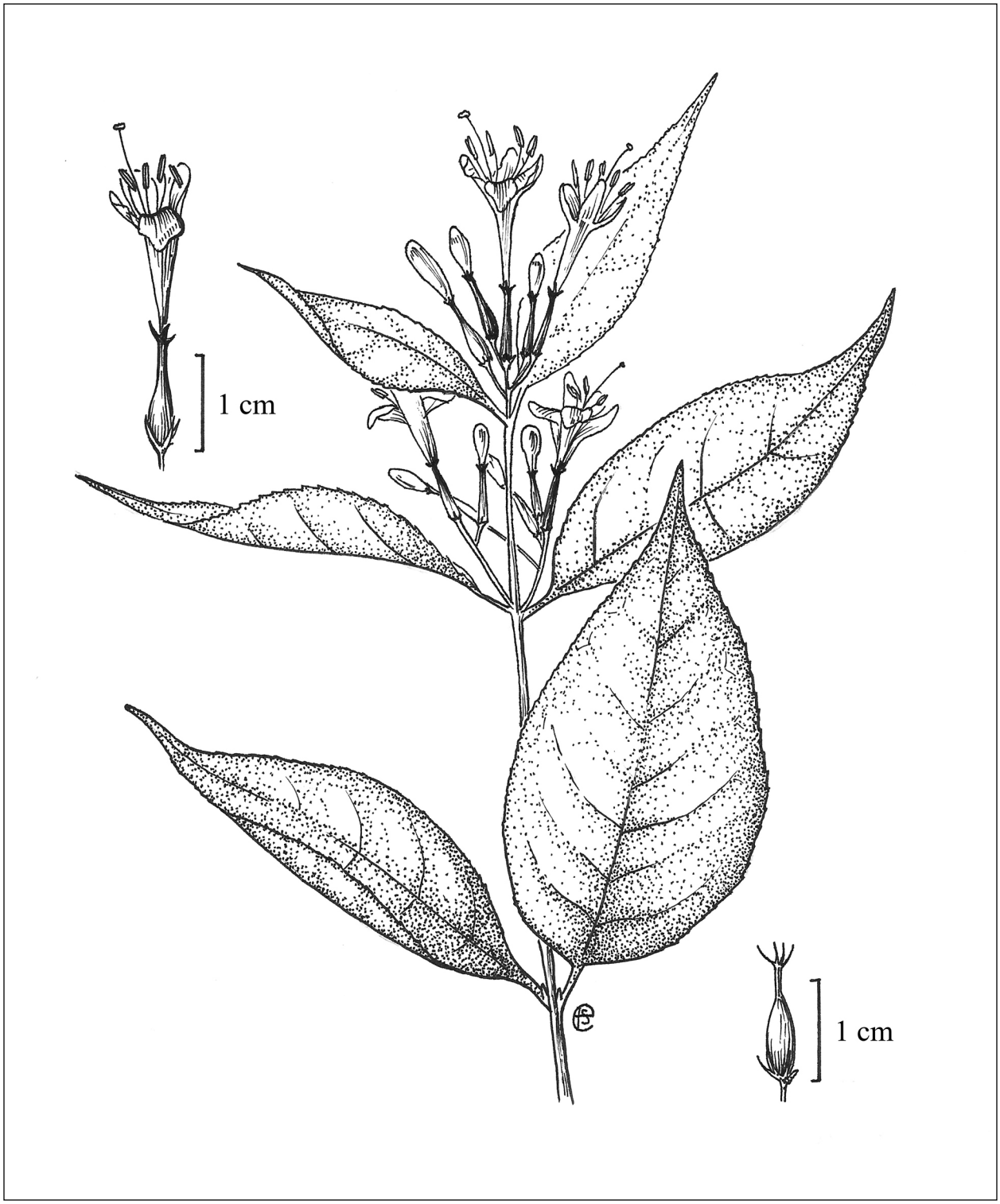
Lonicera diervilla L.

Flowering June–July. Dry woods and open areas, often rocky. A boreal or high-elevation species that has significantly declined in the region, especially in the southern portion.

Self-incompatible, non-apomictic, protogynous, and adapted for pollination by bumble bees (*Bombus* spp.) and hawk moths (family Sphingidae) (Lovell 1900, Schoen 1977). Ovule number per flower increases later in the season, and the plant produces more flowers early in the season. This pattern indicates a possible link between ovule number per flower and expected pollinator abundance (Thomson 1985). In addition to being at the southern extent of its range, this species may have been lost from the southern portion of the region because of a loss of pollinators (Gillespie 2010, Goulson et al. 2005, Williams and Osborne 2009).



Distribution of *Diervilla lonicera*, or bush honeysuckle, recorded in the New York Metropolitan Region during three time categories.



Flower, flowering twig with leaves, and pistil of *Diervilla lonicera*. Illustration by Emma Skurnick.

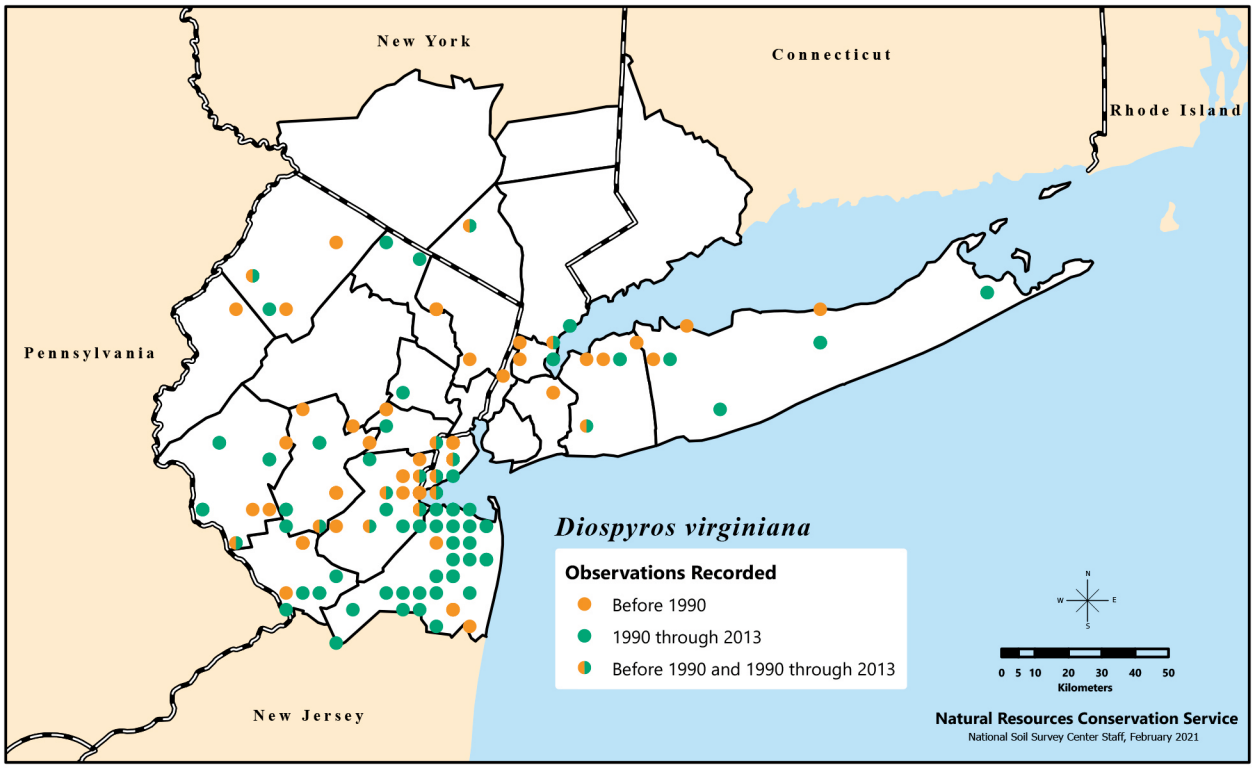
Diospyros L. – persimmon

Ebenaceae. Trees, shrubs. Species 400–700, chiefly tropical, in Africa, Asia, Europe, North America, South America, and the West Indies. Species' ranges difficult to define; White (1962) coined the term ochlospecies ("mob species") for many of the species in Africa that graded into one another. Wood hard, with dark heartwood. Fleshy berry fruit exceptionally astringent when young, but sweet when ripe, especially after exposed to frost. Usually dioecious, although some individuals rarely monoecious, including the native *Diospyros virginiana*. Besides the native species treated here, the cultivated persimmon, *D. kaki* L. f., native to Asia (fruit to 10 cm) occasionally planted; fruiting material (from monoecious individuals) observed in cultivation just outside the region in southern NJ. Species primarily pollinated by bees (order Hymenoptera). Genus name is derived from the Greek "Dios" ("Jove" or "Jupiter") and "pyros" (grain), probably in reference to the fruit.

Native Species

1. *Diospyros virginiana* L. – common persimmon, possumwood ↔

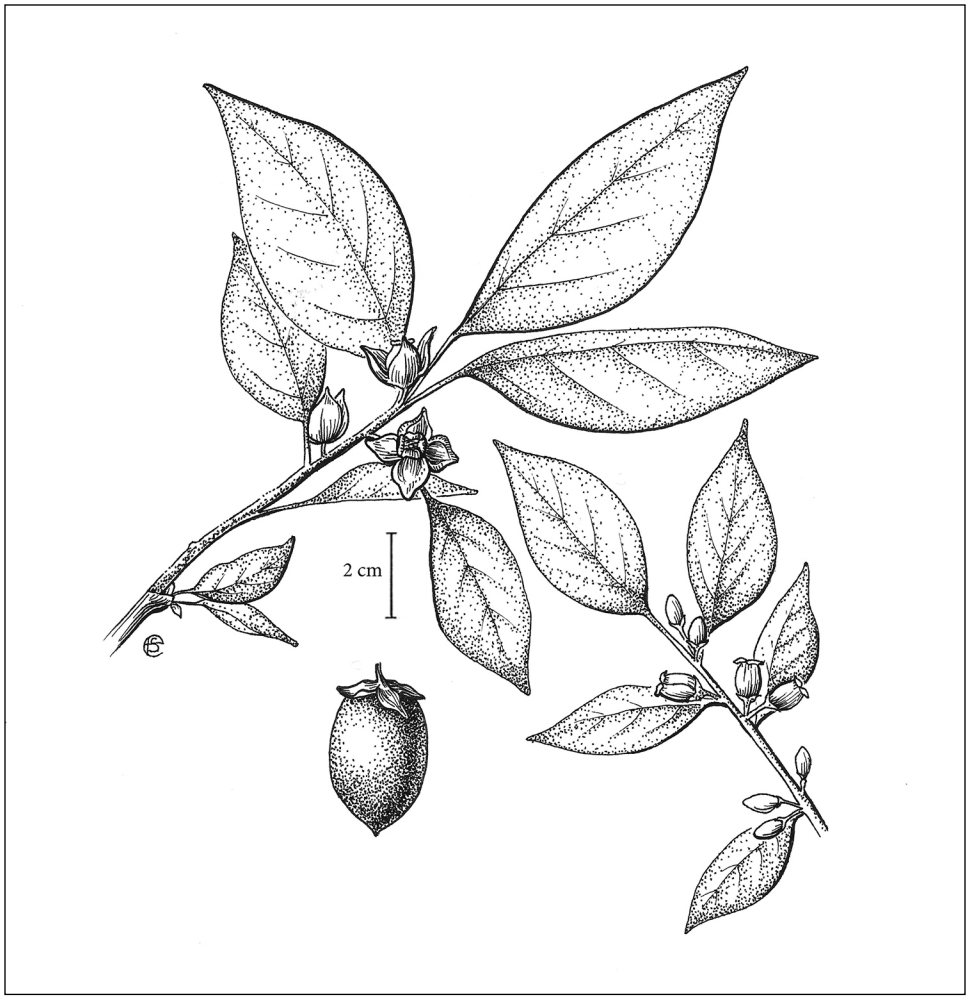
Tree. Flowering May–June; fruiting Oct.–Nov. When not in fruit, readily distinguished by blocky bark and finely reticulate venation on leaf undersides. Shiny, oily flat seeds also distinctive. Seed dispersal dependent on animals (Skallerup 1953). Seeds commonly observed in scat, especially opossum (*Didelphis virginiana*), which prefers the fruit. Widely used by Native Americans and early colonists from Europe in a variety of foods (fresh or dried), such as puddings, pies, and syrup, beer, brandy, and a coffee substitute (seeds). Native Americans also used it to make medicine (astringent, antiseptic, treatment of uterine hemorrhage, diarrhea, dysentery, diphtheria, gonorrhea, hemorrhoids, syphilis, and thrush) and the wood was used for gunstocks, chisel handles, shafts of carriages, and the heads of golf clubs; green fruit were used to make ink and the bark was used to make a dye (Briand 2005).



Distribution of *Diospyros virginiana*, called common persimmon or possumwood, recorded in the New York Metropolitan Region during three time categories.

Diospyros kaki (Japanese persimmon, which is now used commercially instead of *D. virginiana*) is cultivated using *D. virginiana* rootstocks, but disease has been shown to be transmittable from *D. virginiana* rootstocks and unhealthy neighbors of *D. kaki* scions. Only *D. kaki* is affected (Cohen et al. 1991), suggesting *D. virginiana* has defenses against these pathogens. Injured roots sucker and can produce dense clones, but these are rarely seen. Its relatively slow rate of growth makes it susceptible to being shaded out by faster-growing trees. Appears to be limited to temperatures above -3.89 °C and rainfall of at least 76.2 cm annually (Skallerup 1953). Polyploidy with two chromosome races (2n=60 and 2n=90); those found in the region likely 2n=90 (Baldwin and Culp 1941). Approaches the northern limit of its range in the region. Populations, especially in the northern areas, may represent a mixture of native and adventive or escaped material. Some native trees can be found on Staten Island, whereas most of the plants in NY are escapes from cultivation, although there are some native trees on Staten Island (Weldy et al. 2020). Species has apparently spread northward recently. All material examined from region is referable to *D. virginiana* var. *virginiana*, the leaves and branchlets being glabrous. *Diospyros virginiana* var. *pubescens* has branchlets and leaf undersides pubescent, and is not known north of VA.

Tracked as critically imperiled in CT (S1). Listed as threatened in NY (S2). Treated as a nonnative in MA.



Leafy twig with staminate flowers (upper) and twig with pistillate flowers (lower), and fruit of *Diospyros virginiana*. Illustration by Emma Skurnick.

Dirca L. – leatherwood

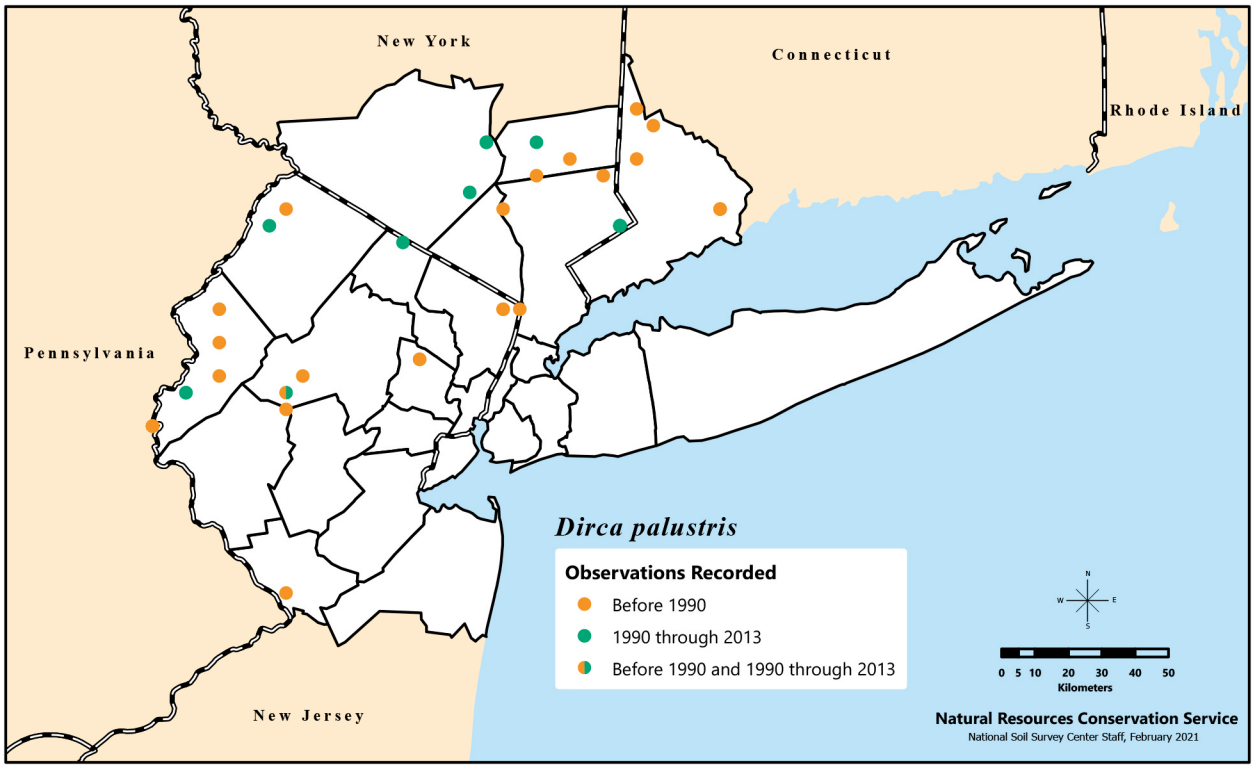
Thymeliaceae. Shrubs. Species 4 in North America. Genus is named after Dirce, wife of Lycus, in Greek mythology.

Native Species

1. *Dirca palustris* L. – leatherwood ↓↓

Flowering Mar.–Apr. before the leaves appear. Mesic deciduous or mixed deciduous coniferous woodlands. Prefers mesic, shady areas and deep soils high in organic matter; often found in alluvial areas and ravines (Dirr 1998). Apparently prefers more alkaline soils and may be a facultative calciphile (a plant that appears to prefer alkaline soils when soils are moist) (Nevling 1962), though it is also associated with slightly acidic soils in other areas (Ward and Horn 1998). Difficult to recognize, because the flowers last only a short time in early spring. The flexible, jointed branches and alternate leaves are good features for general recognition. Epithet from Latin is slightly misleading; the species generally does not occur in true swamps.

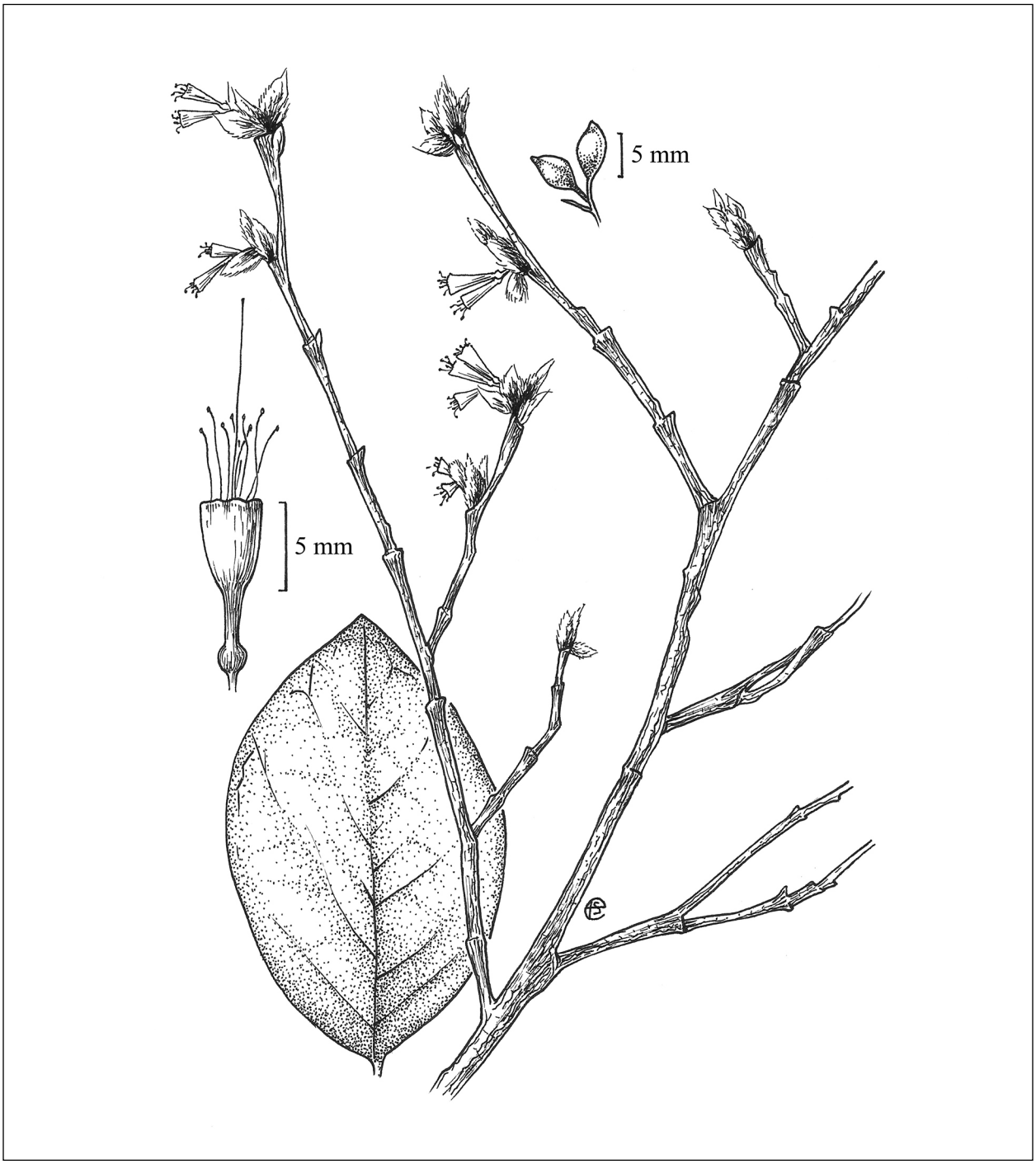
Flowers are perfect and pollinated by insects, mainly bees (order Hymenoptera), but with evidence of self-compatibility or apomixis (or both) (Williams 2004). Flowers 2–3 weeks before forest canopy leafs out and usually before most spring ephemerals bloom. Height at maturity 3–4 m. Individuals as old as 50 years have been found. Does not sprout well in response to stem damage or removal (Zasada et al. 2008). Fruit production depends on shrub size. Smaller individuals growing in shade tend to have 1–2 years of conspicuously good fruit production with many poor fruit production years; larger individuals and individuals in sunlight are more consistent fruit producers (Schulz et al. 2004). Fruit is eaten by birds and never remains on the plant for long (Peterson and Graves 2011). Early flowering may put this species at risk of limited pollinator activity due to lower temperatures. Native Americans used the bark for bow strings, fishing lines, and baskets (Dirr 1998). Not browsed by deer (*Odocoileus* spp.), possibly because of high calcium oxalate crystal content (Holm 1921) or diuretic qualities (Meeker 1993) of the vegetation. Thus, unlike



Distribution of *Dirca palustris*, or leatherwood, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Middlesex County (NJ) and Bronx, New York, Richmond, and Rockland Counties (NY).

many other plants in decline, the decline of leatherwood cannot be attributed to deer. Cultivated since 1750 but with little availability of a commercial source. Some research indicates that if genotypes are selected with greater shoot and root growth and horticultural production uses an acidic medium, *D. palustris* could potentially become a viable horticultural plant (Peterson 2009).

Tracked as imperiled in NJ (S2).



Flowering twig, leaf, flower, and fruits of *Dirca palustris*. Illustration by Emma Skurnick.

Elaeagnus L. – Russian olive, autumn olive

Elaeagnaceae. Shrubs, small trees. Species 50–70 in Asia; northeastern Australia 1; southern Europe 1, possibly an early introduction; and North America 1, native to Midwest and West. Actinobacteria in root nodules fix nitrogen. Leaves copiously dotted (on one or both sides) with silver-brown scales. Fruit proper is a nutlet; fleshy calyx tube enclosing the nutlet gives appearance of a drupe. Genus name derived from the Greek "elaia" ("olive") and "agnos" (ancient name for *Vitex agnus castus* L.).

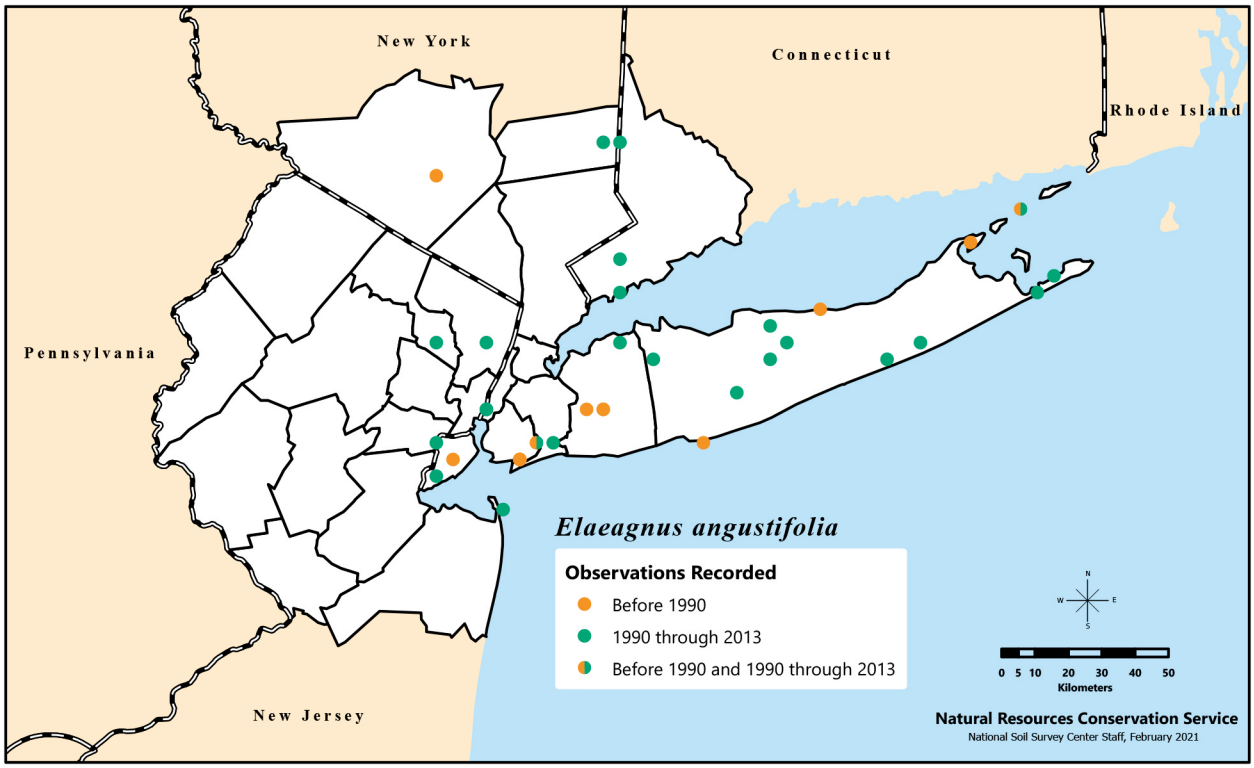
Nonnative Species

1. *Elaeagnus angustifolia* L. – Russian olive ↑

Shrub, small tree. Flowering May–June. Floodplains, riverbanks and streambanks, and marshes; rarely upland woods and disturbed areas. Native to southern Europe and eastern Asia. Not abundant in the region.

Elaeagnus Key

1. Leaves silvery on both sides 2
1. Leaves silvery beneath, soon greenish above 3
2. Branches silvery; fruit yellow . . . . . ***Elaeagnus angustifolia****
2. Branches brown; fruit silvery. . . . . ***Elaeagnus commutata****
3. Bracts brown; fruit ovoid to oblong on stalks 1.2–2.5 cm long. . . . . ***Elaeagnus multiflora****
3. Bracts silvery; fruit subglobose to ovoid on stalks 0.8–1.2 cm long . . . . . ***Elaeagnus umbellata****



Distribution of *Elaeagnus angustifolia*, or Russian olive, recorded in the New York Metropolitan Region during three time categories.

Introduced into the New World for its use as a horticultural plant desired for its silver leaves and colorful berries; it may also have some value as a honey plant. Able to adapt to a range of habitats; planted on highways for erosion control or for sheltering purposes. Due to its association with nitrogen-fixing bacteria, it is commonly used in intercropping to improve soil condition and increase growth yields. However, many of these practices have been reduced because of its threat as an invasive plant (Christensen 1963, Zouhar 2005).

Earliest seed-bearing age 3 years (Olson and Barbour 2008). Seeds germinate best with cold stratification for 60–90 days. Height at maturity 4.6–9 m. Grows in a variety of different soil types and conditions but prefers sandy loams and high light. Can withstand drought and saline soils. At least 1 cultivar (Dirr 1998). Seeds may remain viable in a seed bank for about 3 years (Katz and Shafroth 2003). Much more common in the western U.S. than in the eastern U.S. (Friedman et al. 2005). Like *Elaeagnus umbellata*, *E. angustifolia* is a nitrogen fixer (using *Frankia*) and the degree of nodulation varies with soil pH (highest at a pH of 6.6; Zitzer and Dawson 1992). Decomposing leaves contain high levels of nitrogen (Simons and Seastedt 1999).

Listed as potentially invasive in CT (prohibited).

***Elaeagnus commutata* Bernh. ex Rydb. – silverberry**

Shrub. Flowering May–June. Native to the midwestern and western U.S. One report as a remnant from cultivation from Westchester County (NY).

Occurs only rarely in the region.

***Elaeagnus multiflora* Thunb. – cherry silverberry**

Shrub. Flowering Apr.–May. Native to Asia. Reported once from region in Fairfield County (CT), as a remnant from cultivation or escape.

Occurs only rarely in the region.

2. *Elaeagnus umbellata* Thunb. – autumn olive ↑↑↑

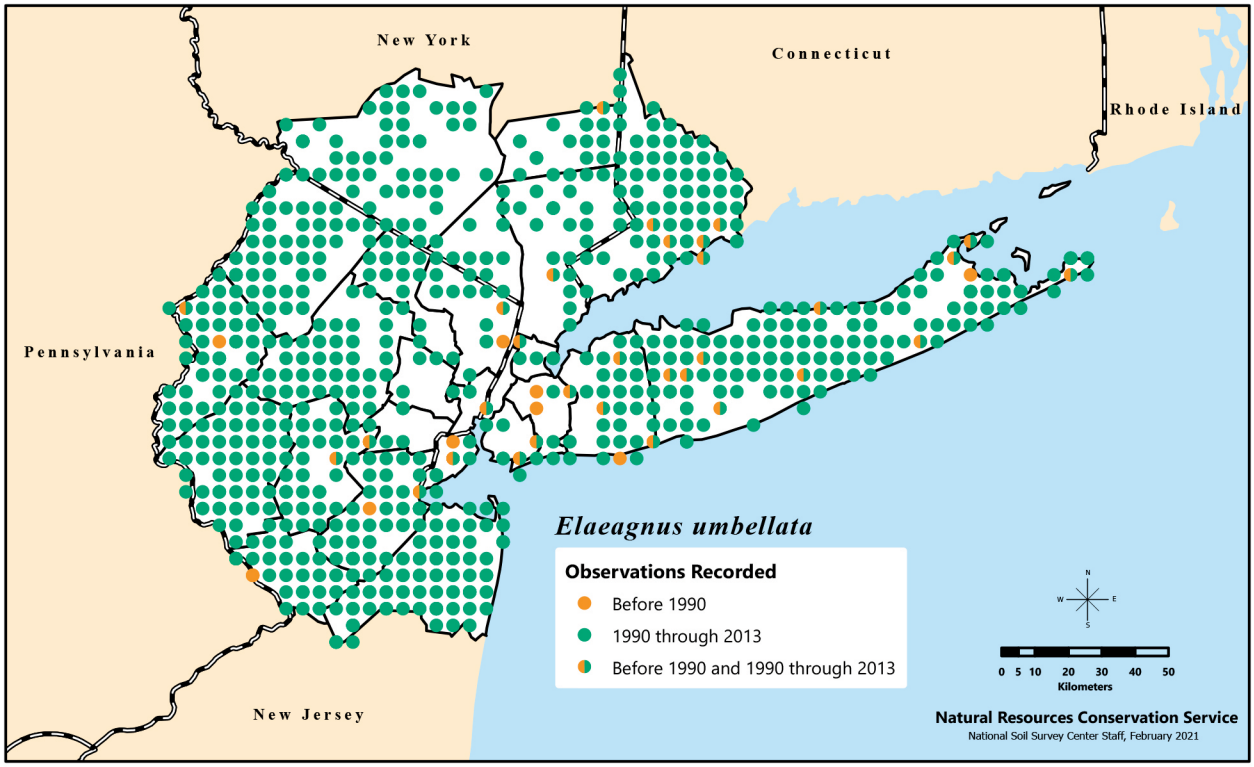
Shrub. Flowering May–June. Mesic to xeric disturbed areas, fields, pastures, thickets, roadsides, open woodlands, and forest edges; rare in dense forests and on wet sites. Native to China, Korea, and Japan.

Cultivated in the U.S. since about 1830 for horticulture, erosion control, wildlife food, and shelter. Height at maturity 3.7 m. Earliest seed-bearing age 6 years. Seeds appear to germinate best after 16 weeks of cold stratification (Olson and Barbour 2008). At least 5 cultivars (USDA NRCS 2019); ‘Cardinal’ possibly most common. Adaptable to a variety of conditions, including open areas and shady pine (*Pinus* spp.) and deciduous woods and low soil fertility (Dirr 1998). Associated with nitrogen-fixing *Frankia*, and root nodules are present (Huss-Danell 1997, Tjepkema and Winship 2004); has been used as a nurse plant for *Juglans nigra* (black walnut) (Funk et al. 1979, Paschke et al. 1989). Fruit is high in lycopenes (red carotenoids) (Fordham et al. 2001) and consumed by many different birds and other animals (Suthers et al. 2000). Consumption by European starlings (*Sturnus vulgaris*) improves the germination of its seed (LaFleur et al. 2009). Drought-resistant (Naumann et al. 2010). Flowers very fragrant (Dirr 1998). The floral volatiles contain many compounds that are common constituents of floral fragrances, and thus may have commercial value (Potter 1995).

Listed as invasive and prohibited in CT and NY; tracked as invasive in NJ (category 1).

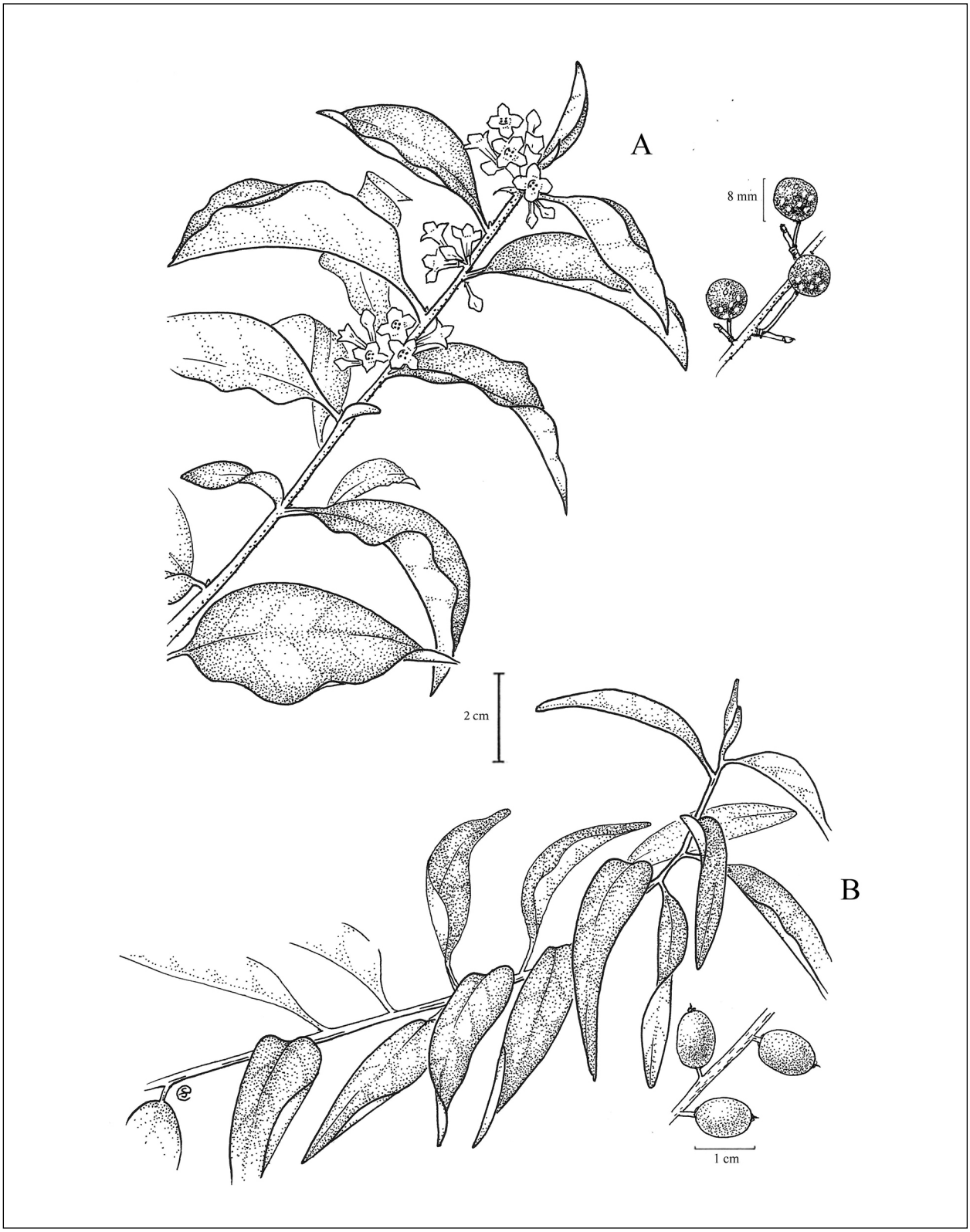
Management

Both *Elaeagnus umbellata* and *E. angustifolia* have the capacity to change the soil quality of the ecosystems that they invade by increasing nitrogen levels. Such a change may make the system more amenable to reinvasion by their progeny as well as other invasive species that can utilize nitrogen at competitive rates compared to existing native species. Once the soil characteristics have changed, it may take several years for the



Distribution of *Elaeagnus umbellata*, or autumn olive, recorded in the New York Metropolitan Region during three time categories.

ecosystem to recover even after complete removal of these shrubs. The drought-resistance of these species may also indicate that expansion into drier areas is in response to climate change. These species sprout prolifically, so fire or harvesting the stems without removing or killing the root system will not be effective. Aerial foliar sprays of herbicides may be the most effective method of controlling very dense populations of these shrubs (Katz and Shafroth 2003). Retreatments are likely to be needed because a seed bank may exist and nearby populations may be dispersed easily back into the open area by birds. Despite the potential benefits to wildlife, the risk of these species changing ecosystem nutrient cycles and the ease of seed dispersal are of greater concern. We strongly advise against planting either species.



Flowering twig with leaves and fruit of A) *Elaeagnus umbellata* and B) *Elaeagnus angustifolia*. Illustration by Emma Skurnick.

Empetrum L. – crowberry

Ericaceae. Dwarf shrubs. Species 1–5; northern and southern Antarctic, Arctic, and temperate areas; Asia, Europe, and North America. Genus name is an ancient Greek name meaning "on the rocks."

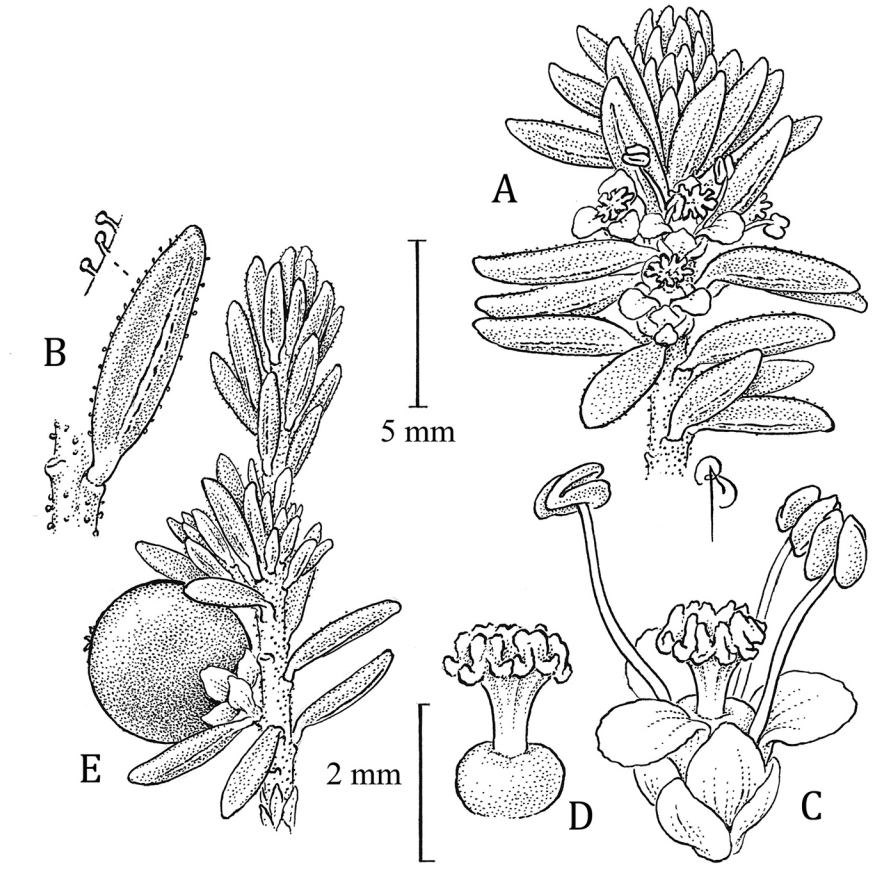
Native Species

1. *Empetrum nigrum* L. – black crowberry Ø♥

Empetrum eamesii subsp. *hermaphroditum* (Hagerup) D.Löve; *Empetrum hermaphroditum* Hagerup; *Empetrum nigum* subsp. *hermaphroditum* (Hagerup) Böcher; *Empetrum nigrum* var. *hermaphroditum* (Hagerup) T.J.Sørenson

Flowering Mar.–Apr. Open heathlands. Historical for the region, with only one record (1924) from Long Island in eastern Suffolk County (NY). All other records in NY from upstate in Essex County, nearly 500 km to the north. Epithet refers to the black drupaceous fruit. Murray et al. (2009) rejected the recognition of infraspecific taxa based on ploidy levels (diploid, tetraploid) and reproduction (monoecy, dioecy) because monoecious tetraploids appear to have arisen multiple times from diploids (Popp et al. 2011).

Tracked as rare in NY (S2).



A) Twig with leaves and flowers; B) leaf with enlarged view showing glands; C) flower; D) pistil; and E) twig with leaves, and fruit of *Empetrum nigrum*. Illustration by Bobbi Angell.

D E

Epigaea L. – mayflower

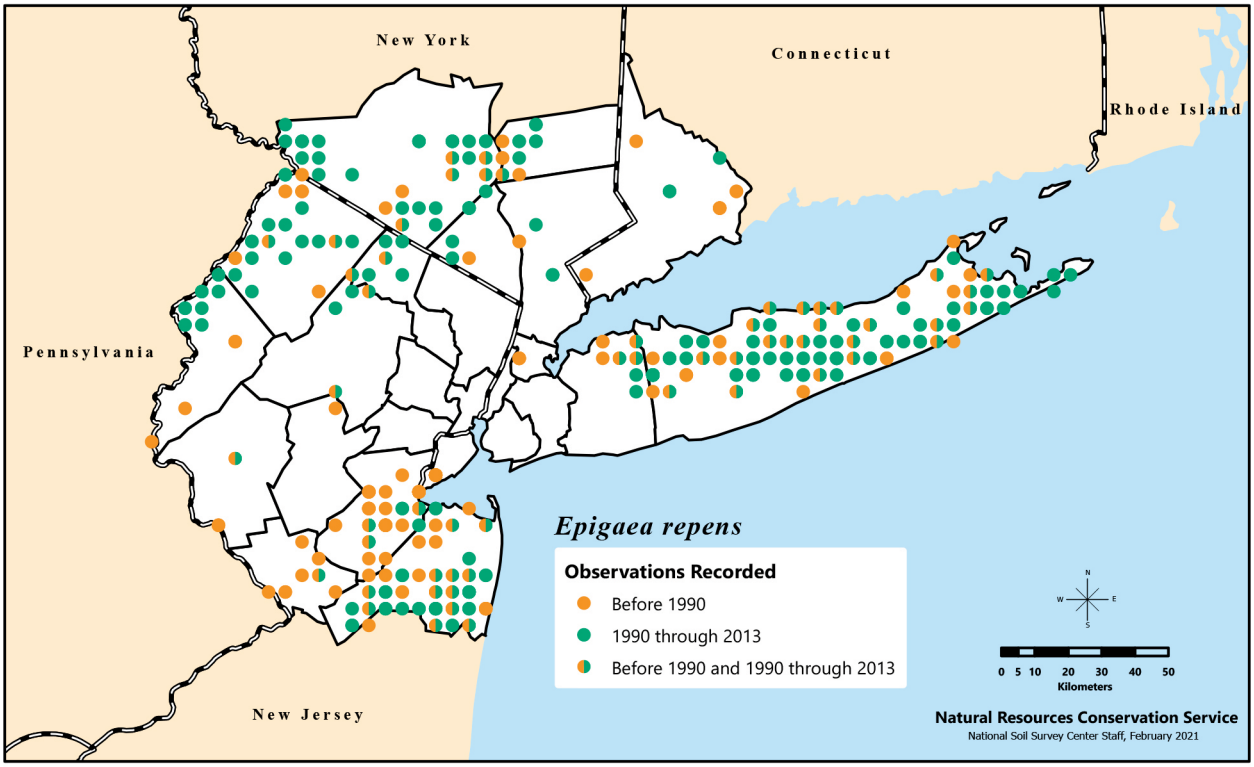
Ericaceae. Creeping subshrubs. Species 1 each in Asia (Japan), eastern Europe (Georgia, Turkey), and North America. Flowers fragrant with significant variation in size and color; corollas white to pink, 0.5–1.5 cm. Cryptic dioecy; male flowers usually larger than female flowers. Seeds dispersed by ants (family Formicidae). Upon dehiscence of seeds, the capsule becomes fleshy and rather berry-like. Genus name is derived from the Greek "epi" ("on") and "gaea" ("earth"), a reference to its prostrate habit.

Native Species

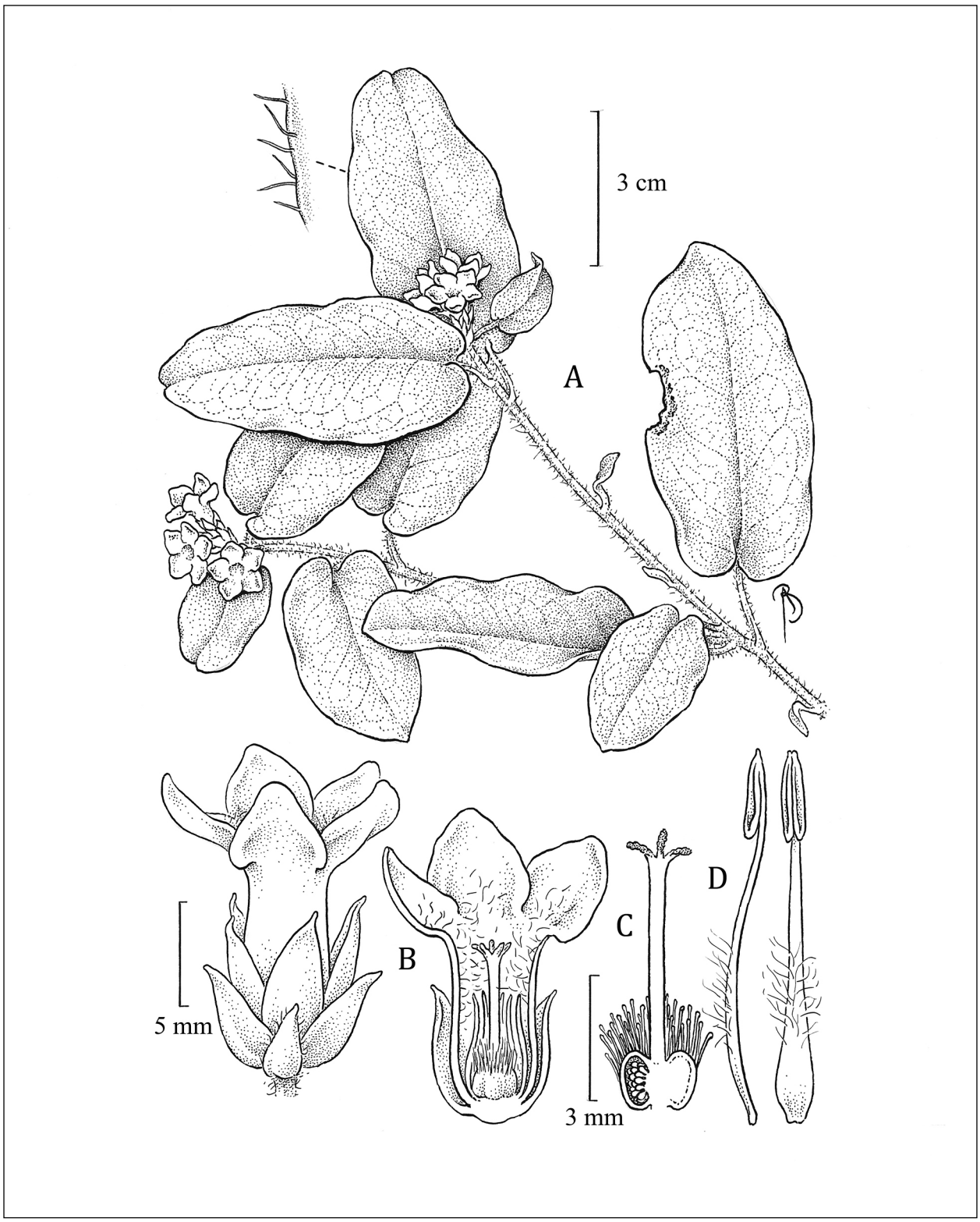
1. *Epigaea repens* L. – trailing arbutus ↔

Flowering late Mar.–May. Oak (*Quercus* spp.) and pine (*Pinus* spp.) woods on sandy or rocky acidic soils; occasionally in rich woods or pond margins. Like the genus name, epithet refers to its prostrate, repent habit. Rarely, a double-flowered form, *Epigaea repens* f. *plena* Rehd., is encountered.

Several insects visit the flowers, including *Aglais milberti*, *Bombus bifarius*, *B. terricola*, *B. vagans*, *Bombylius major*, *Hemaris diffinis*, and *Nymphalis antiopa* (Clay and Ellstrand 1981, Ward 1880, Weed 1894). Placental tissue sweet; ants remove portions of the placenta with attached seeds and return them to their nests. Chipmunks (subfamily Xerinae) may also collect the fruit (Blum and Krochmal 1992, Clay 1983, Clay and Ellstrand 1981). Growth best in association with mycorrhizal fungi; propagation from stems very likely requires a mycorrhizal association (Bonner 2008e). Increases follow a triband elevational pattern similar to *Comptonia peregrina* and *Gaultheria hispidula.*



Distribution of *Epigaea repens*, or trailing arbutus, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Bergen County (NJ).



A) Flowering twig with leaves and enlarged view of leaf margin showing ciliate hairs, B) flower and flower cross-section showing stamens and pistil, C) pistil and cross-section of pistil showing ovules, and D) stamens of *Epigaea repens*. Illustration by Bobbi Angell.

D E

Eubotrys Nutt. – sweetbells, fetterbush

Lyonia subg. *Eubotrys* (Nutt.) A.Gray

Ericaceae. Shrubs. Species 2 in eastern North America. In some treatments, the two species here are placed in a more broadly circumscribed *Leucothoe* D.Don. When treated as a distinct genus, the genus name *Cassandra* Spach (1840) has sometimes been applied. However, this name is an illegitimate later homonym of *Cassandra* D.Don (1834) and cannot be used. *Eubotrys* Nutt. (1842) is a later homonym of *Eubotrys* Raf. (1840); however, *Eubotrys* Nutt. has been formally conserved (Reveal et al. 2009) over *Eubotrys* Raf. and is therefore available for use. The gender is masculine, hence epithets "racemosus" and "recurvus." Genus name is from the Greek "eu-" ("good") and "botrys" ("bunch"), in reference to the racemose inflorescence.

Native Species

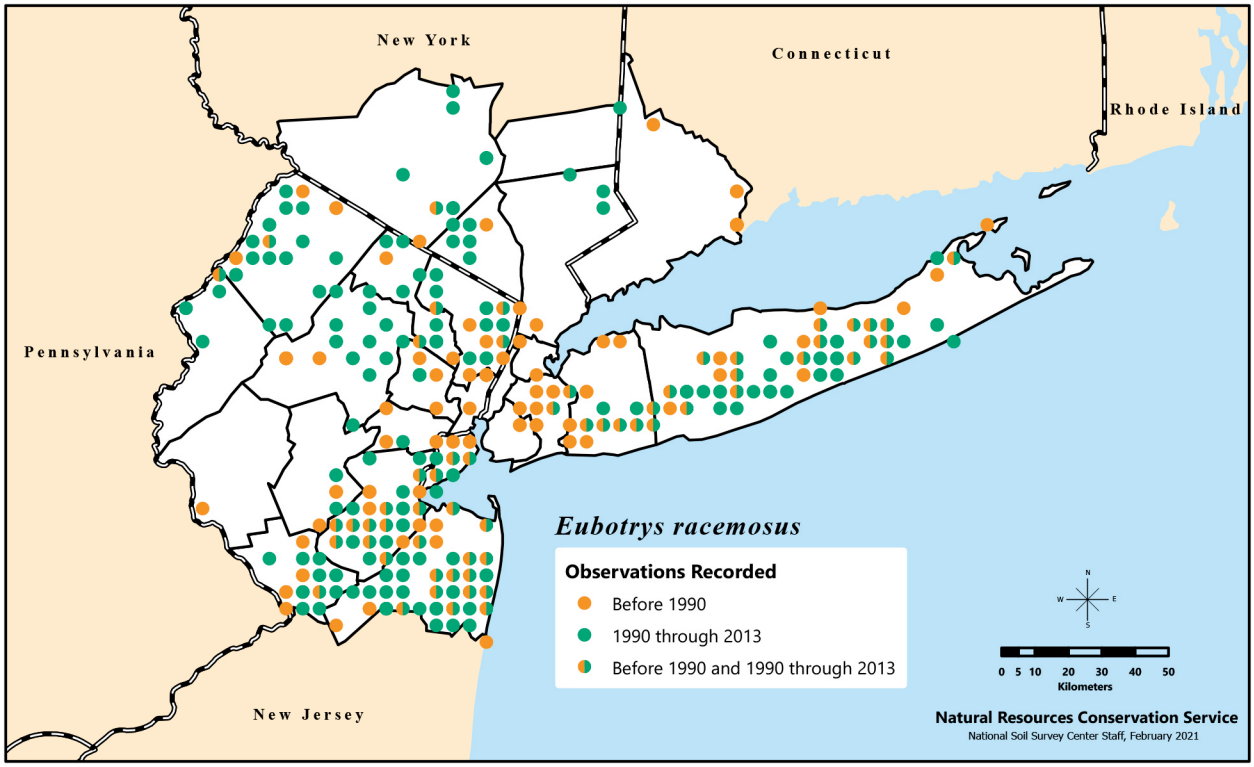
1. *Eubotrys racemosus* (L.) A.Gray – sweetbells ↔

Andromeda racemosa L.; *Cassandra racemosa* (L.) Spach; *Leucothoe racemosa* (L.) A.Gray

Flowering in May. Wet (cedar swamps, shrub fens, shores, and bogs) to dry (oak [*Quercus* spp.] and pine [*Pinus* spp.] woods) areas, with a soil pH of 4.5–5.5 (Wherry 1920).

Eubotrys Key

1. Racemes ascending to erect; seeds not winged (Judd et al. 2012). . . . . ***Eubotrys racemosus***
1. Racemes curved to recurved; seeds winged. . . . . ***Eubotrys recurvus****



Distribution of *Eubotrys racemosus*, or sweetbells, recorded in the New York Metropolitan Region during three time categories.

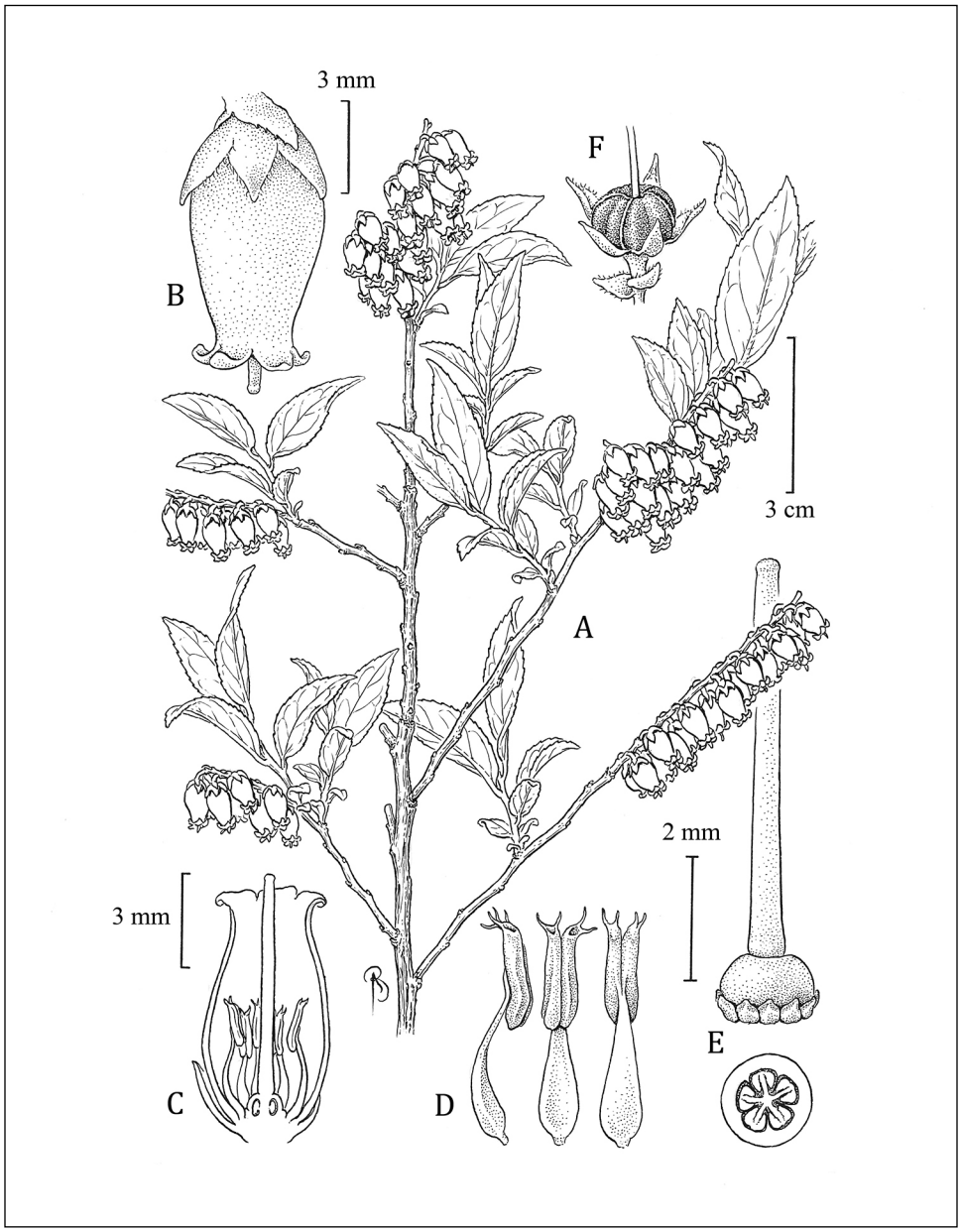
Tends to sucker and produce thickets. Has potential landscaping uses for mesic, shady areas; grows primarily as an understory shrub naturally (Dirr 1998).

Nonnative Species

***Eubotrys recurvus* (Buckley) Britton – fetterbush**

Andromeda recurva Buckley; *Leucothoe recurva* (Buckley) A.Gray

Flowering late Apr.–May. Upland woods and edges of woodlands; heath balds, bogs, and granitic domes (Tucker 2009). Native to mesic woodlands in the Appalachian Mountains (Harper 1947), and recently reported as naturalized outside of its native range, including possibly the NY Metropolitan Region. A population either naturalized or persistent from cultivation is known from Suffolk County (NY).



A) Flowering twig with leaves, B) flower, C) cross-section of flower, D) stamens, E) pistil and cross-section of ovary showing ovules, and F) capsule of *Eubotrys racemosus*. Illustration by Bobbi Angell.

Euonymus L. – burning bush, spindletree

Celastraceae. Shrubs, rarely small trees. Species 125+ in Asia, Australia, and North America. Bees (order Hymenoptera) and flies (order Diptera) are the main pollinators (Brizicky 1964). Fruit primarily bird dispersed (Snow and Snow 1988). Caterpillars of several moth genera (e.g., *Ectropis*, *Herpetogramma*, *Yponomeuta*, and the nonnative euonymus leaf notcher [*Pryeria sinica*]) eat the leaves. Other insects that eat *Euonymus* include weevils (e.g., *Otiorhynchus*) and *Euonymus* scale (*Unaspis euonymi*) (Krischik and Davidson 2013, Hilty 2017). Moist cold stratification required for germination of all species (Zasada and Rudolf 2008), for 60 to 120+ days (Zasada and Rudolf 2008). Species in the region are placed in 4 sections in *Euonymus* L. subg. *Euonymus* (Ma 2001). Genus name is derived from the ancient Greek "euōnumos," meaning "good name," the derivation being ironic as some species of the genus can be poisonous to livestock. In earlier works, the genus name is often spelled *Evonymus*, the original spelling by Linnaeus now abandoned. Some works treat the name *Euonymus* as feminine (instead of masculine as used here) and thus spell the species epithets differently from those used here (e.g., *americana* instead of *americanus*).

Native Species

1. *Euonymus americanus* L. – strawberry-bush, bursting heart ↓↓

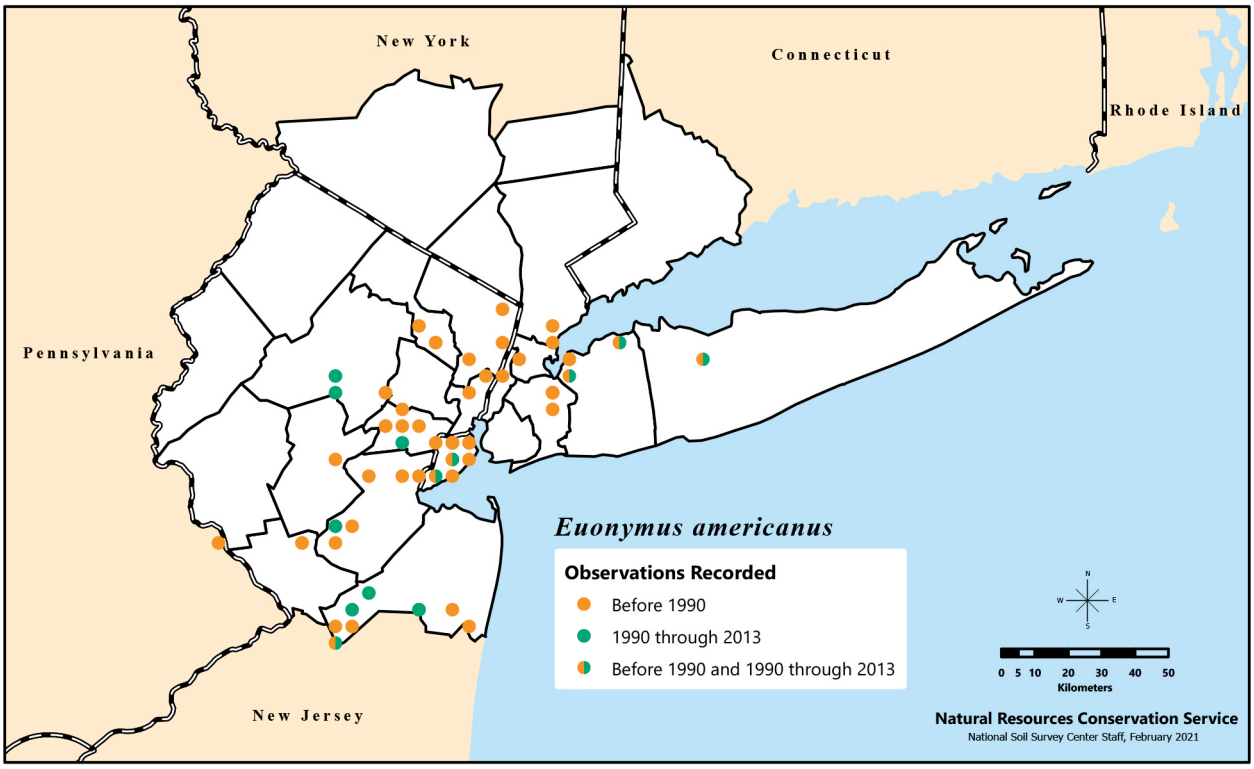
Flowering late May–early July. Woods, dune thickets, riverbanks, and fencerows.

Moist warm stratification for 3 months, followed by 3 months of moist cold stratification, recommended for germination (Dirr 1998, Zasada and Rudolf 2008). Height at maturity 0.9–1.8 m (Zasada and Rudolf 2008). Populations are often heavily impacted by deer (*Odocoileus* spp.) browse; larger plants found in thickets of briars or other armed plants that presumably protect the species from browse. Earlier literature on the region (e.g., Taylor 1915), when deer were less abundant, report *Euonymus americanus* being more common. This species is sometimes referred to as "deer ice cream." Rarely planted despite having red fall foliage and scarlet fruit like *E. alatus*. Extracts from its bark have been used to treat dandruff, uterine troubles, venereal diseases, and skin ailments, and to induce vomiting. Roots and seeds have been used as a laxative (Kurz 1997), but may also be poisonous (Foster and Duke 1990). Highly susceptible to *Euonymus* scale. Cultivated since 1697 (Dirr 1998). Reaching the northern limit of its range in NY; has declined considerably in the region.

Listed as endangered in NY (S1).

Euonymus Key

1. Procumbent, trailing, or climbing shrub . . . . ***Euonymus fortunei**** [*Euonymus* section *Ilicifolia* Nakai]
1. Upright (sometimes straggling) shrub 2
2. Twigs with 2–4 corky wings . . . . ***Euonymus alatus**** [*Euonymus* section *Melanocarya* (Turcz.) Nakai]
2. Twigs lacking corky wings 3
3. Leaves finely hairy beneath . . . . . ***Euonymus atropurpureus*** [*Euonymus* L. section *Euonymus*]
3. Leaves glabrous beneath 4
4. Petioles 1–3 mm; flowers mostly 5-merous; capsule tuberculate . . . . . ***Euonymus americanus*** [*Euonymus* section *Echinococcus* Nakai]
4. Petioles 7 mm or longer; flowers mostly 4-merous; capsule smooth . . . . . ***Euonymus europaeus**** [*Euonymus* L. section *Euonymus*]



Distribution of *Euonymus americanus*, called strawberry-bush or bursting heart, recorded in the New York Metropolitan Region during three time categories.

2. *Euonymus atropurpureus* Jacq. – eastern wahoo ↓↓

Flowering early June–mid-July. Mesic woods, thickets, and fencerows. Epithet is Latin for "dark purple," a reference to the color of the capsules. Material in the region is *Euonymus atropurpureus* var. *atropurpureus*.

Moist warm stratification for 60 days, followed by 60 days of moist cold stratification, recommended for germination (Zasada and Rudolf 2008). Height at maturity 1.8–6.2 m. Like *E. americanus*, populations of this species have been shown to be impacted by deer browse. Some populations in the region are not native but are escapes or remnants from cultivation. In NJ, native populations are probably chiefly limited to the Delaware River area (Britton 1889). Some (e.g., Graves 1910, Taylor 1915) question whether the species is native to CT or NY in the region. Darker purplish flowers apparently attract more fly (order Diptera) visitors than the lighter colored *E. americanus*. Though cultivated since 1756 (Dirr 1998, Kurz 1997), today it is rarely utilized. Oil from the seeds was used in both Europe and the U.S. to kill head lice. The bark has been used as a laxative (Kurz 1997), but all parts of the plant may be poisonous (Foster and Duke 1990). Very rare throughout the region.

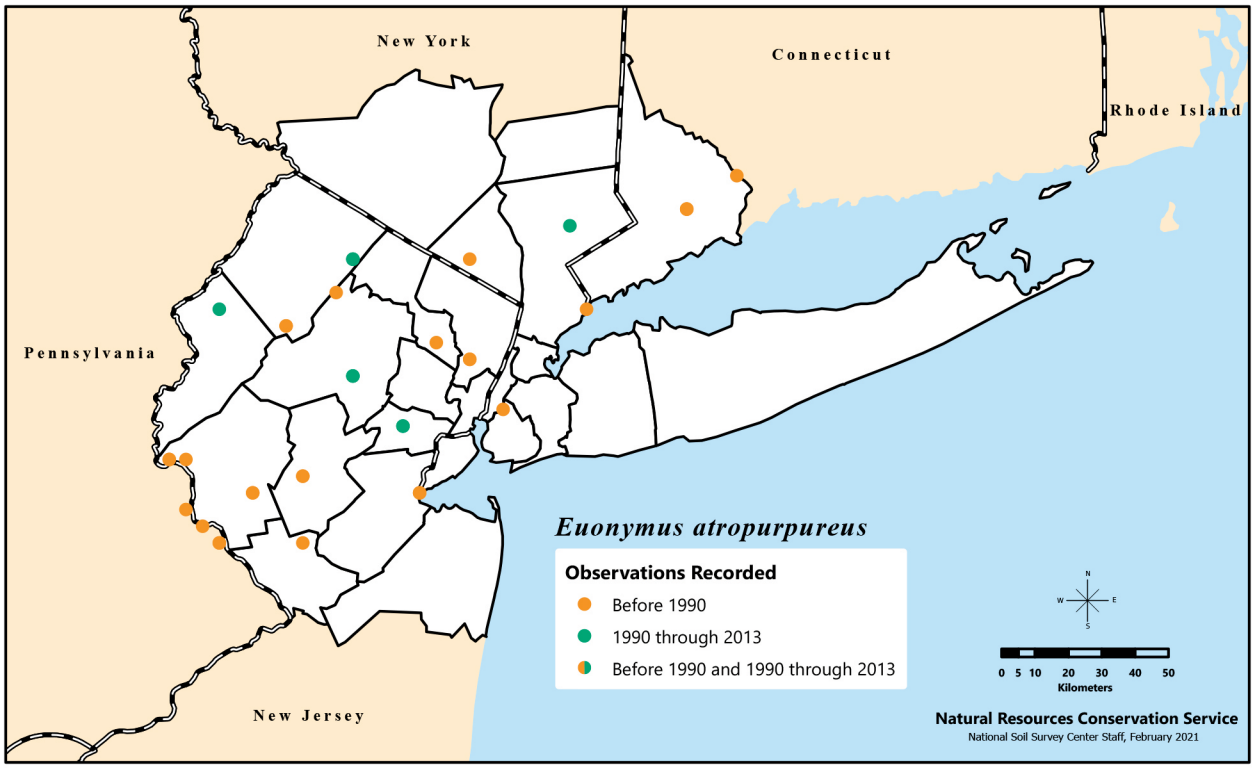
Native populations tracked as possibly critically imperiled in NJ (S1?), with reports from Sussex and Warren Counties.

Nonnative Species

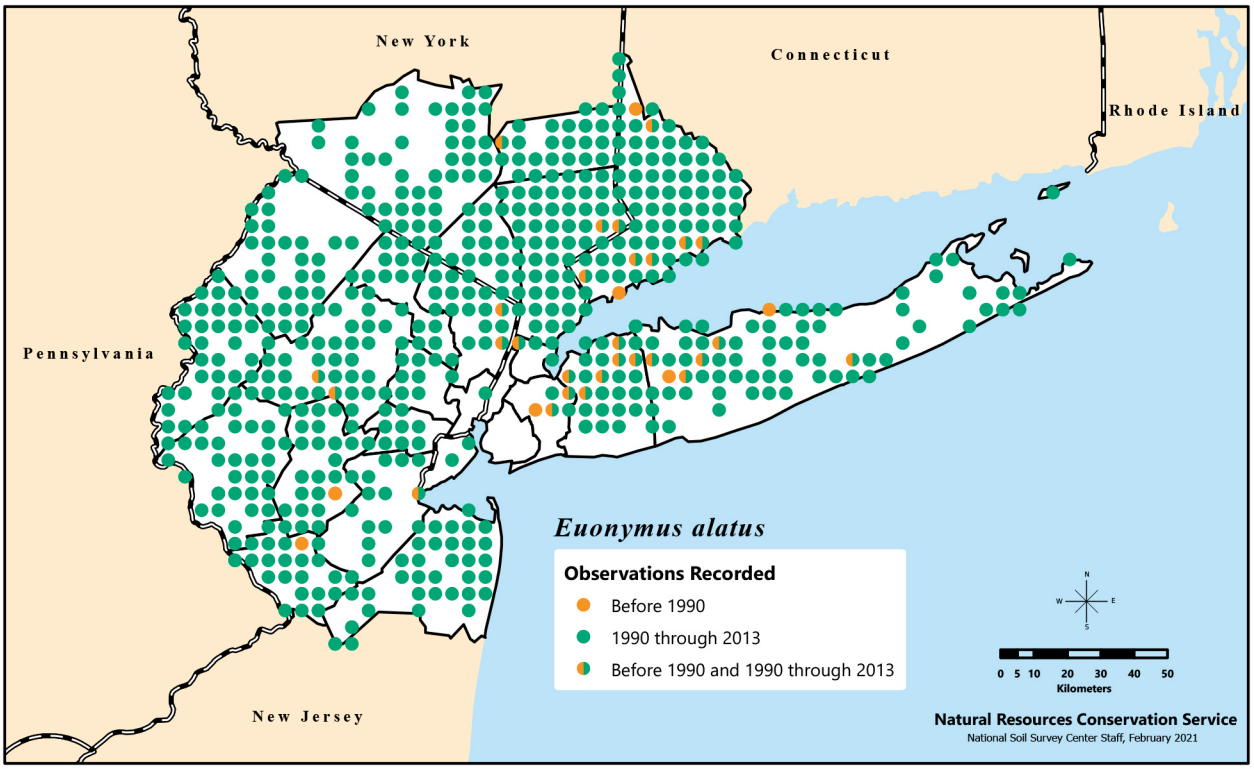
3. *Euonymus alatus* (Thunb.) Sieb. – winged burning bush, spindletree ↑↑↑

Celastrus alatus Thunb.

Flowering late May–late June. Woods, woodland edges, fields, thickets, and roadsides. Native to eastern Asia; commonly cultivated for its attractive red fall foliage. Escaped from cultivation; rapidly spreading throughout the region. Epithet from Latin means "winged," a reference to the corky wings that are often on the twigs.



Distribution of *Euonymus atropurpureus*, or eastern wahoo, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Euonymus alatus*, called winged burning bush or spindletree, recorded in the New York Metropolitan Region during three time categories.

Though it grows better in sunny conditions, it can survive in deep shade (Dirr 1998), and can dominate the understory of mature forests (Ebinger et al. 1984). Propagation can occur from stem cuttings (Smith and Jernstedt 1989) and root suckering, but most spread appears to be from the bird-dispersed seeds (Dirr 1998, Kurz 1997). At least 10 cultivars, some of which do not have winged stems; cultivars vary in size (Dirr 1998) and in degree of invasiveness. The 'Rudy Haag' cultivar is advertised as a noninvasive burning bush, and lower seed and fruit production have been documented for this species (but some seed production still occurs). This cultivar can also cross-pollinate with other cultivars, resulting in a cross with relatively high fruit production (Knight et al. 2011). Thus, a noninvasive *Euonymus alatus* cultivar has not been confirmed. Slow-growing but not susceptible to scale; not generally browsed by deer. Tolerant of most environmental conditions except waterlogged soils or very dry conditions. Adaptable to most pH levels (Dirr 1998).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

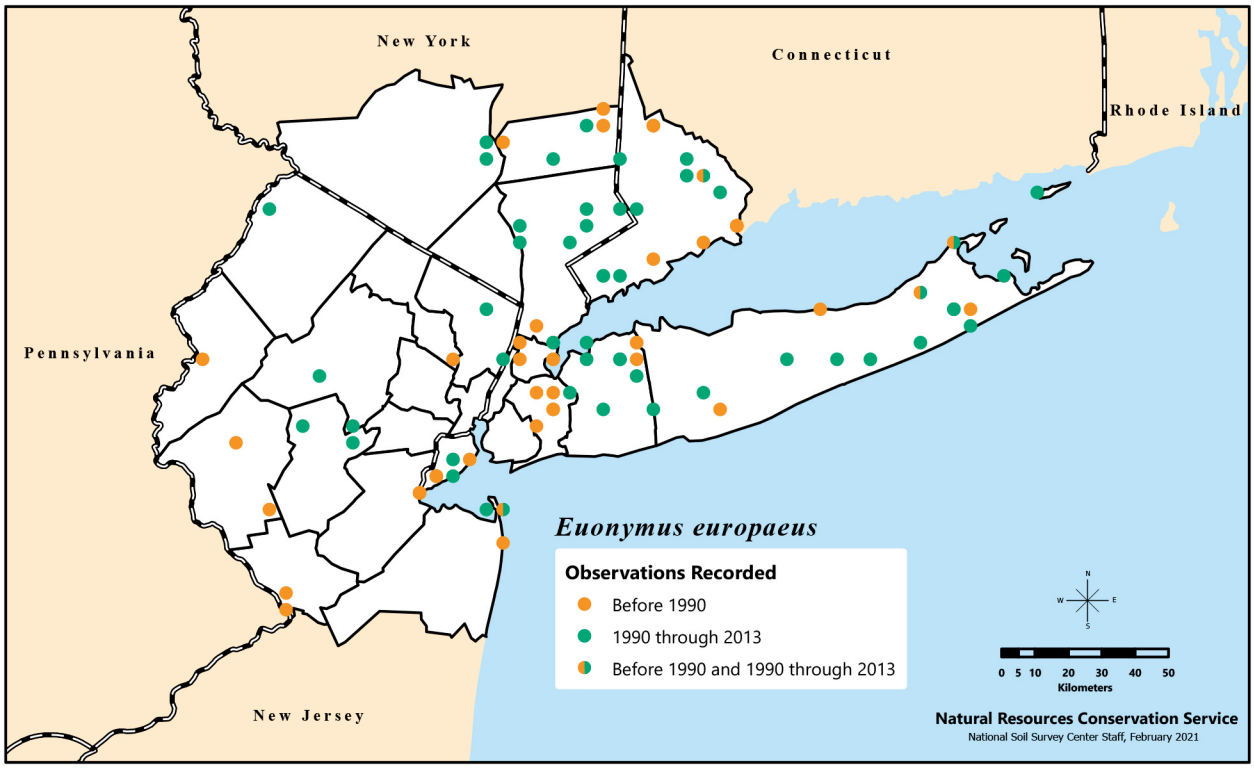
4. *Euonymus europaeus* L. – European spindletree ↔

Flowering late May–early July. Roadsides, fields, and thickets. Native to Europe; currently spreading in the region. While not uncommon, it has been shown to be generally less invasive than *Euonymus alatus* and *E. fortunei*. Cultivated for centuries, with at least 6 cultivars (Dirr 1998). Another nonnative species, *E. japonicus*, would also key here. It differs from *E. europaeus* in having firm, evergreen leaves. See further discussion under *E. fortunei*.

5. *Euonymus fortunei* (Turcz.) Hand. – winter creeper ↑↑↑

Elaeodendron fortunei Turcz.

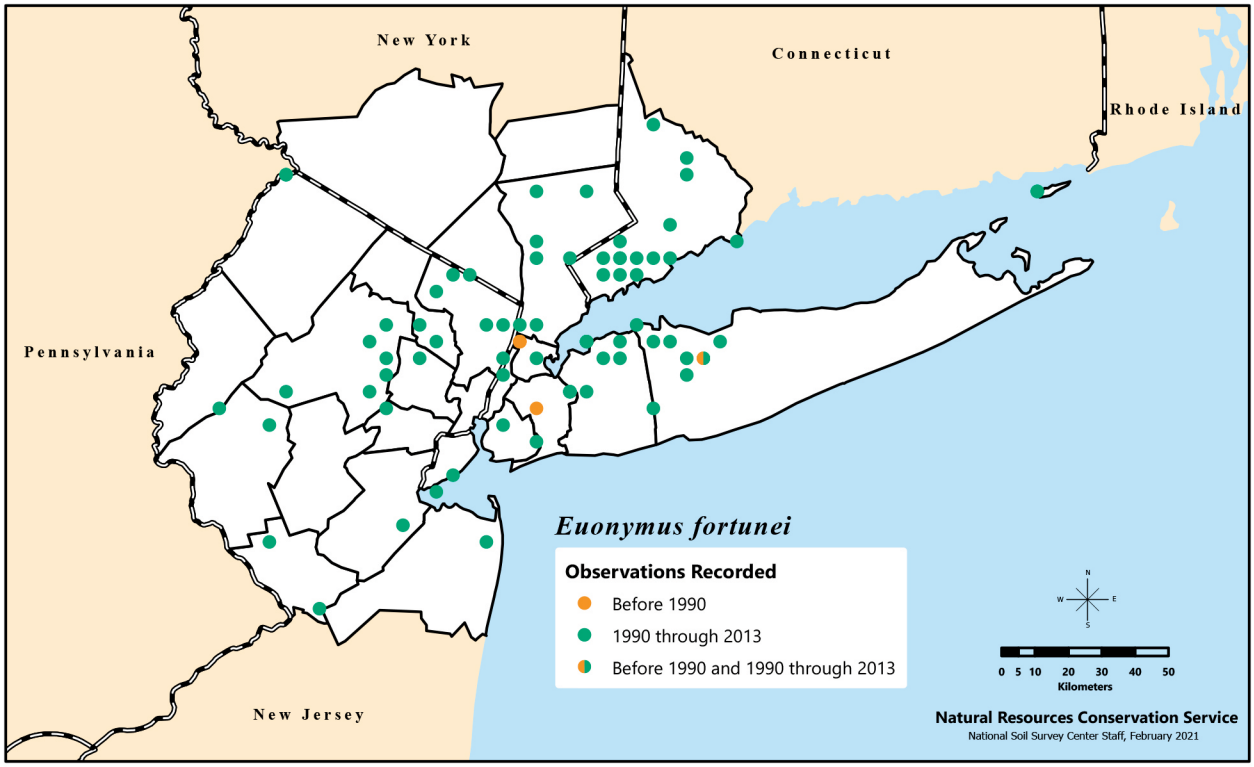
Flowering late May–early July (but see following discussion for later-blooming material).



Distribution of *Euonymus europaeus*, or European spindletree, recorded in the New York Metropolitan Region during three time categories.

Roadsides, fields, and thickets. Native to Asia; species spreading in the NY Metropolitan Region. Other species in the region that would key to *Euonymus fortunei* include *E. japonicus* Thunb. and *E. kiautschovicus* Loes. *Euonymus japonicus* is an erect shrub, with larger (4–7 cm), evergreen, somewhat thick, elliptic to obovate leaves. *Euonymus kiautschovicus* Loes. has a spreading to climbing to somewhat erect habit with larger (5–7 cm), semi-evergreen, somewhat thin, elliptic to obovate leaves; flowers much later (mid-Aug.–mid-Sept.) than other *Euonymus* spp. *Euonymus japonicus* and *E. kiautschovicus* only occasionally encountered as escapes or persisting from cultivation. Epithet is eponymic for Robert Fortune (1817–1880), a Scottish botanist and traveler.

Euonymus fortunei grows rapidly and cuttings root easily, especially if collected in June. Horizontal cuttings will tend to grow along the ground while vertical leaders will tend to grow upward. Easily transplanted; tolerates great variation in environmental conditions, including light and soil pH, but it does not do well in hydric soils. Leaf color varies with the cultivar (Dirr 1998). Trailing or climbing, with small, usually variegated, leaves (2–4 cm); rarely flowers or fruits. Sometimes referred to as *E. radicans* (Siebold ex Miq.) Siebold ex Handel-Mazzetti or *Euonymus fortunei* var. *radicans* (Siebold ex Miq.) Rehder, which are escapes from cultivation or forms of *E. fortunei* (Ma 2001, Ma and Funston 2008). Cultivated since 1907, with at least 53 known cultivars. Mutates readily, which may explain the exceptional morphological and phenological diversity in the species. May form a seed bank (Sakai et al. 2005). Outer fleshy coat of fruit is edible and attracts some predators, such as birds; seed itself is toxic, containing euonosides, alkaloids, and cyanogenic glucosides (Kollmann et al. 1998). Seed toxicity probably true of all species in the genus. Susceptible to several insects and diseases, including scale and anthracnose (Dirr 1998). May alter soil nutrients by increasing carbon, nitrogen, phosphorus, calcium, and magnesium after invading an area (Rounsaville et al. 2019).

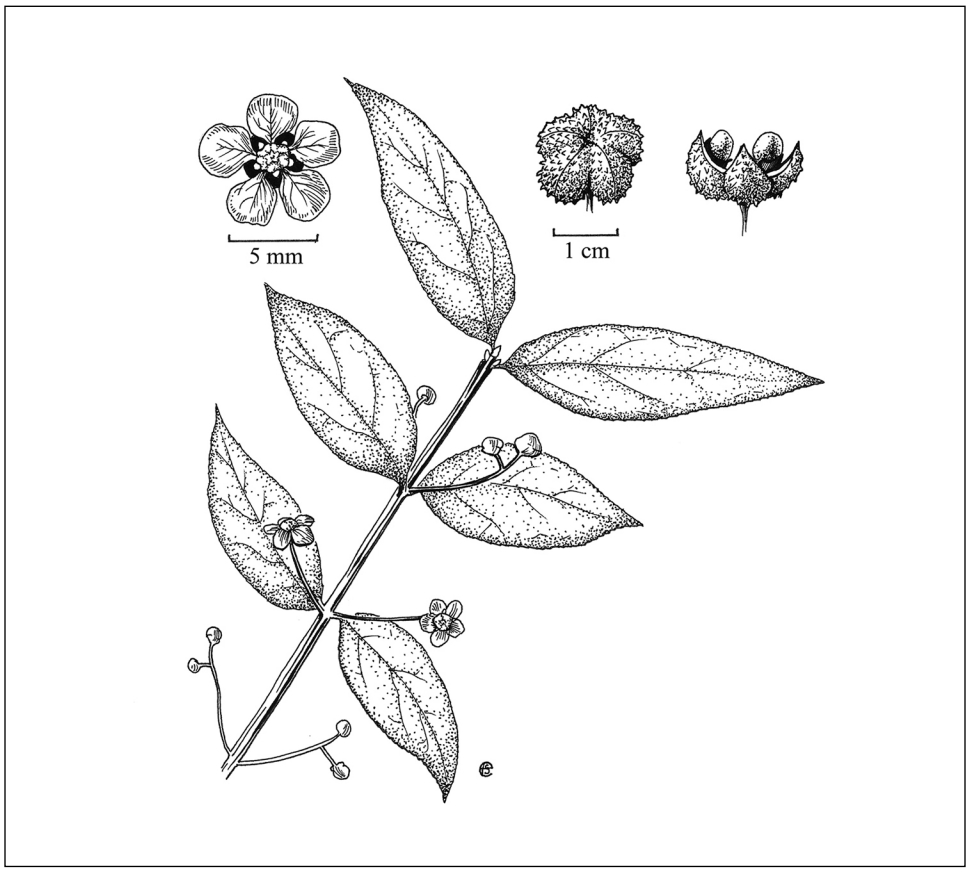


Distribution of *Euonymus fortunei*, or winter creeper, recorded in the New York Metropolitan Region during three time categories.

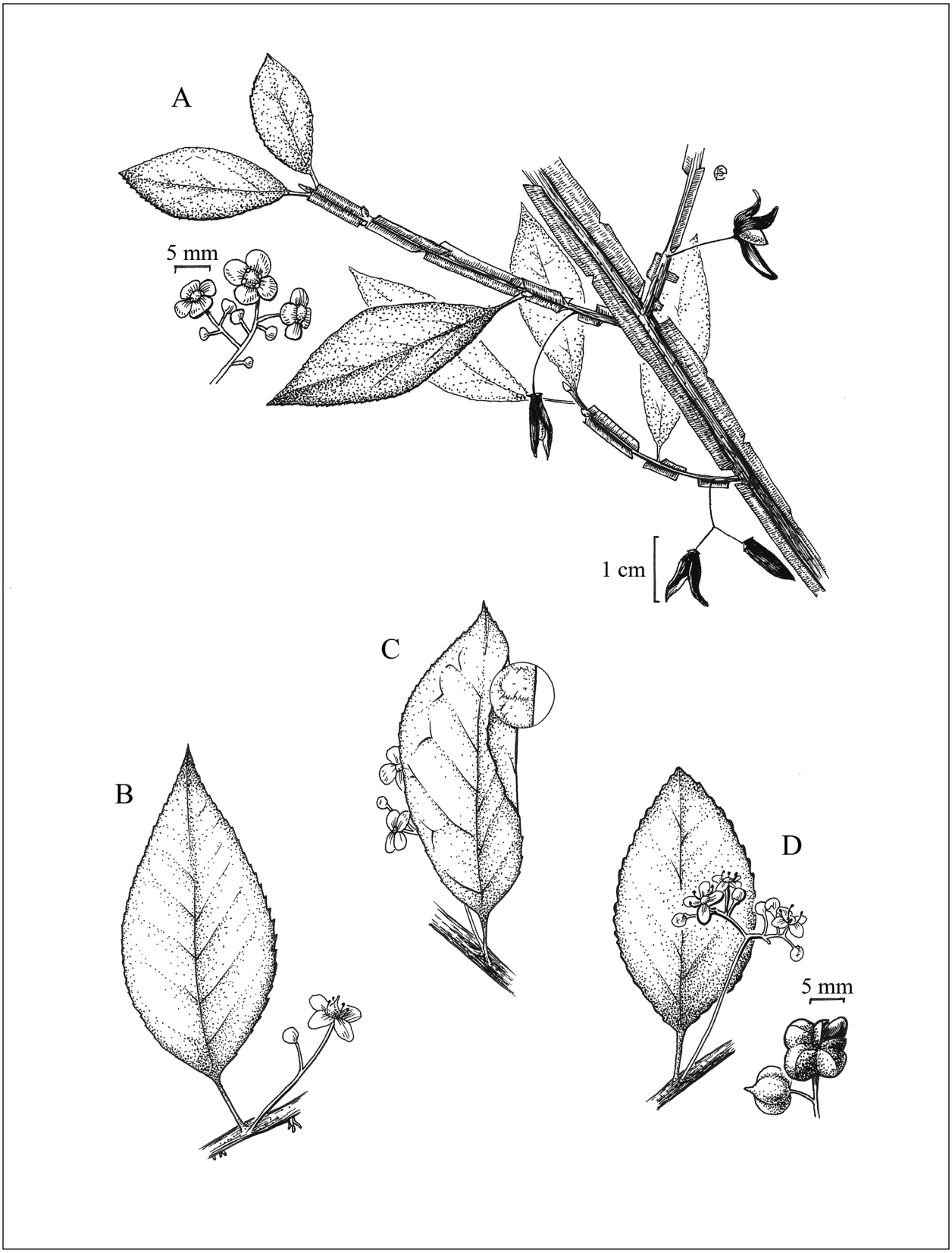
Tracked as potentially invasive in NJ (category 2?); listed as invasive in NY (regulated).

Management

It may be possible to increase population size of any existing native *Euonymus* spp. by maintaining or adding forested corridors, thus enabling bird movement between habitat patches (Machtans et al. 1996). The native species' relatively limited habitat preferences, and increased susceptibility to *Euonymus* scale and deer browse, may limit their use as alternatives to the nonnative invasive *Euonymus* spp. However, they may be candidates for use in areas where deer are limited or absent, such as NYC parklands. Successful removal of the invasive *Euonymus* spp. when young is possible by pulling or digging material out of the ground with most of its roots. Older shrubs may require cutting the main stem at ground level and applying herbicide. Cutting without herbicide treatment is not advised because stem sprouts are possible. If nontarget species are not a concern, foliar application of herbicide can also be effective. Large infestations may be best managed by treating from the invasion front inward toward the core population for at least 500 m (potential distance that seed may be bird dispersed), as well as treating any relatively small satellite populations beyond this invasion front. Many birds tend to utilize forested corridors between patches of habitat (Machtans et al. 1996), and knowledge and possible manipulation of a given landscape where this invader is found may help reduce the movement of seed. If a seed bank is present, multiple treatments may be needed. Potential changes in soil nutrients of long-invaded sites may require further restoration efforts. Though cold stratification improves germination, it is not required, increasing the likelihood of invasion in regions with mild winters.



Leafy flowering twig, flower, fruit, and side view of open fruit of *Euonymus americanus*. Illustration by Emma Skurnick.



A) Leafy twig with open fruit, and flowers of *Euonymus alatus*; B) leaf and flower of *Euonymus europaeus*; C) leaf, with enlarged view of leaf underside, and flowers of *Euonymus atropurpureus*; D) leaf, flowers, and fruit of *Euonymus fortunei*. Illustration by Emma Skurnick.

Fagus L. – beech

Fagaceae. Trees. Species 8–10 (13 species, as cited in Williams-Linera et al. 2003) in the Northern Hemisphere, including Asia, Europe, and North America; Asia has the most species. Pollinated by wind. Long utilized for a myriad of purposes. European beech was one of the first trees to be used for writing material; beech bark and beech wood tablets were used before paper. The Anglo-Saxon word for beech was boc, which became the English word "book." Genus name is derived from the Greek "phaegin" ("to eat"), a reference to the genus' edible nuts. See Rehder (1949) for a treatment of the entire genus.

Native Species

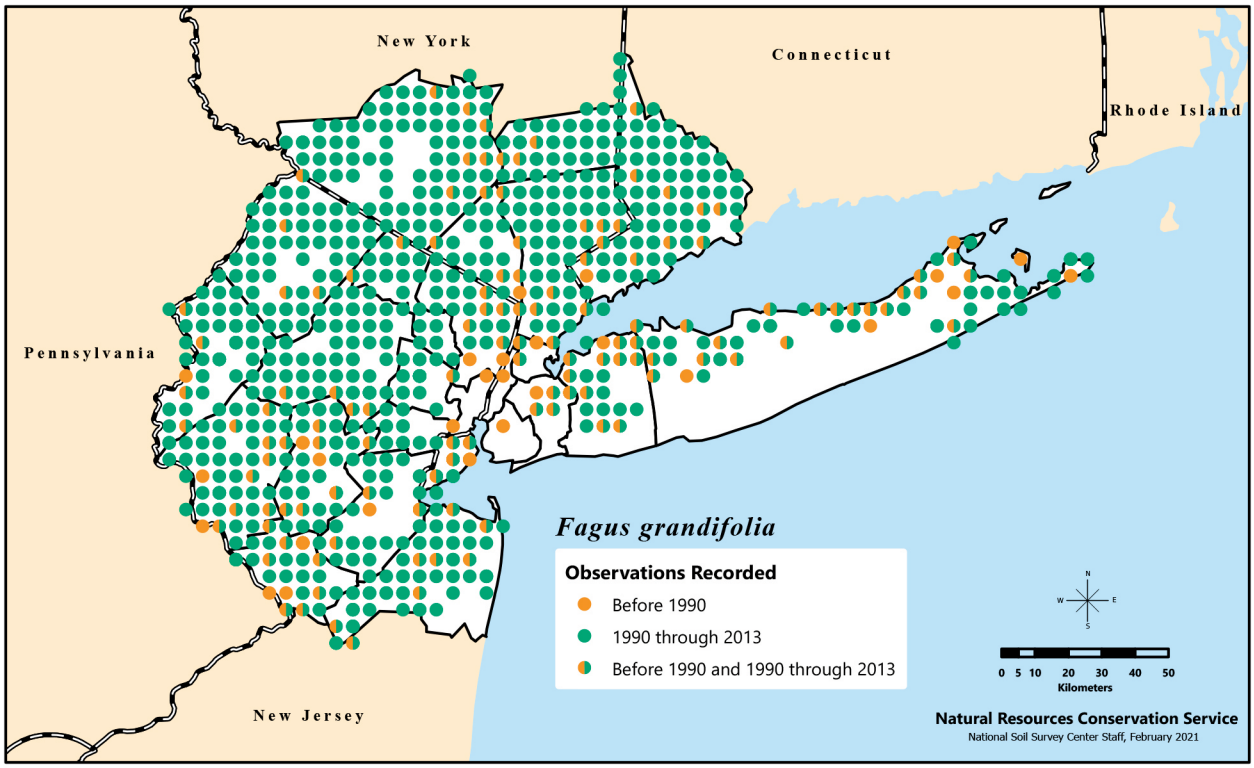
1. *Fagus grandifolia* Ehrh. – American beech ↑↑

Flowering Apr.–May; nuts maturing late July–Aug. Usually found in mesic rich woods, often in deep shade; occasionally semihydric forest sites or even xeric thin soils. Epithet from Latin refers to the leaves, which are very large relative to the leaves of other *Fagus* spp.

Camp (1951) recognized three distinct series of populations of *F. grandifolia*, commonly referred to as red beech, white beech, and gray beech, although he did not give them formal taxonomic

Fagus Key

1. Leaves serrate, with 9–14 pairs of veins . . . . . ***Fagus grandifolia***
1. Leaves crenate, with 5–9 pairs of veins . . . . . ***Fagus sylvatica****



Distribution of *Fagus grandifolia*, or American beech, recorded in the New York Metropolitan Region during three time categories.

status. Most authors tend not to recognize infraspecific taxa (e.g., Hardin and Johnson 1985, Nixon 1997). Other authors have recognized infraspecific taxa based on the degree of pubescence on the leaves (Rehder 1907). Research on *F. grandifolia* population genetics indicates two genetically distinct clusters, one from the Gulf Coastal Plain, eastern Coastal Plain, Piedmont Plateau, and Ozark Plateau; and the other outside the region entirely, in the northern glaciated Canadian territories (Kitamura and Kawano 2001).

Fagus grandifolia is a climax species in the eastern deciduous forests, often forming pure stands, most commonly on soils with a pH of 4–6 (Elias 1971). However, this species can maintain growth even in infertile soils by increasing nutrient use efficiency (Boerner 1984).

Flowers are primarily pollinated by wind (Bonner and Leak 2008), possibly by insects at times (Gleason and Cronquist 1993). Earliest seed-bearing age about 40 years. A masting species; large seed crops every 2–5 years (Bonner and Leak 2008, Cleavitt et al. 2008). Cold stratification for approximately 90 days required for germination (Bonner and Leak 2008). Seeds germinate in early spring to early summer of the following year and germination is epigeal. Several bird species, including the blue jay (*Cyanocitta cristata*), consume the fruit (Dirr 1998) and most likely help disperse the seeds, possibly as far as 4 km (Johnson and Adkisson 1985). Seeds are relatively large (Greene and Johnson 1989), so small rodents (order Rodentia), wild turkeys (*Meleagris gallopavo*), and deer (*Odocoileus* spp.) most likely consume and disperse its seed as well. One study found seed viability (percentage) varied considerably by seed collection site, ranging from 0 to 93 percent among the locations (Stalter 1982). As with *F. sylvatica*, *F. grandifolia* is most likely self-incompatible; 92 percent of self-fertilized flowers are barren (empty seed coats) (Nilsson and Wastljung 1987). Forms no or a very short-lived seed bank (Burt and Bell 1991, Houle 1994). Seedlings less susceptible to herbivory and disease than are suckers (Burt and Bell 1991).

Vegetative growth via root suckers is common (Jones and Raynal 1986, 1988). Most sprouts occur within 2 m of the parent tree but may occur as far as 8 m. Most sprouts remain connected to the parent tree, but if the parent plant is of high vigor, sprouts may sever their connection once they are 10 years or older. Root injury of some kind was the most important stimulant to sprouting. Such injuries could be caused by mammals (digging), disease, freeze-thaw action, and human activity. Low-vigor parent trees (such as those with beech bark disease, an interaction between the scale insect *Cryptococcus fagisuga* and a fungus of the genus *Neonectria*), tended to produce fewer sprout stems per sprout clump, that is, an overall lower production of sprouts as long as the low-vigor tree remained alive (Jones and Raynal 1986). Exposed, injured roots are more likely to sprout than unexposed, injured roots. Sprouting is more prolific if the injury occurs in the spring than in another season (Jones and Raynal 1988). The ability to reproduce extensively from sprouts and less extensively from seed, extreme shade tolerance, and low palatability to deer have resulted in its dominance and reduced species richness in some New England forests (Busby et al. 2008). Responds more rapidly to forest canopy gaps than other shade-tolerant species, such as *Acer saccharum* (Canham 1990, Poage and Peart 1993, Takahashi and Lechowicz 2008). Despite its rapid rate of colonizing gaps, *F. grandifolia* ranks low compared to several *Quercus* spp. and *A. rubrum* as a replacement species for *Castanea dentata*. Only about 2 percent of a total of 2,569 openings created by dead *C. dentata* were colonized by *F. grandifolia*, while 24 percent were colonized by *Q. rubra* (Woods and Shanks 1959). Some evidence of phytotoxicity of leaf leachate to *A. saccharum* seedlings in a greenhouse setting, but there is no known field evidence (Hane et al. 2003).

Cultivated since 1800 (Bonner and Leak 2008), but no named cultivars exist, unlike with the nonnative *F. sylvatica*. *Fagus grandifolia* can be transplanted successfully and outgrows *F. sylvatica* trees planted at the same time. However, it is shallow-rooted and casts heavy shade, so little, not even grass (family Poaceae), can grow well underneath it (Dirr 1998). Native Americans have used preparations from *F. grandifolia* to treat many ailments, including worms, heart and blood problems, burns, and rashes from *Toxicodendron radicans* (poison ivy) (Moerman 1986).

Beech bark disease in North America was first reported in 1914 in NS (Ehrlich 1934) and is thought to have spread westward at a rate of 32 km per year. Even when infected with beech bark disease, *F. grandifolia* can respond quickly enough to replace itself, at least in the subcanopy. Models show that an infected stand of *F. grandifolia* is not at risk of extinction even in the long term; instead it will decline during the first 50 years and then stabilize over 300 years (Le Guerrier et al. 2003).

Nonnative Species

Fagus sylvatica L. – European beech

Flowering Apr.–May; nuts maturing late July–Aug. Native to Europe; occasionally cultivated and possibly naturalized or persistent from cultivation.

Flowers primarily pollinated by wind; an obligate outcrosser (Merzeau et al. 1994) with 92 percent of self-fertilized flowers barren (empty seed coats) (Nilsson and Wastljung 1987). A masting species; masting periods vary from 5–8 years to 15–20 years. Seed production may start a little later for *Fagus sylvatica* (between 40 and 80 years of age) compared to *F. grandifolia* (Bonner and Leak 2008). Likelihood of viable seed increases and seed predation decreases with increasing stand size at least up to 10 ha (Nilsson and Wastljung 1987). Breaking dormancy is also highly variable; some seed requires only 42 days of cold stratification and other seed requires 140–150 days of cold stratification (Bonner and Leak 2008). Though *F. sylvatica* can root sprout (Koop 1987), it primarily reproduces via seed (Teissier du Cros 1981, as interpreted by Jones and Raynal 1988). Unlike *F. grandifolia*'s relatively rapid response to increased light (i.e., due to a canopy gap; Takahashi and Lechowicz 2008), *F. sylvatica* responds only moderately to increased irradiance (Grubb et al. 1996), but is still relatively plastic (Cochard et al. 1999). Positive response to higher light may occur only if accompanied by an increase in fertilization and soil moisture (Madsen 1995). Does not grow well in warm climates (Dirr 1998), and some evidence suggests that increasing temperatures and lower precipitation rates associated with recent changes in climate in the Mediterranean region are correlated with a decline in growth in that region (Jump et al. 2006).

Widely used as an ornamental with numerous cultivars (Rehder 1949). Rarely found locally escaping from nearby cultivated specimens.

Date of first cultivation unknown (Bonner and Leak 2008). Dirr (1998) lists 56 cultivars but notes his list is not complete; some of these cultivars have serrate leaf margins.

Management

Management may be needed to control the prolific sprouting of *Fagus grandifolia*, especially in response to a disturbance and beech bark disease. Kochenderfer et al. (2006) describe a successful method using glyphosate.

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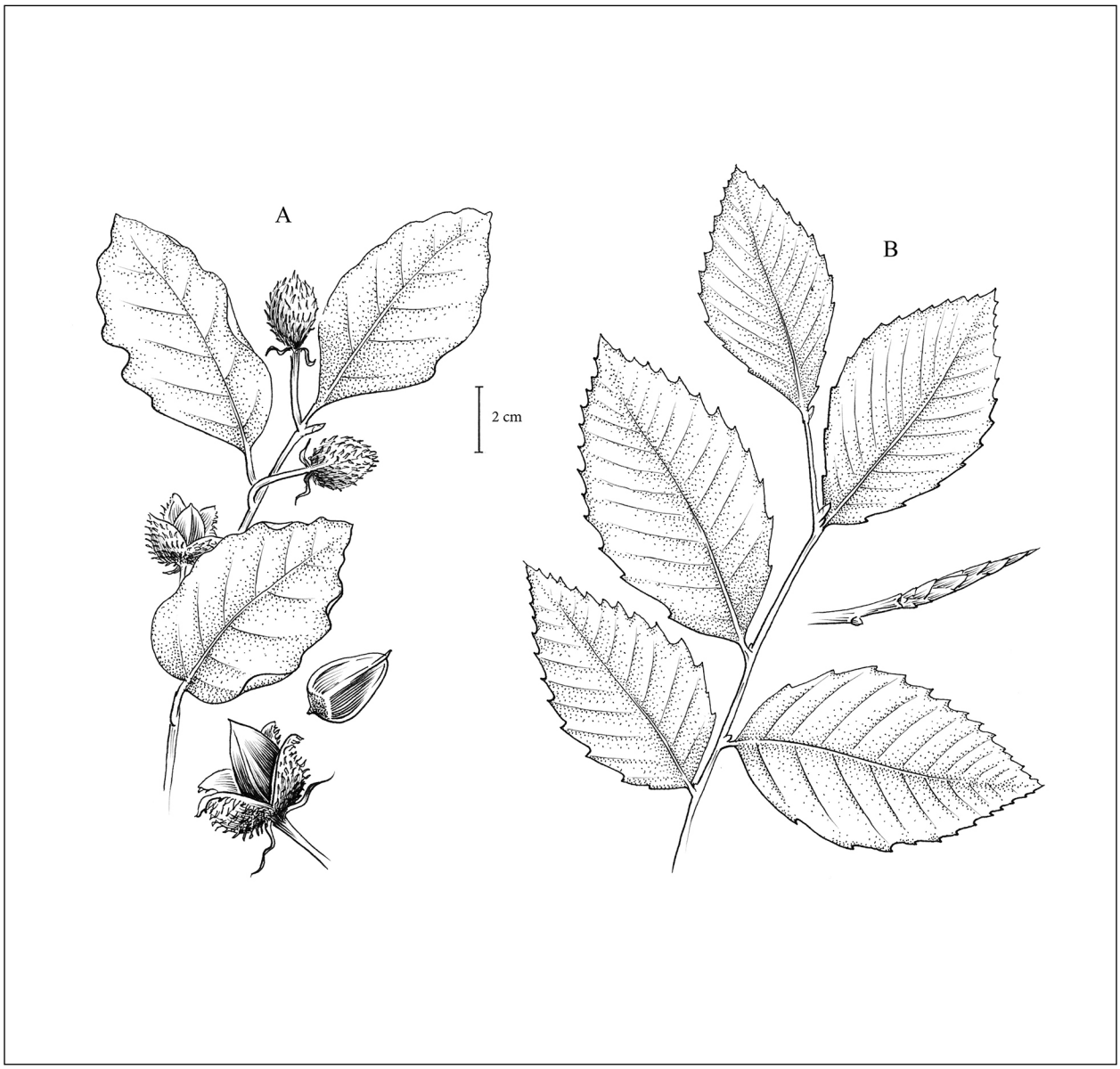


A) Leaves, and fruit (nuts) with and without husks on, of *Fagus sylvatica*; B) leaves and terminal bud of *Fagus grandifolia*. Illustration by Emma Skurnick.

Ficus L. – fig

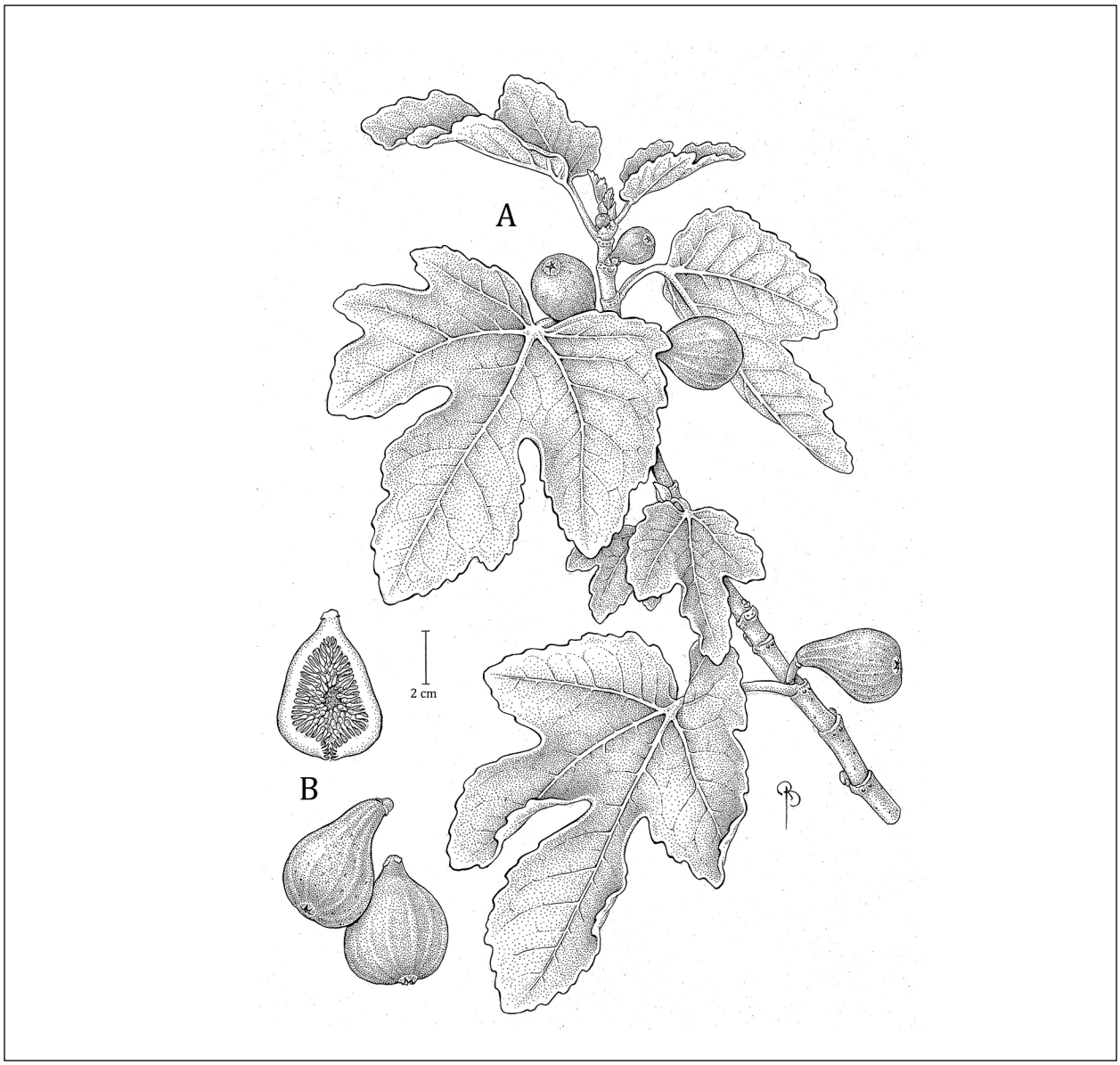
Moraceae. Trees, shrubs, woody vines, woody epiphytes, hemi-epiphytes. Species 750–1,000 in Africa, Asia, Australia, North America, and South America. Genus name is the ancient Latin name for fig.

Nonnative Species

1. *Ficus carica* L. – fig Ø

Flowering May–June; fruiting Aug.–Oct. Native to Asia. Occasionally planted, especially in NYC, sometimes persisting after cultivation or rarely escaping. In the region, cold winters cause significant dieback (Koenig 2014).

Occurs only rarely in the region in vacant lots and other waste areas. Recently reported from Bronx, Kings, Nassau, and Queens Counties (NY).



A) Fruiting leafy branch and B) fruit and cross-section of fruit showing achenes of *Ficus carica*. Illustration by Bobbi Angell.

Forsythia Vahl – forsythia

Oleaceae. Shrubs. Species 11 in Asia; 1 in southeastern Europe. Genus name honors English horticulturist William Forsythe (1737–1800). Two species native to Asia are commonly planted in the region and found often as remnants from cultivation or rarely as escapes.

These species have only a rare occurrence in the region. Consequently, we do not provide additional detailed information.

Frangula Mill. – buckthorn

Rhamnaceae. Shrubs, small trees. Species 50 in northern Africa, eastern Asia, Europe, and North America. Sometimes treated as a section in *Rhamnus* L., R. sect. *Frangula* S.F.Gray. Name may be derived from Latin "frangere," "to break," a possible reference to the ease with which its branches break.

Nonnative Species

1. *Frangula alnus* Mill. – glossy buckthorn ↑↑

Rhamnus frangula L.

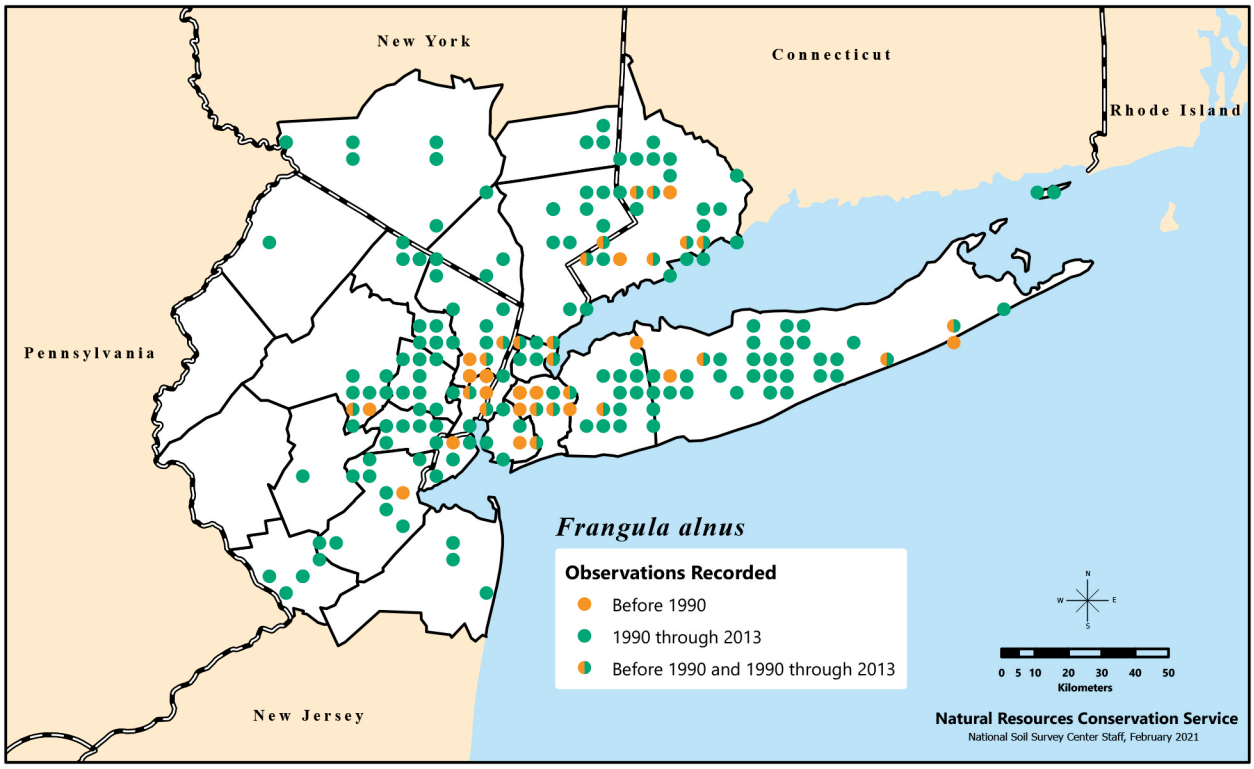
(See *Rhamnus* plate on p. 433 for illustration)

Flowering May–July. Mesic to dry woods, thickets, fields, and roadsides; also swamps, pond and lake shores, and streambanks. Native to northern Africa, Asia, and Europe. Epithet is Latin for "tree."

Flowers are hermaphroditic and well utilized by bees. Several types of insects visit the flowers, including butterflies and moths (order Hymenoptera), bees (family Apidae and Andrenidae), and flies (family Empidae, Syrphididae, Tachinidae, Sarcophagidae, Muscidae, Cordyluridae, Anthomyidae), and perhaps beetles (order Coleoptera) (Robertson 1896). Though not completely self-incompatible, self-fertilization is rare. However, only 2.8 percent of cross-pollinated flowers set fruit and reproduction does not occur vegetatively, suggesting this species may be pollinator and reproductively limited (Medan 1994). Indeed, limited reproduction may be the reason for its recent decline in Spain to such an extent that it is listed as a vulnerable species (Hampe 2005). Flowers produce a pleasant odor and nectar that attract more than 45 different insects (Medan 1994). Fruit dispersed by birds (Dirr 1998). Many birds eat the fruit, including red crossbill (*Loxia curvirostra*), European starling (*Sturnus vulgaris*), American robin (*Turdus migratorius*), Bohemian waxwing (*Bombycilla garrulus*), cedar waxwing (*Bombycilla cedrorum*), and rose-breasted grosbeak (*Pheucticus ludovicianus*) (Ridley 1930). Fruit also possibly dispersed by water, remaining buoyant for several days after falling (Catling 1994). Natural germination in spring. Embryo dormancy overcome somewhat by stratification in moist sand at about 5 °C for 60 days (Youngblood 2008a). Used in landscape plantings, especially the cultivar 'Columnaris' (Flint 1983, Rehder 1949). At least 2 cultivars, 1 of which ('Asplenifolia') may be less likely to become invasive due to its slow-growing nature (Dirr 1998). Evidence of sites where this species clearly dominates, an estimated spread rate of 6.7 m per year (Frappier et al. 2003), and negative impacts on native tree seedling regeneration (Fagan and Peart 2004, Frappier et al. 2004) indicate this species' invasive tendencies and the likelihood that the slow-growing cultivar is not the cultivar most commonly planted.

Forsythia Key

1. Pith solid at nodes; leaves trifoliate or trilobed . . . . . ***Forsythia suspensa* (Thunb.) Vahl***
1. Pith lamellate not solid, composed of thin plates; leaves simple, unlobed . . . . . ***Forsythia viridissima* Lindl.***



Distribution of *Frangula alnus*, or glossy buckthorn, recorded in the New York Metropolitan Region during three time categories.

Prefers well-drained soils and grows well in sun or partial shade (Dirr 1998), though it can be tolerant of moderate soil dryness. Intolerant of shade, though it may be more shade-tolerant than *Rhamnus cathartica* (Godwin 1943). However, Cunard and Lee (2009) found that *Frangula alnus* decreased in abundance as light levels decreased and concluded that this species would be phased out as a young forest went through succession to a mature forest. This species is also correlated with canopy gaps in a forest, surviving longer in larger gaps (Burnham and Lee 2010) and harvested forests (Lee and Thompson 2012). Has high tolerance to flooding (Glenz et al. 2006). Alternate host to the crown rust disease (*Puccinia coronata* var. *avinae*) of oats (*Avena sativa*); prohibited by quarantine laws from many areas where oats are grown, especially in Canada (Flint 1983). Ingestion of fruit or leaves can cause mild to moderate nausea, vomiting, and diarrhea (Burrows and Tyrl 2001). Contains monensis, which inhibits hydrogen-producing bacteria (*Clostridium* spp.) and reduces methane production in rumen fermentation at doses of 1 gram per liter or higher (García-González et al. 2008), possibly reducing a significant source of greenhouse gases. If *F. alnus*, like *R. cathartica*, contains purgative secondary compounds (as advertised on some webpages; Annie's Remedy, n.d., Plants for a Future 2012), such high doses in animal feed could also be detrimental to the animals. Herbarium evidence of being first introduced to the U.S. in the NY Metropolitan Region (Aiello-Lammons 2020).

Listed as invasive in CT (not prohibited) and NY (prohibited).

Management

Multiple applications of a herbicide treatment, such as an initial stump application and then a foliar spraying of any sprouting the following year, are most likely needed for *Frangula alnus*. Greater care in selecting herbicides may be needed, because this species is found often in wetter sites, including wetlands (Nagel et al. 2008). After extensive searching, no promising biocontrol agents have been found for *F. alnus* (Gassmann et al. 2011).

Fraxinus L. – ash

Oleaceae. Dioecious trees. Species 42–65 in Asia, Europe, and North America. All species in flora in *Fraxinus* sect. *Fraxinus* (=F. sect. *Fraxinaster* DC), the flowers apetalous and appearing before the leaves. Planted as street trees; some valuable for timber. Popular wood for baseball bats, although declining now with the increased use of maple (*Acer* spp.). Genus name is the Latin name for ash.

Native Species

1. *Fraxinus americana* L. – American ash ↑↑

Flowering Apr.–May. Rich, mesic deciduous bottomlands throughout the region. Sometimes further divided into 2 varieties or species, *Fraxinus americana* var. *americana* with leaflet undersides not velvety or whitened, and *F. americana* var. *biltmoreana* (Beadle) J.Wright with leaflet undersides velvety and whitened beneath. If recognized, both occur in the region. Recent treatments elevate var. *biltmoreana* to species level as *Fraxinus biltmoreana* Beadle (Nesom 2010, Whittemore et al. 2018). Emerald ash borer (EAB; *Agrilus planipennis*) has been detected in the region at least since 2013, possibly as long ago as 2009 (NY) (Emerald Ash Borer Information Network 2020); *F. americana* is susceptible to infestation, leading to mortality (Rebek et al. 2008). Recent gains in this species, perhaps due to reforestation, may soon become losses.

2. *Fraxinus nigra* Marshall – black ash ↑

Flowering May–June. Wet woodlands, swamps, and streambanks, primarily off the Coastal Plain. Bruised foliage reported to be similar in odor to *Sambucus* (Fernald 1950). Also susceptible to EAB (Rebek et al. 2008); recent increases are likely to change to losses.

3. *Fraxinus pennsylvanica* Marshall – green ash ↑↑↑

Flowering May. Mesic to wet bottomlands, occasionally in drier areas; often planted as street trees. Less frequent on the Coastal Plain, especially eastern Long Island. Also susceptible to EAB (Rebek et al. 2008); recent increases, perhaps due to reforestation, are likely to change to losses.

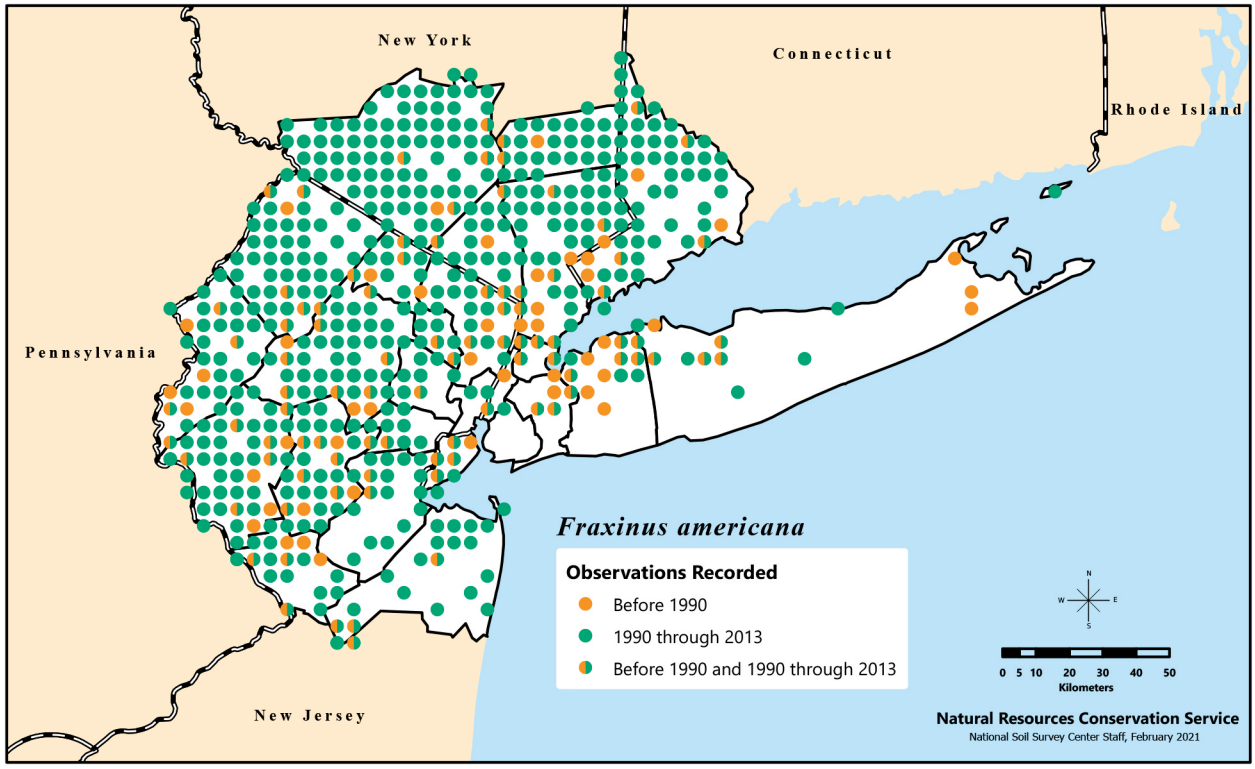
4. *Fraxinus profunda* (Bush) Bush – pumpkin ash Ø

Fraxinus americana var. *profunda* Bush; *Fraxinus michauxii* Britton; *Fraxinus tomentosa* F.Michx. (illegitimate superfluous name)

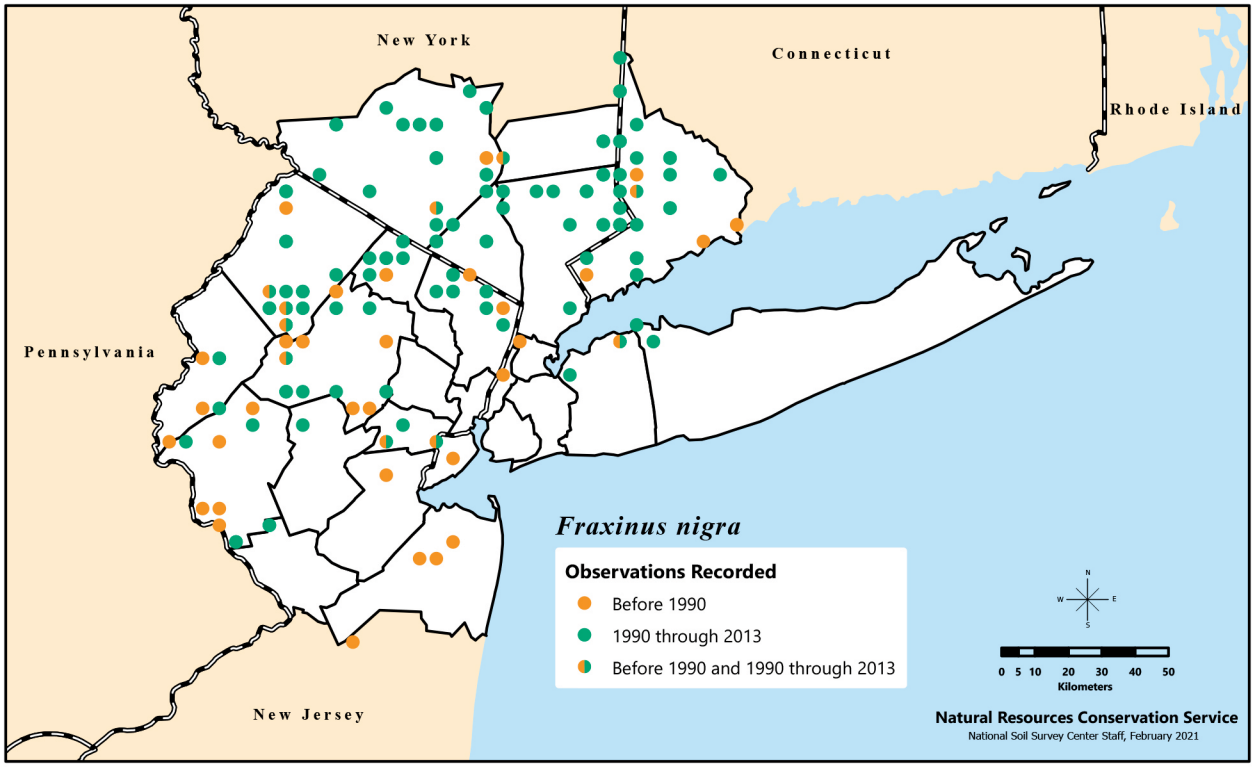
Flowering Apr.–May. Low bottomlands. Exceptionally rare in the region; confirmed reports from Monmouth County (NJ) and Bronx and New York Counties (NY) (see Atha 2016 for discussion of NY populations). Britton (1905) originally described the Bronx populations as a new species, distinguishable from *F. profunda* on the basis of its terete samara body (compressed in *F. profunda*), but this taxonomy is no longer followed. Werier

Fraxinus Key

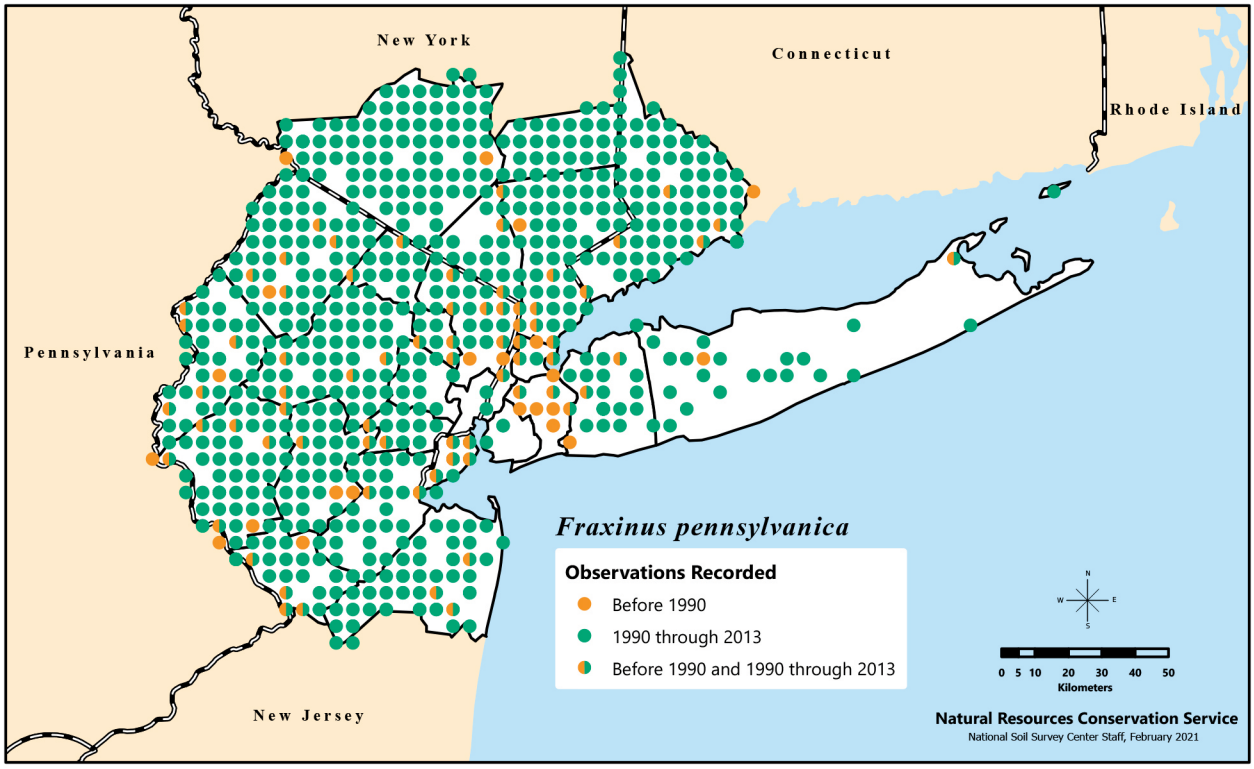
1. Leaflets sessile 2
1. Leaflets with a petiole 3
2. Rachis at base of leaflets with thick reddish tomentum; flowers dioecious. . . . . ***Fraxinus nigra***
2. Rachis without conspicuous tomentum; flower polygamous. . . . . ***Fraxinus excelsior****
3. Leaf scar upper margin sunken, with bud down into scar . . . . . ***Fraxinus americana***
3. Leaf scar upper margin straight, with bud above scar 4
4. Current year's twigs glabrous or with white or gray tomentum . . . . . ***Fraxinus pennsylvanica***
4. Current year's twigs with brownish-yellow tomentum . . . . . ***Fraxinus profunda***



Distribution of *Fraxinus americana*, or American ash, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Fraxinus nigra*, or black ash, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Fraxinus pennsylvanica*, or green ash, recorded in the New York Metropolitan Region during three time categories.

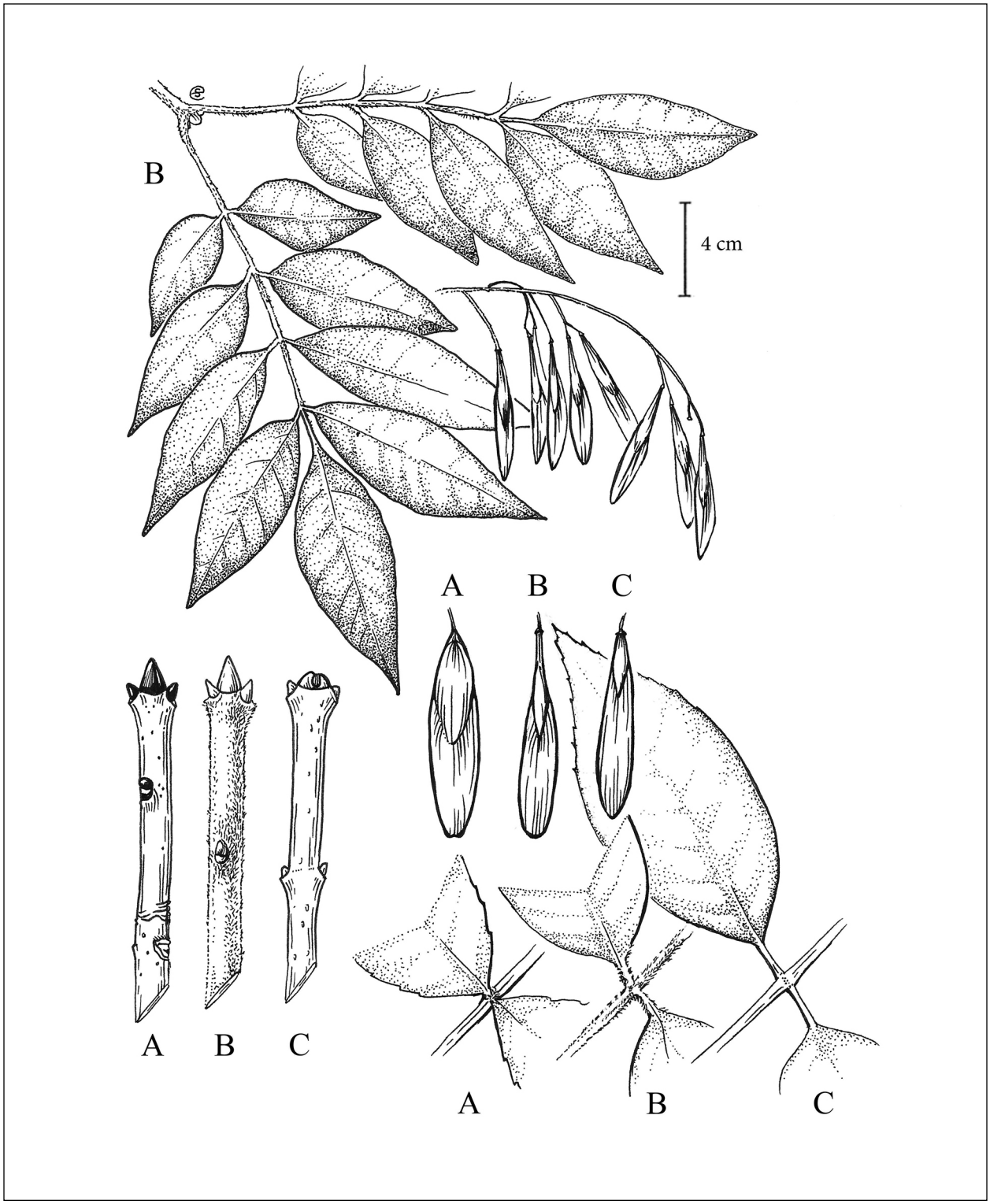
(2017) stated that NY had native and nonnative populations of this species. Etymology of epithet is unclear as there is nothing particularly deep or profound in Bush's original description; possibly Bush was referring to the Biblical "depths," a reference to water, the species growing in swamps.

Listed as endangered in NJ (S1); tracked as critically imperiled in NY (S1).

Nonnative Species

Fraxinus excelsior L. – European ash

Flowering Apr. Rarely encountered in the region as a remnant from cultivation.



Leaves, fruits, terminal buds, and leaf nodes of A) *Fraxinus nigra*, B) *Fraxinus pennsylvanica*, and C) *Fraxinus americana*. Illustration by Emma Skurnick.

Gaultheria L. – winterberry, teaberry

Ericaceae. Shrubs, many creeping half shrubs (low-growing shrubs). Species 135 in Asia, Australia, North America, and South America. Fruit technically a capsule; appears berry-like, the calyx at fruiting fleshy, accrescent, and covering the capsule. Many species (including the two keyed) contain oil of wintergreen (methyl salicylate); used for teas and medicinal purposes. Genus name honors Jean-François Gaultier (1708–1756), naturalist and physician from Quebec.

Native Species

1. *Gaultheria hispidula* (L.) Muhl. – creeping snowberry Ø

Vaccinium hispidulum L.

Creeping half shrub. Flowering Apr.–Aug. Moist to wet ground and edges of swamps. Epithet derived from the Latin word for "bristly," a reference to the bristly hairs on leaf undersides.

Fruit eaten by chipmunks (subfamily Xerinae) and deer mice (*Peromyscus maniculatus*) (Krefting and Roe 1949). People also consume the fruit, either fresh or made into preserves. Many northern Native American tribes made a beverage from the leaves, sweetened with maple sugar (Uphof 1968). Once relatively common. Reported from Fairfield County (CT); Bergen, Hudson, Morris, Passaic, and Sussex Counties (NJ); and New York, Orange, and Westchester Counties (NY). Few recent records known from the region.

Listed as a species of special concern in CT (S2) and endangered in NJ (S1).

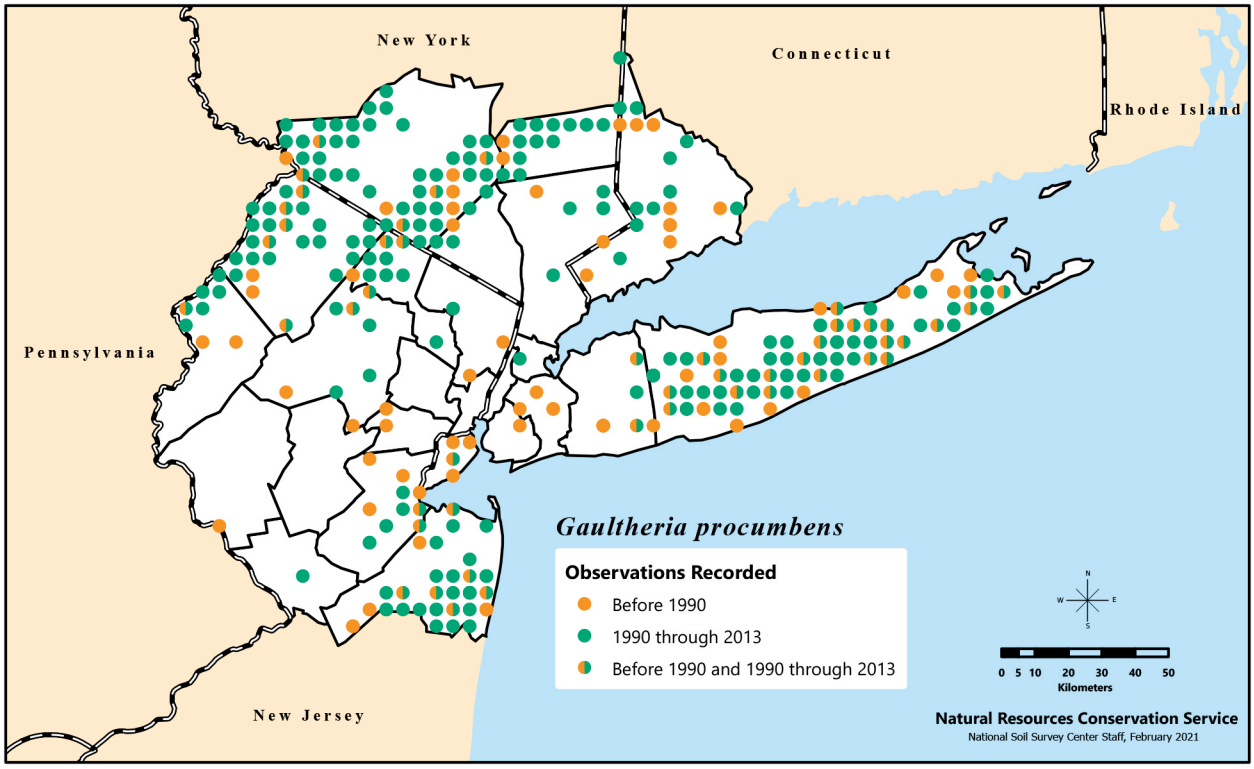
2. *Gaultheria procumbens* L. – wintergreen, teaberry ↔

Creeping half shrub. Flowering June–Aug. Dry to wet woods and clearings: white pine woods; chestnut-oak woods; sandy, peaty pine-oak scrub; oak-hickory woods; sphagnum bogs; pine barrens; swamps. Epithet from Latin refers to the creeping, procumbent habits.

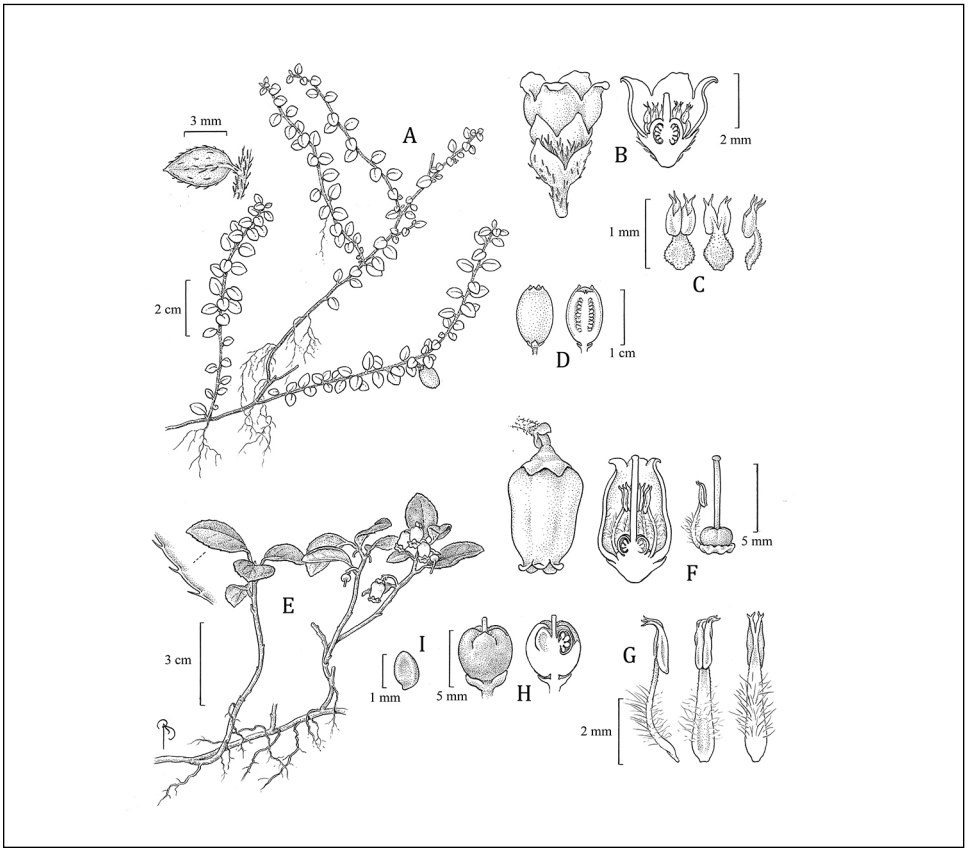
Several insect species visit the flowers, including the bees *Apis mellifera*, *Bombus bimaculatus*, *B. griseocollis*, *B. impatiens*, *B. perplexus*, *B. ternarius*, *B. terricola*, and *B. vagans* (Lovell 1898, Mirick and Quinn 1981, Reader 1977). Fruit eaten by a variety of mammals and birds, including deer (*Odocoileus* spp.), ruffed grouse (*Bonasa umbellus*), and partridge (family Phasianidae) (Alexander 1927, Cook and Hamilton 1944). Its oil (methyl salicylate) is used to add a wintergreen flavor to gum, candies, toothpaste, and mouthwash (Facciola 1998). Increases may be due to increased area of suitable habitat, perhaps following an elevational gradient, resulting in the same triband pattern found with *Comptonia peregrina* and *Epigaea repens*.

Gaultheria Key

1. Leaves 3–9 mm long, with scattered multicellular-multiseriate hairs beneath; fruit white . . . . . ***Gaultheria hispidula***
1. Leaves 1.7–4.1 cm long, glabrous or puberulent along midveins; fruit red . . . . ***Gaultheria procumbens***



Distribution of *Gaultheria procumbens*, called wintergreen or teaberry, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig, and fruit; B) flower and its cross-section; C) stamens; and D) fruit with its cross-section of *Gaultheria hispidula*; E) flowering leafy twig with fruit and enlarged view of leaf margin; F) flower, cross-section of flower, and pistil; G) stamens; H) fruit with its partial cross-section; and I) seed of *Gaultheria procumbens*. Illustration by Bobbi Angell.

F G

Gaylussacia Kunth. – huckleberry

Ericaceae. Shrubs. Species 50 in North America and South America. Often confused with and growing alongside blueberry species (*Vaccinium*); can be distinguished by the presence of resinous yellow glands on the underside of the leaves. Fruit edible with 10 hard seed-like nutlets in each fleshy drupe. Although never domesticated like the blueberry (probably because of the generally poorer quality of the fruit and hard nutlets), huckleberries were at one time a very important economic crop in the region. They continue to be a valuable source of food for local wildlife and insects. Fire adapted with rapid regeneration and stable occupation of space due to presence of rhizome networks and resource reallocation (Matlack 1997). Seed dormancy overcome by warm stratification for 1 month, followed by cool stratification for 2 months; germination occurs after seeds are returned to warm conditions. Seedlings are slow to establish and need consistent surface moisture but can be transplanted successfully (Englert 2002). Genus name honors French chemist Louis Joseph Gay-Lussac (1778–1850).

The box huckleberry, *Gaylussacia brahycera* (Michx.) A.Gray (not reported from the NY Metropolitan Region), was once thought to be on the verge of extinction (Coville 1919). Efforts of the Arnold Arboretum in Boston, MA to reintroduce this species apparently successful. One colony of this species located in central PA covers 750 ha; colony is thought to have originated from one plant and may be 12,000 years old (Dirr 1998). More recent changes in distribution of species may renew concerns over the loss of abundance of species in this genus.

Native Species

1. *Gaylussacia baccata* (Wangenh.) K.Koch – black huckleberry ↑

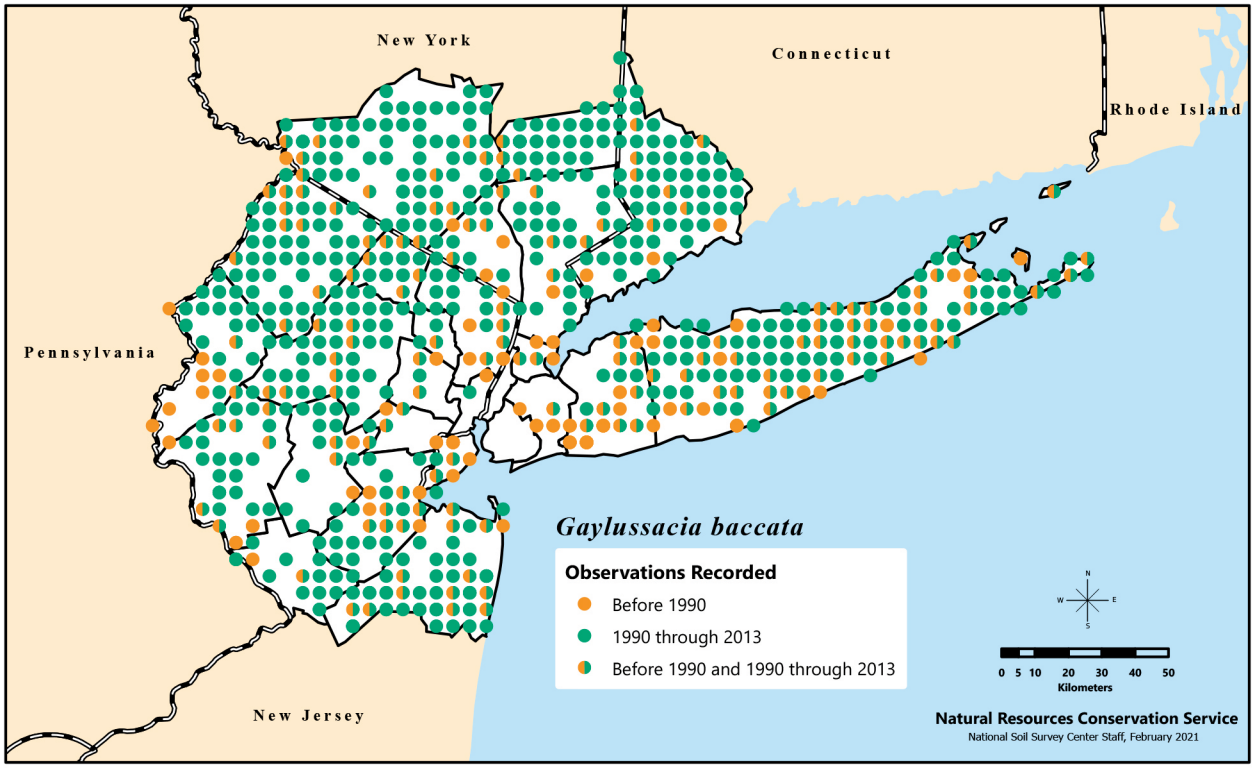
Andromeda baccata Wangenh.

Flowering May–June; fruit maturing July–Aug. Woods and thickets; usually on dry sandy soil or rocky ledges, occasionally in wet sphagnum peat. Epithet refers to the berry fruit, from the Latin "bacca," meaning "berry."

One of the most common woodland shrubs of the region. Flowers are pollinated by andrenid bees (particularly *Andrena vicina* and *A. w-scripta*) or bumble bees (*Bombus* spp.) (Heinrich 1976, Lovell 1940, Small 1976). Self-incompatible (Lovell 1940). Fruit eaten by at least six bird species, including ruffed grouse (*Bonasa umbellus*), sharp-tailed grouse (*Tympanuchus phasianellus*), greater prairie chicken (*Tympanuchus cupido*), northern bobwhite (*Colinus virginianus*), wild turkey (*Meleagris gallopavo*), and mourning dove (*Zenaida macroura*) (Reiners 1965, Vines 1960). The feces of animals that consume the seed may have a blue color and the large seeds are often evident (Reiners 1965). Stratification improves germination (Young and Young 1992).

Gaylussacia Key

1. Stems 0.5 m tall or less; leaves somewhat thick, upper surface shining, margins ciliate, apex mucronate . . . . . ***Gaylussacia bigeloviana***
1. Stems more than 0.5 m tall; leaves thin, not shining, margins chiefly glabrous, apex not mucronate 2
2. Leaves resinous-glandular on both sides; mature twigs pubescent; pedicels less than 1 cm long; fruit black to blue-black. . . . . ***Gaylussacia baccata***
2. Leaves resinous-glandular only beneath; mature twigs hairless; pedicels usually 1 cm or longer; fruit blue . . . . . ***Gaylussacia frondosa***



Distribution of *Gaylussacia baccata*, or black huckleberry, recorded in the New York Metropolitan Region during three time categories.

2. *Gaylussacia bigeloviana* (Fernald) Sorrie & Weakley – bog huckleberry ↓↓↓

Gaylussacia dumosa var. *bigeloviana* Fernald

Flowering May–June; fruit maturing July–Aug. Wet, sandy soils or bogs, on or near the Coastal Plain. Epithet honors Jacob Bigelow (1787–1879), physician, botanist, and professor at Harvard University, whom Fernald credited with discovering the plant.

Previously this material was known as *Gaylussacia dumosa* (Andrews) A.Gray. The similar *G. dumosa* ranges south of the region, reaching the northern limit of its range in VA and WV; has bracts glabrous (or sparsely glandular) and flowers 5–7 mm across. Fruit not as palatable as those of the other two species, the fruit being exceptionally pubescent. Decline may be attributed to habitat loss or a lack of reoccurring fires (or both) (Abrahamson 1984).

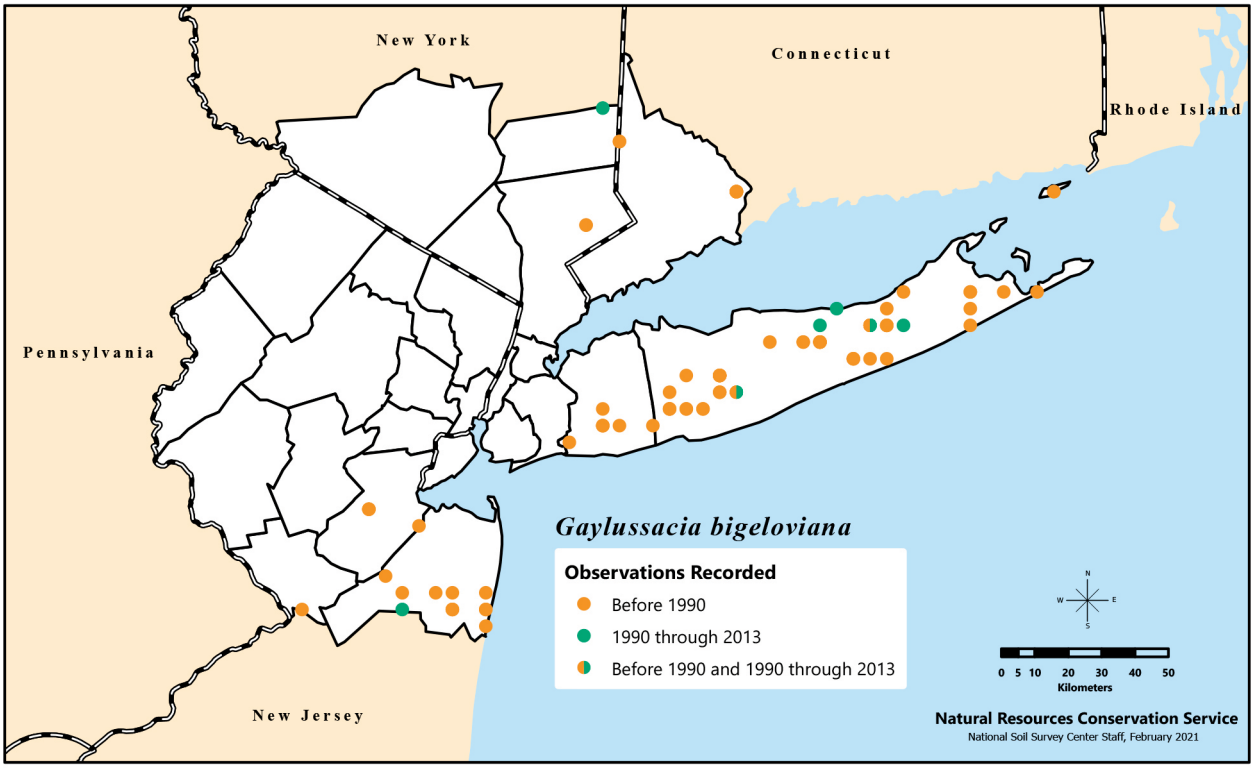
Listed as threatened in CT (S2) and endangered in NY (S1).

3. *Gaylussacia frondosa* (L.) Torr. & A.Gray – dangleberry ↔

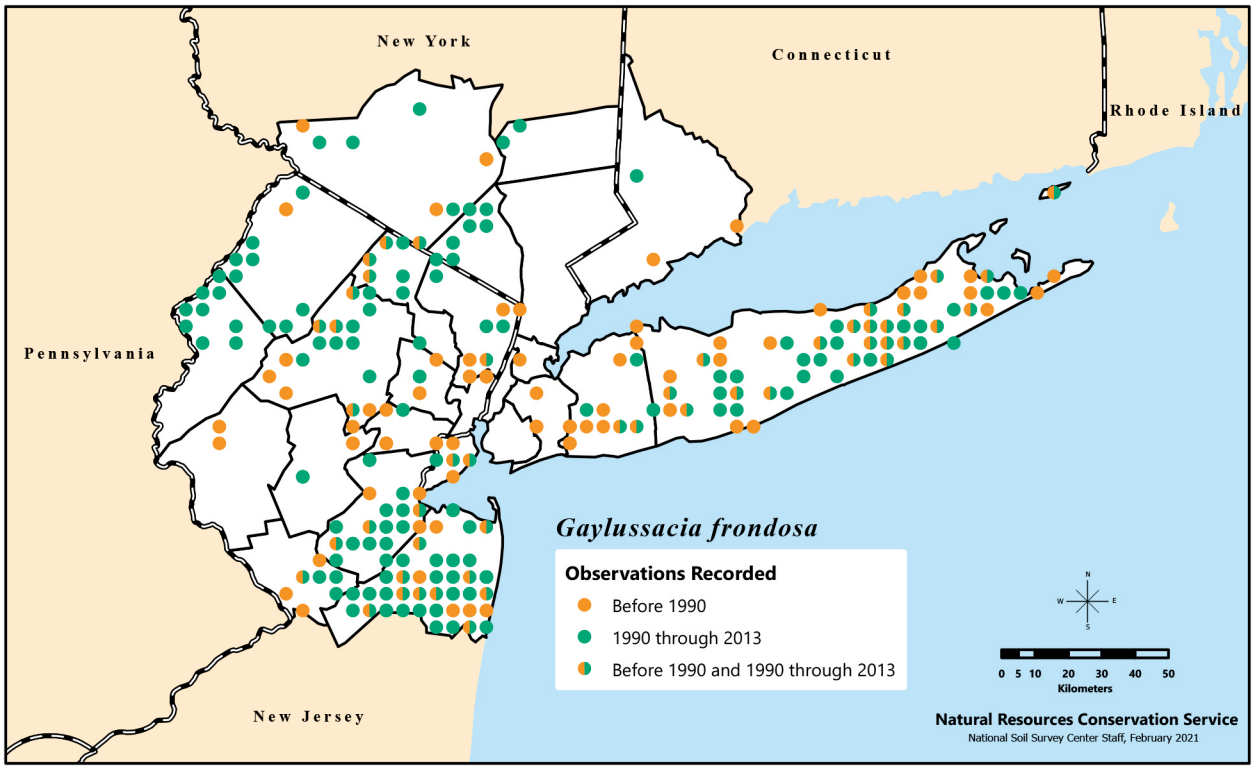
Vaccinium frondosum L.

Flowering May–June; fruit maturing July–Aug. Swamps (pine swamps, magnolia swamps, Atlantic white cedar swamps, cranberry bogs), woods (white pine forest, oak woods and barrens, mesic forest), and thickets. Wet sphagnum peat, and moist and dry upland peat (Wherry 1920). Epithet means “leafy” in Latin and refers to the leafy bracts on the raceme. Perhaps more edaphically restricted than its cogener *G. baccata*; one study of northern NJ upland forests on the impact of geological substratum on species diversity found *G. frondosa* usually occurring only in Martinsburg shales and High Falls sandstones (Davidson 2004).

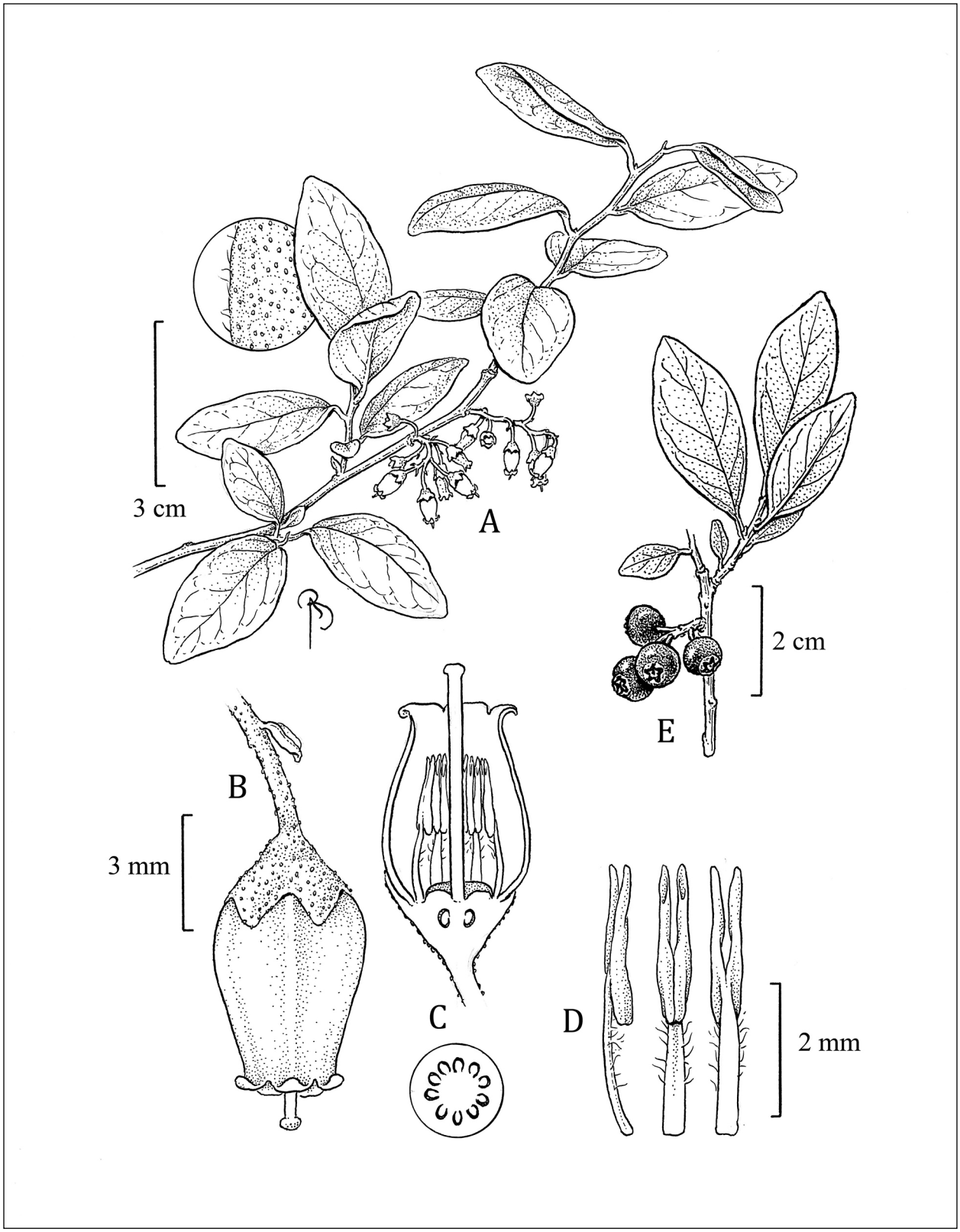
Fruit eaten by several bird species, including cedar waxwing (*Bombycilla cedrorum*), northern bobwhite (*Colinus virginianus*), and ruffed grouse (*Bonasa umbellus*) (Vines 1960).



Distribution of *Gaylussacia bigeloviana*, or bog huckleberry, recorded in the New York Metropolitan Region during three time categories. Also unmapped historical (pre-1990) record from Richmond County (NY).

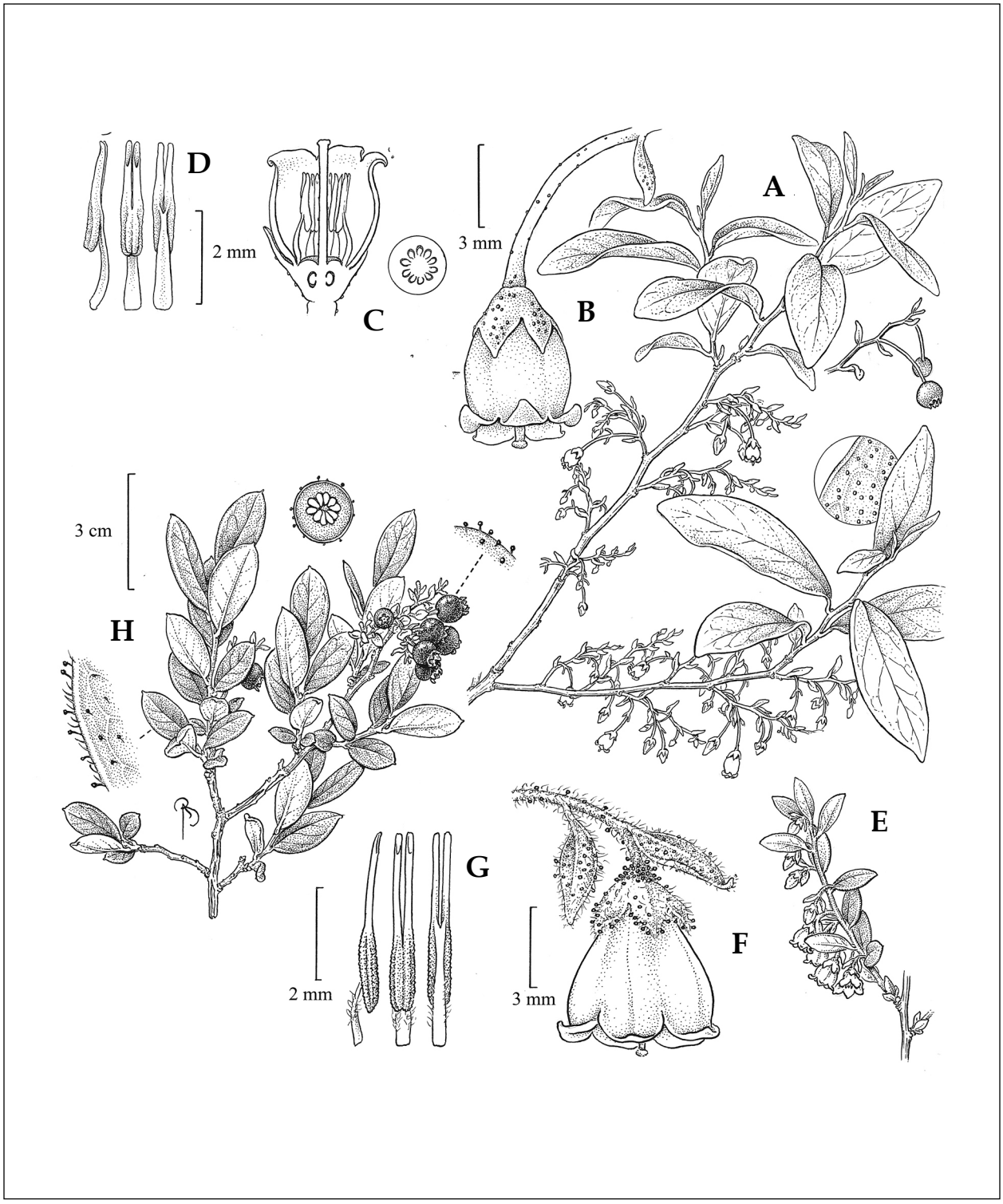


Distribution of *Gaylussacia frondosa*, or dangleberry, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig and enlarged view of leaf margin and upper surface, B) flower and cross-section of flower, C) ovary cross-section, D) stamens, and E) fruiting leafy twig of *Gaylussacia baccata*. Illustration by Bobbi Angell.

F G



A) Flowering leafy twig, with enlarged view of leaf margin and surface, and fruiting twig; B) flower; C) cross-section of ovary; and D) stamens of *Gaylussacia frondosa*; E) flowering leafy twig; F) flower; G) stamens; and H) fruiting leafy twig, with enlarged view of leaf margin and surface; fruit cross-section; and enlarged view of surface of fruit of *Gaylussacia bigeloviana*. Illustration by Bobbi Angell.

Genista L. – broom

Fabaceae. Trees, shrubs. Species 90–126 in Europe and western Asia. Open habitats. Genus name is Latin for "broom."

Nonnative Species

Genista tinctoria L. – Dyer's greenweed, Dyer's greenwood

This legume shrub has been reported twice in the flora, in Fairfield County (CT) and Bronx County (NY). These records are likely to represent remnants from cultivation as opposed to established wild populations. As the epithet (from Latin) indicates, the species was used in the past to make a yellow dye.

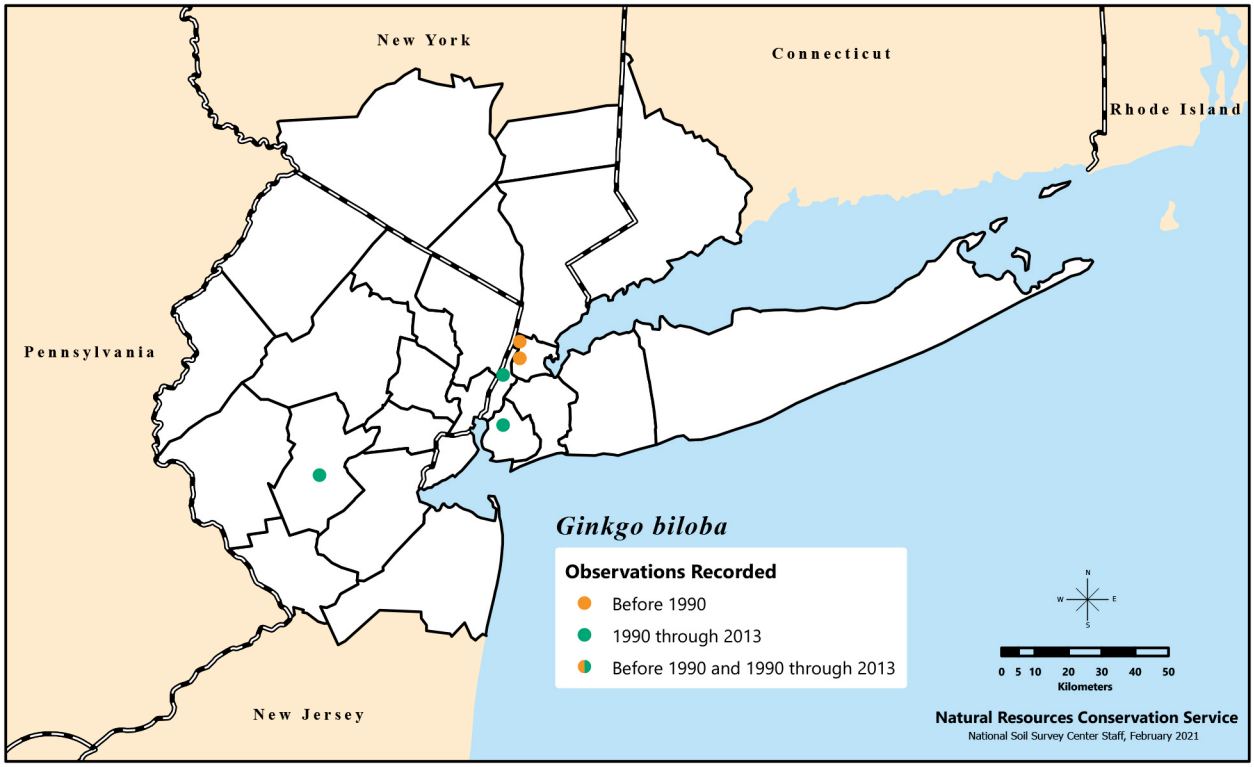
Ginkgo L. – ginkgo

Ginkgoaceae. Trees. Dioecious, monospecific; the single extant species treated here. Fossils in the same order date back 270 million years (Permian period) and are very similar to the extant *Ginkgo biloba*. Genus name first used by German physician and naturalist Engelbert Kaempfer (1651–1716) in 1712. Derived from the Japanese name for the tree, "ginkyo" (ginkgo spelling a possible romanization of the Japanese term), which in turn was derived from the Chinese name for the tree, "yinhsing," meaning "silver apricot," a reference to the fleshy seed.

Nonnative Species

1. *Ginkgo biloba* L. – ginkgo, maidenhair tree Ø♥

Male cones producing pollen in Mar.–Apr.; female (seed-producing) cones absent, sessile ovules borne on branched peduncle. Seeds maturing in Oct. Trunk monopodial (branches arising from a simple axis); growth rhythmic, producing regular tiers of plagiotropic (horizontal or at an oblique angle) branches. Chi-chis, cylindrical woody structures that grow downward from the branches and trunks of old trees, enter the soil and give rise to adventitious shoots and roots. Shoots

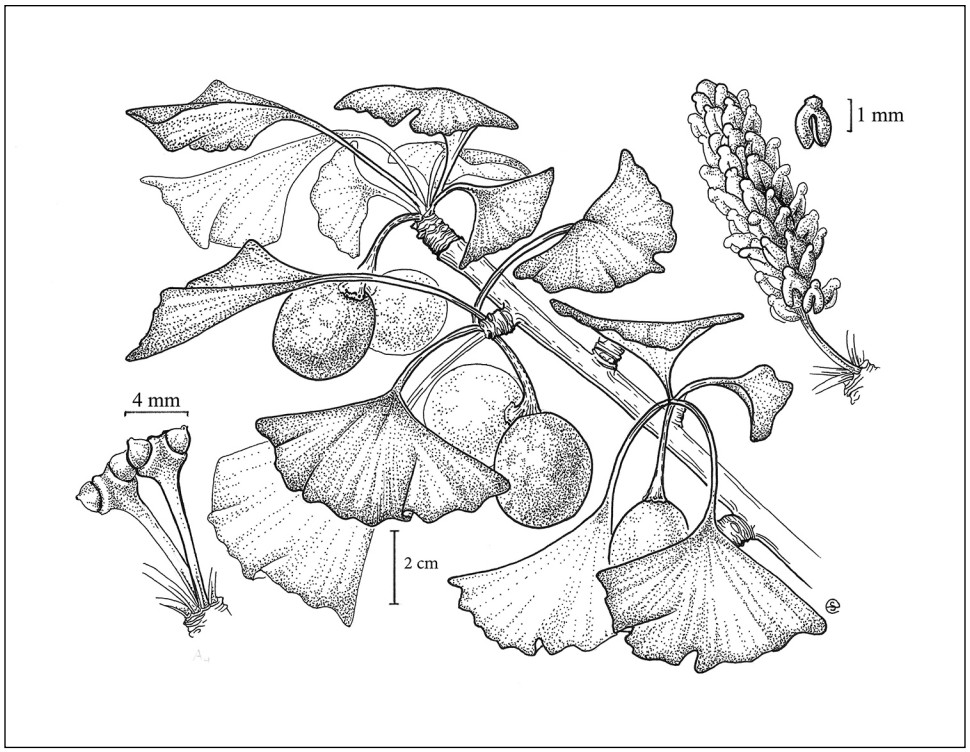


Distribution of *Ginkgo biloba*, called maidenhair tree or ginkgo, recorded in the New York Metropolitan Region during three time categories.

dimorphic, long shoots and short (spur) shoots. Outer portion (integument) of the seed composed of three layers: soft, fleshy, fetid-smelling (due to presence of butyric acid) outer layer (sarcotesta); hard, bony middle layer (sclerotesta) making up the "shell" of the seed; and an inner membranous layer (endotesta). Epithet from Latin refers to the leaves, which are sometimes bilobed. Kaempfer (1712) noted the fan-shaped leaves to be similar in appearance to the maidenhair fern (*Adiantum* L.); hence the common name maidenhair tree.

F G

Genus known in the fossil record from 170 million years ago (Jurassic period) (Zhou and Zheng 2003). Native to China; native populations extremely rare. Cultivated for more than 3,000 years. Dioecious. Male individuals widely planted as street trees, pollen allergenic; female trees not desirable as street trees due to malodorous seeds. Resistant to pollution, pests, and pathogens. Species doubtfully naturalized in the region or elsewhere in North America (Whetstone 1993); seedlings or saplings rarely found near planted trees (this is the case in the region). Birds and mammals suspected of dispersal of seeds but not confirmed (Whetstone 1993). Seeds (with fleshy layer removed) edible; are used in Chinese, Korean, and Japanese dishes. Tree is thought to be sacred in Buddhism, but this has been disputed with no evidence of religious significance of the tree in Buddhism or Taoism. Frequent plantings near temples are more likely an indication that its edible seeds were valued. Monks preserved forests around monasteries and large ginkgoes occurred outside the monastery gardens because they were revered in both China and Japan (Hershey 2000, Li 1963). Some specimens believed to be more than 1,000 years old. Extracts used in treatment of headaches, tinnitus, and memory loss, though effectiveness unsubstantiated (Jacobs and Browner 2000, van Dongen et al. 2000).



Female strobili; twig with leaves and seeds; and male strobilus, with enlarged view of microsporangia, of *Ginkgo biloba*. Illustration by Emma Skurnick.

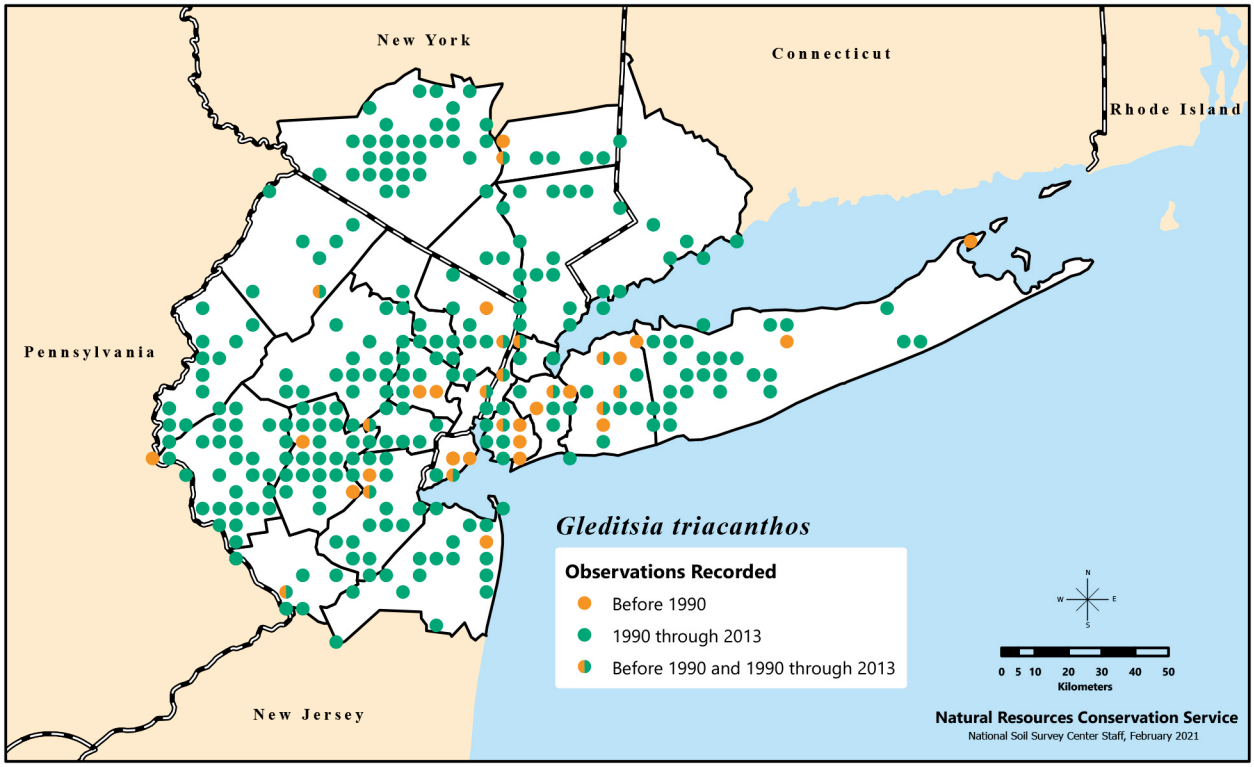
Gleditsia L. – honey-locust

Fabaceae s.l. (Caesalpiniaceae). Trees. Species 14 in Asia, North America, and South America. Distinguished by male and female greenish-yellow flowers on separate inflorescences, branched thorns on stems and trunks, leaves pinnate and bipinnate. Genus name honors German botanist Johann Gottlieb Gleditsch (1714–1786); spelling used by Linnaeus (i.e., not *Gleditschia*) an intentional latinization.

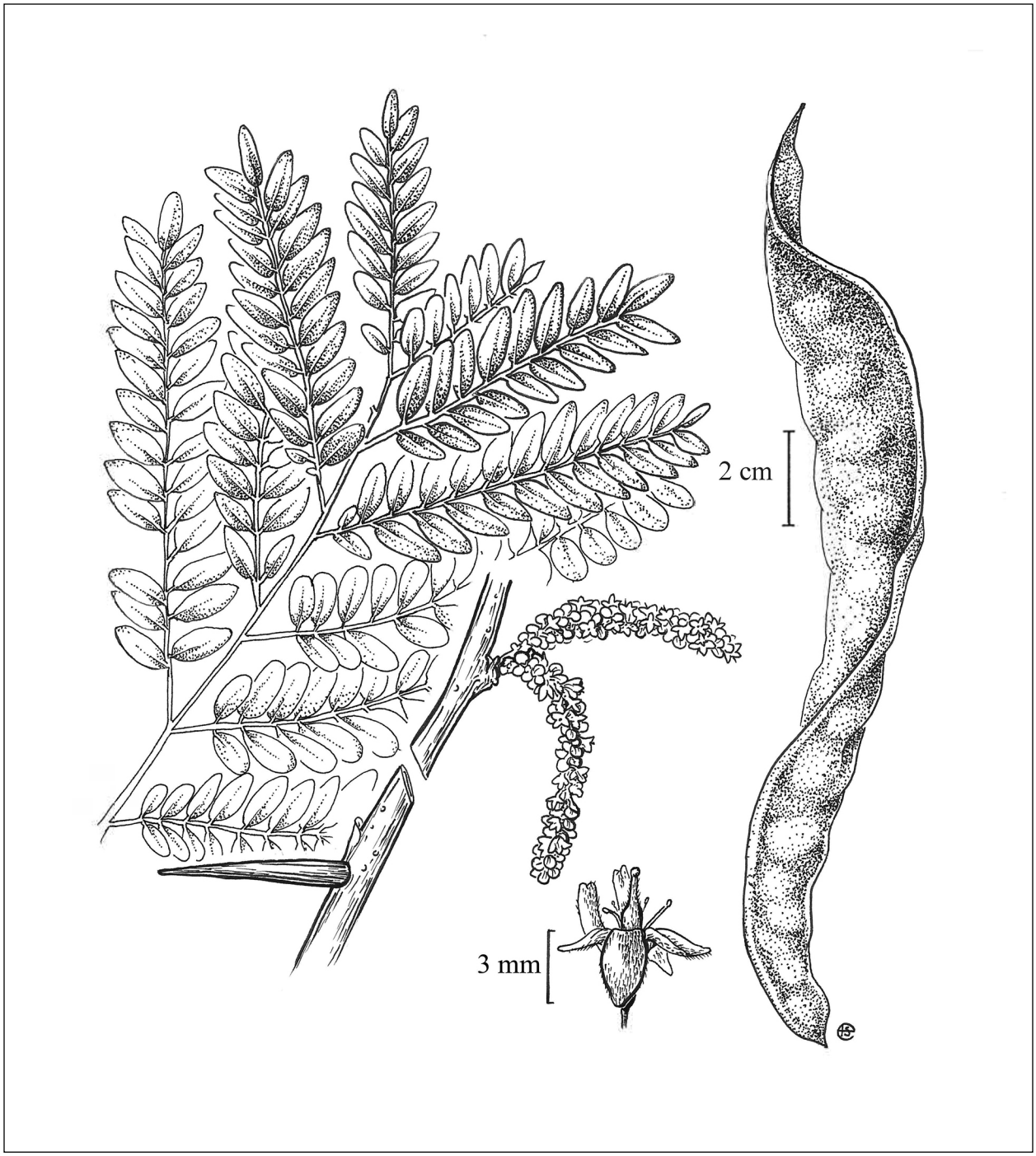
Nonnative Species

1. *Gleditsia triacanthos* L. – honey-locust ↑↑↑

Flowering May–June; fruiting July–Sept. Disturbed open areas and woodland edges. Mature naturalized trees rarely encountered. Native to central U.S. extending to central PA, but not CT, NJ, or NY; introduced in Australia, Asia, and Europe. Pulp in pods sweet; eaten by herbivores (cattle [*Bos taurus*], deer [*Odocoileus* spp.]) that disperse seeds. Epithet from Greek means "three-thorned," in reference to the stout branched thorns present on the stems and trunks; thorns are a possible adaptation to prevent herbivory by Pleistocene megafauna (Barlow 2002), a hypothesized disperser of seeds. Thornless individuals commonly planted as street trees. There are 78 records of such thornless trees, all occurring after 1990; this trait may be increasing or botanists may have recently started to recognize the difference more. We hope that future research will determine whether the thornless trait is increasing over time. Names *Gleditsia triacanthos* var. *inermis* Pursh and *G. triacanthos* forma *inermis* Schneid. often applied to thornless material. However, names cannot be used because they are later homonyms of *G. triacanthos* var. *inermis* (L.) Castigl., which applies to a different species, most likely an *Acacia*.



Distribution of G*leditsia triacanthos*, or honey-locust, recorded in the New York Metropolitan Region during three time categories.



Leaves, twig with thorn, flowering twig, flower, and fruit (legume) of *Gleditsia triacanthos*. Illustration by Emma Skurnick.

Gymnocladus Lam. – coffee tree

Fabaceae s.l. (Caesalpiniaceae). Trees. Species 4–6: Asia 2–5, North America 1. Distinguished by its white flowers in terminal racemes, large bipinnate leaves, and oblong, thick, turgid, pulpy pods. Genus name from Greek means "naked branch," in reference to the stout branches lacking many branchlets.

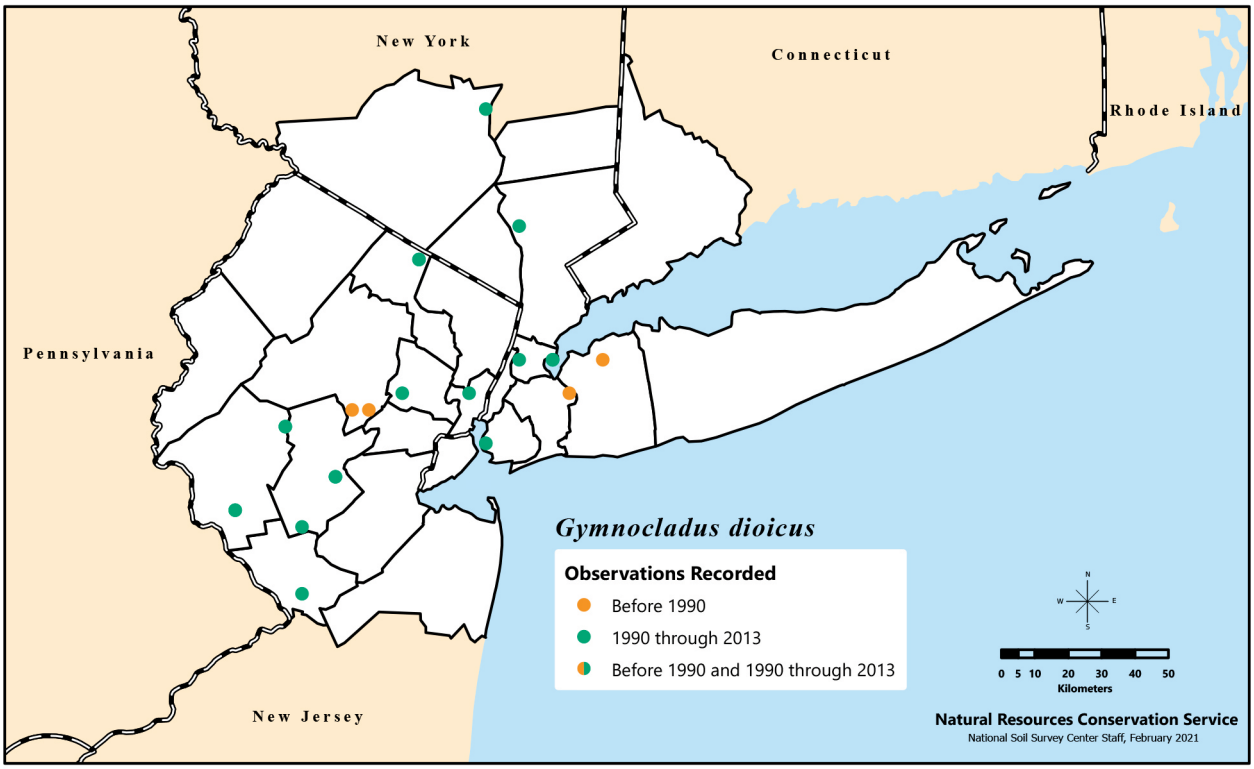
Nonnative Species

1. *Gymnocladus dioicus* (L.) Koch – Kentucky coffee tree ↑↑

Guilandina dioica L.

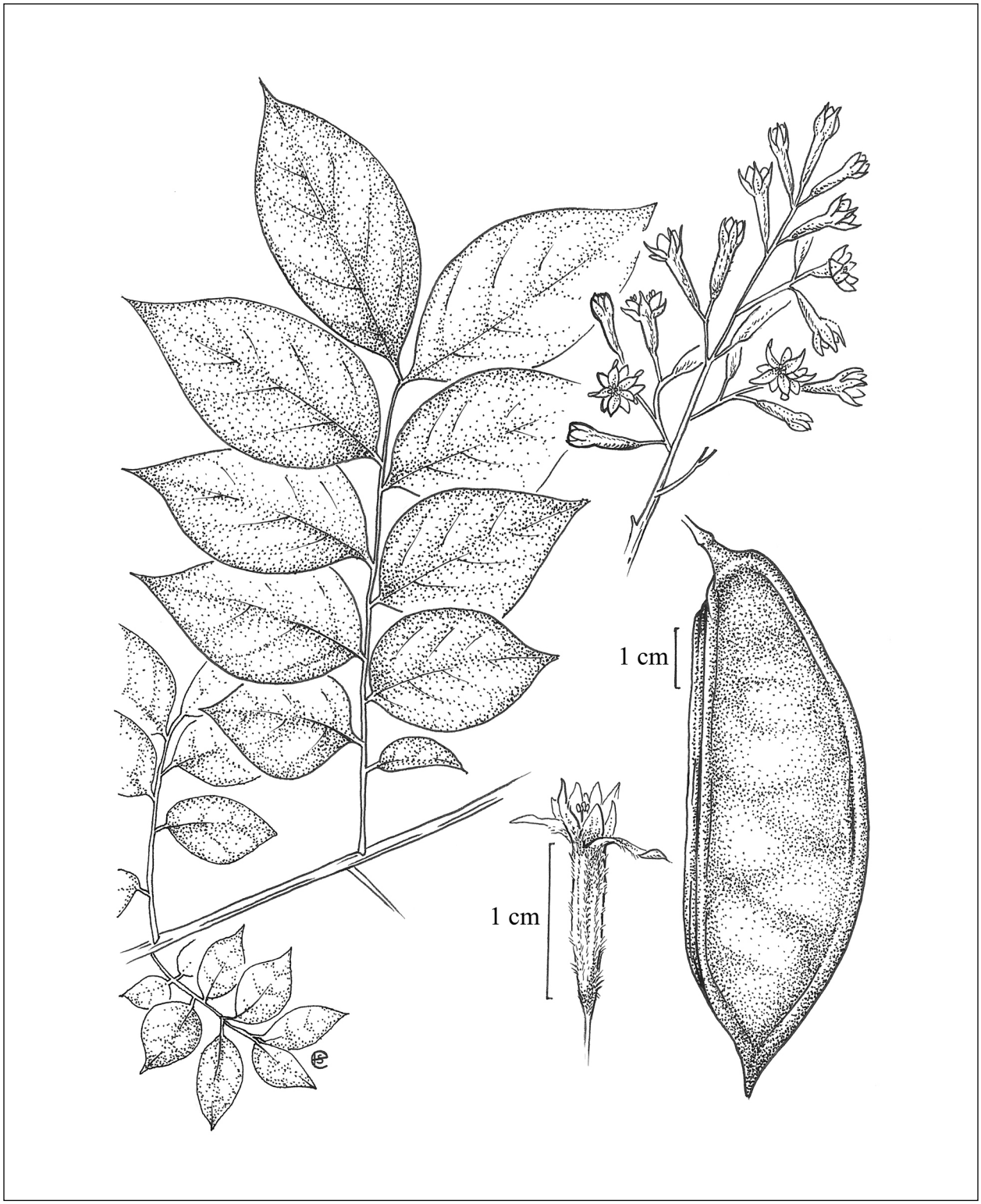
Flowering May–June; fruiting July–Sept. Woodlands and woodland edges, usually in rich soils; rare. Native to the central U.S. and southern ON, east to western PA and central NY. Local populations most likely represent escaped material or remnants from cultivation. Pods and seeds eaten by Native Americans; roasted ground seeds used by Native Americans and early European settlers to make a coffee-like beverage. Also used by Native Americans for medicinal and ceremonial purposes; cultivation by Native Americans may have expanded original range (VanNatta 2009). As with *Gleditsia*, seeds believed to have been dispersed by Pleistocene megafauna. Epithet means "dioecious" in Greek, some individuals having only male or female flowers.

Native populations elsewhere in the state listed as endangered in NY (S1).



Distribution of *Gymnocladus dioicus*, or Kentucky coffee tree, recorded in the New York Metropolitan Region during three time categories.

F G



Leafy twig, inflorescence, flower, and fruit of *Gymnocladus dioicus*. Illustration by Emma Skurnick.

Halesia Ellis ex L. – silver-bell tree

Styracaceae. Shrubs, small trees. Species 3 in North America, 1 in China. White flowers in umbel-like clusters. Fruit dry and indehiscent, conspicuously winged (Gleason and Cronquist 1991).

Nonnative Species

***Halesia tetraptera* Ellis – mountain silverbell**

Flowering Apr. – May. Rich mesic woods. In the Appalachian Mountains and Piedmont, which most likely represent remnants from cultivation. Height at maturity up to 10 m tall. *Halesia carolina* an earlier name. Only five records in the region, which most likely represent remnants from cultivation.

Hamamelis L. – witch hazel, winterbloom

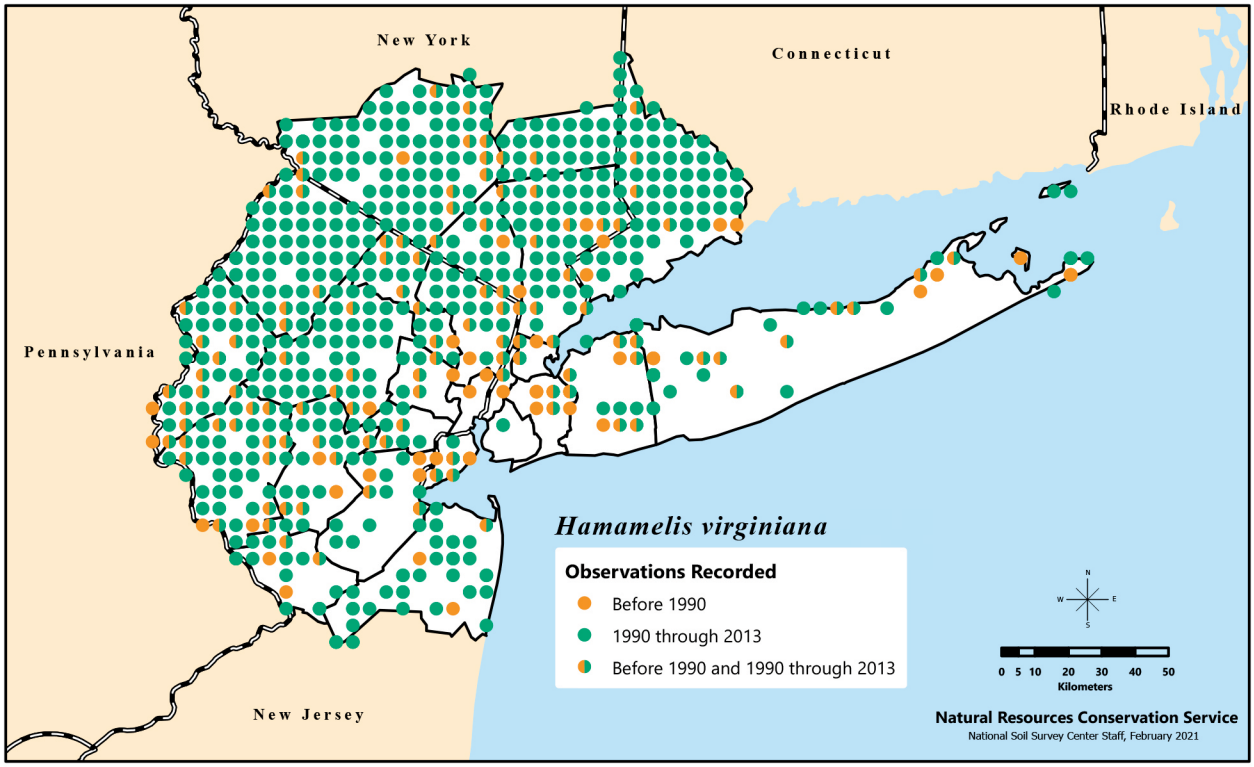
Hamamelidaceae. Small trees, shrubs. Species 4–6 in Asia and North America. Flowering in fall, winter, or early spring. Flowers showy, strongly scented. Petals yellow, orange (rarely red); long and narrow; bearing nectar. Capsules explosively dehiscent. Bark and leaves source of medicinal witch hazel, used by Native Americans. Branches used as divining rods. Genus name is the ancient name for medlar, a small tree in the rose family named *Mespilus germanica*. "Hamamelis" also means "together apple" and was possibly applied to this group of plants as the fruit of the previous season are mature when the season's flowers are blooming.

Native Species

1. *Hamamelis virginiana* L. – witch hazel ↑↑

Flowering late Sept.–Nov. (rarely to early Dec.); fruiting Sept.–Nov. of the next year. Dry to mesic woodlands, woodland edges, and high hammocks.

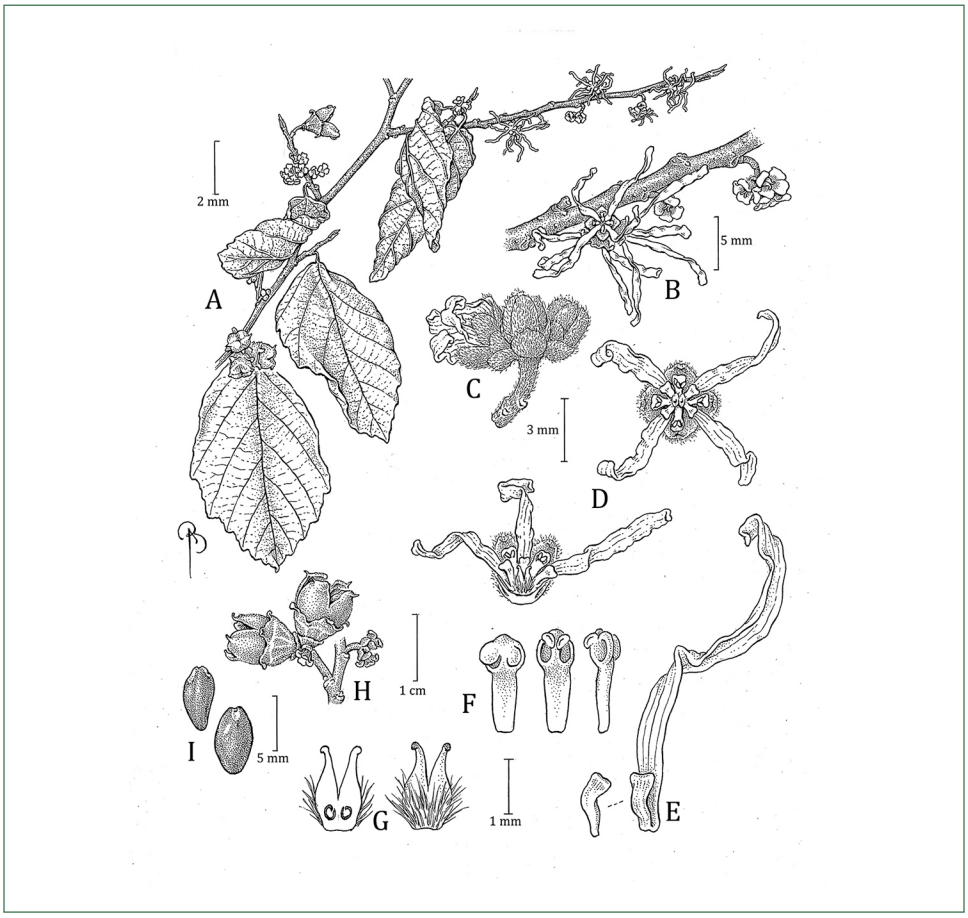
Flowers open in fall, but ovules not fertilized until the following spring. Fruit, a capsule with two seeds (though one usually atrophies), ripens in early fall (Barbour and Brinkman 2008a,



Distribution of *Hamamelis virginiana*, or witch hazel, recorded in the New York Metropolitan Region during three time categories.

Shoemaker 1905). Prefers moist soil but can grow in sun or shade. Plants grown in the sun tend to be rounder and more visually appealing (Dirr 1998).

Flowers emit a faint odor and bear nectar typical of bee- and fly-pollinated flowers. Flies (mostly *Bradysia* spp.) are the most abundant floral visitors, but small bees (order Hymenoptera) also contribute some pollen. However, generally there is a lack of pollinators, which leads to the question of why this plant overproduces flowers for so little seed production. Hypothesis is that more flowers attract more pollinators with higher pollen quality. Species also grows sympatrically with *Hamamelis vernalis*, which flowers in spring, but only in a few locations (e.g., the Ozark Mountains). Theoretically, the two species may have historically grown together and evolved different flowering times to reduce competition for pollinators (Anderson and Hill 2002). Seeds, released from a bursting capsule, may be bird dispersed. Abundant fruit crops occur once every 4 years (Barbour and Brinkman 2008a). Only about 14–16 percent survive predation by insects and mammals (De Steven 1982). Spatial distribution of this species tends to be in clusters, though isolated individuals are less susceptible to insect predation of seed. Plants may occasionally produce suckers. Individual plants appear to remain distinct from each other (De Steven 1983). Though not a common landscape plant, it is tolerant of urban conditions and suffers from few diseases, unless planted near birch (*Betula* spp.) trees, which appear to supply aphids (*Aphis* spp.) that then make small galls on the abaxial side of the leaves. The astringent witch hazel, extracted from bark of young stems and roots (Dirr 1998), is used as a skincare product for treatment of sunburn, irritated skin, and atopic eczema, and promotion of wound healing due to its anti-inflammatory effects (Deters et al. 2001). Substantial increase in species in the region, potentially due to an increase in aging woodlands and forests.



A) Flowering and fruiting leafy twig, B) flowering stem, C) side view of flowers, D) top view of flower, E) petal and staminode, F) stamens, G) pistil and cross-section of pistil, H) fruit, and I) seeds of *Hamamelis virginiana*. Illustration by Bobbi Angell.

Management

Despite the harvest of *Hamamelis virginiana* as a special forest product (witch hazel astringent), there appears to be no cause for concern over the potential loss of this species. Indeed, it is increasing in abundance in the region. It also has potential as a good landscape tree and could substitute for some of the nonnative potentially invasive shrubs planted currently (e.g., *Lonicera maackii*). However, nonnative witch hazel species are also planted as landscape trees, though apparently not yet in the region. If *H. virginiana* is selected as a landscape shrub, care should be taken not to inadvertently select *H. mollis* or *H. japonica*, or their hybrid *H. ×intermedia* (Marquard et al. 1997). All of these have larger and more colorful flowers than *H. virginiana* and, thus, may be more appealing (Gapinski et al. 2014). Because the two nonnative species can hybridize with each other, they may also hybridize with the native *H. virginiana*, though there is no documented evidence of this.

Hedera L. – ivy

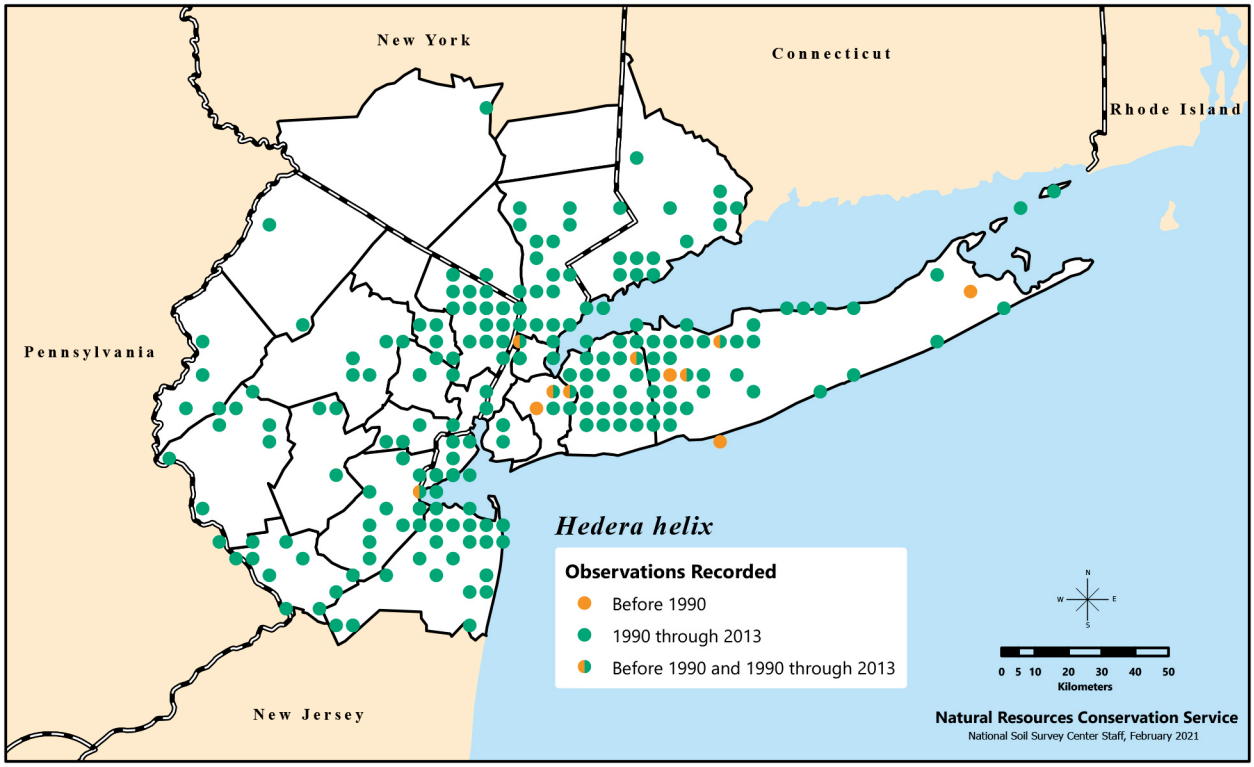
Araliaceae. Climbing to creeping woody vines. Species 13–15 in northern Africa, Asia, and Europe. Genus name is the ancient Latin name for ivy.

Nonnative Species

1. *Hedera helix* L. – English ivy ↑↑↑

Flowering Sept.–Oct.; fruit overwinters. Mesic woodlands, mesic woodland edges, and disturbed areas; often a remnant from cultivation at old homesites. Native to Europe, Russia, and Scandinavia, but has been in cultivation in the U.S. since perhaps the late 1700s. Epithet from Greek refers to the twining habit.

Significant variation in leaves, especially among juvenile, sterile, and fertile branches; dozens of foliage forms described. Leaves of sterile branches usually 3- to 5-lobed; leaves of fertile branches unlobed. Depending on taxonomy, material in



Distribution of *Hedera helix*, or English ivy, recorded in the New York Metropolitan Region during three time categories.

the region may be classified as *Hedera helix* var. *hibernica* G.Kirchn. (=*H. hibernica* (G. Kirchn.) Bean). A common diploid (Green et al. 2013) ornamental species; often found spreading vegetatively from cultivation. Also considered a weedy, invasive native species in some parts of Europe (Grund et al. 2005, Marrs et al. 2010). Grows prolifically vegetatively by producing stolons, but may also be propagated by seed if the pericarp is removed and the seeds are stratified (Dirr 1998) and scarified (Clergeau 1992). Prefers moist, well-drained, fertile soil and full sun or heavy shade, but it can tolerate both acidic and alkaline soil (Dirr 1998, Metcalfe 2005) and some saline conditions. Juvenile form never flowers; adult form, which differs in leaf shape, does flower (Dirr 1998). Black, mildly toxic fruit (Barnea et al. 1993) produced in Apr. or May (Dirr 1998). Fruit high in lipids and low in sugar; consumed, especially by birds, at comparative rates to native vines soon after ripening (Greenberg and Walter 2010). However, the slight toxicity may prevent eating of too many fruit at one time (Barnea et al. 1993). At least 400 cultivars (Clarke and Finn 2006, Dirr 1998). May rarely flower in more northerly cold conditions (Metcalfe 2005). This species and the variety *H. helix* var. *hibernica* Jacq. are likely to respond to increasing carbon dioxide by growing more vigorously in shade environments (Zotz et al. 2006). *Hedera helix* var. *hibernica* is an autotetraploid and differs morphologically from *H. helix* in terms of trichome orientation and subtle differences in leaf shape. Consequently, this variety can be difficult to distinguish from *H. helix*. The diploid and tetraploid hybridize to form a possibly infertile triploid. Lack of fertility of this hybrid needs further research (Green et al. 2013); it could potentially be a way of reducing the spread of *H. helix*.

Tracked as invasive in NJ (category 1).

Management

If the *Hedera* population has not gone to seed, its physical removal may lead to successful regeneration of native flora when there is an existing native seed bank (Biggerstaff and Beck 2007). Herbicide application may be quicker but may impede both natural and planted native species regeneration (Biggerstaff and Beck 2007). Possibly due to the waxy cuticle of the leaves, high rates of herbicide application are often necessary to control *Hedera helix*. Such rates are more likely to deter native species growth and regeneration as well. *Hedera helix* is not able to regenerate after fire, especially multiple fires (Grund et al. 2005). However, its preferred mesic habitat may make fire a difficult management strategy, except in drier areas or years. Goats (*Capra hircus*) have also been effective at consuming large amounts of the juvenile form of *H. helix*, despite the presence of the secondary compound hederin. Thus, the meristematic tissue associated with stolon development appears to be sensitive to physical removal, burning, and goat browsing (Ingham and Borman 2010). Promoting the hybridization of the *H. helix* and *H. helix* var. *hibernica* in order to increase the possibly infertile triploid could eventually lead to an infertile population. However, there remains uncertainty about the infertility of the triploid and its stability. Further, the vegetative form of the triploid could potentially be just as aggressive as or more aggressive than the existing diploid and tetraploid populations. The best control strategy may be to stop planting *H. helix* and to physically remove it, where possible. Where it is planted and not easy to remove completely, it can be kept in check by reducing its expansion (cutting it back regularly) and preventing flowering (cutting off any adult branches).



Leaves, flowers, and fruit of *Hedera helix*. Illustration by Emma Skurnick.

Hibiscus L. – mallow

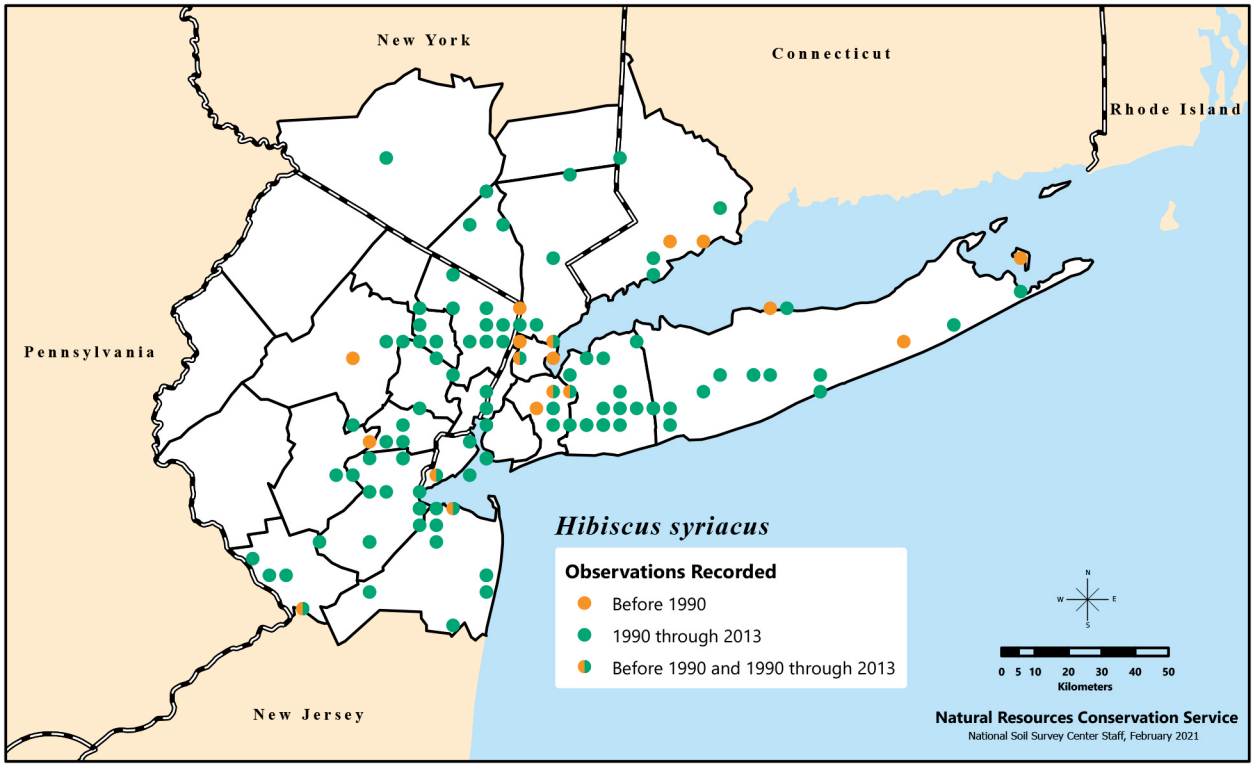
Malvaceae. Herbs, shrubs, small trees. Species about 675 in Africa, Australia, Asia, Europe, North America, and South America, when treated broadly to include *Abelmoschus* Medik.; *Decaschistia* Wight & Arn.; *Goethea* Nees; *Kosteletzkya* C.Presl; *Malvaviscus* Fabr.; *Pavonia* Cav.; *Senra* Cav.; and *Taliparitii* Fryxell. Besides *Hibiscus syriacus*, treated next, two herbaceous species occur in the flora, *H. moscheutos* L. (= *H. palustris* L.) and *H. virginicus* L. (=*Kosteletzkya virginica* (L.) (L.) C. Presl ex A.Gray). Genus name is an ancient Greek and Latin name for some mallow.

Nonnative Species

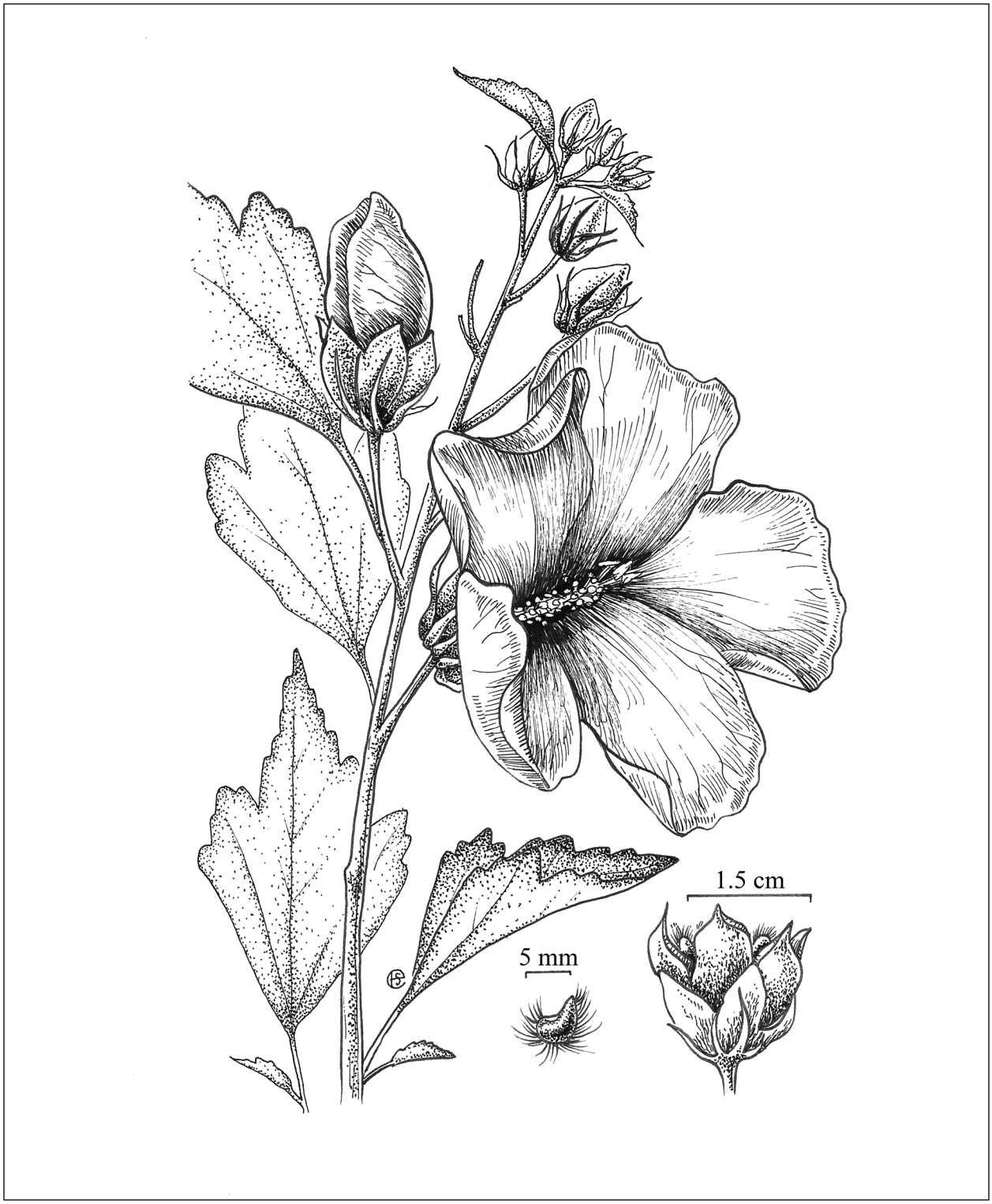
1. *Hibiscus syriacus* L. – rose-of-Sharon ↑↑↑

Flowering July–Sept. Disturbed areas and old homesteads, usually as a remnant from cultivation; occasionally naturalizing as well. Native to Asia (China), but cultivated very early on in the Middle East, including Syria, which is the basis for the epithet.

Seeds require no pretreatment for germination (Dirr 1998). In cultivation since 1600, with at least 31 cultivars. Increase in the region may be an indication of invasive potential or its popularity as a landscape shrub. It is possible that only diploid cultivars have invasive tendencies, whereas the popular, triploid 'Diana' cultivar produces very few seeds (Dirr 1998, Niemiera 2018). We do not know what cultivar predominates, if any, in the region.



Distribution of *Hibiscus syriacus*, or rose-of-Sharon, recorded in the New York Metropolitan Region during three time categories.



Flowering leafy twig, seed, and open fruit (capsule) of *Hibiscus syriacus*. Illustration by Emma Skurnick.

Hudsonia L. – false heather

Cistaceae. Shrubs, half shrubs (low-growing shrubs). Species 2–3 in North America. Possesses a free-living nitrogen fixing microbial association with blue-green algae which may facilitate colonization of nutrient-poor sand sites (Nelson 1985, Nelson et al. 1986). Genus name honors English botanist William Hudson (1730–1793).

Native Species

1. *Hudsonia ericoides* L. – golden heather, pine barrens false heather ↔

Flowering May–June. Sandy dry pinelands and oak-pinelands. Known only from the region on the Coastal Plain in NJ and Long Island. Intermediate material, believed to be a hybrid, can be found when *Hudsonia ericoides* and *H. tomentosa* occur together (Morse 1979). Characteristic species of open upland habitats in the pine barrens of NJ and Long Island. Material with white flowers is rarely encountered. Epithet means "similar to the genus *Erica* L.," a reference to the species' heath-like appearance.

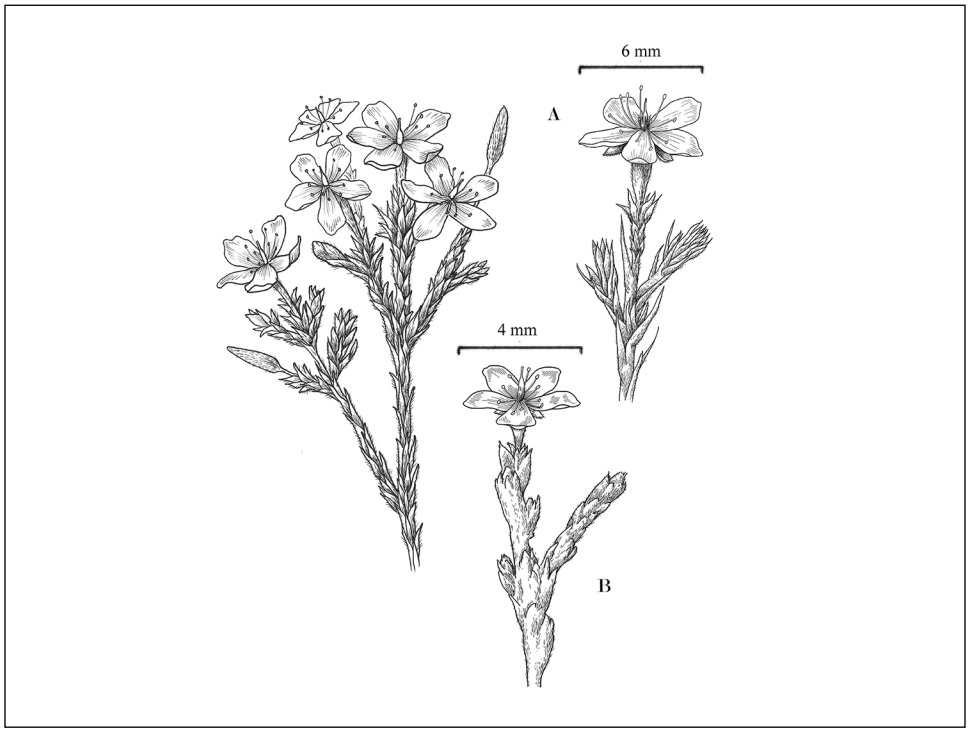
Listed as endangered in CT (S1).

2. *Hudsonia tomentosa* Nutt. – sea beach false heather ↔

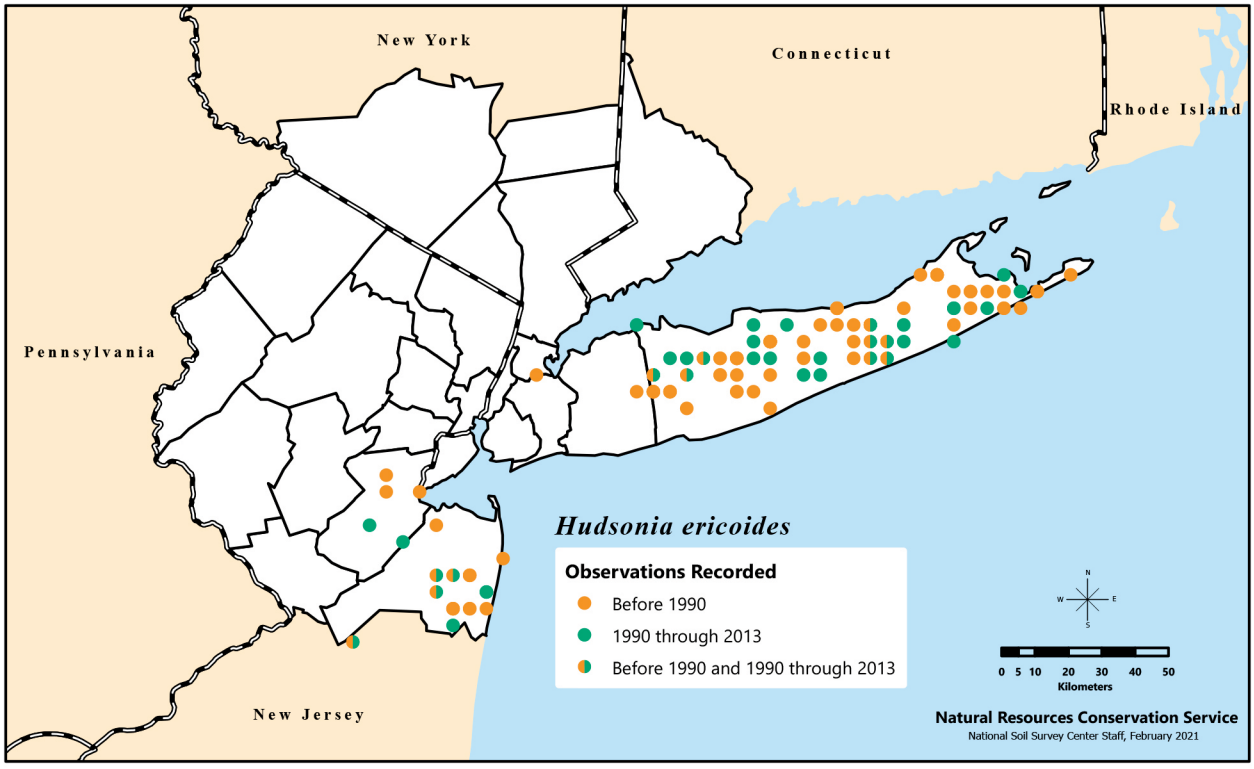
Flowering May–June. Sandy dry pinelands, oak-pinelands, dunes. Largest populations on coastal dunes; occasionally more inland in pine barren areas where sometimes found with *Hudsonia ericoides* (see preceding discussion

Hudsonia Key

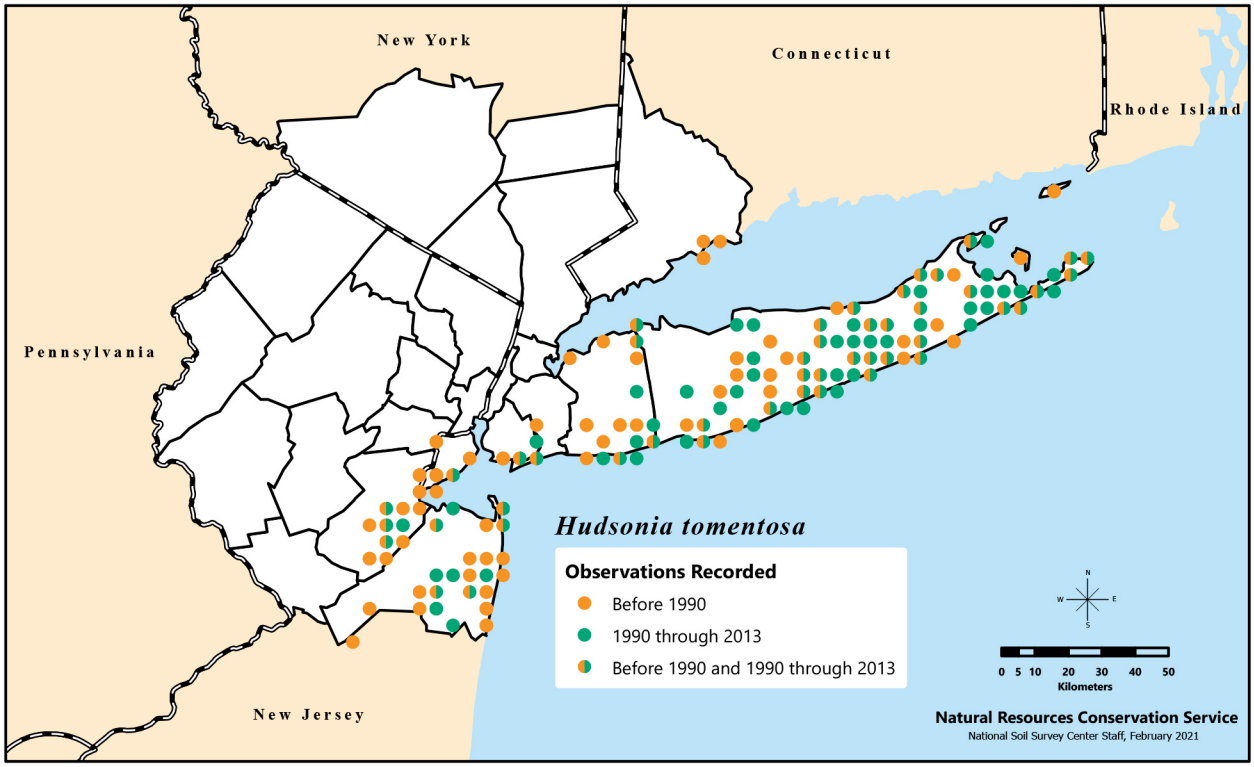
1. Leaves linear to subulate, spreading, not imbricate, green, sericeous; capsules cylindric, pubescent above . . . . . ***Hudsonia ericoides***
1. Leaves lanceolate to ovate-lanceolate, densely imbricate, gray-green, tomentose; capsules ovoid, glabrous . . . . . ***Hudsonia tomentosa***



A) Flowering leafy stem and flower of *Hudsonia tomentosa*; B) flower of *Hudsonia ericoides*. Illustration by Emma Skurnick.



Distribution of *Hudsonia ericoides*, called golden heather or pine barrens false heather, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Richmond County (NY).



Distribution of *Hudsonia tomentosa*, or beach false heather, recorded in the New York Metropolitan Region during three time categories.

about hybridization). Most regeneration is by vegetative clone-forming. Seeds remain viable for several years and can germinate in large numbers under suitable conditions, but seedling mortality rates are high (Morse 1979, Nelson 1985). Moist cold stratification for 60 days recommended for germination (Skaradek 2001).

Listed as threatened in CT (S2).

Hydrangea L. – hydrangea

Hydrangeaceae. Shrubs, woody vines, small trees. Species about 75 in Asia, North America, and South America. Flowers along the margins of the inflorescence often sterile, consisting of a showy, flat, lobed calyx. Besides the two following species, *Hydrangea macrophylla* (Thunb.) Ser. (native to Japan) is widely cultivated, but not yet documented as naturalizing in the region. In *H. macrophylla*, flower color depends on soil pH. Lower pH (less than 7.0) permits the ability to absorb aluminum, producing blue flowers. In higher pH soils this ability is hampered and pink flowers are produced (Dirr 1998). The following species have white flowers, but *H. paniculata*'s flowers may age to greenish or bluish. Genus name is derived from the Greek "hydro" ("water") and "aggeion" ("vessel"), in reference to the shape of the capsules.

Native Species

1. *Hydrangea arborescens* L. – wild hydrangea ↔

Flowering June–July. Rich woods and streambanks, often on rocky soils and slopes. Described as the easiest plant to root though it may not be tolerant of drier conditions (Dirr 1998). Distribution in the region seems most abundant along the border with PA, which we cannot explain. Cultivated since 1736, with at least 6 cultivars (Dirr 1998). Seed production may require outcrossing (Reed 2000).

Listed as threatened in NY (S2).

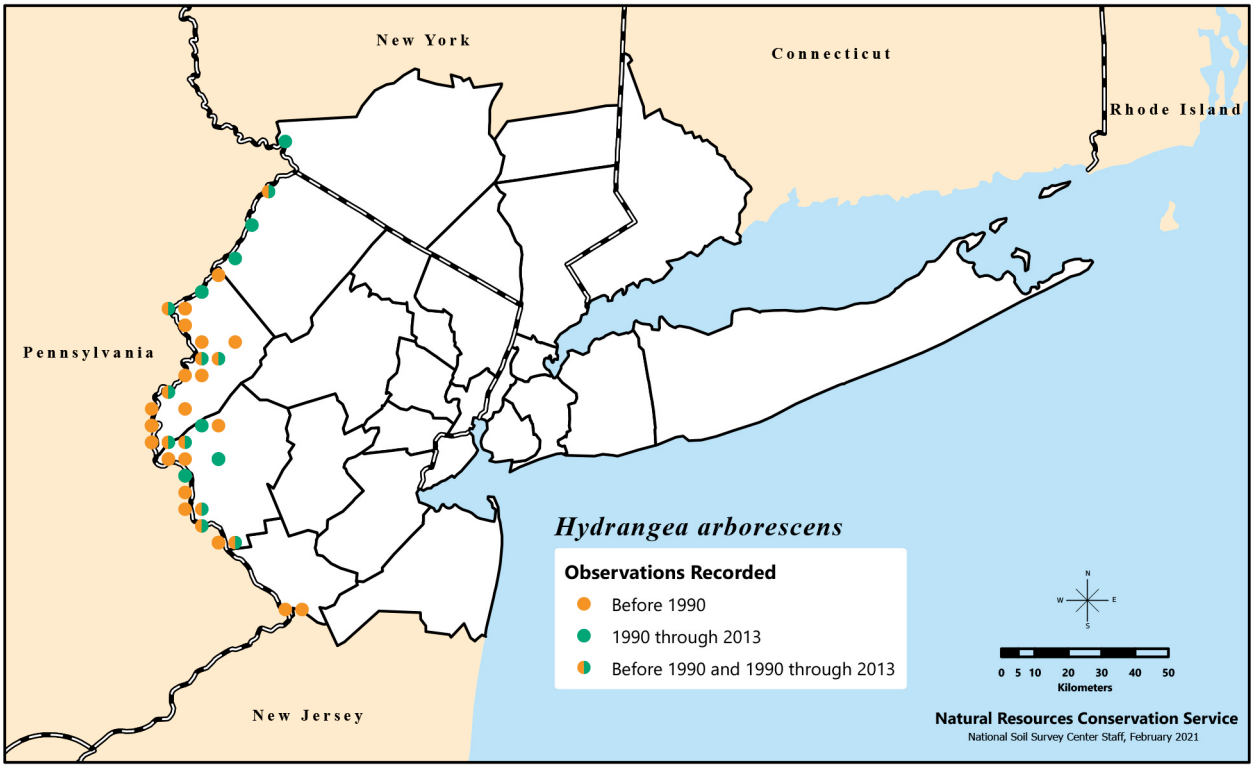
Nonnative Species

2. *Hydrangea paniculata* Sieb. – panicled hydrangea ↑↑↑

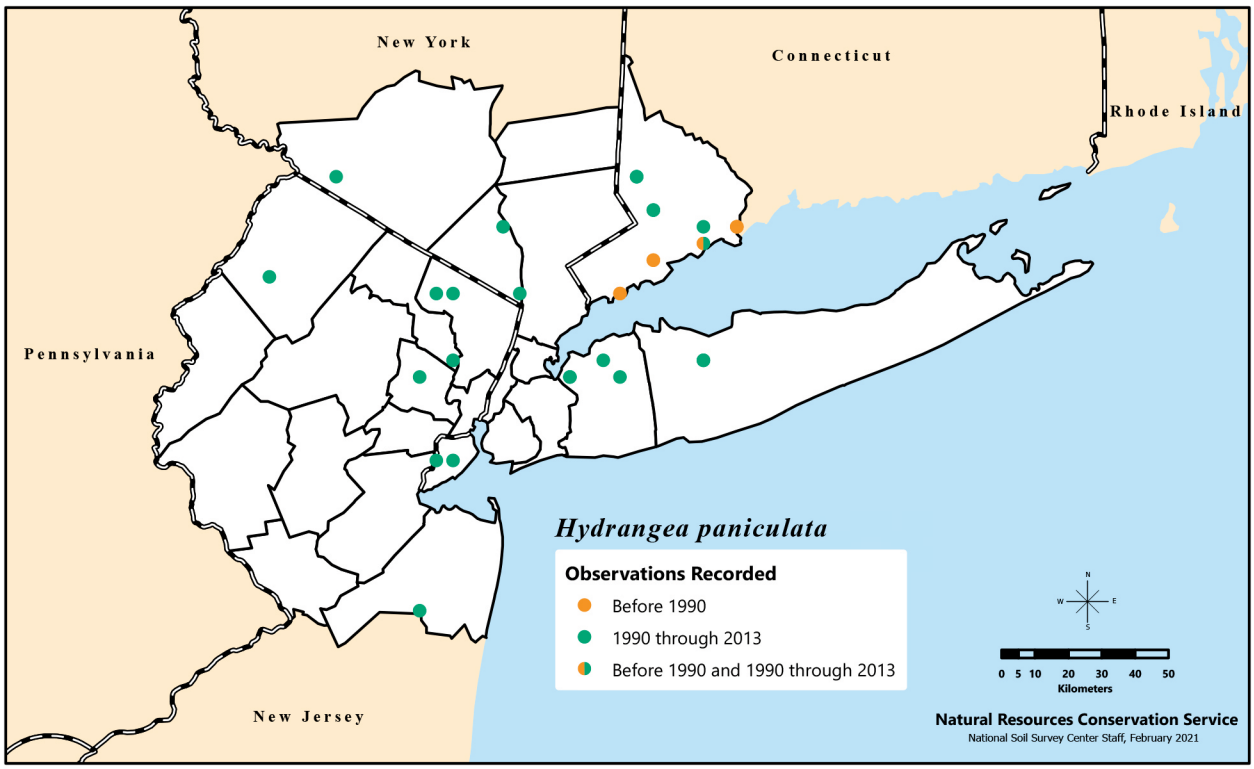
Flowering July–Sept. Rich woods and streambanks, often on rocky soils and slopes; woodland roadsides as an occasional escape. Native to Asia. A very hardy plant, tolerant of urban conditions, and difficult to kill. Ability of this species to thrive in the same habitat as the native, *Hydrangea arborescens*, may be of concern, especially given its increasing abundance. Cultivated since 1861, with at least 24 cultivars (Dirr 1998).

Hydrangea Key

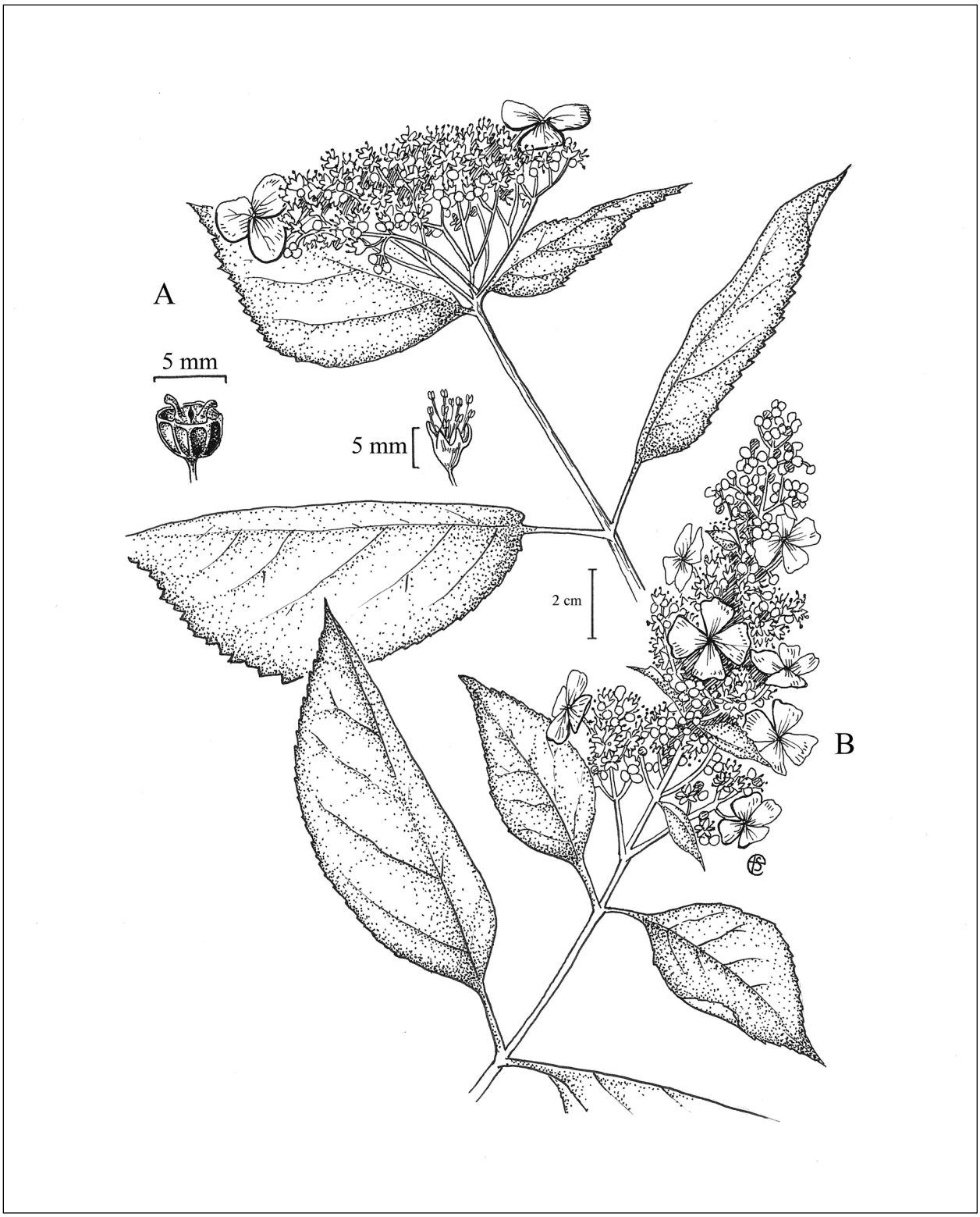
1. Leaf teeth 1–2 mm long; inflorescence flat-topped or broadly convex . . . . . ***Hydrangea arborescens***
1. Leaf teeth 0.5–1 mm long; inflorescence pyriform or ovoid . . . . . ***Hydrangea paniculata****



Distribution of *Hydrangea arborescens*, or wild hydrangea, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Hydrangea paniculata*, or panicled hydrangea, recorded in the New York Metropolitan Region during three time categories.



A) Fruit and fertile flower; and flowering leafy twig, also showing sterile flowers with large petals, of *Hydrangea arborecens*; B) flowering twig of *Hydrangea paniculata*. Illustration by Emma Skurnick.

Hypericum L. – hypericum

Ascyrum L.

Hypericaceae (Clusiaceae s.l.). Herbs, shrubs, trees. Species 490 in Africa, Australia, Asia, Europe, North America, and South America. Norman Robson (b. 1928) of the Natural History Museum, London, U.K., in a series of papers (published from 1977 to 2012; Robson 2003) completed a worldwide monograph of *Hypericum*, recognizing 36 sections and 490 species. Leaves are typically dotted with glands. Besides the 4 species treated here, the region has 13 herbaceous species (one, *H. perforatum* L., is nonnative) of *Hypericum*. Genus name is derived from "hypericon," the ancient Greek name for the plant.

Native Species

1. *Hypericum crux-andreae* (L.) Crantz. – St. Peter's-wort Ø

Ascyrum crux-andreae L.; *Ascyrum* Michx. ex Willd.; *Hypericum stans* W.P.Adams & N.Robson

Flowering July–Sept. Moist to somewhat dry, open to slightly shaded, sandy ground. Reaches the northern limit of its range in Monmouth County (NJ). Not recently reported from there. Was once more frequent in southern NJ. Adams (1957) reported the range as "New Jersey and eastern Pennsylvania southward on the Coastal Plain," but his distribution map for the species indicated a location on Long Island, although he cited no specimen from NY in his specimen list. Specimens collected from Suffolk County (NY) that were identified as *Hypericum crux-andreae* are either misidentified or not identifiable to species. Epithet from Latin would suggest that the common name should be St. Andrew's cross. However, this common name is associated with *Hypericum hypericoides*, and St. Peter's-wort is more commonly applied to this species.

2. *Hypericum densiflorum* Pursh – bushy St. John's-wort ↓↓↓

Flowering July–Sept. Wet to moist sandy open wetlands, swamps, and bogs; rarely also along streams in freshwater intertidal zone, chiefly on the Coastal Plain. See note under *Hypericum prolificum* for confusion with this species. Cultivated since 1889, with 'Creel's Gold Star' as the main cultivar (Dirr 1998). Decline may be attributed to habitat loss.

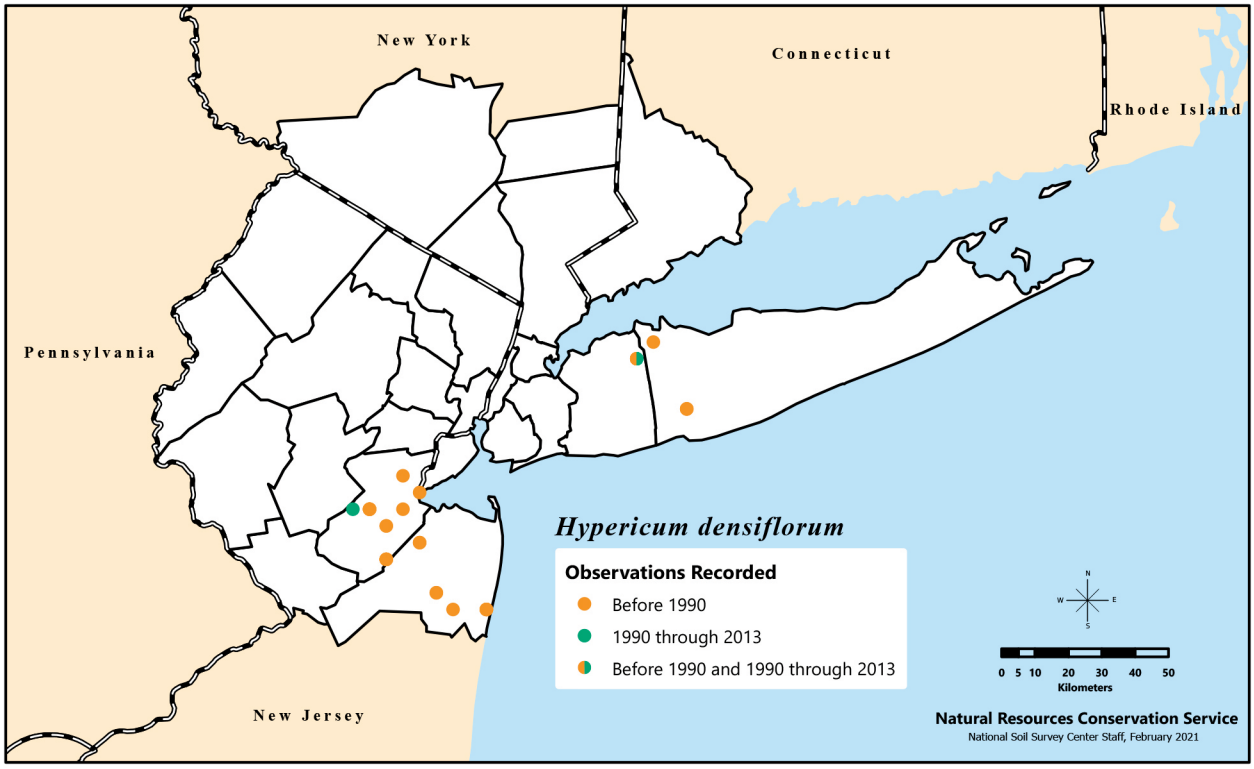
Listed as endangered in NY (S1).

3. *Hypericum hypericoides* subsp. *multicaule* (Michx. ex Willd.) N.Robson – St. Andrew's cross ↔

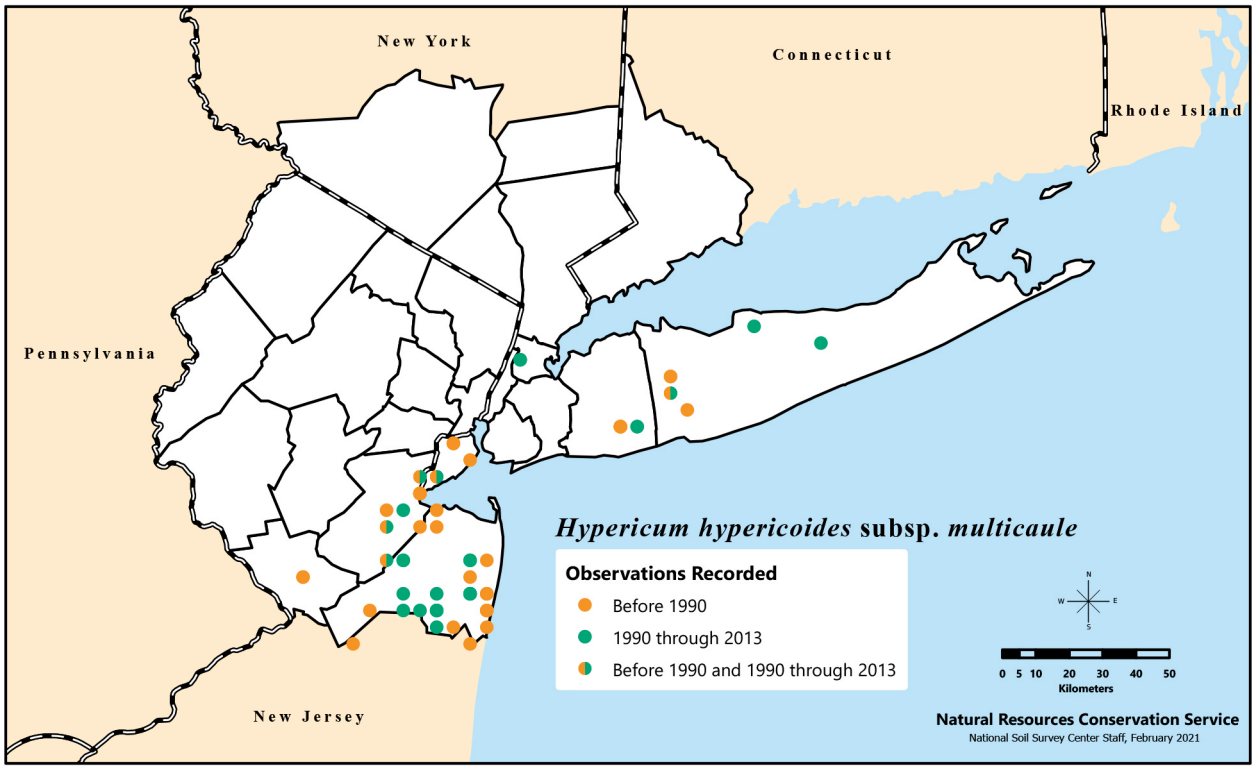
Ascyrum multicaule Michx. ex Willd.; *Ascyrum hypericoides* var. *multicaule* (Michx. ex Willd.) Fernald; *Hypericum hypericoides* var. *multicaule* (Michx. ex Willd.) Fosberg; *Hypericum stragulum* W.P.Adams & N.Robson

Hypericum Key

1. Petals 4; sepals 4, very unequal, the outermost much larger than the 2 innermost 2
1. Petals 5 or rarely 4; sepals 5, equal to subequal, sometimes with 1 sepal conspicuously larger than the rest 3
2. Erect; styles 3 or 4; stamens 50–100; leaves 7 mm wide or more . . . . . ***Hypericum crux-andreae***
2. Decumbent; styles 2; stamens fewer than 50; leaves less than 7 mm wide . . . . . ***Hypericum hypericoides* subsp. *multicaule***
3. Sepals narrowly oblong (length-to-width ratio 6:1 to 3:1, with parallel margins), 4–6 mm long, 1–1.5 mm wide, acute; leaves oblanceolate to elliptic, 20–40 mm long, 2–6 mm wide; capsules ovoid, acute, 3 mm wide . . . . . ***Hypericum densiflorum***
3. Sepals ovate, elliptic, or foliaceous, more than 2 mm long; leaves usually more than 10 mm wide . . . . . ***Hypericum prolificum***



Distribution of *Hypericum densiflorum*, or bushy St. John's-wort, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Queens County (NY).



Distribution of *Hypericum hypericoides* subsp. *multicaule*, or St. Andrew's cross, recorded in the New York Metropolitan Region during three time categories.

Flowering July–Sept. Dry open sandy ground, chiefly on the Coastal Plain. All material from the region is *Hypericum hypericoides* subsp. *multicaule*; reports of *H. hypericoides* subsp. *hypericoides* have not been verified.

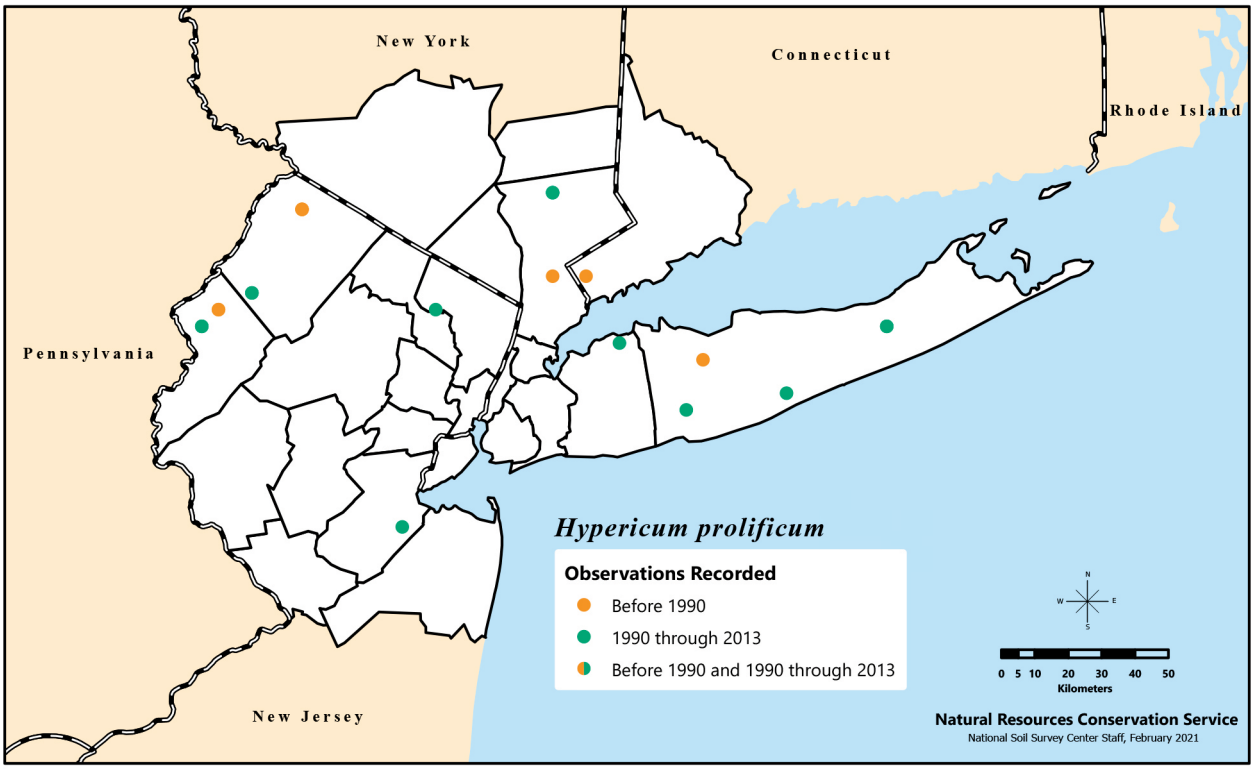
Listed as endangered in NY (S1) under the name *Hypericum stragulum*.

4. *Hypericum prolificum* L. – shrubby St. John's-wort ↑

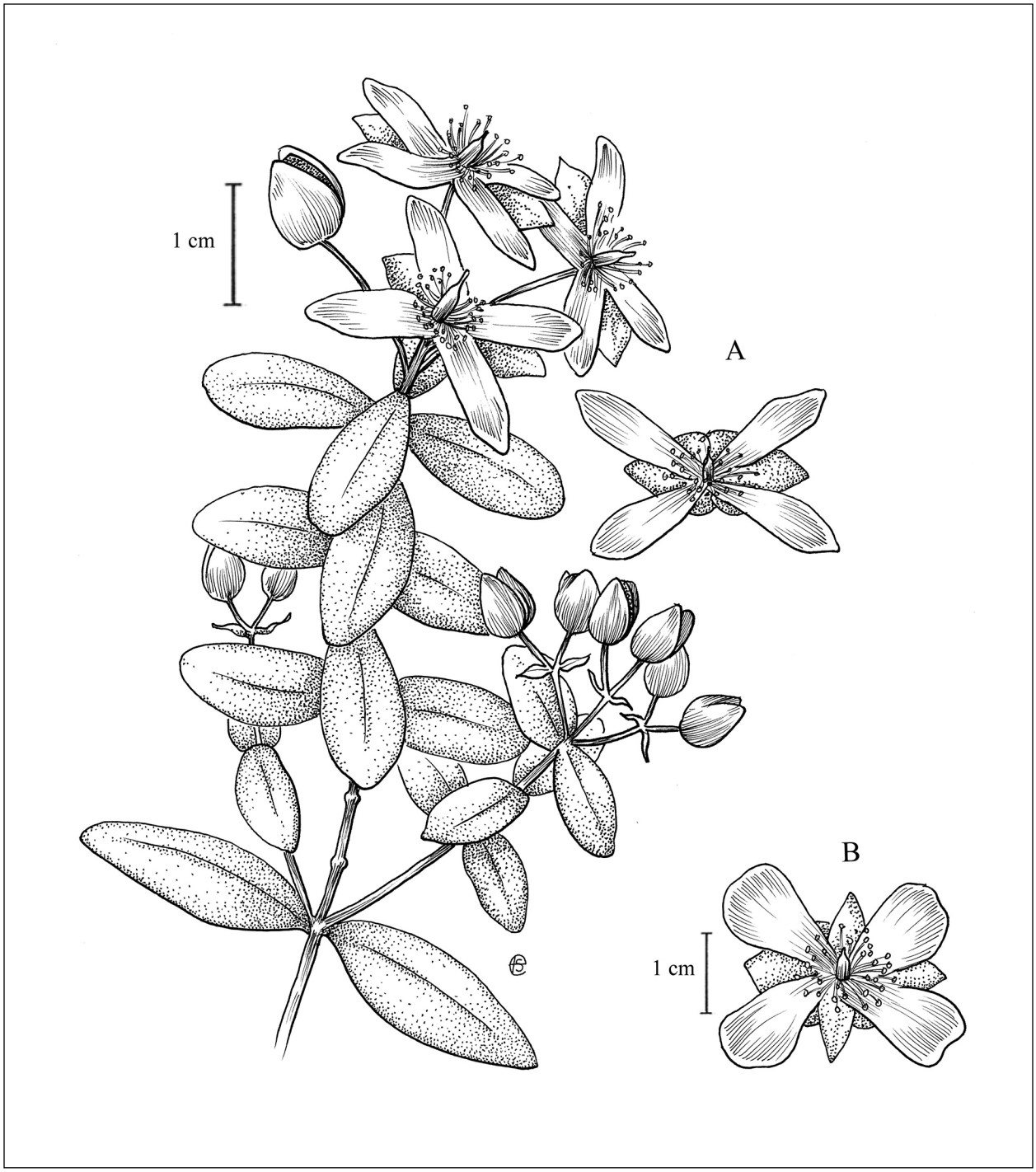
Hypericum spathulatum (Spach) Steudel

Flowering July–Sept. Somewhat dry to damp open areas on sandy or rocky soils, off the Coastal Plain. This species has been confused with *Hypericum densiflorum*. Besides the differences in the key, locally the two species are generally geographically distinct. *Hypericum densiflorum* is chiefly restricted to the Coastal Plain and *H. prolificum* is not.

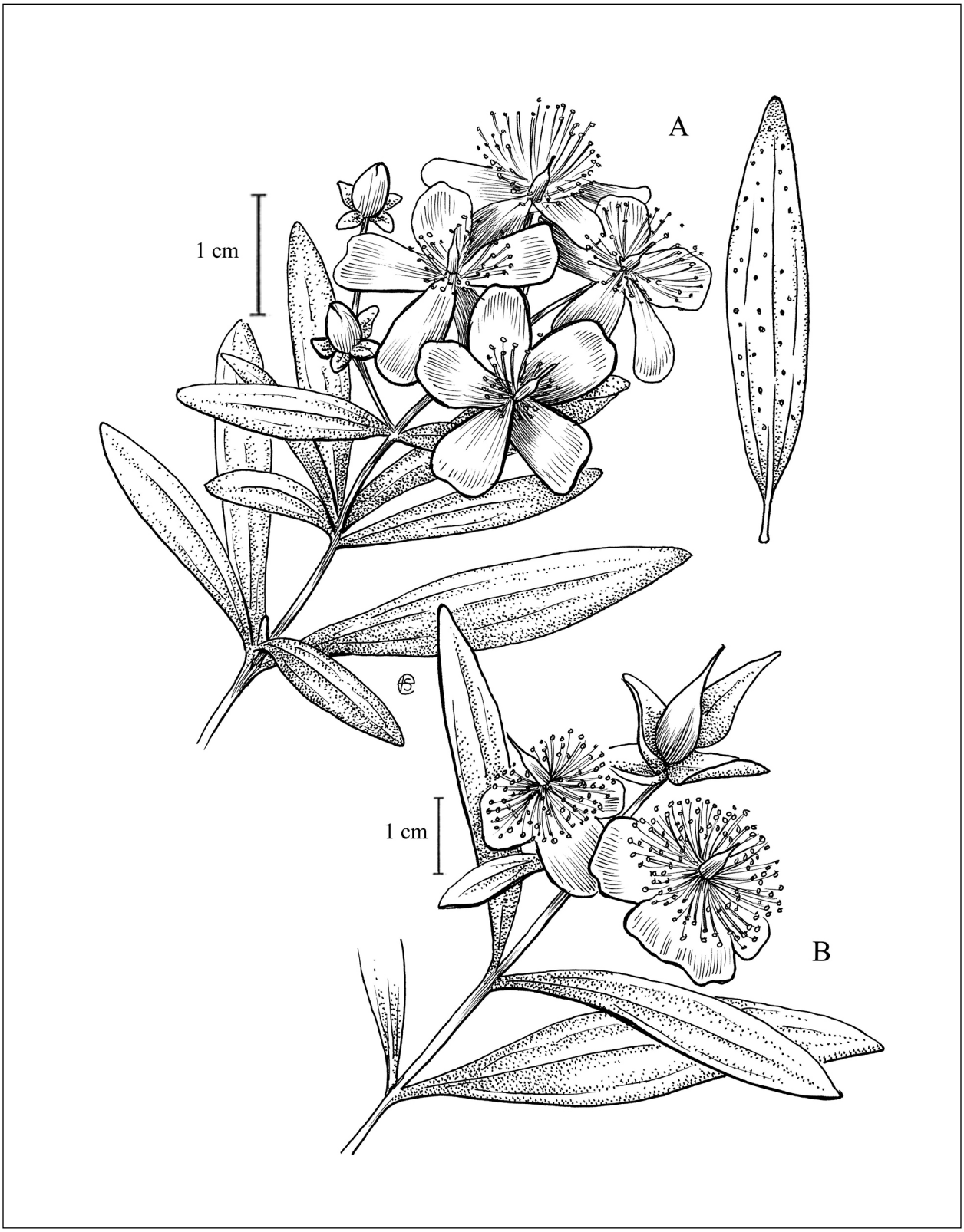
Listed as endangered in NJ (S1) and threatened in NY (S2).



Distribution of *Hypericum prolificum*, or shrubby St. John's-wort, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Monmouth County (NJ) and Bronx County (NY).



A) Flowering leafy twig with fruit (opening capsules) and flower of *Hypericum hypericoides* subsp. *multicaule*; B) flower of *Hypericum crux-andreae*. Illustration by Emma Skurnick.



A) Flowering leafy twig and enlarged view of leaf showing punctate glands of *Hypericum densiflorum*; B) flowering leafy twig of *Hypericum prolificum*. Illustration by Emma Skurnick.

Ilex L. – holly

Aquifoliaceae. Trees, shrubs. Species 300–400 in this large cosmopolitan genus; center of diversity in Central America and South America. Flowers dioecious (Cavigelli et al. 1986). Probably chiefly insect pollinated; bees (order Hymenoptera) and flies (order Diptera) have been observed visiting *Ilex* flowers. Some species apomictic. Fruits eaten by many bird species; they are usually taken later in the winter when most other more desirable fruits have already been eaten, and freezing temperatures have reduced some of the toxic compounds present in the fruits (Ridley 1930). Sometimes fruit will ferment while on the tree; birds can become intoxicated from ingesting the fruit. Small mammals (e.g., mice [*Mus* spp.], squirrels [family Sciuridae], raccoons [*Procyon lotor*]) have also been reported to take the fruits of some species. Several species are cultivated for ornamental use, for either their showy leaves or fruit. In nature, seeds usually germinate 1–3 years after dispersal, and natural regeneration commonly is sparse. Seeds have hard seed coats and are dormant or have immature embryos; as a rule, they are exceptionally difficult to germinate (a rate of 1 in 10 million has been given; Ives 1923). Germination is epigeal. Seeds have a deep dormancy that may take 12 months of warm stratification followed by 3 months of cold stratification to break (Dirr and Heuser 1987). Genus name refers to the ancient Latin name of the holly or holm oak (*Quercus ilex* L.) from the Mediterranean. "Holm" is derived from the Old English word "holegn," the name for holly. Thus, the holm oak is named for holly and the hollies are named for the holm oak.

Native Species

1. *Ilex glabra* (L.) A.Gray – inkberry ↔

Prinos glaber L.

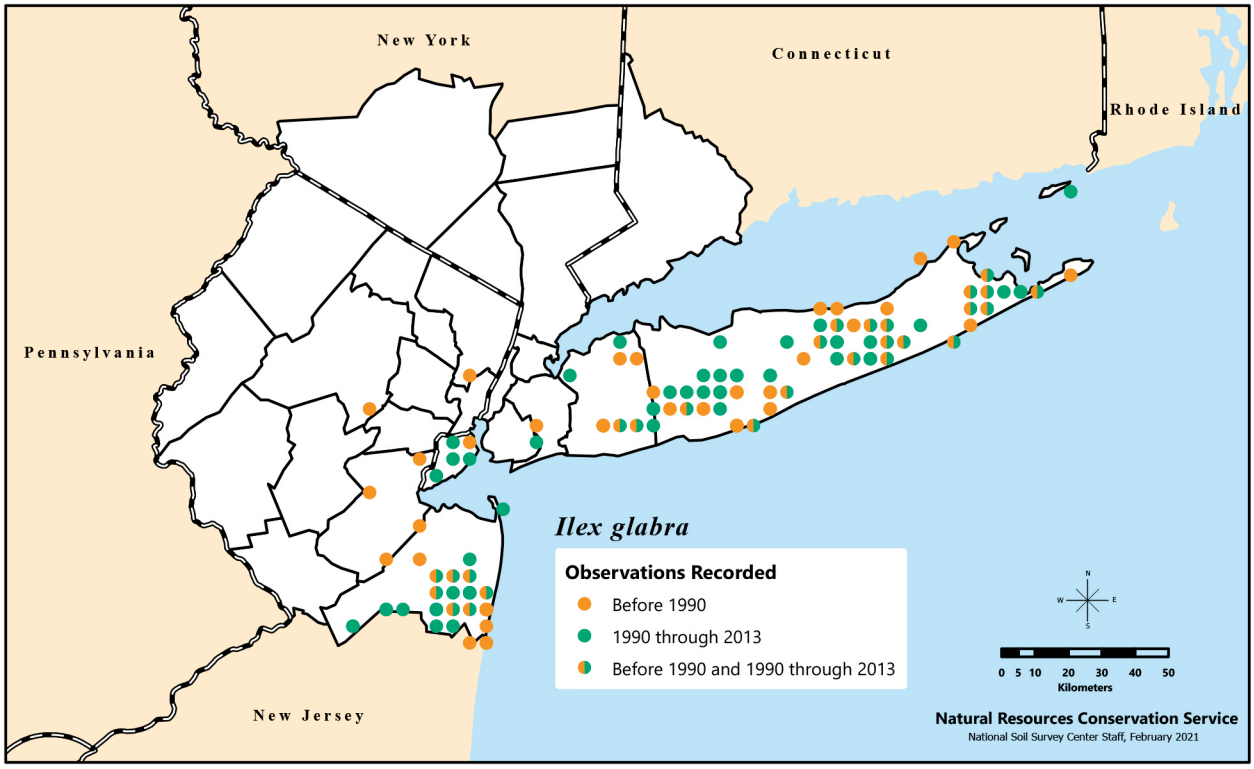
Shrub. Flowering mid-June–late July. Bogs, swamps, pond shores, and wet woods, usually in acidic substrate; often in sandy soils. Has a high degree of salt tolerance (Eberwine and Dirr 1979, Martin 1959). Found mostly along the Coastal Plain of the region. Epithet from Latin refers to the glabrous leaves.

Recommended for hedges, foundation plants, and accent plants; could easily take the place of *Ilex crenata*, an often-preferred nonnative. Cultivated since 1759, with at least 22 cultivars. Spreads by rhizomes; it is the only holly in the region to do so (Dirr 1998). Height at maturity 4 m (Bonner 2008f).

Native populations listed as threatened in CT (S2).

Ilex Key

1. Leaves somewhat thick (most likely evergreen) 2
1. Leaves thin, not leathery (most likely deciduous) 3
2. Leaves with a spiny margin . . . . . ***Ilex opaca***
2. Leaves without a spiny margin 4
3. Sepals entire, even at maturity of the fruit . . . . . ***Ilex laevigata***
3. Sepals ciliate, even at maturity of the fruit 5
4. Leaves with few obtuse teeth near apex or entire; flowers 5–8-merous . . . . . ***Ilex glabra***
4. Leaves serrate or crenate, very rarely with only a few teeth near apex; flowers 4-merous . . . . . ***Ilex crenata****
5. Leaves thin; petals ciliate; nutlets grooved on back . . . . . ***Ilex montana***
5. Leaves somewhat thick, crenate to pubescent on underside; petals entire or minutely erose; nutlets smooth on back . . . . . ***Ilex verticillata***



Distribution of *Ilex glabra*, or inkberry, recorded in the New York Metropolitan Region during three time categories.

2. *Ilex laevigata* (Pursh) A.Gray – smooth winterberry ↓

Prinos laevigatus Pursh

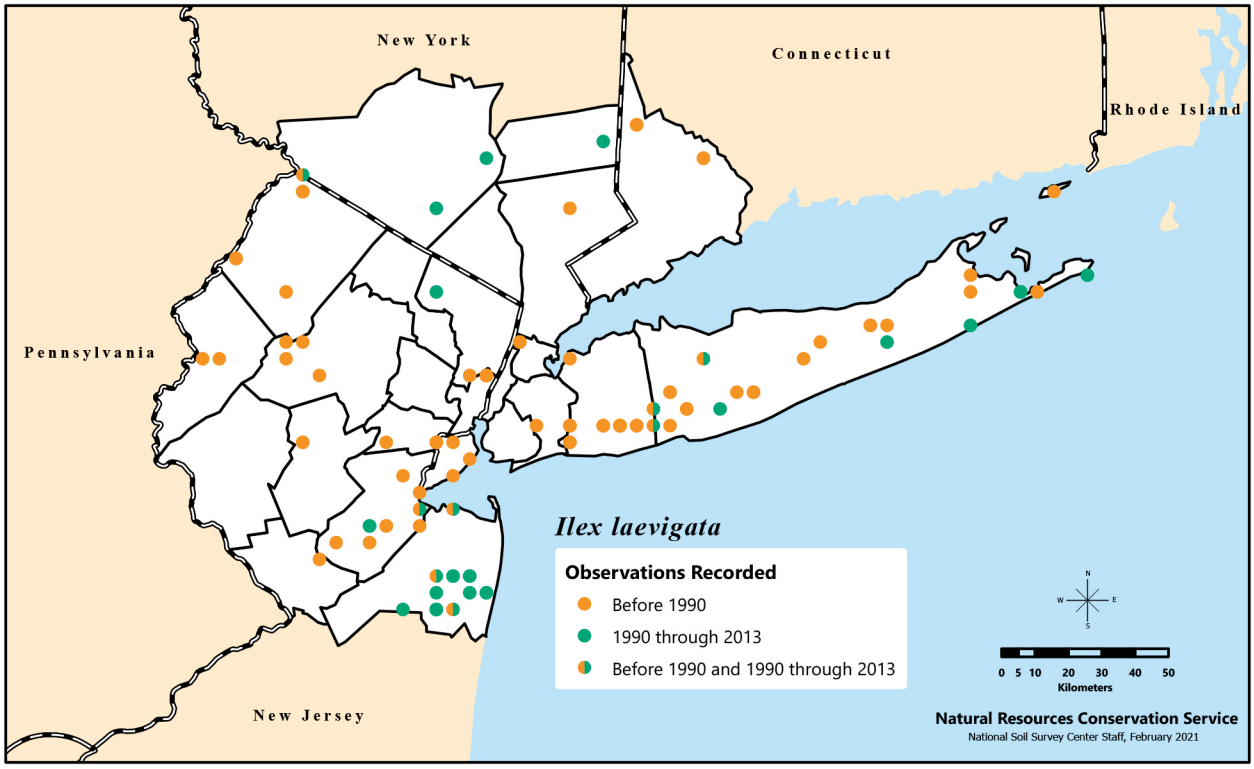
Shrub. Flowering early June–early July. Bogs, swamps, shores of streams and ponds, and wet woods, usually in well-drained, acidic soil. Historically distributed throughout the region; now found mainly on the Coastal Plain. Epithet refers to the smooth (not fringed as in *Ilex verticillata*) calyx lobes.

Most closely related to *I. verticillata*. Fruit can be set without pollination. Cultivated since 1812, but rarely used; 1 known cultivar (Dirr 1998). Indicative of rich mesic woodlands in the 19th century in NYC (DeCandido et al. 2007). The reasons for its decline are unknown.

3. *Ilex montana* Torr. & A.Gray – mountain winterberry Ø

Shrub. Flowering June. Mesic upland woods. Historically distributed throughout the region; now found mostly inland. Prefers well-drained, wooded slopes (Dirr 1998).

Sex ratio tends to be male-biased with males flowering more than female trees (both on individual trees and across trees); nonflowering trees potentially being mostly female. These conclusions are based on 1 year of data; cumulative sex ratio could be 1:1 as female trees flower more abundantly across time (Cavigelli et al. 1986). The national champion of this species, reaching 10 m, is in the Brooklyn Botanic Garden (Dirr 1998), but this species may reach a height of 12 m. Cultivated since 1870, but no known cultivars (Bonner 2008f).



Distribution of *Ilex laevigata*, or smooth winterberry, recorded in the New York Metropolitan Region during three time categories.

Listed as endangered in NJ (S1); reported from Morris, Passaic, Sussex, and Warren Counties (NJ) and New York, Orange, Rockland, and Suffolk Counties (NY), the New York County record being from 1857 and the Suffolk County records likely introductions or remnants from cultivation.

4. *Ilex opaca* Aiton – American holly ↑↑↑

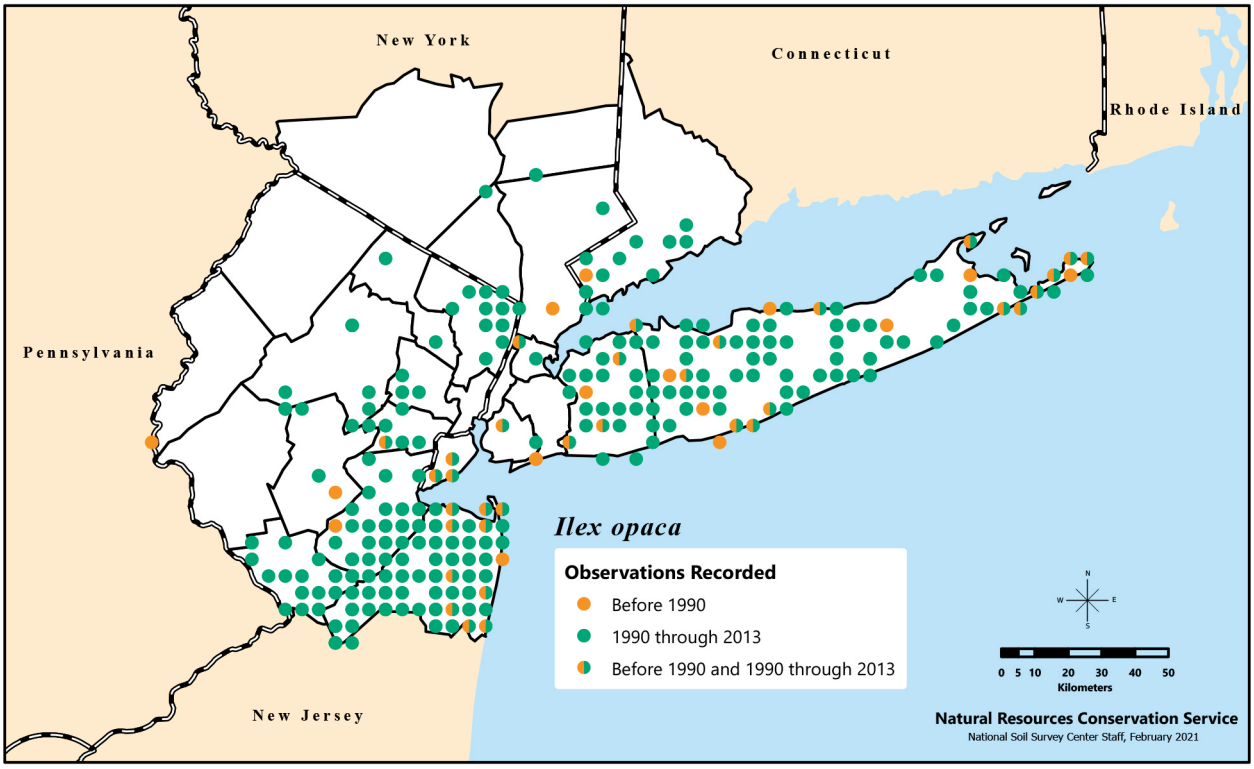
Tree. Flowering late May–late June. Dry to mesic woods, usually in well-drained, acidic soils; also sandy barrier islands. Epithet from Latin refers to the somewhat dull (i.e., not shiny) leaves, which contrast with many of the species cultivated in Europe and Asia.

Height at maturity 30 m. Earliest seed-bearing age 5 years (Bonner 2008f). Cultivated since 1744, with at least 22 cultivars. Suffers from many diseases. Often found in shady woods; cold-tolerant but not wind-tolerant. Though found in shady conditions, it tends to increase in density when growing in full sun (Dirr 1998). Female trees and shrubs flower at a later age than male trees and shrubs (Clark and Orton 1967); more male than female flowers are produced (Carr 1991). Fruit considered low-quality (high levels of phenolics and low levels of nutrients inhibit fungal infections) (Gargiullo and Stiles 1991). *Osmanthus heterophyllus* (G. Don) P.S. Green (syn. *Osmanthus ilicifolius* (Hassk.) Mouillef.), or false holly, is similar to *I. opaca* but has opposite leaves. *Osmanthus heterophyllus* is often used as a landscape ornamental and is recently reported to be naturalizing in Suffolk County, NY (Bustamante et al. 2019), though no records have been confirmed from the region.

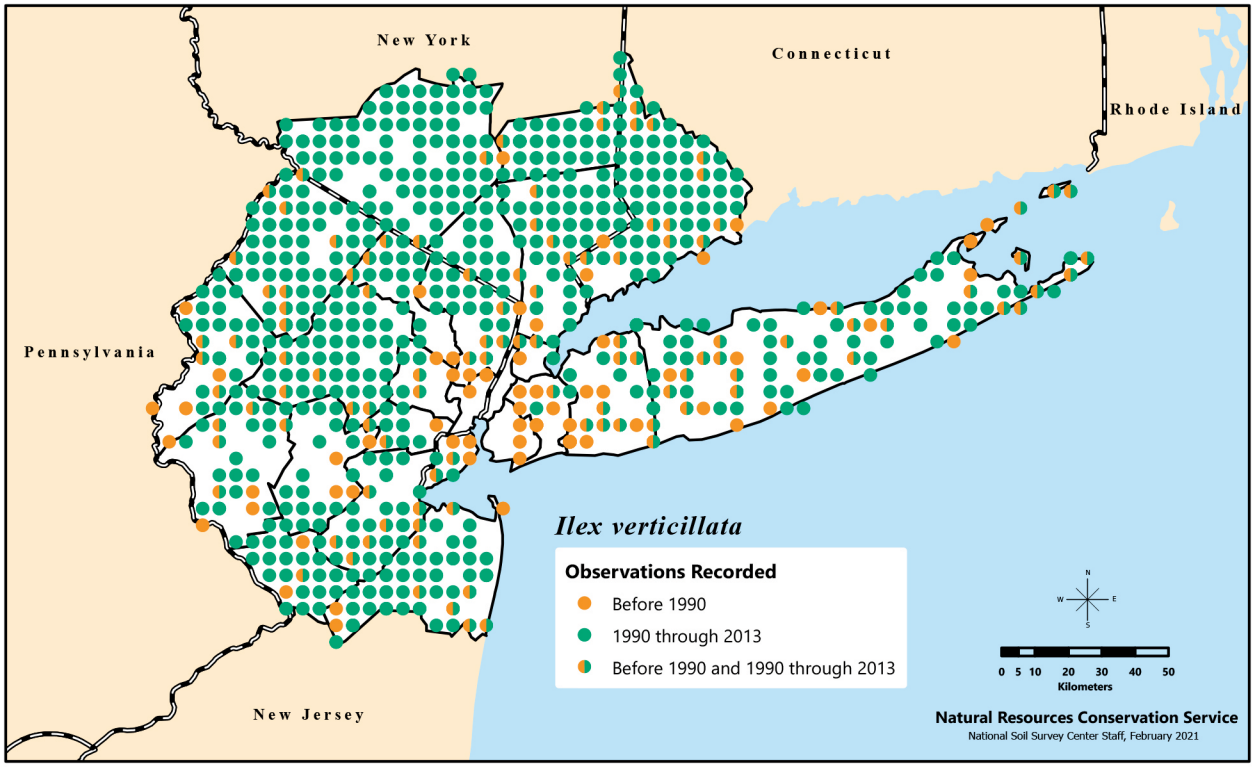
***5. Ilex verticillata* (L.) A.Gray – winterberry ↑↑**

Prinos verticillatus L.

Shrub. Flowering late May–July. Dry to wet woods, fields, thickets; swamps, bogs, pond shores, salt marsh margins; sandy dunes and grasslands; usually in acidic substrate. Epithet from Latin refers to the whorls of axillary flower clusters.



Distribution of *Ilex opaca*, or American holly, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Ilex verticillata*, or winterberry, recorded in the New York Metropolitan Region during three time categories.

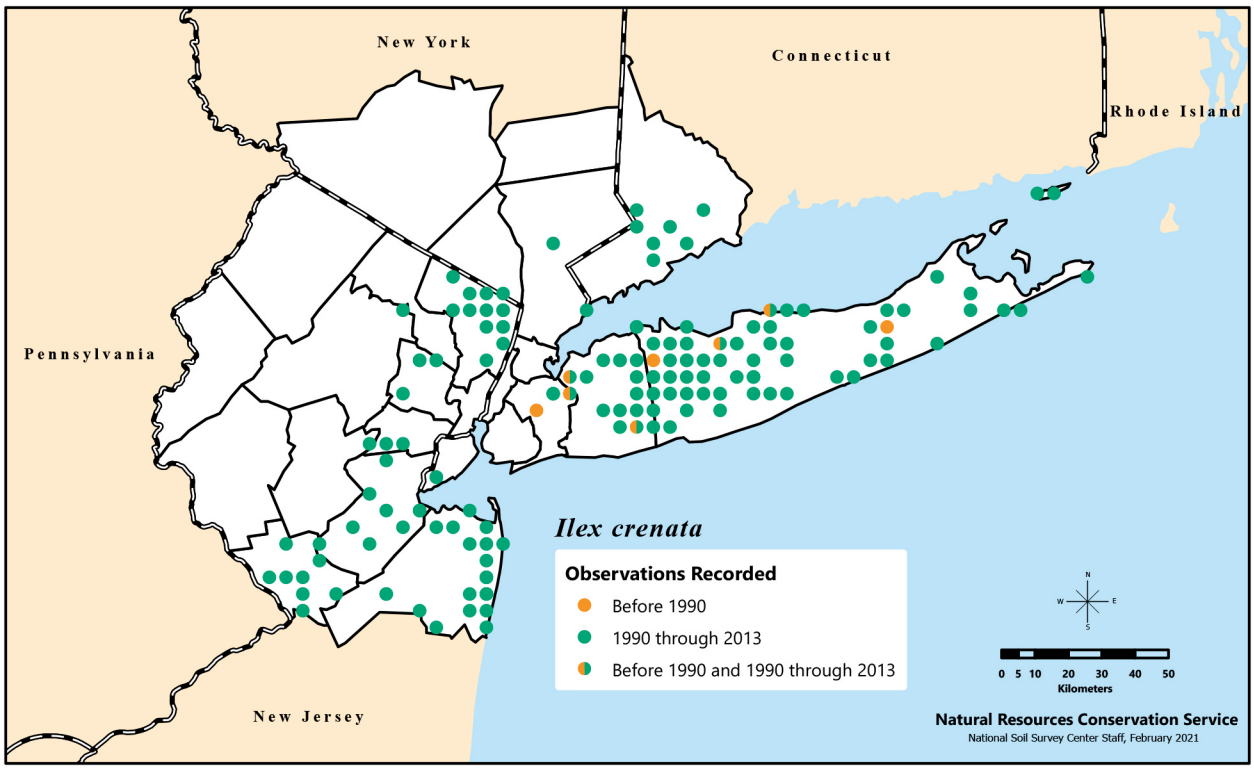
Height at maturity 8 m (Bonner 2008f). Cultivated since 1736, with at least 37 cultivars. Highly recommended for landscaping purposes, especially for mass plantings. It does, however, hybridize with *Ilex serrata*, forming a more vigorous hybrid that grows faster than *I. verticillata*. An additional 10 cultivars are associated with this hybrid. Note that *I. serrata* is native to Japan and China (Dirr 1998) but is not documented in the region yet. Further research should be conducted to confirm that the hybrid is not present in the area and escaping (and possibly confused with *I. verticillata*, which appears to be increasing).

Nonnative Species

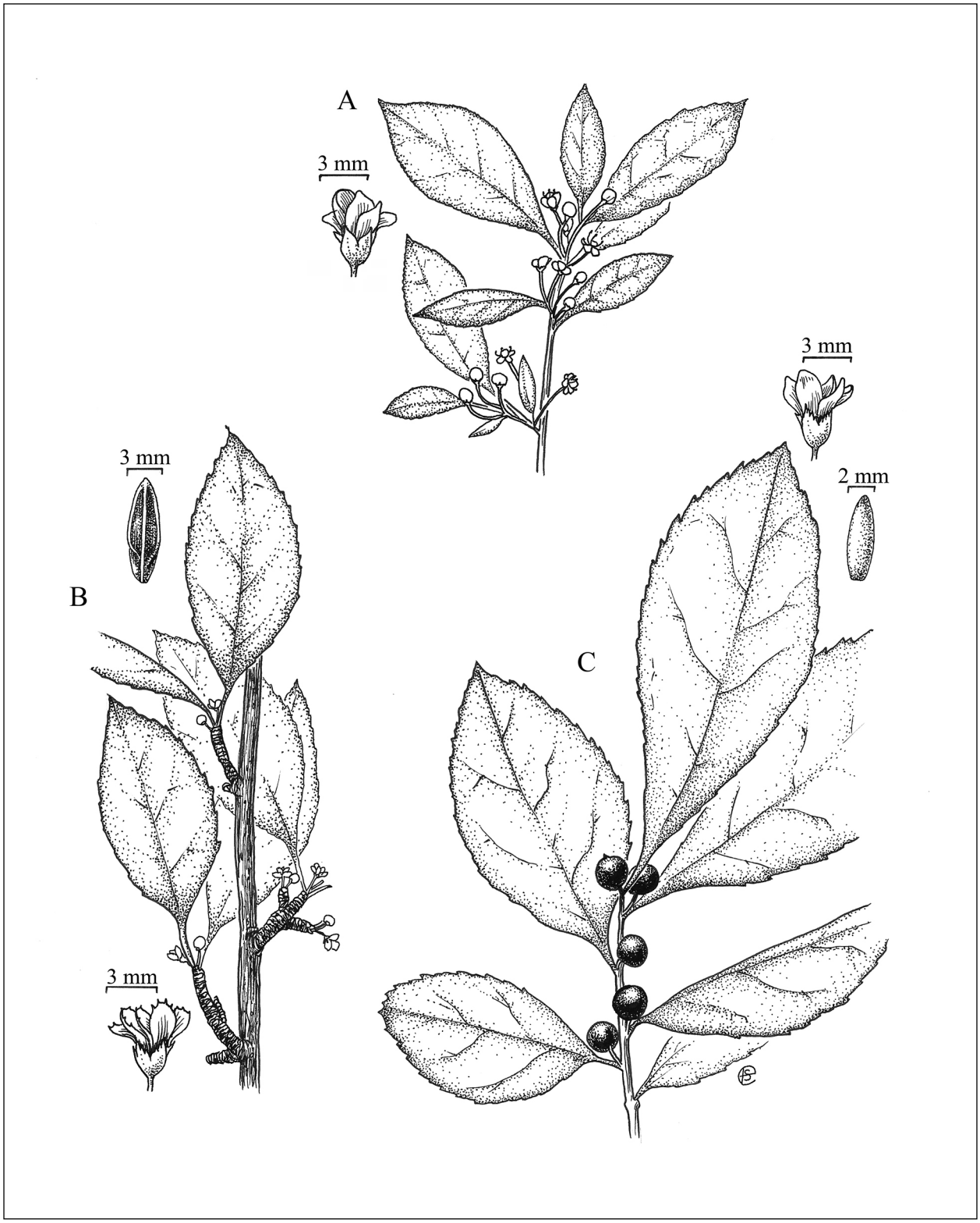
6. *Ilex crenata* Thunb. – Japanese holly ↑↑↑

Shrub. Flowering June. Mesic woodlands, usually in well-drained, acidic soils. Native to Asia (China, Japan, Korea, Russia's Far East, Taiwan), the Himalayan region of the Indian subcontinent, and the Philippines. Escaping from cultivation, mainly on the Coastal Plain.

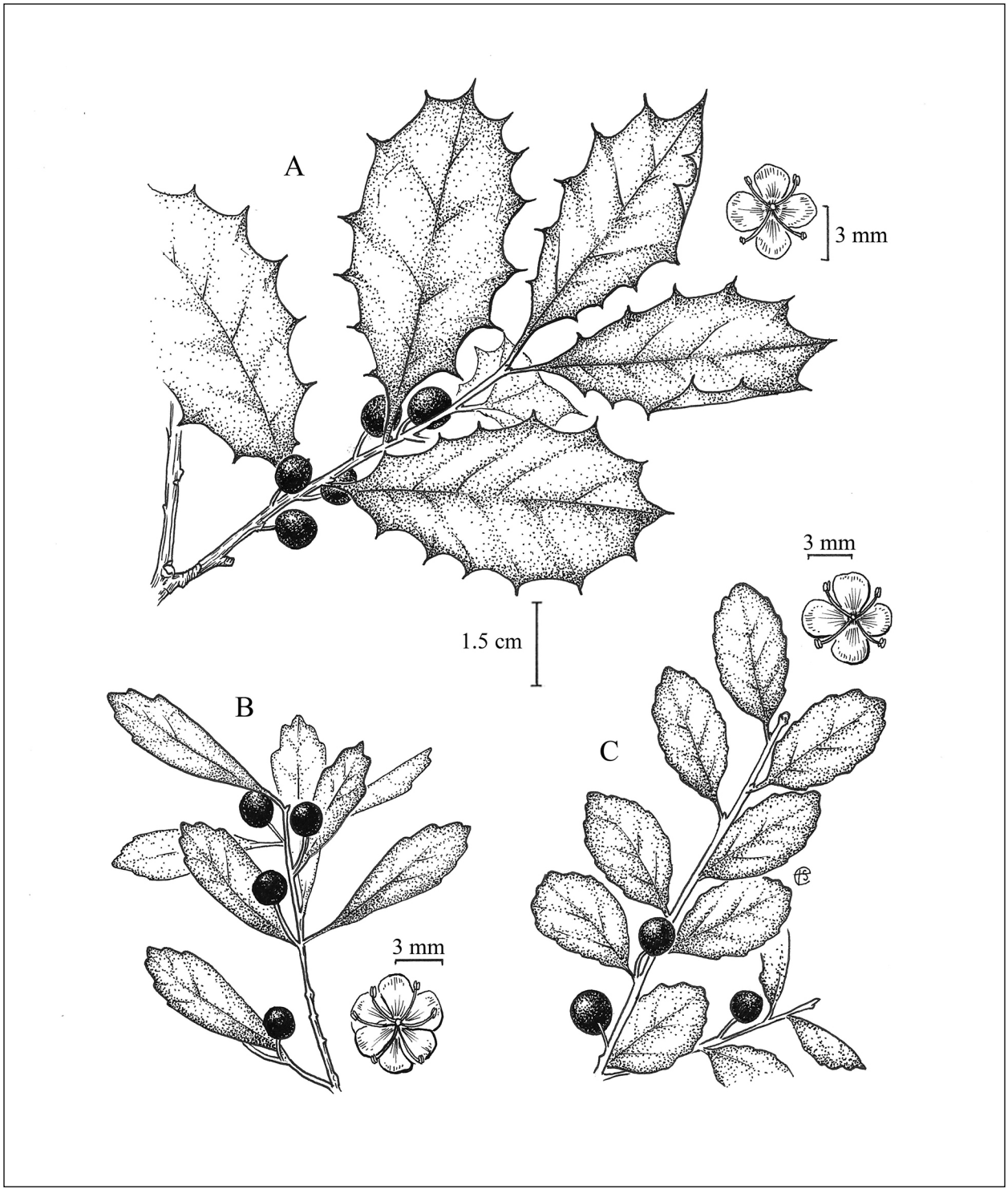
Introduced into the U.S. in 1898. At least 61 cultivars. Native hollies are better choices for planting, but this species has somehow gained popularity. Susceptible to many diseases (Dirr 1998). Found more recently in urban forests and natural areas in the region, which may suggest it is potentially invasive (Loeb 2012).



Distribution of *Ilex crenata*, or Japanese holly, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig and flower of *Ilex laevigata*; B) grooved seed and flower, and flowering leafy twig of *Ilex montana*; C) flowering leafy twig and flower, and smooth seed of *Ilex verticillata*. Illustration by Emma Skurnick.



Fruiting leafy twig and flower of A) *Ilex opaca*, B) *Ilex glabra*, and C) *Ilex crenata*. Illustration by Emma Skurnick.

Itea L. – sweet spire

Iteaceae (Escalloniaceae s.l.; Grossulariaceae s.l.; Saxifragaceae s.l.). Shrubs, small trees. Species 10–29 in Asia and 1 in North America. Some species grown for their rather showy racemes of white to whitish fragrant flowers, which attract bees (order Hymenoptera) and butterflies (order Lepidoptera), as well as their fall color, the leaves turning a brilliant red. Genus name is the Greek name for willow; the leaves are similar to *Salix* in appearance.

Native Species

1. *Itea virginica* L. – sweet spire Ø♥

Flowering early June–early July. Swamps, mesic woodlands and woodland edges, and streambanks. Reaches the northern limits of its range in the region in NJ. Confirmed recent reports from Middlesex County (see also Snyder 1984) and Monmouth County; historically known from Bergen County, where it was collected by the American botanist D.C. Eaton (1843–1895) in 1862 (specimen at the University of North Carolina herbarium). As a cultivated plant, this species tolerates several hardiness zones throughout New England.



A) Twig with leaves and flowers, B) flower bud, C) flower, and D) fruit of *Itea virginica*. Illustration by Bobbi Angell.

Iva L. – marsh-elder

Asteraceae. Shrubs, herbs. Species about 9 in Central America, North America, and the West Indies. Closely related to ragweed (*Ambrosia*); pollen allergenic to some. Etymology of genus name unclear; it may refer to an ancient medicinal plant, possibly the mint *Ajuga iva* (L.) Schreb (Rehder 1940).

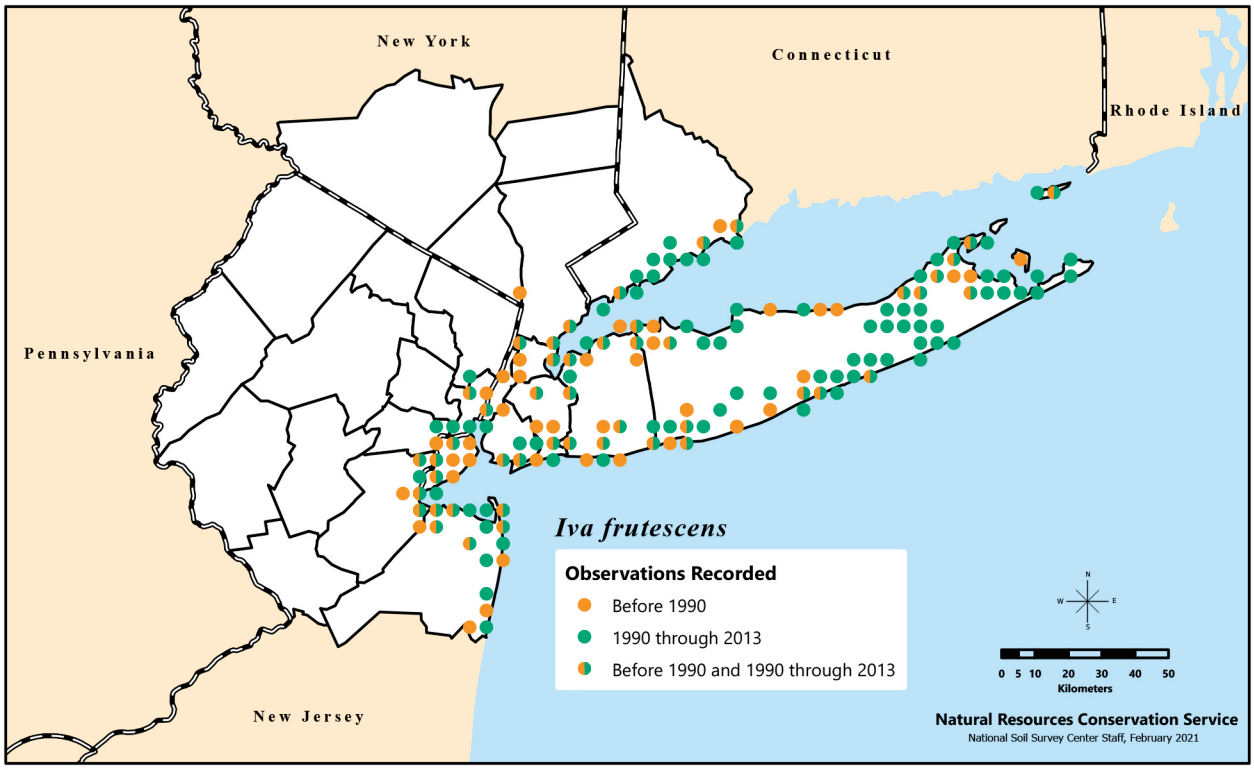
Native Species

1. *Iva frutescens* L. – saltmarsh-elder ↔

Flowering early Aug.–early Oct. Salt marshes and edge of salt marshes, commonly growing with *Baccharis halimifolia*, the region's only other woody species in the Asteraceae, and *Spartina* spp.

Epithet from Latin means "shrubby," a reference to the species being woody.

If recognized, material in the region would be referable to *Iva frutescens* var. *oraria* (Bartlett) Fernald & Griscom. The typical variety, *I. frutescens* var. *frutescens*, is reported as far north as southern NJ (Fernald 1950) just outside the region. The two reportedly based on height (usually more than 2 m in typical variety; usually less than 2 m in var. *oraria*), leaves (length-to-width ratio less than 4 in typical variety; more than 4 in var. *oraria*), and achenes (less than 2.6 mm long in typical variety; more than 2.6 mm long in var. *oraria*).



Distribution of *Iva frutescens*, or saltmarsh-elder, recorded in the New York Metropolitan Region during three time categories.



Flowering leafy twig tip and flowering leafy twig of *Iva frutescens*. Illustration by Emma Skurnick.

Juglans L. – walnut

Juglandaceae. Trees, shrubs. Species about 20 in Asia, North America, South America, and the West Indies; 1 in Europe. Readily distinguished by pinnately compound leaves, twigs with chambered pith, and fruit with nut enclosed in a large indehiscent husk. Important source of nuts, dyes, and wood; two species most commonly grown for commerce, *Juglans regia* (English walnut) and *J. nigra* (black walnut). Allelopathic compound juglone released into soils prevents growth of plants under *Juglans*. Genus name from Latin is a contraction of "Jovis glans" (meaning "Jupiter's nut"), ancient name for *Juglans regia*.

The following hybrids involving the species reported in literature but not observed in the wild in the region: *J.* ×*bixbyr* Rehder (*J. ailantifolia* × *J. cinerea*); *J.* ×*intermedia* Jacques (*J. nigra* × *J. regia*); *J.* ×*notha* Rehder (*J. ailantifolia* × *J. regia*) *J.* ×*quadrangulata* (Carrière) Rehder (*J. cinerea* × *J. regia*). Anagnostakis (2011) reported some of the cultivated "butternuts" from the region actually represent *J.* ×*bixbyi* Rehder.

Native Species

1. *Juglans cinerea* L. – butternut ↔

Flowering May–June; fruiting late Sept.–Oct. Rich woods, river terraces, streambanks. Declining throughout much of its range largely due to butternut canker. Causal organism of canker first reported to be the fungus *Melanconis juglandis*; now reported to be the fungus *Ophiognomonia clavigignenti-juglandacearum* (=*Sirococcus clavigignenti-juglandacearum*), *M. juglandis* representing a secondary infection (Anagnostakis 2011; Broders and Boland 2011). The *Juglans cinerea* and *J. ailantifolia* hybrids are geographically extensive across *J. cinerea*'s eastern and southern ranges. Natural hybridization could lead to a loss of native genetic diversity but may also transfer some useful traits from the nonnative to the native, such as resistance to butternut canker (Hoban et al. 2009). Hybrids are difficult to distinguish from *J. cinerea* (Zhao and Woeste 2011). Hybrids are known as buartnuts and are vegetatively vigorous, highly fecund, and more resistant to butternut canker than *J. cinerea*. The native should have a darker pith, longer and thinner axillary buds, round lenticels, and notched leaf scars (Ross-Davis et al. 2008). Thousand cankers disease, described in full under *J. nigra*, also kills *J. cinerea* (Hishinuma et al. 2016).

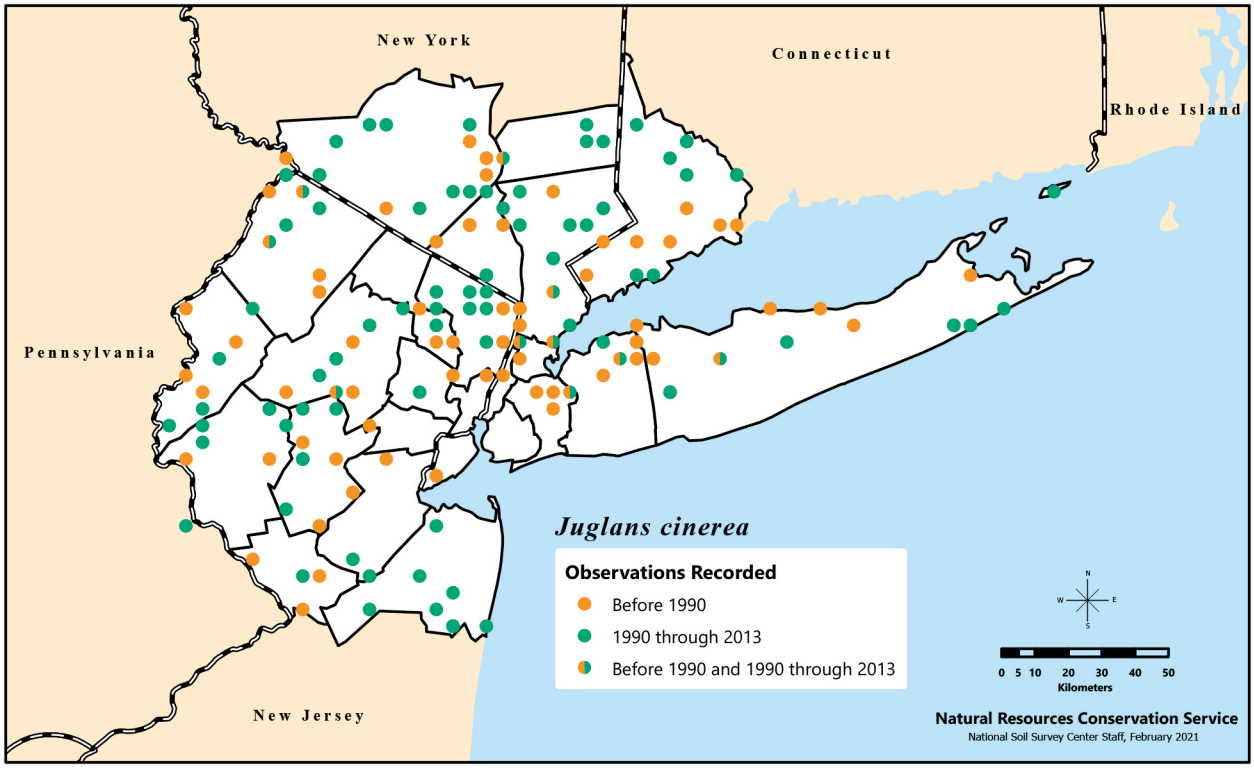
Listed as rare in NJ (S3) and exploitably vulnerable in NY (S4).

2. *Juglans nigra* L. – black walnut ↑↑↑

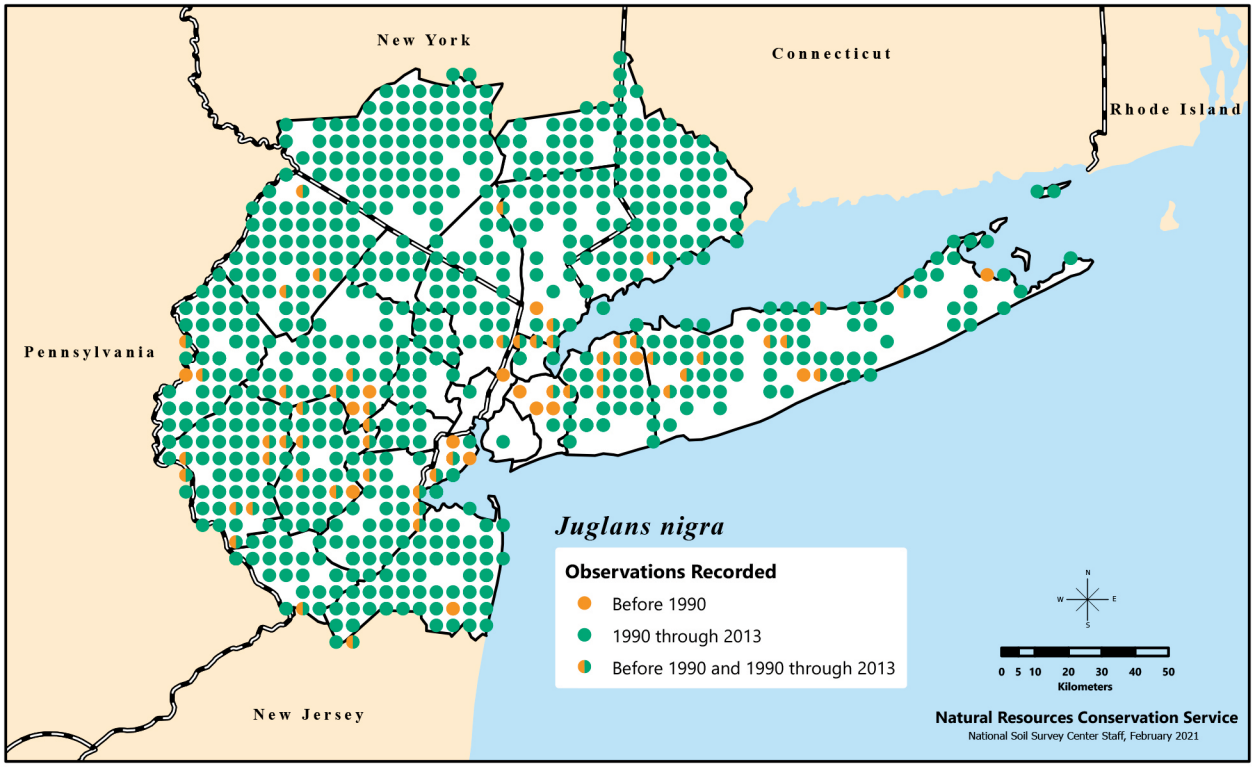
Flowering May; fruiting late Sept.–Oct. Rich mesic woodlands. Many populations, especially those on the Coastal Plain, represent escapes from cultivation and remnants from cultivation; excellent indicator of previous homesteads. Its allelopathy can negatively affect the growth of various crop species, ornamental plants, and several woody species (Jose and Gillespie 1998). Also toxic to horses (*Equus caballus*), making them lame (Galey et al. 1991). Despite its allelopathy, it is an important timber tree as

Juglans Key

1. Fruits in long pendulous racemes (*J.* sect. *Cardiocaryon* Dode) . . . . . ***Juglans ailantifolia****
1. Fruits singular or in small clusters, not in long pendulous racemes 2
2. Leaflets entire (*J.* sect. *Juglans*) . . . . . ***Juglans regia****
2. Leaflets toothed 3
3. Pith dark chocolate-brown; dense pad of short gray hairs above margin of old leaf scars; fruit oblong to ovoid, with several longitudinal ridges (white walnuts; *J.* sect. *Trachyocaron* Dode ex Manning) . . . . . ***Juglans cinerea***
3. Pith tan to creamy; lacking pad of hairs above margin of leaf scars; fruit globose, ridges absent (black walnuts; *J.* sect. *Rhysocaryon* Dode) . . . . . ***Juglans nigra***



Distribution of *Juglans cinerea*, or butternut, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Juglans nigra*, or black walnut, recorded in the New York Metropolitan Region during three time categories.

well as an important component of coves and well-drained bottomland forests, though it is also found less abundantly in a variety of habitats (Williams 1990). Because of its high-quality wood, this species is often managed in plantations (more often in the U.S. Midwest); management may include interplanting with nurse crops such as *Alnus glutinosa* (black alder) (Bohanek and Groninger 2003). Thousand cankers disease, responsible for widespread mortality of *Juglans nigra* since the mid-1990s, is caused by the fungus *Geosmithia morbida*; vector is the walnut twig beetle (*Pityophthorus juglandis*) (Kolarik et al. 2011). Recovery from the disease may be possible when ample soil moisture present (Griffin 2015). The disease is also now in Europe (Montecchio and Faccoli 2014); not yet documented in the NY Metropolitan Region but found in PA, TN, VA (Randolph et al. 2013), OH, MD, IN (Daniels et al. 2016), and NC (Hadziabdic et al. 2014). Consequently, we may soon witness decreases in this species. Current increases may be due to reforestation.

Nonnative Species

3. *Juglans ailantifolia* Carrière – Japanese walnut Ø

Native to Japan. Two reproducing populations discovered on Long Island in Suffolk County (NY) (Lamont et al. 2011). Hybrids with *Juglans cinerea* more commonly found in anthropogenic landscapes; even small forested areas serve as a substantial barrier to hybrid establishment (Hoban et al. 2012).

***Juglans regia* L. – English walnut, Persian walnut**

Native to Asia and Europe. Occasionally planted in the region, though most cultivars require a warmer climate. Not yet reported as an escape in the region.

Management

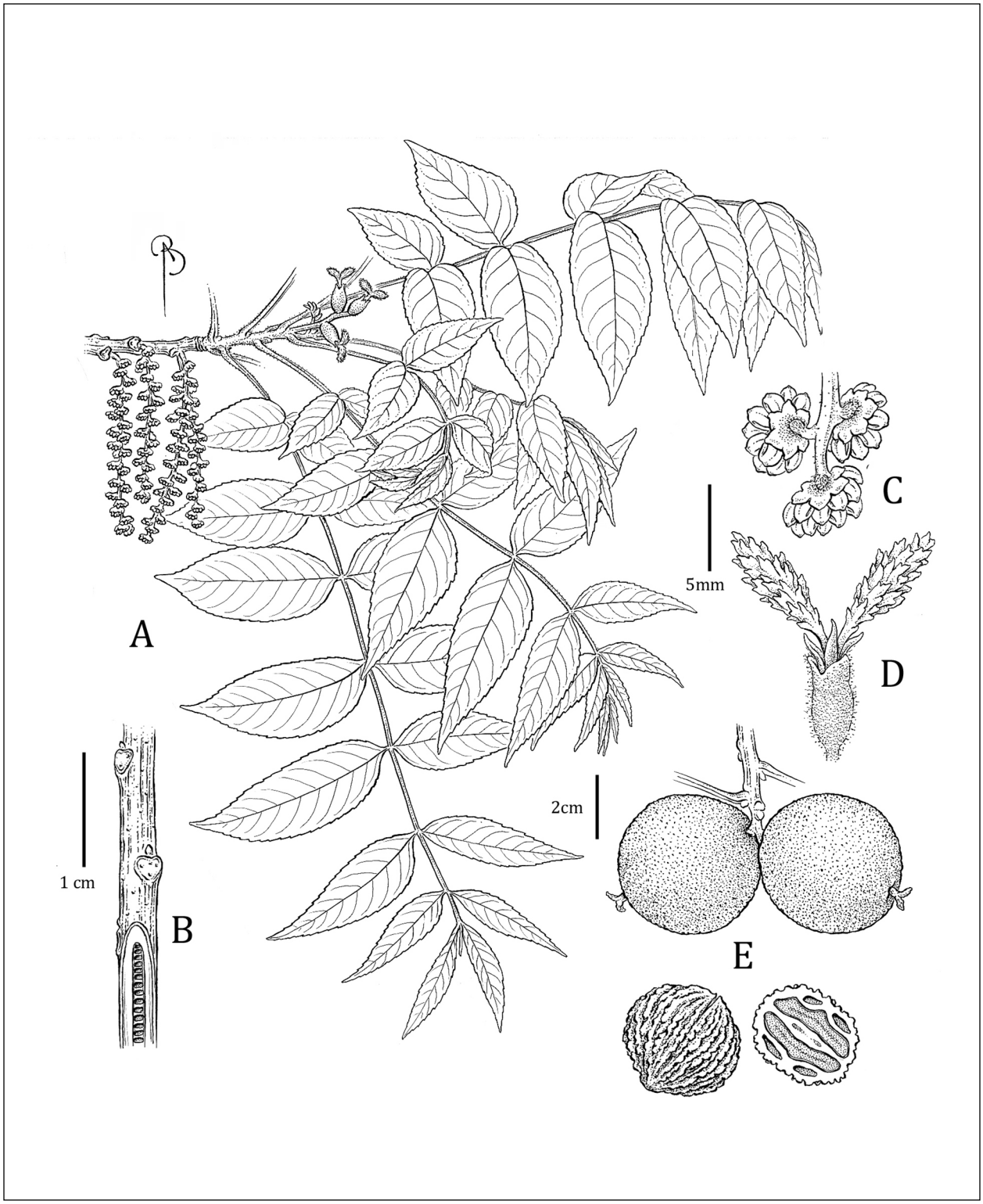
Planting *Juglans ailantifolia*, especially near *J. cinerea*, should be discouraged. However, if there are signs of resistance against either butternut canker or thousand cankers disease of existing *J. cinerea* individuals or the hybrids between *J. cinerea* and *J. ailantifolia*, they should be documented and further studied. Likewise, any resistance found in existing individuals or populations of *J. nigra* should be evaluated. Regulations that prevent the spread of these diseases, such as not moving wood products of infected trees, should be implemented. Given the proximity of thousand cankers disease to the region, it is possible that *J. nigra* and *J. cinerea* populations and plantations may soon decline further.

Juniperus L. – juniper

Cupressaceae. Trees, shrubs. Species 50–65 in Africa (1), Asia, Central America, Europe, North America, and the West Indies. Readily distinguished by fleshy blue (sometimes brown, reddish, or orange in other species) berry-like female (seed-bearing) cones. Dioecious (rarely monoecious). Widely cultivated for flavorings, ornament, and timber. Genus name is the ancient Latin name for the group.

Juniperus Key

1. Shrub, rarely small tree; leaves all needle-like, not decurrent on stem, in whorls of three; staminate cones axillary (*J.* sect. *Juniperus*) . . . . . ***Juniperus communis***
    White midvein stripe as wide or wider than the green margin . . . . ***J. communis* var. *communis****
    White midvein stripe narrower than green margin . . . . . ***J. communis* var. *depressa***
1. Tree; most leaves scale-like (needle-like leaves on young material), decurrent on stem, opposite; staminate cones terminal (*J.* sect. *Sabina* Spach) . . . . . ***Juniperus virginiana***



A) Leafy twig with catkins, B) twig with chambered pith, C) male flowers, D) female flower, and E) fruit and nut with cross-section of nut of *Juglans nigra*. Illustration by Bobbi Angell.

Native Species

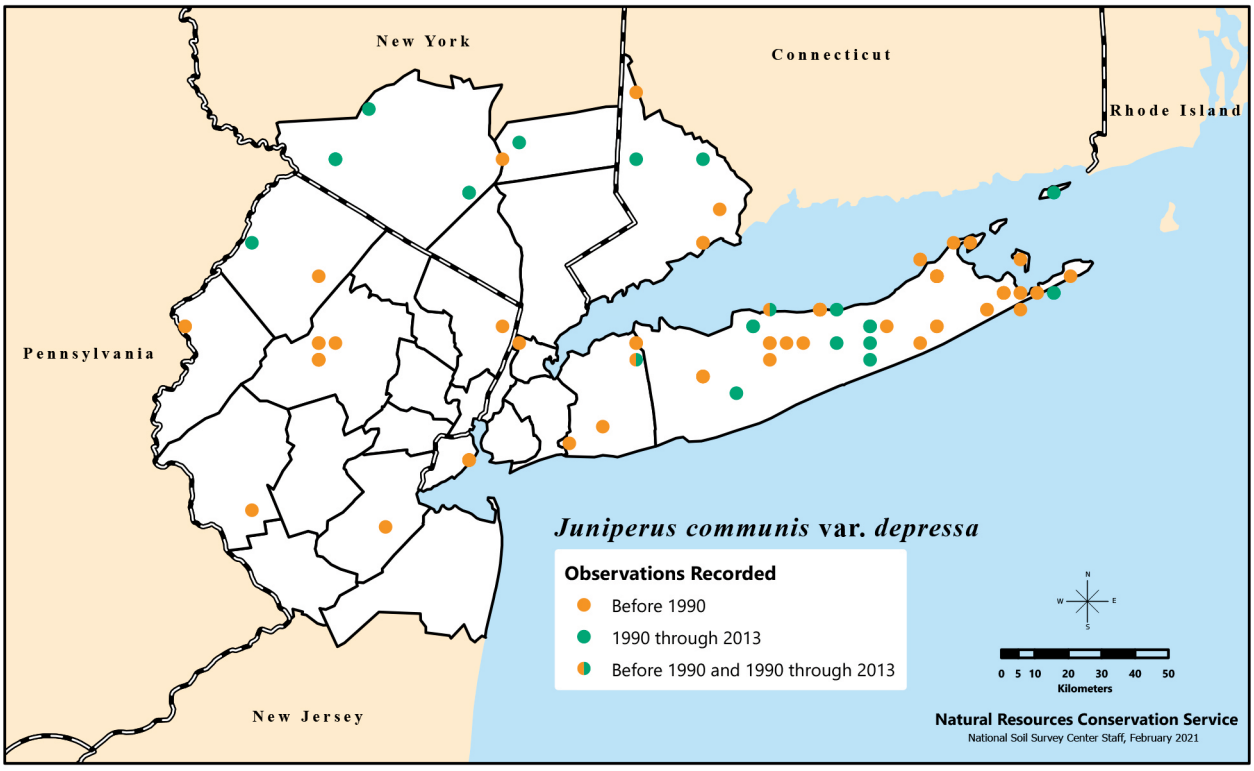
1. *Juniperus communis* var. *depressa* L. – common juniper ↓

Pollen shed mid-Apr.–May from bud formed from previous season; cones maturing Oct. Sterile, dry, open, often rocky areas; rare and apparently declining, especially in the southern parts of the region. All material in the eastern U.S. is *Juniperus communis* var. *depressa* Pursh; previous reports of *J. communis* var. *communis* were misidentifications (Adams 1993). However, more recently, a large population of hundreds to thousands of trees of *J. communis* var. *communis* was documented (with molecular evidence) in a wilderness area of WV; population is presumed to be planted and may negatively impact existing native populations (Adams et al. 2016). Given this information, some of the *J. communis* populations in the region may be nonnative *J. communis* var. *communis*. Declines in this species could be due to deer browse; deer find this species moderately palatable, especially in winter (Hill 1946). Seed cones ("berries") are used to flavor meat and alcoholic beverages (van Wyk 2005).

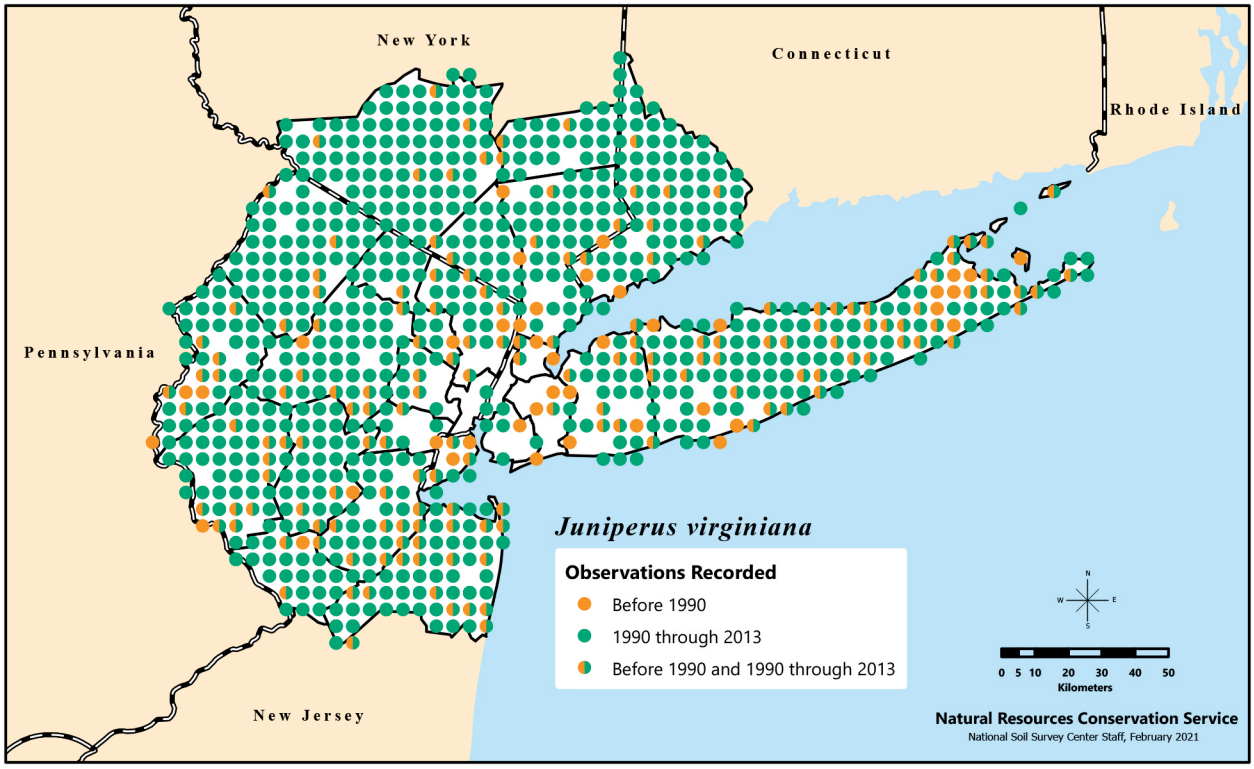
Tracked as critically imperiled in NJ (S2). Species also critically imperiled (S1) or imperiled (S2) in GA, KY, NC, PA, SC, VA, and WV, which make up the southeasternmost extent of its range.

2. *Juniperus virginiana* L. – eastern redcedar ↑↑

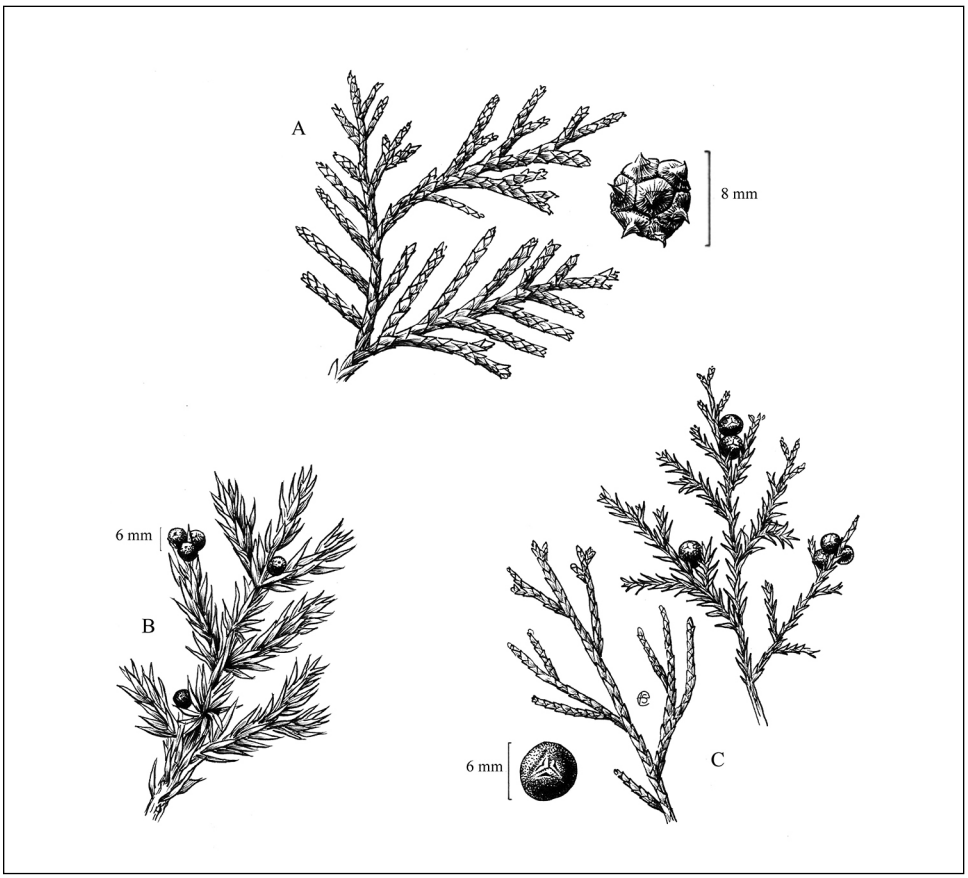
Pollen shed mid-Mar.–Apr. from bud formed from previous season; cones maturing Sept.–Oct. Dry (rarely mesic) open, early-successional woodlands, fields, and rocky uplands. Commonly invades old fields in the region, very likely with the help of birds to disperse its seeds (McDonnell and Stiles 1983). Some material represents remnants from cultivation; species a good indicator of former homesteads. Wood used to make chests and balls to protect clothes from insect damage. Alternate host for cedar apple rust disease caused by the fungus *Gymnosporangium juniperi-virginianae* Schwein., a problem in *Malus* spp. (apple) orchards (Waggoner and Rich 1981). Cultivated for landscape use with over 70 known cultivars of varying shapes and sizes (Cope 1986).



Distribution of *Juniperus communis* var. *depressa*, or common juniper, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Essex, Mercer, and Monmouth Counties (NJ) and Queens and Westchester Counties (NY).



Distribution of *Juniperus virginiana*, or eastern redcedar, recorded in the New York Metropolitan Region during three time categories.



Leafy twig and mature female cones of A) *Chamaecyparis thyoides*, B) *Juniperus communis* var. *depressa,* and C) *Juniperus virginiana*. Illustration by Emma Skurnick.

Kalmia L. – laurel

Ericaceae. Evergreen shrubs; rarely small trees. Species 10 in North America and the West Indies. Corollas hold the anthers under tension in small sacs; visiting insects (mostly bees; order Hymenoptera) release them and get dusted with pollen in the process. Occasionally cultivated for ornament; leaves poisonous. Genus honors Peter Kalm (1716–1779), student of Linnaeus' who traveled and collected extensively in eastern North America, including the NY Metropolitan Region.

Native Species

1. *Kalmia angustifolia* L. – sheep laurel ↔

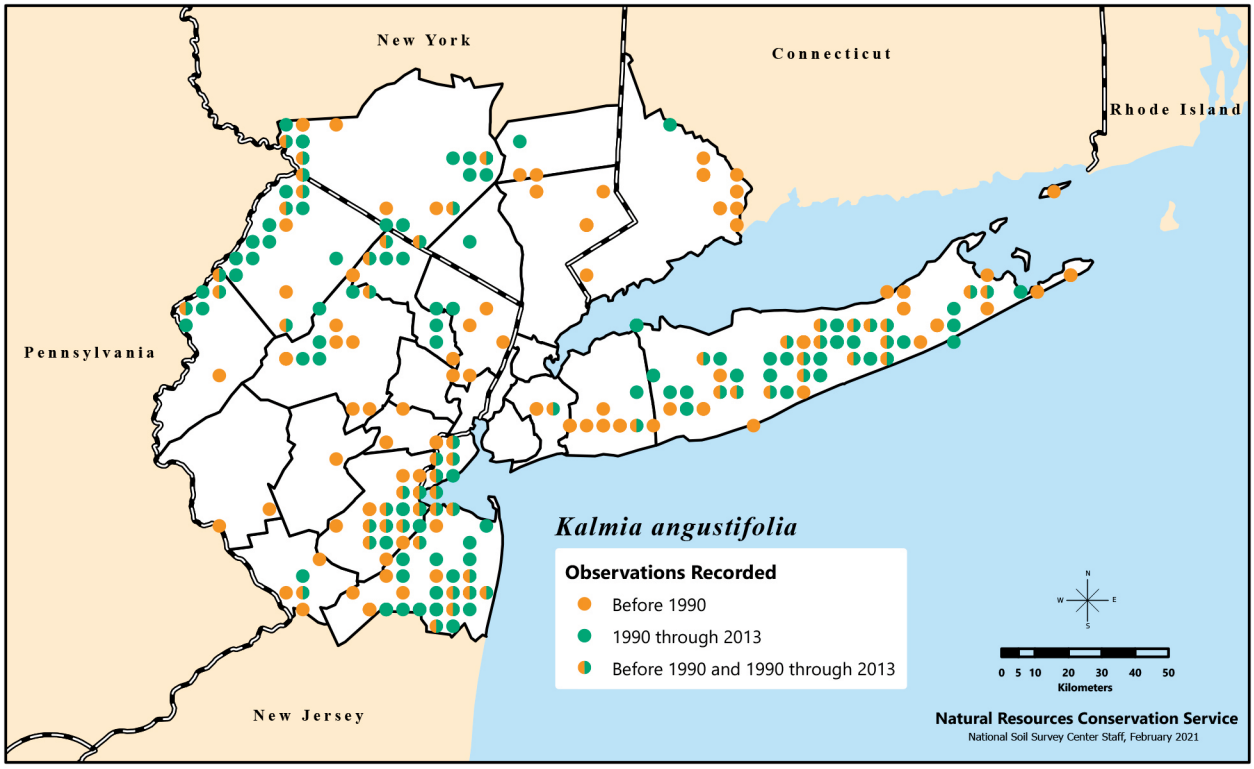
Shrub. Flowering May–July. Wet to dry woodlands and old pastures; often in sterile acidic soils. Common species in shrub layer of oak and pine woodlands. Considered a weed in other locations, such as Canada, where it has taken over *Vaccinium angustifolium* Aiton (lowbush blueberry) fields (Hall et al. 1973). Cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), and horses (*Equus caballus*) can be poisoned if they consume its leaves (Muenscher 1952). The NY Metropolitan Region is part of its southern geographic extent (Hall et al. 1973), which may explain why it is not the weed in this region that it is farther north. *Kalmia angustifolia* litter inhibits soil enzyme processes associated with carbon, nitrogen, and phosphorus cycles, which may be associated with the negative impact of *K. angustifolia* on other plant species, such as *Picea mariana* (black spruce) (Joanisse et al. 2007).

2. *Kalmia latifolia* L. – mountain laurel ↑

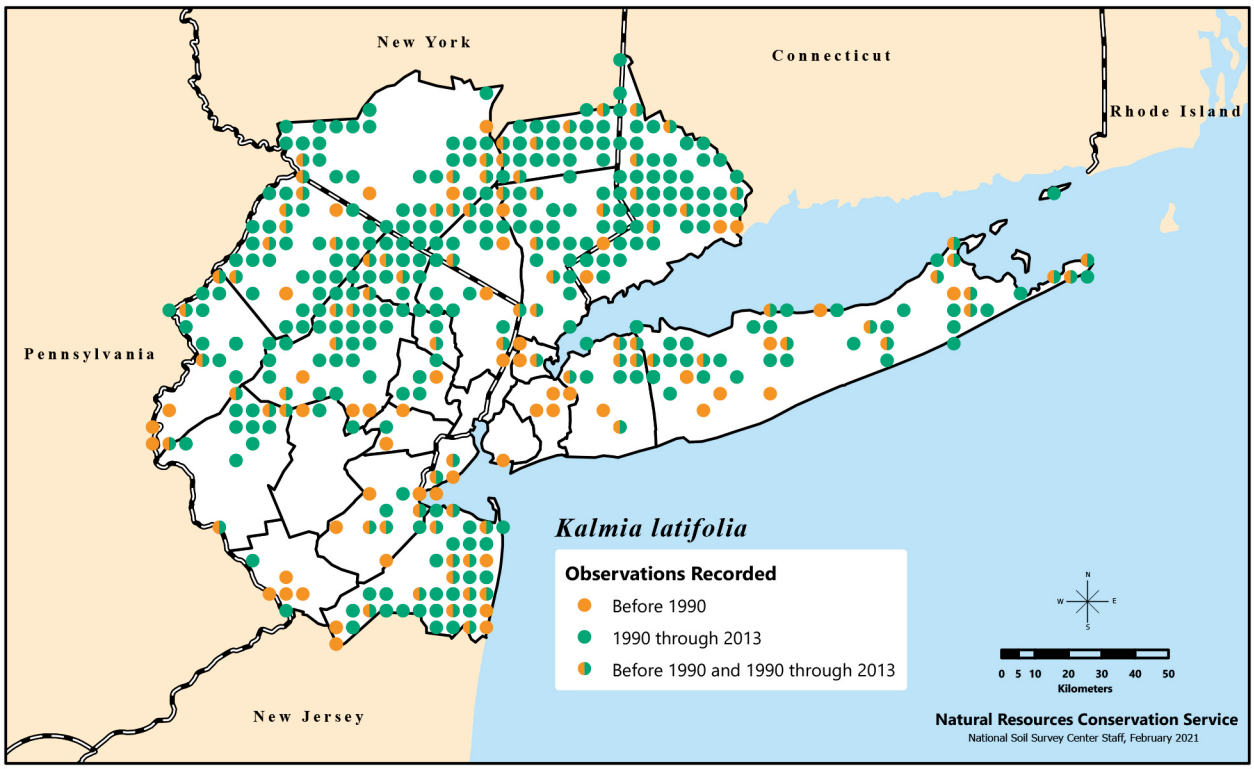
Shrub. Flowering late May–early July. Rocky to sandy dry to mesic woodlands; sometimes swamps. Common species in shrub layer of woodlands throughout much of the region. Considerable variation in flower color from white to deep pink; large stands exceptionally showy when in full bloom. May become expansive (Pyšek et al. 2004, Richardson et al. 2000) and interfere with tree regeneration (Kaeser et al. 2008), especially after a disturbance such as a spongy moth (*Lymantria dispar*) defoliation event (Chastain and Townsend 2008), timber harvest (Moroni et al. 2009), fire suppression (Brose and Waldrop 2010), or increasing soil acidity via acid deposition (Bailey et al. 2005). Ability to dominate may be due in part to comparatively long lifespan of flowers, which may last 21 days if not pollinated. A long flowering period enables *Kalmia latifolia* to outlast co-flowering competitors, ensuring successful reproduction (Rathcke 2003). Wood close-grained, hard, brittle; used for rustic furniture, handles, weavers' shuttles, pulleys, spoons, trowels, and fuel (Jaynes 1997). Roots used for making imitation briarwood (*Erica arborea*) pipes. Leaves sometimes used in Christmas decorations. Leaves, twigs, flowers, and pollen are poisonous (Forbes and Bechdel 1931); used as a poison by Native Americans (Delaware Indians) for suicide (Lewis and Elvin-Lewis 2003).

Kalmia Key

1. Branchlets 2-edged; leaves sessile, subsessile, linear, margins revolute; pedicels glabrous; calyx with ring at base . . . . . ***Kalmia polifolia***
1. Branchlets terete; leaves petiolate, elliptic to lanceolate, margins not revolute; pedicels puberulent or glandular; calyx without ring at base 2
2. Slender shrub; leaves papery, in whorls of 3; calyx glandular puberulent; corolla usually less than 1.2 cm broad; pedicels recurving in fruit . . . . . ***Kalmia angustifolia***
2. Coarse shrub, small tree; leaves leathery; calyx viscid (not puberulent); corolla usually more than 2 cm broad; pedicels ascending in fruit . . . . . ***Kalmia latifolia***



Distribution of *Kalmia angustifolia*, or sheep laurel, recorded in the New York Metropolitan Region during three time categories.

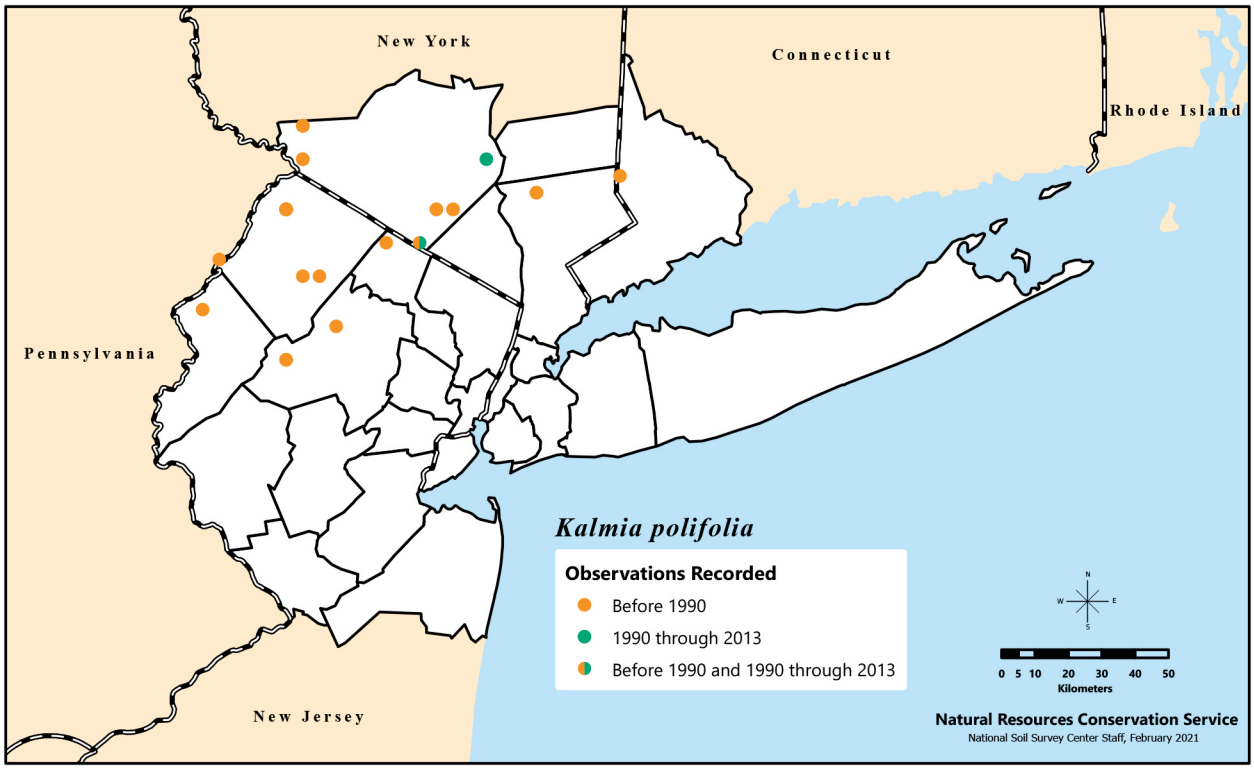


Distribution of *Kalmia latifolia*, or mountain laurel, recorded in the New York Metropolitan Region during three time categories.

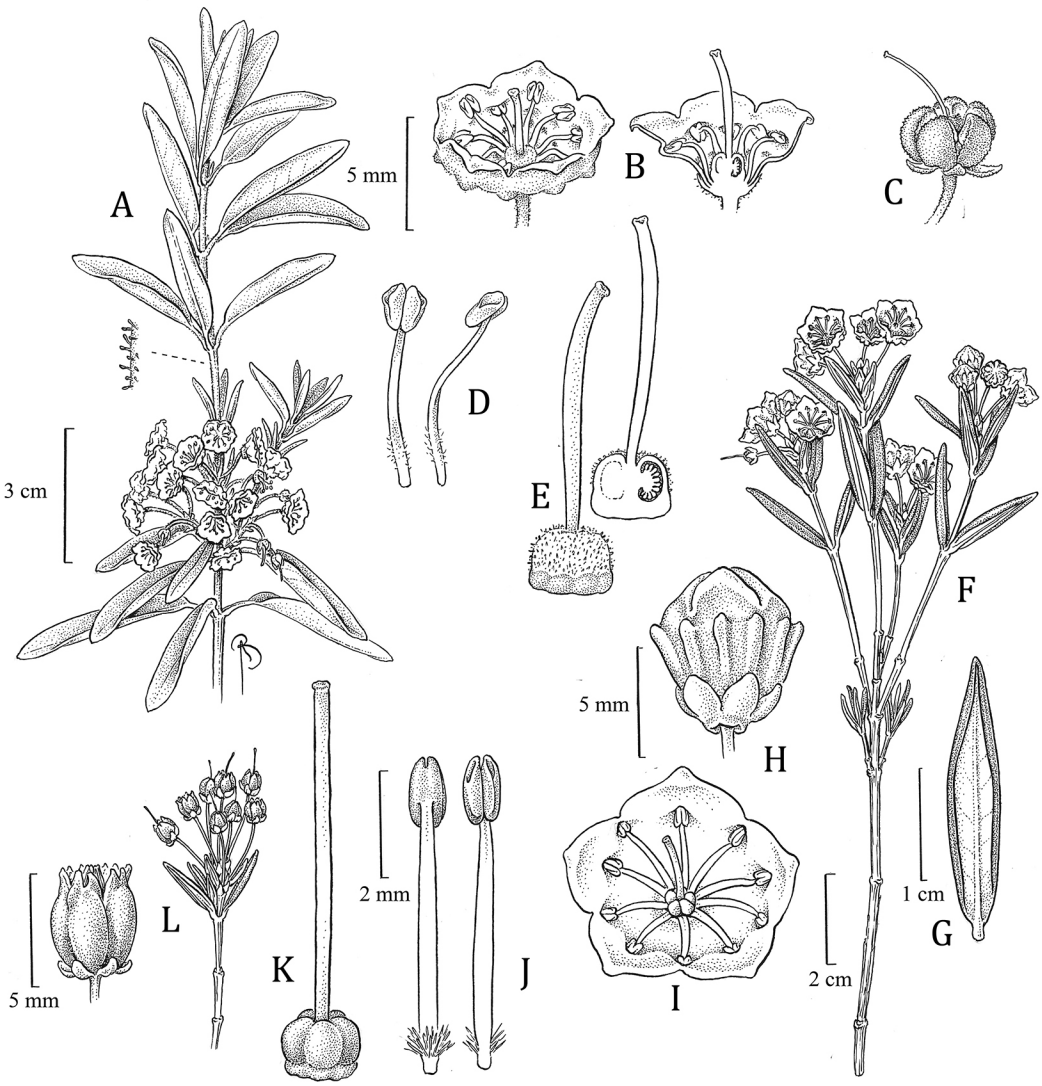
3. *Kalmia polifolia* Wangenh. – bog laurel ↓↓↓

Shrub. Flowering late mid-May–early July. Bogs and open swamps on peaty soils; declining in the region. Epithet means “with leaves of Polium,” in Latin, “Polium” a pre-Linnean genus name applied to some mint species placed in *Teucrium* L., including *Teucrium polium*, with linear, whitened leaves. Declining populations may be due to habitat loss (Weltzin et al. 2003).

Listed as endangered in NJ (S1).



Distribution of *Kalmia polifolia*, or bog laurel, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig, showing axial (instead of terminal) flowers, with enlarged view of stipitate glands on the stem (which also may be associated with the underside of the leaves); B) flower and its cross-section; C) fruit that is opening; D) stamens; E) pistil and cross-section of pistil of *Kalmia angustifolia*; F) flowering leafy twig, G) leaf underside, H) flower bud, I) flower, J) stamens, K) pistil, L) fruiting twig, and fruit of *Kalmia polifolia*. Illustration by Bobbi Angell.

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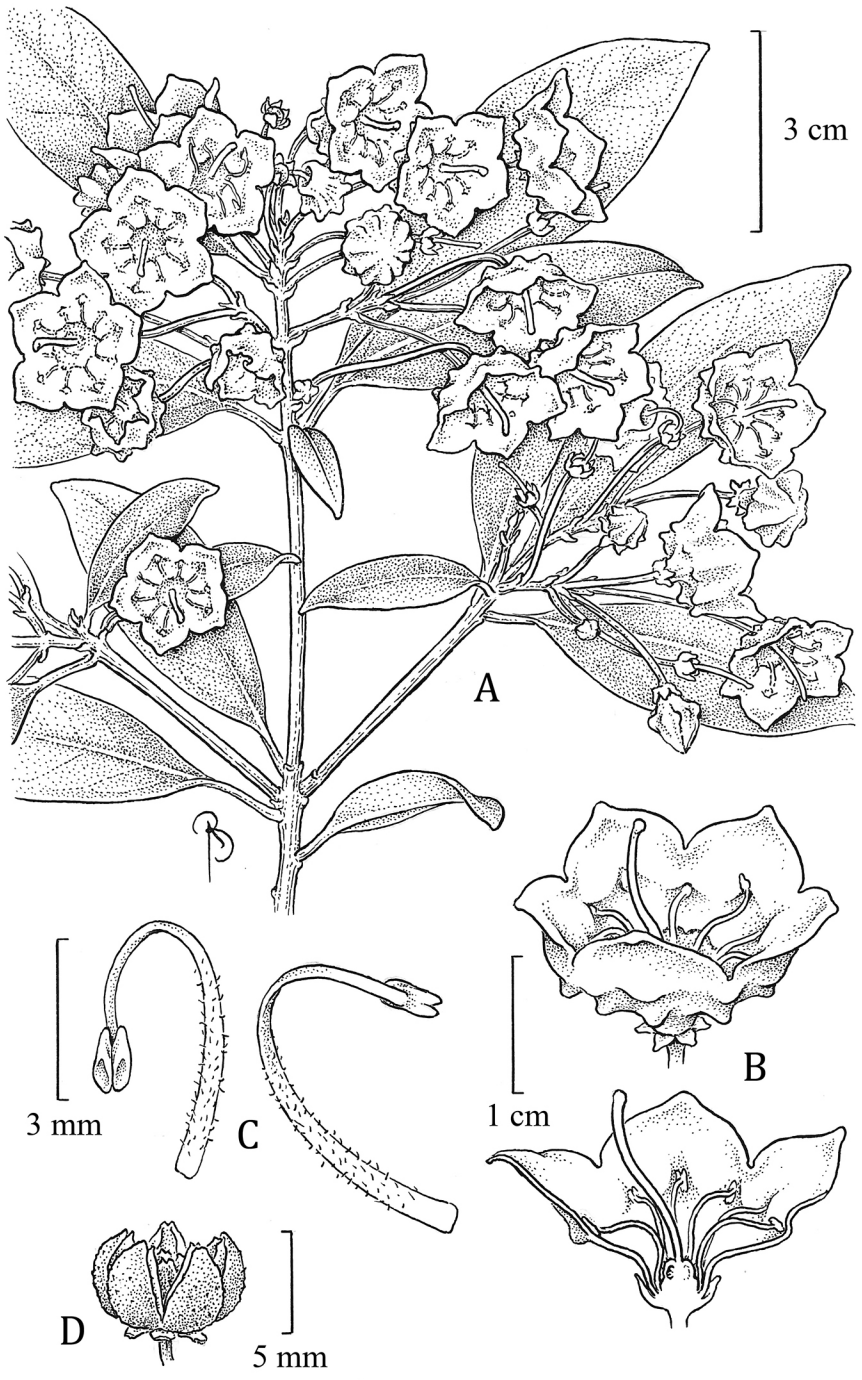


A) Flowering leafy twig, B) flower and cross-section of flower, C) stamens, and D) fruit that is opening of *Kalmia latifolia*. Illustration by Bobbi Angell.

Kerria DC. – Easter rose, Japanese rose

Rosaceae. Shrubs. Monospecific genus native to eastern Asia. Distinguished from other shrubs in the rose family by its 5-petaled yellow or orange flowers and fruit, an aggregate of nutlets. Genus honors Scottish botanist and plant collector in Asia, William Kerr (ca. 1779–ca. 1814) and not John Bellenden Ker (1764–1842; previously known as John Gawler, often referred to as "Ker-Gawler" in botanical literature), as reported by Fernald (1950).

Nonnative Species

1. *Kerria japonica* (L.) DC. – Easter rose, Japanese rose Ø

Rubus japonicus L.

Occasionally planted and persistent after cultivation. Native to Asia (China, Japan), and closely related and morphologically similar to *Rhodotypos scandens* (Thunb.) Makino (Rosaceae), but with alternate leaves (opposite in *Rhodotypos*) and flowers yellow (or orange in cultivar 'Pleniflora') and 5 petaled (white, 4 petaled in *Rhodotypos*). Scattered historical and recent reports throughout the region; verified reports of naturalized populations from Fairfield County (CT), Hunterdon County (NJ), and Orange, Queens, and Suffolk Counties (NY).

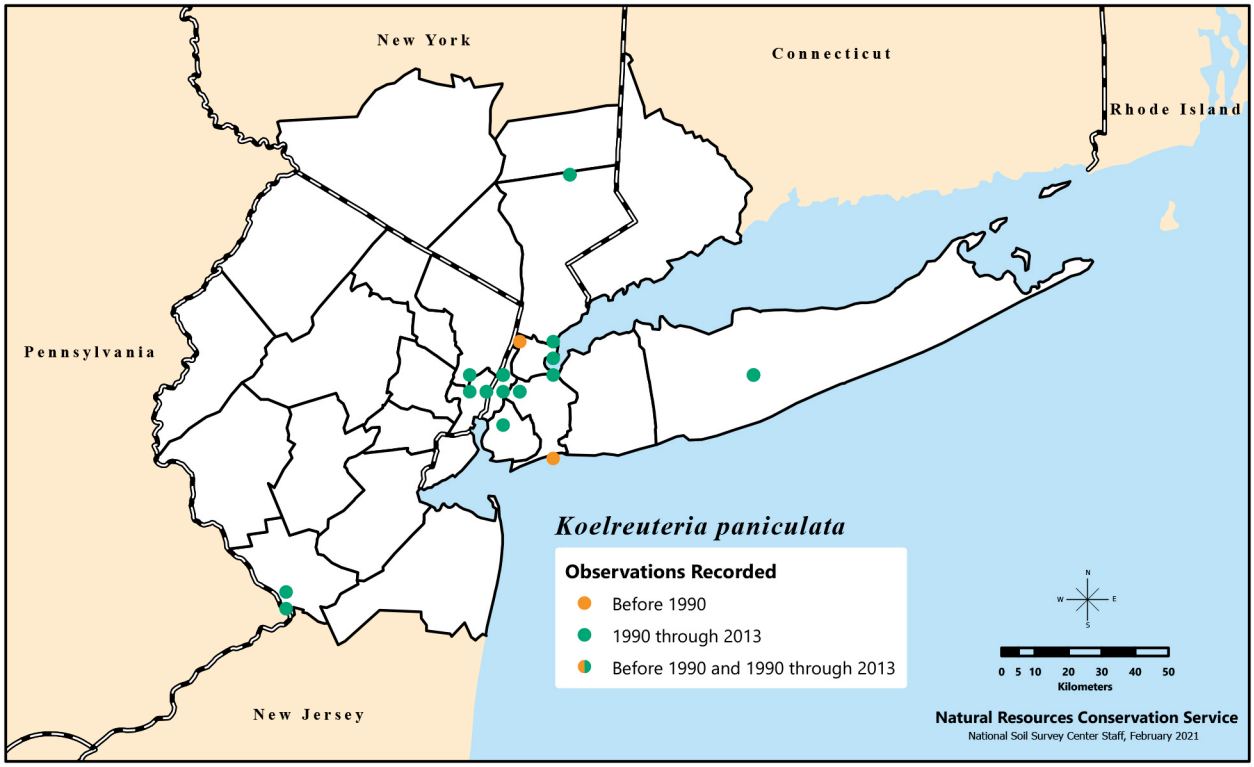
Koelreuteria Laxm.– golden rain tree

Sapindaceae. Trees. Species approximately 4 in eastern Asia. Genus honors Joseph Gottlieb Kölreuter (1733–1806), professor of natural history and director of the botanical garden at Karlsruhe in Baden-Württemburg (present-day Germany) (Rehder 1949).

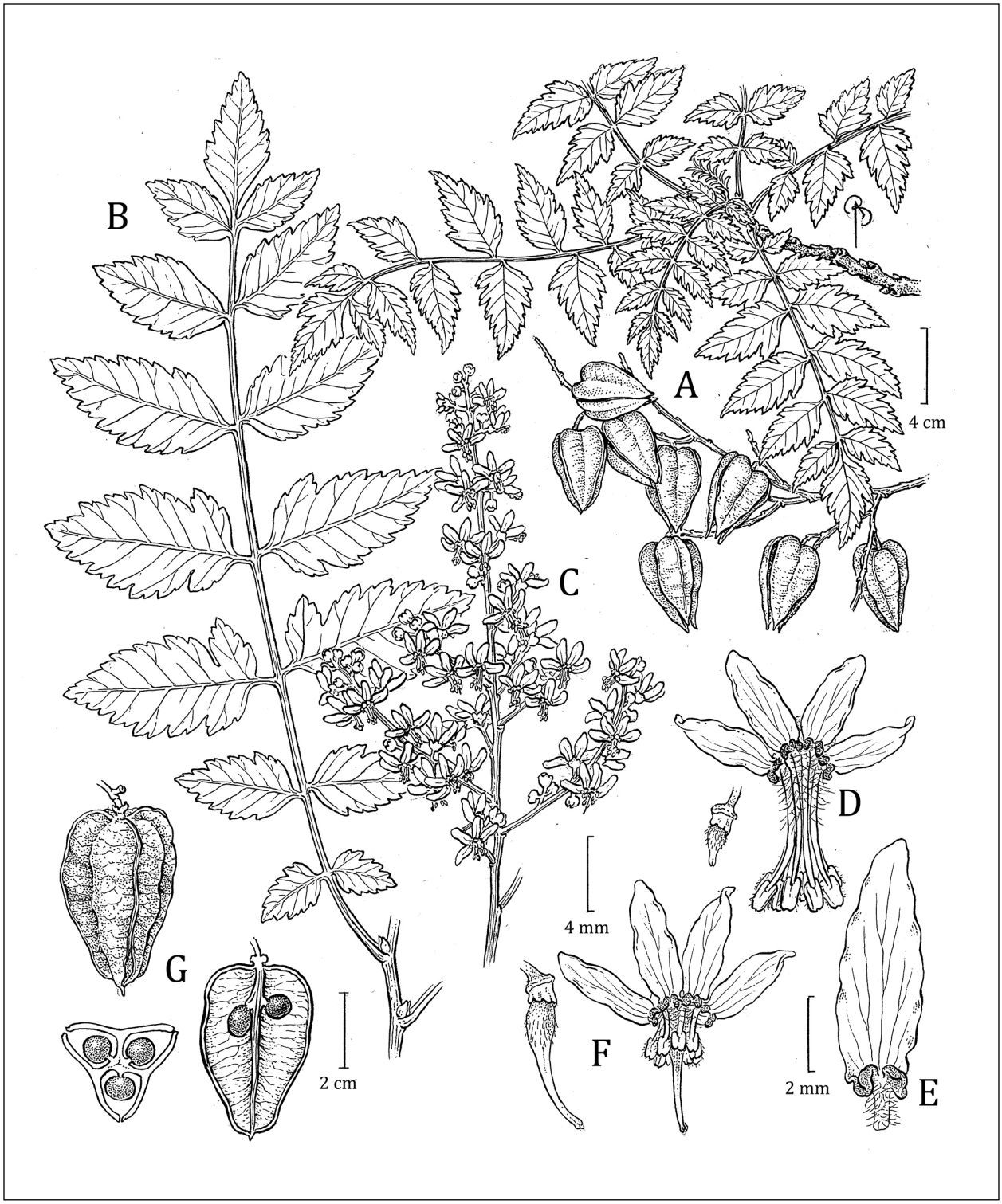
Nonnative Species

1. *Koelreuteria paniculata* Laxm. – golden rain tree ↑↑↑

Native to Asia; occasionally planted, including as a street tree. May be encountered as a remnant from cultivation or as an escape. Possibly invasive.



Distribution of *Koelreuteria paniculata*, or golden rain tree, recorded in the New York Metropolitan Region during three time categories.



A) Branch with leaves and fruit, B) leaves, C) inflorescence, D) male flower, E) petal, F) female flower and pistil, and G) longitudinal section and cross-section of capsular fruit showing seeds of *Koelreuteria paniculata*. Illustration by Bobbi Angell.

Larix Mill. – larch, tamarack

Pinaceae. Deciduous coniferous trees. Species 10–15 in Asia, Europe, and North America. Distinguished from other conifers by its needles in clusters of 10 or more, without a scaly sheath and borne on short (spur) shoots. Cultivated for timber and turpentine. Genus name is the ancient Latin name for the group.

Native Species

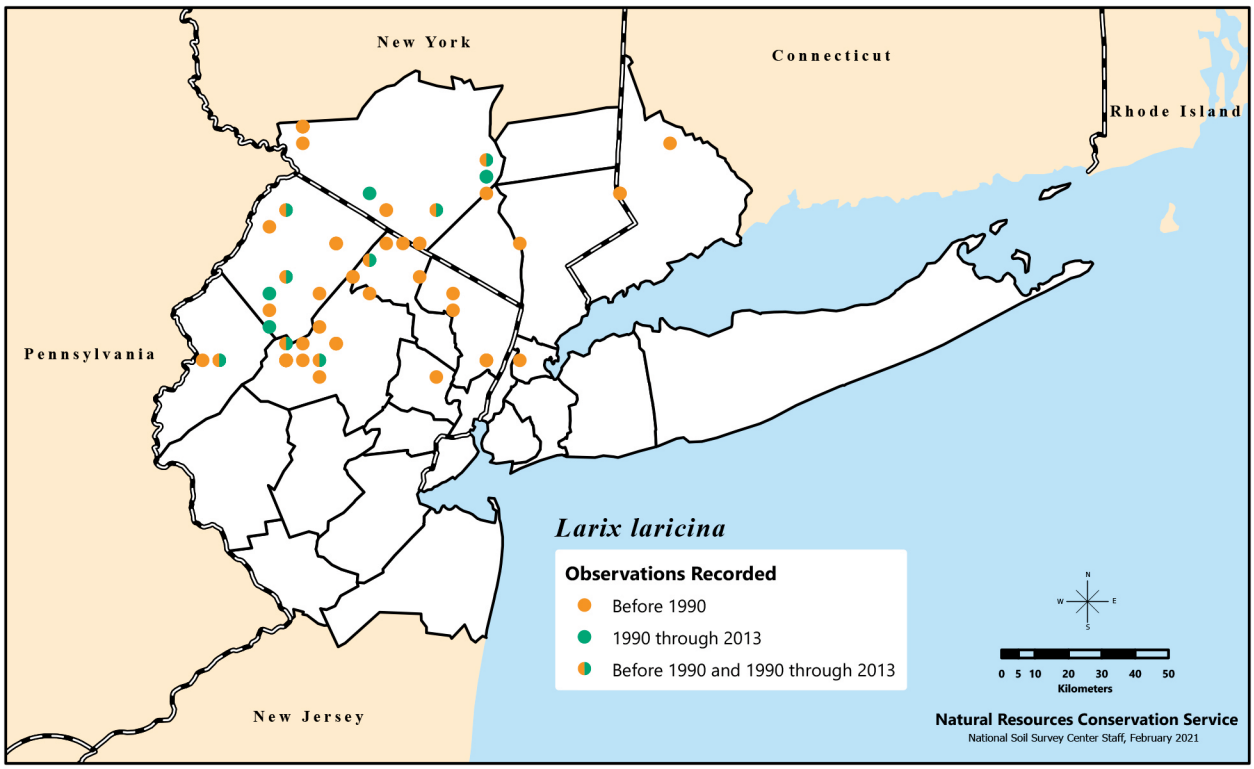
1. *Larix laricina* (DuRoi) Koch – American larch ↓↓

Pinus laricina DuRoi

Pollen maturing Mar.–Apr.; seed maturing Aug.–Dec. (Duncan 1954), with 65 percent of the seed dispersed in Sept. and the remaining dispersed

Larix Key

1. Leaves with white bands beneath; seed cone scales reflexed at apex . . . . . ***Larix kaempferi****
1. Leaves without white bands beneath; seed cone scales straight at apex 2
2. Twigs orange-brown; needles angled on upper surface;
   seed cones 2 cm long or less with 10–30 scales . . . . . ***Larix laricina***
2. Twigs yellow or yellow-brown; needles flat on upper surface;
   seed cones 2–3.5 cm long with 35 or more scales . . . . . ***Larix decidua****



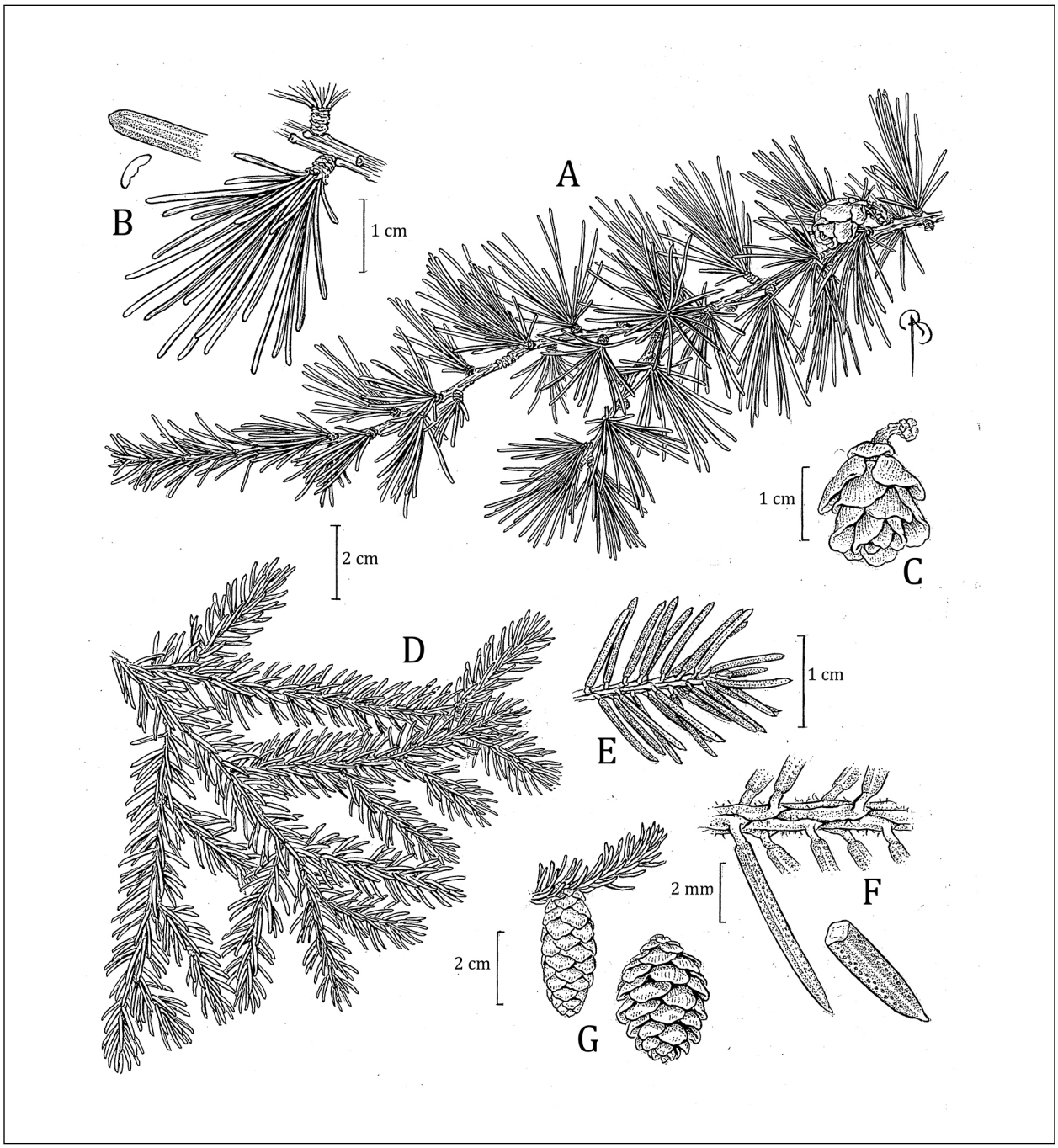
Distribution of *Larix laricina*, or American larch, recorded in the New York Metropolitan Region during three time categories.

L

in the year, but empty seed cones may persist for years (Fowells 1965). Bogs and swamps; apparently declining in the region. Epithet is redundant: Johann Philipp Du Roi (1741–1785), a German doctor and botanist with a focus on dendrology, first described the species as a *Pinus*.

Nonnative Species

European larch (*Larix decidua* Mill.) and Japanese larch (*L. kaempferi* (Lamb.) Carrière) are occasionally planted and can be encountered, but rarely, as remnants from cultivation or escapes.



A) Twig; B) enlarged view of needle and fascicle, including cross-section of needle; and C) mature female cone of *Larix laricina*; D) twig, E) needles, F) enlarged view of needle and a leaf cross-section, and G) immature and mature female cones of *Picea rubens*. Illustration by Bobbi Angell.

Leiophyllum (Pers.) R.Hedw. – sand myrtle

Ledum subgen. *Leiophyllum* Pers.

Ericaceae. Shrubs. Species 1 in North America. Sometimes merged, along with *Loiseleuria* Desv., into *Kalmia* L., based on molecular phylogenetic evidence (Kron and King 1996). However, *Leiophyllum* and *Loiseleuria* lack *Kalmia*'s strikingly distinct floral morphology (i.e., saucer-shaped corollas with pouches that receive the anthers in bud), and no suite of morphological characters that diagnoses *Kalmia* + *Leiophyllum* + *Loiseleuria* relative to other ericaceous genera has been identified. Flowers pollinated by small bees (order Hymenoptera) (Strand and Wyatt 1991). Genus name is derived from the Greek "leios" ("smooth") and "phyllon" ("leaf").

Native Species

1. *Leiophyllum buxifolium* (Bergius) Elliott – sand myrtle Ø

Ledum buxifolium Bergius; *Kalmia buxifolia* (Bergius) Gift, Kron & P.F.Stevens

Flowering May–early June. Dry to moist sandy open ground of pinelands. Characteristic species of the pinelands of southern NJ, including Middlesex and Monmouth Counties in the region; this area is the northern limit of species' range. Reports from Long Island are unconfirmed; specimens collected from Bronx and Westchester Counties (NY) very likely represented cultivated material. Epithet refers to the leaves' similarity to those of boxwood (*Buxus* L.).

Lespedeza Michx. – bush clover, lespedeza

Fabaceae. Herbs, trailing vines, and shrubs. About 40 species in Asia and North America.

The two described lespedezas are shrubs native to Asia; they are occasionally planted (especially for wildlife) and can rarely be found as remnants from cultivation or escapes (especially in fish and game lands). In the region, the two species flower Aug.–Oct. All other lespedezas in the region are herbaceous. Genus name attempts to honor Vincent Manuel de Céspedes (ca. 1721–1794), Spanish governor of east Florida (1784–1790) during the explorations of André Michaux (1746–1802), a farmer from Versailles, France, who became a renowned botanist; genus name a misspelling (Hochreutiner 1934, Ricker 1934).

Nonnative Species

***Lespedeza bicolor* Turcz. – shrub lespedeza, bicolor lespedeza**

Flowering July–Aug. Flowers rosy purple; fruit a downy 1-seeded pod. Introduced from northern China, Korea, and Japan. Cultivated since 1856, with at least 3 cultivars (Dirr 1998).

***Lespedeza thunbergii* (DC.) Nakai – Thunberg's lespedeza**

Flowering Aug–Sept.; possibly flowers in June and then again in Aug. or Sept. Like *Lespedeza bicolor*, has rosy purple flowers, but there is a white cultivar. Fruit also a 1-seeded pod. Introduced from China and Japan. Cultivated since 1837, with at least 3 cultivars (Dirr 1998).

Leucothoe D.Don – staggerbush

Ericaceae. Shrubs. Species 6 in Asia and North America. *Eubotrys* Nutt. sometimes included here. *Eubotrys* differs from *Leucothoe* in having the pedicel bracts located close to the pedicel apex (bracts near base of pedicel in *Leucothoe*). Genus name originates from Greek mythology; Leucothoe was the daughter of Orchamus and Eurynome, king and queen of Babylonia or Persia.

Lespedeza Key

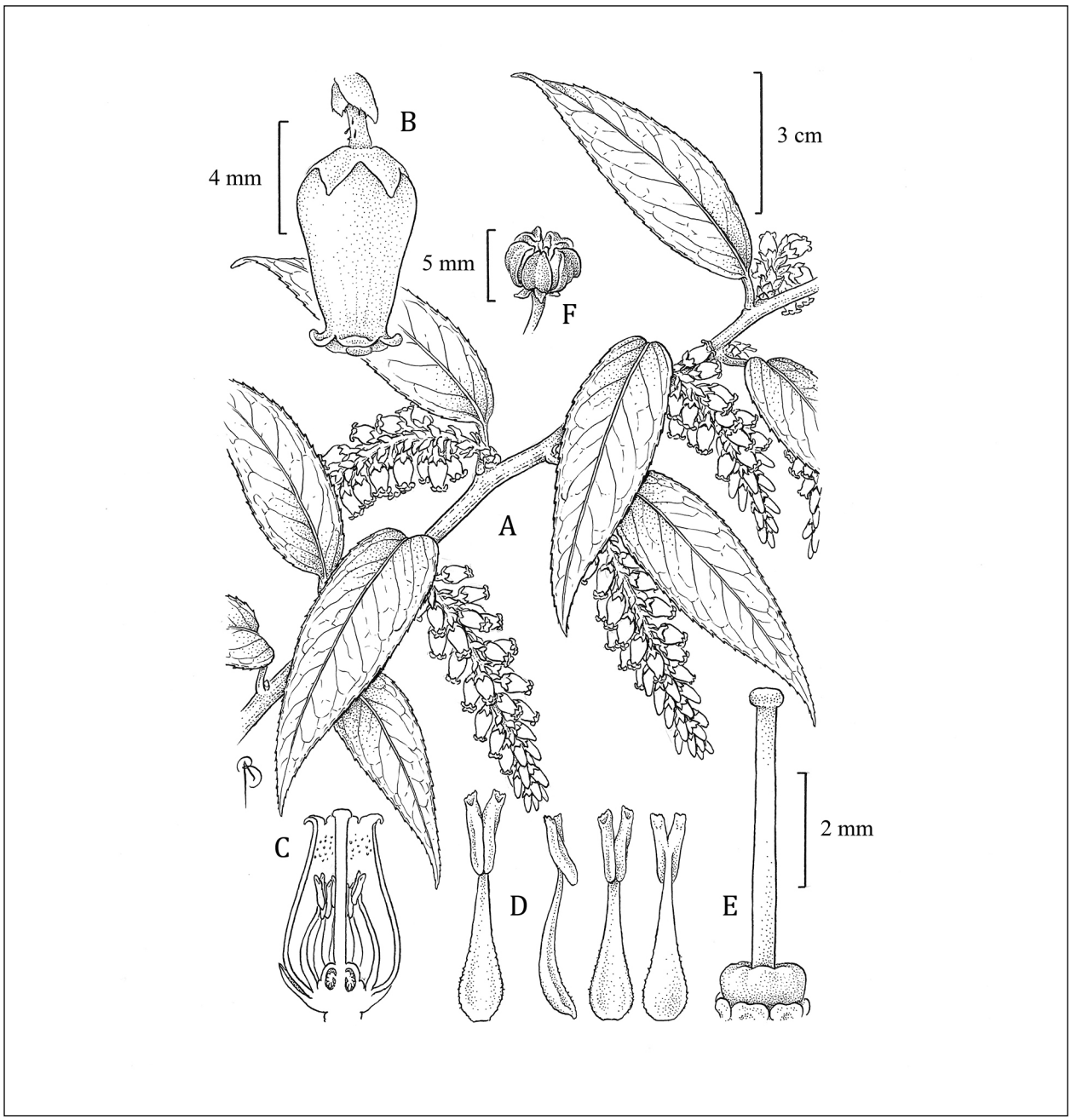
1. Flowers in raceme, close together, compact, upright;
   calyx lobes about half as long as the tube; legumes orbicular . . . . . ***Lespedeza bicolor****
1. Flowers in raceme, spaced apart, loose, drooping;
   calyx lobes longer than the tube; legumes obovoid to oblong . . . . . ***Lespedeza thunbergii****

Nonnative Species

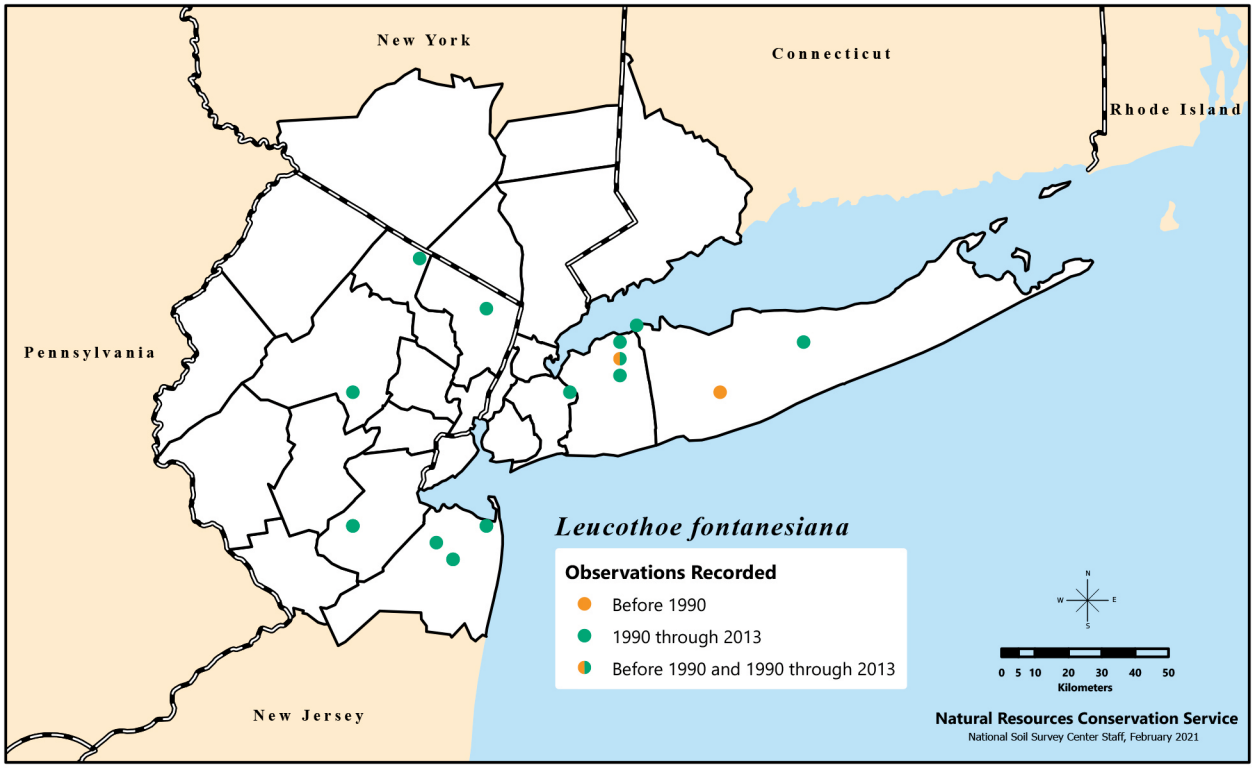
***Leucothoe fontanesiana* (Steud.) Sleumer – dog-hobble ↑↑↑**

Andromeda fontanesiana Steud.; *Andromeda lanceolata* Desf. non Wall.; *Leucothoe editorum* Fernald & B.G. Schub.; *Leucothoe axillaris* var. *editorum* (Fernald & B.G. Schub.) H.E.Ahles

Flowering May. Native to the southeastern U.S. north to VA in moist mountain woodlands. Cultivated in the region; occasionally escapes or persists after cultivation. Sometimes treated as a variety of *L. axillaris*. Epithet honors French botanist René Louiche Desfontaines (1750–1833).



A) Flowering leafy twig, B) flower, C) cross-section of flower, D) stamens, E) pistil, and F) fruit of *Leucothoe fontanesiana*. Illustration by Bobbi Angell.



Distribution of *Leucothoe fontanesiana*, or dog-hobble, recorded in the New York Metropolitan Region during three time categories.

Ligustrum L. – privet

Oleaceae. Shrubs, small trees. Species about 40 native to northern Africa, Asia, Australia, and Europe. Closely related to *Syringa* (lilacs); recent phylogenetic evidence has suggested that *Ligustrum* is nested within *Syringa*, which may warrant the merging of the two genera (Chang et al. 1996, Li et al. 2012, Wallander and Albert 2000). Primary distinction between the two genera lies in the fruit; *Ligustrum* possesses a berry, *Syringa* a capsule. Members of *Syringa* subg. *Ligustrina* (Rupr.) K.Koch (tree lilacs), like typical *Syringas*, have capsular fruits. However, floral structure is similar to *Ligustrum*; for example, calyx and corolla are of similar size. Tree lilacs, such as *Syringa reticulata* (Blume) H.Hara (sometimes planted in the region as a street tree), have occasionally been treated in *Ligustrum* or placed in their own genus, *Ligustrina* Rupr. Also, the Asian *Parasyringa sempervirens* (Franch.) W.W.Sm. has a fruit with intermediate morphology; it is fleshy like a berry (as in *Ligustrum*) but dehiscent like a capsule (as in *Syringa*). Besides being placed in its own genus (*Parasyringa* W.W.Sm.), this species has been treated in *Ligustrum* and *Syringa* by some authors. *Ligustrum* is the ancient Latin name for *L. vulgare*.

Besides the species treated here, there are reports of *Ligustrum amurense* Carrière (= *L. obtusifolium* subsp. *suave* (Kitag.) Kitag.) and *L. sinense* Lour. from the region, both native to Asia and established in the southeastern U.S., but neither has been shown to be established in the region. Also *L. japonicum* Thunb., *L. lucidum* W.T.Aiton, and *L. quilhoui* Carrière, all native to Asia, have not been reported to escape in the region but have been reported as rarely or occasionally escaping south of the region.

Ligustrum Key

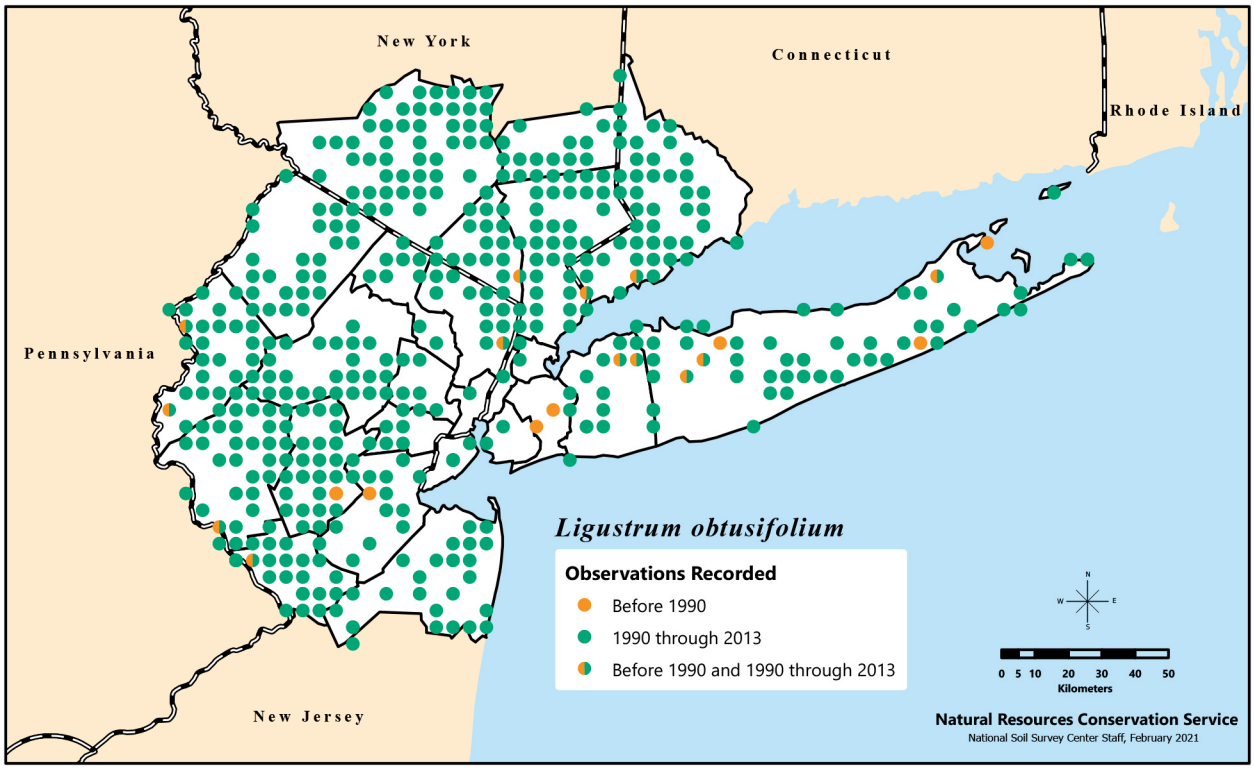
1. Twigs pubescent; leaves pubescent (at least on midrib) beneath. . . . . ***Ligustrum obtusifolium****
1. Twigs glabrous or slightly puberulent (in *L. vulgare*); leaves glabrous. 2
2. Leaves evergreen or semi-evergreen;
   corolla tube 2–3 times longer than the lobes . . . . . ***Ligustrum ovalifolium****
2. Leaves deciduous; corolla tube shorter or equal in length to the lobes . . . . . ***Ligustrum vulgare****

Nonnative Species

1. *Ligustrum obtusifolium* Sieb. – border privet ↑↑↑

Flowering late May–June. Thickets, woodland edges, and roadsides. Native to Asia. Found throughout the NY Metropolitan Region, it is the area's most common naturalized privet.

Once recommended as a hedge or screen plant for northern climates. First introduced into the U.S. in 1860 from its native Japan. At least 2 cultivars (Dirr 1998). Best distinguished from *Ligustrum sinense* and *L. vulgare* by its shorter peduncles (Gleason and Cronquist 1993, Haines 2011). *Ligustrum sinense* and *L. vulgare* are both common nonnative *Ligustrum* spp.; *L. sinense* is not documented in the region but instead is found in adjacent southern states (Maddox et al. 2010). *Ligustrum vulgare* and *L. sinense* also tend to be more evergreen or semi-evergreen than *L. obtusifolium*, which tends to be mostly deciduous to somewhat evergreen (Nesom 2009). Seeds are dispersed by birds (Maddox et al 2010) as well as deer (*Odocoileus* spp.) (Stromayer et al. 1998).



Distribution of *Ligustrum obtusifolium*, or border privet, recorded in the New York Metropolitan Region during three time categories.

Black cutworm (*Agrotis ipsilon*), an important pest of agricultural crops, has been observed feeding on *L. obtusifolium* as an adult moth. Presence of these *Ligustrum* spp. may make infestations of nearby cropland by black cutworm more likely (Wynne et al. 1991). This and the following two species, if similar to other *Ligustrum* spp., are likely to root readily from stem cuttings, and this is the suggested method of propagation. Seeds also germinate if fruit material is removed; pericarp may contain chemicals that prevent germination. Moist cold stratification for 3 months recommended for germination (Dirr 1998). This and other *Ligustrum* spp. (e.g., *L. ovalifolium* and *L. vulgarum*) may invade open areas, including rare community types such as limestone cedar glades, dominated by *Juniperus virginiana* (eastern redcedar) (Morris et al. 2002), as well as closed canopy forests, though fruit production is likely to be lower in low light conditions (Brown and Pezeshki 2000).

Listed as potentially invasive in CT (prohibited) and invasive in NY (prohibited).

2. *Ligustrum ovalifolium* Hassk. – California privet Ø

Flowering late May–June. Native to Japan and Korea. This species is the characteristic hedge privet commonly planted on Long Island; rarely escapes from plantings on Long Island.

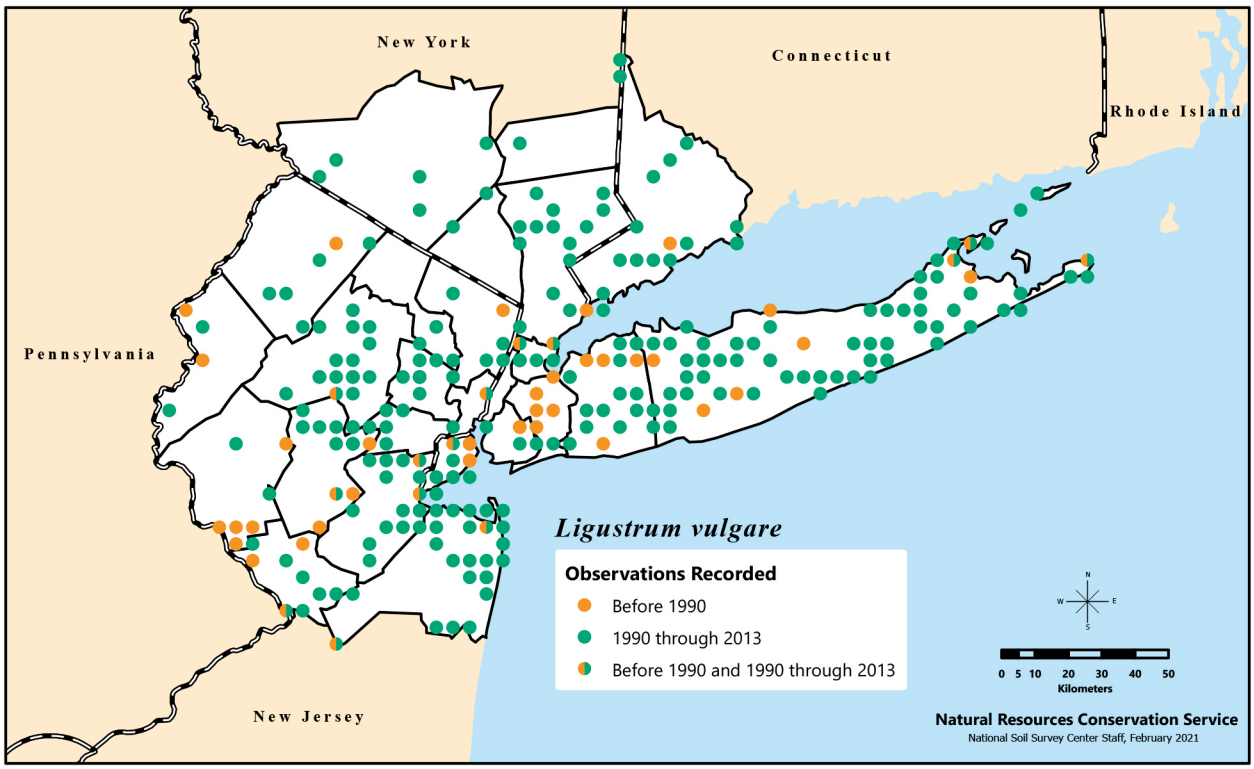
Height at maturity 5 m (Mikowski and Stein 2008). Cultivated since 1847, with at least 9 cultivars (Dirr 1998). Due to its rarity, no additional distribution information is available.

Listed as potentially invasive in CT (not prohibited).

3. *Ligustrum vulgare* L. – European privet ↑↑↑

Flowering late May–June. Thickets, woodland edges, fields, and roadsides. Native to Europe. Though found throughout the region, it is more common on the Coastal Plain.

Introduced into the U.S. from Europe (Dirr 1998). Widely planted as a landscape plant since at least 1920 (Zhao et al. 2013), with at least 20



Distribution of *Ligustrum vulgare*, or European privet, recorded in the New York Metropolitan Region during three time categories.

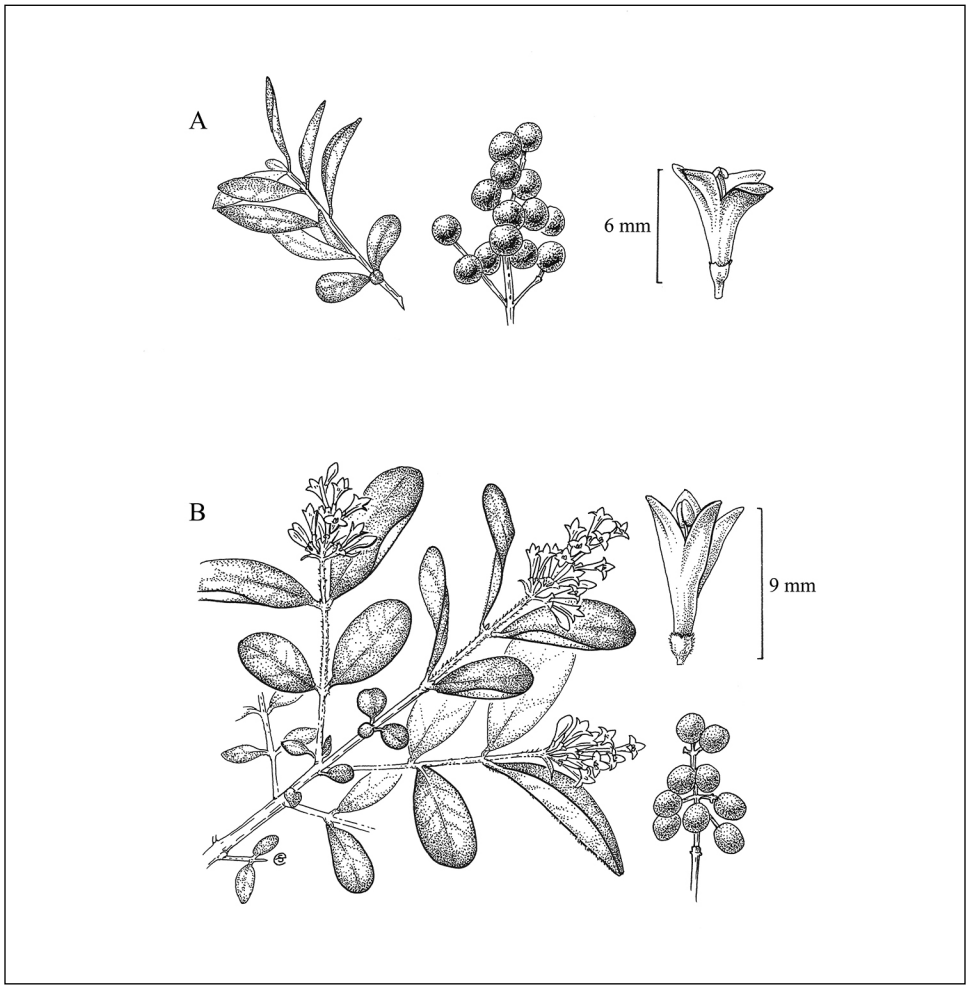
cultivars (Dirr 1998). Leaf defoliation appears not to impact flower or fruit production for this species (Obeso and Grubb 1993). The presence of *Ligustrum vulgare* reduces arbuscular mycorrhizal fungi colonization of roots of associated native species (Shannon et al. 2014). The mechanism behind this remains unclear. Though there could be allelopathic properties that may impact fungi, no significant allelopathic effects could be detected on seed germination (Pisula and Meiners 2010). Once a popular landscape plant; suffers from anthracnose twig blight (*Glomeralla cingulata*), which causes its leaves to dry out and cankers to develop on its stem, making it an unattractive landscape shrub (Dirr 1998).

Listed as potentially invasive in CT (not prohibited); tracked as potentially invasive in NJ (category 2).

Management

The relative ease of vegetative propagation and having bird- and deer-dispersed seed give *Ligustrum* spp. a means of rapid spread. If young, *L. obtusifolium* and *L. vulgare* may be controlled by hand-pulling, removing the entire root system. Several chemical controls are effective against larger plants (Maddox et al. 2010). Herbicide application may not be a control option in rare communities or forested sites. *Ligustrum vulgare* may be less of a concern due to the twig blight, but *L. obtusifolium*, especially in the Northeast, should be considered a serious threat and researched more thoroughly. It is also somewhat surprising, but good news, that there are no current reports of hybridization among the many *Ligustrum* spp.

L



A) Twig with leaves, and fruit and flower of *Ligustrum vulgare*; B) flowering twig with leaves, and flower and fruit of *Ligustrum obtusifolium*. Illustration by Emma Skurnick.

Lindera Thunb. – spicebush

Lauraceae. Shrubs, small trees. Species about 100 in temperate and tropical Asia; Australia (1); North America (3). Genus name *Benzoin* Boerh. ex Schaeff. (1760) has priority over *Lindera* Thunb. (1783); however, the latter name has been formally conserved over the former. Genus name honors Swedish botanist Johann Linder (1676–1723).

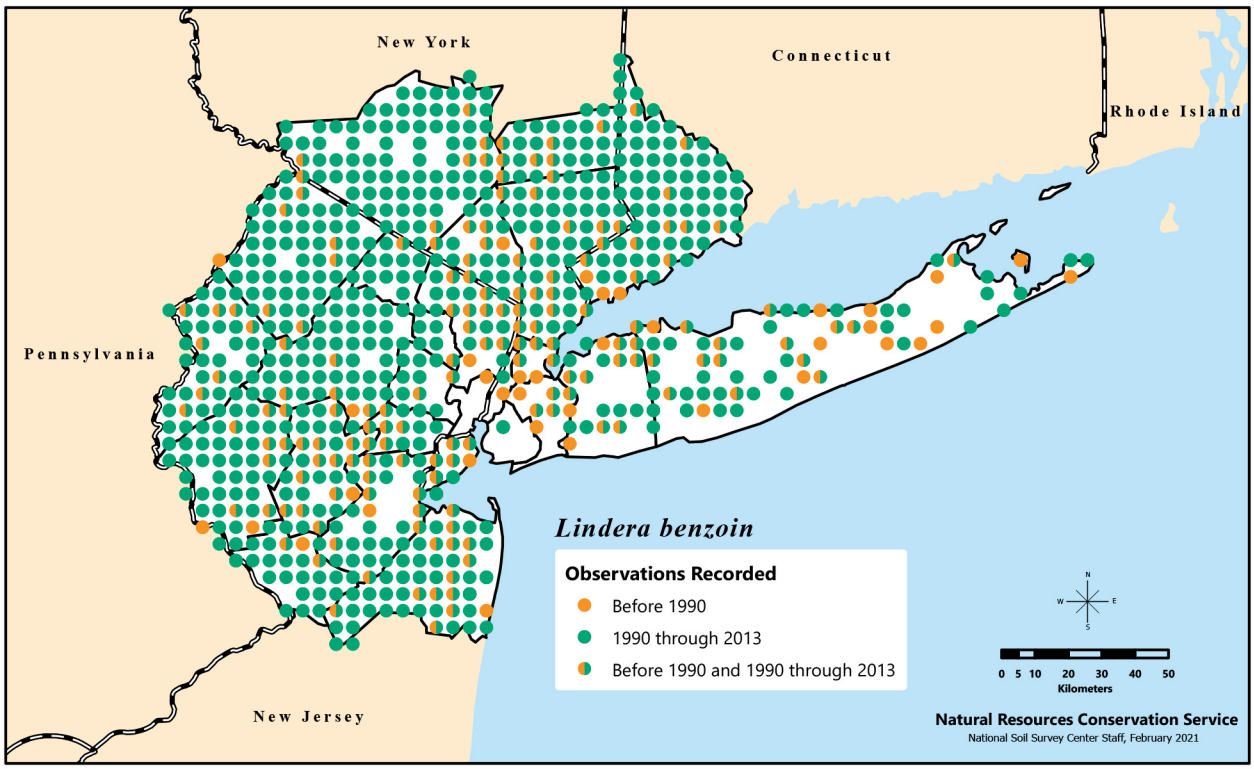
Native Species

1. *Lindera benzoin* (L.) Blume – spicebush ↑↑

Laurus benzoin L.; *Benzoin odoriferum* Nees

Flowering late Mar.–early Apr. Mesic to wet woodlands and streambanks. Frequent throughout the region, except in pine barren wetlands. Prefers moist, well-drained soils (Dirr 1998). Epithet refers to the spicy odor of the plant; benzoinum is a pre-Linnean name for *Styrax benzoin* Dryand., native to Java and Sumatra, and one of the *Styrax* spp. from which the aromatic resin of benzoin was first derived.

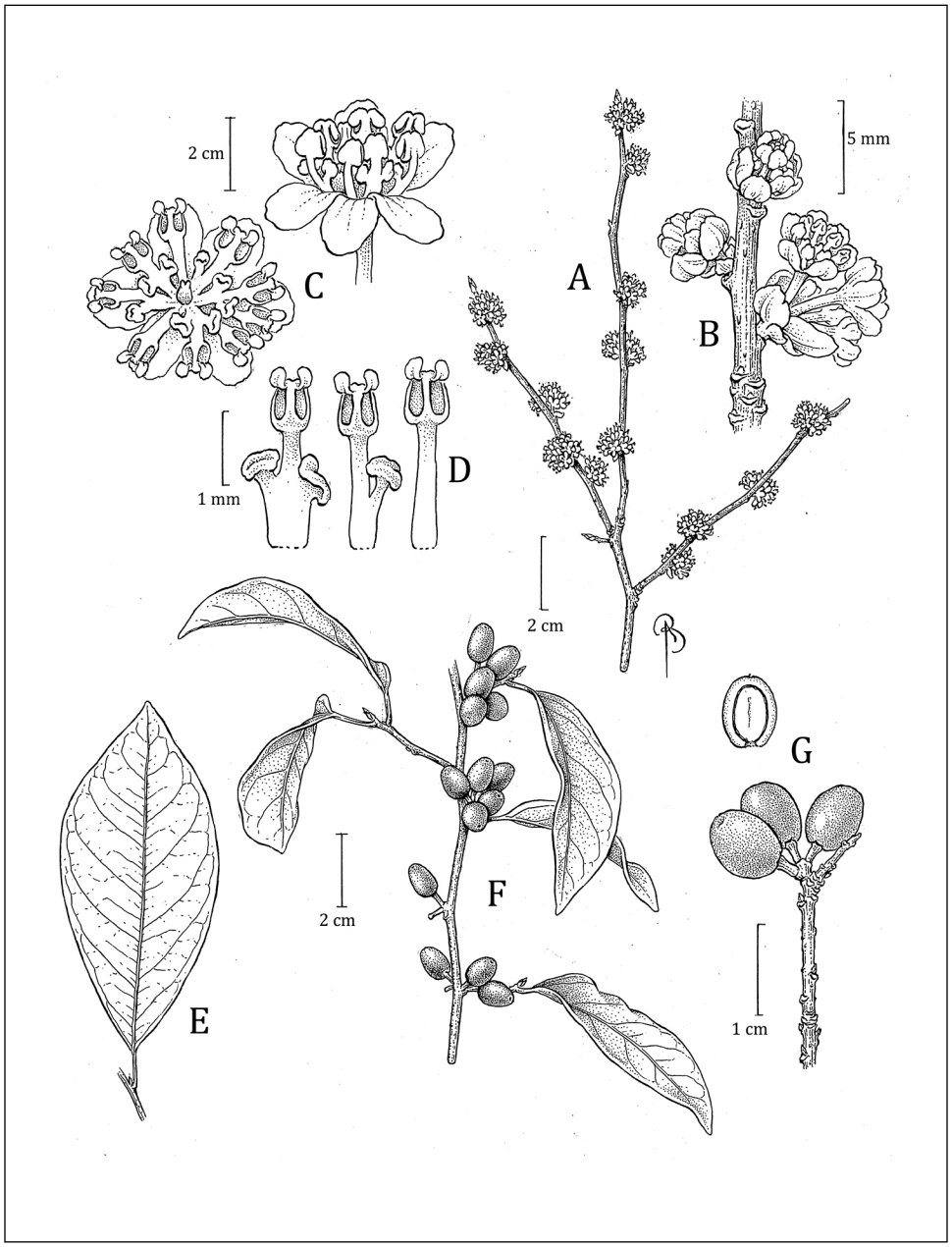
Dioecious. Female plants tend to grow less than male plants or nonflowering plants. Plants growing in a shaded environment are more susceptible to herbivory and grow at a lower rate. Herbivores do not prefer a gender (Niesenbaum 1992). Height at maturity 4.6 m. Cultivated since 1863, with at least 3 cultivars (Dirr 1998). Heavy shade from *Lindera benzoin* appears to prevent regeneration of tree species (including some nonnative tree species such as *Acer platanoides*) in urban forests of NYC (Profous and Loeb 1986). Deer (*Odocoileus* spp.) do not browse this species (Rossell et al. 2007). Appears to respond negatively to forest fragmentation (Medley 1996). There is evidence of boring and infection by the redbay ambrosia beetle (*Xyleborus glabratus*), though reproduction of the beetle on this species has not been documented yet. This beetle causes laurel wilt, a lethal disease affecting several Lauraceae genera in the southeastern U.S.; preferred host is *Persea* spp., but beetle also kills other species, such as *Sassafras albidum* (Pena et al. 2012).



Distribution of *Lindera benzoin*, or spicebush, recorded in the New York Metropolitan Region during three time categories.

Management

The substantial increase in abundance of *Lindera benzoin* is most likely due to a lack of deer browse and possibly due to increasing forested land cover in the region. The species makes a good native substitute for nonnative shrubs, especially in more alkaline soils. Because of the lack of other native shrubs also immune to deer browse to replace nonnative species in restored sites, the increasing abundance of *L. benzoin* should be watched. Its potential susceptibility to the redbay ambrosia beetle, which could eventually adapt to colder climates, may lead to excessive loss of understory native shrub abundance.



A) Flowering twig, B) flowering twig section, C) flower top and side views, D) stamens, E) leaf, F) fruiting leafy twig, and G) fruiting twig and cross-section of fruit of *Lindera benzoin*. Illustration by Bobbi Angell.

Liquidambar L. – sweetgum

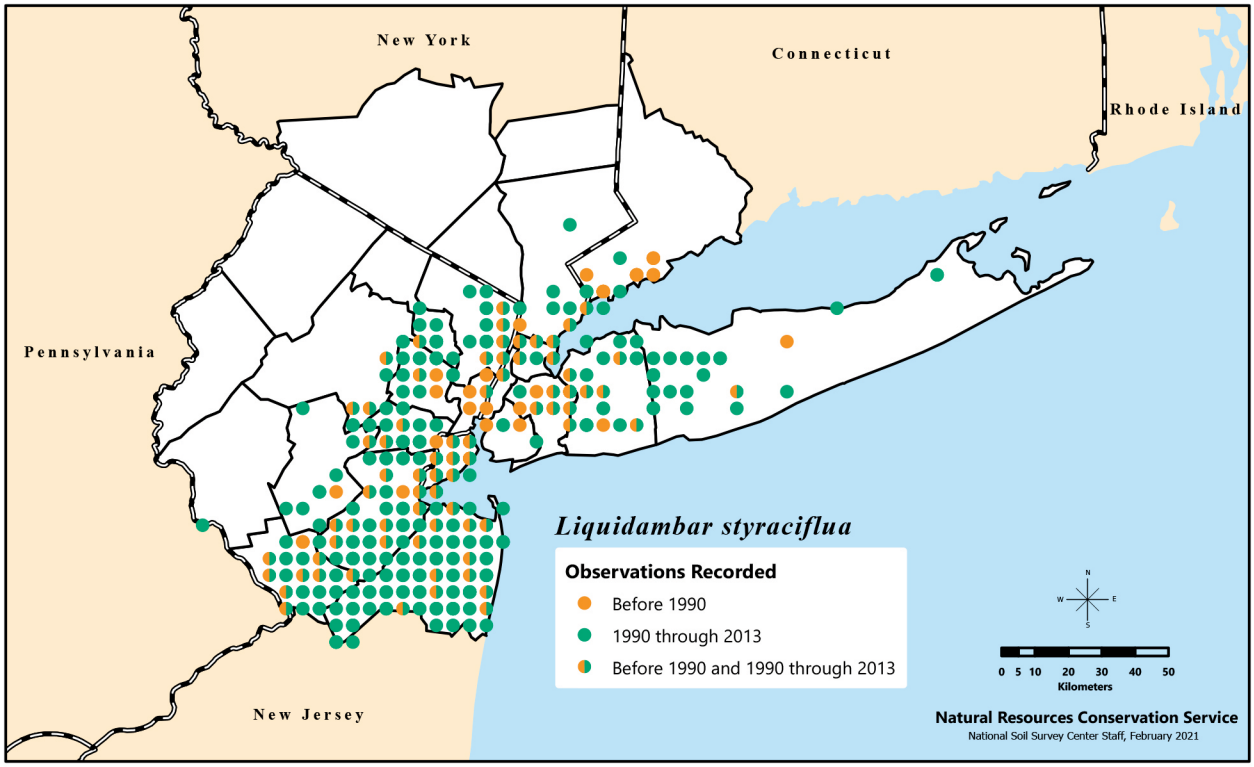
Hamamelidaceae. Trees. Species 3 or 4 in Asia, Central America, and North America. Readily distinguished by lobed palmately veined leaves and "gumball" fruit, each ball consisting of many capsules fused at their bases. Wind pollinated. Cultivated for timber, aromatic balsam (storax), and ornament (fall color). Genus name is derived from the Latin "liquidus" ("fluid"), and Arabic "ambar" ("amber"), in reference to the aromatic gums exuded by the tree.

Native Species

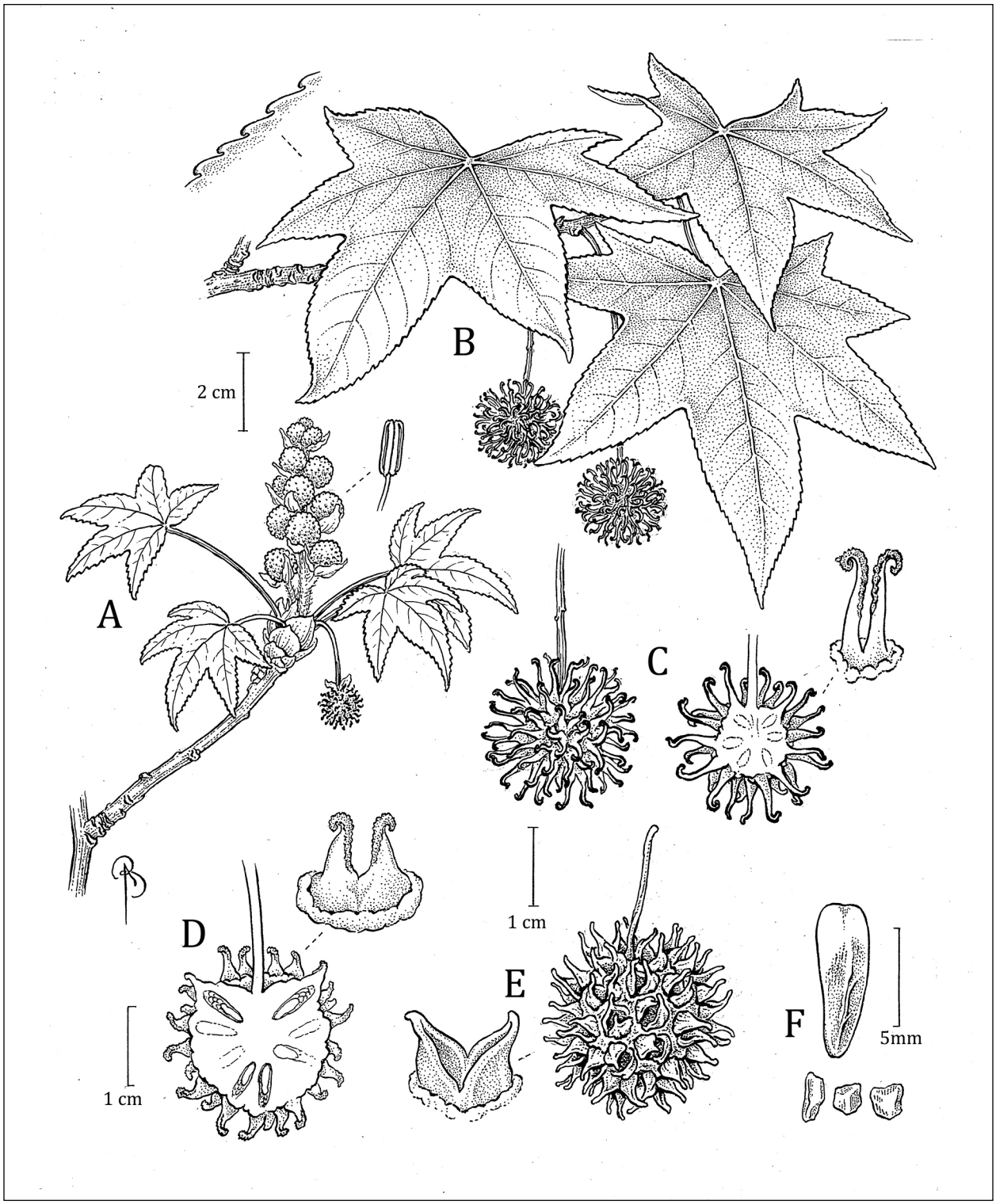
1. *Liquidambar styraciflua* L. – sweetgum, bilsted ↑

Flowering Apr.–May; fruiting Oct.–Nov., persisting into next season. Woodlands, edges of woodlands, swamps, and old fields, often coming in after disturbance. The region represents the historical northern limit of its native range; early manuals report it from southern CT and southeastern NY. Range may be spreading northward (or species is escaping cultivation). Species more recently reported from upstate NY, as well as MA and RI. Leaves fragrant when crushed, crimson in fall; branchlets (especially young trees or saplings) with corky ridges. Epithet from Latin is the old genus name, meaning "flowering gum."

Prefers deep, moist, slightly acidic soils. The extensive, fleshy root system takes time to develop. Although planted often as a street, lawn, or park tree, *Liquidambar styraciflua* occurs naturally in alluvial soils of bottomlands and a variety of different sites. Not especially cold-tolerant and not a good urban tree, where root space may be limited (Dirr 1998, Kjelgren and Clark 1993). Not tolerant of water or air pollutants (Dirr 1998). Flowers wind pollinated (Morris et al. 2008); fruit globose, composed of several two-celled capsules, which give the appearance of a small spiny ball, about golf-ball size. The spiny fruit balls that do fall to the ground can be a painful nuisance. Capsules open once moisture content is less than 70 percent, and contain one to two winged seeds that are wind dispersed.



Distribution of *Liquidambar styraciflua*, called bilsted or sweetgum, recorded in the New York Metropolitan Region during three time categories.



A) Flowering and fruiting leafy twig, with enlarged view of stamen; B) leafy twig with enlarged view of leaf margin; C) female flower head and its cross-section with enlarged view of single pistil; D) immature fruiting head with enlarged view of single capsule; E) mature fruiting head, with enlarged view of opened capsule; and F) seeds with smaller chaff of *Liquidambar styraciflua*. Illustration by Bobbi Angell.

Birds, squirrels (family Sciuridae), and chipmunks (family Sciuridae, subfamily Xerinae) may also disperse any seed that they do not consume (Kormanik 1990), but most seeds fall within 50–100 m of the parent tree (Morris et al. 2008). Fernald (1950: 753) reported the capsules "filled mostly with abortive seeds, which resemble sawdust." The empty fruiting heads may remain on the trees throughout the winter. Seed crops occur every year; some masting or bumper crops occur every 3 years. Trees fruit as early as 4 to 5 years of age, but most do not bear good seed crops until they are 20–30 years old. Trees may live to at least 200 years. Seeds have a shallow dormancy in that germination rates may be increased with moist cold stratification, especially for seeds from northern latitudes (Bonner 2008g).

Potential pathogens and pests include leaf spots, bleeding necrosis, sweetgum leafroller (*Sciota uvinella*) and other caterpillars, and scale. Chlorosis may occur in soils with high pH. There is a great variation in fall color; some trees turn a bright red while others appear to never turn. Cultivated since 1681, with at least 29 cultivars, 1 of which, 'Rotundiloba,' does not set fruit. An economically important timber tree used for furniture, cabinets, and plywood. Sap is sweet and gummy; hence the common name (Dirr 1998). Genetic evaluation of this species suggests that U.S. coastal and Florida populations may show greater divergence (about 8 million years ago) than other populations found in the U.S., Mexico, and Guatemala; populations in Mexico and Guatemala share genes with TX, MS, KY, OH, and northern VA (Morris et al. 2008). Increases its biomass in response to elevated carbon dioxide (CO_2) (Tolley and Strain 1984) and may be able to tolerate lower soil moisture if combined with elevated levels of CO_2 (Tolley and Strain 1985). Contains shikimic acid, which is used in the drug Tamiflu® (Hoffmann-LaRoche, Nutley, NJ) (Martin et al. 2010). Some midwives have used this compound to alleviate abdominal pain and as a purgative to clean the womb after a birth (Ticktin and Dalle 2005).

Management

Liquidambar styraciflua, a relatively fast-growing pioneer species, can be aggressive. It may invade abandoned open areas and floodplains, where it can grow optimally (Dirr 1998). The presence of aggressive native plants such as this species may enable certain plant communities that could be invaded by nonnatives to withstand that invasion. However, given the amount of cultivation that *L. styraciflua* has undergone, it is difficult to distinguish whether the aggressive individuals are of a cultivated origin or wild (or both). If cultivated, such individuals could have negative impacts similar to those of nonnative invasive plants. It would be useful to know which individuals, cultivated or wild, are increasing in the region.

Liriodendron L. – tulip poplar, tulip tree

Magnoliaceae. Trees. Species 2 closely related in Asia (1) and eastern North America (1). Readily distinguished by distinctively lobed leaves, the terminal lobe truncate and emarginate. Pollinated by bees (order Hymenoptera) and beetles (order Coleoptera). Cultivated for ornament and timber. Genus name is from the Greek "lirio" ("tulip") and "dendron" ("tree"), the flowers superficially resembling tulips.

Native Species

1. *Liriodendron tulipifera* L. – tulip poplar, yellow poplar ↑↑

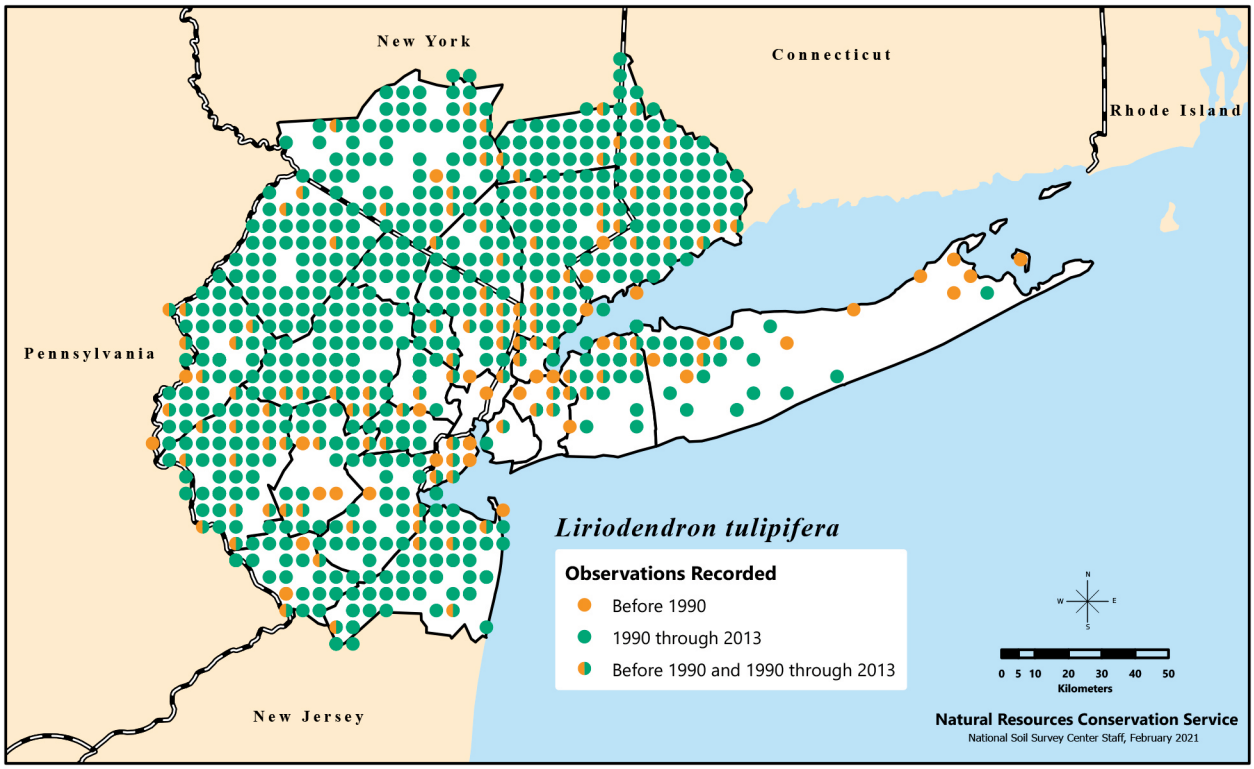
Flowering May–June; fruiting Sept.–Nov. (dispersal into next season). Mesic woodlands and woodland edges, usually in rich soils. Old-growth representatives are some of the largest trees in the region.

Found in various climatic conditions including sea level to over 1,000 m in the Appalachian Mountains and 300 m in the northern part of its range (VT) (Beck 1990, Griswald 1999). Prefers full sun and moist, well-drained loamy soils

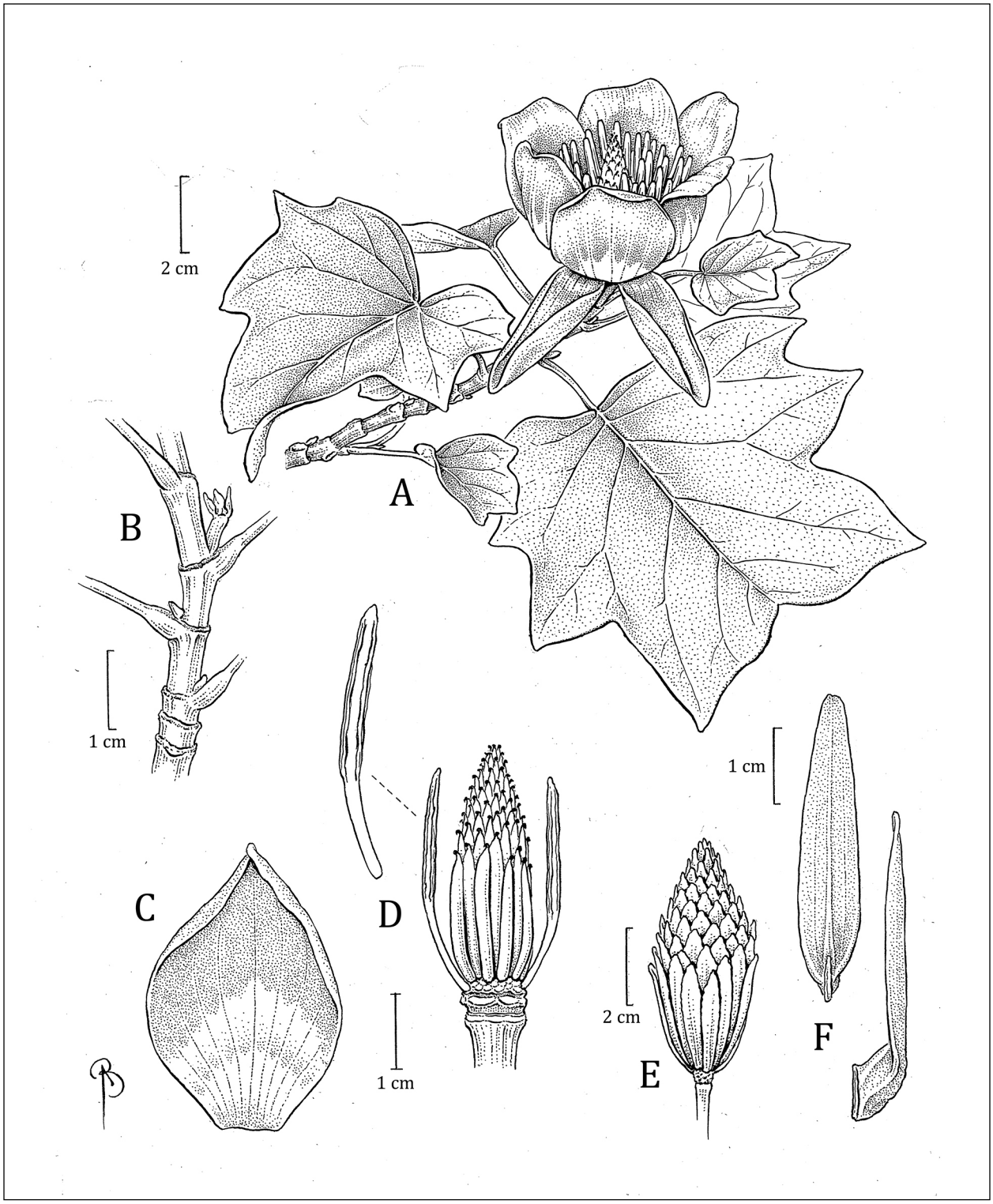
that are slightly acidic, though it can adapt to various pH levels. Because of its large size, it is not a tree for small properties (Dirr 1998). A gap-obligate forest species that rapidly grows in height and diameter to reach the canopy following disturbances that result in large gaps (Busing 1995, Orwig and Abrams 1994). Its wood, possibly dependent on the cultivar, can be weak and may break easily in response to ice and severe storms (Dirr 1998). Can grow as tall as 61 m and is among the largest eastern hardwood tree species. Good seed crops occur nearly every year; bumper crops or mast years occur very infrequently (Beck 1990). Seed-bearing age as young as 9 years, but most trees do not bear seeds until 15–20 years of age (Bonner 2008h).

Flowers pollinated by insects (Boyce and Kaeiser 1961). Natural populations typically have only about 10 percent of each in infructescence-producing seed. Controlled pollinations can produce infructescences that are 75 percent full of seed. Some managers of tulip tree orchards have used beehives to increase samara production with variable results (Bonner 2008h). Seeds can be stored for several years at low moisture content (6–10 percent) and at low temperatures (2–5 °C). Moist cold stratification required for adequate germination. There may be a large number of empty seeds; if these are removed, seed germination rates may reach 80–90 percent (Bonner 2008h). Can also reproduce vegetatively by sprouting from stumps (Dirr 1998).

Valued for its lumber and veneer wood; makes a good honey tree. Planted extensively as an ornamental (Bonner 2008h). Not tolerant of pollutants such as ozone, acid rain, and sulfur dioxide, especially in combination (Chappelka et al. 1985), and, consequently, may not make the best urban or street tree. Cultivated since 1663, with at least 11 known cultivars (Dirr 1998). Susceptible to cankers, powdery mildews, root and stem rot, leaf spots, *Verticillium* wilt, aphids, scale, and galls. Aphids secrete copious amounts of "honeydew" as a waste material from feeding; the honeydew coats the leaves, which are then overtaken by a black sooty mold (Dirr 1998). This



Distribution of *Liriodendron tulipifera*, called tulip poplar or yellow poplar, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig, B) leaf nodes, C) exterior of petal, D) side view of flower with petals and sepals removed and enlarged view of stamen, E) fruiting head or cone, and F) fruit (samaras) or winged seeds of *Liriodendron tulipifera*. Illustration by Bobbi Angell.

honeydew-black mold combination also happens in natural settings and may be caused by scale as well.

Can be easily genetically manipulated and transgenic plants have been produced. One transgenic was transformed to express a modified mercuric reductase (merA) gene construct found in mercury-resistant bacteria. Plantlets with this gene grew in toxic levels of mercury. Such plants could be used for phytoremediation of areas polluted with mercury (Rugh et al. 1998). Considered for use as a biofuel (Nkansah et al. 2010). The functional genomics is relatively well studied, showing 1,089 novel genes (not found in other genomes, such as *Arabidopsis*). These novel genes may help researchers improve economic properties of key characteristics, such as wood (lignin) biosynthesis (Liang et al. 2008). Has a high level of polymorphism and genetic diversity compared with other outbreeding species. Populations appear to cluster in terms of genetic similarities along a north-south gradient with three general groups forming: upland, coastal plain, and Florida peninsula. Genetic data indicate that these differences may be the product of once isolated populations which became sympatric during glacial periods followed by introgression (hybridization) and spread into the current locations (Parks et al. 1994). Medicinal properties include use as a tonic, stimulant, fever reducer, and malaria treatment. It was used as a replacement for quinine by American settlers and during the Civil War. The compounds in *L. tulipifera* that are effective at treating malaria have been isolated and include six known aporphine alkaloids from the bark and two sesquiterpene lactones from the leaves (Graziose et al. 2011).

Management

Liriodendron tulipifera responds to gap-forming disturbances with very rapid growth. Moreover, it can then survive well as a canopy tree and dominate some forests. This gap-obligate native species ensures forest regeneration after disturbances and may, consequently, help deter invasion by nonnative species, especially if it reaches the site first. *Liriodendron tulipifera* also performs well as an ornamental if the area is big enough to accommodate its large size. Its high-quality wood as well as medicinal properties (treatment of malaria) make this tree an economically important species. It is susceptible to some diseases and may not grow well in polluted environments, especially if water is overly abundant or scarce, but such limitations help keep this relatively rapid growing species in check. We recommend managing some forests for *L. tulipifera* regeneration and planting this species in larger residential areas, keeping in mind "honeydew" droppings may be a problem.

Lonicera L. – honeysuckle

Caprifoliaceae. Shrubs; twining or climbing vines. Species about 180 in the Northern Hemisphere, including northern Africa, Asia (including Java, Philippines), Europe, and North America; Asia has the most species (approximately 100). Many species (more than 100) cultivated for their attractive, fragrant flowers. Some have escaped cultivation and are invasive. Seeds of all species dispersed by many bird species, which eat the fruits (Ingold and Craycraft 1983, Ridley 1930), and deer (*Odocoileus* spp.) (Myers et al. 2004). Genus name honors German herbalist and physician Johan Lonitzer (1499–1569) (Laros 1994, Linnaeus 1737), not Adam Lonitzer (1528–1586) as often reported (e.g., Fernald 1950, Rehder 1949). See Rehder (1903) for a treatment of the entire genus.

Native Species

1. *Lonicera canadensis* Bartram & W.Bartram ex Marshall – American fly honeysuckle Ø

Shrub. Flowering late Apr.–mid- to late May. Dry to moist, often cool woodlands, sometimes adjacent to streams and in swamps.

More common in northern and high-elevation areas; declining in the region. The more northerly environments in which this species is documented in the literature may also indicate a preference for colder climates (Bormann and Buell 1964, Curtis 1946, Milne and Forman 1986). No seed dormancy or special stratification requirements; seeds germinate in spring after overwintering (Brinkman 1974). Air-dried seeds may be able to

Lonicera Key

1. Twining or climbing shrubs or vines; stems hollow; leaves below inflorescence connate into a disk; flowers sessile or short stalked in axillary or terminal (or nearly so) whorled clusters (*Lonicera* subg. *Caprifolium* (Adans.) Dippel) 2
1. Shrubs or twining vines (*Lonicera japonica*); stems with solid pith (may become hollow with age) or hollow; all leaves distinct; flowers in axillary pairs on a single peduncle (*Lonicera* subg. *Lonicera*) 3
2. Corolla greenish, whitish to yellow (sometimes tinged with purple), strongly bilabiate, less than 27 mm long; stamens and styles greatly exserted; fruiting spike sessile (or on peduncle up to 10 mm) of 1–3 close whorls; seeds 3.0–3.5 mm × 1.5–2.5 mm . . . . . ***Lonicera dioica***
2. Corolla scarlet (rarely yellow-orange), scarcely bilabiate, trumpet shaped, 27 mm or more long; stamens and style slightly exserted or included; fruiting spike on peduncles 10–50 mm and of 2–4 well-spaced whorls; seeds 4.0–4.5 mm × 3.0–3.5 mm . . . . . ***Lonicera sempervirens***
3. Twining vines; corolla 3.0–4.5 cm; fruit black . . . . . ***Lonicera japonica****
3. Shrubs; corolla 0.5–3.0 cm; fruit red (rarely yellow) 4
4. All stems with solid pith; style glabrous 5
4. Older stems hollow; style hirsute. 6
5. Petioles longer than 4 mm; flowers not appearing before the season's leaves; corolla with regular (or nearly so) 5-lobed limb; ovaries distinct except at base. . . . . ***Lonicera canadensis***
5. Petioles less than 4 mm long; flowers appearing before the season's leaves; corolla bilabiate; ovaries connate along half their length. . . . . ***Lonicera fragrantissima****
6. Leaves 50–80 mm, apices acuminate; peduncles less than 5 mm, shorter to slightly longer than petioles . . . . . ***Lonicera maackii****
6. Leaves 30–50 mm, apices acute or obtuse; peduncles greater than 5 mm, much longer than petioles. 7
7. Leaves glabrous beneath; peduncles 1.5–2.5 cm, glabrous; corolla light pink to red (rarely white), not changing to yellow with age . . . . . ***Lonicera tatarica****†
7. Leaves pubescent; peduncles 0.5–2.5 cm, pubescent; corolla yellowish or white to pinkish and changing to yellow with age 8
8. Leaf blades ovate to obovate, considerably longer than wide (length-to-width ratio: 1.80–2.70); peduncles 0.3–1.5 cm, shorter or equal to flowers; corolla slightly bilabiate, upper lip lobed nearly to base; filaments glabrous . . . . . ***Lonicera morrowii****
8. Leaf blades broadly ovate to obovate or orbicular, only slightly longer than wide (length-to-width ratio: 1.15–1.41); peduncles 1.5–2.5 cm, mostly longer than flowers; corolla bilabiate, upper lip lobed to about half its length; filaments pubescent at base . . . . . ***Lonicera xylosteum****

†*Lonicera* ×*bella*, the common hybrid involving *L. tatarica* and *L. morrowii*, combines characters of both species and is very difficult to separate from its parents.

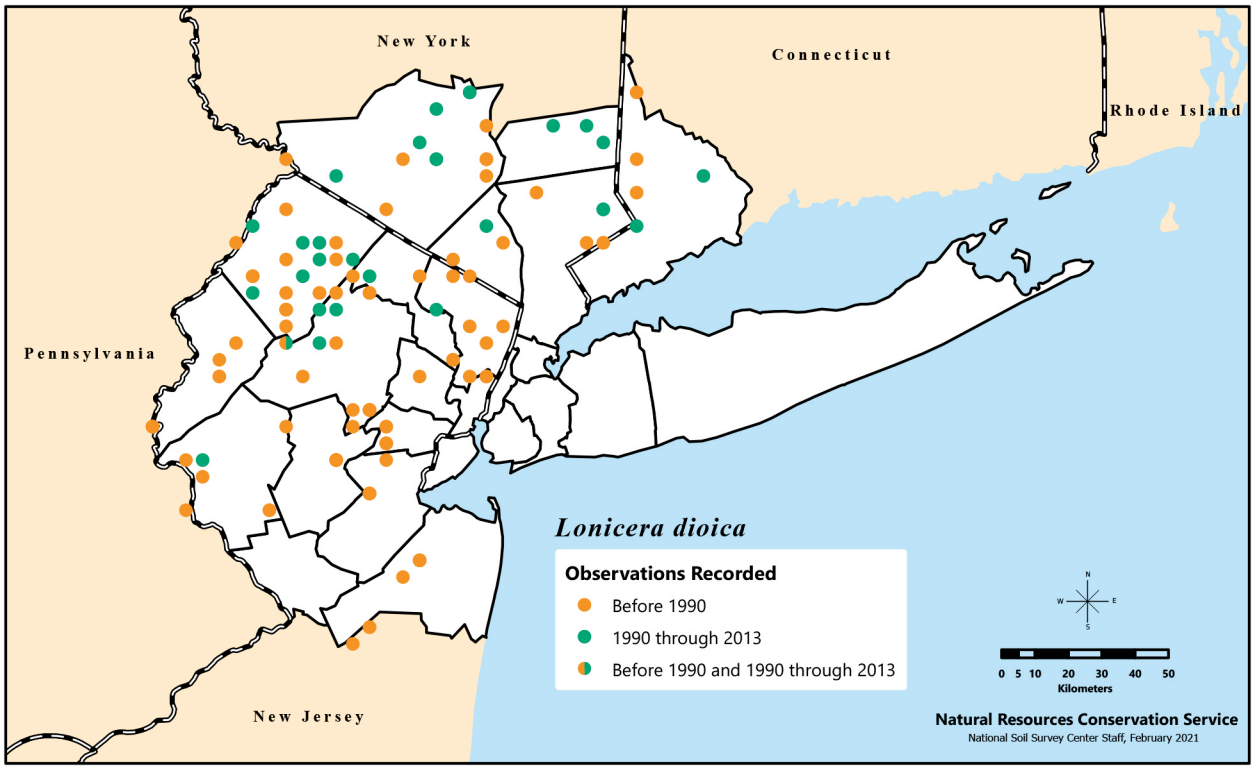
be stored for many years without significant loss of viability (Heit 1967). Propagation via stem cuttings is possible (Dirr and Heuser 1987). Height at maturity 1.5 m (Dubois and Bazich 2008). This species has among the lowest leaf nutrient content of several forest understory species; though consumed by moose (*Alces alces*) in locations where it is found in relatively high abundance (e.g., Isle Royale National Park in MI), it is not a preferred food (Belovsky 1981). However, it ranks as the second choice out of four levels for browse preference by deer on the Apostle Islands (MI) (Beals et al. 1960), which may indicate that deer control may help increase the abundance of this species. The following bee genera have been reported to visit the flowers of this species: *Adrena*, *Bombus*, *Halictus*, and *Osmia* (Graenicher 1900, Lovell 1900). Leaves and berries have been used as a diuretic and treatment for urinary and venereal diseases (Erichsen-Brown 1979, Moerman 1998).

Listed as endangered in NJ (S1), with records from Morris, Passaic, and Sussex Counties.

2. *Lonicera dioica* L. – limber honeysuckle ↓

Climbing shrub. Flowering late Apr.–mid-June. Dry to moist woods and thickets, often along banks and slopes; also alluvium and swamps. Prefers open sites, such as forest edges and thickets (Harper and Macdonald 2002). Our material is *Lonicera dioica* L. var. *dioica*. Epithet from Greek means “dioecious”; epithet given to this species by Linnaeus is unusual as it is not dioecious.

Two nonnative species, *L. caprifolium* L. (native to Asia, Europe) and *L. periclymenum* L. (native to northern Africa, Asia, Europe) that would key to this species have rarely been reported as escapes from the region. They differ from *L. dioica* in their longer corollas (4–5 cm) with an unspurred, glabrous tube. In *L. caprifolium*, the flowers are subtended by sessile connate leaves, whereas in *L. periclymenum*, the leaves are subtended by petiolate bract-like leaves. Like *L. canadensis*, has no seed dormancy or special stratification requirements; seeds germinate in spring after



Distribution of *Lonicera dioica*, or limber honeysuckle, recorded in the New York Metropolitan Region during three time categories.

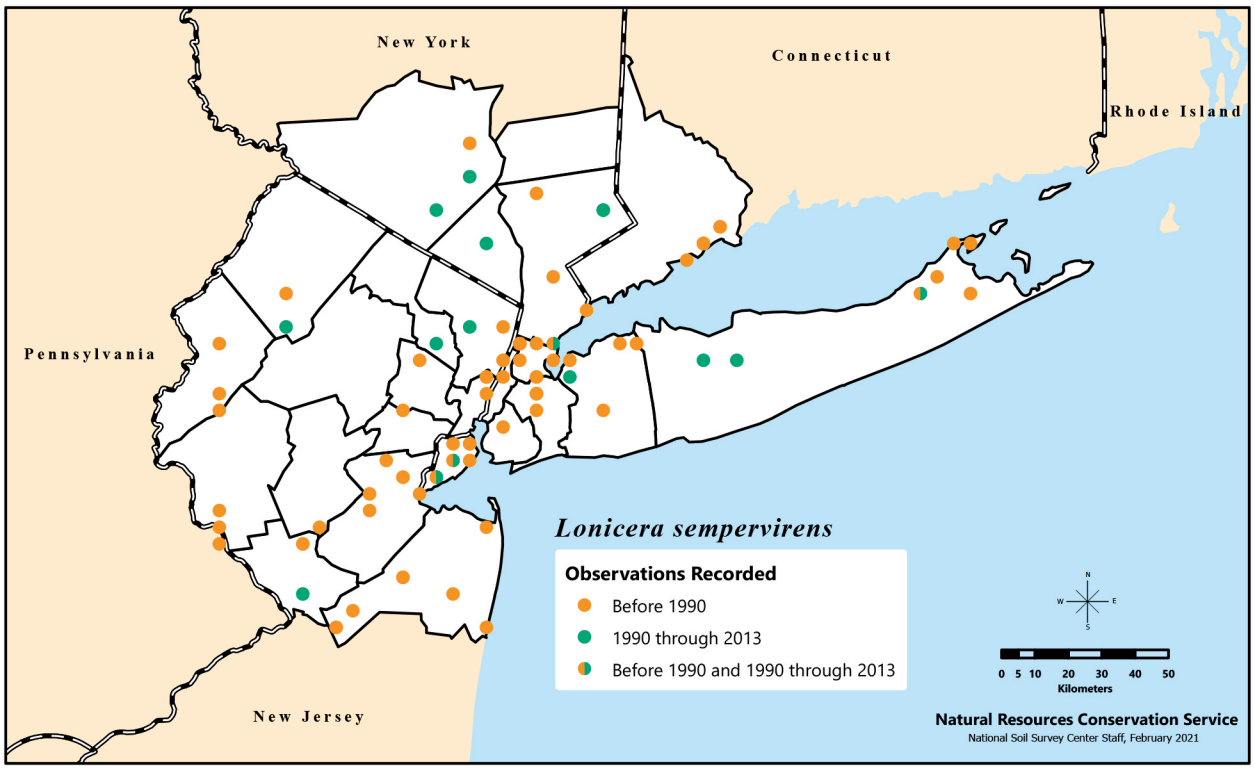
overwintering (Brinkman 1974). Air-dried seeds may be able to be stored for many years without significant loss of viability (Heit 1967). Species may also be able to be propagated through stem cuttings (Dirr and Heuser 1987).

Preference for cooler climates. There are well-documented declines of this species in the region over the past 100 years, particularly in the southern areas (Clemants and Moore 2005). Besides hummingbirds (family Trochilidae), the following bee genera have been reported to visit the flowers of this species: *Adrena*, *Bombus*, *Halictus*, *Megachile*, and *Osmia* (Graenicher 1900). Berries and leaves have been used to treat fever, sore throats, respiratory ailments, and kidney stones and as a cathartic and diuretic (Erichson-Brown 1979, Moerman 1998).

3. *Lonicera sempervirens* L. – trumpet honeysuckle, coral honeysuckle ↓↓

Twining vine. Flowering mid-May–mid-July (rarely later). Mesic conditions, such as roadside banks, woodland edges, and thickets. Epithet from Latin means "evergreen," a reference to the leaves, which can be somewhat persistent.

Unlike the other two native *Lonicera* spp. from the region (*L. canadensis*, *L. dioica*), this species is not more commonly found in more northern and higher elevation areas. However, it too has shown significant decline in the region; probable contributing factors are habitat alteration, invasive species, and herbivory. *Lonicera sempervirens* does not share the extended leafing-out period noted with the nonnative invasive *L. japonica*, and its overall photosynthetic and water use efficiency tend to be significantly lower than that of *L. japonica* (Schierenbeck and Marshall 1993). Both vertical and horizontal stems of *L. sempervirens* rotate (circumnutate) at the same rate, which reduces the growth rate in terms of distance covered of the horizontal, prostrate shoots (Larson 2000). Herbivory by insects and mammals of *L. sempervirens* plays a significant role in its lack of competitiveness when compared to *L. japonica*



Distribution of *Lonicera sempervirens*, called trumpet honeysuckle or coral honeysuckle, recorded in the New York Metropolitan Region during three time categories.

(Schierenbeck et al. 1994). Increases in this species may be possible if deer populations are controlled. Initial cultivation date unknown, but there are at least 12 cultivars (Dirr 1998). Some populations in the region may represent escaped material. Earlier floras (Britton 1889, Stone 1911, Taylor 1915) of the region reported the species to be native along the coast and near major river (Delaware and Hudson) systems. Pollinators are probably similar to those for *L. dioica*.

***Lonicera villosa* (Michx.) Schult.**

Xylosteon villosum Michx.

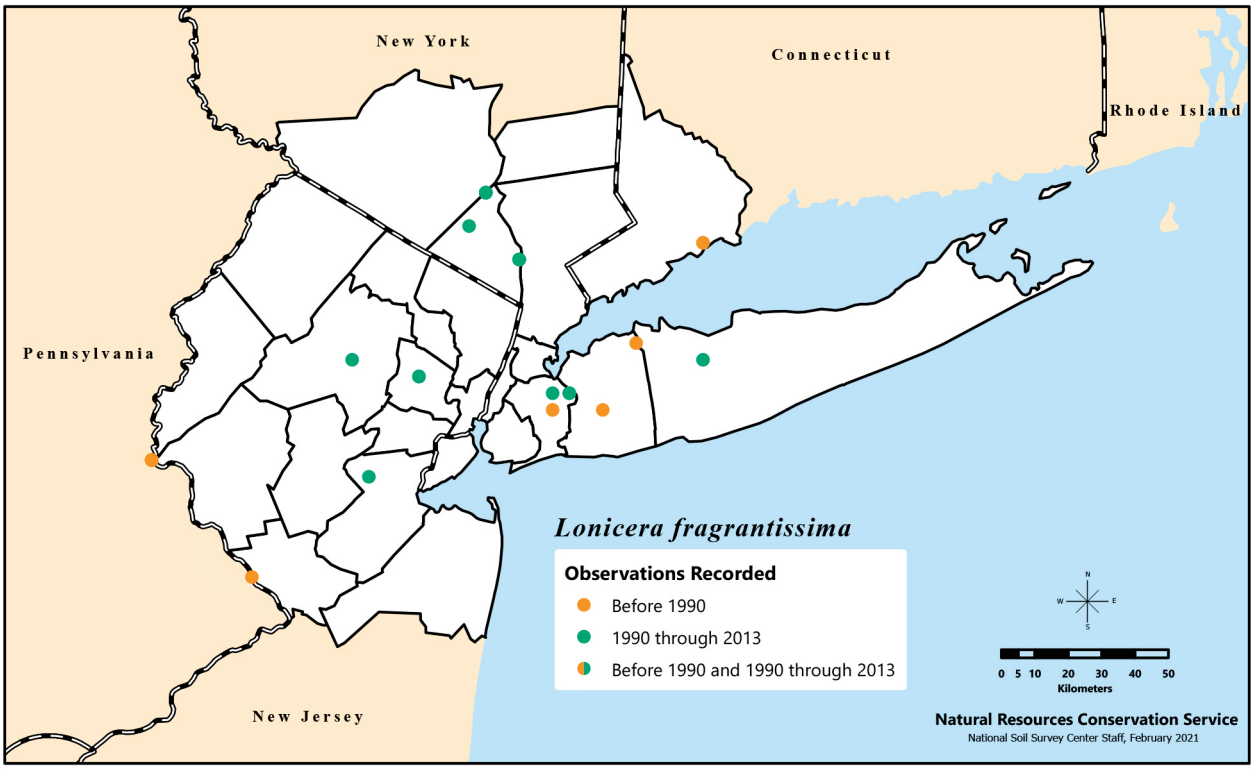
This species also appears to be more northerly in its distribution (Curtis 1946, Milne and Forman 1986). Known from CT and NY but no confirmed records for the region; 5 accepted varieties.

Nonnative Species

4. *Lonicera fragrantissima* Lindl. & Paxt. – sweet breath of spring, fragrant honeysuckle ↑

Shrub. Flowering early Mar.–late Apr. Mesic disturbed sites including thickets, old fields, and rocky outcrops. Native to eastern China. In some previous works (e.g., Fernald 1950), material from the region was thought to belong to the closely related *Lonicera standishii* Jacques from China. *Lonicera ×purpusii* Rehder, the hybrid between *L. fragrantissima* and *L. standishii*, has also been reported as a possible escape from the region. Epithet from Latin refers to the highly fragrant flowers. Flowers appear before the leaves.

Height at maturity 2 m (Dubois and Blazich 2008). In cultivation since 1845 (Rehder 1949), with 3 cultivars used in landscaping (Dirr 1998). In the Northeast, the species is not known north of the NY Metropolitan Region (Weldy et al. 2020). Its preference for warmer climates and susceptibility to honeysuckle aphid (*Hyadaphis tetaricae*) (Herman and Davidson 1997) and several other



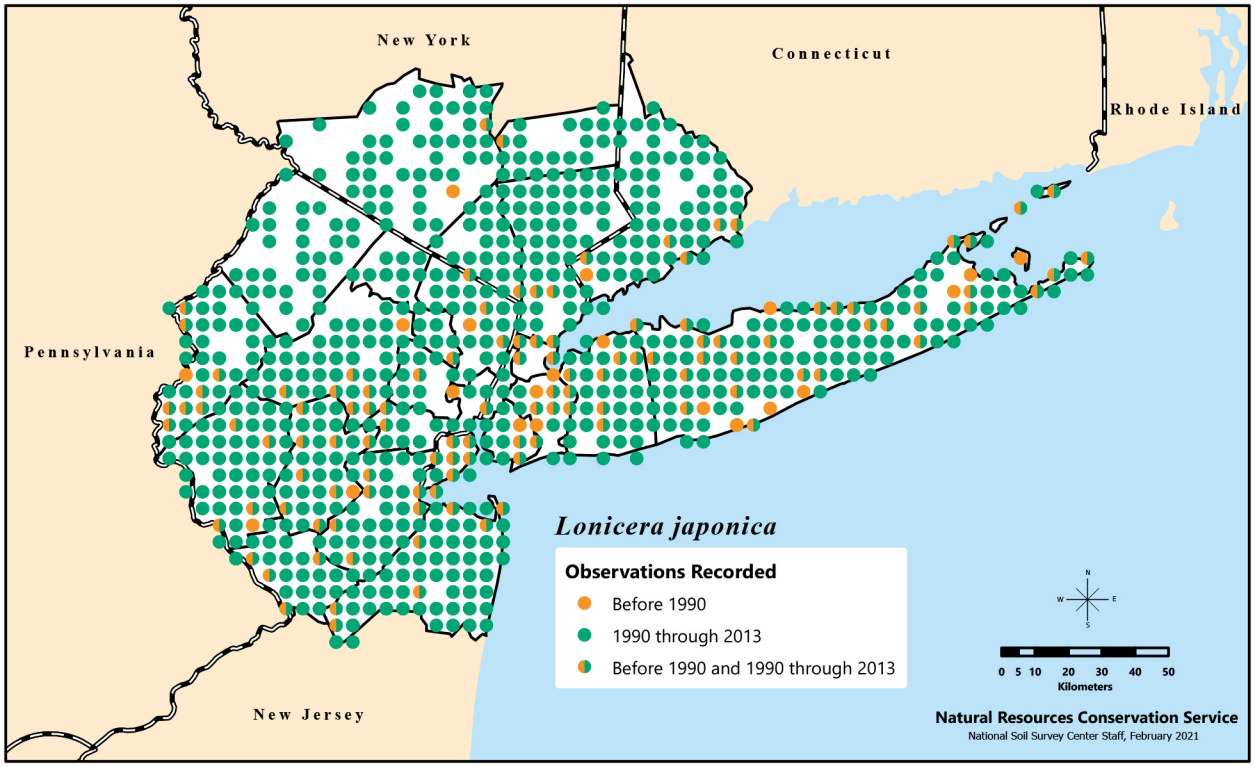
Distribution of *Lonicera fragrantissima*, called sweet breath of spring or fragrant honeysuckle, recorded in the New York Metropolitan Region during three time categories.

pests and pathogens, may explain why it is not invasive in the region despite having the same extended growing season, fast growth, high germination rates, and relatively broad distribution and environmental preferences as other invasive species of honeysuckle (Dirr 1988). However, it has been documented at several new locations, and it could become more firmly established in the region with a warming climate.

5. *Lonicera japonica* Thunb. – Japanese honeysuckle ↑↑↑

Twining vine. Flowering late May–mid-July. Dry to wet situations in sun or shade, including woods, thickets, fields, fence rows, swamps, roadsides, and urban woodlots. Some material has glabrous, purplish leaves and twigs and reddish flowers with more deeply divided lips and, if recognized, would be referable to *Lonicera japonica* var. *chinensis* (P.W.Wats.) Baker.

A vine native to eastern Asia and first introduced into the U.S. on Long Island in 1806 (Leatherman 1955). At least 6 cultivars, varying in leaf and flower color (Dirr 1998). Remains somewhat popular in cultivation because of its rapid growth and fragrant flowers, the fragrance coming from the nectar-bearing glandular hairs in the flowers (Roberts 1979). Flowers tend to open at dusk, receiving visits from both diurnal bees (e.g., *Adena* spp.) and nocturnal hawk moths (family Sphingidae) (Miyake and Yahara 1998). This species has pollinator-limited fruit production (it is an obligate outcrosser; Larson et al. 2002) and low seed viability (Haywood 1994). Thus, much of its spread may be due to its rapid and efficient vegetative growth (Larson 2000). Can grow in a wide variety of soil, moisture, and light conditions. Able to photosynthesize through much of the winter, allowing it to survive in areas with low-light summer conditions (Nuzzo 1997). Tolerance and rapid growth make it an invasive species throughout much of its nonnative range. However, north of the region, the species becomes much less frequent and less invasive, possibly because of its preference for warmer climates. Despite its black fruit, birds are an important dispersal vector in addition to several mammals (Dyess et al. 1994).



Distribution of *Lonicera japonica*, or Japanese honeysuckle, recorded in the New York Metropolitan Region during three time categories.

Fruit poisonous if taken in large quantities, causing vomiting, diarrhea, rapid heartbeat, and even respiratory failure and coma (Schierenbeck 2010). However, the nectar is edible; children commonly consume it without problems (Carolinas Poison Center, n.d.).

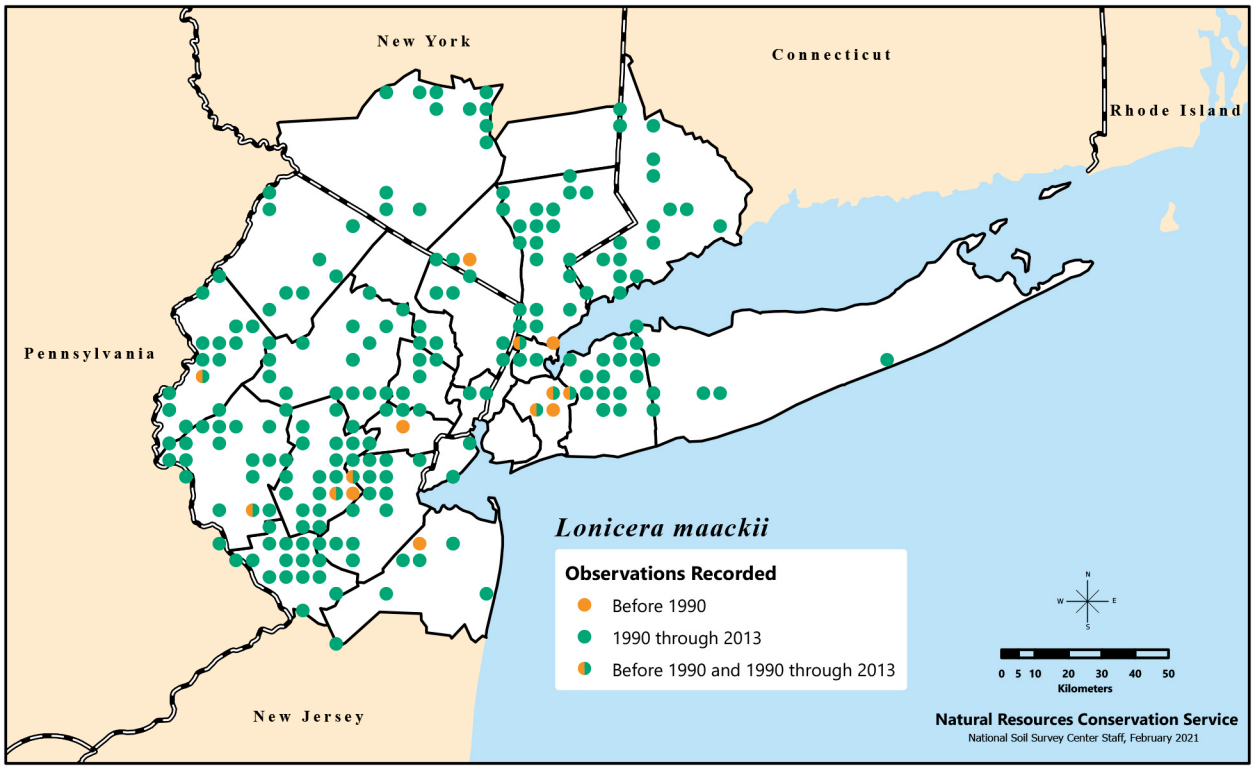
Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

6. *Lonicera maackii* (Rupr.) Herder – Amur honeysuckle ↑↑↑

Xylosteon maackii Rupr.

Shrub. Flowering early May–early June. Mesic forests, thickets, fields, and roadsides. Native to northern China, Japan, and Korea. Epithet honors Estonian plant explorer Richard Maack (1825–1886), who first collected the species in Siberia in the Amur River valley.

Height at maturity 5 m (Dubois and Blazich 2008). Introduced into cultivation in the U.S. ca. 1860 and into northeastern North America ca. 1898. The first record of its escape from cultivation was in the mid-1920s from Chicago, IL; by the 1950s numerous naturalized populations in the Northeast were known (Luken and Thieret 1997). The species tolerates broad conditions with respect to temperature, light, moisture, and soils. Fruit dispersed by mammals (including white-tailed deer [*Odocoileus virginianus*]) and birds (Castellano and Gorchov 2013, Ingold and Craycraft 1983, Williams et al. 1992) but does not appear to be a preferred food source (White and Stiles 1992, Williams et al. 1992), possibly because of relatively low lipid content. There are notable differences in cultivars, including differences in seed stratification requirements (USDA NRCS 2019) that may lead to variations in response to different environments and possible management techniques. Allelopathy negatively affects fungal mutualisms (Cipollini et al. 2008). Less susceptible to frosts, and thus has a 2- to 3-week longer growing season (McEwan et



Distribution of *Lonicera maackii*, or Amur honeysuckle, recorded in the New York Metropolitan Region during three time categories.

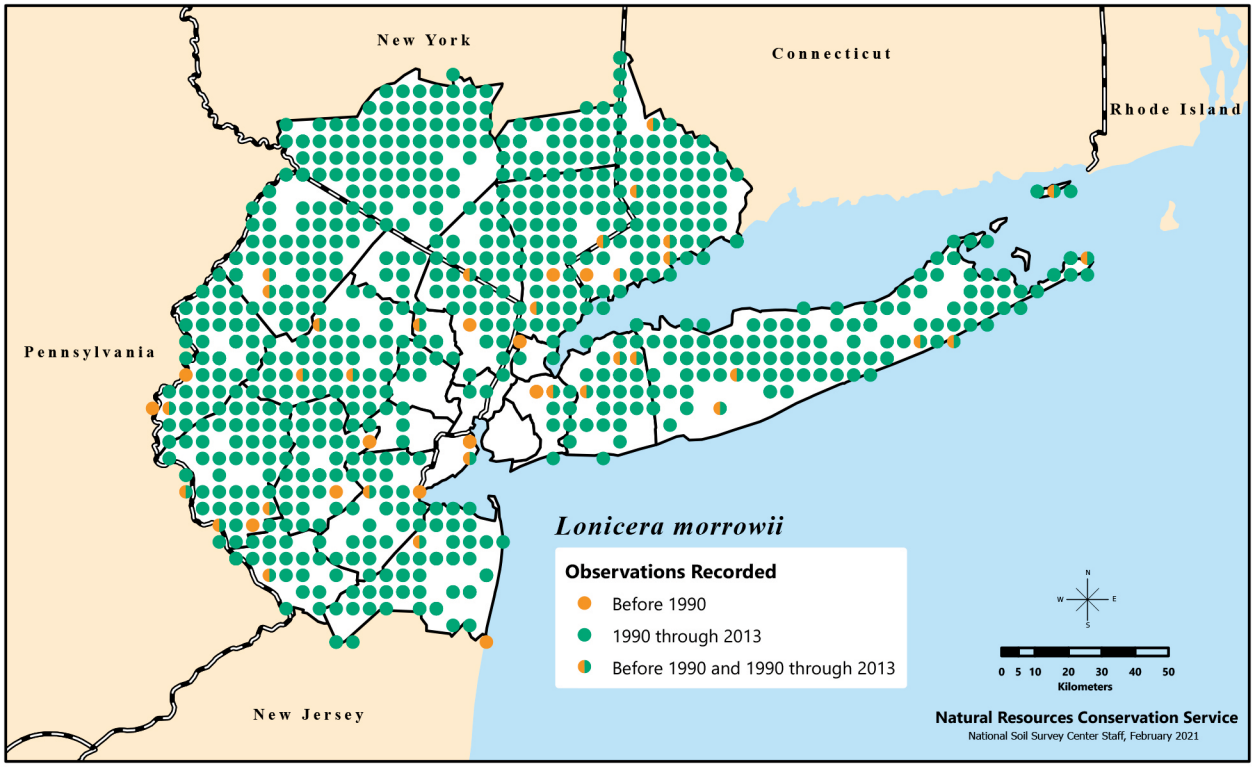
al. 2009) than other plant species. In removal efforts, native species diversity benefits if dead *L. maackii* stems (from herbicide basal application) are left behind; the stems apparently deter deer herbivory of the native species (Cipollini et al. 2009). Higher germination rates in areas where litter is removed than in areas where there is leaf litter (Bartuszevige et al. 2007). Seed banks unlikely, especially where leaf litter is removed, due to the high germination rate (Luken and Goessling 1995). Thus, removing leaf litter increases germination rates of seeds but reduces the likelihood of the establishment of a seed bank. (Luken et al. 1995). Its leaf litter decomposes rapidly and four times faster than *Acer saccharum* leaves. Nitrogen from *L. maackii* litter is also released at a faster rate than nitrogen from native plant leaf litter (Trammell et al. 2012).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as potentially invasive in NJ (category 2).

7. *Lonicera morrowii* A.Gray – Morrow's honeysuckle ↑↑↑

Shrub. Flowering late Apr.–early June. Dry to wet situations in sun or shade, including woods, thickets, fields, roadsides, and swamps. Like *Lonicera maackii*, *L. morrowii* tolerates broad conditions of light, moisture, and soils. Epithet honors species' discoverer, agriculturist James Morrow (1820–1865), who was on Commodore Matthew Perry's expedition to Japan.

Height at maturity 3 m. Though much of our material keys readily to *L. morrowii*, other material is intermediate (e.g., pubescence density, peduncle length, flower color) between *L. morrowii* and *L. tatarica*. Such material keys to the hybrid between these two species, *L.* ×*bella* Zabel. However, some traits in *L.* ×*bella*, including leaf length, bract length, and corolla length, can be larger than either parent, suggesting hybrid vigor (Barnes and Cottam 1974). While *L.* ×*bella* is commonly



Distribution of *Lonicera morrowii*, or Morrow's honeysuckle, recorded in the New York Metropolitan Region during three time categories.

found in the region growing with *L. morrowii*, the other reputed parent, *L. tatarica*, is largely absent from the region. Thus, material of *L.* ×*bella* in the region today is unlikely to represent recent hybridization between the two purported parents. Further study is needed to clarify the taxonomic and hybrid status of our material that currently is called *L.* ×*bella*. The "Flora of China" (Yang et al. 2011) treats *L. morrowii* and *L. tatarica* as varieties, *L. tatarica* var. *morrowii* (A.Gray) Q.E.Yang and *L. tatarica* L. var. *tatarica*.

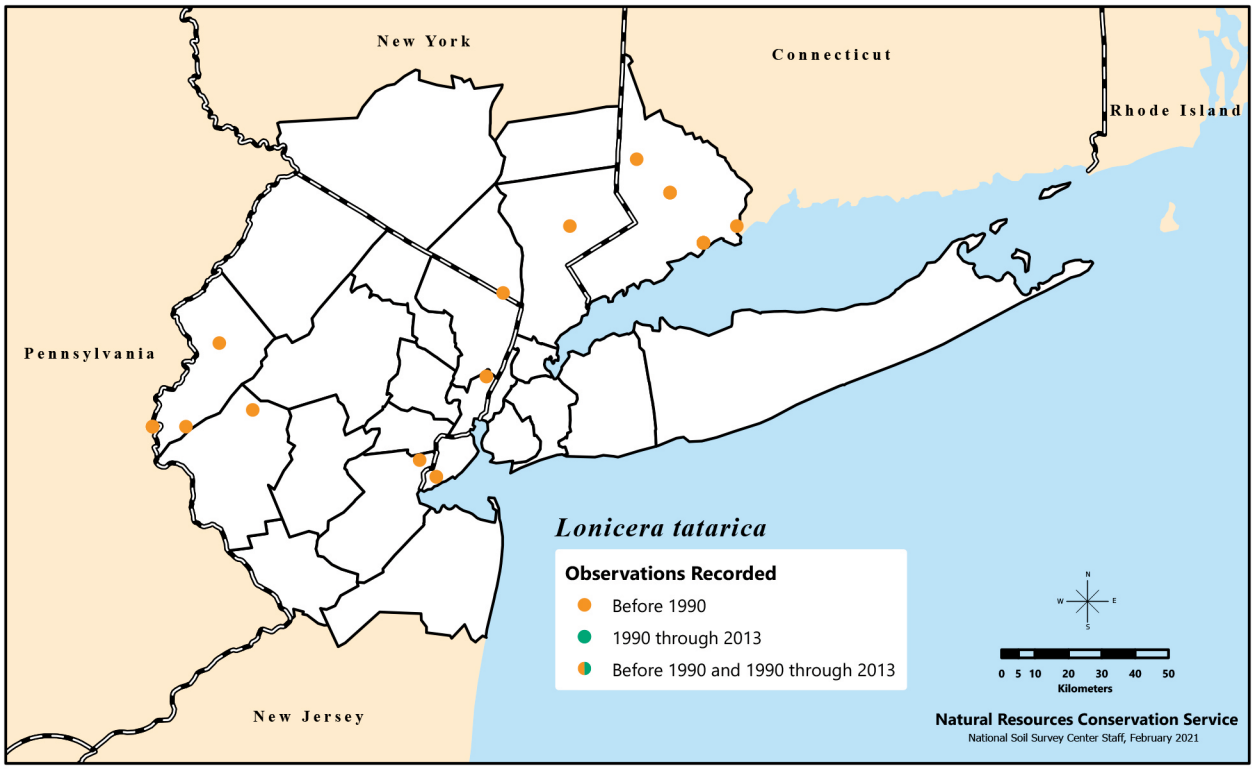
Native to Japan and introduced in the U.S. around 1875. Described as an early successional, pioneer species in its native Japan (Ahulu et al. 2005). Though both *L. maackii* and *L. morrowii* were introduced into the region in the late 1800s, *L. morrowii* became established as an escape much earlier, appearing in earlier regional flora manuals (e.g., Fernald 1950).

Fruit of *L. morrowii* is high in sugar but low in lipids (like *L. maackii*). Nonetheless, cedar waxwings (*Bombycilla cedrorum*) show a documented preference for the high-sugar fruit of *L. morrowii*. The relatively low protein requirements and high intake rate of this bird species explain this association (Witmer and Van Soest 1998). Cedar waxwings feeding on *L. morrowii* fruit develop orange-tipped feathers (Witmer 1996). Susceptible to honeysuckle aphids (Herman and Davidson 1997).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

8. *Lonicera tatarica* L. – Tartarian honeysuckle ↓↓↓

Shrub. Flowering Apr.–June. Distinguished from the other bush honeysuckles (*Lonicera canadensis*, *L. maackii*, *L. morrowii*, *L. xylosteum*) on the basis of its glabrous leaves, long peduncles (1.5–2.5 cm), and pink to red corollas that do not become yellowish with age. It is most closely related to *L. morrowii*, with which it has been reported to hybridize (see discussion under *L. morrowii*).



Distribution of *Lonicera tatarica*, or Tartarian honeysuckle, recorded in the New York Metropolitan Region during three time categories.

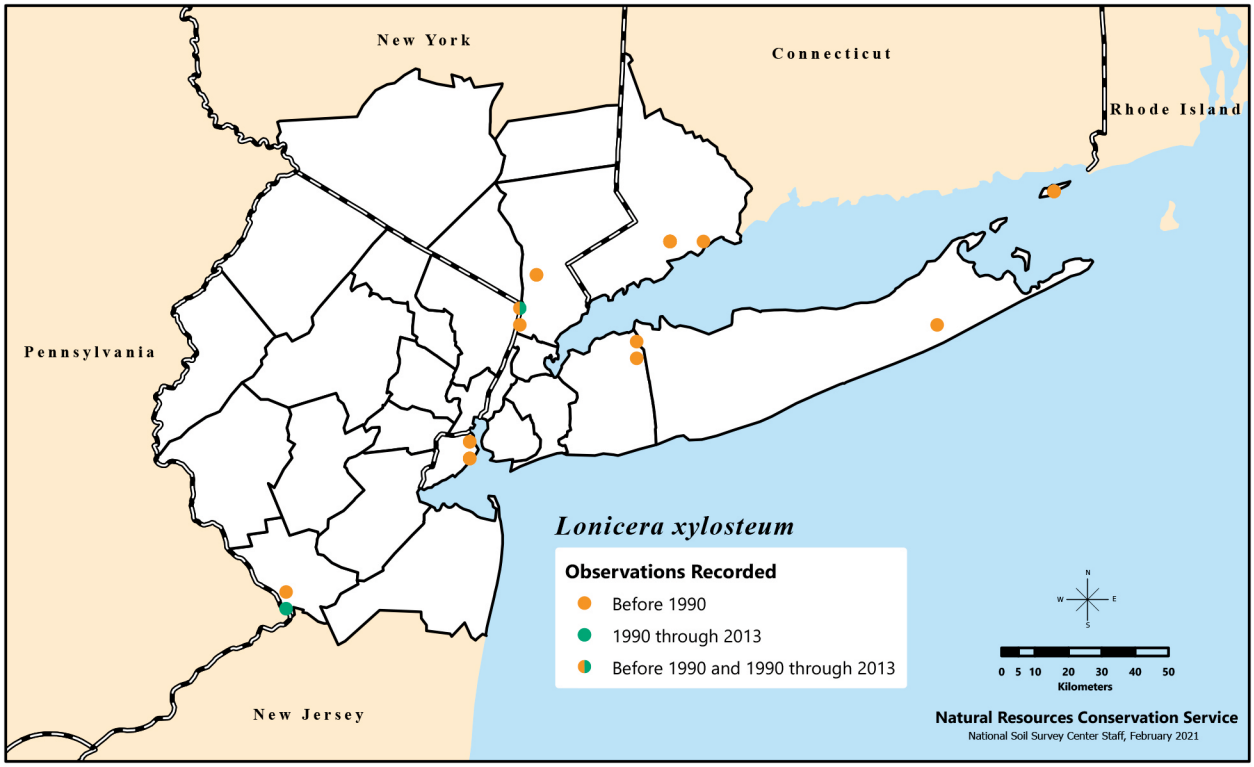
Though most regional floras (e.g., Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1993) attribute this species to the region, recent field research has not located any current populations. Furthermore, herbarium research has shown many earlier records of *L. tatarica* to be based on specimens of *L. morrowii* or *L.* ×*bella*, the latter two taxa not appearing (or only incidentally mentioned) with *L. tatarica* in earlier floras (e.g., Britton 1889, Britton and Brown 1913). Many or most of the remaining historical records may represent material that was persistent from cultivation rather than true escapes. Furthermore, based on its native and nonnative ranges, *L. tatarica* prefers cooler climates, but its distribution is wide (Dirr 1988). Thus, like many native species with similar preferences (e.g., *L. canadensis*, *L. dioica*), the species' range could be contracting northward away from the region. This species, like *L. morrowii* and their hybrid, is somewhat susceptible to honeysuckle aphids (Herman and Davidson 1997).

Listed as potentially invasive in CT (prohibited) and invasive in NY (prohibited).

9. *Lonicera xylosteum* L. – European fly honeysuckle ↓↓↓

Shrub. Flowering May. Epithet is an old name for bonewood.

Height at maturity 3 m (Dubois and Blazich 2008). Distinguished from the other bush honeysuckles (*Lonicera canadensis*, *L. maackii*, *L. morrowii*, *L. tatarica*) on the basis of its pubescent leaves (especially abaxial surface), broadly ovate to obovate or orbicular, blades only slightly longer than wide (length-to-width ratio: 1.15–1.41), long peduncles (1.5–2.5 cm), and small flowers with white to yellow corollas. Long cultivated, with at least 5 cultivars (Dirr 1998). There are few current known records for the species in the region. Many or most of the remaining historical records may represent material that was persistent from cultivation rather than true escapes. Furthermore,



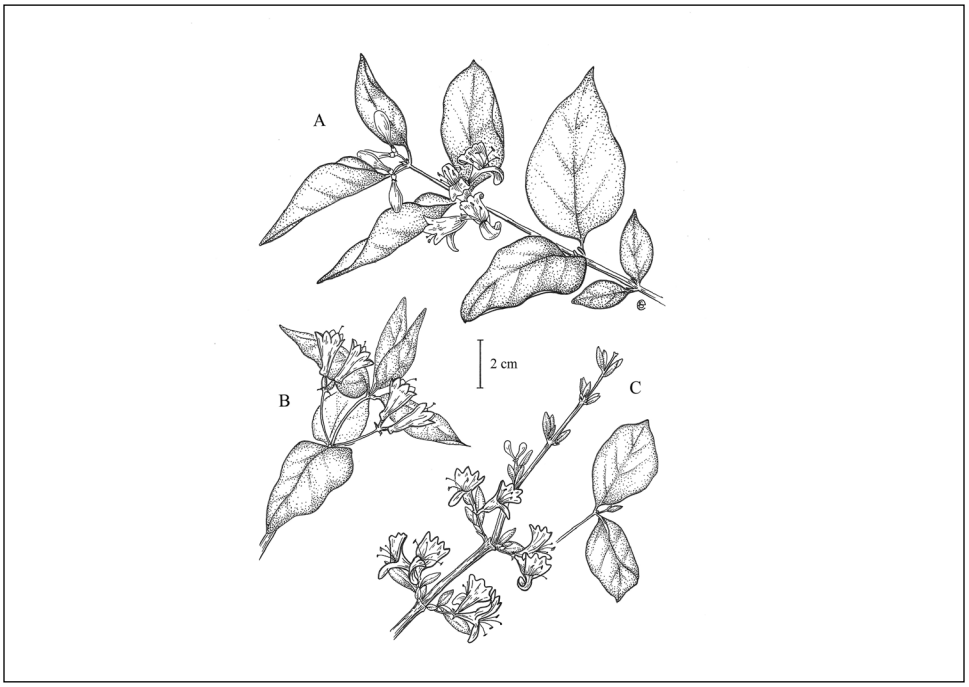
Distribution of *Lonicera xylosteum*, or European fly honeysuckle, recorded in the New York Metropolitan Region during three time categories.

based on its native and nonnative ranges, *L. xylosteum* prefers cooler climates (Dirr 1988). Thus, like many native species with similar preferences (e.g., *L. canadensis*, *L. dioica*), the species could be contracting northward away from the region. This species shows resistance to honeysuckle aphids (Herman and Davidson 1997).

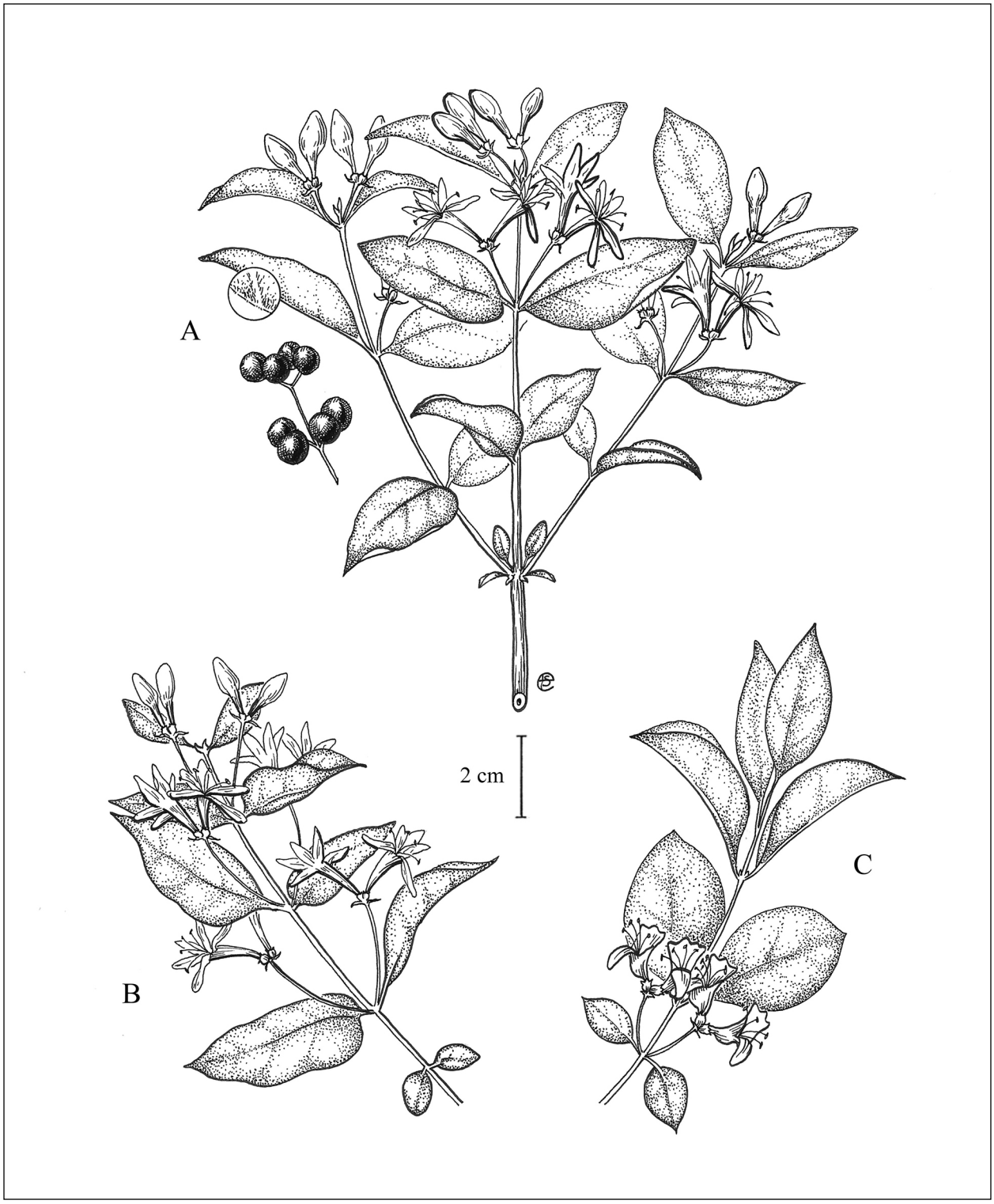
Listed as potentially invasive in CT (prohibited).

Management

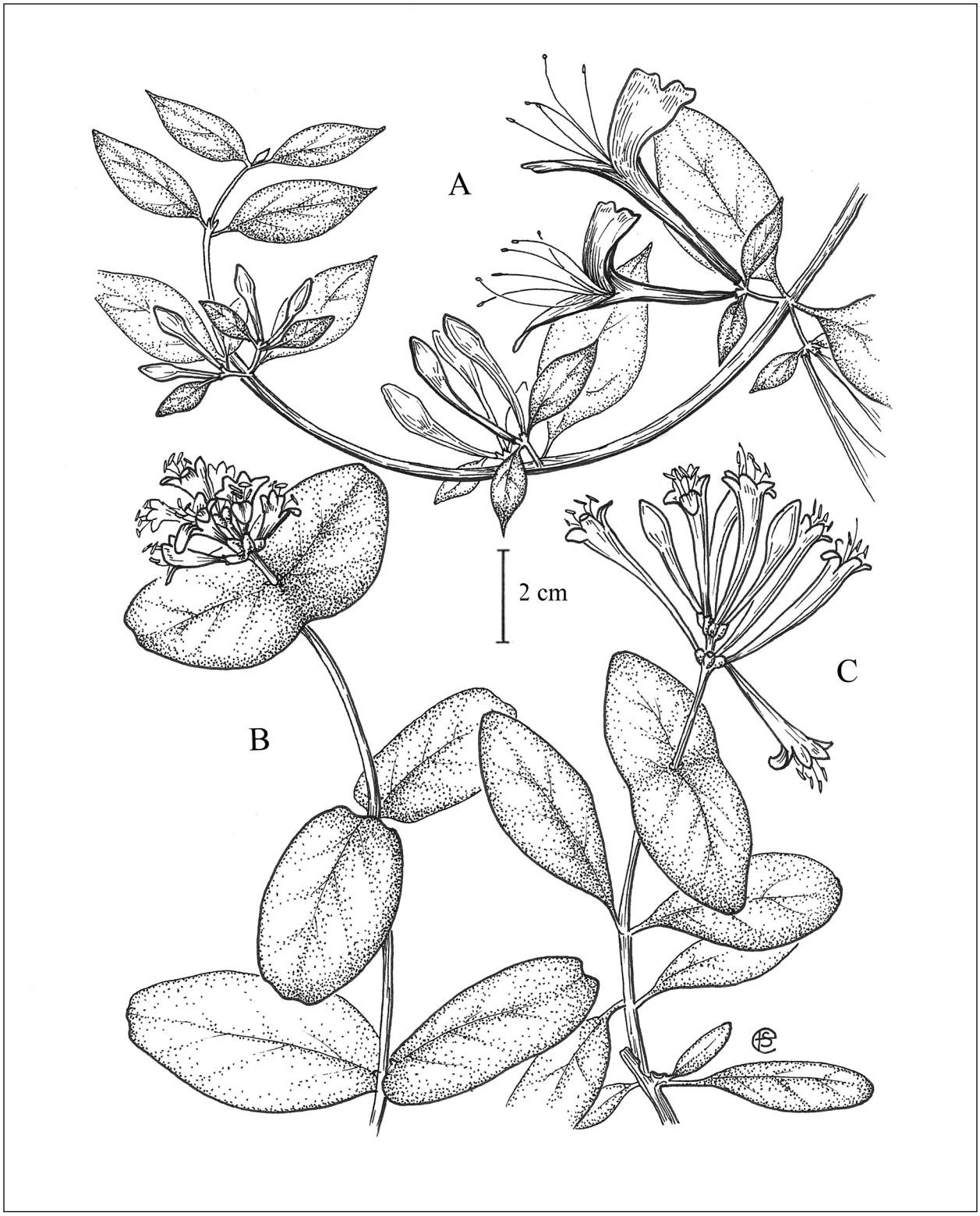
Because all the *Lonicera* spp. seeds are bird dispersed, any control and restoration efforts should attempt to achieve a *Lonicera*-free buffer of about 500 m between the treated area and any seed sources. Cedar waxwings, which may be among the dominant dispersers of these species, have relatively short gut retention times, which may mean the distance from seed sources could be shorter (Levey and Karasov 1994). However, dispersal by deer and other mammals may suggest that a wider area will need to be monitored. It may also be safe to assume that all these species, like *L. maackii*, have some level of allelopathy, and removal of the species will not remove remnant allelopathic chemicals (at least not initially). Management that does not disturb existing leaf litter or mulch, such that bare ground is not exposed, may help reduce successful germination and survival of new seedlings (Bartuszevige et al. 2007), but may allow the development of a seed bank. Many removals have resulted in increases in native species fitness (reproduction and survival; Miller and Gorchov 2004) as well as increases in native species diversity (especially over longer time periods; Hartman and McCarthy 2008). A lack of response in native species to *L. maackii* removal may be attributed to existing deer herbivory pressure (Cipollini et al. 2009). Leaving dead stems behind appears to alleviate this problem in one study, which could be an added benefit to basal bark application as a method of control. Successful removal of this species when young is possible by pulling or digging it out of the ground with most of its roots. Older shrubs may require cutting the main stem at ground level and immediately applying a herbicide. Cutting without herbicide treatment is not advised because stem sprouts are possible. Though individuals are not prolific sprouters and not clonal, the production of the new stem sprouts will reduce progress in attempts to control growth and seed production of this genus, unless stems can be cut frequently. If nontarget species are not a concern, foliar application of herbicide can also be effective.



Flowering leafy twig of A) *Lonicera maackii* and B) *Lonicera canadensis*; C) flowering twig (flowers before the leaves) and leaves of *Lonicera fragrantissima*. Illustration by Emma Skurnick.



A) Fruit and flowering leafy twig and enlarged view of pubescent leaf underside of *Lonicera morrowii*; flowering leafy twig of B) *Lonicera tatarica* and C) *Lonicera xylosteum*. Illustration by Emma Skurnick.



Flowering leafy twig of A) *Lonicera japonica*, B) *Lonicera dioica*, and C) *Lonicera sempervirens*. Illustration by Emma Skurnick.

Lycium L. – matrimony vine

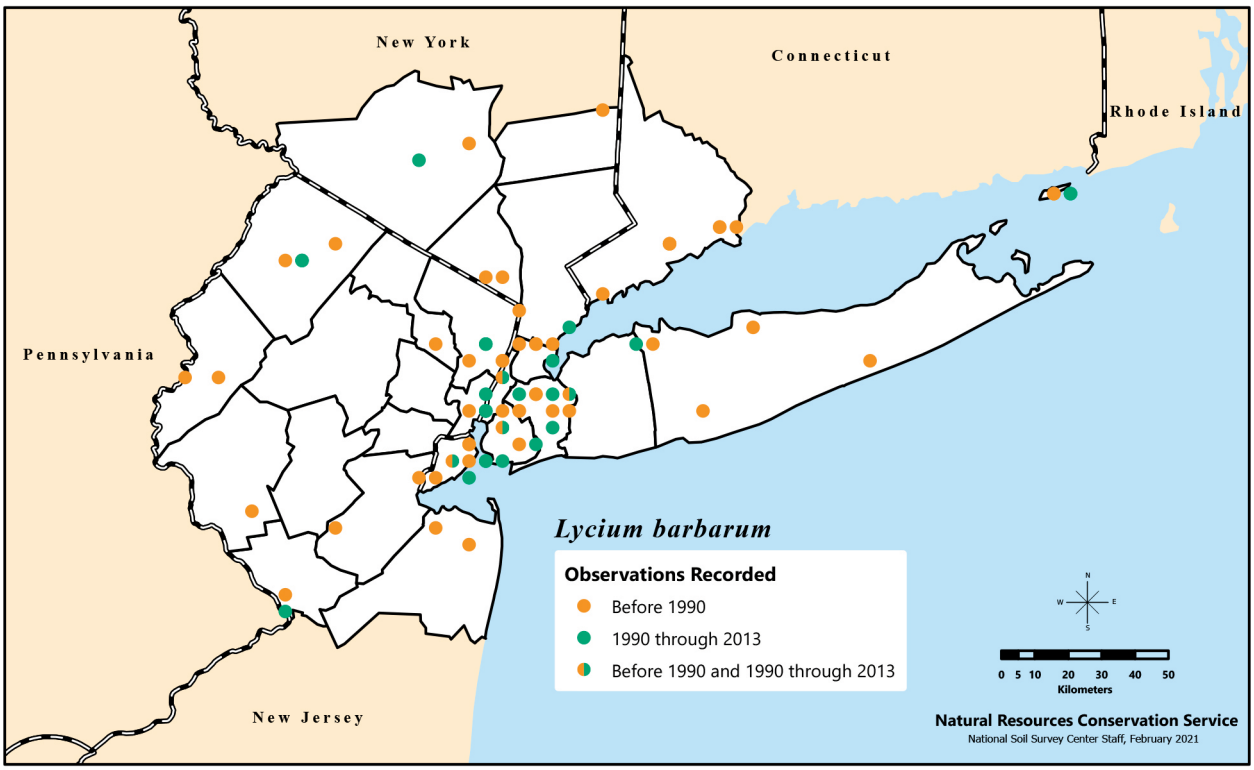
Solanaceae. Shrubs, often spiny. Species about 80 in southern Africa, Asia, Australia, Europe, North America, and South America. Genus name is derived from the Greek "lycion," the name of a prickly shrub growing in Lycia (now part of Turkey).

Nonnative Species

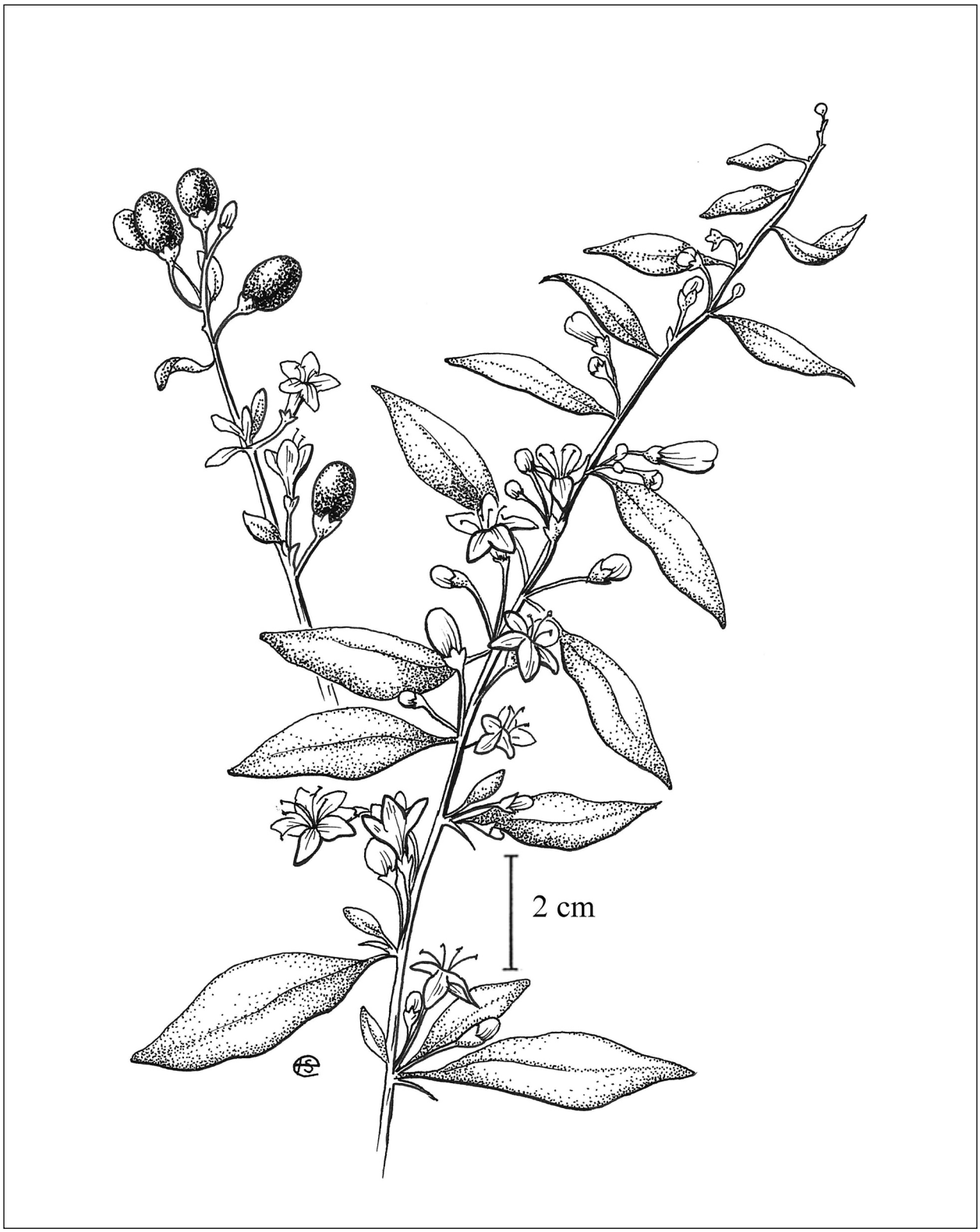
1. *Lycium barbarum* L. – matrimony vine ↓

Lycium halimifolium Mill.

Flowering June–Sept.; fruiting Aug.–Oct. Roadsides and other disturbed areas. Native to Asia and southeastern Europe. Horticultural plant that appears to be losing popularity in the region.



Distribution of *Lycium barbarum*, or matrimony vine, recorded in the New York Metropolitan Region during three time categories.



Fruiting and flowering twig and flowering leafy twig of *Lycium barbarum*. Illustration by Emma Skurnick.

Lyonia Nutt. – maleberry, staggerbush

Ericaceae. Shrubs, rarely small trees. Species 35–36 in Asia, North America, and the West Indies. Flowers pollinated by bees (family Hymenoptera). Grayanotoxin, named for American botanist Asa Gray (1810–1888) and also called andromedotoxin, present (at least in *Lyonia mariana*); this neurotoxin is known to cause livestock poisoning (causing animals to "stagger"), and honey produced from the pollen of plants can be toxic. Genus name honors Scottish-born botanist John Lyon (1765–1814), early explorer of the southern Appalachian Mountains. Occasionally planted for ornament. The leaves of the two species described contain andromedotoxin and are known to cause livestock poisoning.

Native Species

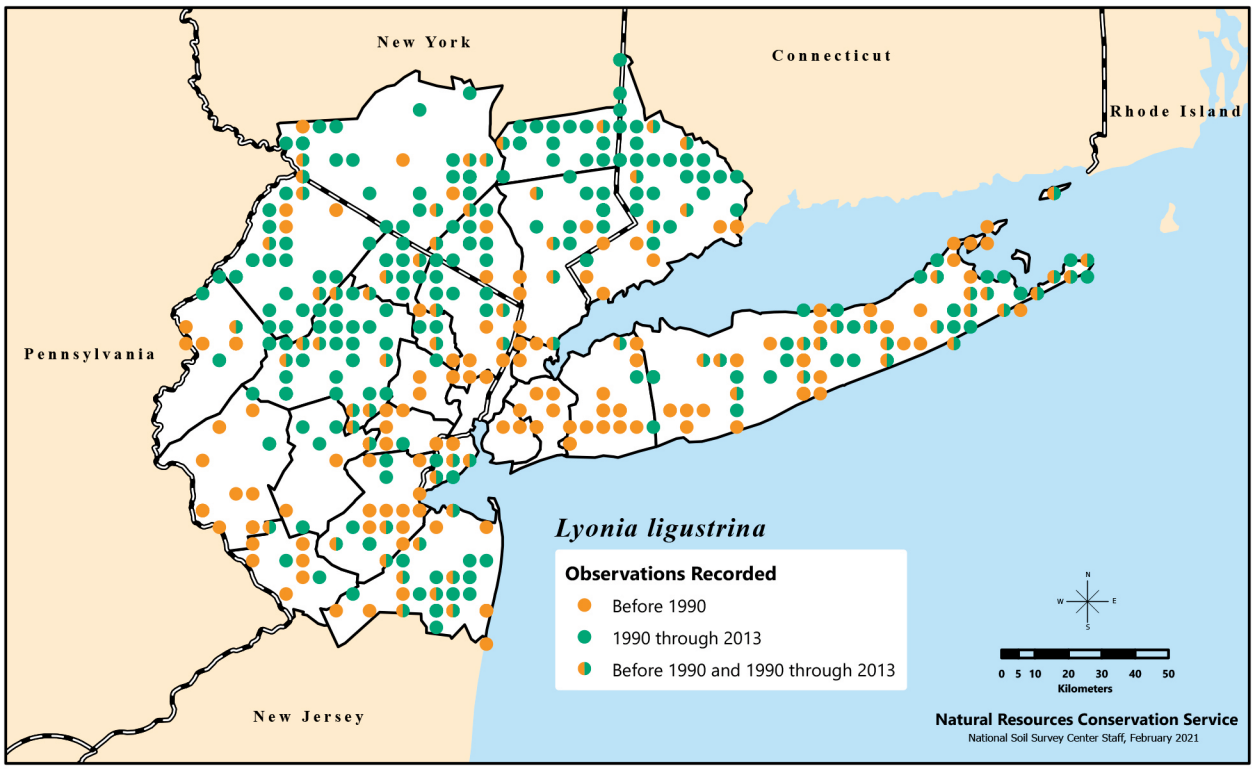
1. *Lyonia ligustrina* (L.) DC. – maleberry, he-huckleberry, male-blueberry ↔

Vaccinium ligustrinum L.

Flowering May–July. Dry to mesic woodlands, woodland edges, and watersides. Epithet from

Lyonia Key

1. Leaf margins serrulate; inflorescences umbellate-racemose; flowers and capsules ovoid-cylindric, 3–5 mm long . . . . . ***Lyonia ligustrina***
1. Leaf margins entire; inflorescences paniculate; flowers and capsules urceolate-globose, 7–13 mm long . . . . . ***Lyonia mariana***



Distribution of *Lyonia ligustrina*, variously called maleberry, he-huckleberry, or male-blueberry, recorded in the New York Metropolitan Region during three time categories.

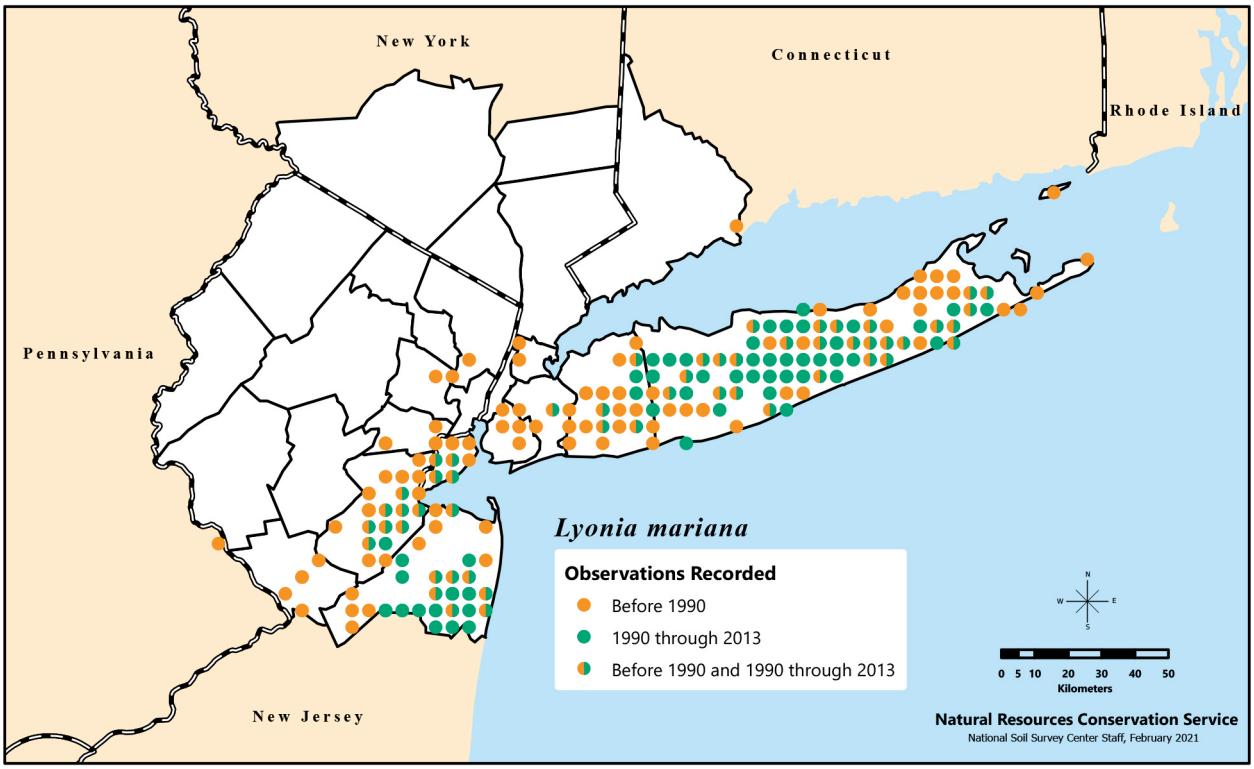
Latin refers to the superficial similarity with privet (*Ligustrum*). Local material is referable to *Lyonia ligustrina* var. *ligustrina*. Increases may be due to reforestation. The unusual common names are the result of the species' original placement in a genus (*Vaccinium*) that included fleshy edible fruits (e.g., cranberries, blueberries); the inedible dry fruited species were apparently taken as male.

2. *Lyonia mariana* (L.) D.Don – staggerbush ↔

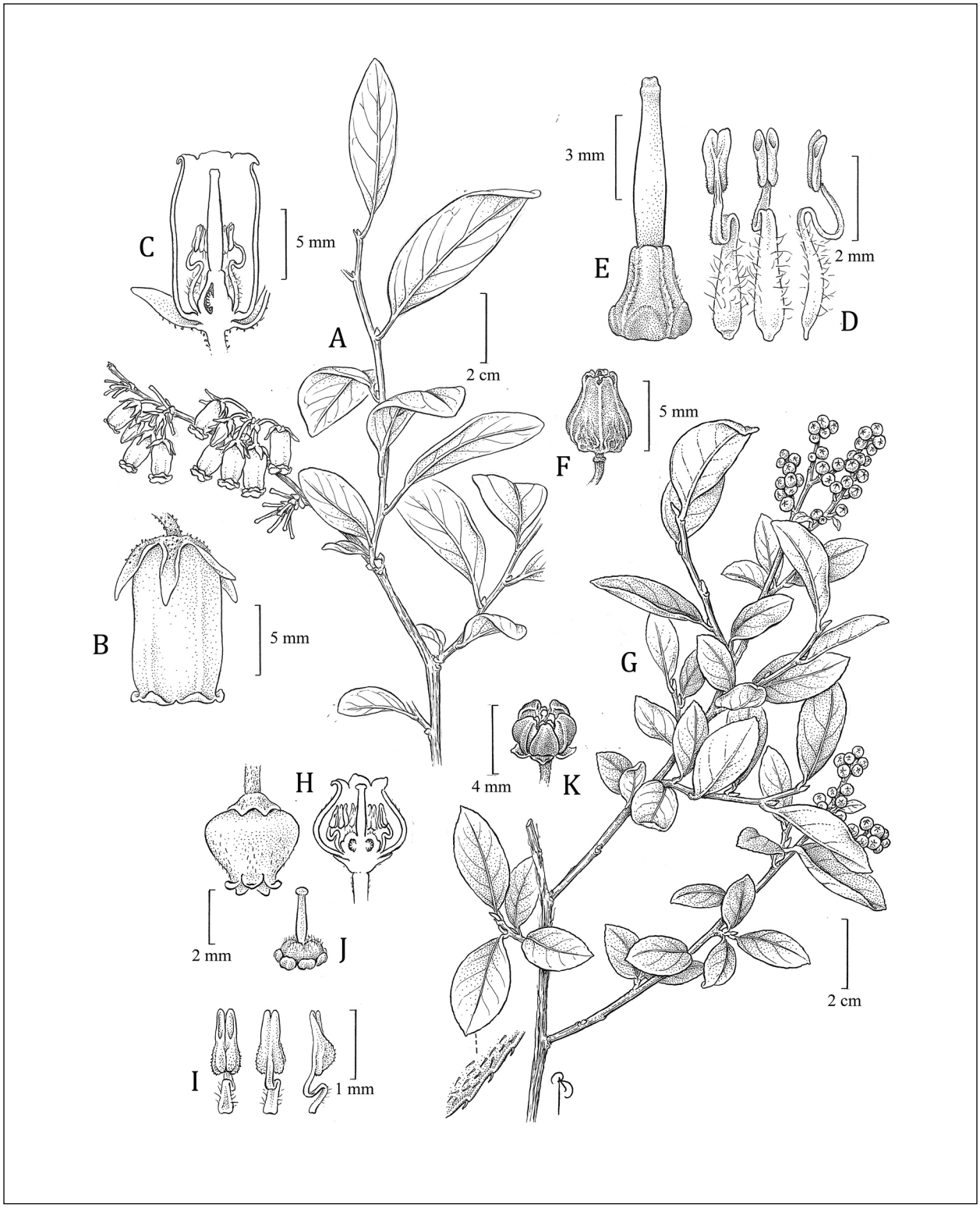
Andromeda mariana L.

Flowering mid-Apr.–July. Dry to mesic woodlands and woodland edges; sandy or peaty open pinelands. Epithet is a reference to Maryland. Unlike *Lyonia ligustrina*, *L. mariana* is primarily restricted to the Coastal Plain. Flowers can sometimes be produced in mass, some floriferous shoots being largely leafless. Increases may be due to reforestation or more open pineland habitat. The common name is due to its being poisonous.

Listed as a species of special concern in CT (SH).



Distribution of *Lyonia mariana*, or staggerbush, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig, B) flower, C) cross-section of pistil, D) stamens, E) pistil, and F) fruit of *Lyonia mariana*; G) fruiting leafy twig, with enlarged view of leaf margin and partial underside, H) flower and cross-section, I) stamens, J) pistil, and K) separating fruit (capsule) of *Lyonia ligustrina*. Illustration by Bobbi Angell.

Maclura Nutt. – Osage-orange, hedge apple

Cudrania Trécul.

Moraceae. Spiny trees. Species 11–12 in Africa, Asia, Australia, North America, Pacific Islands, and South America. Readily distinguished by large globose fruit, the product of all of the flowers of an inflorescence (a syncarp or multiple fruit). Fruit may have been eaten by Pleistocene megafauna. Dioecious; wind pollinated. Sometimes planted for wood or as a living fencerow. Formerly treated as a monospecific genus (only *Maclura pomifera*); now includes species previously placed in *Cudrania* Trécul. Genus name honors American geologist William Maclure (1763–1840).

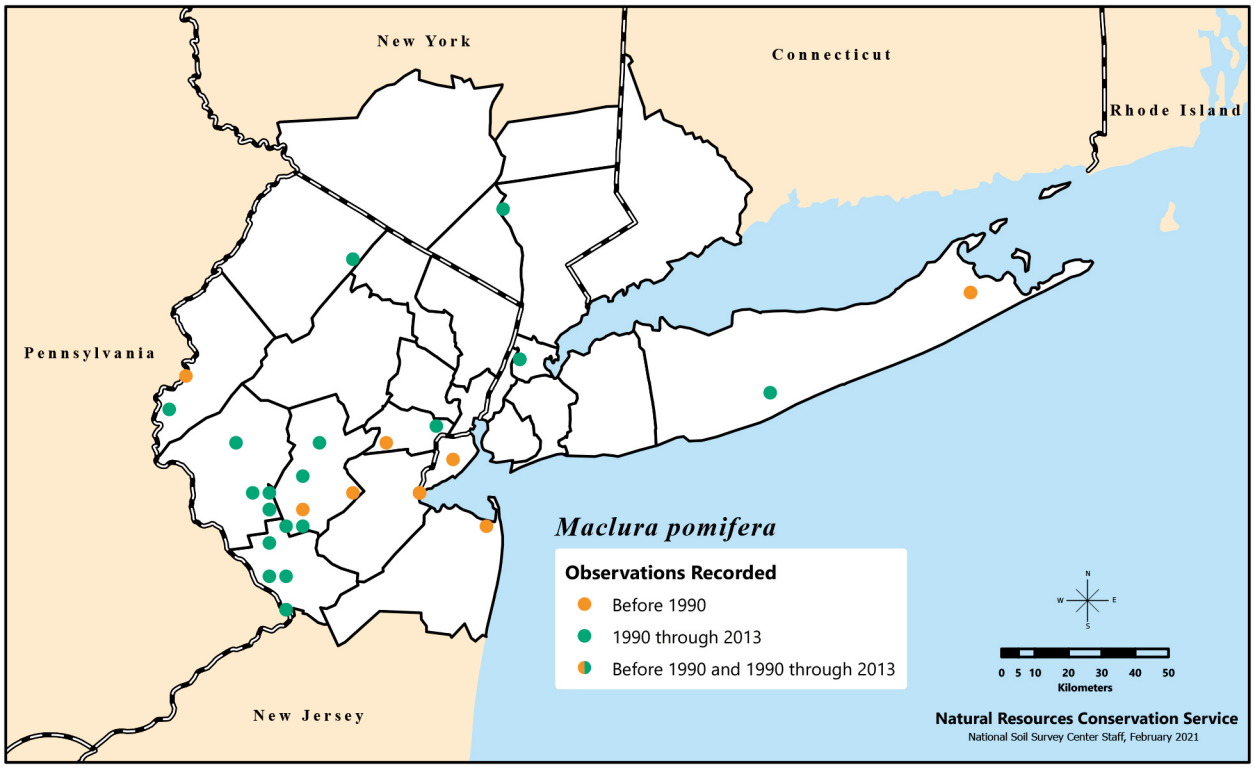
Nonnative Species

1. *Maclura pomifera* (Raf.) Schneid. – Osage-orange ↑

Ioxylon pomiferum Raf.

Flowering late May–June; fruiting Sept.–Oct. Remnant from cultivation or escape in woodlands, edges of woodlands, fields.

Thrives in poor conditions and, once established, can withstand wetness, dryness, wind, extreme heat, and both high and low pH conditions. Prefers full sun and does not tolerate the shade well (Dirr 1998, Smith and Perino 1981). Originates from AR, OK, and TX but was planted throughout the U.S. (Dirr 1998) as a living fence from 1850 to 1875. The extent of its natural range is uncertain (Smith and Perino 1981).



Distribution of *Maclura pomifera*, or Osage-orange, recorded in the New York Metropolitan Region during three time categories.

Earliest fruit-bearing age 10 years (Smith and Perino 1981). Each fruit contains 200–300 seeds (Smith and Perino 1981). Fresh seeds from rotted fruit are not likely to be dormant and require no pretreatment for germination (Bonner 2008i). Stored seeds may require being soaked (imbibing) overnight (Engstrom and Stoeckeler 1941). Cultivated since 1818, with at least 15 cultivars. Few, if any, diseases or insects affect this species. Has a rapid rate of growth, growing 2.7–3.7 m in 3–5 years (Dirr 1998).

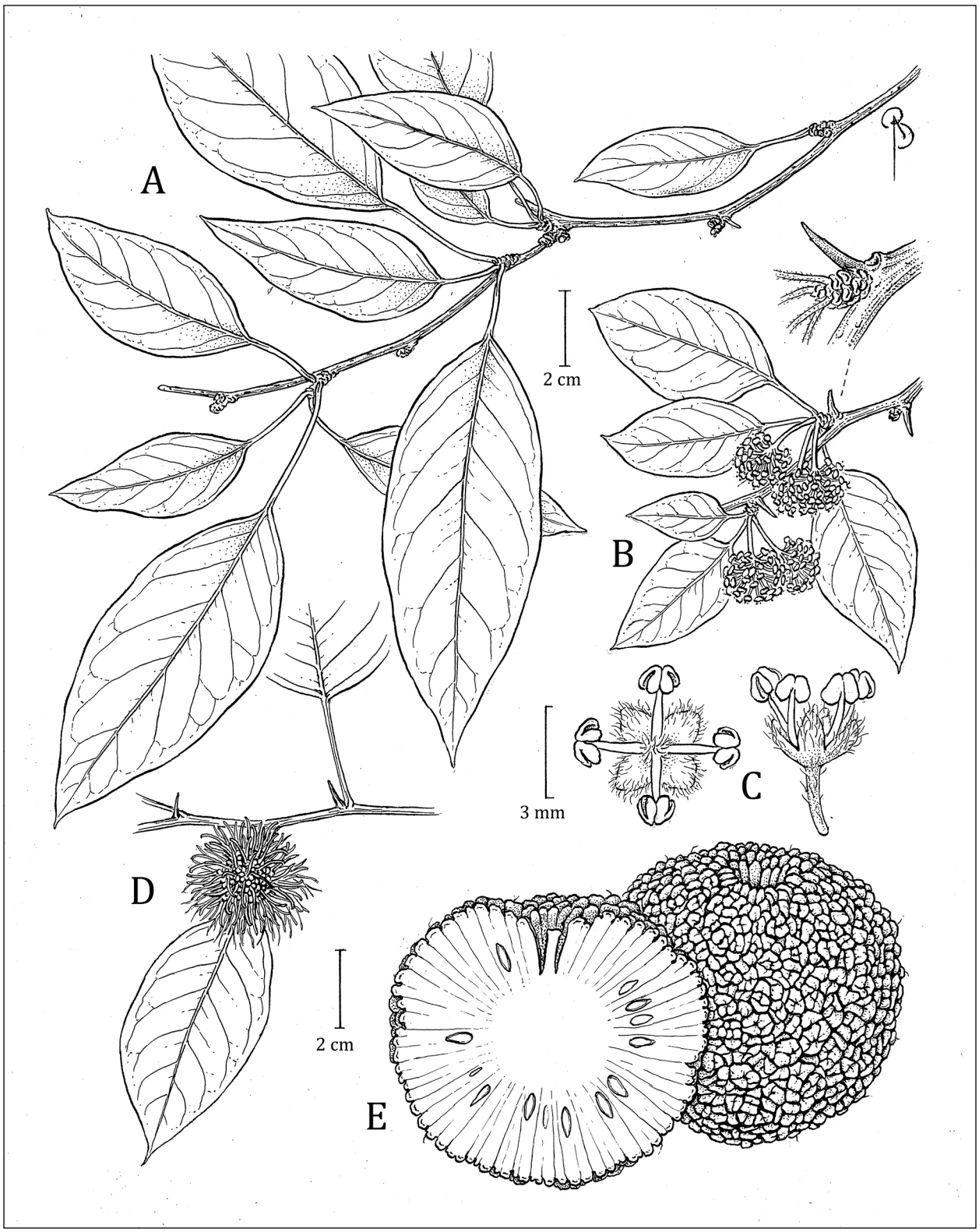
The large globose fruit is composed of connate (grown-together) carpels that have grown and ripened collectively though they come from multiple flowers; this fruit can be messy. Several thornless male cultivars are used as urban street trees. Squirrels (family Sciuridae) eat the seeds. *Maclura pomifera* hybridizes with *M. tricuspidata* (Dirr 1998, Smith and Perino 1981). Branches growing in full sun have the largest thorns; those growing in shade have smaller thorns or are missing thorns. A fairly long-lived tree, reaching 175 years and possibly older. Roots are diffuse and can cover large areas with extensive spread, especially in shallow soils. Branches may be highly twisted because they are competing for light and, consequently, tree may be less attractive as a landscape plant (Smith and Perino 1981).

This species is not a component of any forest, but instead is a pioneer species that invades exposed mineral soils, overgrazed pastures, and abandoned cropland; it can be a dominant species in these habitats. Can also be readily propagated from root suckers and stump sprouts (Smith and Perino 1981). Despite its large seed production and ability to spread vegetatively, it ranks low in terms of its potential invasiveness, mainly because it grows best on poor sites (Burton 1990). Wood is extremely resistant to decay due to an antifungal agent in the heartwood (Barnes and Gerber 1955). Wood is used for fence posts and furniture. A yellow dye can be extracted from the wood. Historically, Native Americans of the Great Plains, including the Osage, made their bows from *M. pomifera* wood (Smith and Perino 1981). The wood is also very strong and is used as railway ties, house blocks, bridge pilings, telephone poles, street paving blocks, mining timbers, parquet flooring, insulator pins, treenails, pulley blocks, and machinery parts (Burton 1973).

Fruit contains a proteolytic enzyme, which can be used in cheese making, meat tenderizing, chill-proofing of beer, skin bating in the leather industry, and shrink-proofing of wool (Hokes et al. 1976). The amount of this enzyme in the fruit is large enough that commercial production developed and may continue to grow. Little support for reports that fruit is poisonous. However, the stickiness of the fruit may be a choking hazard to animals that consume it. Nonetheless, two pigments isolated from the root bark are toxic to goldfish (*Carassius auratus*) and mosquito (family Culicidae) larvae (Smith and Perino 1981). Ripe fruit of this species has been used as an insect repellent, repelling cockroaches (order Blattaria) (Peterson et al. 2002) and other insects (Peterson et al. 2001). Seeds rich in tocopherols; could be used in cosmetic, pharmaceutical, and food products (Saloua et al. 2009). Isoflavones that are major constituents of *M. pomifera* fruit exhibit inhibitory activity of some human tumor cell lines, especially the colon tumor cell line (Son et al. 2007); antioxidant activity (Tsao et al. 2003); and anti-inflammatory and painkilling properties (Kupeli et al. 2006). *Maclura pomifera* is an autotetraploid (Schnabel et al. 1991).

Management

The moderate increase of *Maclura pomifera* in the region may reflect new poor habitats (urban or low-quality abandoned agricultural fields). New occurrences may be due to new plantings of this species, but if so, such plantings are likely to be male trees. Given its limited habitat, spread of this species beyond poor sites is not a concern and, thus, this species requires little management. However, the potential medicinal and insect-repellent applications as well as its high-quality wood could provide enough incentive to grow this species commercially. The ability to use poor-quality or marginal sites may be an additional benefit.



A) Leafy twig, B) leafy twig with male flowering heads with view of node and thorn, C) top and side view of a single male flower, D) female flowering head, and E) fruit and cross-section of fruit of *Maclura pomifera*. Illustration by Bobbi Angell.

Magnolia L. – magnolia

Magnoliaceae. Trees. Species 200+ in Asia, North America, South America, and the West Indies. Some taxonomists (Xia et al. 2008) choose to split up the broadly circumscribed *Magnolia* into several smaller segregate genera: *Alcimandra* Dandy; *Houpoëa* N.H.Xia & C.Y.Wu; *Lirianthe* Spach; *Magnolia* L. s.s.; *Manglietia* Blume; *Michelia* L., *Oyama* (Nakai) N.H.Xia & C.Y.Wu; *Pachylarnax* Dandy; *Parakmeria* Hu & W.C.Cheng; *Talauma* Juss.; *Woonyoungia* Y.W.Law; and *Yulania* Spach. In such a treatment, all the species in the local flora would be retained in *Magnolia*, except the introduced Asian *M. kobus*, which would be placed in *Yulania*. The only native species in the region is *M. virginiana*. Two species native to the South, *M. macrophylla* and *M. tripetala*, have recently become established in the region. Moist cold stratification is generally required for *Magnolia* seed to germinate (Barbour 2008). Genus name honors French botanist Pierre Magnol (1638–1715), professor at the University of Montpellier in France and director of the Royal Botanic Garden of Montpellier.

Native Species

1. *Magnolia virginiana* L. – sweet bay ↔

Flowering late May–early July. Swampy woodlands and wet thickets. The material in the region has deciduous leaves and is usually multi-trunked, and is referable to *Magnolia virginiana* var. *virginiana*. In the southern U.S. there is material with evergreen leaves and single trunks that is sometimes treated as a segregate, *M. virginiana* var. *australis* Sarg (McDaniel 1966, Tobe 1998). Molecular work has suggested that these two may warrant recognition as separate species (Azuma et al. 2011).

Height at maturity 6–7 m. Cultivated since 1688, with at least 22 cultivars. May show chlorosis in alkaline soils (Dirr 1998).

Listed as endangered in NY (S1).

Nonnative Species

2. *Magnolia acuminata* (L.) L. – cucumber magnolia ↔

Magnolia virginiana var. *acuminata* L.

Flowering May–June. Cultivated and occasionally naturalized or adventive in rich upland woods and woodland edges. Though native to western NY, it is not considered native to the NY Metropolitan Region; none of the early floras (e.g., Britton 1881, 1889; Graves 1910; Peck 1897; Taylor 1915) records the species from the region. Epithet from Latin refers to the species' acuminate leaves.

Height at maturity about 25 m. Cultivated since 1736, with at least 37 cultivars (Dirr 1998).

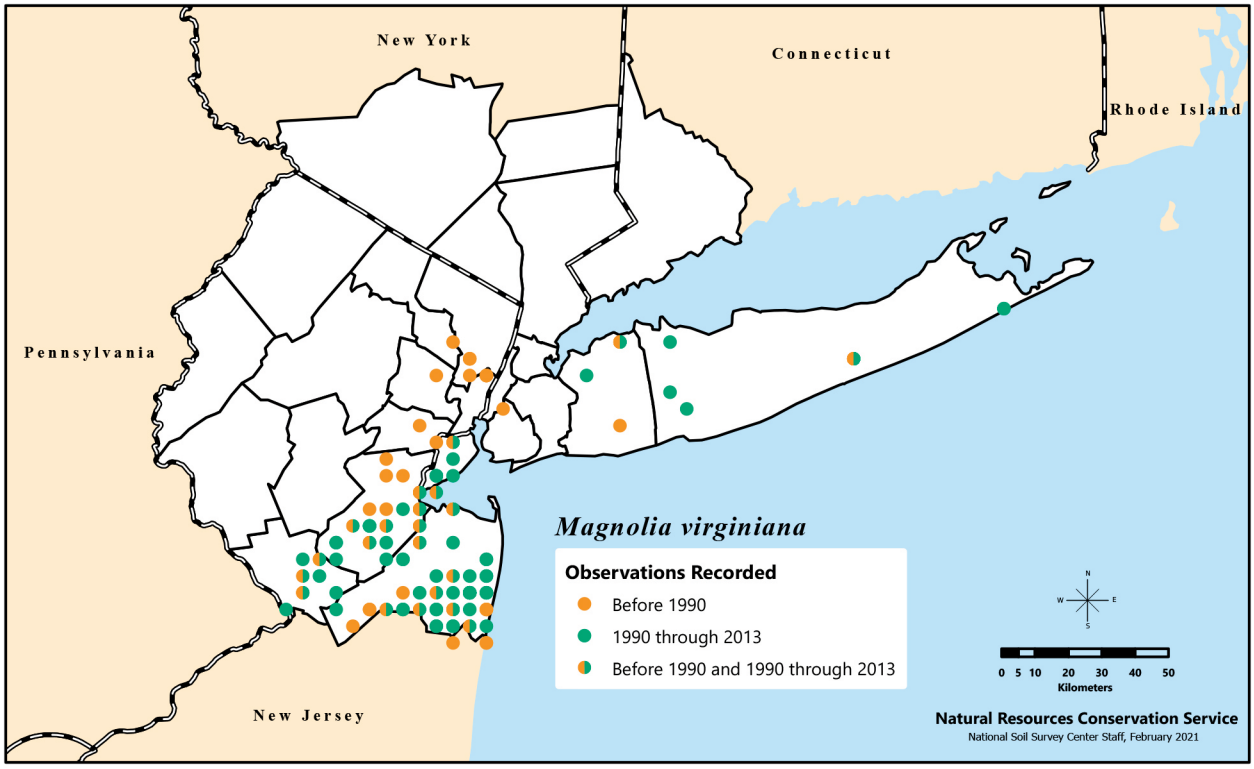
3. *Magnolia kobus* DC. – Kobus magnolia Ø

Yulania kobus (DC) Spach; *Magnolia praecocissima* Koidz.

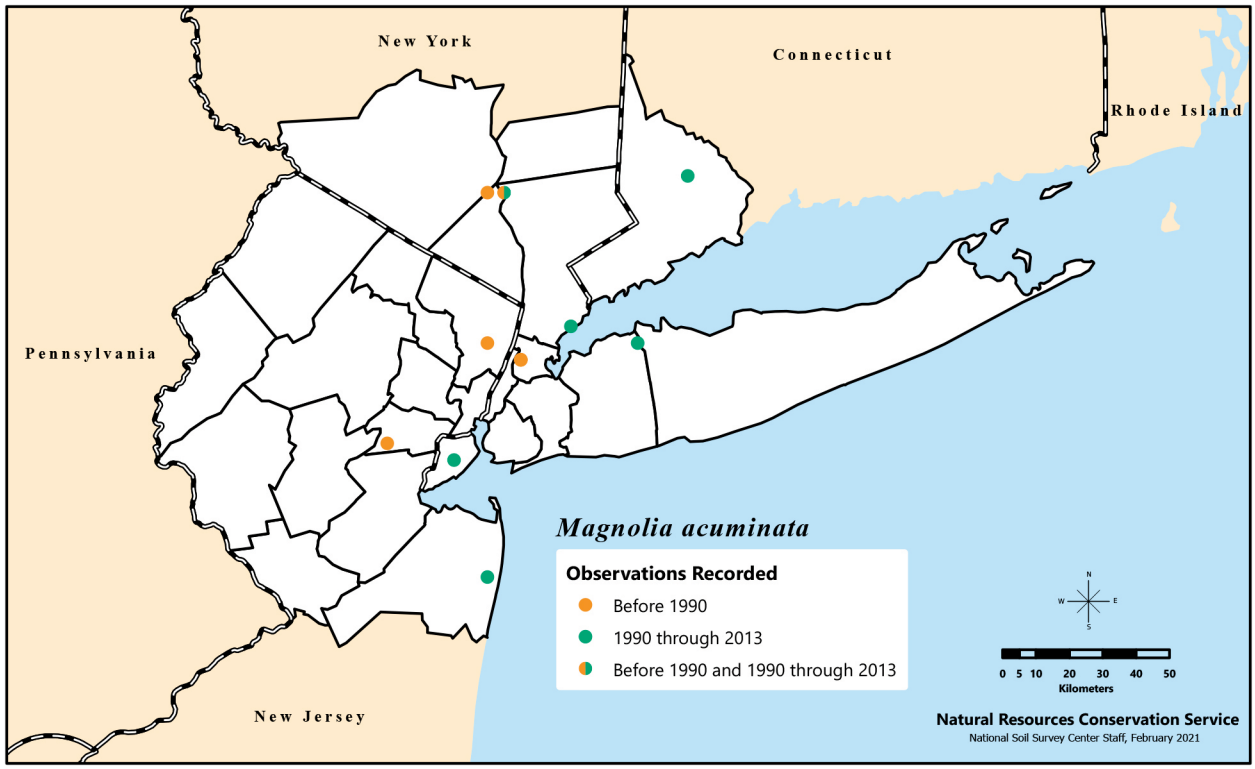
Flowering late Mar.–Apr. Native to Japan. Occasionally cultivated and rarely naturalized

Magnolia Key

1. Flowers appearing before the leaves . . . . . ***Magnolia kobus****
1. Flowers appearing with or after the leaves 2
2. Leaves green beneath 3
2. Leaves glaucous beneath 4
3. Leaves widest near or below the middle, scattered along the twig; winter terminal buds hairy . . . . . ***Magnolia acuminata****
3. Leaves widest well above the middle, in terminal whorl-like clusters; winter terminal buds glabrous . . . . . ***Magnolia tripetala****
4. Leaves acute to broadly rounded at base . . . . . ***Magnolia virginiana***
4. Leaves distinctly cordate at base . . . . . ***Magnolia macrophylla****



Distribution of *Magnolia virginiana*, or sweet bay, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Somerset County (NJ) and Queens County (NY).



Distribution of *Magnolia acuminata*, or cucumber magnolia, recorded in the New York Metropolitan Region during three time categories.

in disturbed open woods; recent reports of naturalizing populations from Bergen County (NJ) and Nassau County (NY).

Height at maturity about 13 m. Introduced in 1865, with at least 4 cultivars (Dirr 1998).

4. *Magnolia macrophylla* Michx. – large-leaved cucumber-tree Ø

Flowering May–June. Native to the southern U.S. Cultivated and occasionally naturalized or adventive in rich upland woods and woodland edges; recent reports of naturalizing populations from Nassau and Suffolk Counties (NY). Epithet from Latin refers to the species' large leaves, which can approach 90 cm.

Height at maturity about 13 m. Cultivated since 1800, with at least 2 cultivars (Dirr 1998).

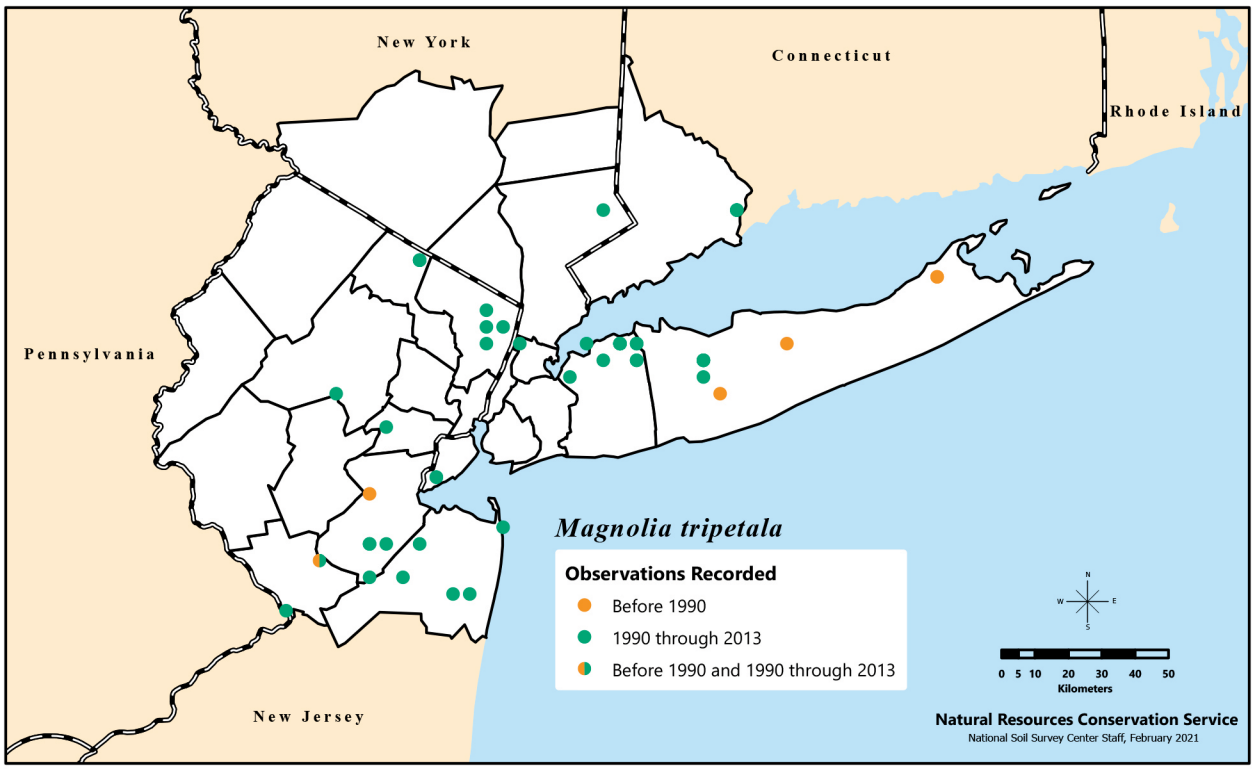
5. *Magnolia tripetala* (L.) L. – umbrella magnolia ↑↑↑

Magnolia virginiana var. *tripetala* L.

Flowering late May–June. Native to the southern U.S. Cultivated and occasionally naturalized or adventive in woods and woodland edges.

Height at maturity about 10 m. Cultivated since 1752, with at least 3 cultivars. Hybridizes naturally with *Magnolia virginiana*, forming *M.* ×*thompsoniana* (Loud.) Vos. This hybrid is a shrub-tree with vigorous growth but poor shape and is, thus, unlikely to be a popular landscape plant (Dirr 1998).

Tracked as potentially invasive in NJ (category 2).



Distribution of *Magnolia tripetala*, or umbrella magnolia, recorded in the New York Metropolitan Region during three time categories.



Flowering leafy twig and fruit of *Magnolia tripetala*. Illustration by Emma Skurnick.

Malus Mill. – apple

Rosaceae. Trees, shrubs. Species 25–55 in Asia, Europe, and North America; widely cultivated in native range and elsewhere for ornamental flowers (largely bee-pollinated) and edible fruit. Genus sometimes merged with *Pyrus* L. (pears). *Malus* distinguished from *Pyrus* based on sweet-smelling flowers (somewhat fetid smelling in *Pyrus*) and the lack of grit cells in fruit. Genus name is derived from the Latin "malum," meaning "evil," the apple representing temptation and sin in art and literature.

Malus is difficult taxonomically; identification to species often difficult, especially the cultivated and often escaped crabapples. Many hybrids known. The native species in the eastern U.S., *M. angustifolia* (Aiton) Michx. (southeastern U.S. north to southern NJ), *M. coronaria* (L.) Miller, and *M. ioensis* (Alph.Wood) Britton, are in *M.* sect. *Chloromeles* (Decne.) Rehder, and differ from the nonnative species in having anthers pink-purple before dehiscence (as opposed to white or yellow) and the leaf blades on vigorous shoots being lobed (as opposed to unlobed; although vigorous shoots can have lobed leaves in *M. toringo*).

Native Species

1. *Malus coronaria* (L.) Mill. – sweet crabapple ↓↓

Pyrus coronaria L.; *Malus glaucescens* Rehder; *Malus lancifolia* Rehd.

Flowering late Apr.–May; fruiting Aug.–Oct. Edges of woodlands, old fields, and thickets; not common. Some material may represent escapes or remnants from cultivation. Fruit yellow-green, with a very harsh, acid taste. Epithet means "suitable for a wreath" in Latin.

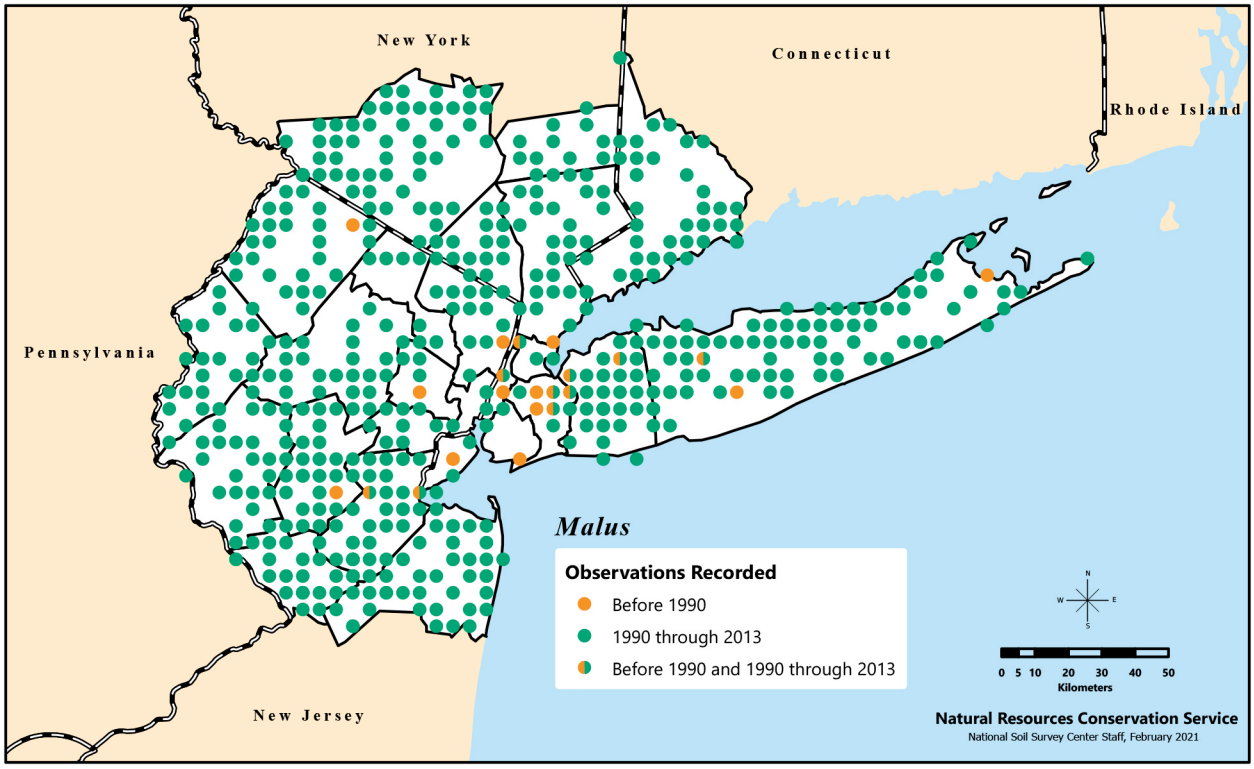
Cultivated since 1724 (Anderson and Crossley 2008). Evidence of hybridization with *Malus domestica* and gene flow from *M. domestica* to *M. coronaria* populations; potential impacts on the native *Malus* should be monitored (Kron and Husband 2009). Cross-compatibility among *Malus* spp. is common, so hybridization with the many nonnative crabapples is also of concern (Dickson 2014).

Nonnative Species

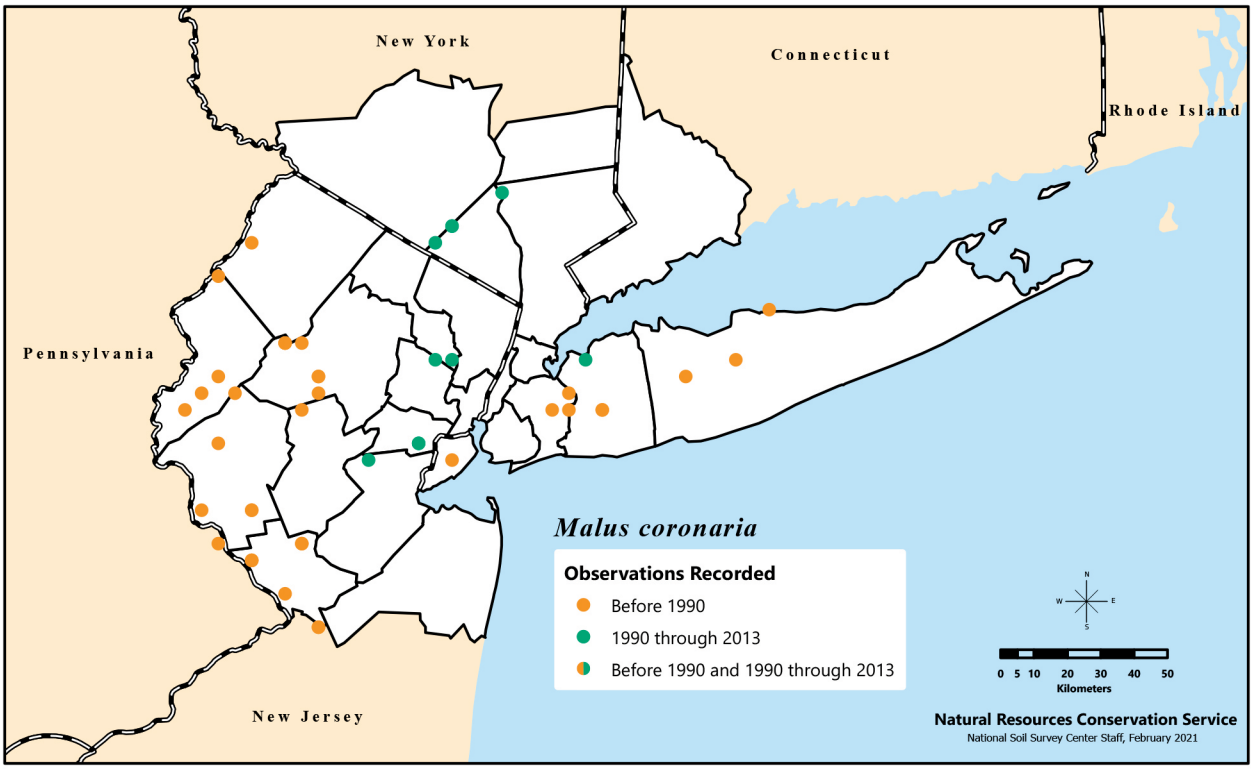
The following information applies to all of the *Malus* spp. listed next. Flowering late Apr.–May; fruiting Aug.–Oct. Edges of woodlands, old fields, thickets, and roadsides. Native to Asia.

Malus Key

1. Leaves unlobed 2
1. Leaves lobed 3
2. Leaves glabrous beneath . . . . . ***Malus pumila****
2. Leaves tomentose beneath 4
3. Leaves irregularly serrate; calyx persistent; anthers pink-purple before dehiscence . . . ***Malus coronaria***
3. Leaves sharply serrate; calyx deciduous; anthers yellow before dehiscence . . . . . ***Malus toringo****
4. Leaves convolute in bud; calyx glabrous. 5
4. Leaves conduplicate or convolute in bud; calyx villous or tomentose 6
5. Calyx deciduous. . . . . ***Malus baccata****
5. Calyx persistent . . . . . ***Malus prunifolia****
6. Leaves convolute in bud, margins crenate-serrate. . . . . ***Malus pumila****
6. Leaves conduplicate in bud, margins sharply serrate 7
7. Leaves folded in bud; calyx pubescent, deciduous . . . . . ***Malus floribunda****
7. Leaves convolute in bud; calyx villous or glabrous, persistent. . . . . ***Malus prunifolia****



Distribution of *Malus*, or apple, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Malus coronaria*, or sweet crabapple, recorded in the New York Metropolitan Region during three time categories.

2. *Malus baccata* (L.) Borkh. – Siberian crabapple ↑↑

Pyrus baccata L.

Fruit red or yellow. Cultivated since 1784 (Anderson and Crossley 2008). Epithet means "berry-like."

3. *Malus floribunda* Siebold ex Van Houtte – Japanese flowering crabapple Ø

Pyrus floribunda G.Kirchn. non Lindley (illegitimate later homonym)

Fruit red or yellow. Cultivated since 1862 (Anderson and Crossley 2008). Reported from Union County (NJ) and Bronx, Nassau, Richmond, and Suffolk Counties (NY); also reported from CT outside the region.

4. *Malus prunifolia* (Willd.) Borkh. – plum-leaved crabapple Ø

Pyrus prunifolia Willd.

The cultivar 'Callaway' is derived from this species. Callaway fruit is reddish maroon and large and persists on the tree for an extended period (Dirr 1998). Reported from Bergen County (NJ) and Bronx, New York, and Suffolk Counties (NY); also reported from CT outside the region.

5. *Malus pumila* Mill. – common apple ↑↑

Malus sylvestris Miller; *Pyrus malus* L.; *Pyrus malus* var. *sylvestris* L.

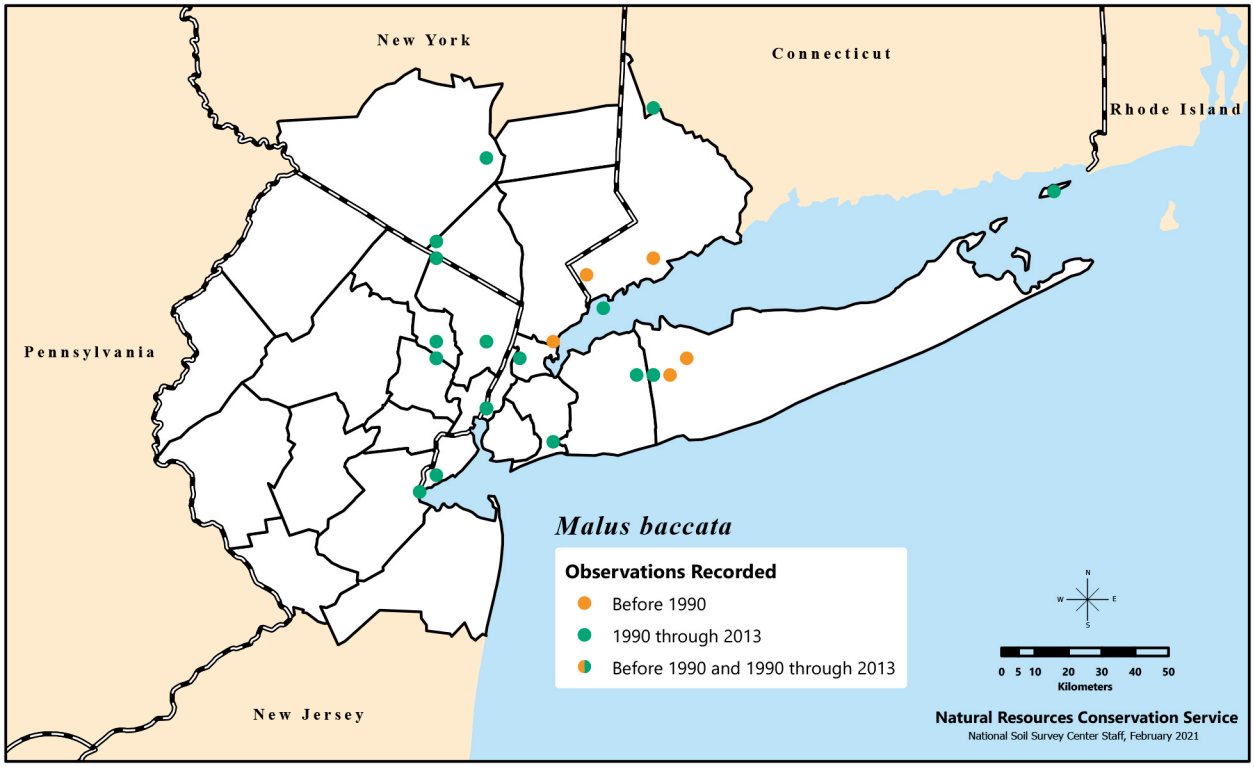
Fruit yellow to red. Cultivated since ancient times (Anderson and Crossley 2008). Ancestor to the orchard apples. Epithet means "dwarf."

6. *Malus toringo* (Seibold) Seibold ex de Vriese – toringo crabapple ↑↑↑

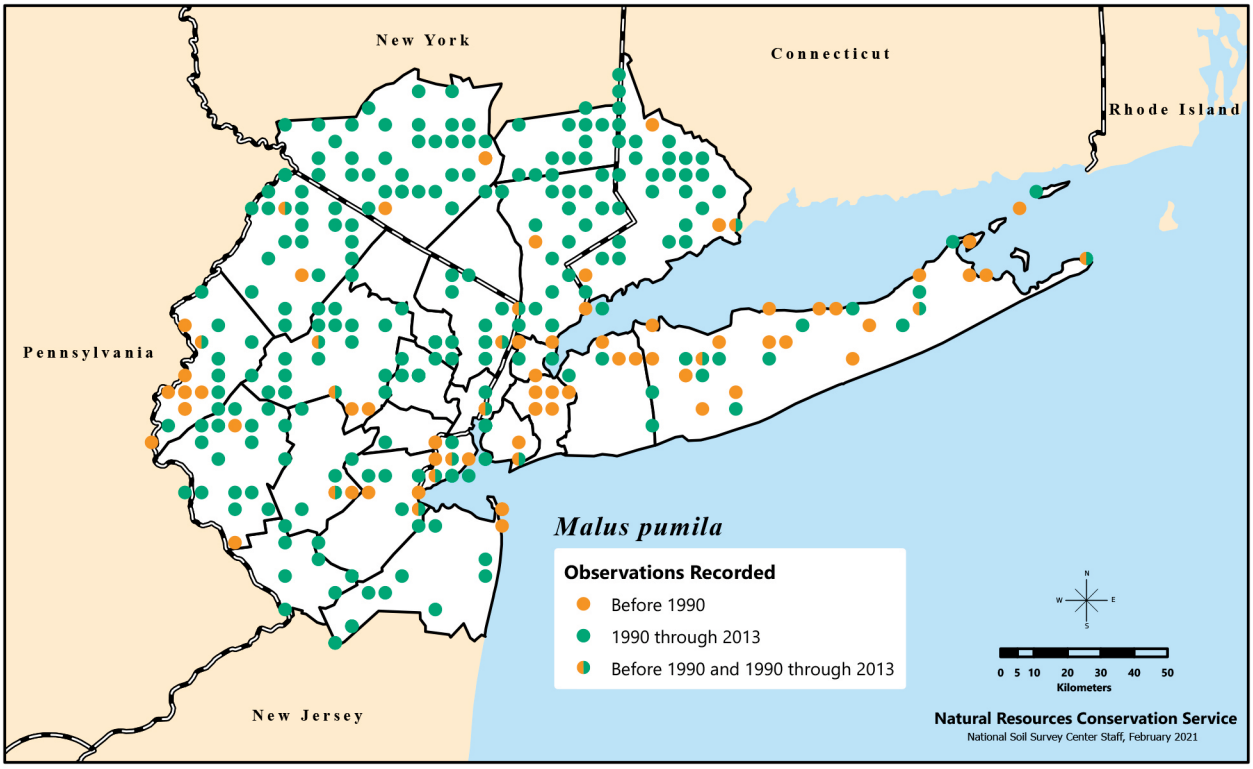
Sorbus toringo Seibold; *Malus seiboldii* Rehder (illegitimate superfluous name); *Pyrus seiboldii* Regel (illegitimate superfluous name); *Pyrus toringo* (Siebold) Miq.

Fruit pear-shaped and yellow-green with russet dots. Leaves light yellow-orange to red in the fall (Dirr 1998). Epithet from Japanese means "Chinese" ("to-") "apple" ("ringo").

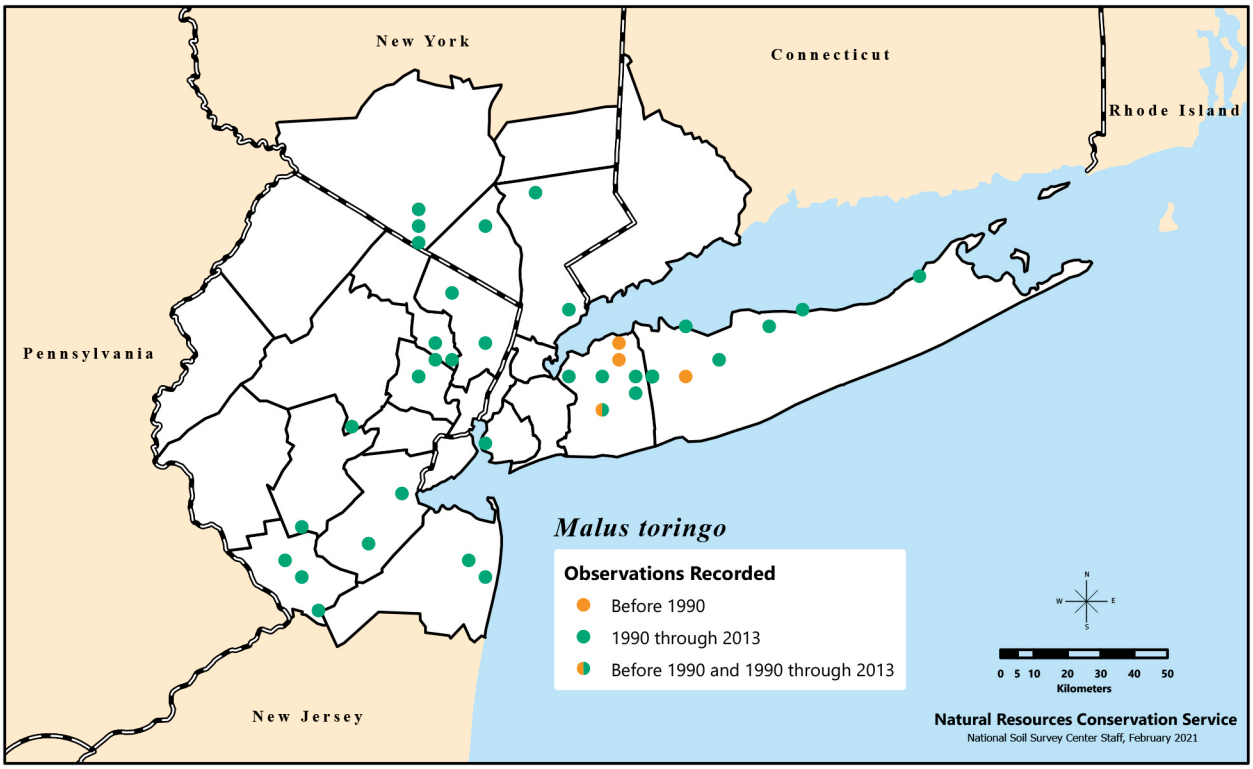
Tracked as potentially invasive in NJ (category 2?).



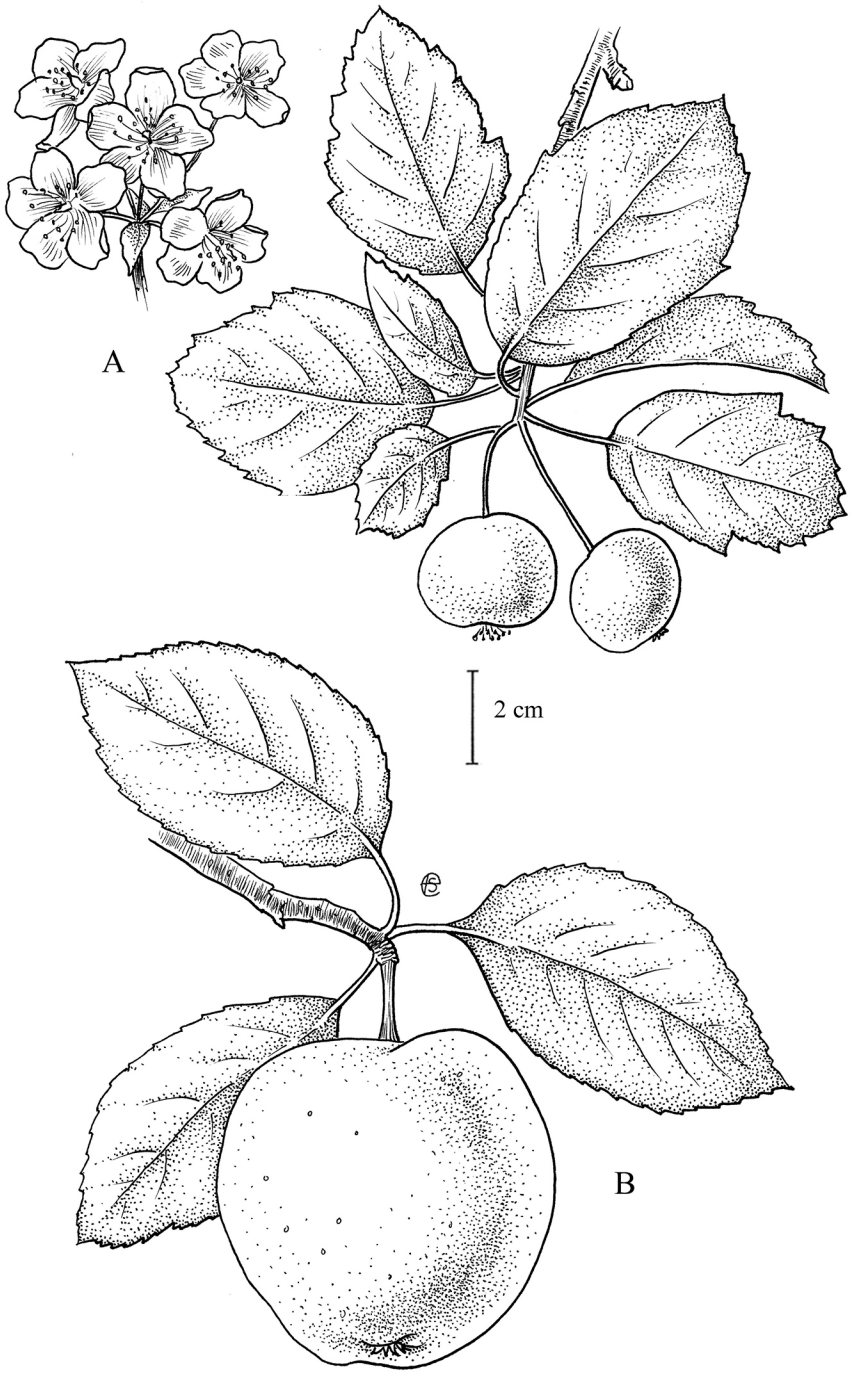
Distribution of *Malus baccata*, or Siberian crabapple, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Malus pumila*, or common apple, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Malus toringo*, or toringo crabapple, recorded in the New York Metropolitan Region during three time categories.



A) Flowers and fruiting leafy twig of *Malus coronaria*; B) fruiting leafy twig of *Malus pumila*. Illustration by Emma Skurnick.

Melia L. – Chinaberry

Meliaceae. Trees. Species 5–12 in east India and Australia. Genus name is derived from the Greek word used by Theophrastus ("father of botany," 371–287 B.C.) for a morphologically similar species, *Fraxinus ornus*.

Nonnative Species

Melia azedarach L. – Chinaberry, pride of India, Persian lilac, bead tree

Flowering May; fruiting Sept.–Oct. A fast-growing pest tree that can propagate via sprouts and seed. Cultivated since the late 1500s, with at least 2 cultivars (Dirr 1998). Few reported unvouchered occurrences in the region from Long Island (NY); not clear whether these populations were naturalized and whether they overwintered.

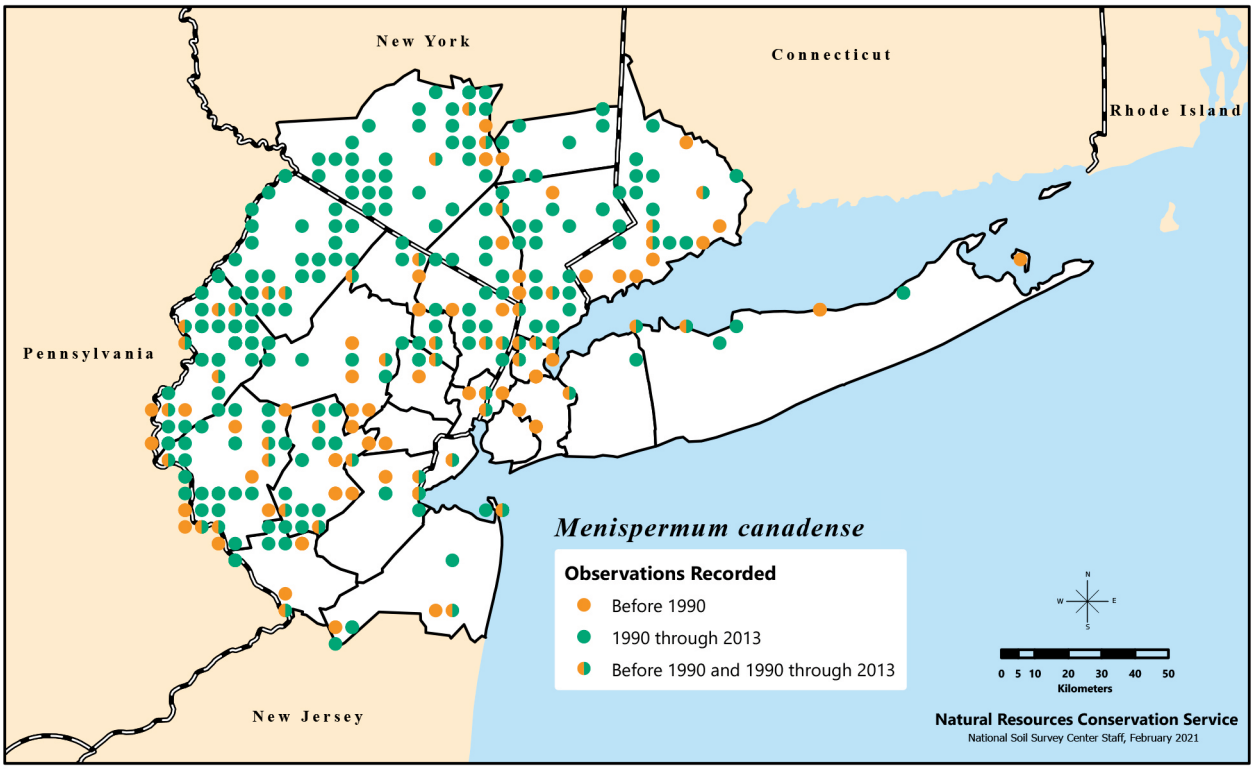
Menispermum L. – moonseed

Menispermaceae. Dioecious vines. Species 2–4 in eastern Asia and eastern North America (including Mexico). Readily distinguished from other vines by the orbicular, peltate leaves and blackish glaucous drupes with crescent-shaped seeds. Genus name is derived from the Greek "men" ("moon") and "sperma" ("seed"), in reference to the crescent-shaped seeds.

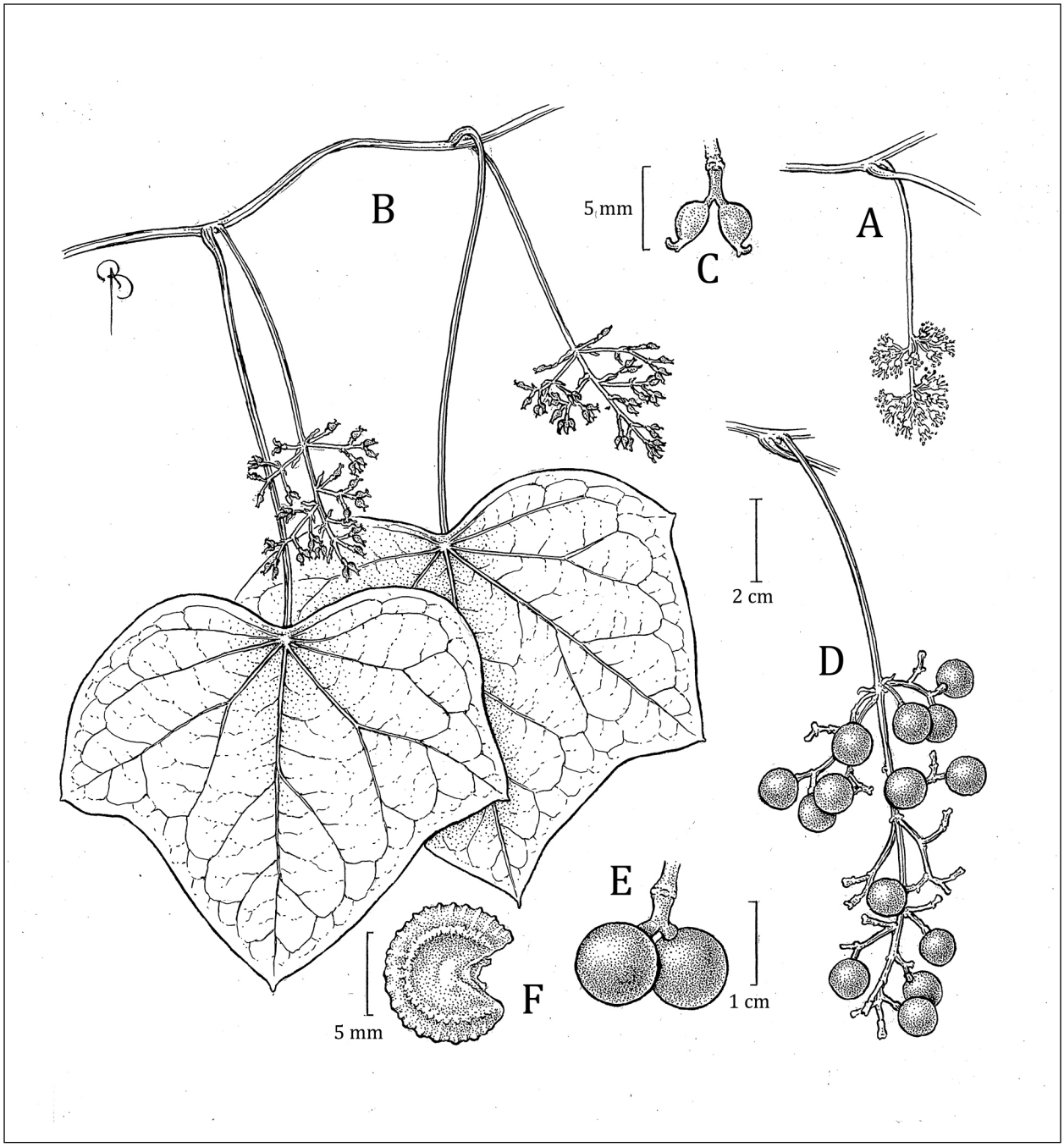
Native Species

1. _Menispermum canadense_ L. – moonseed ↑

Flowering June–early July; fruiting late Aug.–Oct. Mesic woodlands, woodland edges, streambanks, and floodplains. Poisonous, containing isoquinoline alkaloids; fatalities reported from ingesting fruit and seed. Birds apparently able to eat fruit and seeds without incident (Lewis and Elvin-Lewis 2003). Used for medicinal purposes by Native Americans (Moerman 1986) possibly as a diuretic, laxative, or tonic (Smyth 1903). Increases may be related to increases in woodland areas.



Distribution of *Menispermum canadense*, or moonseed, recorded in the New York Metropolitan Region during three time categories.



A) Male flower, B) leafy twig with female flowers, C) carpels, D) infructescence (fruit [drupes]), E) drupe, and F) seed (stone) of *Menispermum canadense*. Illustration by Bobbi Angell.

Metasequoia Hu & W.C.Cheng – dawn redwood

Cupressacae (Taxodiaceae). Monospecific; from China, where it was first described in 1948 (Hu and Cheng 1948). Extremely rare in the wild; known only from Lichuan County in the Hubei province of China. Before that report, it was known only from fossils. The Greek prefix "meta-" indicates taxonomic closeness to the North American conifer genus *Sequoia* Endl.

Nonnative Species

Metasequoia glyptostrobioides Hu & W.C.Cheng – dawn redwood

Cones maturing Dec. (Sloan and Johnson 2008). Increasingly frequent planted tree in the region.

Morella Lour. – bayberry

Myricaceae. Trees, shrubs. Species 40–50 in Africa, Asia, Europe, North America, and South America. Like *Alnus*, *Comptonia*, and *Myrica*, nitrogen fixation occurs through an association of the roots with the actinobacteria genus *Frankia* (Callaham et al. 1978). Often treated as a subgenus of *Myrica* though Wilbur (1994) argued for its recognition as a distinct genus. Plants strongly fragrant; wax from fruit used in making bayberry candles (Connor 2015). Genus name is a diminutive for the genus *Morus* (mulberry); João de Loureiro (1790) in his original description remarked that the small fruits of *Morella* were superficially similar to the fruits of *Morus*.

Native Species

1. _Morella cerifera_ (L.) Small – wax-myrtle Ø

Myrica cerifera L.

Small tree, shrub. Flowering May–June. Marshes and edges of marshes, often along the coast. Readily hybridizes with *Morella pensylvanica* when the two grow together (Bornstein 1997). Northern limit of range in central NJ known from Middlesex and Monmouth Counties; all reports of species from NY are misidentifications of *M. pensylvanica*. Epithet from Latin means "bearing wax," in reference to the waxy coating of the fruit. Apparently less salt tolerant than *M. pensylvanica*. It may not die from salt, but growth is severely impacted (Sande and Young 1992). Increases may be due to increases in marsh habitats. Potential allelopathic effects (Overholt et al. 2012). Invasive in HI (Kurten et al. 2008).

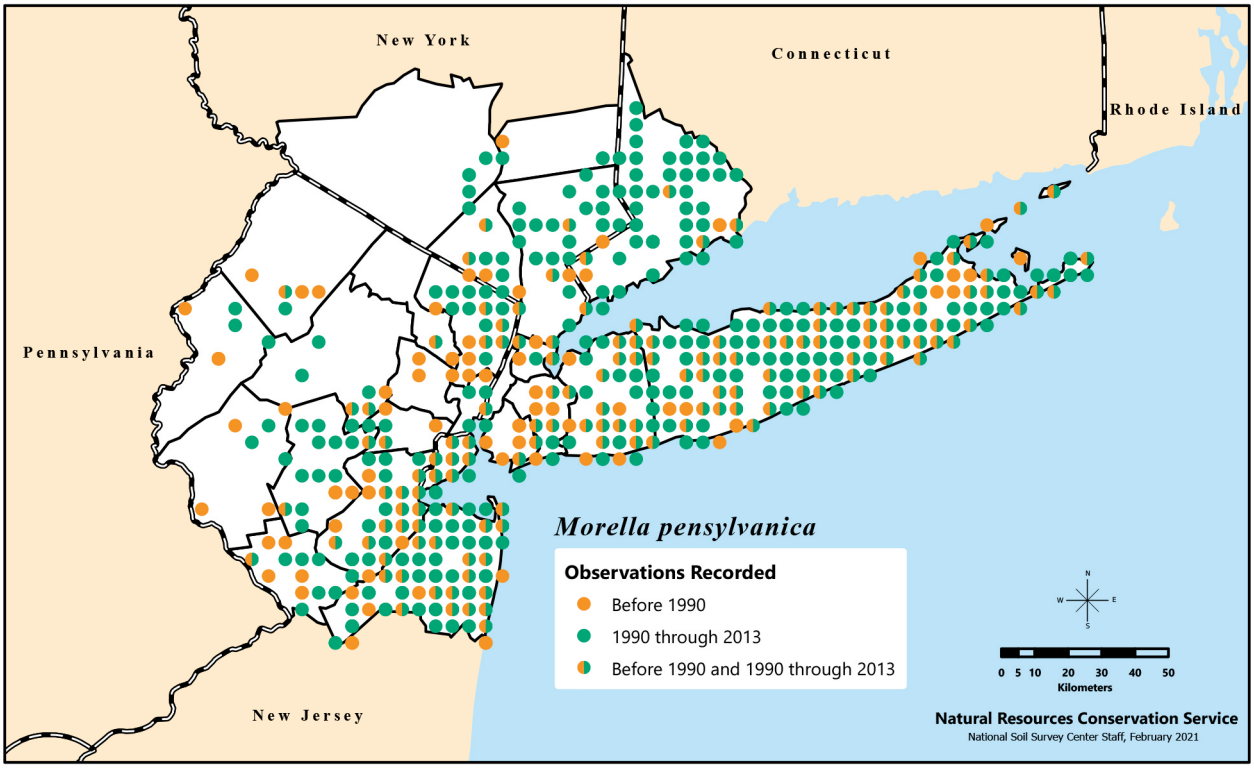
2. _Morella pensylvanica_ (Mirb.) Kartesz – northern bayberry ↔

Myrica pensylvanica Mirb.

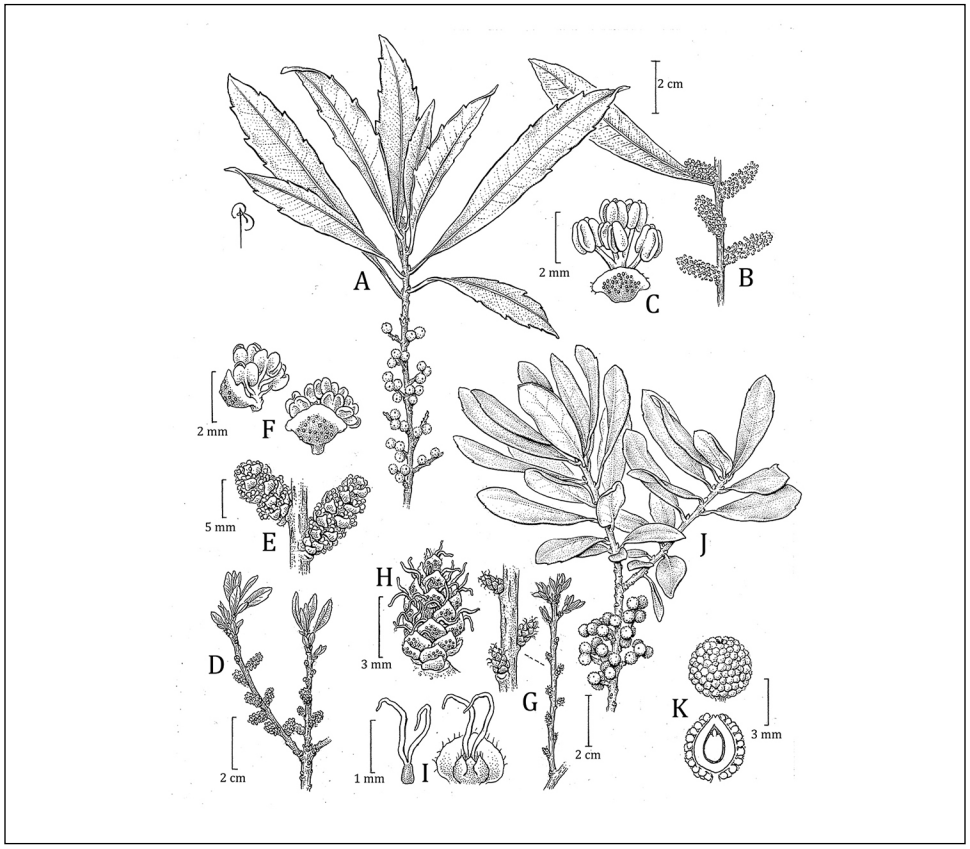
Shrub. Flowering May–June. Dry to wet open to shaded areas, including oak woodlands, pinelands, deciduous swamps, bogs, and Atlantic white cedar swamps. See preceding description for hybridization with *Morella cerifera*. Some material in southern NJ (including material from Monmouth County in the region), especially material in bogs and other wetlands, may properly be referred to as *Morella caroliniensis* (Mill.) Small (=*Myrica heterophylla* Raf.), which if recognized reaches the northern limit of its range in New Jersey. The fruit wall of *M. pensylvanica* is hairy (glabrous in *M. carolinensis*), branches are gray (black in *M. carolinensis*), and leaves are deciduous (persistent or tardily deciduous in *M. carolinensis*). Material from the northern limit of the range of *Morella caroliniensis* is often intermediate between *M. pensylvanica* and *M. heterophylla*, and Bornstein (1997) reported that the two species readily hybridize. Wilbur (1994) lumped the two, treating *M. pensylvanica* as a synonym of *M. carolinensis*, and Houghton (1988) treated the two as subspecies under *Myrica pensylvanica*. Potential use for landfill restoration (Flower et al. 1981). Has a high degree of salt tolerance (Martin 1959).

Morella Key

1. Leaves chiefly less than 14 mm wide, resinous glands of two kinds (shining yellow; dull brown); fruit 1.8–3.2 mm diameter . . . . . ***Morella cerifera***
1. Leaves chiefly wider than 14 mm, resinous glands of one kind; fruit 3.5–5.5 mm diameter . . . . . ***Morella pensylvanica***



Distribution of *Morella pensylvanica*, or northern bayberry, recorded in the New York Metropolitan Region during three time categories.



A) Fruiting leafy twig, B) twig section with male catkins, C) male flower, D) twig section with female catkins, E) twig section with female catkins, and F) female flower of *Morella cerifera*; G) twig with female catkins and enlarged view of twig section with female catkins, H) female catkins, I) female flower and pistil, J) fruiting leafy twig, and K) fruit and cross-section of fruit of *Morella pensylvanica*. Illustration by Bobbi Angell.

Morus L. – mulberry

Moraceae. Trees, shrubs. Species about 16 in Africa, Asia, and Europe. Readily distinguished by the fleshy edible syncarp fruits, superficially similar in appearance to *Rubus* fruits (blackberries, raspberries). Wind pollinated. Genus name is the ancient Latin name for the group.

Native Species

1. *Morus rubra* L. – red mulberry ↓↓↓

Flowering May–June; fruiting late June–early Aug. Woodlands and woodland edges, usually in rich soils.

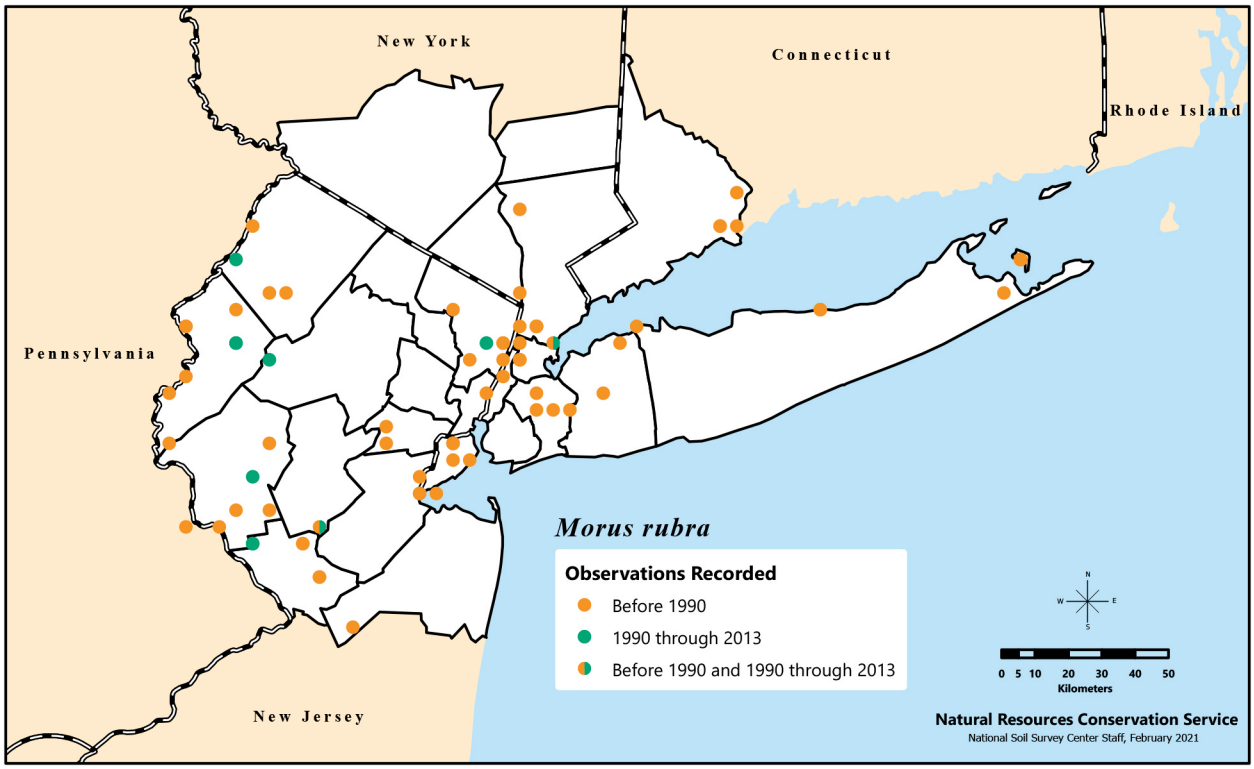
Prefers rich soils and mesic conditions (Dirr 1998); despite this preference, it has a wide range, covering most of the eastern U.S. (Barbour et al. 2008). Substantial decrease in the region with apparent increases in the nonnative *Morus alba* described in the next entry (Clemants and Moore 2005).

Earliest fruit-bearing age 10 years, with 2–3 years between large crops. Cold stratification may

Morus Key

1. Leaf blades 10–30 cm × 8–15 cm, scabrous on upper surface with short, stiff appressed hairs, pubescent along secondary and tertiary veins on lower surface . . . . ***Morus rubra***
1. Leaf blade 5–10 cm × 3–6 cm, glabrous on upper surface or slightly pubescent, glabrous or sparsely pubescent along the larger veins on lower surface . . . . . ***Morus alba****

Note: Despite common names, two species cannot be distinguished based on fruit color. The color of mature fruit of *Morus alba* can be white; however, fruit can also be red to blackish-purple, as in *M. rubra*.



Distribution of *Morus rubra*, or red mulberry, recorded in the New York Metropolitan Region during three time categories.

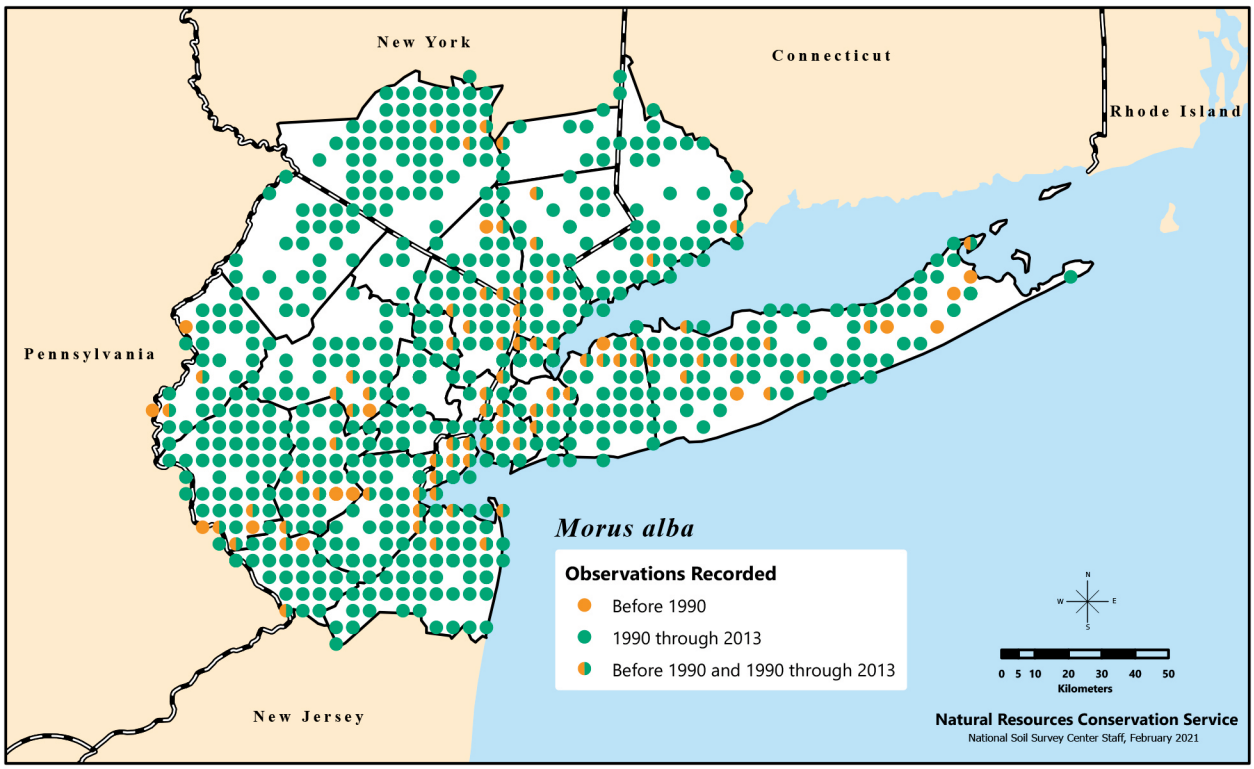
improve germination, though pretreatment is not required. Fruit consumed by birds and several different animals, including opossums (*Didelphis* spp.), squirrels (family Scuiridae), and rabbits (family Leporidae) (Barbour et al. 2008). Seeds are covered with a thin membranous coat that may require bacteria to help break it down before germination. Seeds do not germinate in sterile soil (Ramirez 1976). Mulberry fruit can develop without seed (Barbour et al. 2008). Cultivated since 1629 (Dirr 1998). Hybridizes with *M. alba*, whose pollen is more abundant; *M. rubra* then mates with this hybrid, further increasing the cost to its fertility (Burgess et al. 2008). *Morus alba* crossed with itself is the most fit combination, followed by *M. alba* (maternal) crossed with the *M. rubra* and *M. alba* hybrid (paternal), followed by *M. alba* (maternal) crossed with *M. rubra* (paternal). Crosses with *M. rubra* or the hybrid as the maternal parent were generally less fit than crosses with *M. alba* as the maternal parent (Burgess and Husband 2004). While *M. rubra* can be found at low densities in NYC forests, its seeds are not found in the seed bank, though *M. alba* is in the existing vegetation and the seed bank (Kostel-Hughes et al. 1998). Fruit is made into jams, marmalades, wines, and juices and is a rich source of antioxidants, including ascorbic acid, anthocyanins (mainly cyanidin 3-glucoside), and phenolics (Koca et al. 2008).

Nonnative Species

2. *Morus alba* L. – white mulberry ↑↑↑

Flowering May–June; fruiting late June–July. Common in disturbed, open areas.

Grows best in moist, well-drained, fertile soils, but can withstand a wide range of soil pH levels, and drought, urban, and high salt conditions (Dirr 1998). It may survive up to 7 m of flooding and large fluctuations in water depth (Liu and Willison 2013). Prefers full sun to light shade. Originates from China; introduced for use in the silkworm industry but escaped. It is an invasive problem in both the eastern and the western U.S. (Dirr 1998), parts of Europe (Csiszár 2009), South America (Ghersa et al. 2002), and southern Africa (2007).



Distribution of *Morus alba*, or white mulberry, recorded in the New York Metropolitan Region during three time categories.

Earliest seed-bearing age 5 years. First cultivated in the U.S. in the 1700s (Barbour et al. 2008) and much earlier in Europe, with at least 20 cultivars (Dirr 1998). Seeds have similar germination requirements and seed dispersal vectors as *Morus rubra* (Barbour 2008). May grow 0.7 m annually. It is impacted by several pests including bacterial blight, cankers, powdery mildews, and mites (order Arachnida) (Dirr 1998). Pollen is released at very high speeds (as high as half the speed of sound or Mach 0.7); pollen release speeds of *M. rubra* have not been evaluated. Being able to disperse pollen large distances rapidly may give *M. alba* an evolutionary advantage (Taylor et al. 2006). *Morus alba* has potential allelopathic effects that have been shown to inhibit the growth of radish (*Raphanus* spp.) seedlings by as much as 50 percent (Hong et al. 2003). Juglone, one of the allelopathic compounds associated with *Ailanthus altissima* and *Juglans nigra*, is also found in *M. alba* (Csiszár 2009). The North American fall webworm (*Hyphantria cunea*) is now infesting trees of this species in its native range in China. It is especially prone to damage by this insect because of *M. alba*'s high density due to its use for silkworm breeding and agriculture (Tang et al. 2012). Abundance appears to be the most important factor determining whether *M. alba* trees will be impacted by fall webworm in eastern U.S. states (Mason et al. 2011). Most (67–68 percent) hybrids contain more genetic material (nuclear markers and chloroplast genome) from *M. alba* than *M. rubra* (Burgess et al. 2005). Because *M. rubra* is less fit than *M. alba* and the hybrid between *M. alba* (maternal) and *M. rubra* (paternal), *M. alba* is likely to replace *M. rubra* over time (Burgess and Husband 2006) unless efforts are made to reduce the abundance of *M. alba* significantly.

Leaves are a rich source of beta-carotene, iron, calcium, zinc, and ascorbic acid. Its leaf powder may be a good commercial source of nutrient supplementation in food products, potentially improving the economic and nutritional status of the poor in developing countries working in sericulture (rearing silkworms) (Srivastava et al. 2006). Leaves and fruit have a high antioxidant potential, which may inhibit neurodegenerative disorders (such as Alzheimer's and Parkinson's diseases), atherosclerosis, and general oxidative stress. Leaves and fruit also contain components that inhibit hyperglycemia and lipid peroxidation in diabetics. May also improve skin tone and act as an antimicrobial agent (Butt et al. 2008). Antioxidative responses to water stress differ among the cultivars (Reddy et al. 2004, Sekhar et al. 2017). Antioxidant action also varies seasonally, with the highest levels found in Oct. and the lowest levels in Feb. (Sivaci and Sökmen 2008).

Management

Though the planting of *Morus rubra* in its native range, especially in marginal lands for commercial purposes, is encouraged, it should not be planted beyond its native range. *Morus alba*'s adaptability to a wide range of habitats, including high stress habitats, and its ability to genetically dominate any hybridization that may occur with other *Morus* species make this species a threat to the region. Within the region, we advise that *M. alba* be removed where feasible and that *M. rubra* be planted in its place. Marking the medicinal qualities that *M. rubra* shares with *M. alba* may be added incentive to planting the native *M. rubra*.

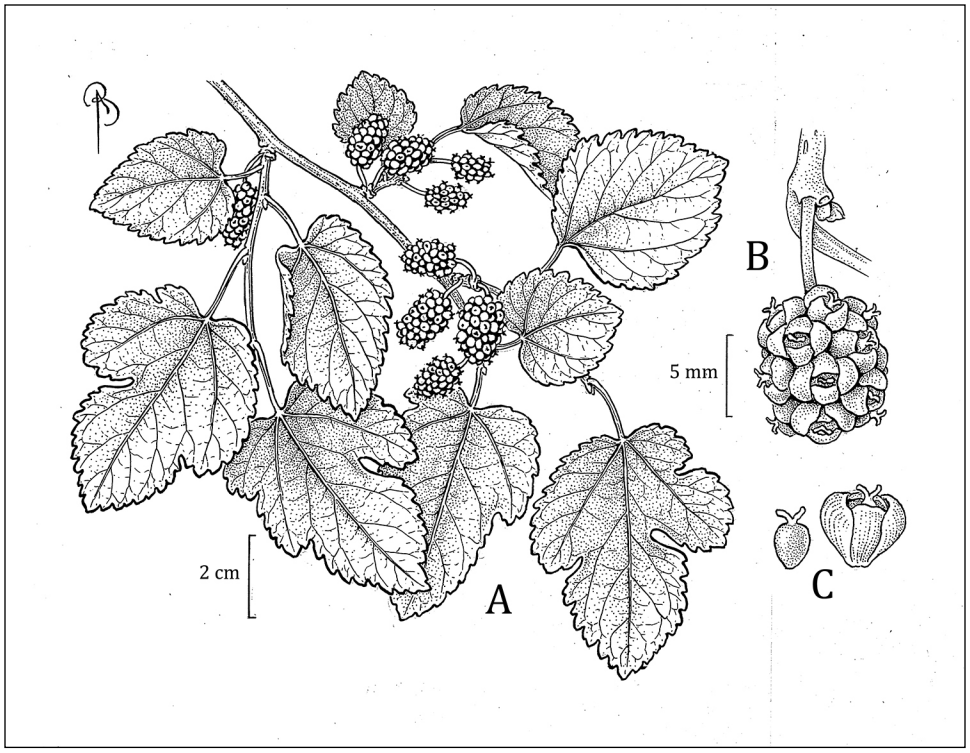
Myrica L. – sweet-gale

Myricaceae. Shrubs, small trees. Species 2 in Asia, Europe, and North America. Like *Alnus*, *Comptonia*, and *Morella*, nitrogen fixation occurs through an association of the roots with the actinobacteria genus *Frankia* (Callaham et al. 1978). Genus name is derived from the Greek "Myrike," probably an ancient name of tamarisk later applied to this fragrant genus.

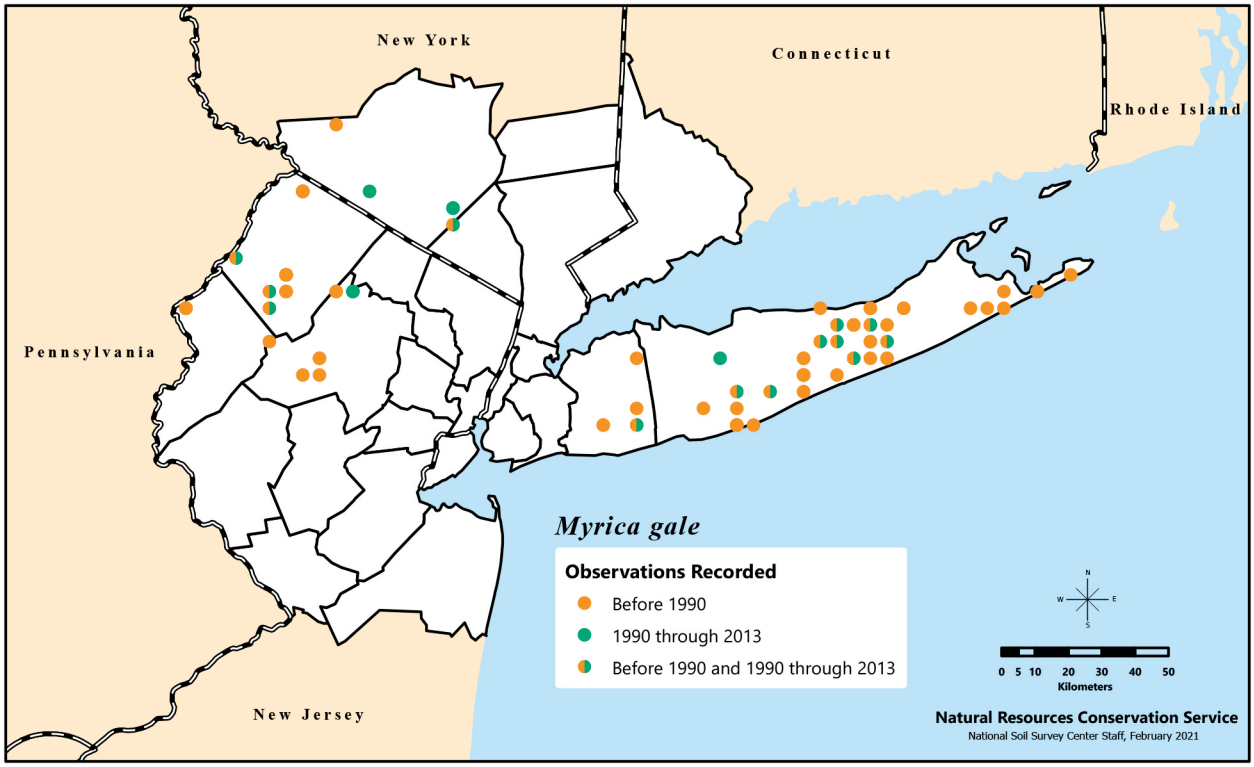
Native Species

1. *Myrica gale* L. – sweet-gale ↓
(see *Comptonia* plate on p. 149 for illustration)

Flowering May–June. Wet open areas, often near watersides; infrequent, with a disjunct distribution in the Appalachian Mountains and then skipping to the Coastal Plain. Native to all higher latitudes in the northern hemisphere (Dirr 1998). Epithet is a pre-Linnean name for this genus.



A) Twig with leaves and fruit, B) fruit, and C) individual mature flower with achene of *Morus alba*. Illustration by Bobbi Angell.



Distribution of *Myrica gale*, or sweet-gale, recorded in the New York Metropolitan Region during three time categories.

Cultivated since 1750 (Dirr 1998). Seed can germinate without stratification, but cold stratification for 6 weeks improves germination (Schwintzer and Ostrofsky 1989). Loss of habitat possibly due to a shrinking southern range may be the primary reason for its population decline.

Listed as rare in NJ (S3).

Nemopanthus Raf. – mountain holly

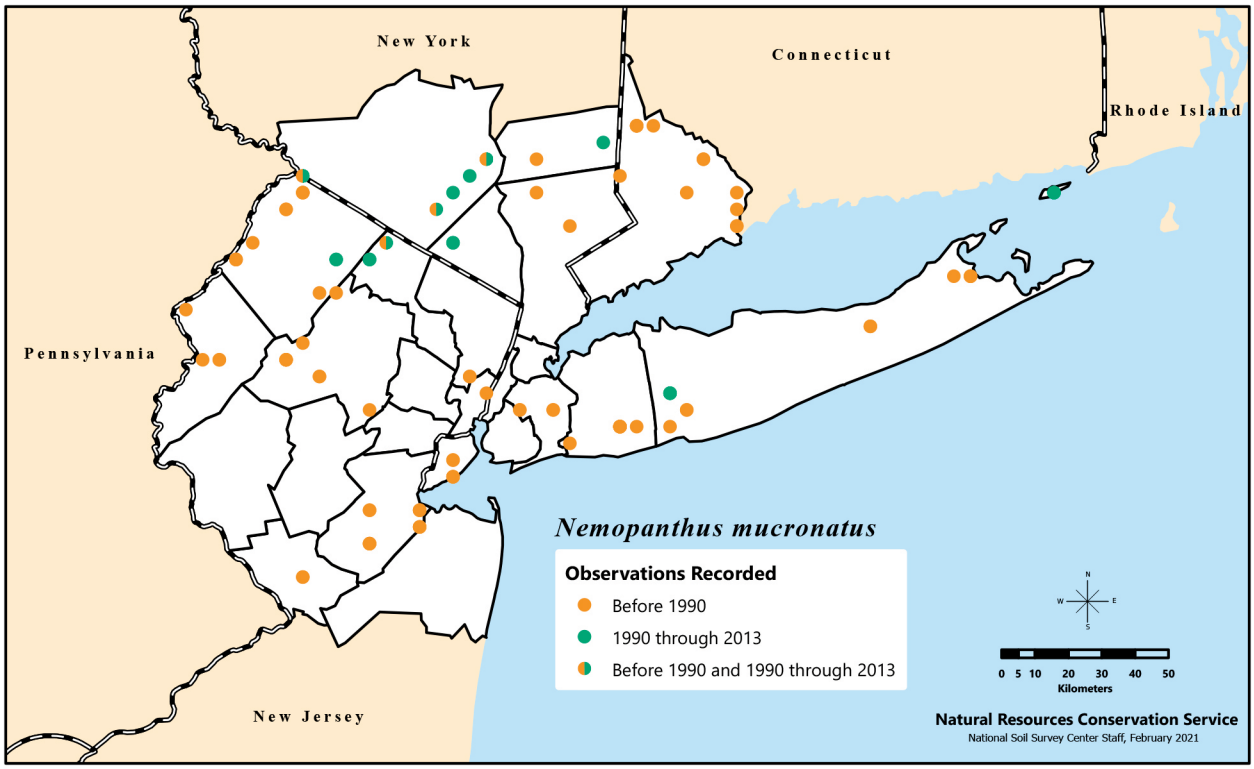
Aquifoliaceae. Shrub. Species 1 in North America. Phylogenetically nested within *Ilex* (Cuénoud et al. 2000) and thus sometimes placed in *Ilex* L. (Powell et al. 2000). *Nemopanthus* can be distinguished by its obsolete (so small that appears to be missing) calyx, linear yellow petals (broader, white in *Ilex*), and free stamens (adnate in *Ilex*). Pollination and dispersal likely similar to *Ilex*. Genus name is from the Greek "nema" ("thread"), "pous" ("foot"), and "anthos" ("flower"), in reference to the linear petals.

Native Species

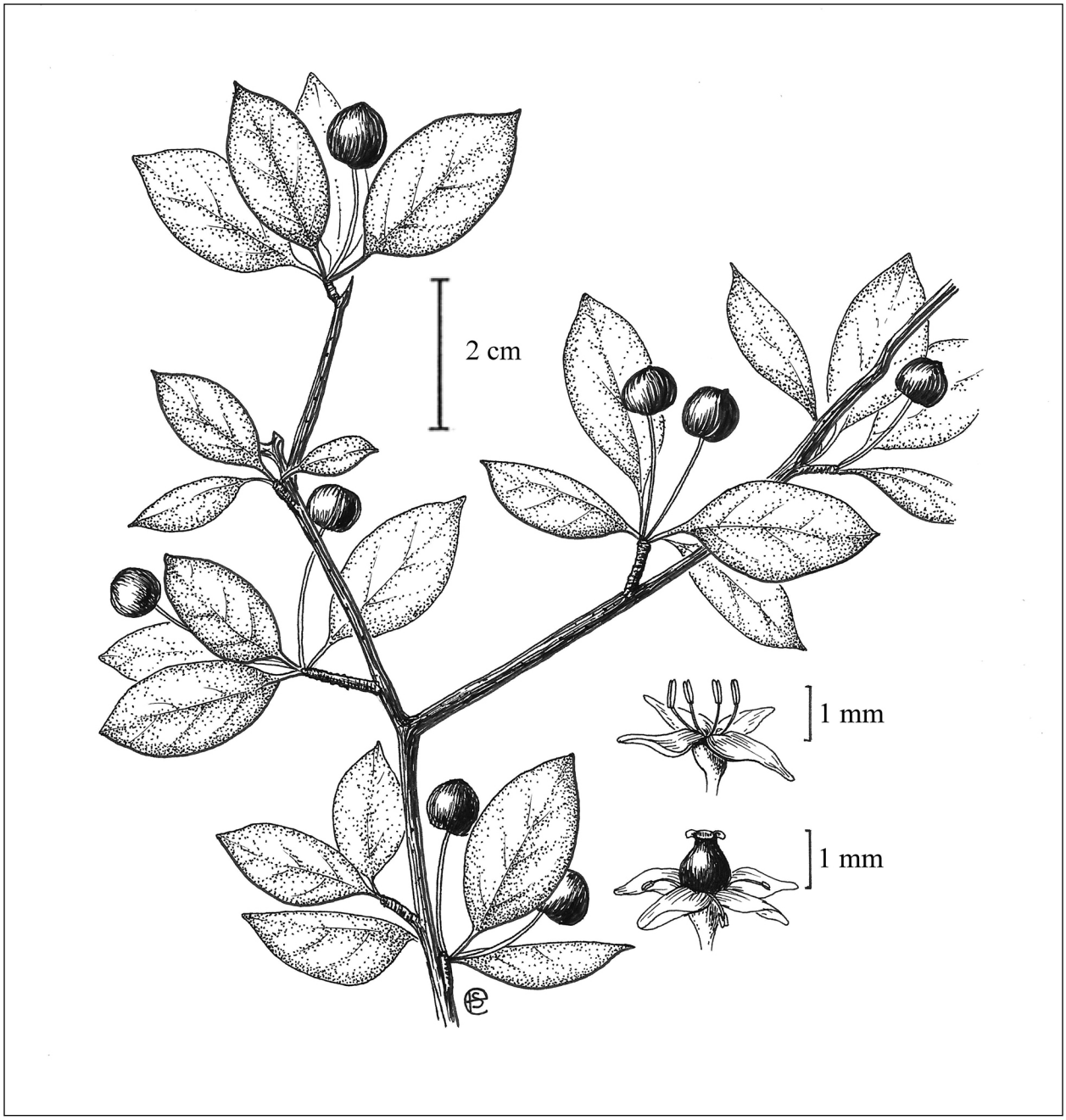
1. *Nemopanthus mucronatus* (L.) Trel. – mountain holly, catberry ↓↓

Vaccinium mucronatum L.; *Ilex mucronata* (L.) M.Powell, Savol. & S.Andrews; *Ilicioides mucronata* (L.) Britton

Flowering Apr.–May; fruiting July–Sept. Bogs, swamps, wet woods. Mainly dioecious, with some monoecious individuals; seeds dispersed by animals. Seeds are doubly dormant and require a period of after-ripening; recommended 5 months of warm followed by 3 months of cold stratification (Zasada and Schopmeyer 2008). Declining considerably; an example of a boreal and high-elevation species (La Roi 1967) that appears to be declining within its southern range, possibly due to changes in climate. Other factors could play a role in its decline, including flooding caused by beavers (*Castor canadensis*) (Mitchell and Niering 1993).



Distribution of *Nemopanthus mucronatus*, or mountain holly, recorded in the New York Metropolitan Region during three time categories.



Fruiting leafy twig, male flower, and female flower with smaller anthers of *Nemopanthus mucronatus*. Illustration by Emma Skurnick.

Nyssa L. – black gum, sour gum

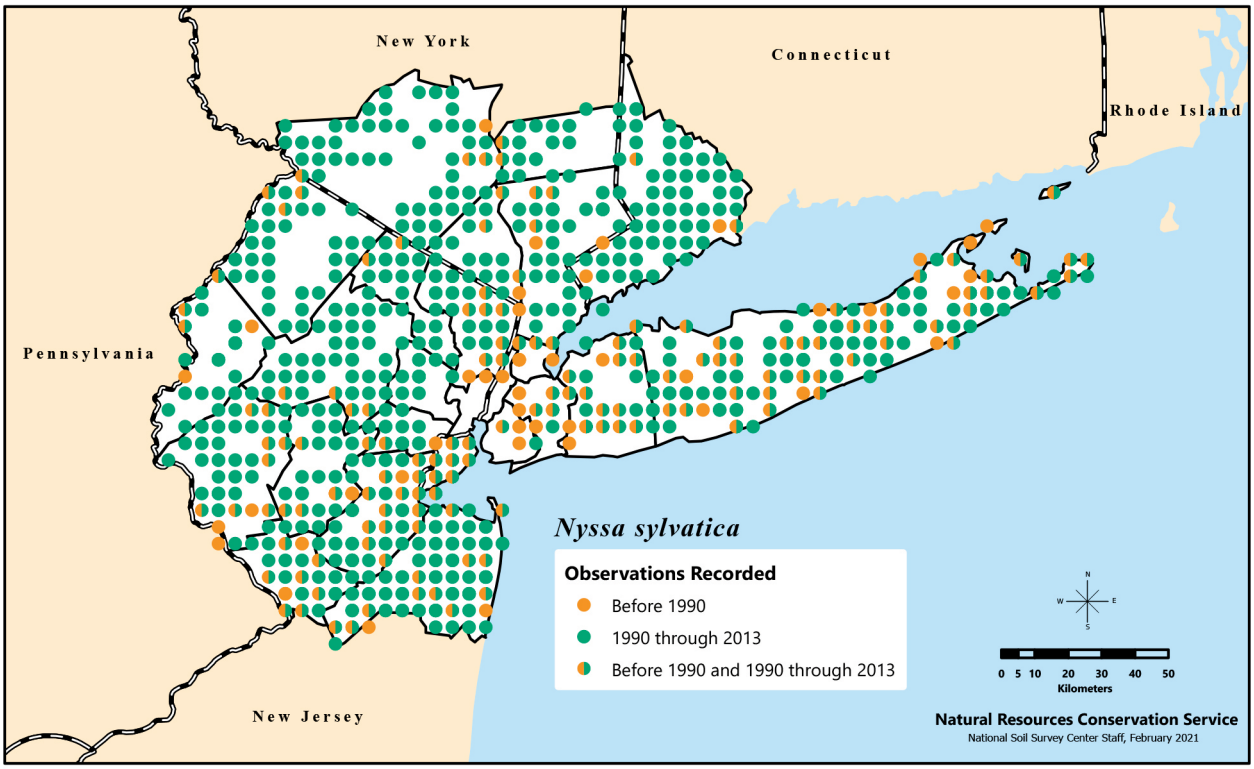
Nyssaceae (Cornaceae s.l.). Dioecious trees. Species 8 in Asia and North America. Occasionally cultivated for timber, ornament (fall color), fruit. Readily distinguished by the diaphragmed pith and blue-black drupe fruits. Bees (order Hymenoptera) pollinate the flowers. Genus name is the name of a Greek water nymph, applied to this genus because the species grow in wet habitats.

Native Species

1. *Nyssa sylvatica* Marshall – black gum, sour gum, tupelo ↑↑
(see plate for *Cornus florida* and *C. canadensis* on p. 158 for illustration)

Flowering May–mid-June; fruiting July–Sept. Mesic (rarely dry) woodlands and swamps. Our material is referable to *Nyssa sylvatica* var. *sylvatica*. The more southern *N. sylvatica* var. *biflora* (Walter) Sarg. reaches the northern limit of its range in DE (sometimes also reported from southern NJ).

Prefers moist, well-drained acidic, deep soils, but is often found on dry mountain ridges, burned-over forest land, and abandoned fields. Also prefers full sun or semi-shade. Could make a good street tree, but it is not tolerant of pollution or high-pH soils (Dirr 1998) although a NJ study found it to be one of the best tree species for landfill restoration (Flower et al. 1981). Height at maturity 15–18 m (Bonner 2008j). Seed production can be expected once the trees reach 20 cm in diameter; trees typically fruit abundantly each year (Johnson 1990a). Seeds dispersed by birds (Davidar and Morton 1986). Moist cold stratification improves germination (Bonner 2008j). Cultivated since 1750, with at least 8 cultivars (Dirr 1998). Shade-tolerant species but can grow rapidly in response to a canopy gap, making it a gap-facultative tree species (Orwig and Abrams 1994). Increases may be due to increases in woodlands and forests.



Distribution of *Nyssa sylvatica*, variously called black gum, sour gum, or tupelo, recorded in the New York Metropolitan Region during three time categories.

Ostrya Scop. – hop-hornbeam

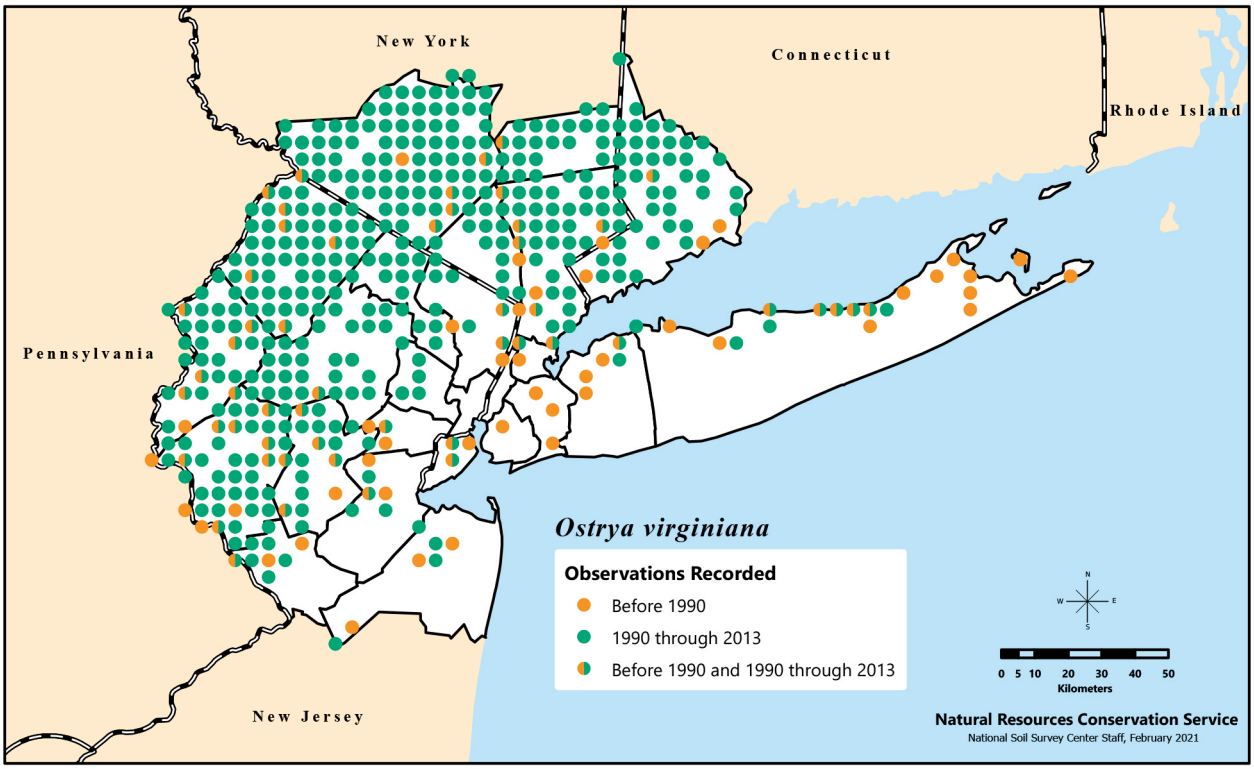
Betulaceae. Slender trees. Species 5–8 in Asia, Europe, and North America. Distinguished by leaves with doubly serrate leaf margins, and by fruit, small nutlets enclosed in a green bladdery involucre composed of floral bracts. Wood exceptionally hard (species sometimes called ironwood, a common name also applied to *Carpinus*), and previously used for sleigh runners, airplane propellers, tool handles, and mallet heads. Genus name is an ancient name for a tree with hard wood; Greek "ostryos" ("scale") a possible reference to the involucre that encloses the fruit.

Native Species

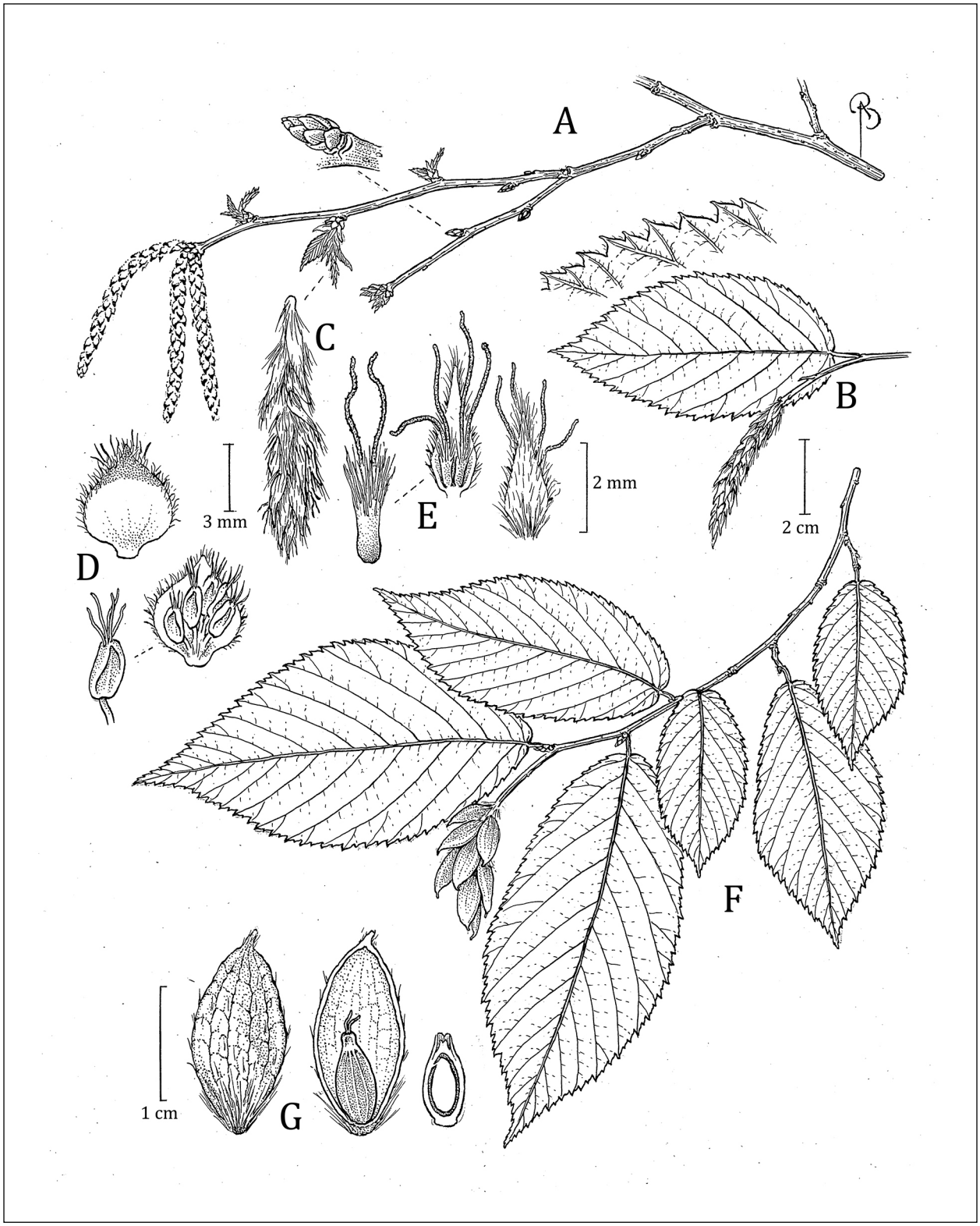
***Ostrya virginiana* (Mill.) Koch – hop-hornbeam ↑↑**

Carpinus virginiana Mill.

Flowering Apr.–May; fruiting Sept.–Oct. Monoecious. Dry to mesic woodlands, usually in rich soils. Rare on the Coastal Plain and most locations on the North Shore of Long Island; material on the Coastal Plain could represent a different variety, *Ostrya virginiana* var. *lasia* Fernald, of which only the young individuals are characterized by smaller, pubescent leaves, and pubescent branchlets. Sometimes confused with vegetatively similar *Carpinus caroliniana*. Increases may be correlated with increases in woodlands and forested areas.



Distribution of *Ostrya virginiana*, or hop-hornbeam, recorded in the New York Metropolitan Region during three time categories.



A) Twig with enlarged view of bud, pendulous male catkins, and shorter female catkin; B) twig with leaf and female catkin and enlarged view of leaf margin; C) female catkin; D) male flower, its cross-section, and stamen; and E) female flower, its cross-section, and pistil; F) fruiting leafy twig; and G) fruit and its cross-section, showing the nutlet; and cross-section of nutlet, of *Ostrya virginiana*. Illustration by Bobbi Angell.

Oxydendrum DC. – sourwood

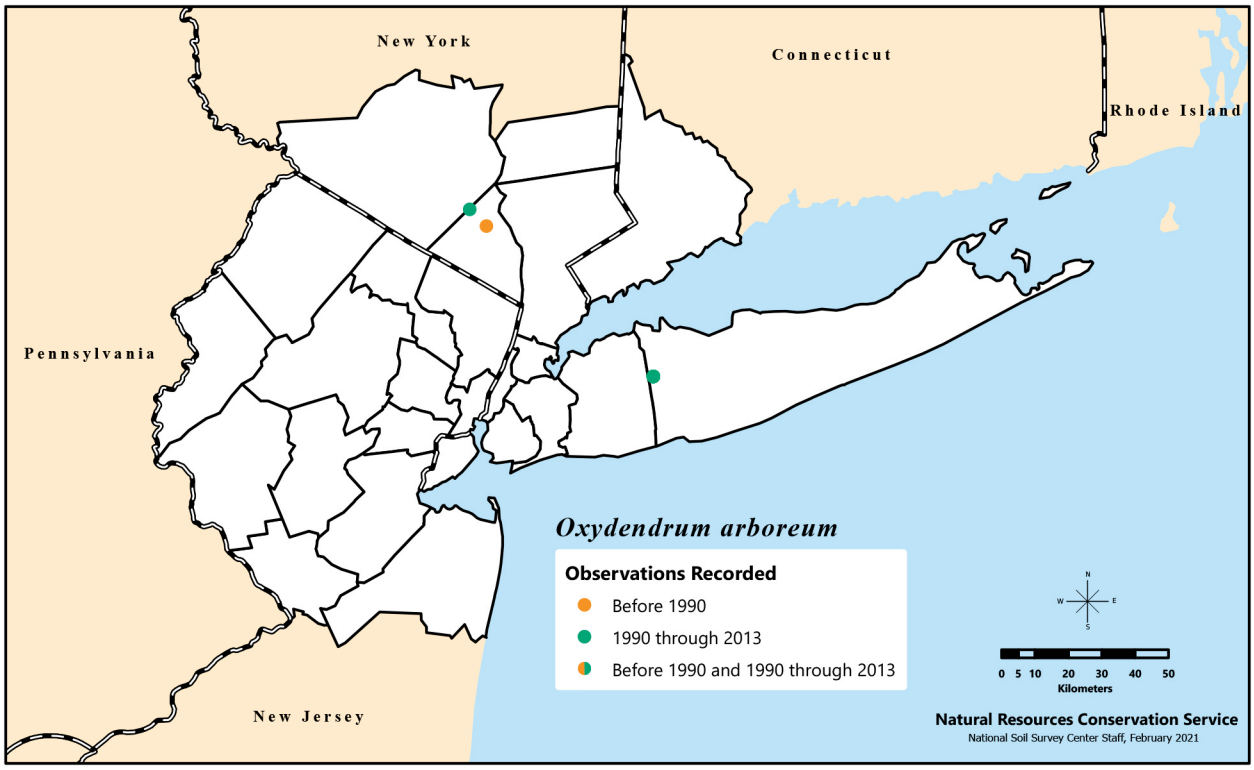
Ericaceae

Nonnative Species

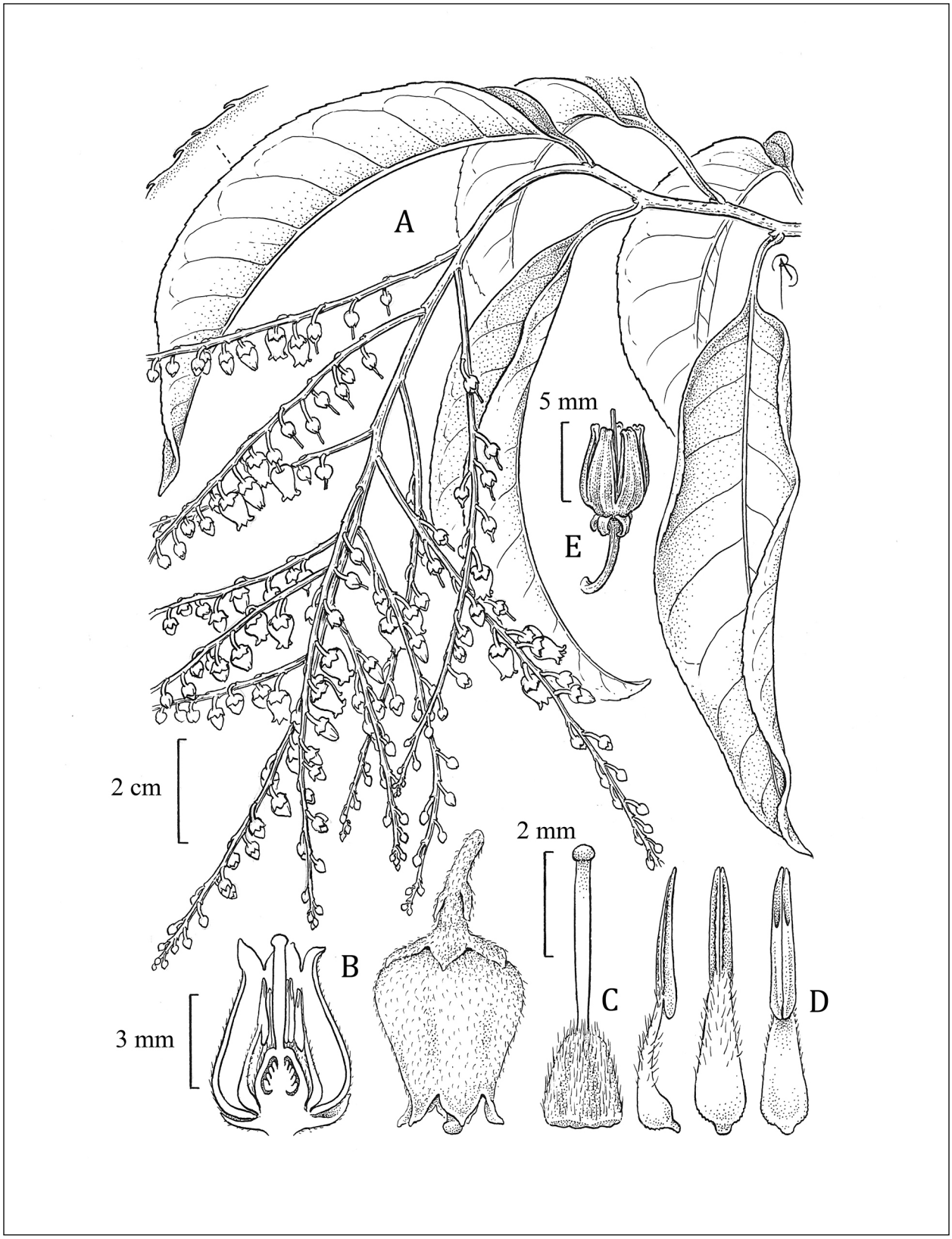
1. *Oxydendrum arboreum* (L.) DC. – sourwood Ø♥

Andromeda arborea L.

Flowering June–early July. Native to the southeastern U.S. north to PA, OH, and WV. Sometimes grown in the NY Metropolitan Region; rarely persists or escapes from cultivation, with known likely naturalized populations from Fairfield County (CT) and Rockland and Suffolk Counties (NY). Readily distinguished from other members of the heath family by its (usually) tree habit, sour foliage and sap (hence the name *Oxydendrum*, which means "sour wood"), and large terminal inflorescences composed of curved, one-sided racemes of white flowers. Foliage turns a brilliant scarlet in fall. Sourwood honey is exceptionally pale and light in taste. Cultivated since 1747, with at least 3 cultivars (Dirr 1998).



Distribution of *Oxydendrum arboreum*, or sourwood, recorded in the New York Metropolitan Region during three time categories.



A) Flowering leafy twig and enlarged view of leaf margin, B) flower and cross-section of flower, C) pistil, D) stamens, and E) fruit (capsule) of *Oxydendrum arboreum*. Illustration by Bobbi Angell.

Parthenocissus Planch. – Virginia creeper, woodbine

Psedera Neck.

Vitaceae. Woody climbing vines. Species 10–13 in temperate Asia and North America. Readily distinguished from other vitaceous vines by monoecy, multiple branched tendrils usually with adhesive disks, palmately lobed or divided leaves, and petals free (not united at apex as in *Vitis*). Grown for ornament, wall covers, and arbors. Genus name is from the Greek "partheno" ("virgin") and "cissos" ("ivy"), a latinization of the common name Virginia creeper.

Native Species

1. *Parthenocissus inserta* (Kern.) Fritsch – grape woodbine ↔

Vitis inserta Kern.; *Ampelopsis quinquefolia* var. *vitacea* Knerr; *Parthenocissus quinquefolia* var. *vitacea* (Knerr) L.H.Bailey; *Parthenocissus vitacea* (Knerr) A.Hitch.; *Psedera vitacea* (Knerr) Greene; *Vitis inserta* Knerr; *Vitis vitacea* (Knerr) Bean

Flowering June–late July; fruiting Sept.–Oct. Woodland edges, fields, thickets, and other open disturbed areas. May be overlooked; this species may be mistaken for the similar and much more common *Parthenocissus quinquefolia*. Besides the characters noted in the key, *P. inserta* is more strongly toothed (Rhoads and Block 2007). Also lacking adhesive disks, it less often climbs and is usually found "leaning" on other vegetation or trailing.

Some works use the name *Parthenocissus vitacea*, based on the conclusion that *P. inserta* does not apply to this species. However, Pringle (2010) concluded that *P. inserta* does apply to this species. Others consider it the same species as *P. quinquefolia* (Gill et al. 2008). Invasive in Hungary (Csiszar 2009) and Belgium (Ricotta et al. 2010) and may be allelopathic with relatively high juglone concentrations (Csiszar 2009).

2. *Parthenocissus quinquefolia* (L.) Planchon – Virginia creeper ↑↑

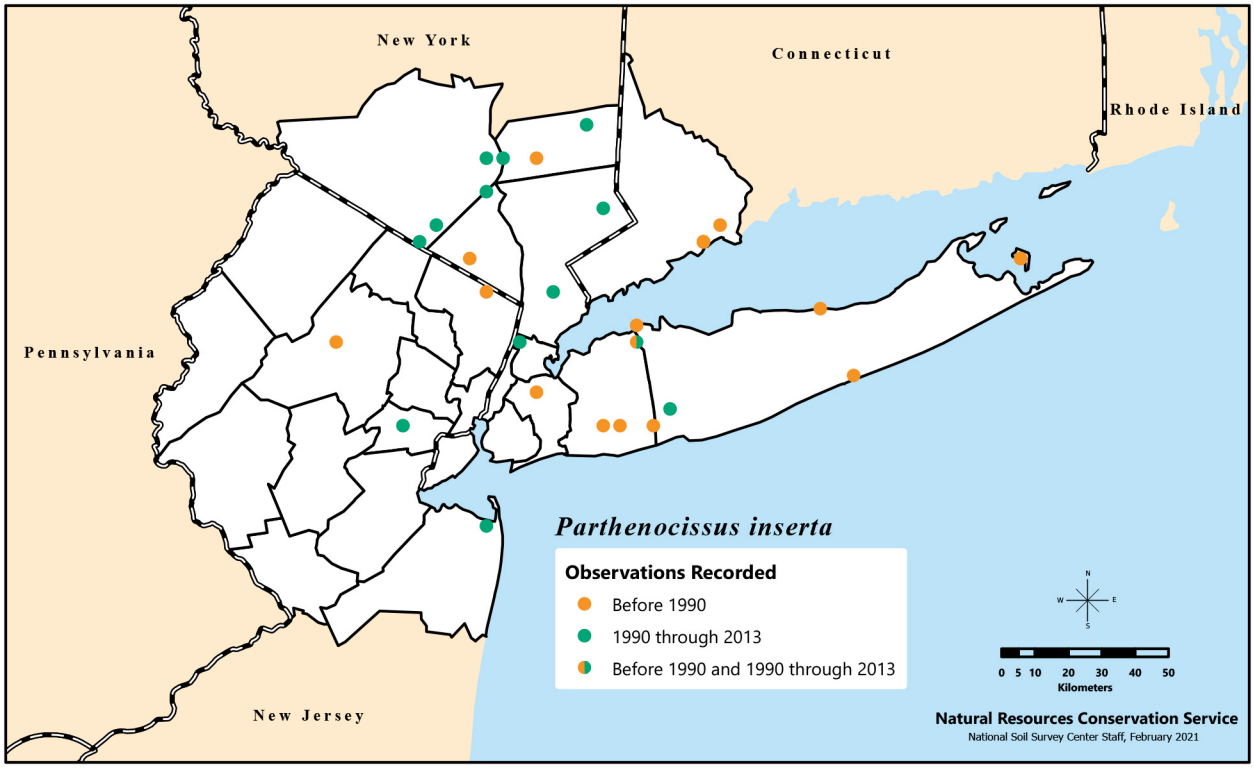
Hedera quinquefolia L.; *Ampelopsis quinquefolia* (L.) Michx.; *Psedera quinquefolia* (L.) Greene; *Vitis quinquefolia* (L.) Lam.

Flowering June–early Aug.; fruiting Sept.–Oct. Woodlands; woodland edges, fields, thickets, and other open disturbed areas. Epithet from Latin means "five-leaved," a reference to the leaves, which typically have five leaflets.

Tolerates almost any kind of soil, full sun or full shade, high exposure and pollution, and salt. Best adapted to shade. Susceptible to canker, downy mildew, wilt, beetles, leaf hoppers, and other insects and diseases (Dirr 1998). Moist cold stratification improves germination (Gill and Pogge 1974). Fruit popular with birds, which disperse the seeds. Cultivated since 1622 (Rehder 1949), with at least 4 cultivars (Dirr 1998). Fragmented forests with more edge have more *Parthenocissus quinquefolia* and similar woody vines (Londré and Schnitzer 2006). Increases in carbon dioxide may increase growth of some woody species, with the highest increases

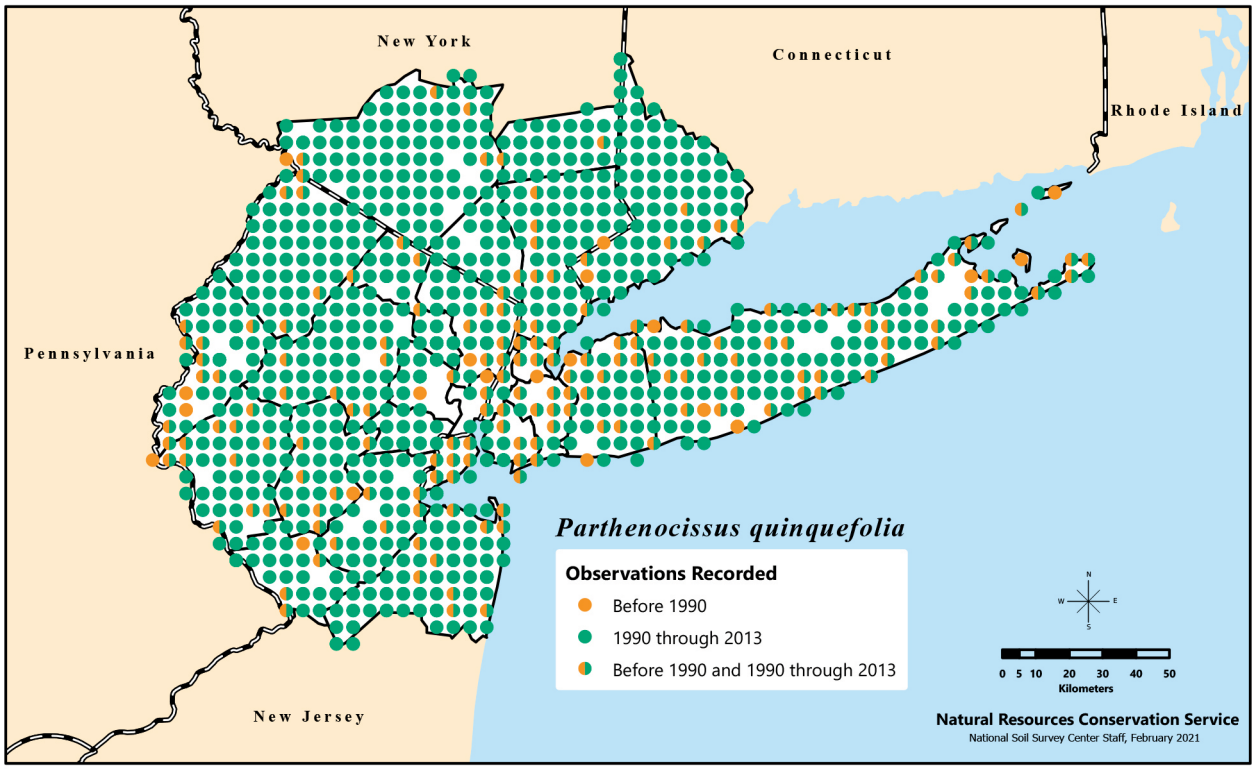
Parthenocissus Key

1. Leaves usually entire and 3-lobed (trifoliate on basal sprouts) . . . . . ***Parthenocissus tricuspidata****
1. Leaves palmately compound, leaflets (3–)5(–7) 2
2. Tendrils few-branched, without adhesive disks;
   fresh leaves lustrous on upper surface; inflorescence of 10–75 flowers,
   inflorescence axis dichotomous, lacking a central axis . . . . . ***Parthenocissus inserta***
2. Tendrils many-branched, terminating with adhesive disks;
   fresh leaves opaque on upper surface (not lustrous);
   inflorescence of 25–200+ flowers, inflorescence with a central axis . . . . ***Parthenocissus quinquefolia***



Distribution of *Parthenocissus inserta*, or grape woodbine, recorded in the New York Metropolitan Region during three time categories.

P Q



Distribution of *Parthenocissus quinquefolia*, or Virginia creeper, recorded in the New York Metropolitan Region during three time categories.

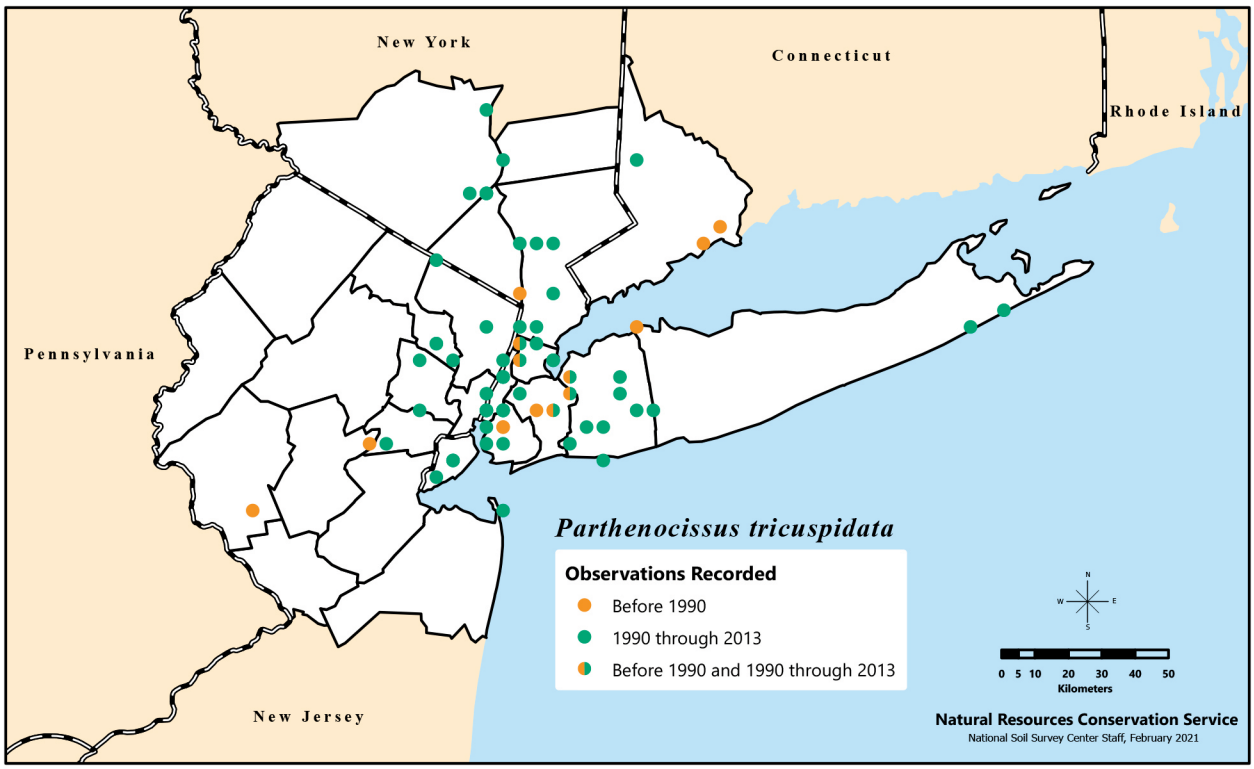
associated with a vine species, *Hedera helix* (Hattenschwiler and Korner 2003); however, a study in WI found no increases in *P. quinquefolia* in forest interiors, suggesting that light remains the most limiting factor for this species (Londré and Schnitzer 2006). Increases in *P. quinquefolia* may indicate an increase in more fragmented woodlands and forests. Invasive in China (Liu et al. 2008).

Nonnative Species

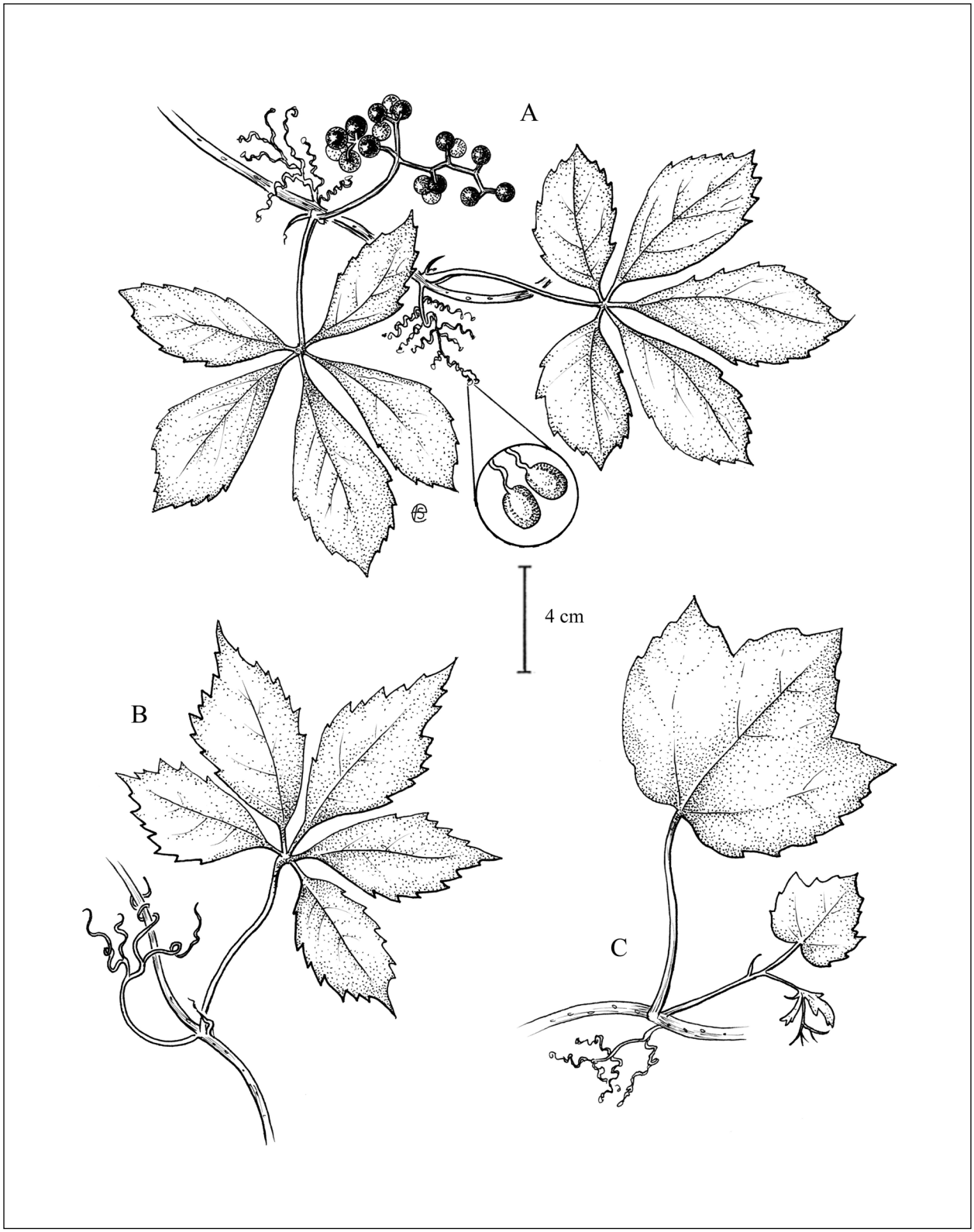
3. *Parthenocissus tricuspidata* (Siebold & Zucc.) Planch. – Boston ivy ↑↑

Ampelopsis tricuspidata Siebold & Zucc.; *Psedera tricuspidata* Rehder

Flowering May–July; fruiting Sept.–Oct. Native to Asia. Cultivated, often as a wall cover, and occasionally found as a remnant from cultivation or escape. This is the ivy that covers the outfield wall in Wrigley Field, Chicago, IL. Has similar tolerance to a variety of conditions as *Parthenocissus quinquefolia*, but possibly not as hardy (Dirr 1998). First imported to the U.S. in 1862 (Rehder 1949), with at least 9 cultivars (Dirr 1998). A carrier of Pierce's disease of grapes caused by the bacterium *Xylella fastidiosa* subsp. *fastidiosa* (Freitag 1951).



Distribution of *Parthenocissus tricuspidata*, or Boston ivy, recorded in the New York Metropolitan Region during three time categories.



A) Fruiting leafy twig, with enlarged view of tendril's adhesive disks of *Parthenocissus quinquefolia*; leafy twigs with tendrils of B) *Parthenocissus inserta* and C) *Parthenocissus tricuspidata*. Illustration by Emma Skurnick.

P Q

Paulownia Siebold & Zucc. – empress tree

Paulowniaceae (Bignoniaceae s.l.; Scrophulariaceae s.l.) Trees. Species 7–10 in Asia. Distinguished by its large leaves, velvety pubescent on both sides, and panicles of large, showy, violet bilabiate flowers. Cultivated for timber and ornament. Genus name honors Anna Paulovna (spelled "Paulowna" in the early 1800s due to Dutch transliteration conventions of the time; 1795–1865), princess and queen consort of the Netherlands.

Nonnative Species

1. *Paulownia tomentosa* (Thunb.) Siebold & Zucc. – empress tree, princess tree ↑↑

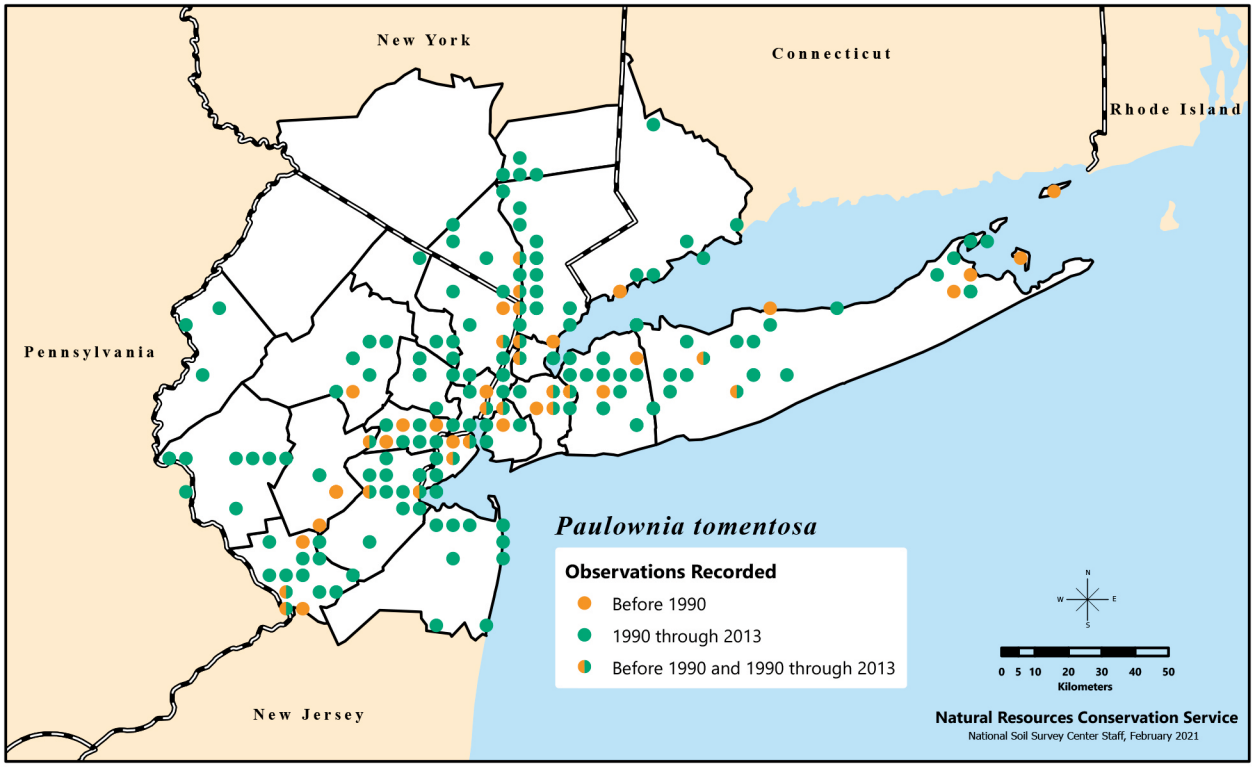
Bignonia tomentosa Thunb.

Flowering late Apr.–May (before the leaves); fruiting Sept.–Oct. (persisting on tree through winter). Disturbed woodlands, woodland edges, roadsides, railroad rights-of-way, and vacant lots. Native to China; introduced into the U.S. in 1834. A common tree in urban areas.

In Asia, 2 varieties are recognized based on pubescence on leaf undersides (densely pubescent in var. *tomentosa*, sparsely hairy in var. *tsinlingensis* (Pai) Gong Tong). Material in the region is referable to *Paulownia tomentosa* var. *tomentosa*.

Prefers moist, deep, well-drained soil, but can tolerate a wide range of soil conditions. Can grow in full sun or partial shade. Intolerant of cold; may die back at temperatures below -18 ºC. Relatively tolerant of air pollution but prefers to be protected from wind (Dirr 1998).

Earliest seed-bearing age 8–10 years (Bonner 2008k). A large tree may produce 20 million seeds annually (Dirr 1998). Though first introduced as an ornamental, this species has been planted extensively, especially in the southeastern U.S., for its specialty wood and for mine reclamation (Bonner 2008k). However, very acidic soils may



Distribution of *Paulownia tomentosa*, called empress tree or princess tree, recorded in the New York Metropolitan Region during three time categories.

deter germination of *P. tomentosa* seed (Turner et al. 1988). Seeds appear to express no or little dormancy. Light ensures timely germination, but moist cold stratification for up to 8 weeks removes the need for light (Bonner 2008k). This species does not appear to be a good competitor (Dirr 1998). Invades after a fire, but does not persist in most instances 2–6 years after the fire, except on the driest sites with exposed slopes. Unfortunately, some of these sites also contain rare species (Kuppinger et al. 2010). *Paulownia tomentosa* can take up heavy metals, making it a potentially good candidate as a remediation species (Doumett et al. 2008), except for its invasive tendencies. It may be of concern only in highly disturbed areas, such as roadsides and recently burned or harvested sites. Some have concluded that it is not invasive in forested areas (Williams 1993).

During the early stages of development, leaves are protected by glandular hairs and trichomes that secrete glycerides and trap small insects, while mature plants protect themselves with extrafloral nectaries which attract protective ants (family Formicidae) (Kobayashi et al. 2008). Nevertheless, this species is palatable to herbivores, such as goats (*Capra hircus*) and deer (*Odocoileus* spp.) (Longbrake and McCarthy 2001, Mueller et al. 2001). The ability to sprout and the relative growth rate of *P. tomentosa* grown in shade are significantly lower than found in higher light areas, but resprouting is still possible (Longbrake and McCarthy 2001). Under natural conditions *P. tomentosa* is a diploid (2n=40), but polyploidy has been artificially induced using colchicine. The resulting tetraploid differs morphologically; it has larger flowers and round leaves (Tang et al. 2010).

Wood is prized by some and is used to make bowls, spoons, furniture, coffins (Dirr 1998), houses, pulp, paper (Akyildiz and Kol 2010), and musical instruments (Ono and Norimoto 1984). In traditional Chinese medicine, the leaves and flowers of this species were used to prevent skin from wrinkling and hair from graying (Nagata et al. 2013). This species shares many characteristics with *Catalpa*, including dropping of copious amounts of flowers, fruit, and large leaves. At least 3 cultivars. Similar species are also found in the U.S. nursery trade, including *P. fargessii* Franch., *P. fortunei*, and *P. kawakamii* (Dirr 1998), and may be sold simply as *P. tomentosa* or empress tree.

Listed as potentially invasive in CT (prohibited).

Management

Paulownia tomentosa is primarily a pioneer species needing light and disturbed areas free of plant competition to establish. However, it can grow quickly and, consequently, potentially take over such sites rapidly. Despite its valuable wood and attractive flowers, it is a messy ornamental with a potential to spread and, thus, it should be removed where feasible; planting is not advised. Any sightings of escaped individuals of the tetraploid or related species should be noted.

Phellodendron Rupr. – cork tree

Rutaceae. Dioecious trees. Species 10 in Asia. Distinguished by its corky outer bark, bright yellow inner bark, opposite odd-pinnate leaves, and black berry-like (multiseeded) drupes. Cultivated for ornament, timber, and medicinal uses. Despite its common name, not used in commercial production of cork (which comes primarily from *Quercus suber* L., cork oak). Genus name is from the Greek "phellos" ("cork") and "dendron" ("tree").

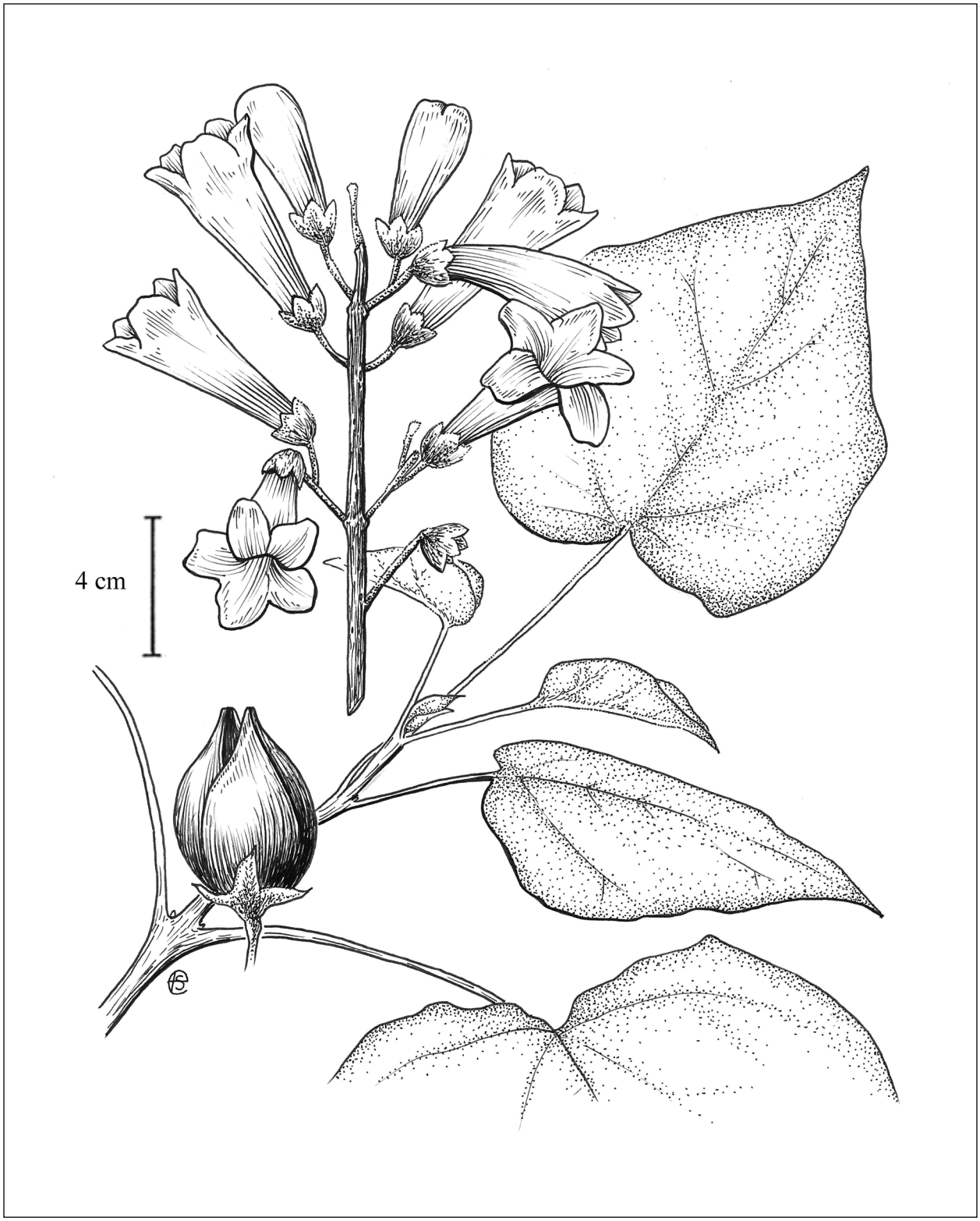
Nonnative Species

1. *Phellodendron amurense* Rupr. – Amur cork-tree ↑↑

Phellodendron japonicum Maxim.;
Phellodendron lavallei Dode;
Phellodendron sachalinense (F.Schmidt) Sarg.

Flowering mid-May–June; fruiting Sept.–Oct. (attached into winter) (Read and Zasada 2008). Woodlands, woodland edges, and roadsides. Native to China, Japan, Korea, and Russia's Far East; introduced into the U.S. in 1856.

Prefers full sun and reportedly can withstand both alkaline and acidic soil conditions, drought, and pollution (Dirr 1998). Reported as shade-intolerant and an early successional species that gives way to more shade-tolerant trees over time in its native forests (Yoshida and Kamitani 1999). However, it is found growing in several closed



Fruit, flowers, and leafy twig of *Paulownia tomentosa*. Illustration by Emma Skurnick.

canopy woodlands in the eastern U.S. (Glaeser and Kincaid 2005, Morgan and Borysiewicz 2012). Though not yet widespread in the NY Metropolitan Region, this species has increased in abundance.

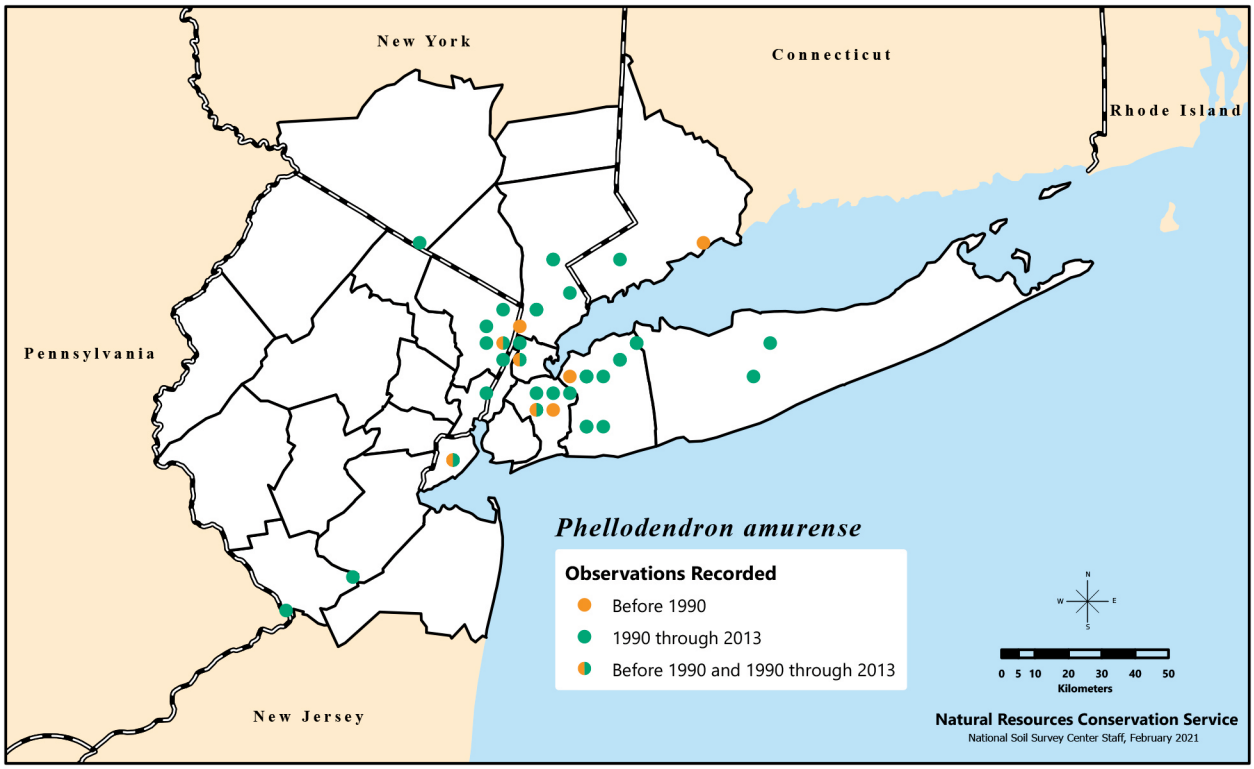
Earliest seed-bearing age 7–13 years (Read and Zasada 2008). Propagated mainly by seed, though it is transplanted easily (Dirr 1998). Fresh seeds require no pretreatment to germinate, but stored seeds may germinate better after moist cold stratification for 28–166 days. Female trees tend to be bushier than male trees (Read and Zasada 2008). This species may not be as adaptable to stressful conditions, especially pollution found in urban areas, as once thought; others have noted severe leaf scorch and defoliation by Aug. However, it appears to suffer from few insects or diseases. At least 3 cultivars (Dirr 1998). Two other nonnative similar species (here treated as synonyms of *P. amurense*) have been cultivated in the U.S.: *Phellodendron lavallei* and *P. sachalinense*, the latter of which is reportedly hardier and faster growing than *P. amurense*. The three are difficult to distinguish morphologically; some consider *P. lavallei* and *P. sachalinense* as varieties of *P. amurense* rather than separate species (Dirr 1998). Two others (*P. japonicum* and *P. chinense*) are also cultivated in the U.S. and may be difficult to distinguish from *P. amurense* (Glaeser and Kincaid 2005). Currently only *P. amurense* and *P. chinense* are recognized (Ma et al. 2006).

This species is endangered in China due to excessive harvesting for medicinal uses (Wan et al. 2014). It has also shown signs of declining in Tokyo, Japan, possibly due to a fungal species (*Cylindrocladium colhounii*), which causes severe leaf blight and leaf abscission (Watanabe et al. 1995). These symptoms sound similar to the ones described by Dirr (1998) in preceding paragraph in response to supposedly stressful conditions. The same fungus may affect trees in the U.S.

The bark of *P. amurense* is a source of berberine, which is used for stomach aches, controlling intestinal functions, and as an anti-inflammatory (Ida et al. 1993).

Listed as invasive in NY (prohibited).

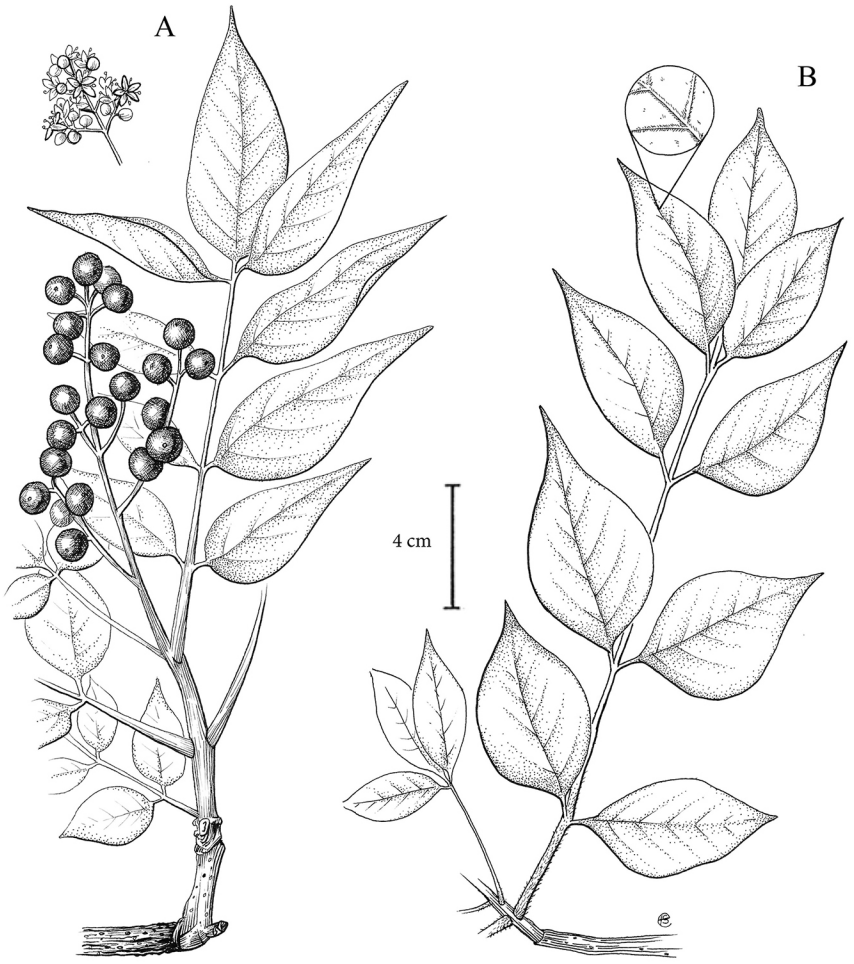
P Q



Distribution of *Phellodendron amurense*, or Amur cork-tree, recorded in the New York Metropolitan Region during three time categories.

Management

Phellodendron amurense, or perhaps related species, can spread in the region, even in shady forested woodlands. Consequently, though *Phellodendron amurense* may still be described as a good ornamental tree, we advise that planting of this species and related species be discontinued. Early leaf fall thought to be related to urban air pollution may be due to a fungal infection that has been causing significant declines of this species in its native Japan. If true, this fungus has unknown affinities and could be harmful to other plant species in the U.S. The research to confirm the presence of this fungus in U.S. *P. amurense* trees has yet to be completed. Additional research that we consider important before we can understand the potential invasiveness of *P. amurense* includes its genetic make-up and whether it has hybridized with related species listed earlier.



A) Male flowers and fruiting leafy twig, and B) leafy twig with enlarged view of leaf midrib and punctate glands of *Phellodendron amurense*; this glandular material sometimes held distinct as *Phellodendron japonicum*. Illustration by Emma Skurnick.

Philadelphus L. – mock orange

Hydrangeaceae. Shrubs. Species about 80 in temperate Northern Hemisphere in Asia, Europe (1), and North America (9). Distinguished by its opposite cucumber-scented leaves, usually fragrant (not in *Philadelphus inodorus* L. and *P. pubescens* Loisel.) white protogynous flowers. Cultivated for ornament. Native Americans used the stems for basketry, arrows, combs, and pipes (Crowder 2003). Sometimes locally referred to as "Philadelphia bush," the genus name presumed to honor Philadelphia, PA, but etymology of genus name uncertain; it may honor Ptolemy Philadelphus (283–247 B.C.), king of Egypt (Moore 2016). Another common name for the group, syringa, causes confusion as this is the correct genus name for the lilacs (see discussion under *Syringa* entry).

Nonnative Species

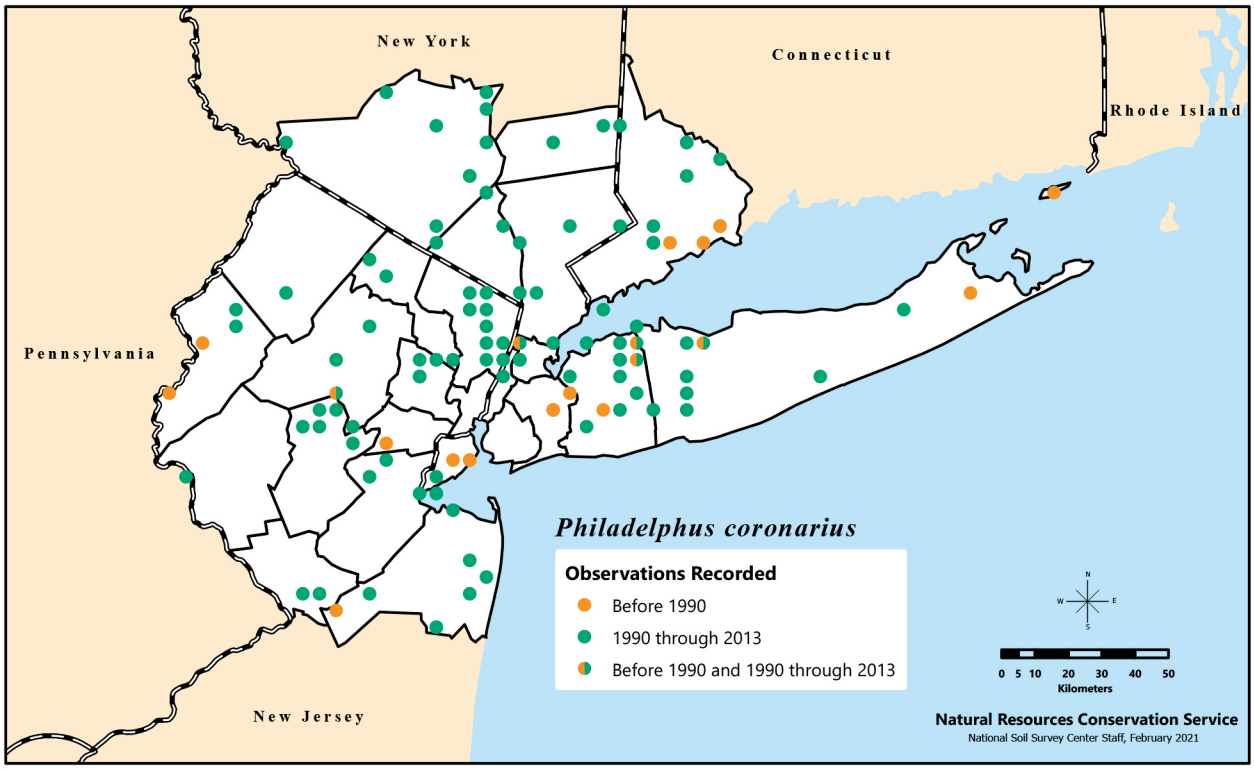
1. *Philadelphus coronarius* L. – sweet mock-orange ↑↑↑

Flowering mid-May–mid-June. Native to Asia and Europe. Cultivated, occasionally escaping and found along woodland edges, roadsides, and old homesteads. Increase may be due to invasive tendencies (DeCandido and Lamont 2004, Schaefer and Hocking 2015). Epithet means "suitable for a wreath."

Philadelphus Key

1. Bark brown, peeling; leaves pubescent beneath in axils of veins, along veins, and extending onto blade; flowers fragrant . . . . . ***Philadelphus coronarius****
1. Bark gray, not peeling; leaves pubescent beneath in axils of veins and along veins only, not extending onto blade; flowers not fragrant . . . . . ***Philadelphus inodorus****

P Q



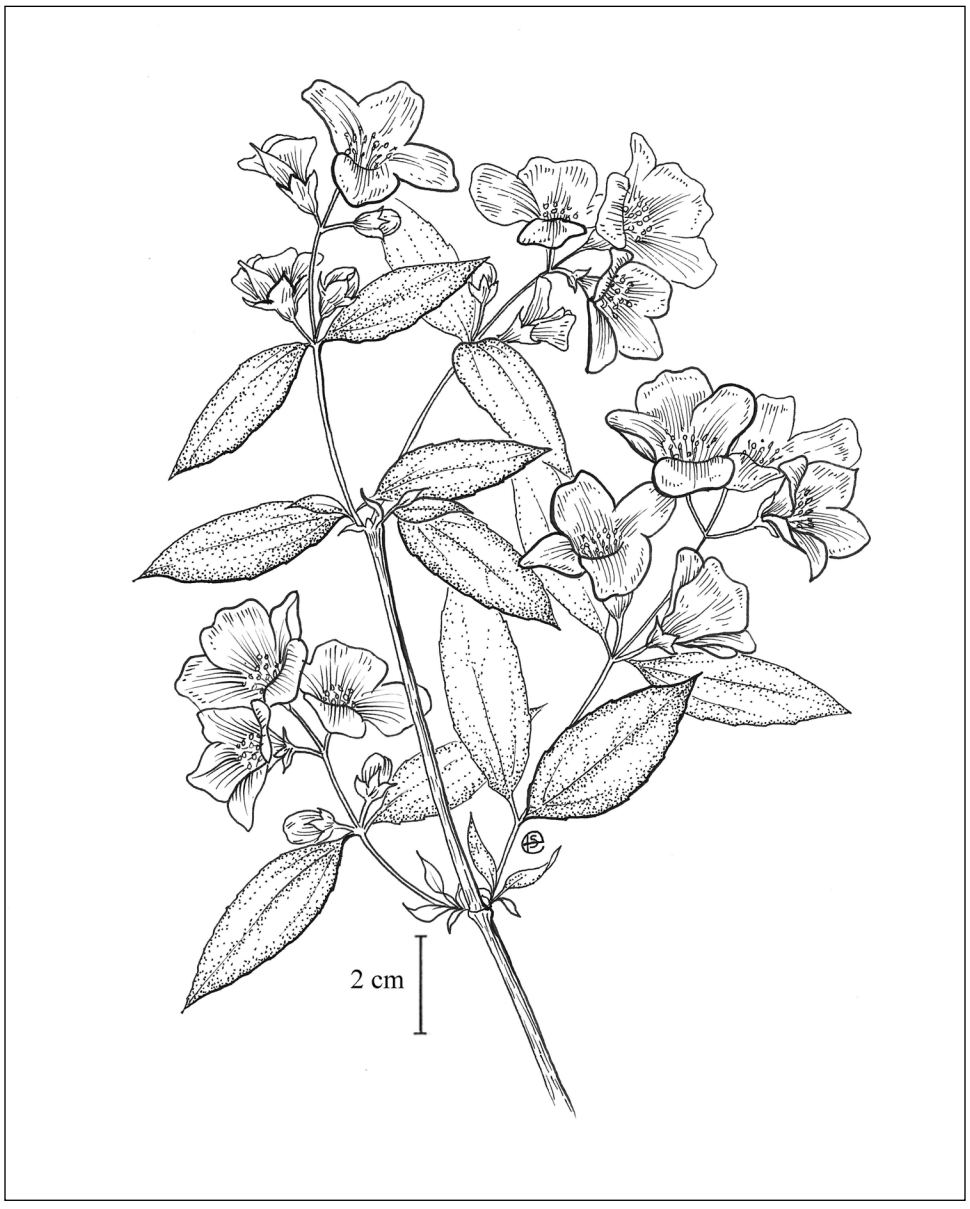
Distribution of *Philadelphus coronarius*, or sweet mock-orange, recorded in the New York Metropolitan Region during three time categories.

2. *Philadelphus inodorus* L. – Appalachian mock-orange Ø

Flowering May. Native to the southeastern U.S. Cultivated, remnant of cultivation, or possibly escaping and found along woodland edges and roadsides; reports possibly from Bergen County (NJ) and Bronx, Nassau, New York, and Suffolk Counties (NY). Reported from outside the region in CT.

***3. Philadelphus pubescens* Loisel. – hoary mock-orange Ø**

Native to the southeastern U.S. and occasionally cultivated; may also be encountered as a remnant from cultivation or casual escape, with a report of a possibly naturalized population from Orange County (NY). Like *Philadelphus coronarius*, it has leaves with densely pubescent undersides and flowers 5–9 in racemes; however, like *P. inodorus*, it has gray bark that does not peel, and its flowers are not fragrant.



Flowering leafy twig of *Philadelphus coronarius*. Illustration by Emma Skurnick.

Phoradendron Nutt. – mistletoe, false mistletoe

Santalaceae (Loranthaceae s.l.; Viscaceae s.l.). Parasitic shrub or half shrub (low-growing shrub). Species 190–200 in chiefly tropical North America, South America, and the West Indies. Genus name is from the Greek "phor" ("thief") and "dendron" ("tree"), in reference to its parasitic habit.

Native Species

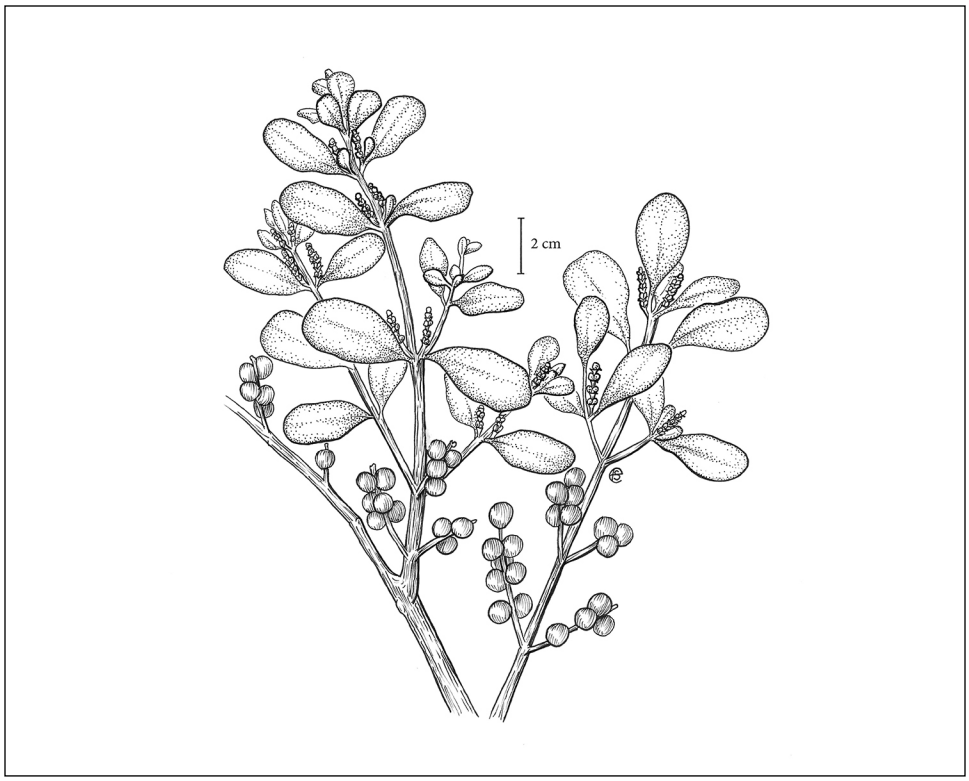
1. *Phoradendron leucarpum* (Raf.) Reveal & M.C.Johnst. – American mistletoe, Christmas mistletoe Ø

Viscum leucarpum Raf.; *Phoradendron flavescens* (Pursh) Nutt. ex A.Gray; *Phoradendron serotinum* (Raf.) M.C.Johnst.; *Viscum flavescens* Pursh; *Viscum serotinum* Raf.

Flowering Sept.–Oct; fruiting Oct.–Nov. of the next year. Epithet means "white-" ("leu") "fruited" ("carpum"), a reference to the white drupe fruits. Parasite on numerous tree species but limited to the following in the region: *Acer rubrum*, *Acer saccharinum* (only one report: Arsenault in Gordon 2011), *Liquidambar styraciflua* (Lockwood 1884), and *Nyssa sylvatica* (Spooner 1983), the last being the most common host species. Reaches the northern limit of its range in the region. Although many known extant locations in southern NJ, including adjacent Burlington and Ocean Counties, no extant populations currently known in the NY Metropolitan Region.

In a detailed note Weldy et al. (2020) accept the historical reports from the 1800s for Staten Island as credible. There are also confirmed historical records from the region in NJ from Monmouth and Middlesex Counties (Snyder 1984) and possibly Mercer County. Thus, Britton's (1884) observation that the "probability" that *Phoradendron leucarpum*'s "northward extension along the Atlantic Coast was formerly greater than at present" appears to also hold true today (Spooner 1983). This northern range contraction of a southern species is contrary to the general patterns that other species are showing (i.e., contraction of the southern and low-elevation ranges of boreal and high-elevation species; expansion of the northern range limits of southern species).

Listed as extirpated in NY (SX).



Flowering and fruiting leafy twig of *Phoradendron leucarpum*. Illustration by Emma Skurnick.

Photinia Lindl. – photinia

Rosaceae. Trees, shrubs. Species 40–60 in Asia and North America (Mexico); introduced in Australia, Europe, North America, and the Pacific Islands. Distinguished from other members of the rose family with pome fruits in that its pomes lack sclereid cells and its stipules are free from the petiole and deciduous. *Aronia* sometimes included in *Photinia*, but here treated as distinct. Genus name is from the Greek "photeinous" ("shining"), a reference to the shiny leaves.

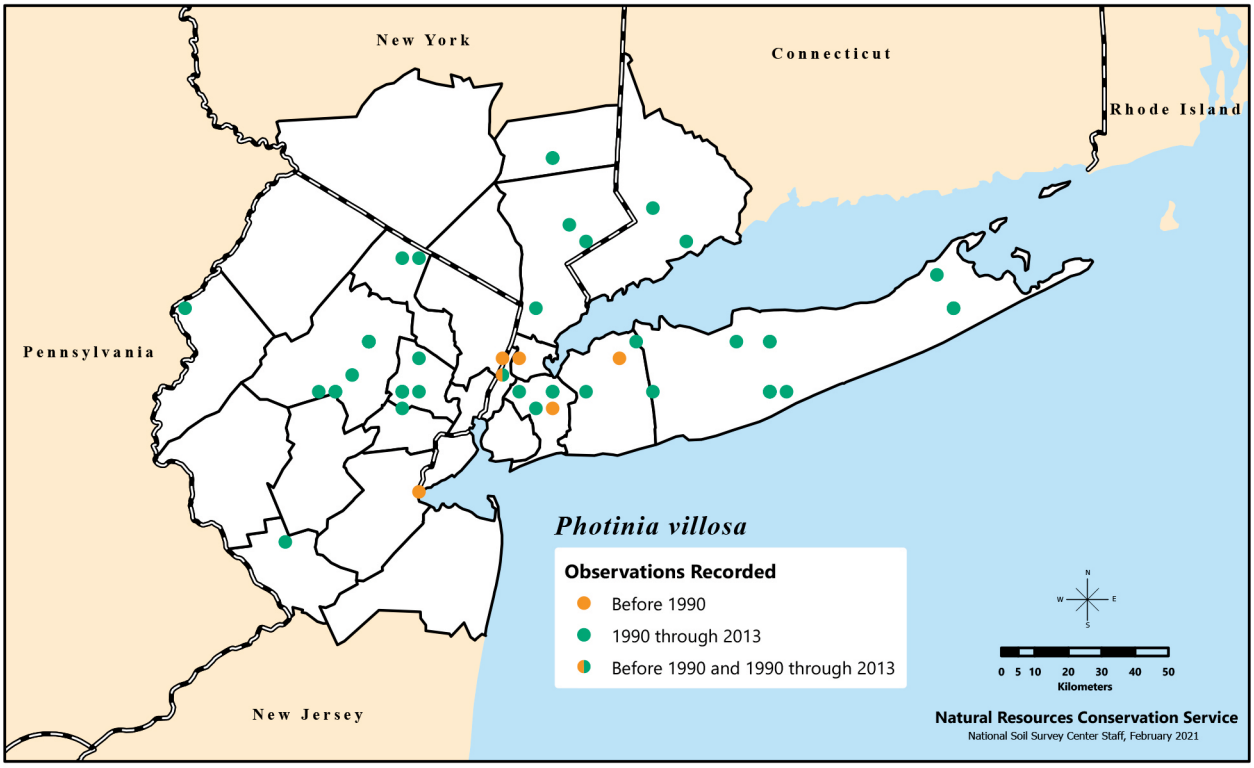
Nonnative Species

1. *Photinia villosa* (Thunb.) DC. – photinia ↑↑↑

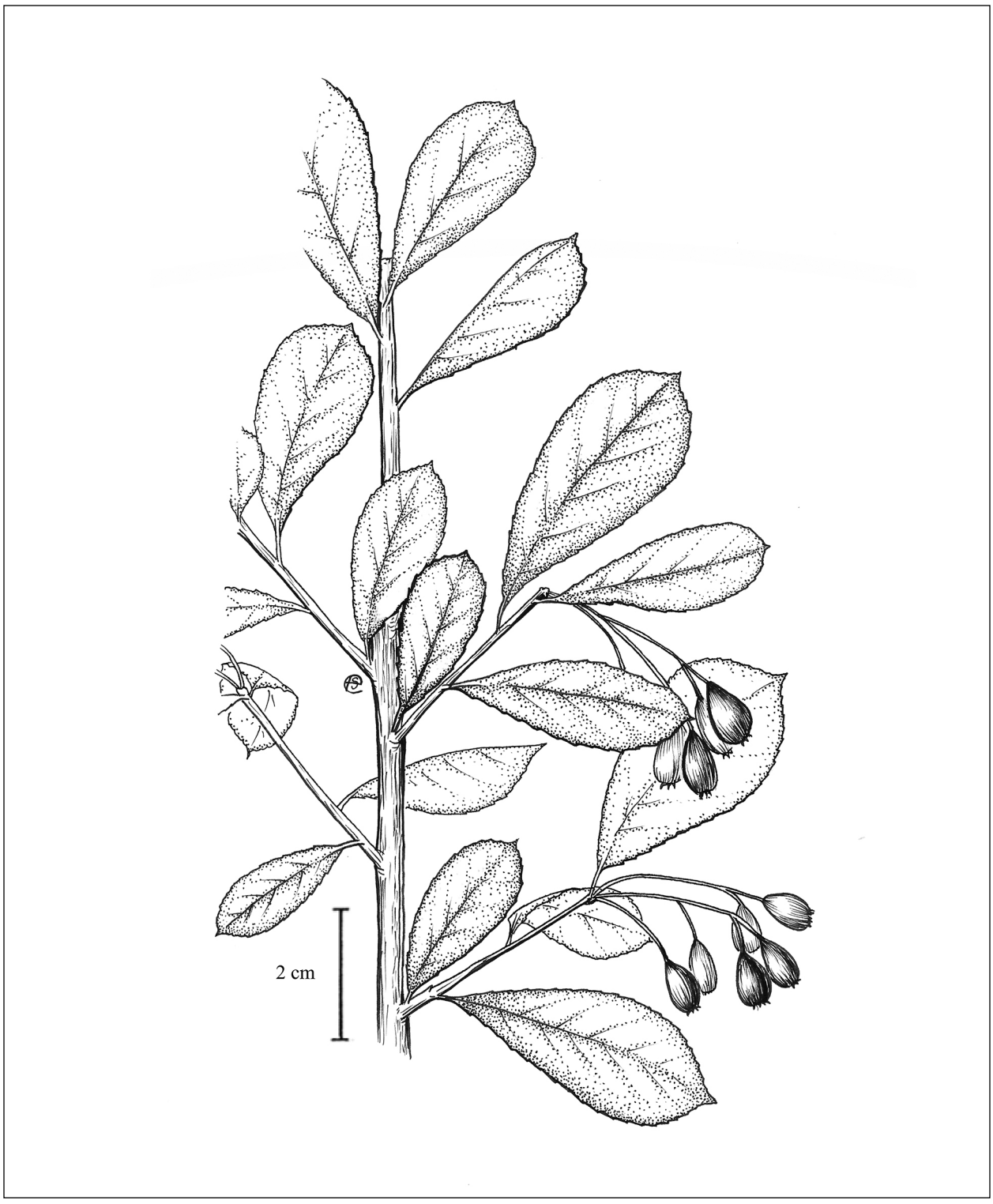
Crataegus villosa Thunb.

Flowering May–June; Sept.–Oct. Edges of woodlands, fields, and thickets. Native to Asia (China, Japan, Korea). Considered invasive in NJ (Connolly and Brand 2016). However, very little information available in the literature. Epithet refers to the villousness of the young branchlets, petioles, leaves, pedicels, ovary, and fruit.

Tracked as potentially invasive in NJ (category 2).



Distribution of *Photinia villosa*, or photinia, recorded in the New York Metropolitan Region during three time categories.



Fruiting leafy twig of *Photinia villosa*. Illustration by Emma Skurnick.

Physocarpus (Cambess.) Raf. – ninebark

Spiraea sect. *Physocarpus* Cambess.

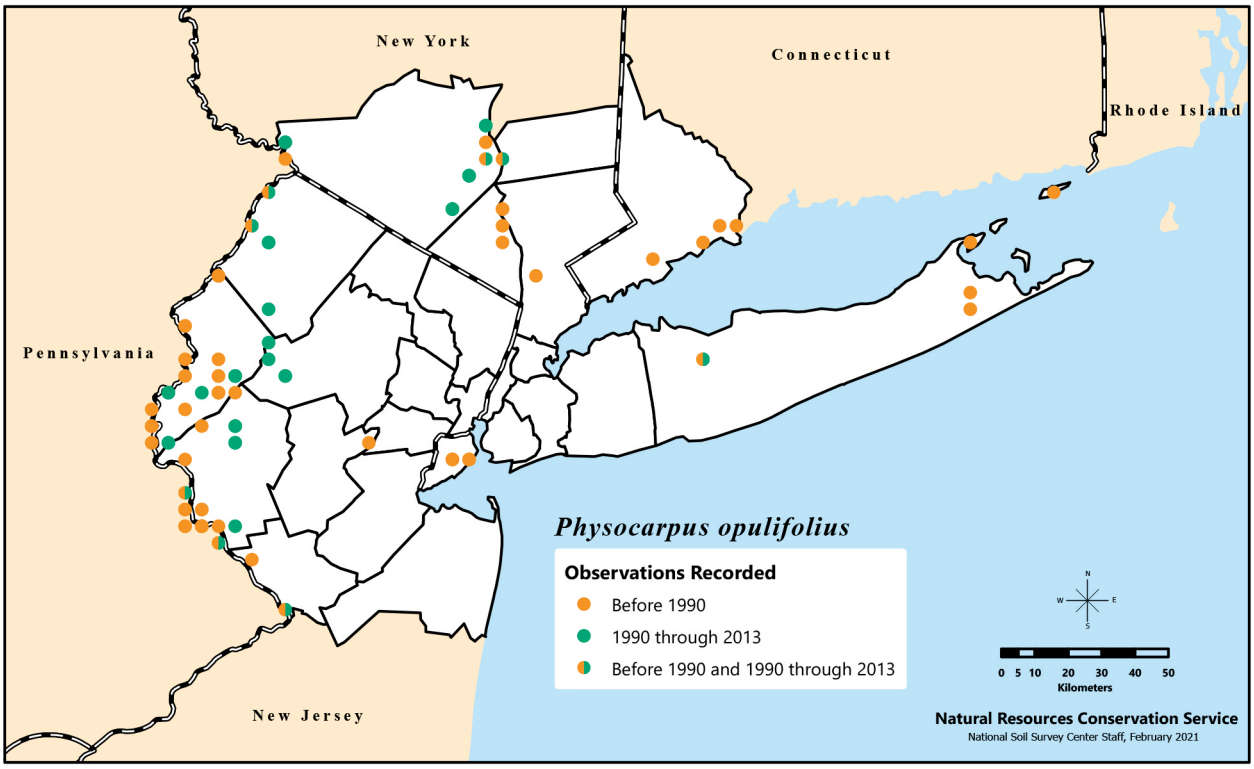
Rosaceae. Shrubs. Species 20 in Asia and North America. Distinguished from other members of the rose family in that its leaves have palmate venation, carpels are united at base, and fruit ripen collectively to form connate (like organs grown together) carpels from different flowers. Sometimes planted as an ornamental. Genus name is derived from the Greek "physa," ("bellows") and "karpos" (fruit) in reference to the fruit, an aggregate of inflated follicles.

Native Species

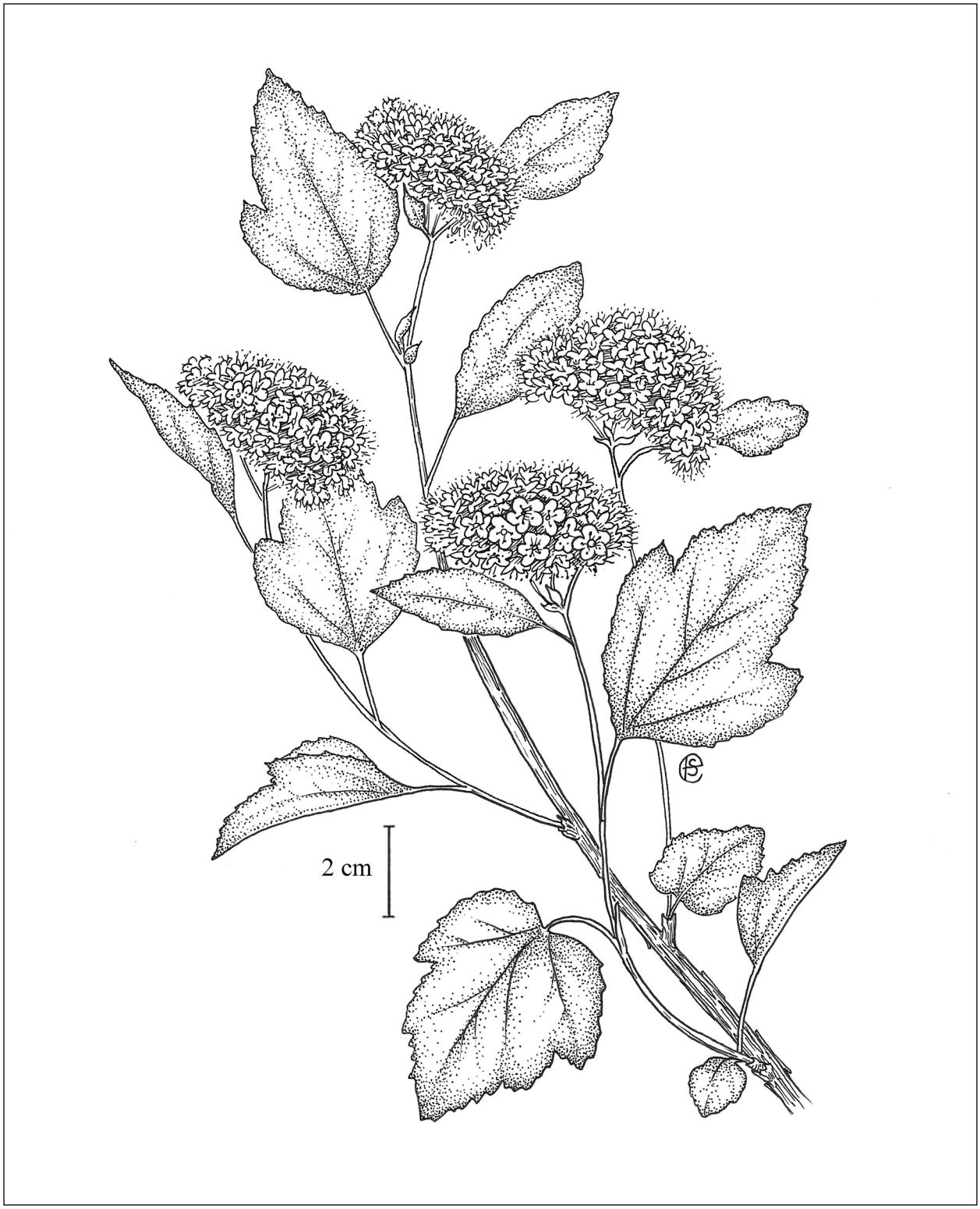
1. *Physocarpus opulifolius* (L.) Maxim. – ninebark ↓

Spiraea opulifolia L.

Flowering May–June. Woodlands, woodland edges, and streamsides on sandy or rocky ground. Cultivated; some material may represent remnants from cultivation or escapes. Cultivated since 1687, with at least 7 cultivars. Grows in full sun or partial shade (Dirr 1998). Native populations best represented in the valleys of the Delaware, Hudson, and Raritan Rivers. Epithet from Latin refers to the similarity of the leaves to those of *Viburnum opulus*. Reasons for decline in the region are unclear.



Distribution of *Physocarpus opulifolius*, or ninebark, recorded in the New York Metropolitan Region during three time categories.



Flowering leafy twig of *Physocarpus opulifolius*. Illustration by Emma Skurnick.

Picea A.Dietr. – spruce

Pinaceae. Coniferous trees. Species about 35 in Asia, Europe, and North America. Genus name from Latin "pix," meaning "pitch," a reference to the resin that is derived from some coniferous trees, especially *Pinus*.

Native Species

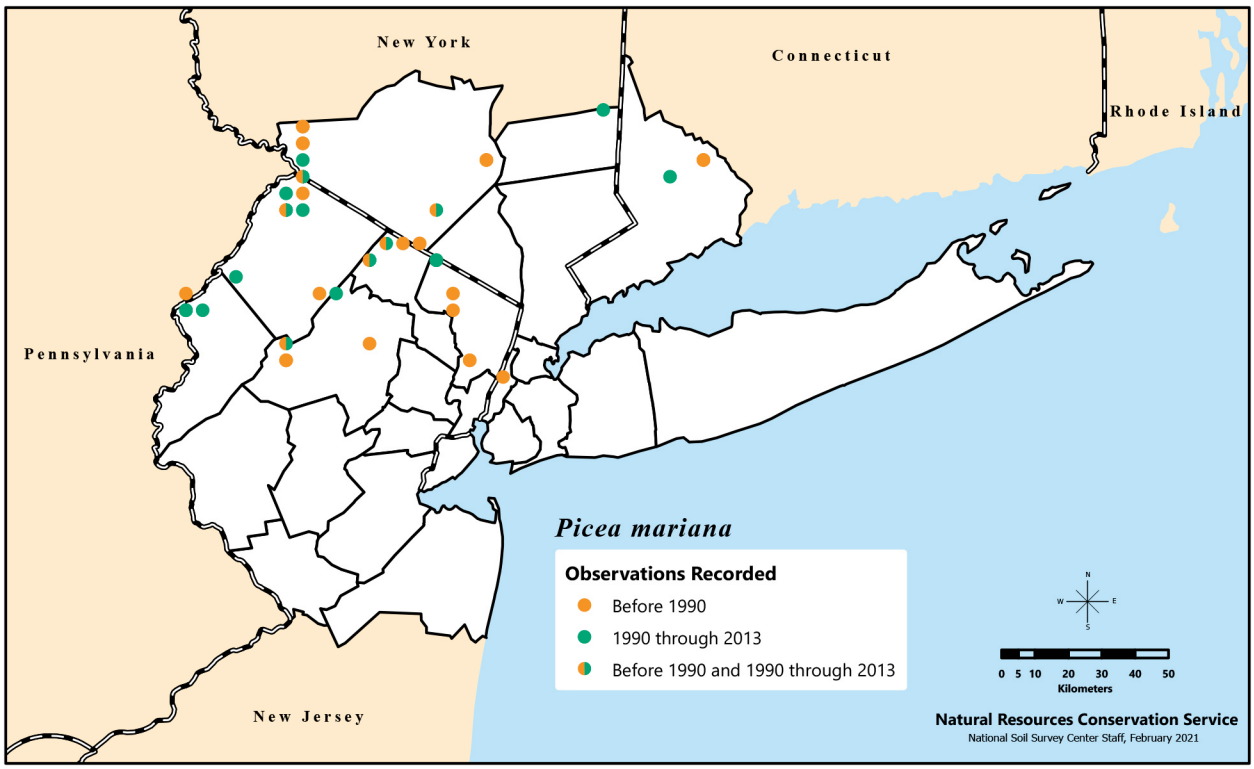
1. *Picea mariana* (Mill.) BSP. – black spruce ↔

Abies mariana Mill.

Pollen cones maturing in May; seed cones maturing in fall of the same year. Cones can

Picea Key

1. Twigs glabrous 2
1. Twigs pubescent 3
2. Leaves 2–4 cm long, spreading at right angles from the branch . . . . . ***Picea pungens****
2. Leaves 0.8–2 (–2.5) cm long, arching forward from the branch 4
3. Decurrent ridges on twigs below needle attachment flattened on top side; cones generally less than 2.5 cm. . . . . ***Picea mariana***
3. Decurrent ridges on twigs below needle attachment rounded on top side; cones generally 2.5 cm or longer . . . . . ***Picea rubens***
4. Leaves not malodorous when crushed; winter buds acute. . . . . ***Picea abies****
4. Leaves malodorous when crushed; winter buds obtuse. . . . . ***Picea glauca****



Distribution of *Picea mariana*, or black spruce, recorded in the New York Metropolitan Region during three time categories.

P Q

persist on the tree for many years. Bogs, swamps, and hillsides at boreal and higher elevations (Greene and Johnson 1999). Somewhat rare in the region. Epithet refers to Maryland, a state not in the species' range; however, the English botanist Philip Miller (1691–1771), who originally described this species, used the epithet to mean "North American."

Prefers cold climates; restricted to cold sphagnum bogs in the southernmost part of its range, which includes the NY Metropolitan Region. Cultivated since 1700, with at least 4 cultivars. Planted as a landscape tree, albeit less frequently than other spruces (Dirr 1998). Earliest seed-bearing age 10 years; large seed crops every 4 years. Cones are semiserotinous and release seeds throughout the year for several years. Height at maturity 9–27 m (Youngblood and Safford 2008).

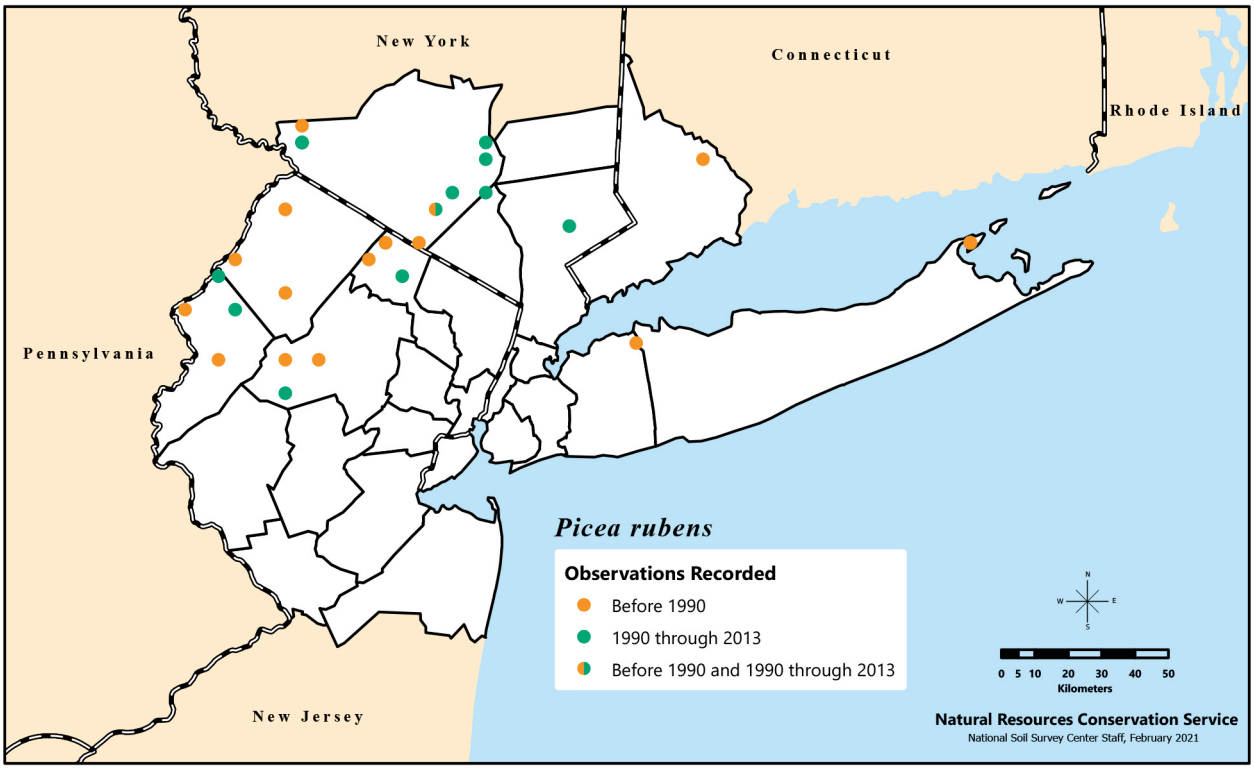
2. *Picea rubens* Sarg. – red spruce ↔
(see *Larix* plate on p. 272 for illustration)

Picea rubra (DuRoi) Link 1831 non A.Diet. 1824; *Pinus mariana* var. *rubra* DuRoi

Pollen cones maturing in May; seed cones maturing in fall of the same year. Cones can persist on the tree for many years. Boreal species found in bogs and mesic woodlands, usually in rocky areas at higher elevations (Pastor et al. 1987). Currently the species is not known from the Coastal Plain, but historically it was reported from Long Island (Taylor 1915). Epithets used by American botanist Charles Sprague Sargent (1841–1927) and German doctor and botanist Johann Phillip Du Roi (1741–1785) refer to the reddish-brown color of the mature female cones.

Earliest seed-bearing age 30–50 years; large seed crops every 3–8 years. Height at maturity 21–30 m (Youngblood and Safford 2008). Though used as a landscape tree since 1750, it is not well suited for cultivation and not planted as often as many other spruce trees (Dirr 1998). Species is exceptionally rare throughout the region.

Listed as endangered in NJ (S1).



Distribution of *Picea rubens*, or red spruce, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Bergen, Hudson, and Hunterdon Counties (NJ) and Putnam and Rockland Counties (NY).

Nonnative Species

3. *Picea abies* (L.) Karst. – Norway spruce ↑↑↑

Pinus abies L.

Pollen cones maturing in May; seed cones maturing in fall of the same year, falling the next year. Native to northern and central Europe; widely used in landscape plantings. Often encountered in the region as a remnant from cultivation, but many seedlings and saplings escaping from cultivation are also found.

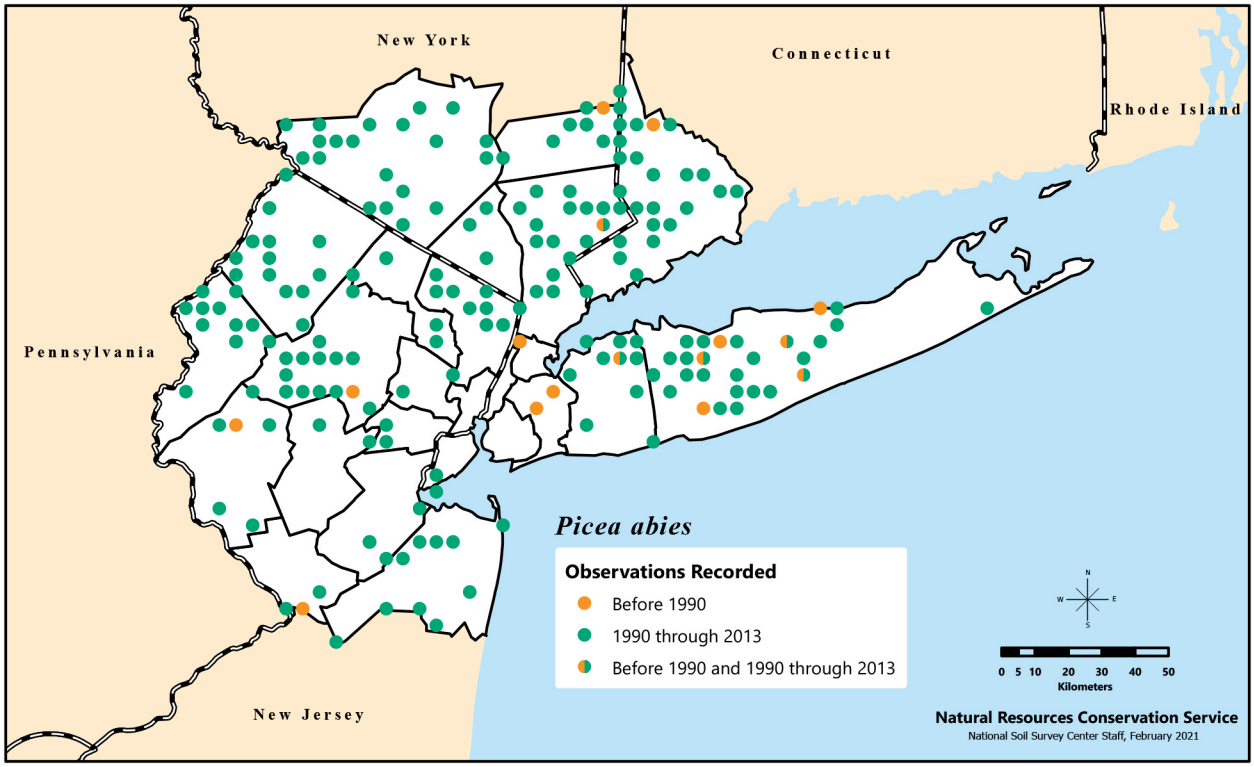
Earliest seed-bearing age 40–60 years; large seed crops every 4–13 years. Frequency of seed production and overall growth may decline with increasing elevation (Oleksyn et al. 1998). Height at maturity 30–60 m (Youngblood and Safford 2008). Prefers moist, well-drained acidic and sandy soils, cold climates, and full sun, though it can survive in less optimal conditions. Susceptible to budworms (*Choristoneura fumiferana*) and borers, red spiders (family Tetranychidae), and spruce or pineapple gall aphids (*Adelges abietis*). Has been in the U.S. since colonial times and is still planted, perhaps overplanted, as a landscape tree with possibly 120 or more cultivars (Dirr 1998). The most widely cultivated spruce in North America and widely naturalized, though not labeled as invasive (Richardson and Rejmánek 2004).

4. *Picea glauca* (Moench) Voss – white spruce Ø

Pinus glauca Moench

Pollen cones maturing in May; seed cones maturing and falling (after the seeds have been released) in late summer to fall of the same year. Native north of the region. Epithet from Latin refers to the needles, which can be glaucous.

Earliest seed-bearing age 30 years; large seed crops every 2–13 years (Youngblood and Safford 2008). Height at maturity 15–30 m (Youngblood and Safford 2008). Planted as a landscape tree since 1700, with at least 27 known cultivars. Grows in a variety of different conditions but prefers moist loam or alluvial soils and full



Distribution of *Picea abies*, or Norway spruce, recorded in the New York Metropolitan Region during three time categories.

P Q

sun. It is one of the most tolerant of all the spruces and can survive heat, cold, drought, and wind. Susceptible to red spiders, trunk and root rot, spruce bagworms (*Thyridopteryx ephemeraeformis*), and European spruce sawflies (*Gilpinia hercyniae*) (Dirr 1998). The few records from the region in Passaic and Sussex Counties (NJ) and Nassau, Orange, and Rockland Counties (NY) are likely escapes or persistent from cultivation. Also reported from outside the region in CT.

5. *Picea pungens* Engelm. – Colorado blue spruce Ø

Pollen cones maturing in May; seed cones maturing in fall of the same year. Native to the West in montane forests. Introduced elsewhere in the U.S. around 1862. Epithet refers to the needles, which terminate in a hard, sharp point.

Earliest seed-bearing age 20 years; large seed crops every 1–3 years. Height at maturity 21–50 m (Youngblood and Safford 2008). A popular, perhaps overplanted, landscape tree with at least 45 cultivars. Highly adaptable to different environmental conditions; drought-tolerant, though it prefers rich, moist soil, and full sun. Susceptible to several diseases and insects including spruce gall aphids, spruce budworms (*Choristoneura fumiferana*), and spider mites (*Tetranychus urticae*) (Dirr 1998). The few records from the region from Nassau, Orange, Rockland, and Suffolk Counties (NY) most likely represent escapes or persistent from cultivation.

Management

Though escapes and naturalized populations are documented for both *Picea abies* (more common) and *P. pungens*, neither species is considered an invasive species of concern (Richardson and Rejmánek 2004). Despite being planted frequently in the past, they are less favored as landscape trees currently. Indeed, the natives *P. glauca* and *P. mariana*, though not planted as often historically, should perform just as well if not better as landscape trees in the region. We advise planting these natives, though conservatively, with a diverse selection of other landscape trees.

Pinus L. – pine

Pinaceae. Evergreen trees or shrubs. Species more than 100 throughout the Northern Hemisphere (1 species in Sumatra occurring south of the equator): northern Africa, Asia, Europe, and North America. Within the NY Metropolitan Region, several species are pioneer species, requiring fire or other disturbance types to regenerate. Pines are monoecious and wind pollinated with staminate cones shedding pollen between Apr. and June. *Pinus banksiana* is an early successional species and invades areas where mineral soils have been exposed by disturbances such as fire (Hosie 1979). Many mycorrhizal species representing nine genera (*Amanita*, *Boletus*, *Cenococcum*, *Gomphidius*, *Lepiota*, *Paxillus*, *Rhizopogon*, *Russula*, *Scleroderma*) are known to form associations with the roots of pine trees (Hepting 1971). Shoestring fungus (*Armillaria mellea*) and annosum root rot (*Heterobasidion annosum*) are two major root rot fungal infections of *Pinus* spp. (Skilling 1981). Southern pine beetle (*Dendroctonus frontalis*), now in the region, may pose a threat (Gilrein 2016). Pines are also sensitive to ozone damage, some more so than others (Phillips and Skelly 1975). Pines provide crucial habitat for several endangered birds (Conner et al. 1991). *Pinus* is the classical Latin name for the group.

Native Species

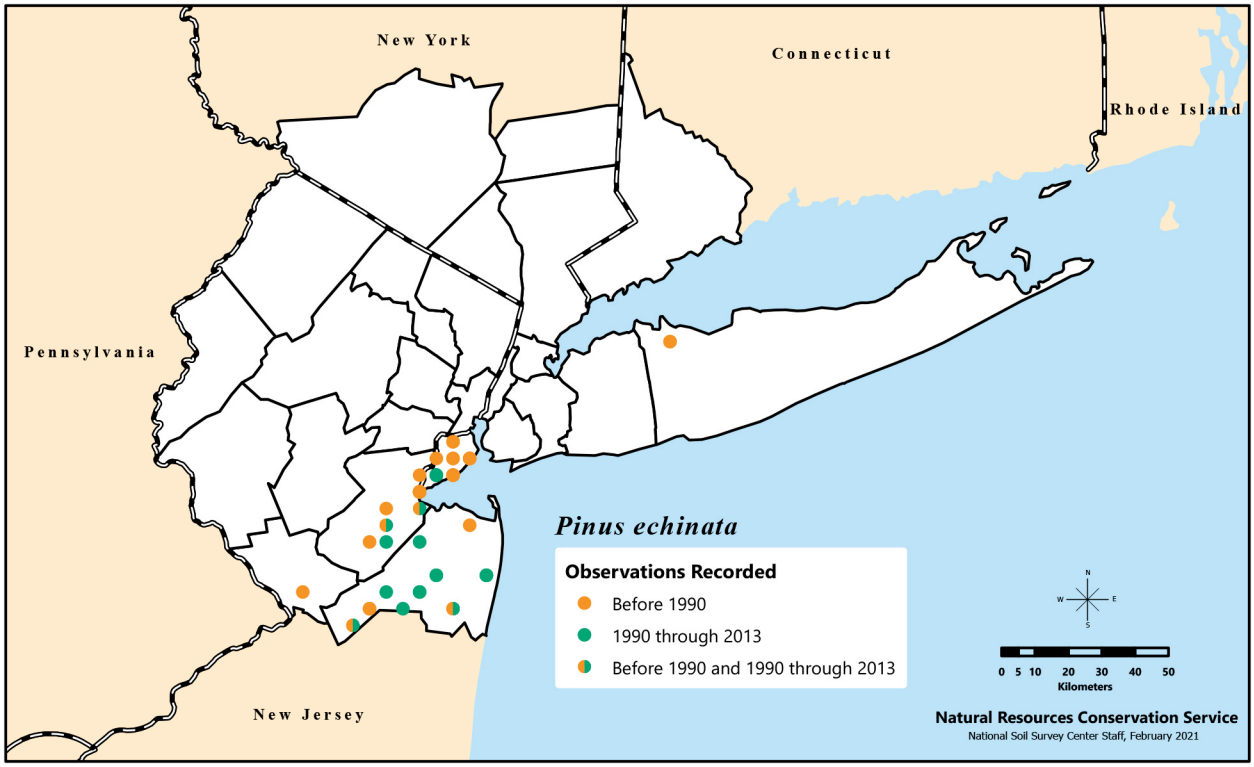
1. *Pinus echinata* Mill. – shortleaf pine, yellow pine ↔

Pollen cones maturing May; seed cones maturing in fall of the next year. Cones can persist on the tree for many years. Dry, rocky or sandy soils. Reaches the northern limit of its range in NJ, NY, and PA. Epithet means “spiny” and refers to the prickle on the face of the cone scale (umbo).

Earliest seed-bearing age 5–20 years; cone crops every 3–10 years. Height at maturity 2–30 m. Cultivated since 1726 (Krugman and Jenkinson 2008). Because of its adaptability, *Pinus echinata* has potential for rehabilitating eroded areas and mine sites (Lawson 1990). Important timber species in southern U.S. (Dirr 1998). The Federally endangered red-cockaded woodpecker

Pinus Key

1. Leaves in clusters of 5, wood soft, not very resinous . . . . . ***Pinus strobus***
1. Leaves in clusters of 2 or 3, wood hard, strongly resinous 2
2. Umbo without a terminal spine or with a minute spine 3
2. Umbo with a terminal spine or prickle 7
3. Leaves 9–16 cm long 4
3. Leaves 2–7 cm long 6
4. Resin ducts marginal . . . . . ***Pinus resinosa***
4. Resin ducts medial 5
5. Cones 5–8 cm long, apophysis strongly keeled . . . . . ***Pinus nigra****
5. Cones short stalked, 4–6 cm long, apophysis flattened . . . . . ***Pinus thunbergii****
6. Cones more or less erect; leaves 2–3.5 cm long . . . . . ***Pinus banksiana****
6. Cones reflexed; leaves 3–7 cm long. . . . . ***Pinus sylvestris****
7. Cone scales with a triangular, spreading, upcurved spine 3–8 mm long . . . . . ***Pinus pungens***
7. Cone scales with a triangular spine 1–3 mm long 8
8. Leaves usually in threes, 7–12 cm long; twigs brown, glaucous. . . . . ***Pinus rigida***
8. Leaves in twos 9
9. Leaves 7–12 cm long, twigs pale. . . . . ***Pinus echinata***
9. Leaves 4–7 cm long, twigs purplish brown . . . . . ***Pinus virginiana***



Distribution of *Pinus echinata*, called shortleaf or yellow pine, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Westchester County (NY).

(*Dryobates borealis*; found in the southeastern U.S. and not in the NY Metropolitan Region) lives in old-growth *P. echinata* with decayed heartwood (Conner et al. 1991). Future changes in climate could make this association relevant.

Except for Middlesex and Monmouth Counties (NJ), the species is exceptionally rare in the region.

Listed as endangered in NY (S1).

2. *Pinus pungens* Lamb. – Table Mountain pine Ø

Pollen cones maturing May–June; seed cones maturing in fall of the next year. Cones can persist on the tree for many years. Dry or rocky soil, mainly on mountain slopes. Epithet is an allusion to the sharp pointed spine on the face of the cone scale (umbo).

Earliest seed-bearing age 5 years. Height at maturity 9–18 m. Cultivated since 1804 (Krugman and Jenkinson 2008). Endemic to the central and southern Appalachian Mountains; may produce self-maintaining, nonsuccessional populations on dry, exposed ridges and steep slopes. May colonize more-mesic sites after a fire. Fire-resilient; cones are serotinous. With decreasing fire frequency in the Appalachian region, *Pinus pungens* may be decreasing in importance, though there is evidence that shallow pine litter and canopy openings may help maintain populations of *P. pungens* (Williams and Johnson 1992). In the region, the species is known only from one location in Hunterdon County (NJ).

Listed as endangered in NJ (S1.1).

3. *Pinus resinosa* Aiton – red pine, Norway pine ↑

Pollen cones maturing May–June; seed cones maturing in fall of the next year. Boreal, northern species (Bergeron and Dubue 1988) found in dry woods; sandy or rocky soil. Some material may represent naturalized material. Epithet refers to the resinous nature of the tree.

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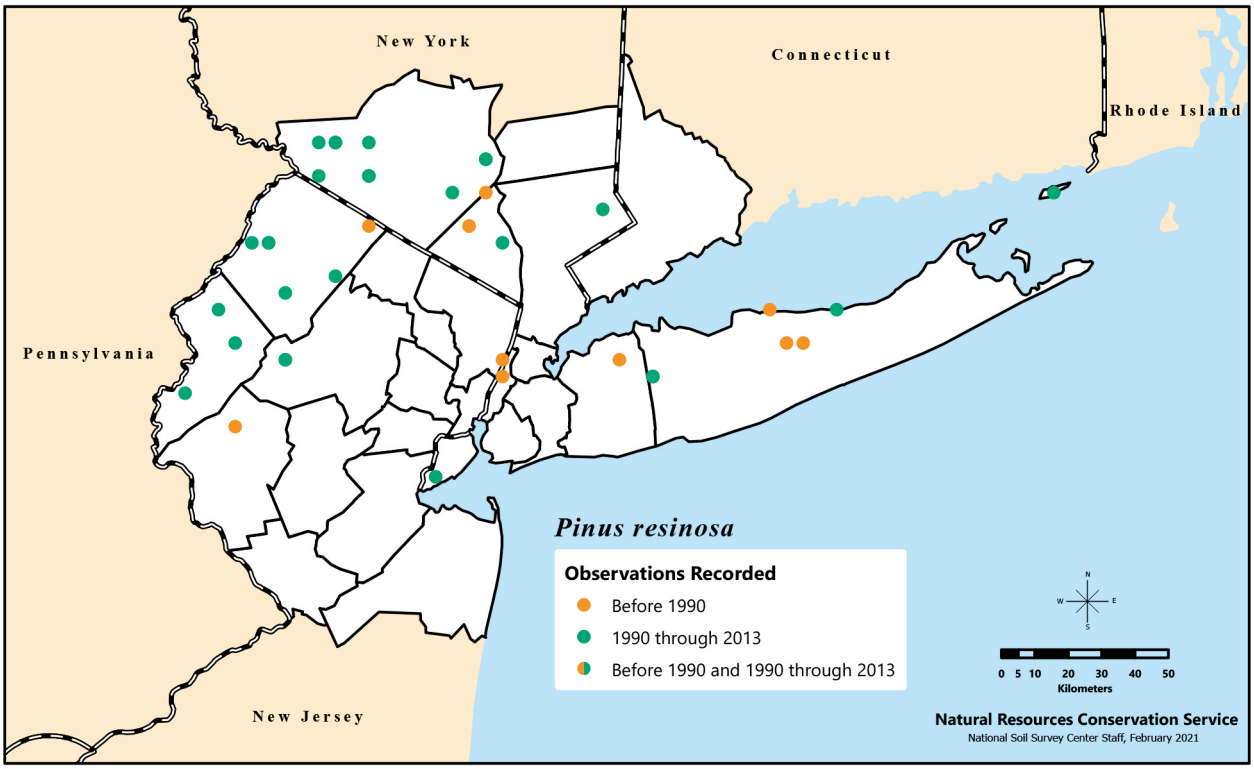


Distribution of *Pinus resinosa*, called red or Norway pine, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Middlesex County (NJ).

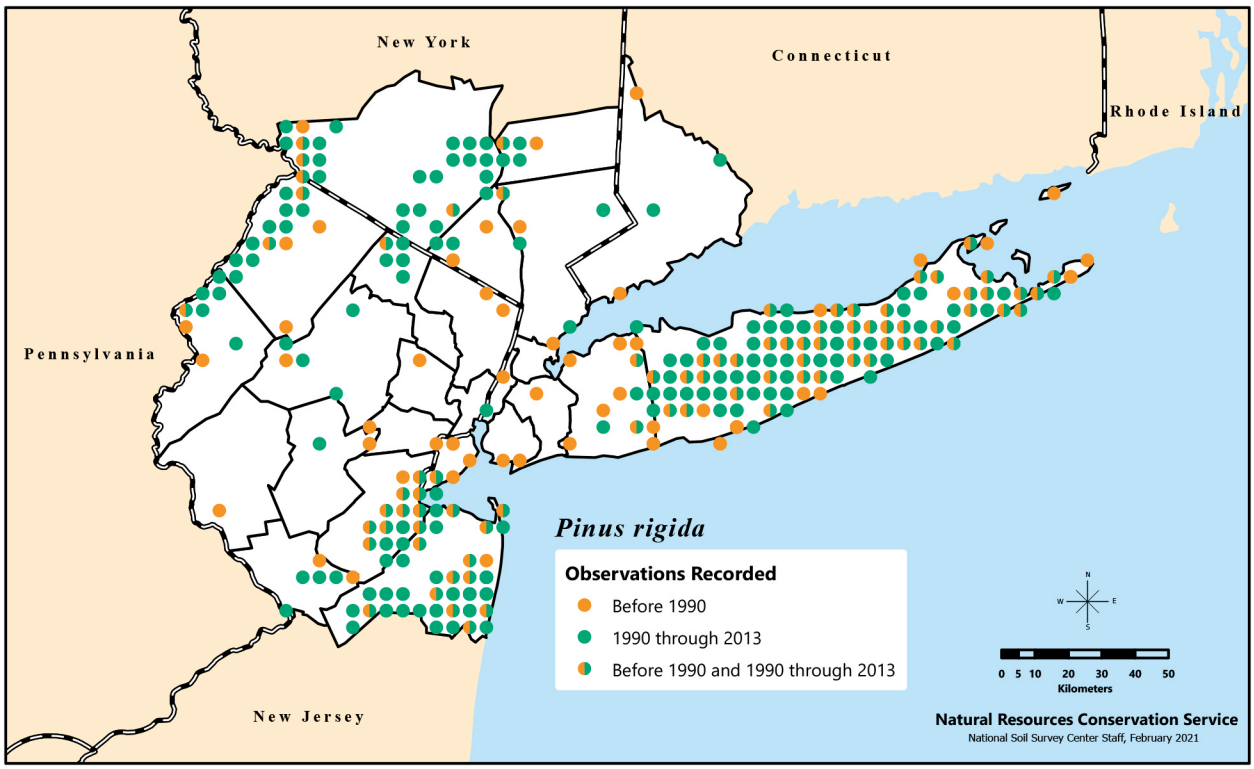
Earliest seed-bearing age 20–25 years; cone crops every 3–7 years. Height at maturity 21–46 m (Krugman and Jenkinson 2008). Cultivated since 1756, with at least 2 cultivars (Dirr 1998). This species can be found in small pockets of high elevation as far south as WV (Rudolf 1990). Increases in the region may be the result of escapes from plantings.

Native populations are listed as endangered in CT (S1) and NJ (S1.1), known from NJ from only one site in Sussex County.

4. *Pinus rigida* Mill. – pitch pine ↔

Dry, rocky, or sandy soils; dominant in the pine barrens of NJ and Long Island but rarely on the southern Coastal Plain. Able to survive on dry, unproductive sites and is salt-tolerant, though it prefers acid, moist, well-drained soils (Dirr 1998). Epithet from Latin refers to the somewhat stiff nature of the needles.

Pollen cones maturing May–June; seed cones maturing in fall of the next year. Cones can persist on the tree for many years. Earliest seed-bearing age 3–4 years; cone crops every 4–9 years (Krugman and Jenkinson 2008). Height at maturity 6–30 m. Often dominant in pine barren vegetation in the northeastern U.S. On extremely harsh sites, it may be a climax vegetation type (Abrams and Orwig 1995). Has numerous fire adaptations that allow it to establish or regenerate on burned sites (Little 1953). One of the few conifers that produces sprouts from cut or burned stumps (Dirr 1998). Once important commercially for building wooden ships due to its very high resin content. Also used for railroad ties, fencing, and mine props as well as pulp, fuel, and crates. Cultivated since 1759, possibly earlier, with at least 1 cultivar (Dirr 1998, Krugman and Jenkinson 2008). *Pinus rigida* and *P. taeda* have been crossed successfully, and this hybrid is produced in large quantities in South Korea for commercial plantings. With further screening of this hybrid, the Northeastern Forest Experiment Station of the USDA Forest Service produced faster growing trees with good form and winter hardiness (Little and Garrett 1990).



Distribution of *Pinus rigida*, or pitch pine, recorded in the New York Metropolitan Region during three time categories.

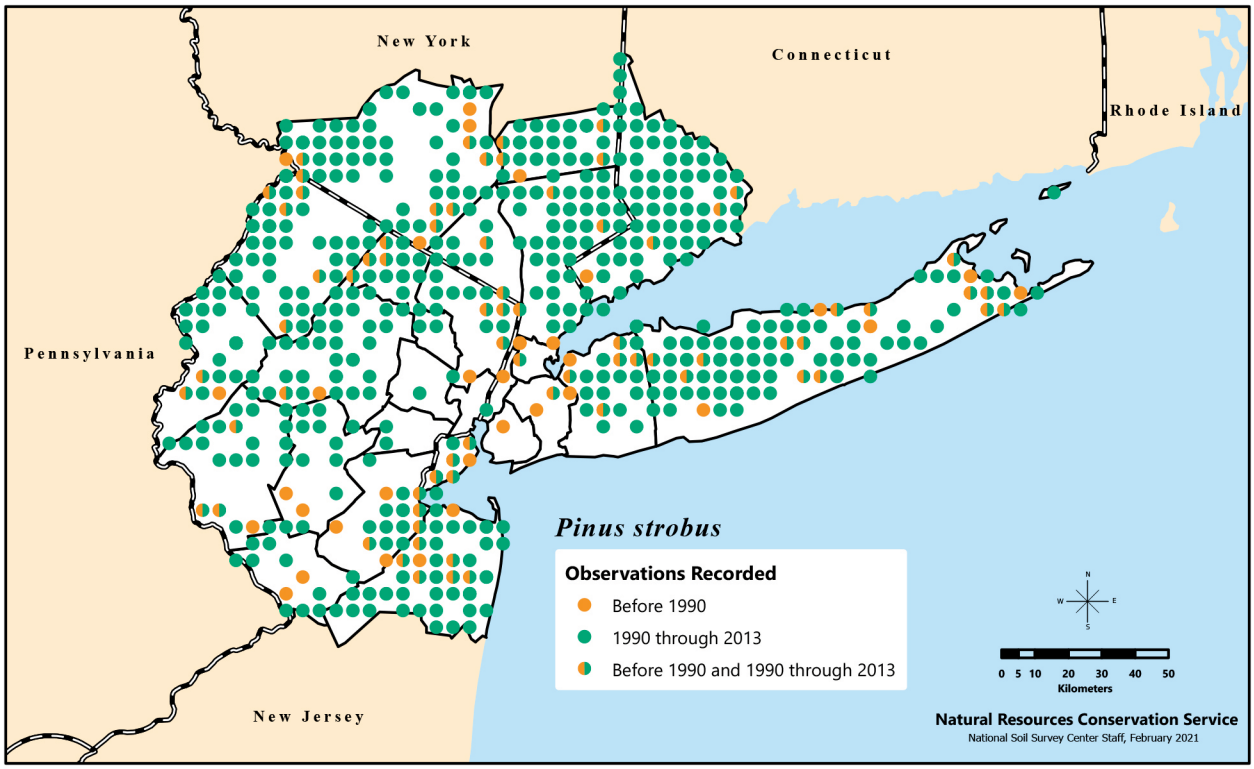
P Q

5. *Pinus strobus* L. – white pine ↑↑↑

Rich woods, slopes, sandy soils; adaptable. Prefers fertile, rich soils and habitats without major disturbances. Some of the material in the region represent escapes from cultivation. Epithet from Latin refers to an ancient tree used for incense.

Pollen cones maturing June; seed cones maturing in fall of the next year, usually falling from the tree in the winter. Earliest seed-bearing age 5–10 years; cone crops every 3–10 years. Height at maturity 24–67 m (Krugman and Jenkinson 2008). One of the more aggressive native species. It produces cones at an early age and can quickly seed into abandoned fields. Nonetheless, it is a valued timber species (Dirr 1998). By the 1800s most of the virgin stands of *Pinus strobus* had been logged (Goodlett 1954). Surprisingly, *P. strobus* was relatively low in abundance compared to *Tsuga canadensis*, *Fagus grandifolia*, *Quercus* spp., and *Acer saccharum* in pre-European-settlement forests of the northeastern U.S., though its dominance was exaggerated to attract settlers (Abrams 2001, Lutz 1930). One of the fastest growing conifers; makes a good tree for reforestation projects, landscaping, and Christmas trees. It is also one of the most widely planted trees in the U.S. Cultivated since 1705, with at least 10 cultivars (Dirr 1998). Hybridizes with *P. monticola* (western white pine), *P. peuce* (Balkan pine), *P. griffithii* (blue pine), and *P. parviflora* (Japanese white pine) as well as (but not as readily) *P. flexilis* (limber pine) and *P. ayacahuite* (Mexican pine). The *P. strobus* ×*griffithii* cross is more vigorous than *P. strobus* and more tolerant of cold than *P. graffithii* (Wendel and Smith 1990). Increases in the region may be associated with the pine plains of Concord, MA, where prolific seed production and the invasion of abandoned agricultural land by *P. strobus* have been documented (Glitzenstein et al. 1990). Declines in *P. strobus* elsewhere have been attributed to a lack of frequent fire (suggested fire rotation period of every 15 years) and fewer other disturbances such as blow-downs (Clark and Royall 1996, Dey and Guyette 1996).

P Q



Distribution of *Pinus strobus*, or white pine, recorded in the New York Metropolitan Region during three time categories.

6. *Pinus virginiana* Mill. – Jersey pine, scrub pine, Virginia pine ↓↓

Dry, sandy, or sterile soils. Like *Pinus echinata*, *P. virginiana* reaches the northern limit of its range in the region.

Earliest seed-bearing age 5 years, with 1 year between cone crops. Pollen cones maturing late Apr.–mid-May; seed cones maturing in fall of the next year. Cones can persist on the tree for many years. Height at maturity 15–30 m (Krugman and Jenkinson 2008). Cultivated since 1739, with at least 1 cultivar (Dirr 1998). *Pinus virginiana* often grows in pure stands; usually a pioneer species on old fields, burned areas, or other disturbed sites (Eyre 1980). Of 18 pine species tested, *P. virginiana* is most sensitive to ozone (Davis and Wood 1972, Phillips and Skelly 1975). Can grow on heavy clay soils unlike most plants and may be one of the few species that can colonize impoverished sites (Dirr 1998).

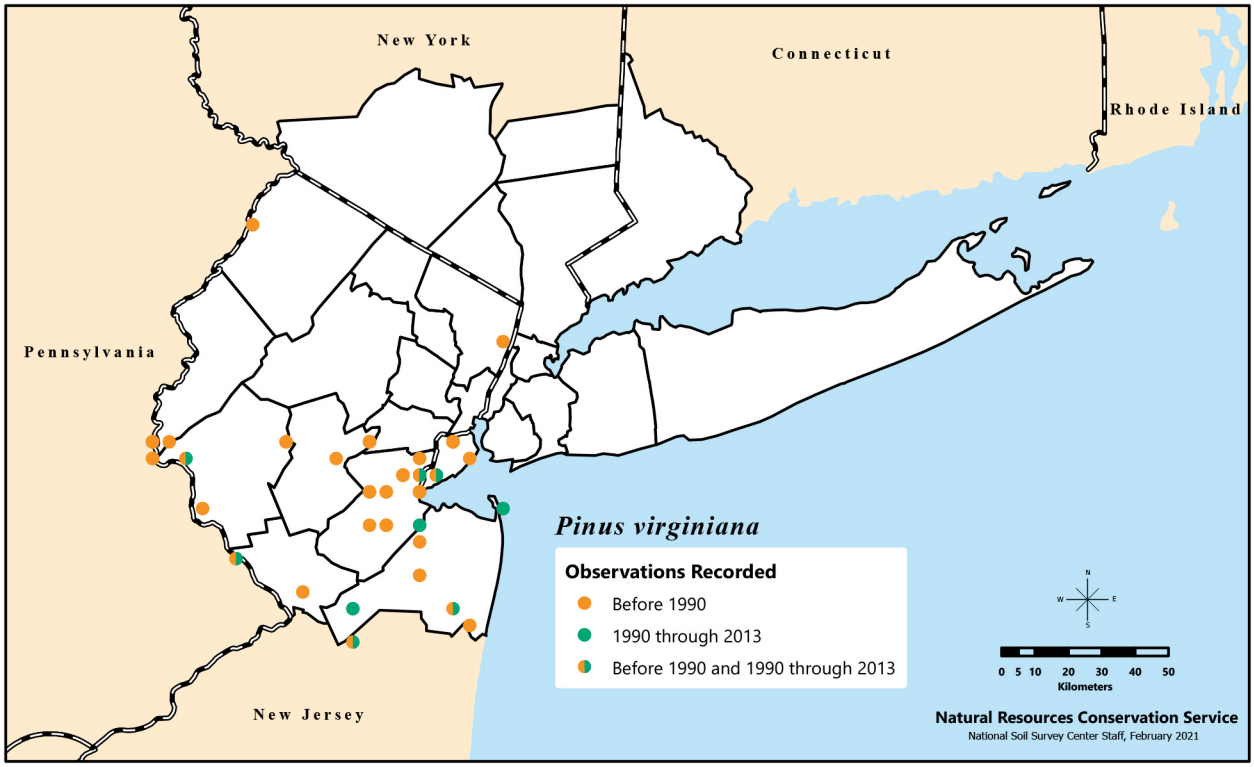
Listed as endangered in NY (S1).

Nonnative Species

7. *Pinus banksiana* Lamb. – jack pine, scrub pine Ø

Dry, sandy, rocky, or sterile soils. Native to the U.S. and Canada, north and west of the NY Metropolitan Region. Primarily found in the northern latitudes; northern NY is at the southernmost part of its distribution (Dirr 1998). Native populations are listed as rare in NY (S3). The few records from the region from Nassau, Orange, and Suffolk Counties (NY) are likely escapes or persistent from cultivation, although one record in Orange County has been debated. Epithet honors Sir Joseph Banks (1743–1820), English explorer and naturalist.

Earliest seed-bearing age 3–15 years, with 3–4 years between cone crops. Pollen cones maturing May; seed cones maturing in fall of the next year. Height at maturity 17–30 m (Krugman and Jenkinson 2008). Cultivated since 1783 or earlier, with at least 2 cultivars. A valuable pioneer species



Distribution of *Pinus virginiana*, variously called Jersey pine, scrub pine, or Virginia pine, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Nassau, Suffolk, and Westchester Counties (NY).

on infertile sandy soils, but it rapidly gives way to *Pinus strobus* or *P. resinosa*, except on the poorest of soils (Dirr 1998). Kirtland's warbler (*Setophaga kirtlandii*) uses *P. banksiana* as a breeding area (Mayfield 1953); the rare sightings of this bird in NY (Chung 2018) need further verification and were not necessarily associated with *P. banksiana*.

8. *Pinus nigra* Arnold – Austrian pine Ø

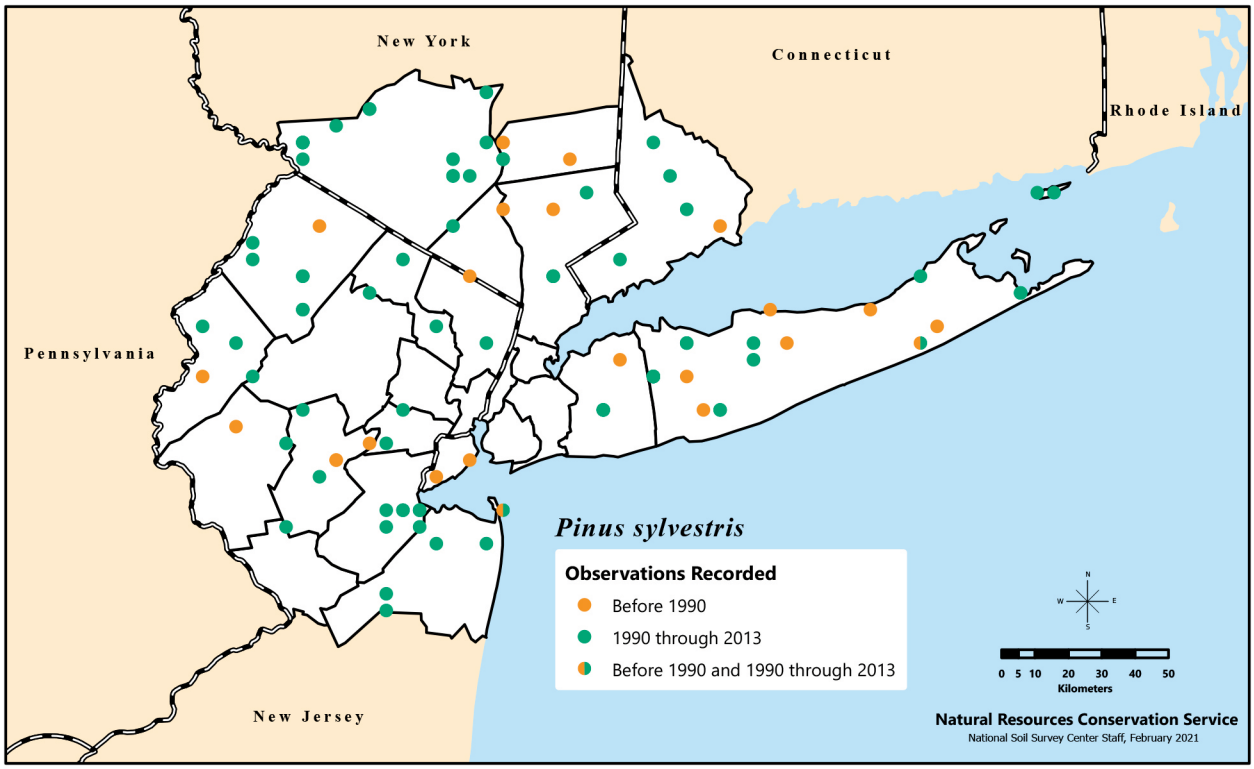
Introduced from Europe in 1759; escaped from cultivation. Earliest seed-bearing age 15–40 years; cone crops every 2–5 years. Pollen cones maturing May; seed cones maturing in fall of the next year. Height at maturity 20–50 m (Krugman and Jenkinson 2008). Salt-tolerant. At least 4 cultivars (Dirr 1998). The few occurrences from the region, from Somerset and Warren Counties (NJ) and Nassau, Orange, and Suffolk Counties (NY), represent material that has spread from cultivated stands.

9. *Pinus sylvestris* L. – Scots pine, Scotch pine ↑↑

Native to Europe; occasionally escapes from cultivation. Considered naturalized in some places in New England. One of the most widely distributed *Pinus* spp. world-wide.

Earliest seed-bearing age 5–15 years; cone crops every 4–6 years. Pollen cones maturing May; seed cones maturing in fall of the next year. Cones can persist on the tree for many years. Height at maturity 24–40 m (Krugman and Jenkinson 2008). Long cultivated, with 19–38 cultivars available and 4 cultivars commonly used in the U.S. Suffers from several diseases and insects, including *Sirex noctilio* (Dodds et al. 2010), and is not recommended as a landscape tree. Despite these problems, it is one of the most widely distributed pines and one of the most popular pines for Christmas trees (Dirr 1998). Recruitment from long-term plantings is apparent at nine introduction sites across the U.S., including two sites in MA, suggesting the potential for spread (Mortenson and Mack 2006).

P Q



Distribution of *Pinus sylvestris*, or Scots pine, recorded in the New York Metropolitan Region during three time categories.

10. *Pinus thunbergii* Parl. – Japanese black pine ↑↑↑

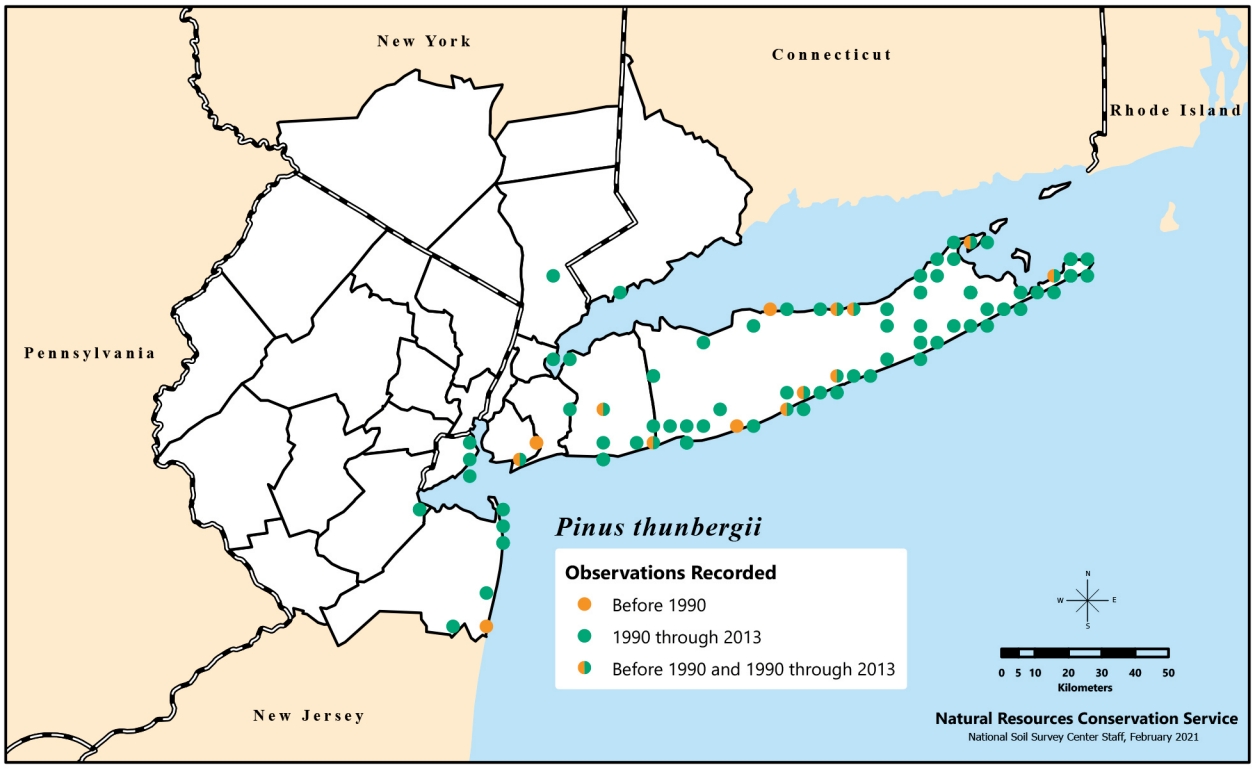
Introduced from Japan in 1855; escaped from cultivation. Species honors Swedish botanist Carl Peter Thunberg (1743–1828).

Earliest seed-bearing age 6–40 years. Pollen cones maturing May; seed cones maturing in fall of the next year. Height at maturity 30–40 m (Krugman and Jenkinson 2008). Very salt-tolerant (Dirr 1998). May be negatively impacted if grown close to *Robinia pseudoacacia* (black locust), a nitrogen fixer. In such conditions, there is evidence of a reduction in ectomycorrhizal fungi associated with *Pinus thunbergii* (Taniguchi et al. 2007). Cultivated since 1855, with at least 11 cultivars (Dirr 1998). Notably invasive on Nantucket Island, MA. However, severe mortality of adults occurs due to pine wilt disease, caused by a native pinewood nematode (*Bursaphelenchus xylophilus*) (Mortenson and Mack 2006). In its native Japan, regeneration of *P. thunbergii* was inhibited by the invasive *R. pseudoacacia*, which reduced light and increased soil nitrogen at a shared site. The increasing soil nitrogen caused soil eutrophication, which accelerated the development of pine wilt disease (Taniguchi et al. 2007).

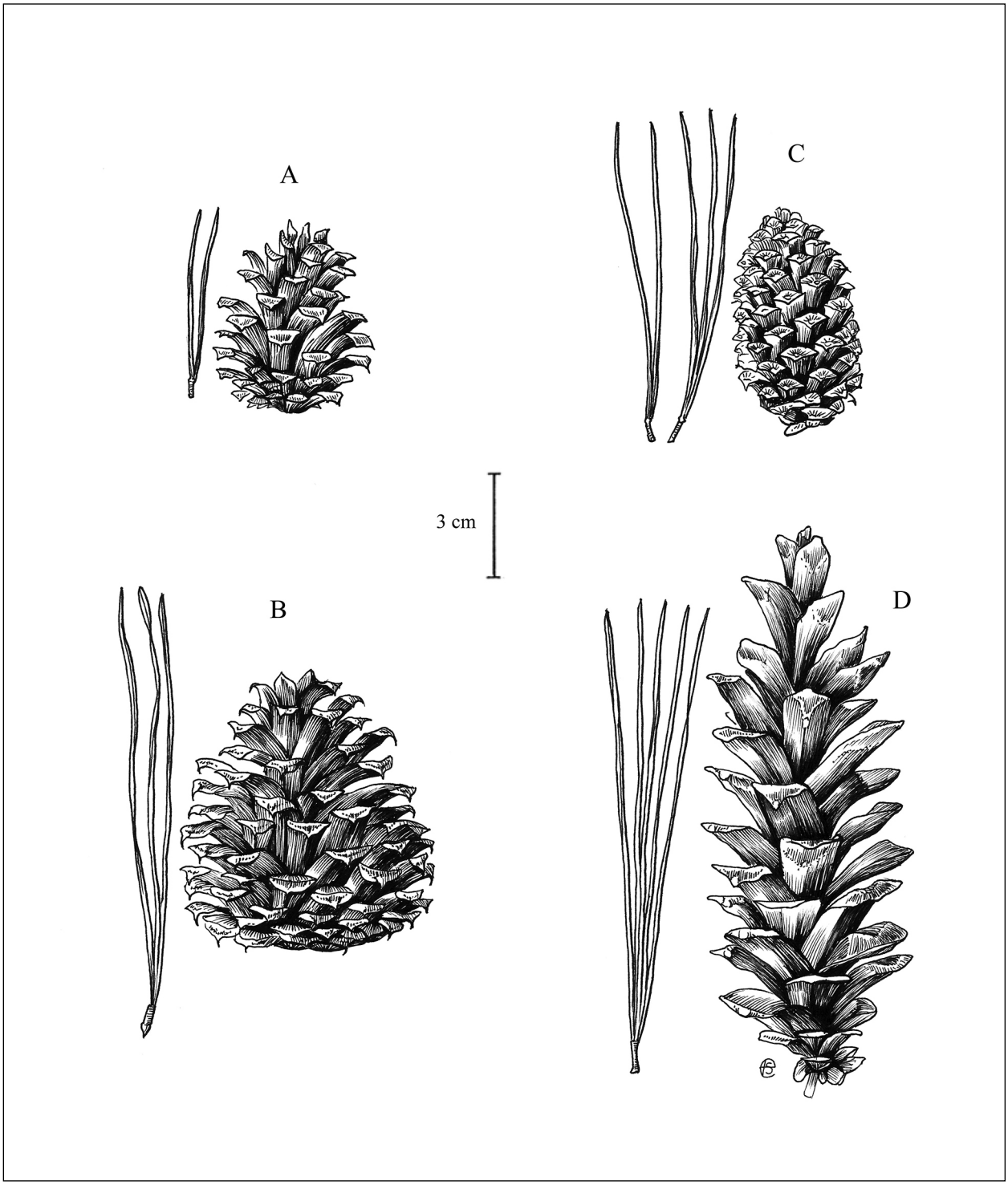
Tracked as a moderate invasive in NY (not prohibited, not regulated).

Management

Very few conifers are invasive in North America, but *Pinus sylvestris* and *P. thunbergii* demonstrate the potential to spread and invade. The pine nematode may help contain *P. thunbergii* (Mortenson and Mack 2006). Because several native pines also have commercially valuable timber and make good landscape and Christmas trees, we strongly encourage less planting of nonnative pines and more plantings of native pines. Such natives may include *P. strobus*, a relatively aggressive native species, but care should be taken not to plant hybrids, some of which tend to be even more aggressive than *P. strobus* (*P. strobus* ×*griffithii*). Sites with poor, sandy soil or soils high in clay may be rehabilitated with native pines, such as *P. echinata* and *P. virginiana*, respectively.



Distribution of *Pinus thunbergii*, or Japanese black pine, recorded in the New York Metropolitan Region during three time categories.



Leaves (in two-, three-, or five-needle fascicles) and female cone of A) *Pinus virginiana*, B) *Pinus rigida*, C) *Pinus echinata*, and D) *Pinus strobus*. Illustration by Emma Skurnick.

P Q



Leafy twig, leafy twig with female cone, and leaves (two-needle fascicle) of *Pinus banksiana*. Illustration by Emma Skurnick.



Leafy twig with male cones, female cone, and leaves (two-needle fascicle) of *Pinus thunbergii*. Illustration by Emma Skurnick.

Platanus L. – sycamore, buttonwood

Platanaceae. Trees. Species about 8 and 1 widely planted hybrid (see following) in Asia, Europe, and North America. Distinguished by its smooth inner bark, palmately lobed leaves, and fruit a "ball" of capsules. Much planted as shade and street trees. Pollinated by wind. Hairs from the leaves and fruit when airborne can cause bronchial problems when inhaled (Lewis and Elvin-Lewis 2003). Genus name is derived from the Greek "platys" ("broad"), probably in reference to the broad leaves.

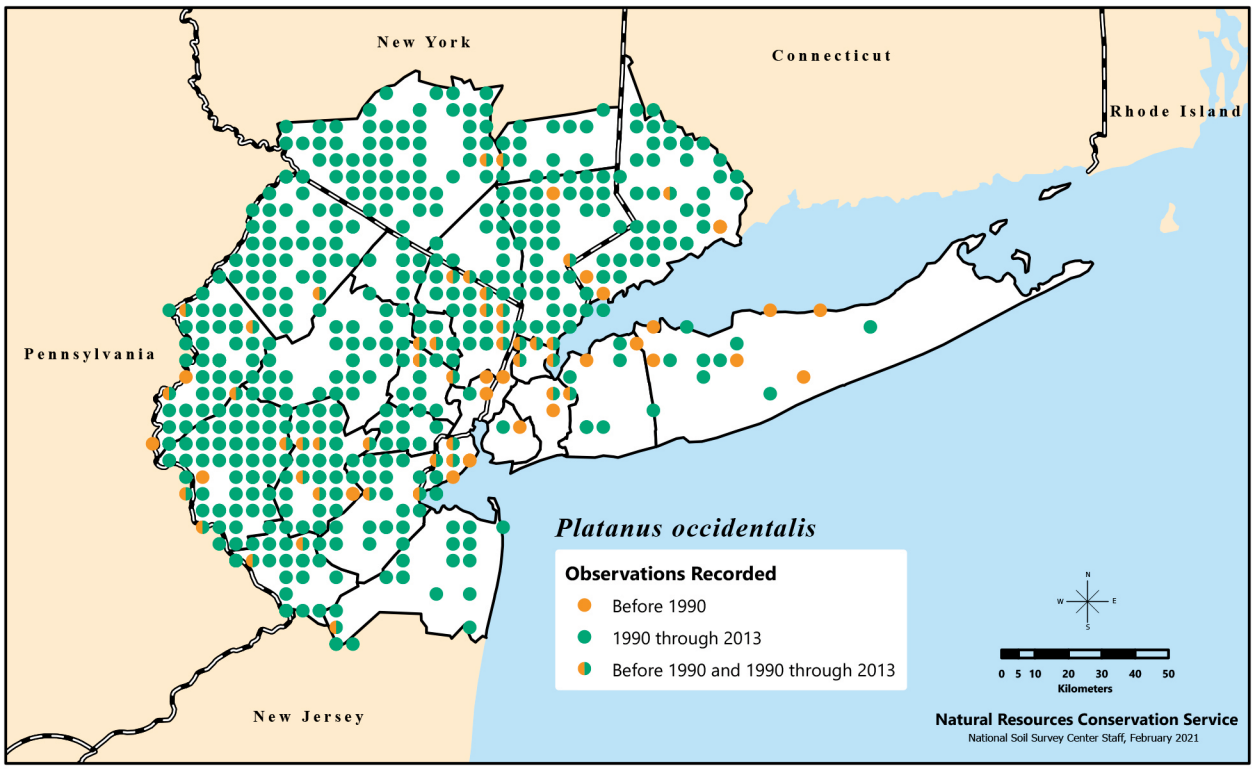
Native Species

1. *Platanus occidentalis* L. – sycamore ↑↑↑

Flowering mid-Apr.–mid-May (before leaves appear); fruiting Oct. Fruit persist over winter; seeds sometimes released early next season. Mesic woodlands, floodplains, bottomlands, and riversides; some material persistent from cultivation (often planted as a street tree) or escapes. Prefers full sun. Epithet from Latin means "western," a reference to its occurrence in the Western Hemisphere.

Platanus Key

1. Bark whitish; leaves mostly reniform;
   heads borne singly . . . . . ***Platanus occidentalis***
1. Bark yellowish; leaves more truncate or cordate at base;
   heads 2–3 per peduncle . . . . . ***Platanus ×hispanica****



Distribution of *Platanus occidentalis*, or sycamore, recorded in the New York Metropolitan Region during three time categories.

Platanus occidentalis has increased substantially in the region, though it has decreased in more-coastal locations with ideal habitat. Monoecious (Bonner 2008m). No pretreatment needed for germination; seeds germinate best with alternating day and night temperatures of 30 ºC and 20 ºC, respectively (Bonner 1972). Suffers from several diseases and insects including anthracnose, the sycamore plant bug (*Plagiognathus albatus*), the sycamore tussock moth (*Halysidota harrisii*), scale, aphids, bagworms, and borers. Anthracnose is the most serious of these, causing significant dieback (Dirr 1998). It is a valued timber species used for fiber pulp and paper production (Nugent and McGarity 1979). Also used in restoration of wetlands and mine reclamation (Haynes et al. 1988, Wells and Schmidtling 1990). Use of this species in restoration of bottomland sites may require some manual removal of weeds, but fertilization and tree shelters do not improve survival. Herbicide treatment to control weeds negatively impacted *P. occidentalis* (Twedt and Wilson 2002). The wood, which is heavy, hard, and coarse grained, is also used for furniture, crates, and butcher's blocks. Cultivated extensively, especially in the 1960s, in plantations to supply the demand for *P. occidentalis* seedlings for use in soil reclamation, windbreaks, and beautification (Briscoe 1969). Planted and cultivated since 1640, with 1 known cultivar having bright yellow foliage. Because it is constantly dropping leaves, branches, and fruit, it can be relatively messy; planting this species as a landscape or street tree is not advised. However, wherever it is found naturally it should be kept (Dirr 1998). Allelopathic properties may be present (Al Naib and Rice 1971). Being considered for use as a short rotation woody bioenergy crop, replacing *Zea mays* (corn), *Gossypium hirsutum* (cotton), and other crops currently used for bioenergy. Doing so is likely to reduce soil erosion and improve runoff water quality (Joslin and Schoenholtz 1997). Hairs within the fruit can cause irritation to eyes, nose, ears, and throat. Efforts have been made to produce cultivars with lower fruit production to avoid this problem (Sun and Wu 1989). Wearing masks to protect lungs when working with the fruit is advised (Nugent and McGarity 1979). *Platanus* pollen is a major allergen and a significant cause of pollinosis (hay fever) (Varela et al. 1997).

Nonnative Species

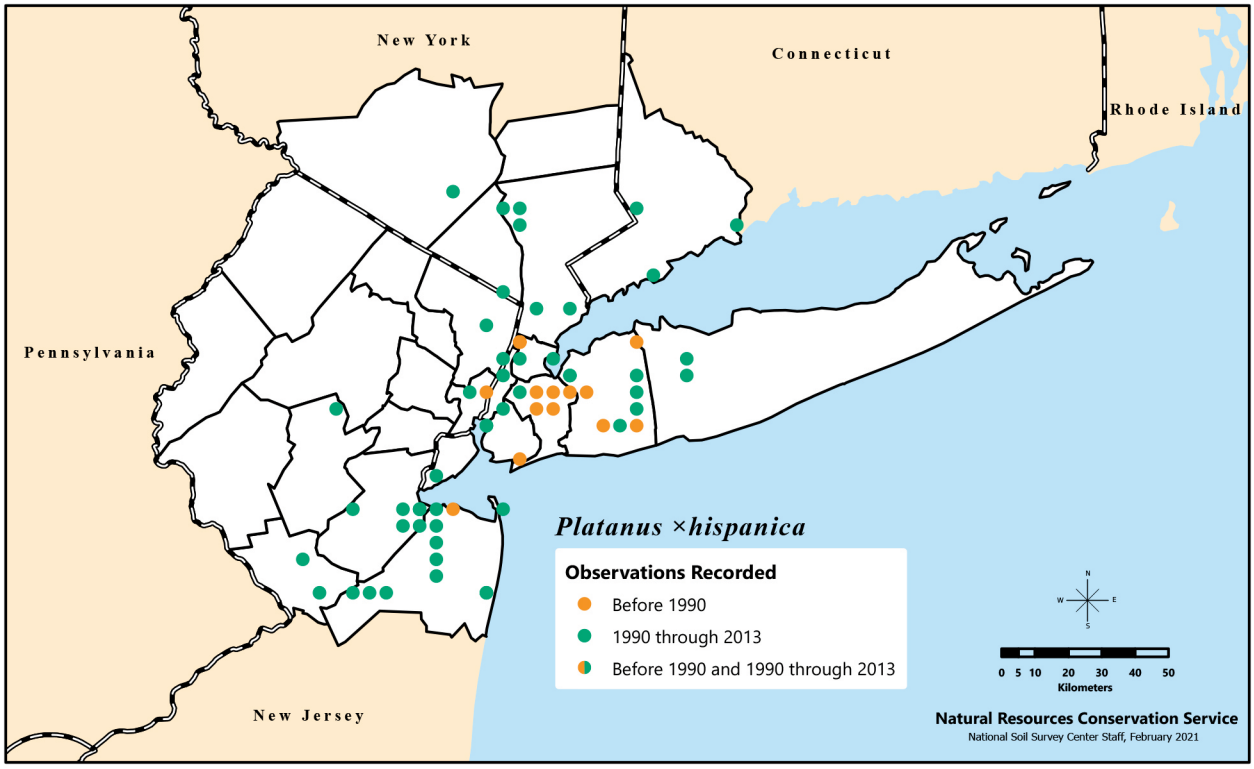
2. *Platanus ×hispanica* Mill. ex Münchh. – London plane-tree ↑↑

Platanus ×acerifolia (Aiton) Willd. (pro sp.); *Platanus densicoma* Dode; *Platanus ×hybrida* Brot.; *Platanus orientalis* L. var. *acerifolia* Aiton; *Platanus pyramidalis* Dippel

Flowering mid-Apr.–mid-May (before leaves appear); fruiting Oct. (persisting over winter; seeds sometimes released early next season). Cultivated and sometimes appearing as persistent from cultivation or as an escape. One of the most common park and street trees in NYC (City of New York 2019).

Has similar habitat preferences as *Platanus occidentalis*, but it will grow in almost any soil type, withstanding high pH and pollutants. Prefers full sun or very light shade. A hybrid between *P. occidentalis* and *P. orientalis* (southeastern Europe and western Asia); originated in London, England and was first documented in 1663 (Dirr 1998). Has also been known as *P. ×acerifolia* and *P. ×hybrida*, but the currently accepted name is *P. ×hispanica* (Geerinck 1979).

Seeds are viable (Santamour 1972) and require a cold treatment of 45–60 days, but some seeds may germinate without pretreatment. Propagation from cuttings is also common. Popular street tree in Europe. At least 5 cultivars in the U.S.; at least 8 additional cultivars found elsewhere. Suffers from many of the same diseases as *P. occidentalis*, including anthracnose, powdery mildew, cankers, and borers. The most serious disease is canker stain caused by the fungus *Ceratocystis fimbriata* f. sp. *platani*. Canker stain originated in the U.S. and has recently invaded Europe, which is of much concern (Besnard et al. 2002). Three U.S. cultivars are resistant to anthracnose (Dirr 1998). *Platanus ×densicoma* is also a hybrid between *P. occidentalis* and *P. orientalis*; however, the female parent for *P. ×densicoma* is *P. occidentalis* whereas the female parent for *P. ×hispanica* is *P. orientalis* (Besnard et al. 2002, Cennamo and Cafasso 2002). *Platanus ×hispanica* may be one of the trees in NYC that store the most carbon (Nowak and Crane 2000), but pollution affects leaf longevity and carbon sequestration (Gratani and Varone 2007). Used as an indicator species



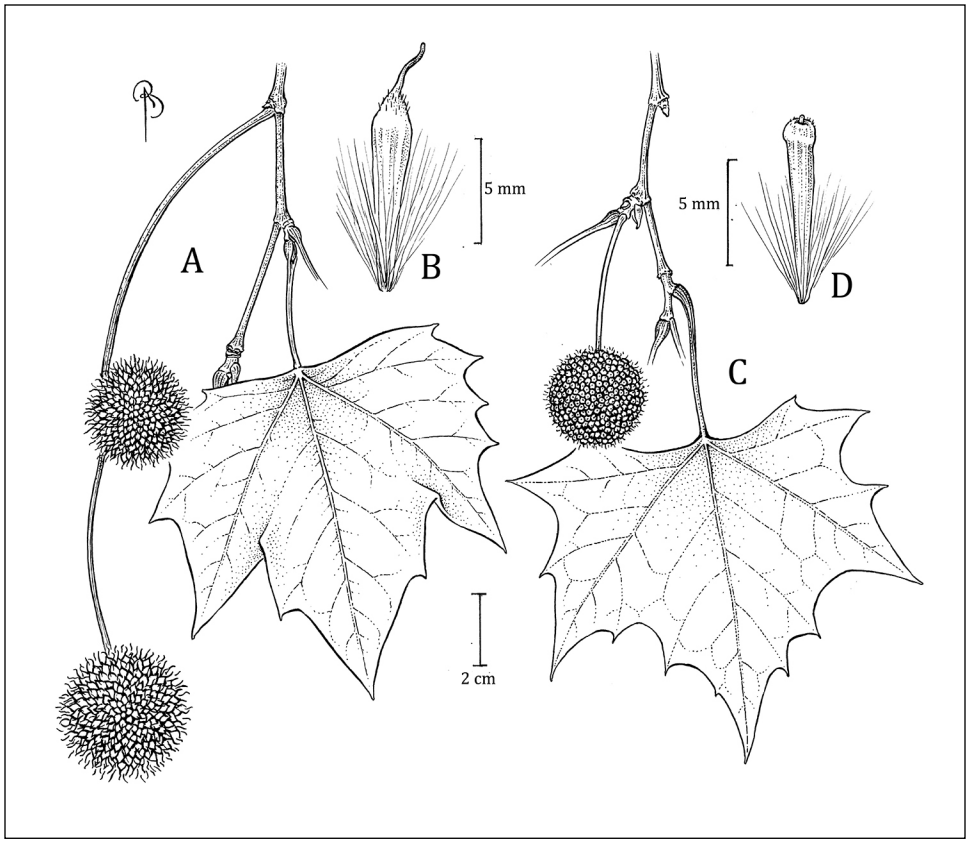
Distribution of *Platanus ×hispanica*, or London plane-tree, recorded in the New York Metropolitan Region during three time categories.

P Q

to detect atmospheric pollution (Viladevall et al. 2013). Leaf litter of this species decomposes at a faster rate than that of associated native species in riparian areas, which may impact other trophic levels such as macroinvertebrates (Menéndez et al. 2013). *Platanus ×hispanica* is also found in some, possibly many, urban seed banks (Cockel and Gurnell 2012).

Management

The increase in *Platanus occidentalis* in the region is unexplained but is an encouraging development for this native species. However, the increase in *P. ×hispanica* may be of concern. The hybrid's tolerance of a larger range of conditions may also mean it could be more competitive than *P. occidentalis* when they are collocated. However, there have been no studies yet on displacement of *P. occidentalis* by *P. ×hispanica*, nor have there been documented cases of backcrossing of *P. ×hispanica* with *P. occidentalis*. Genetically speaking, there seems to be little reason why *P. ×hispanica* would not be able to backcross with *P. occidentalis* and there is anecdotal evidence that some individuals of each species share morphological characteristics and may indeed be a backcross of *P. ×hispanica* with *P. occidentalis*. If this backcrossing is occurring and there is any form of genetic dominance of *P. ×hispanica*, then *P. occidentalis* could decrease in abundance over time. Indeed, the apparent increase in *P. occidentalis* may possibly include backcrosses of *P. ×hispanica* with *P. occidentalis* that key more readily to *P. occidentalis* than *P. ×hispanica.* Unfortunately, until we have more information, we are reluctant to question the positive aspects of *P. ×hispanica*. We advise that *P. ×hispanica* be planted where *P. occidentalis* is not present or that *P. occidentalis* be planted preferentially where possible.



A) Fruiting twig with leaf and B) seed with subtending hairs of *Platanus* ×*hispanica*; C) fruiting twig with leaf and D) seed with subtending hairs of *Platanus occidentalis*. Illustration by Bobbi Angell.

Populus L. – poplar, aspen

Salicaceae. Trees. Species 35–100 in Africa, Asia, Europe, and North America. Distinguished by dilated and usually broadly ovate, rounded, cordate toothed leaves; channeled or flattened petioles (leaves of many species "trembling" in the wind); and wind-dispersed seeds with silky down (as in *Salix*). Dioecious. Unlike *Salix*, flowers lack nectary disks and are most likely wind-pollinated. Cultivated for pulp, fuel, windbreaks, phytoremediation; some species as well as some hybrids are among the fastest growing species in temperate regions. "Populus" is the ancient Latin name for the group.

Species described fall into four readily recognized groups: (1) white poplars or aspens (*P.* sect. *Leuce* Spach—*P. alba*; *P. canescens*; *P. grandidentata*; *P. tremuloides*), (2) cottonwoods (*P.* sect. *Aigeiros* Duby—*P. deltoides*, *P. nigra*), (3) balsam poplars (*P.* sect. *Tacamahaca* Spach—*P. balsamifera*), and (4) swamp poplars (*P.* sect. *Leucoides* Spach—*P. heterophylla*).

Native Species

1. *Populus balsamifera* L. – balsam poplar ↔

Flowering Apr.–May; fruiting May–June. Alluvial bottoms, river flats, sand bars, streambanks, and borders of swamps and lakes. Not shade-tolerant; found in all but the most wet or dry soils.

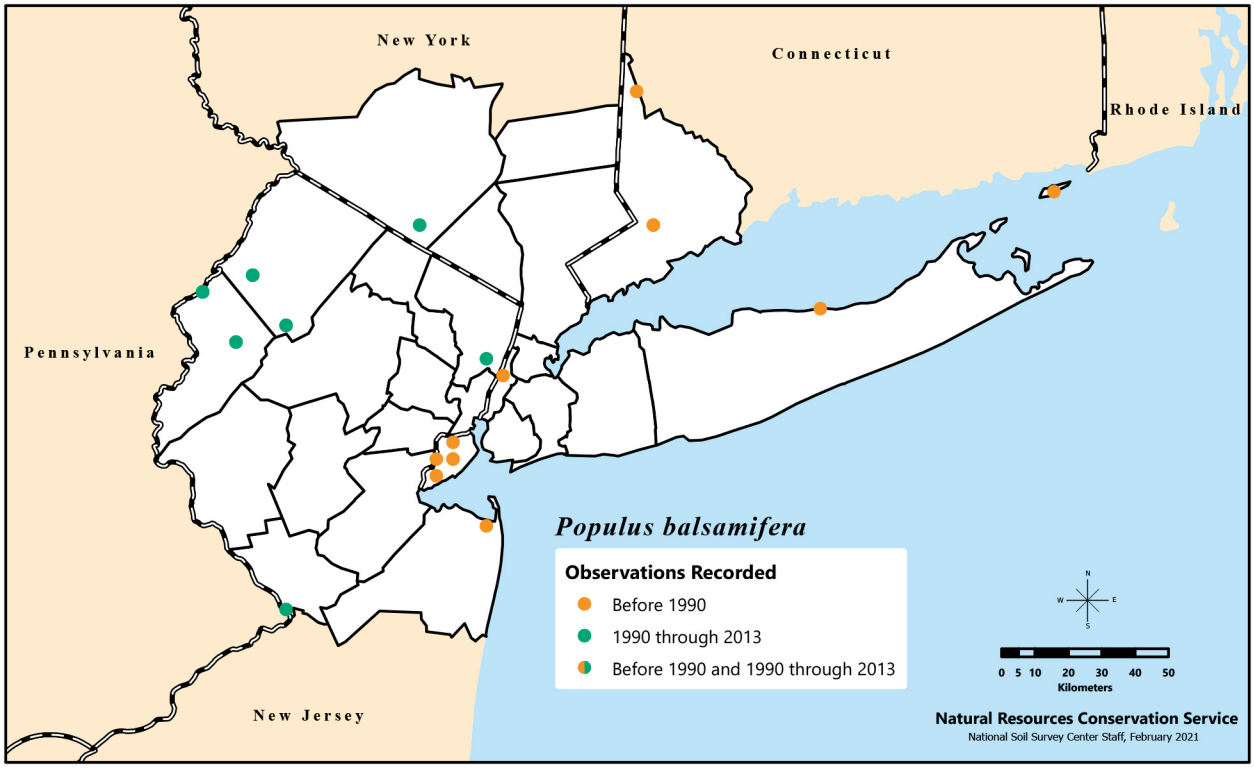
Native to OR and ranging from AK to NL south to NY (Wyckoff and Zasada 2008). Early floristic works (Britton 1889, Taylor 1915) and more recent works (Hough 1983) did not include this species in the NY Metropolitan Region. Its range extends across seasonally variable environments, resulting in three genetic clusters (northern, central, and eastern U.S.) (Keller et al. 2011). Earliest seed-bearing age 8–10 years (Wyckoff and Zasada 2008). Seeds exhibit no apparent dormancy, germinating at temperatures ranging from 2 to 40 ºC (Wyckoff and Zasada 2008). Flowers are among the first to open. Buds and leaves are gummy and smell of balsam (Dirr 1998). Given the cottony attachment, seeds are primarily dispersed by wind and water (Wyckoff

Populus Key

1. Leaves white-tomentose beneath 2
1. Leaves glabrous or nearly so (densely white-tomentose on young leaves of *P. balsamifera* and *P. grandidentata*) 3
2. Leaves lobed; lower surface densely tomentose . . . . . ***Populus alba****
2. Leaves entire or dentate; lower surface more sparsely tomentose. . . . . ***Populus ×canescens****
3. Petioles terete 4
3. Petioles strongly laterally compressed. 5
4. Leaf outline slightly convex toward the blunt or rounded tip; pedicels 2–8 mm long . . . . . ***Populus heterophylla***
4. Leaf outline slightly concave toward the very acute to short acuminate tip; pedicels less than 2 mm long . . . . . ***Populus balsamifera***
5. Leaves strongly deltoid or diamond-shaped; leaf margin with firm, colorless border thicker than the adjacent major veinlets; stamens more than 14; scales of catkins glabrous, fringed with many thread-like segments 6
5. Leaves orbicular to reniform or obscurely deltoid; leaf margins often without colorless border; stamens less than 13; scales of catkins pilose, fringes with only 3–7 linear or narrowly lanceolate segments 7
6. Glands prominent at junction of blade and petiole; leaf blade deltoid 8
6. Glands absent at junction of blade and petiole; leaf blade diamond-shaped . . . . . ***Populus nigra****
7. Leaf margins closely crenate to serrate; buds and new growth glabrous. . . . . ***Populus tremuloides***
7. Leaf margins closely undulate to dentate; buds and new growth tomentose. . . . . ***Populus grandidentata***
8. Blades of early leaves light green above; leaf margins very coarsely dentate, the largest teeth 2–6 mm deep, ciliate. . . . . ***Populus deltoides***
8. Blades of early leaves dark green above; leaf margins coarsely dentate, the largest teeth 1–2 mm deep, not ciliate . . . . . ***Populus ×jackii***

and Zasada 2008). Can expand by root suckering, typically expanding radially in concentric circles, with the oldest individuals in the center (Barnes 1966). Spring flush is temperature driven whereas fall senescence (cessation of height growth and leaf fall) is photoperiod driven. Extended spring and fall periods due to climate change result in curtailed height growth because *Populus balsamifera* reaches its competency before the summer solstice (Soolanayakanahally et al. 2013). Cultivated since at least 1689 (Dirr 1998).

Can hybridize with other poplar species, including two nonnative poplars, *P. laurifolia* and *P. nigra* (Talbot et al. 2012). The hybridization between *P. deltoides* and *P. balsamifera* is primarily asymmetric in that the hybrid is usually the result of a cross with *P. balsamifera* as the paternal donor and *P. deltoides* as the maternal donor (Hamzeh et al. 2007). These hybrids are fertile and are likely to affect the genetic integrity of *P. balsamifera* (Thompson et al. 2009). Hybridization with nonnative poplars has become such a problem that microsatellite markers were developed to monitor gene flow of nonnative and native poplar populations (Khasa et al. 2005). Female trees tend to dominate at both the regional and local scales, which is not uncommon for dioecious species. There is a weaker pattern of female trees being associated with more mesic environments while male trees are associated with drier environments (Comtois et al. 1986). Some laboratory evidence of allelopathy, inhibiting growth of *Alnus crispa* (green alder) by 25 percent (Jobidon and Thibault 1982). Leaves high in tannins and phenolics. The tannins act as a general microbial inhibitor and inhibit respiration and nitrogen mineralization.



Distribution of *Populus balsamifera*, or balsam poplar, recorded in the New York Metropolitan Region during three time categories.

P Q

The phenolics stimulate respiration, acting as a growth substrate. The combined effect of inhibiting mineralization and stimulating immobilization, reduces soil nitrogen-availability during succession, in which *P. balsamifera* replaces alder (Schimel et al. 1996). Vulnerable to cavitation during dry conditions (Hacke and Sauter 1995); roots are the most vulnerable, followed by branches then petioles (Hacke and Sauter 1995). Extracts have been shown to reduce insulin levels, decrease glycemia, and augment levels of the protein adiponectin. In addition, taking 250 mg of this extract per kilogram body weight results in a significant reduction in food intake in mice and an increase in energy expenditure, indicating a possible therapeutic approach to the treatment of obesity and diabetes (Harbilas et al. 2012).

Decreases in eastern portions of the region and increases in the western portion are evident. Such gains may be planted individuals. *Populus balsamifera* is a north temperate to boreal hardwood early successional species, dominating much of its range (Soolanayakanahally et al. 2009); the NY Metropolitan Region is at the edge of its range.

2. *Populus deltoides* Bartr. ex Marshall – cottonwood ↑↑↑

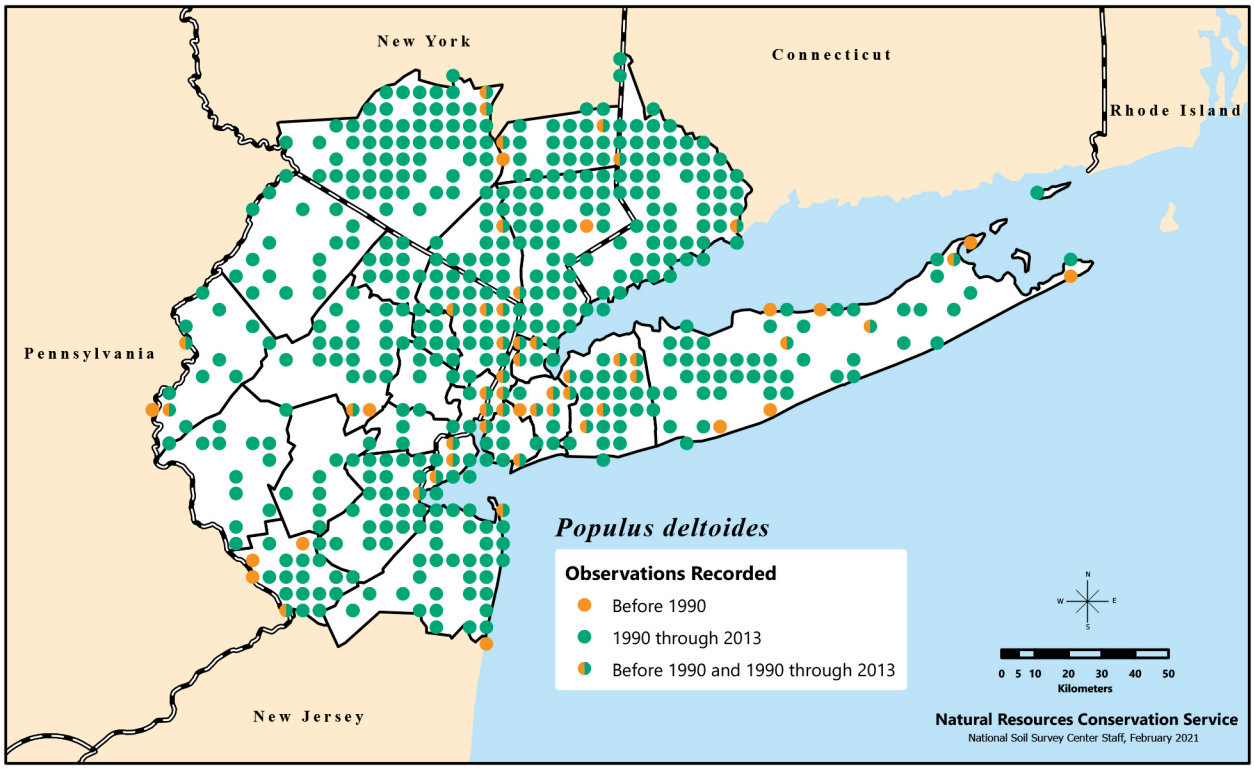
Flowering late Mar.–early Apr.; fruiting May–June. Wastelands, urban lots, roadsides, riverbanks, pond and lake shores, alluvium, gravelly islands, semiwooded slopes and floodplain woods, alluvial woods, and sandy river bottoms; tolerant of inundation, siltation, and urban conditions. Epithet from Greek is a reference to the triangular outline of the leaf.

Prefers moist, alluvial conditions. Tolerates saline conditions and pollutants and is adaptable to a wide range of soil pHs (Dirr 1998) and deep infertile soils (Cooper 1980). Earliest seed-bearing age about 10 years (Wyckoff and Zasada 2008), but possibly as early as 5 years (Cooper 1980). Cultivated since at least 1750 (Wyckoff and Zasada 2008), with at least 7 cultivars. Some

cultivars are cottonless (male) hybrids between *Populus deltoides* and *P. nigra*. Like other poplars, seeds require no pretreatment, and propagation from cuttings is relatively easy. A short-lived early successional species; individuals deteriorate rapidly after 70 years of age. Suffers extensively from cankers (Dirr 1998). Though short-lived, considered the fastest growing commercial species in North America. One of the tallest tree species east of the Mississippi River, reaching heights of 58 m. Has an extensive range and is found in environments that range from annual mean minimum temperatures of -45 ºC to annual mean maximum temperatures of 46 ºC, 380 to 1400 mm of rain per year, and 100 to 200 consecutive frost-free days per year. Used and grown commercially for furniture and pulpwood. Unlike many other dioecious species and other poplars, this species' sex ratio is 1:1, though the males flower first. After slow root growth during first 3 weeks, root growth may exceed shoot growth for the first year. Very intolerant of shade but does not respond well to release from crowding, either. Within clones, natural thinning allows the larger trees to dominate, under seemingly wasteful spacing. Vulnerable to fire; even a non-intense burn kills younger trees. The following hybrids are known to naturally occur: *Populus* ×*acuminata* Rydb. (*P. angustifolia* × *P. deltoides*), *Populus* ×*bernardii* Boivin (*P. deltoides* × *P. tremuloides*), *Populus* ×*jackii* Sarg. (*P. balsamifera* × *P. deltoides*), and *Populus* ×*polygonifolia* Bernard (*P. balsamifera* × *P. deltoides* × *P. tremuloides*) (Cooper 1980). This species may be able to colonize a disturbed riparian community more quickly than the invasive nonnative *Tamarix ramosissima* (Sher et al. 2002) and indeed appears to be more competitive than *T. ramosissima* (Sher and Marshall 2003).

Populus ×*jackii* Sarg.

A hybrid between *Populus balsamifera* and *P. deltoides* (Greenaway et al. 1990). Based on morphological data, is an intermediate between the two species (Eckenwalder 1984) and is found in the region. Introduced into cultivation in North America in 1900. Although not common in



Distribution of *Populus deltoides*, or cottonwood, recorded in the New York Metropolitan Region during three time categories.

North America, the cultivar 'Aurora,' which has appealing rose, pink, and cream variegated shoots, is very common in Europe, especially Ireland (Dirr 1998). Epithet honors John George Jack (1861–1949), educator and collector at the Arnold Arboretum in Boston, MA and first collector of the hybrid.

3. *Populus grandidentata* Michx. – big-tooth aspen ↑↑

Flowering mid-Mar.–Apr; fruiting May. Mesic to dry open woodlands, woodland edges, and fields; pioneer species of disturbed (including fire-disturbed) sites. Extremely shade-intolerant. Prefers moist, fertile soils but can grow on dry, sandy or gravelly soils. Epithet from Latin means "large-toothed," a reference to the toothed leaves.

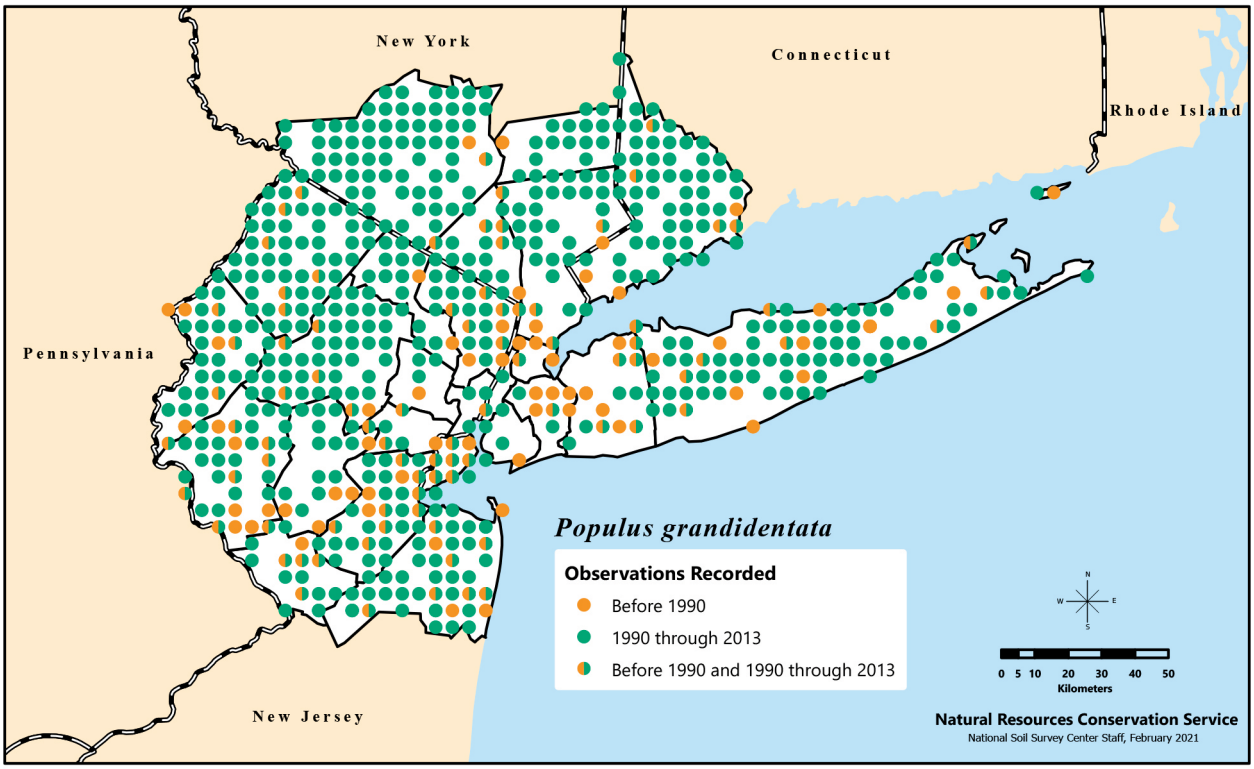
Cultivated since 1772 (Dirr 1998). Female clones of this species, like *Populus tremuloides*, tend to have more ramets and greater basal area, which disagrees with the dioecy hypothesis that females should invest less in vegetative growth (Sakai and Sharik 1988). It is used commercially for pulp (Dirr 1998). Increases in the region may be associated with increases in open areas reverting to woodlands.

4. *Populus heterophylla* L. – swamp cottonwood ↓↓

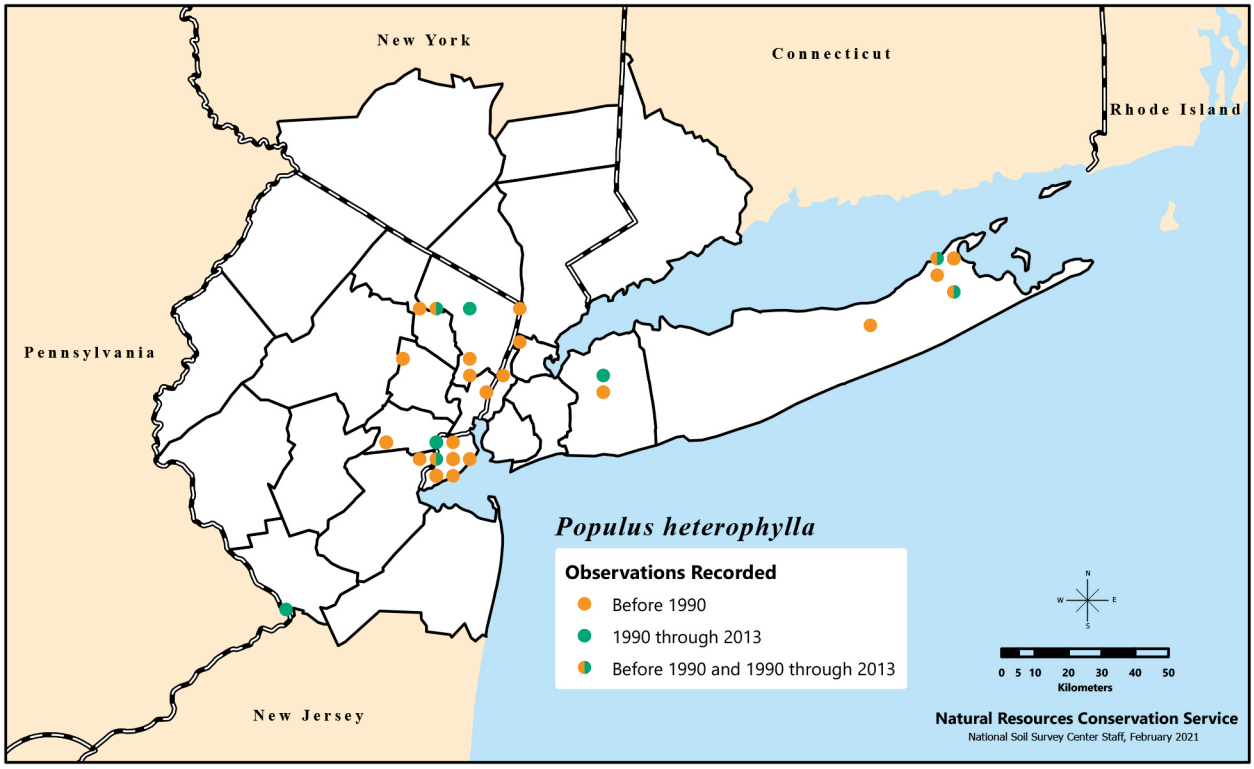
Flowering Apr.–May; fruiting May–June. Swamps and wet bottomlands; reaches the northern limit of its range in the region. A bottomland hardwood species whose native range extends from the bottomlands of the Coastal Plain from CT and southeastern NY to GA and northwestern FL and as far west as LA. Prefers deep, moist soils of shallow swamps and areas near tidewater (Johnson 1990b).

Seedlings require full sunlight to survive. Because of its wide range, this species is found in environments with yearly average temperatures ranging from -29 to 21 ºC, average rainfall from 890 to 1500 mm per year, and consecutive frost-free days from 180 to 300 per year. Earliest

P Q



Distribution of *Populus grandidentata*, or big-tooth aspen, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Populus heterophylla*, or swamp cottonwood, recorded in the New York Metropolitan Region during three time categories.

P Q

seed-bearing age 10 years. As with other poplar species, the seeds have a tuft of hair that aids in wind and water dispersal. Under field conditions, seeds remain viable no more than 2 weeks. Though *Populus heterophylla* can sprout, its clonal root system is not as extensive as other poplars', tending to grow in very small patches. Difficult to propagate from cuttings, which limits its commercial value. Its wood can be used for the same products as *P. deltoides*. Very little research has been conducted on this species. No hybrids with this species have been reported, possibly due to a lack of information (Johnson 1990b).

Listed as threatened in CT (S2) and NY (S2) and tracked as imperiled in NJ (S2).

5. *Populus tremuloides* Michx. – quaking aspen ↑↑

Flowering mid-March–early May; fruiting late Apr.–mid-June. Mesic to dry open woodlands, woodland edges, and fields; pioneer species of disturbed (including fire-disturbed; Kulakowski et al. 2013) sites. Extremely shade-intolerant. Epithet refers to the species' similarity to *Populus tremula*, a native of Europe and Asia.

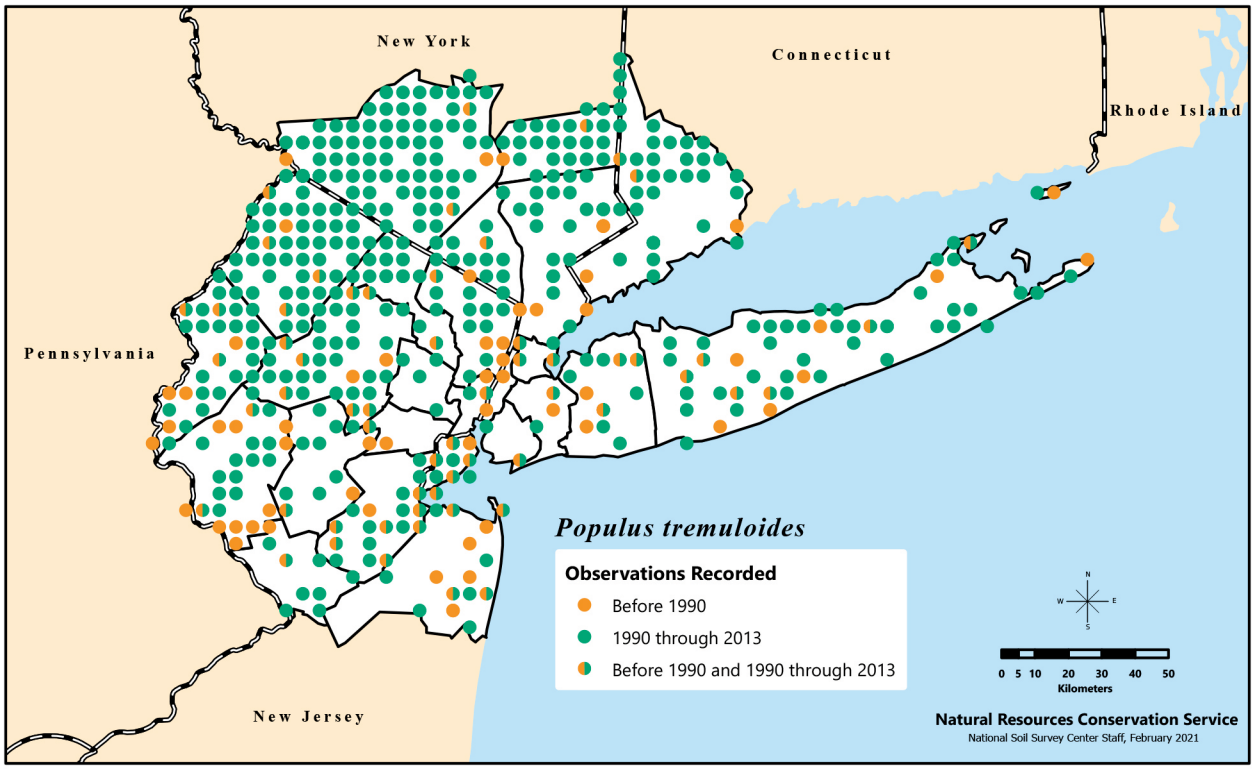
The most widely distributed tree species in North America (Dirr 1998). Indifferent to soil type; grows well in a wide variety of soil types. Can grow in temperatures ranging from -57 to 41 ºC. Can occur anywhere that precipitation exceeds evapotranspiration (Perala 1990).

Earliest seed-bearing age 10–20 years. Best growth occurs on fertile and moist but well-drained soils. Has a high nutrient demand and responds well to fertilization (van den Driessche et al. 2003), possibly because of its tendency for rapid growth. Susceptible to many diseases and once it is infected, regeneration by suckering may actually maintain the infection. Fire may both stimulate suckering and kill saplings; an intense fire could kill surface roots and reduce sucker regeneration (Perala 1990, Wang 2003). Species, in general, has low flammability and may make a good fire break in some cases. Cultivated since 1812 (Wyckoff and Zasada 2008). Some clones may

be thousands of years old. Hybridizes with many other poplars, including the nonnative *P. alba* and western species *P. angustifolia*. Also hybridizes with the native *P. balsamifera*, *P. deltoides*, and *P. grandidentata* as well as the hybrid *P. balsamifera* × *P. deltoides*. The cross with *P. alba* produces viable seed (Perala 1990). It has been successfully crossed with *P. tremula* (a European aspen), resulting in a hybrid that produced 3.2 times as much wood volume as *P. tremula* (Yu et al. 2001). Despite being primarily asexual, *P. tremuloides* has higher genetic diversity and proportion of polymorphic loci than comparable samples of sexually reproducing plants (Cheliak and Dancik 1982). Disturbances give rise to new seedlings, most of which die, but those that survive may add genetic diversity to the existing clones (Romme et al. 2005). The presence of litter may prevent or reduce root suckering (Lavertu et al. 1994). Clone size, which is affected by environmental conditions, is not a good proxy for clone age (Ally et al. 2008). Extrafloral nectaries are present and demonstrate variable mutualistic associations with ants (Wooley et al. 2007).

Male trees of this species tend to have higher stomatal conductance and higher rates of carbon assimilation than female trees (Wang and Curtis 2001). Female and male clones are more dominant at lower elevations and higher elevations, respectively. Females show a higher growth rate than males at their preferred elevations, but growth rates decrease rapidly for females with increasing elevation (Grant and Mitton 1979). Some genetically distinct clones used in short-rotation woody crops for bioenergy production are preferred bird nesting sites over other clones (Dhondt et al. 2004). Clones also vary in foliar chemistry (Lindroth and Hwang 1996), which may affect herbivores and insects such as spongy moth (*Lymantria dispar*) that feed on plants (Osier et al. 2000). Foliar chemistry varies with clone age, with the highest concentrations of phenolic glycoside in younger clones and tannins in older

P Q



Distribution of *Populus tremuloides*, or quaking aspen, recorded in the New York Metropolitan Region during three time categories.

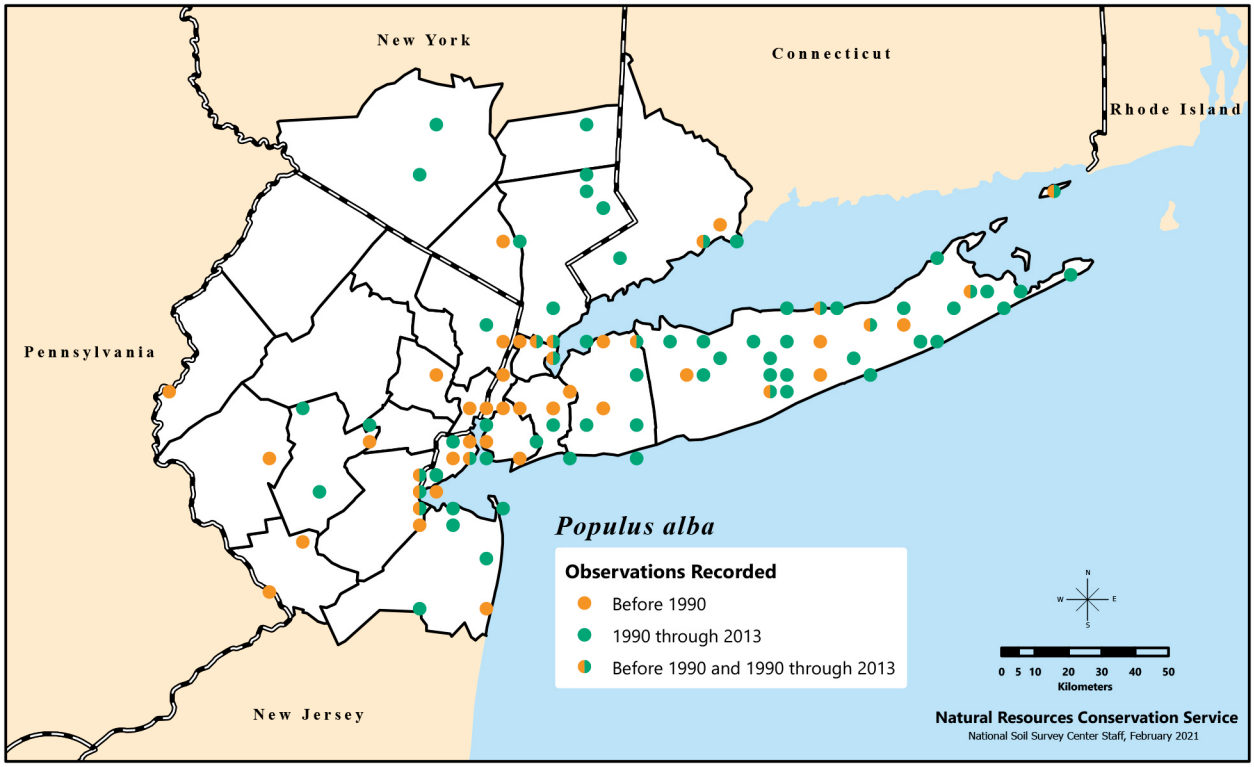
clones (Donaldson et al. 2006). Clonal integration (connections among mother and daughter ramets) does not improve the ability of individuals within a clone to compete with another species (Peltzer 2002). Depression in growth rates in response to long-term carbon dioxide enrichment is correlated with decreases in plant nutrients (Brown 1991). Roots are colonized by both arbuscular mycorrhizal (AM) and ectomycorrhizal (EM) fungi; AM fungi preferentially colonize deeper than 10 cm and EM colonize above 10 cm soil depth (Neville et al. 2002). The root-to-shoot ratio and concentrations of tannins of this species increase with nitrogen limitation and competition (Donaldson et al. 2006). Since the early 2000s, there have been declines in *P. tremuloides* throughout North America. This decline has been attributed to tent caterpillars (*Malacosoma* spp.) (Worrall et al. 2013), aspen bark beetles (*Trypophloeus populi*), poplar borer (*Saperda carcharias*), and cankers combined with drought (Worrall et al. 2008, 2013).

In contrast, there has been a general increase in this species in the NY Metropolitan Region. This increase is primarily in the western portion with some noted declines in the east. Increases may be due to increasing disturbed habitats that are now reverting to woodlands.

Nonnative Species

6. *Populus alba* L. – white poplar ↔

Flowering Apr.–May; fruiting late May–early June. Cultivated and frequently encountered as an escape in disturbed areas, especially on the Coastal Plain. Originated in central and southern Europe to western Siberia and central Asia (Wyckoff and Zasada 2008). Introduced into the U.S. in 1784. Will grow under most conditions, but prefers moist, deep loamy soils and full sun. Adaptable to different soil pHs; tolerant of air pollution and salt (Dirr 1998).



Distribution of *Populus alba*, or white poplar, recorded in the New York Metropolitan Region during three time categories.

Earliest seed-bearing age 10–15 years (Wyckoff and Zasada 2008). At least 5 cultivars. As with other *Populus* spp., seeds require no pregermination treatment and can germinate once dispersed. Susceptible to many insects and diseases. Not recommended as an ornamental tree because it continually drops leaves, stems, and branches. The wood is brittle, and the roots can clog drain lines (Dirr 1998). Used in phytoremediation, with some clones being better heavy-metal accumulators than others (Castiglione et al. 2009). Hybrids with *P. grandidentata* are transgenics that have genetically altered traits for insect resistance, herbicide tolerance, and cold tolerance. If this hybrid were to cross with wild relatives, these traits could be transferred to wild poplar populations (Snow and Palma 1997). Natural hybridization between *P. alba* and native poplars is common. Hybridization was especially common during a time when many farms were abandoned, but more recently lower levels of hybridization may be attributed to fewer suitable seed germination sites near *P. alba* trees due to succession and a reduction in human activity (Spies and Barnes 1982).

Listed as potentially invasive in CT (prohibited).

***Populus* ×*canescens* (Aiton) Sm. – gray poplar**

Populus alba var. *canescens* Aiton

Populus ×*canescens* is considered a natural hybrid between *P. alba* and *P. tremula* (European aspen). Genetic analyses reveal that though *P.* ×*canescens* contains alleles from both species, most come from *P. alba*. This hybrid also backcrosses with *P. alba* (Rajora and Dancik 1992). Native to Europe and western Asia (Wyckoff and Zasada 2008). Generally found where *P. alba* and *P. tremula* overlap in their native regions in northern Africa and central and western Europe (Rajora and Dancik 1992). Epithet from Latin means "gray," a reference to the color of the leaf undersides.

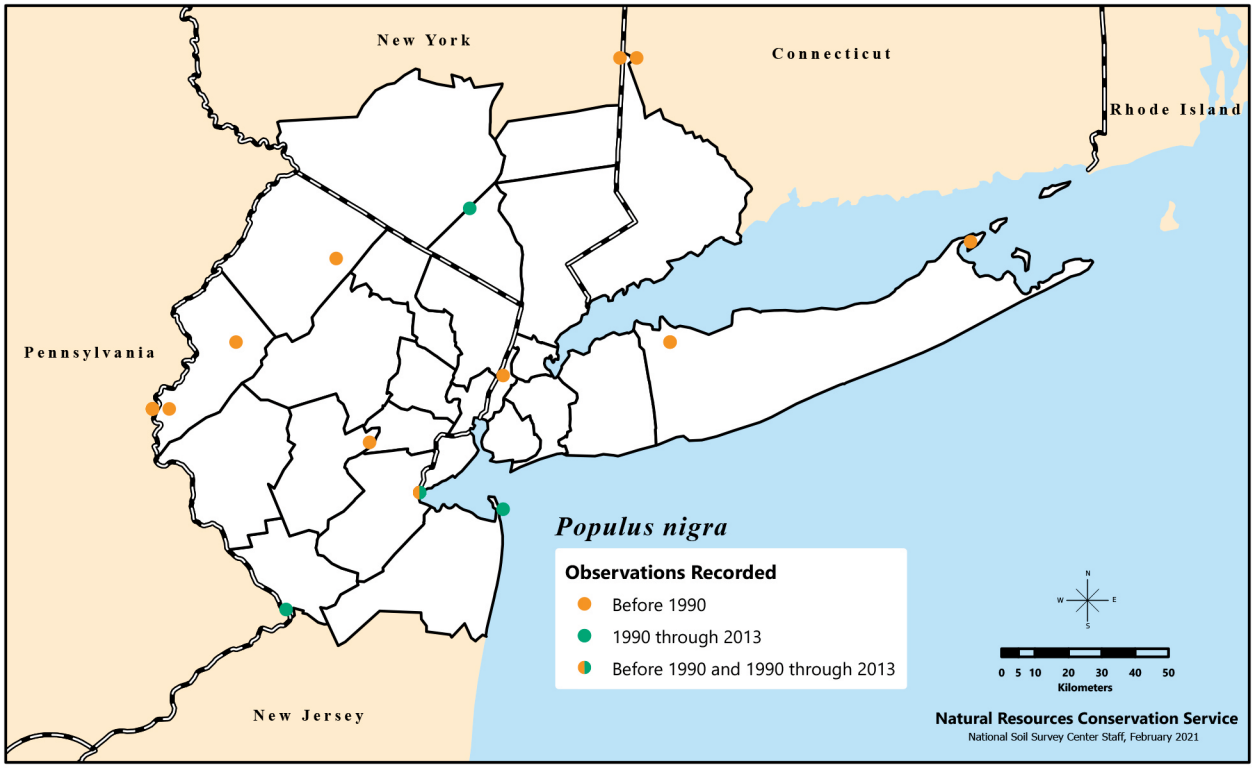
Earliest seed-bearing age 8–15 years (Wyckoff and Zasada 2008). Sensitive to salt (Bolu and Polle 2004). Known for its vigorous growth and the superior rooting ability of its shoot cuttings (Rajor and Dancik 1992). A prominent invader in southern Africa (Henderson 2007). This species has increased and decreased in almost equal numbers in different locations in the region.

7. *Populus nigra* L. – black poplar ↓↓

Flowering Apr.–early May; fruiting late May. Cultivated and rarely escapes from cultivation in disturbed areas. Native to Europe and western Asia (Wyckoff and Zasada 2008). In its natural habitat, it is a pioneer species of riparian ecosystems; it is in decline in Europe due to loss of habitat and its narrow-based cultivated gene pool (Lefèvre et al. 1998).

Earliest seed-bearing age 8–12 years (Wyckoff and Zasada 2008). *Populus nigra* 'Italica' (Lombardy or black poplar) is a male clone and is propagated by cuttings. Introduced into the U.S. in 1784. At least 8 other cultivars (Dirr 1998). Sexual reproduction exists for *P. nigra*, at least in its native region (Legionnet et al. 1997). In Europe, *P. nigra* is considered rare and endangered in parts of its native region because it has been hybridizing with the nonnative (to Europe) *P. deltoides*, forming *P.* ×*canadensis* (Holderegger et al. 2005). Due to a lack of flower-time synchrony, *P. nigra* 'Italica' cannot hybridize with female *P. nigra* or female *P.* ×*canadensis* (Vanden Broeck et al. 2003). *Populus nigra* may have two origins, one derived from *P. alba*, and the second distinct from *P. alba* (Smith and Sytsma 1990). Three transgenic clones of *P. nigra* have been developed using *Bacilllus thuringiensis* (B.t.) with evident insecticidal activity and are being grown at a large scale in China for evaluation (Wang et al. 1996).

Populus ×*canadensis* Moench. possibly found in the NY Metropolitan Region. This hybrid is more aggressive than either parent, propagating very easily from cuttings. It grows best in more southerly climates, including USDA Hardiness Zone 4 and south of it. At least 11 cultivars of this hybrid, some of which are resistant to canker and somewhat resistant to leaf rust diseases (Dirr 1998). *Populus* ×*canadensis* successfully crosses back with *P. nigra* as well as *P. nigra* 'Italica.' Indeed, without mating interactions with *P. nigra*, sexual reproduction of *P.* ×*canadensis* is very low, suggesting that keeping *P. nigra* away from *P.* ×*canadensis* could reduce the flow of genes from nonnatives into the gene pool. Successful



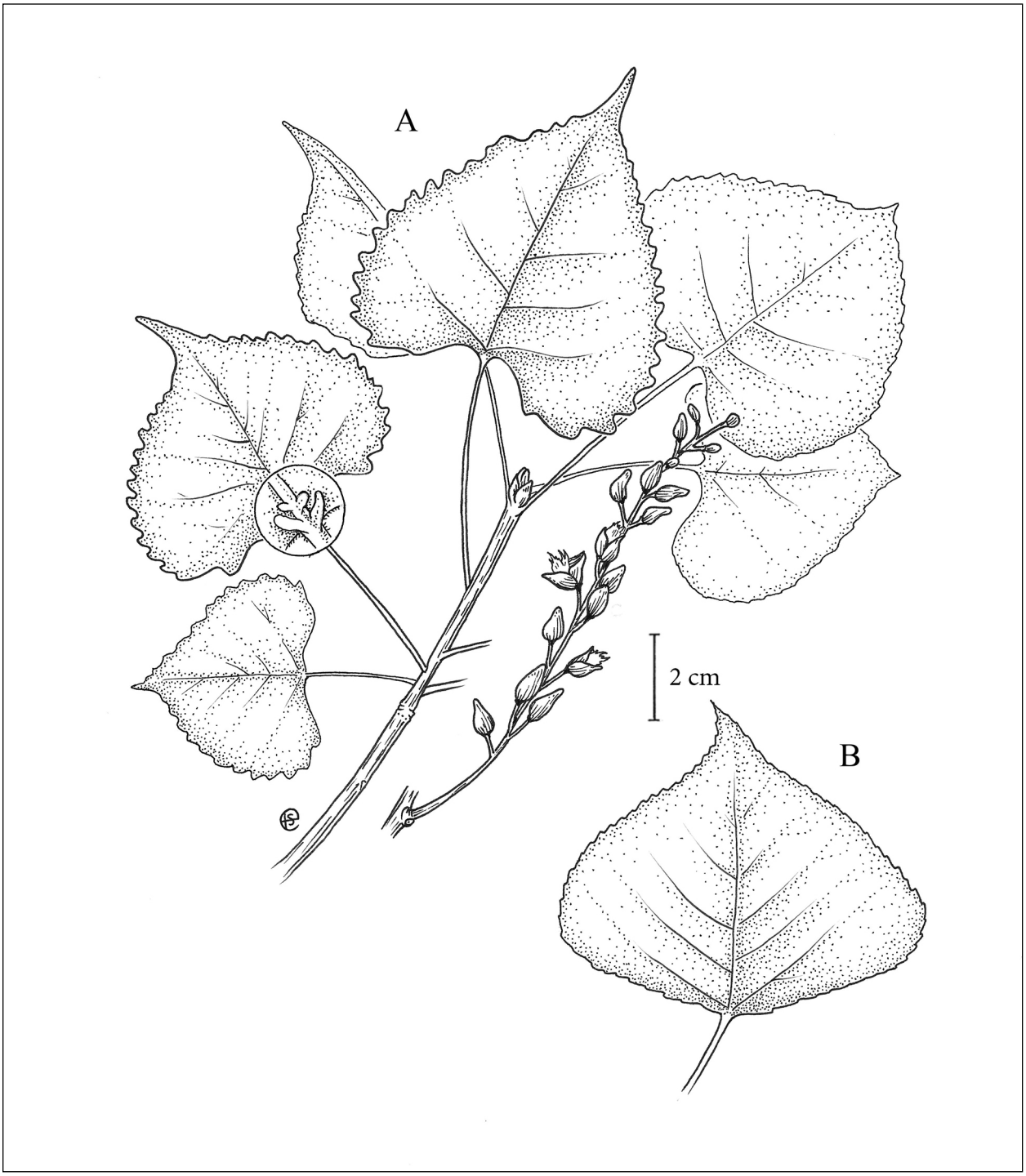
Distribution of *Populus nigra*, or black poplar, recorded in the New York Metropolitan Region during three time categories.

crosses between *P.* ×*canadensis* and *P. nigra* are usually with *P.* ×*canadensis* as the female parent and *P. nigra* as the male parent. Thus, a reduction in risk of increasing nonnative genes in the poplar gene pool can be achieved by planting male *P.* ×*canadensis*, especially if *P. nigra* may be in the vicinity (Vanden-Broeck et al. 2012). When 18 potential cultivars of *P.* ×*canadensis* were tested for actual parentage, 2 distinct groups were identified, with 1 larger group showing a high degree of genetic interrelationship (Rajora and Zsuffa 1989).

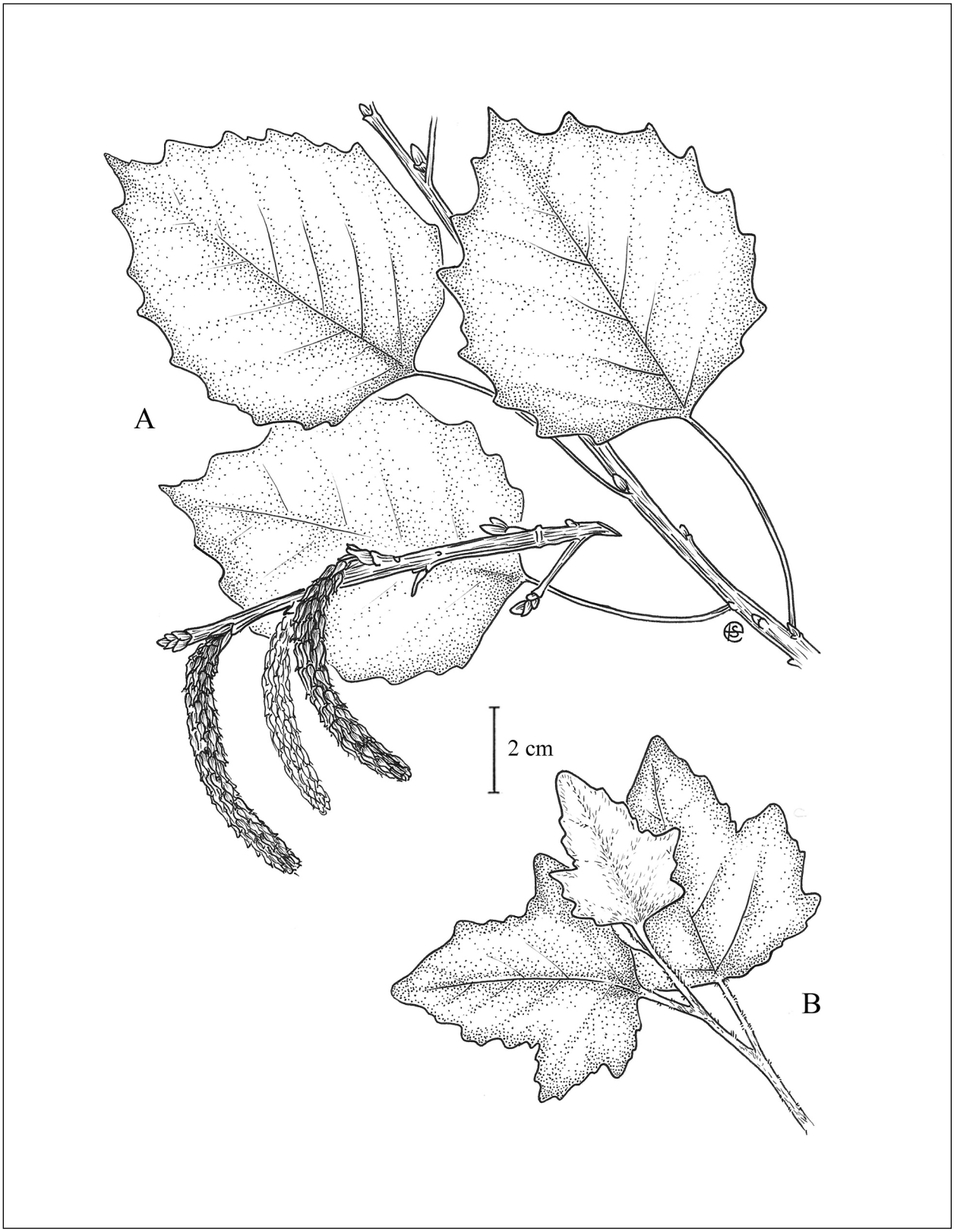
Management

Populus spp. are commercially important and are used for wood products; they also have potential as a biofuel. Unfortunately, hybridization among many of the species, including nonnative and transgenic species, is highly likely with a great risk of loss of native poplar alleles and spread of nonnative and transgenic traits over time.

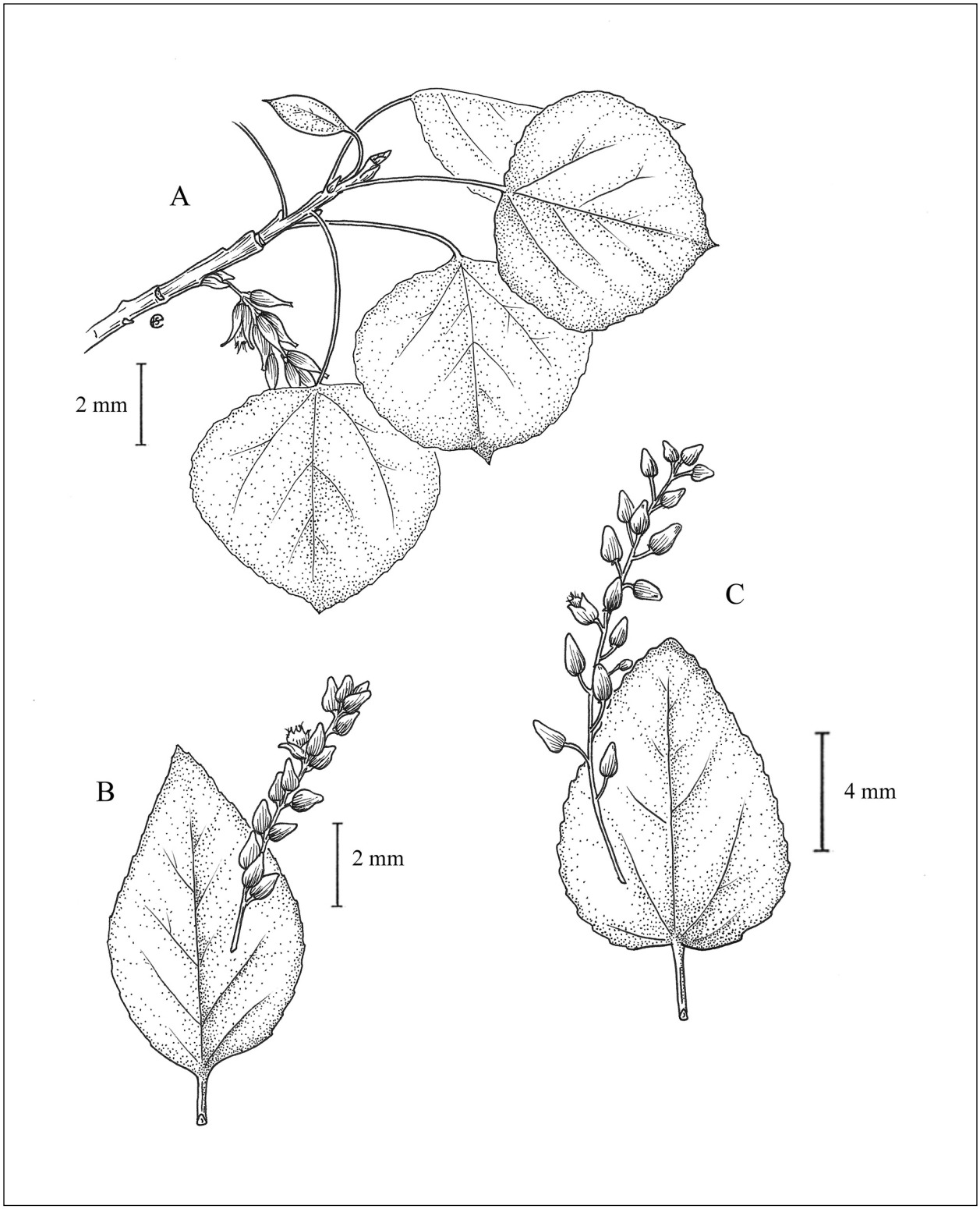
Consequently, we encourage planting of native species if populations of *P. alba* and *P. nigra* (male), and potentially any other poplar species, are not in the vicinity. Planting of natives may help reestablish some of the declining native populations. We also encourage removal of nonnative poplars where possible. While some of the known hybrids may not be invasive yet in North America, the fact that they have proven to be invasive elsewhere is foreboding. Large clones are less likely to occur in the eastern U.S. because of their relatively young age and the greater likelihood of seedling establishment. The result is greater competition among different clones and with other, more shade-tolerant species (Kemperman and Barnes 1976). These smaller patches of different clones may also indicate that different poplar species could be distributed in similar small patches, making hybridization among different species possibly more likely to occur in the eastern U.S.



A) Leafy twig, with enlarged view of petiole glands, and catkin of *Populus deltoides*; B) leaf of *Populus nigra*. Illustration by Emma Skurnick.



A) Twig with leaves and twig with catkins of *Populus grandidentata*; B) twig with leaves of *Populus alba*. Illustration by Emma Skurnick.



A) Flowering twig with leaves of *Populus tremuloides*; leaf and catkin of B) *Populus balsamifera* and C) *Populus heterophylla*. Illustration by Emma Skurnick.

Prunus L. – cherry, peach, plum

Rosaceae. Trees, shrubs. Species 200+ in Africa, Asia, Australia, Europe, North America, and South America; most abundant in temperate areas. Readily distinguished from other genera in the rose family by their fleshy, stone (drupe) fruit. Largely pollinated by bees (order Hymenoptera). Widely cultivated for timber, ornament, and edible fruits. "Prunus" is the ancient Latin name for plum.

Prunus is sometimes split into many genera (e.g., Gu and Bartholomew 2003a, 2003b; Li and Bartholomew 2003; Lu and Bartholomew 2003a, 2003b, 2003c): *Amydalus* L. (almonds, peaches); *Armeniaca* Scop. (apricots); *Cerasus* Mill (cherries; leaves deciduous, flowers solitary or in small clusters); *Laurocerasus* Duhamel (cherries; leaves evergreen, flowers produced on long axillary racemes); *Padus* Mill. (cherries; leaves deciduous, flowers produced on long terminal racemes from new branchlets); *Prunus* L. s.s. (plums). Most recognize a single genus (e.g., Rohrer 2014) sometimes with subgenera recognized, such as Rehder (1949), who recognized as subgenera all but one of the genera cited here. The exception: apricots and plums, which were placed in the same subgenus (apricots and plums can hybridize).

Besides the keyed species, the apricot, *Prunus armeniaca* L. (*Armeniaca vulgaris* Lam.), is sometimes cultivated and could be expected to be found as a remnant from cultivation, as noted for PA (Rhoads and Block 2007). *Prunus armeniaca* is originally from Asia.

The following hybrids involving the species treated here have been reported (Rehder 1949) and also may be encountered in the region: *Prunus* ×*cistena* N.E.Hansen (*P. cerasifera* × *P. pumila*); *P.* ×*dunbarii* (*P. americana* × *P. maritima*); *P.* ×*effusa* (Host) Schneid. (*P. avium* × *P. cerasus*); *P.* ×*fontanesiana* Schneid. (*P. avium* × *P. mahaleb*); *P.* ×*fruticans* Weihe (*P. domestica* × *P. spinosa*); *P.* ×*laucheana* Bolle (*P. padus* × *P. virginiana*).

Prunus Key

1. Inflorescences elongate racemes of many (at least 12, usually at least 20) flowers, terminating in a new leafy branchlet of the current year 2
1. Inflorescences corymbs or umbels of fewer than 12 flowers (or flowers solitary), sessile or on short lateral shoots (leafy or not) 3
2. Flowers 10–15 mm across, petals 6 mm or longer; fruit 8 mm or less diameter . . . . . ***Prunus padus****
2. Flowers 8–10 mm across, petals 4 mm long or less; fruit more than 8 mm diameter 4
3. Flowers and fruit sessile or nearly so, mostly solitary (or 2); ovaries and fruit densely pubescent; flowers pink or white . . . . . ***Prunus persica****
3. Flowers and fruit on distinct slender pedicels, often not solitary; ovaries and fruit glabrous; flowers in most species white 5
4. Leaves with blades ovate or elliptic to lanceolate, mostly broadest at or below the middle, somewhat glossy above, the teeth somewhat incurved, giving the margin a crenulate aspect; calyx lobes entire or nearly so (at most 5 glandular teeth), persistent, with the floral tube beneath the maturing fruit . . . . . ***Prunus serotina***
4. Leaves with blades elliptic to obovate, mostly broadest at or above the middle, dull above, the teeth narrowly acuminate and ascending to spreading, giving the margin a sharply and finely serrate aspect; calyx lobes with numerous irregular gland-tipped teeth, deciduous with the floral tube, leaving only a smooth disk beneath the maturing fruit. . . . . ***Prunus virginiana***

5. Calyx lobes glabrous throughout (at most, glandular-margined);
fruit (cherry) somewhat globose, not grooved, not glaucous,
the pit rounded rather than 2-edged 6
5. Calyx lobes pubescent, at least sparsely at the base above;
fruit (plum) with a longitudinal shallow furrow or groove,
usually glaucous, the pit 2-edged, often somewhat flattened 7
6. Plant a low spreading shrub (native), with mostly decumbent
or ascending elongate branches; leaf blades oblanceolate (to obovate-elliptic),
the teeth obscure or absent on lower third or half;
calyx lobes with irregularly glandular-toothed margins;
petals less than 7.5(9) mm long . . . . . ***Prunus pumila***
6. Plant an erect small or large tree or tall bushy shrub;
leaf blades ovate to obovate, regularly toothed to the base;
calyx lobes without glands (or a few glandular teeth
in the large-flowered *P. cerasus*); petals various 8
7. Teeth of leaf sharp (almost bristle-tipped), glandless;
calyx lobes without marginal glands (rarely a few teeth at end in *P. americana*) 9
7. Teeth of leaf gland-tipped (evident in young leaves unfolding as the flowers open),
the rounded tip with a callus scar if gland is shed;
calyx lobes with glandular margins (except in *P. cerasifera*). 10
8. Petals 4–7.5 mm long; fruit less than 10 mm diameter 11
8. Petals about 9–15 mm long; fruit more than 10 mm diameter 12
9. Leaves ovate, oval, obovate, or rounded, long-acuminate, sharply serrate;
petals 10–15 mm long; fruit red, purple, or yellow . . . . . ***Prunus americana***
9. Leaves lanceolate to ovate, elliptic, or ovate-oblong,
merely acute or nearly acute to obtuse or truncate, crenate or dentate,
the teeth sharp-pointed; petals 4–8 mm long; fruit blue or dark purple
(sometimes purple or yellow) 13
10. Margins of calyx lobes pubescent but not glandular;
petals about 5–7 mm long; young twigs shiny reddish-brown;
leaves small, the blades mostly less than 50 mm long . . . . . ***Prunus cerasifera****
10. Margins of calyx lobes glandular; petals 5–12 mm long; twigs and leaves various 14
11. Inflorescences few-flowered corymbose racemes; petals glabrous;
leaf blades round-ovate, less than 1.5 times as long as wide; fruit nearly black . . . . ***Prunus mahaleb****
11. Inflorescences usually umbellate (occasionally somewhat corymbose);
petals hairy on the outside at the base; leaf blades usually at least
twice as long as wide; fruit bright red . . . . . ***Prunus pensylvanica***
12. Calyces with entire lobes, constricted below them; bud scales at base umbel
not leaf-like, the inner ones divergent or reflexed; leaves retaining some pubescence,
especially along the midrib, beneath, the blades about 7–15 cm long at maturity
and the petioles with conspicuous glands near the summit;
fruit more than 1.5 cm diameter, fruit sweet. . . . . ***Prunus avium****
12. Calyces with glandular-toothed lobes, not constricted below them; bud scales
often with leaf-like tips, the inner ones erect; leaves becoming glabrous beneath,
the blades mostly 4–8 cm long at maturity with glands toward the base
(rather than on the petiole); fruit more than 1.5 cm diameter, fruit sour . . . . . ***Prunus cerasus****

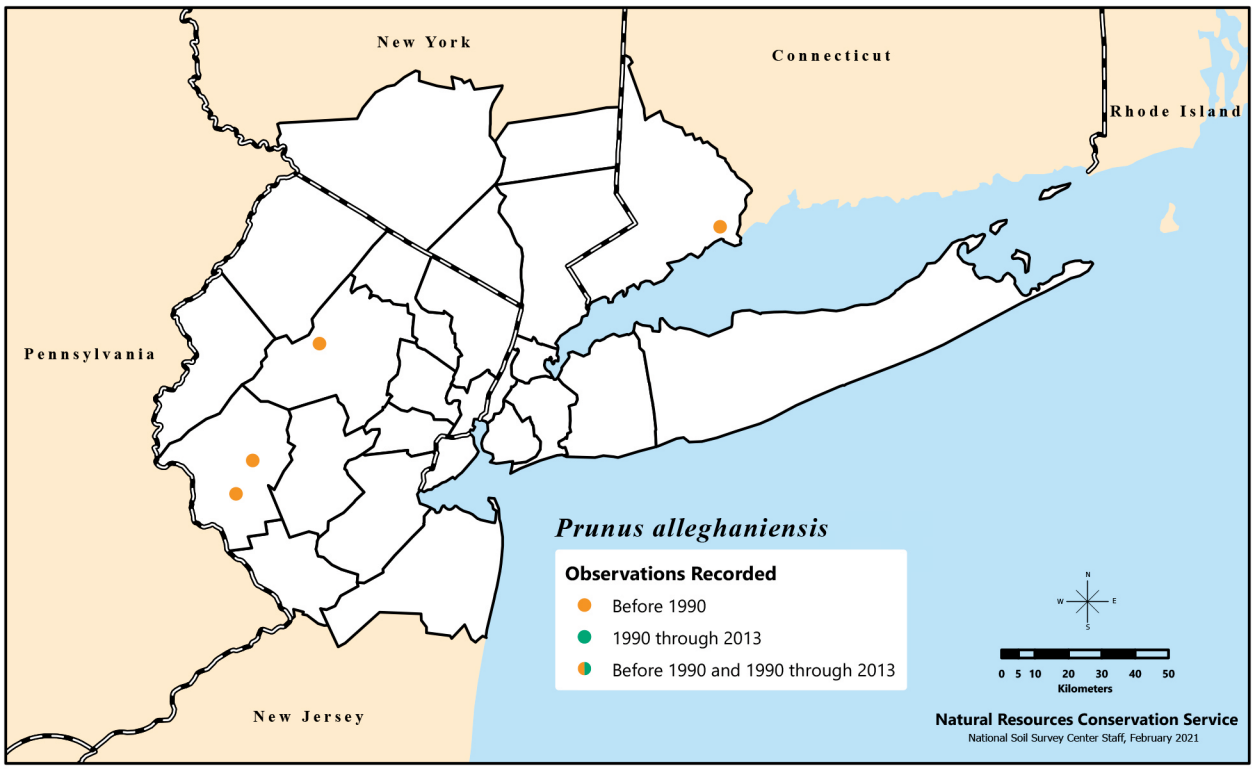
13. Pedicels and lower surface of leaf pubescent . . . . . ***Prunus maritima***
13. Pedicels and lower leaf surface glabrous or nearly so . . . . . ***Prunus alleghaniensis***
14. Twigs not spiny, often glabrous; petals about 8–12 mm long; fruit more than 25 mm diameter, pendent at maturity . . . . . ***Prunus domestica****
14. Twigs spiny, the young ones finely pubescent; petals 5–8 mm long; fruit usually less than 10(15) mm diameter, erect at maturity . . . . . ***Prunus spinosa****

Native Species

1. *Prunus alleghaniensis* Porter – Allegheny plum Ø♥

Shrub. Flowering late Apr.–May; fruiting early Aug.–Sept. Dry woodlands and woodland edges, often on rocky ground. Known only historically from the region from Fairfield County (CT) and Hunterdon, Morris, and Sussex Counties (NJ).

Has a curious distribution with isolated reports in western NC, southeastern KY, and TN; a rather continuous distribution in the mountains of VA and WV into central PA; and scattered records north and eastward in CT, NJ, and MA. Also disjunct in MI (this material sometimes treated as a separate variety, *Prunus alleghaniensis* var. *davisii* (Wight) Sarg.). Rohrer (2014) treated *P. alleghaniensis* as synonymous with *P. umbellata* Elliott, a species from the southeastern U.S. *Prunus alleghaniensis* is genetically most closely related to *P. umbellata*, *P. angustifolia*, *P. gracilis*, *P. nigra*, and *P. munsoniana*. *Prunus umbellata* and *P. alleghaniensis* also look alike morphologically, which cannot be said of the other genetically



Distribution of *Prunus alleghaniensis*, or Allegheny plum, recorded in the New York Metropolitan Region during three time categories.

related species in this Chickasaw clade. Shared membership of this clade may be due to frequent hybridization among the species or a shared hybrid origin (Shaw and Small 2004). Only *P. nigra* is also potentially found in the NY Metropolitan Region and its presence may be due only to occasional plantings; the shared hybrid origin may be more likely than hybridization among species not found geographically close to each other (Shaw and Small 2005). Preferred habitats include dry sand prairies and *Pinus banksiana* (jack pine) plains, both of which depend on fire (Higman and Penskar 1996).

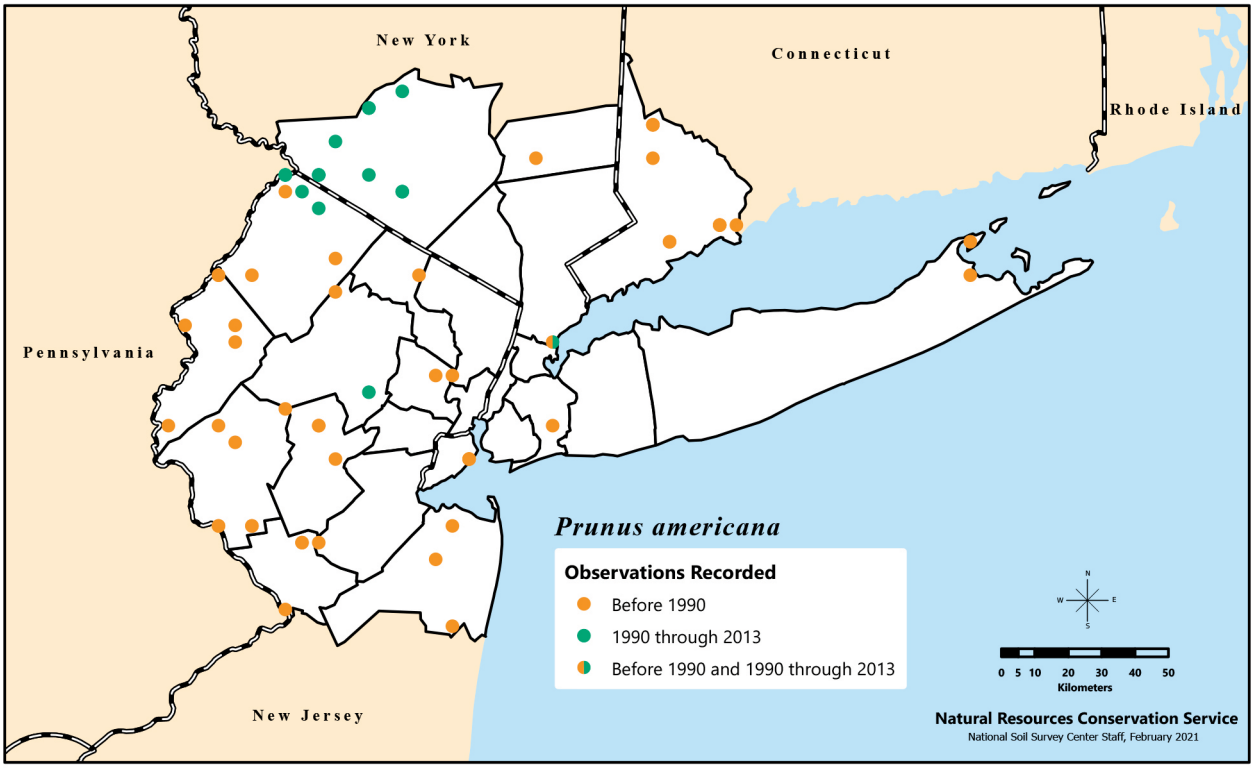
Also found in shale barrens in MD (Kalhorn et al. 2003). Has the ability to hold soil, making it a good candidate to prevent or reduce soil erosion. Highly shade-intolerant, preferring sites with morning sun and afternoon shade (i.e., east-facing slopes) (Taylor 1990). In MI, this species (represented by *P. alleghaniensis* var. *davisii*) is in decline, primarily because of a loss of habitat resulting from fire suppression. Roadsides and other disturbed areas may serve as a refuge for this species, but other disturbances such as herbicide application have decimated some clonal populations of this species (Higman and Penskar 1996). Infrequent in MD, but it is widespread and rather weedy in PA (Reveal and Broome 1982). No known hybrids of *P. alleghaniensis* with commercial plums (Okie 2001). Earliest fruit-bearing age 4 years; can produce a large seed crop annually. Cold stratification required for 150 days, but may have relatively low germination rates of around 25 percent (Grisez et al. 2008). Birds and mammals eat the fleshy fruit and may help disperse the seeds (Higman and Penskar 1996). Fruit is of the summer large-seeded type and available before fall bird migration. Rodents (order Rodentia) are seed predators instead of disseminators of the large seeds. Fruit tends to be high in carbohydrates and low in lipids, hence considered lower quality (Stiles 1980). This species is not typically used by breeders because fruit is relatively small and is bitter (Okie 2006). Cultivated since 1889 (Dirr 1998).

Presumed extirpated in CT and NJ (SX). No confirmed records from NY.

2. *Prunus americana* Marshall – hedge plum ↓↓

Shrub, rarely small tree. Flowering late Apr.–May; fruiting early Aug.–Sept. Open deciduous woodlands, woodland edges, floodplains, and roadsides.

Earliest fruit-bearing age 4 years; large seed crops every 1–2 years. Cold stratification for 90–150 days required for germination (Grisez et al. 2008). Is clonal and may spread aggressively, but single-stemmed 8 m tall trees are also found. Cultivated since 1768 (Dirr 1998). Fruit a preferred food source for white-tailed deer (*Odocoileus virginianus*) (Sotala and Kirkpatrick 1973) and black bear (*Ursus americanus*) in early fall (Rogers 1987); also eaten by coyotes (*Canis latrans*) in summer and fall (MacCracken and Uresh 1984). Both fruit and seeds are eaten by the eastern woodrat (*Neotoma floridana*) (Post et al. 1993). It is a favored nesting location for red-winged blackbirds (*Agelaius phoenicus*) (Hergengrader 1962). Sensitive to elevated levels of ozone, as indicated by leaves with red patches to purple coloration and eventually early leaf senescence (Orendovici et al. 2003). May hybridize with other plum species, including *Prunus salicina*, to possibly improve cold hardiness of *P. americana* (Quamme et al. 1982). Most closely related to *P. munsoniana*, *P. hotulana*, *P. subcordata*, and *P. angustifolia* (Mowrey and Werner 1990), all of which may fall within *P. americana*'s relatively wide distribution, but none of which is found in the NY Metropolitan Region. Fruit used commercially for jellies and jams (Dirr 1998). Considered an invasive shrub in some habitats, including tallgrass prairies (McCarron and Knapp 2001). Fruit have high antioxidant activity (Muñoz Acuña et al. 2002); dried fruit or prunes have antioxidant, anticancer, antihyperglycemic, antihyperlipidemic, antihypertensive, antiosteo-porosis, laxative, and hepatoprotective activities (Jabeen and Aslam 2011). This species may suffer from five fungi of the sooty blotch (caused by multiple fungi) and flyspeck disease (causal agent: the fungus *Zygophiala jamaicensis*) complex, which is known to cause significant economic losses to *Malus* spp. (apples) (Latinović et al. 2007). This disease complex may explain some of this species' decline.



Distribution of *Prunus americana*, or hedge plum, recorded in the New York Metropolitan Region during three time categories.

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3. *Prunus maritima* Marshall – beach plum ↔

Prunus gravesii Small; *Prunus maritima* var. *gravesii* (Small) G.J.Anderson

Shrub, rarely small tree. Flowering late Apr.–May; fruiting late Aug.–Oct. Open woodlands, woodland edges, pinelands, roadsides, dunes, and beaches; chiefly limited to the Coastal Plain.

Prunus maritima var. *gravesii* (the varietal epithet honoring its discoverer, Charles Burr Graves [1860–1936], CT physician and botanist) represented a single population in Groton, CT (New London County), just outside the NY Metropolitan Region. The one population no longer extant; now presumed extinct in the wild, but is in cultivation from cuttings taken from the site. It differs from typical *P. maritima* in having orbicular leaves. This variety is more recently considered the rare forma *gravesii* instead of a variety (Klooster et al. 2018). *Prunus maritima*'s native range is from ME to DE (Grisez et al. 2008), suggesting that MD and VA populations may be escapes or examples of range expansion. Found as far south as VA and as far north as NS.

Grows in sandy, rocky soils along the coast and is tolerant of salt (Dirr 1998) and drought (Uva and Whitlow 2007). Though relatively drought-tolerant, it is typically found on moist sandy soils; there are more drought-tolerant *Prunus* spp. in the U.S. (e.g., *P. andersonnii* and *P. besseyi*) (Rieger and Duemmel 1992). Though it is found primarily in sandy coastal areas, its growth rate may increase in more fertile soils, but irrigation appears to have no effect on its growth (Grisez et al. 2008).

Cultivated since 1818, with at least 3 cultivars. A valued species, especially in Cape Cod, MA (Dirr 1998). Earliest fruit-bearing age 3 years. Cold stratification for 90 days required for germination (Grisez et al. 2008). Fruit (both commercially grown and found in the wild) used for jams, jellies, and preserves. Most fruit use is from wild stands and the demand for the fruit exceeds the supply, suggesting a potential economic opportunity (Uva and Whitlow 2007). Indeed, it is actively cultivated in southern NJ with the help of the NJ Plant Materials Center. Also considered to have a promising commercial future in China because of its tasty fruit, high ornamental value, and strong

adaptability to harsh environments. However, it suffers from deficiencies in propagation, which may be overcome by using tissue culture and hardwood cuttings inoculated with vesicular arbuscular (VA) mycorrhizae, all of which result in increases in the size of cloned populations. This method has been utilized to colonize waste areas in China with this species (Zai et al. 2009). Use of VA mycorrhizae may help alleviate any salt damage to chloroplasts and facilitate photosynthesis by increasing phosphorus and magnesium uptake and reducing cellular sodium concentrations (Zai et al. 2012). Electromagnetic fields also increase sprouting and growth of this species (Yan et al. 2009), suggesting this species may also grow well in some power line corridors. Genetically associated with either the Beach or Chickasaw clades, which include *P. alleghaniensis*, *P. umbellata*, and *P. geniculata*, among others (Shaw and Small 2005).

This species has relatively high sorbitol concentrations compared to other *Prunus* spp.; sorbitol may play a role in *P. maritima*'s response to environmental stress (Moing et al. 1997). Susceptible to the newly introduced spotted wing drosophila (*Drosophila suzukii*), which will infest and damage the fruit (Maier 2012). Favored host of browntail moth (*Euproctis chrysorrhoea*), a successful nonnative invader. Between 1906 and 1910, browntail moth significantly declined after the introduction of several European parasitoids released to control spongy moth (*Lymantria dispar*). This decline did not reach the coastal habitat of *P. maritima*, where large populations of browntail moth persist most likely because the parasitoid requires alternate hosts during its lifecycle and this habitat is rather species-depauperate (Elkinton et al. 2006). Thus, declines in *P. maritima* could be attributed to the browntail moth. However, there are noted increases on Long Island, where browntail moth populations most likely have not declined; habitat availability for *P. maritima* may have increased with recent

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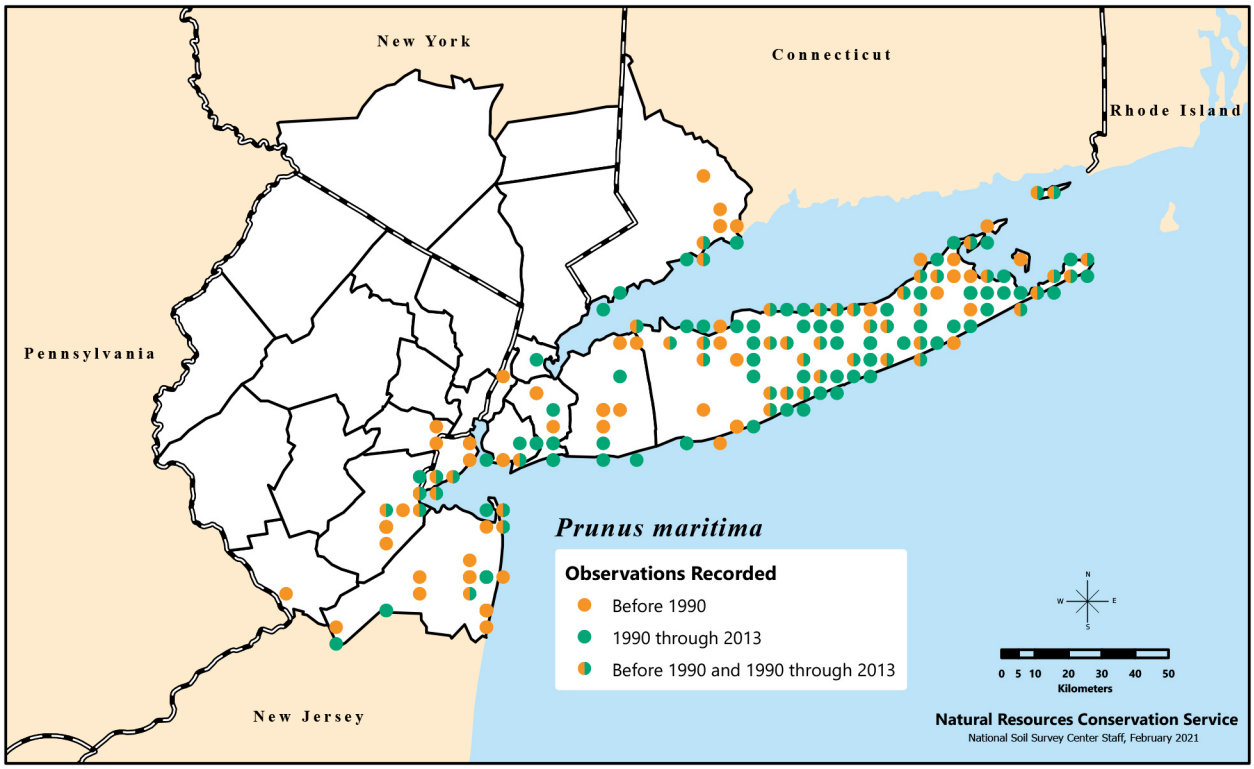


Distribution of *Prunus maritima*, or beach plum, recorded in the New York Metropolitan Region during three time categories.

hurricane events. This species has decreased in the NY Metropolitan Region in the western part of its original range and increased in the eastern part of its original range.

Prunus angustifolia Marshall – Chickasaw plum

Known just south of the region in southern NJ, including adjacent Burlington and Ocean Counties, with one report from the region in Monmouth County. Differs from other *Prunus* spp. in having leaves (at least some of them) folded along the midrib, thus trough-like.

Tracked as imperiled in NJ (S2).

Prunus nigra Aiton – Canada plum

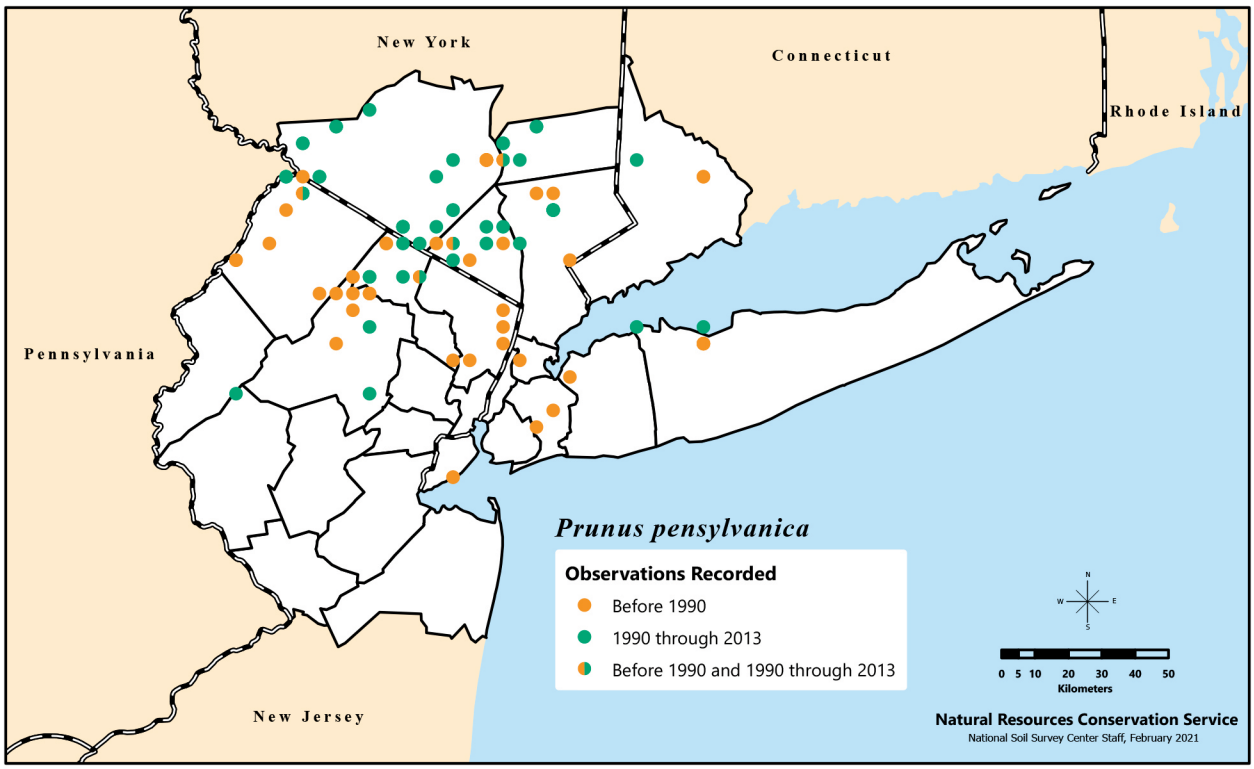
Reports of this plant from the region most likely represent either misidentifications or escapes from cultivation, the native range being farther north (confirmed in CT and NY but outside the region). The prominent lenticels and the black bark give this tree a horticultural distinction, especially in the winter. Cultivated since 1773 (Dirr 1998). Considered a boreal relic in IN (Welch 1935).

4. *Prunus pensylvanica* L.f. – pin cherry ↔

Cerasus pensylvanica (L.f.) Loisel.

Shrub, rarely small tree. Flowering late Mar.–early July; fruiting late July–Sept. Open woodlands, woodland edges, roadsides, and burned or cleared areas; declining in the region, especially in the southern areas.

Earliest fruit-bearing age 2 years. Moist warm stratification for 60 days and moist cold stratification for 90 days required for germination (Grisez et al. 2008). Viable seed may be found in the seed bank at least 90 years since dispersal (Peterson and Carson 1996). However, seedlings of *Prunus pensylvanica* are often present when a 40- to 60-year stand is cut but often absent when an 80- to 100-year stand is cut, suggesting a shorter seed bank lifespan (Marks 1974).



Distribution of *Prunus pensylvanica*, or pin cherry, recorded in the New York Metropolitan Region during three time categories.

Sprouts and root suckers extensively from cut stems, forming large clones (as many as 32 root suckers per cut stem) (Jobidon 1997). Rapid early establishment may stabilize early ecosystems by retarding runoff (Marks 1974). However, despite its intolerance to shade, high densities of *P. pensylvanica* may deter establishment of other mid-successional and late successional species (Heitzman and Nyland 1994, Ristau and Horsley 2006). Nonetheless, new problems with invasion of other rapidly colonizing nonnative plants may make *P. pensylvanica* the preferred rapid colonizer. May preferentially take up ammonium over nitrate and sites with high ammonification rates may be more conducive to rapid establishment of *P. pensylvanica*. Sites with low ammonification rates, which are usually high in nitrates after a disturbance, may be more conducive to establishment of *Rubus* spp., which preferentially take up nitrates over ammonium (Truax et al. 1994). However, nitrate was found to stimulate the germination of *P. pensylvanica* seed (Auchmoody 1979). This species responds with compensatory growth after deer (*Odocoileus* spp.) browse, but such growth is less likely to occur at high stem densities. Thus, in areas with high deer densities, it would be counterproductive to thin *P. pensylvanica* stems that are at high stem densities (Shabel and Peart 1994). Biocontrols (e.g., an indigenous fungus, *Chondrosterium purpureum*) have been tried to reduce root suckering and sprouting of *P. pensylvanica*, but *P. pensylvanica* appears somewhat resistant and its response varies with the fungal isolate (Jobidon 1998).

Slightly more counties in the region have lost *P. pensylvanica* than have gained this species. Part of this change may be due to aging forests that are losing early-successional tree species.

5. *Prunus pumila* L. s.l. – sand cherry ↔

Cerasus pumila (L.) Michx.

Shrub. Flowering late Mar.–early July; fruiting late July–Sept. Dry to wet open areas on acidic or basic soils, including dunes, beaches, pinelands, sand bars, rocky slopes, and fields. Epithet means "dwarfish," a reference to the plant's short height.

Cultivated since 1756. This species is easy to propagate and could be marketed as a native landscape shrub, but besides its dark red fall foliage, horticultural advantages of this shrub over other native shrubs are not defined (Shrestha and Lubell 2015).

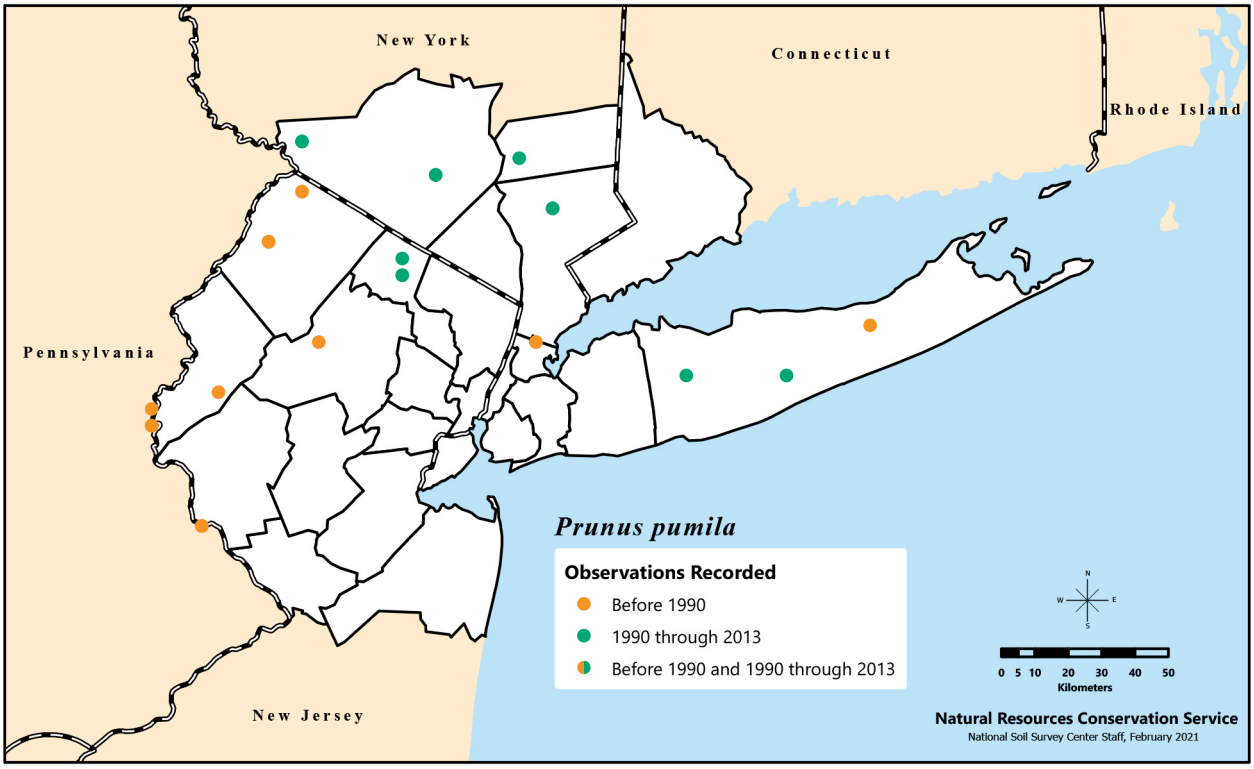
Two varieties, sometimes recognized as subspecies or distinct species, are reported from the region (see key). *Prunus pumila* var. *depressa* appears to prefer more basic soils and has been reported from open habitats along the Delaware River from Hunterdon, Mercer, Morris, Sussex, and Warner Counties (NJ), although not recently observed. Also historically reported from Bronx and Suffolk Counties (NY). Most records from the region are likely to represent *P. pumila* var. *susquehanae*, which apparently prefers acidic soils. Numerous records exist from the area off the Coastal Plain, as well as on the Coastal Plain on Long Island. Long (1915) also reported the species from the NJ Coastal Plain just south of the region in Ocean County. Additional field and herbarium work are needed to better understand each variety's distribution in the region.

Prunus pumila var. *depressa* is listed as endangered in NJ (S1) and threatened in NY (S2). *Prunus depressa* var. *susquehanae* is tracked as rare in NJ (S3).

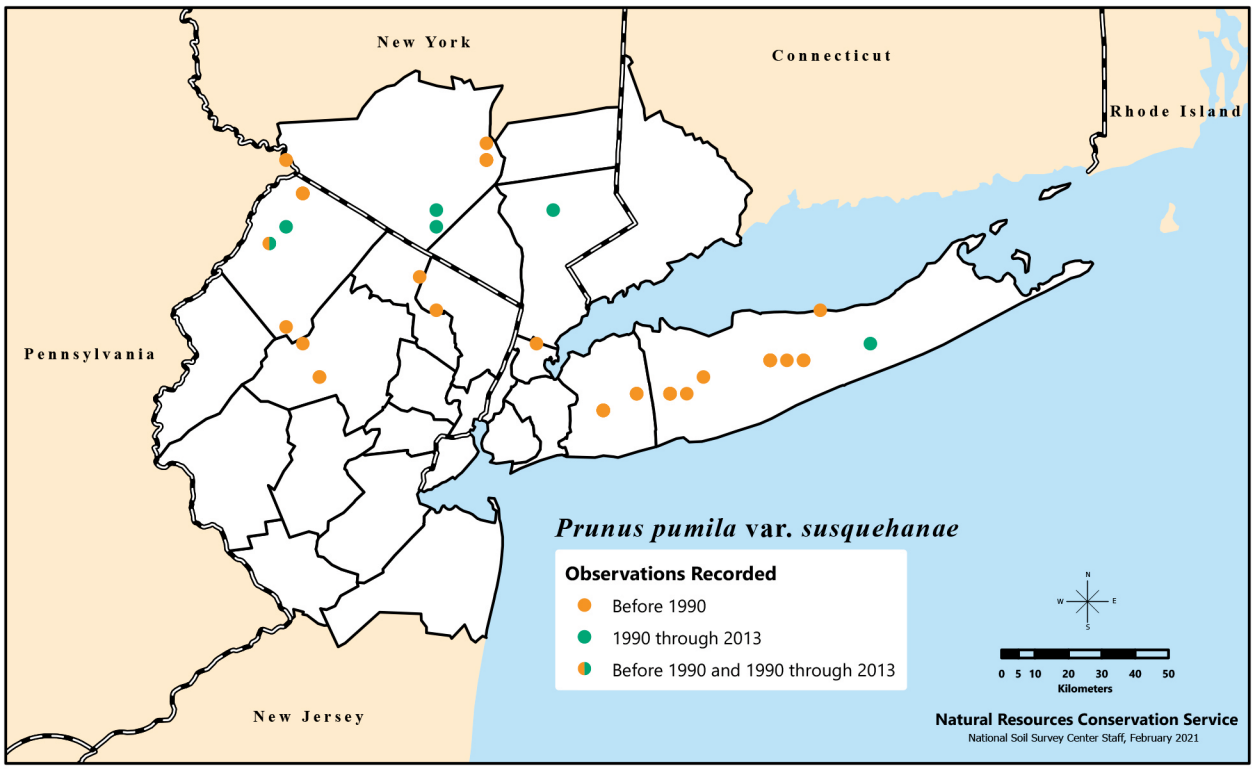
Prunus pumila L. s.l. Key

1. Branches trailing, forming mats. . . . . ***Prunus pumila* var. *depressa* (Pursh) Bean**
(*Cerasus depressa* (Pursh) Ser.; *Prunus depressus* Pursh) Ø

1. Branches erect to ascending. . . . . ***Prunus pumila* var. *susquehanae* (Willd.) H. Jaeger**
(*Cerasus susquehanae* (Willd.); *Prunus cuneata* Raf.; *Prunus pumila* var. *cuneata* (Raf.) L.H. Bailey; *Prunus pumila* subsp. *susquehanae* (Willd.) R.T.Clausen; *Prunus susquehanae* Willd.) ↓↓



Distribution of *Prunus pumila*, or sand cherry, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Prunus pumila*, var. *susquehanae*, or sand cherry, variety *susquehanae*, recorded in the New York Metropolitan Region during three time categories.

6. *Prunus serotina* Ehrh. – black cherry, rum cherry ↑↑

Padus serotina (Ehrh.) Borkh.

Tree. Flowering late Apr.–June; fruiting July–Aug. Woodlands, woodland edges, fields, edges of dunes, roadsides, and vacant lots; often in disturbed areas. One of the region's most common species. Epithet from Latin means "late," a reference to the ripening of the fruit.

Three or 4 *Prunus serotina* subspecies are sometimes recognized (additional varieties within these subspecies also recognized); many of the subspecies are geographically distinct (McVaugh 1951, Rohrer 2014). *Prunus serotina* is a tetraploid (2n=32), but it is not known whether it is an autotetraploid or an allotetraploid (Downey and Iezzoni 2000). In early literature, the name *P. virginiana*, properly applied to the preceding species (*P. pumila*), was sometimes misapplied to *P. serotina* (Gandhi et al. 2009).

Timber-quality trees can be found growing on deep, moist, fertile soils, but *P. serotina* also can be found growing under a variety of conditions including dry, sandy, or gravelly soils (Dirr 1998). Largest of the native cherries in the U.S. and the only *Prunus* species used for commercial lumber, which is considered high quality for cabinet making. Wide distribution, but commercial-quality trees are distributed primarily in the Allegheny and Pocono Plateaus of northern PA and the Catskill Mountains of western NY (Hough 1960); thus, not likely to be found in the region. Recent declines in northwest PA and southwest NY in the northern Allegheny Plateau attributed to reductions in nitrogen deposition and lower soil nitrate levels on which *P. serotina* germination and growth are dependent (Royo et al. 2021). The leaves appear early, before the flowers, which are perfect and pollinated by insects, including flies, beetles, and bees (Hough 1960). Moist cold stratification for 120 days required for germination; germination rate may be as high as 90 percent (Grisez et al. 2008). Several bird species consume the fruit and regurgitate or defecate the seeds. However,

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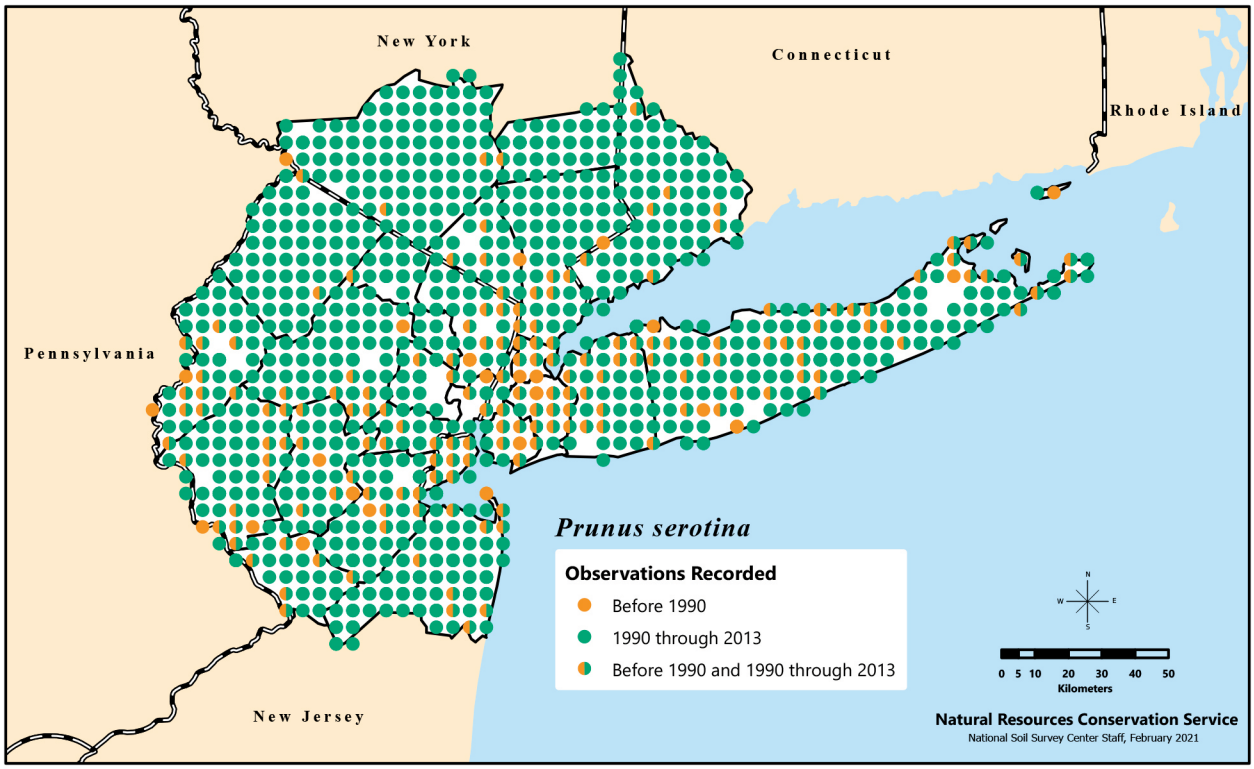


Distribution of *Prunus serotina*, called black cherry or rum cherry, recorded in the New York Metropolitan Region during three time categories.

most of the seed crop falls near the parent tree (Hough 1960). Despite the abundant seed, soil pathogens (including *Pythium* spp.) close to mature trees of this species reduce the survival of its seedlings throughout its native range (Packer and Clay 2003, Reinhart et al. 2005); there is evidence of increased root growth in response to removal of the soil pathogens. The soil pathogens associated with *P. serotina* can negatively affect all ages of this species but are most detrimental to new seedlings. This negative feedback may promote coexistence of other species and reduce competition between individuals (Packer and Clay 2003).

Earliest fruit-bearing age 5 years, with up to 5 years between large fruit crops (Grisez et al. 2008). Sprouts easily from stumps; the sprouts can grow rapidly, especially in open areas. Deer and rabbits (family Leporidae) can significantly damage regenerating seedlings; porcupines (*Erethizon dorsatum*) can damage trees by injuring the bark, which makes the tree more susceptible to fungal attack. Though healthy foliage is safe for deer to eat, wilted foliage is poisonous; leaves, twigs, and bark contain cyanic acid (Hough 1960). Leaves (wilted and fresh), twigs, and bark are poisonous to livestock and humans (Mulligan and Munro 1981). Wood rots and leaf spot (caused by the fungus *Blumeriella jaapii*) are common in this species (Hough 1960). The eastern tent caterpillar (*Malacosoma americanum*) is a major defoliator. May be less susceptible to the tent caterpillar during floral nectar production, which is highest after budbreak. At this time, the red-headed ant (*Formica obscuripes*) is drawn to the nectar and preys upon any tent caterpillars and other insects that are present. This mutualistic interaction lasts only about 3 weeks after flower budbreak, at which time the caterpillar becomes too large for the ants (Tilman 1978). Fall webworms (*Hyphantria cunea*), which also commonly attack *P. serotina*, are less likely to occur on trees impacted by tent caterpillars (Travis 2005).

The root system is shallow, mostly restricted to the upper 60 cm of soil. Despite the shallow root system, *P. serotina* is often taller than most of its associated forest trees, which makes it prone to windthrow (Hough 1960). Though potentially common in second-growth forests, especially those that were clearcut, it is shade-intolerant, making its regeneration limited to tree gaps and other open areas. Maintaining stands of this species requires a management approach that allows for relatively large open areas in the canopy (Hough 1960). Others classify this species as somewhat tolerant of shade with a more plastic response (Gale and Grigal 1987, Gottschalk 1994) and have data indicating that its root system can be relatively deep compared with associated species (Gale and Grigal 1987).

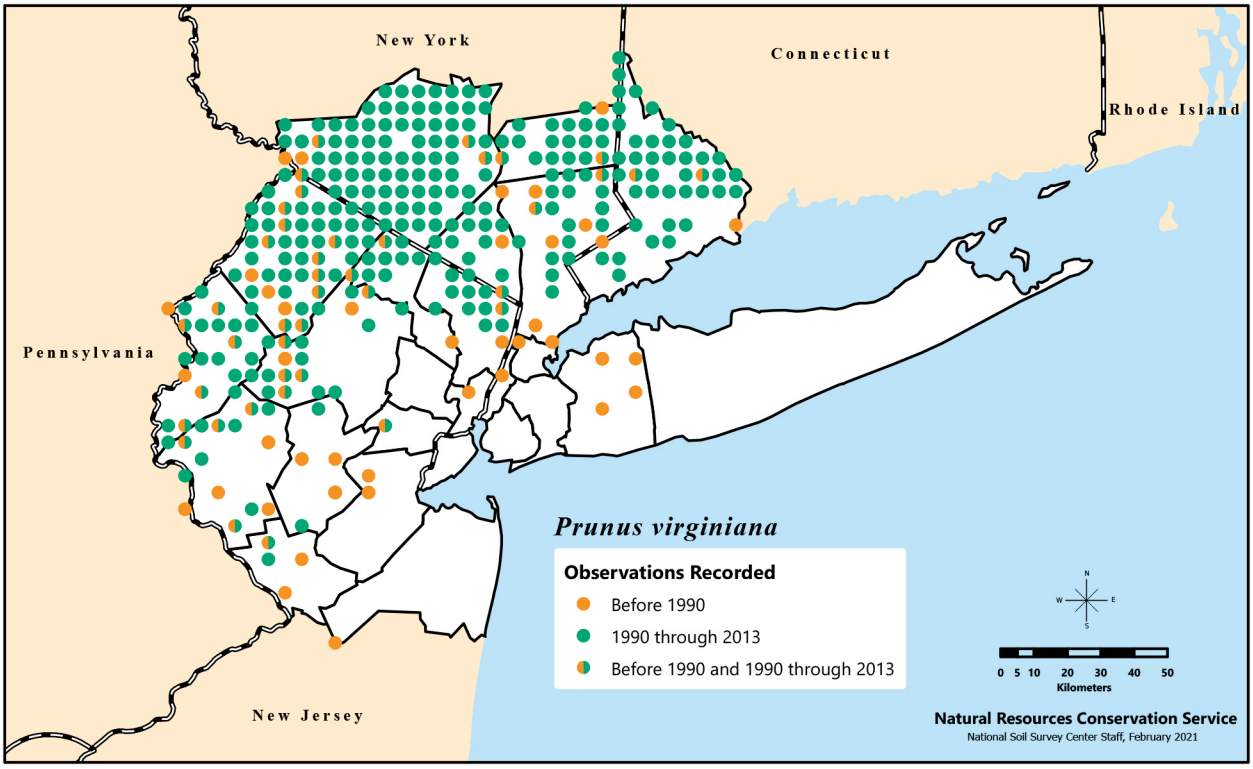
Cultivated since 1629. It is a valuable timber tree and its fruit, though small, are used to make wine as well as jellies (Dirr 1998). Its leaves and flowers also contain several flavonoids and polyphenols, which are a confirmed source of antioxidants (Olszewska 2007). Seeds may be roasted and eaten. Fruit also a source of anthocyanin pigments, which may be used by the food industry. Fruit maturation often varies over 2 months, making harvesting and use of the fruit comparatively difficult (Ordaz-Galindo et al. 1999).

Prunus serotina is an invasive species in Europe. Successful invasions may be due in part to a lack of soil-borne pathogens. It does encounter such pathogens in its nonnative range, but they are less virulent (Reinhart et al. 2010). Even though germination rates and seedling survival rates are relatively low, the large number of seeds dispersed both near the parent tree and by birds is so large that forest floors are covered with seedlings. The high sapling survival rate further seems to explain the success of invasions in Europe (Pairon et al. 2006). Increases in the NY Metropolitan Region may reflect increases in young forests or woodlands or more gaps (tree falls) in older forests.

7. *Prunus virginiana* L. – choke cherry ↑↑

Padus nana (Du Roi) Borkh.; *Padus virginiana* (L.) Mill.; *Prunus nana* Borkh.

Small tree, shrub. Flowering late Apr.–June; fruiting late July–Oct. Rocky woodlands, woodland edges, thickets, and fields. Our material is *Prunus virginiana* var. *virginiana*; the other variety, *P. virginiana* var. *demissa* (Nuttall) Torr.,



Distribution of *Prunus virginiana*, or choke cherry, recorded in the New York Metropolitan Region during three time categories.

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is in western North America, east to TX. Although historically reported from the Coastal Plain in the region, it is not currently encountered there; records may represent misapplication of the name *P. virginiana* to *P. serotina*.

Moist cold stratification for 120–160 days required for germination (Grisez et al. 2008). Cultivated since 1724, with at least 7 cultivars (Dirr 1998). The cultivars differ in their chemical properties, including fruit color (hue angle and chroma) and pH (Zatylny et al. 2005). It is one of the few tetraploids that have 32 chromosomes (Wang et al. 2012a). Fruit is used to make jams, jellies, pies, sauces, and wines (Dirr 1998). The dried fruit is also eaten. Grown as an ornamental for its white flowers in the spring and colorful leaves and fruit in the fall (Wang et al. 2012b). Leaves, twigs, flowers, and fruit contain prunasin, a cyanogenic glycoside (precursor compound to cyanide), which may be poisonous. Amounts are high enough to cause acute signs of poisoning in cattle (Majak et al. 1981).

Nonnative Species

8. *Prunus avium* (L.) L. – bird cherry ↑↑↑

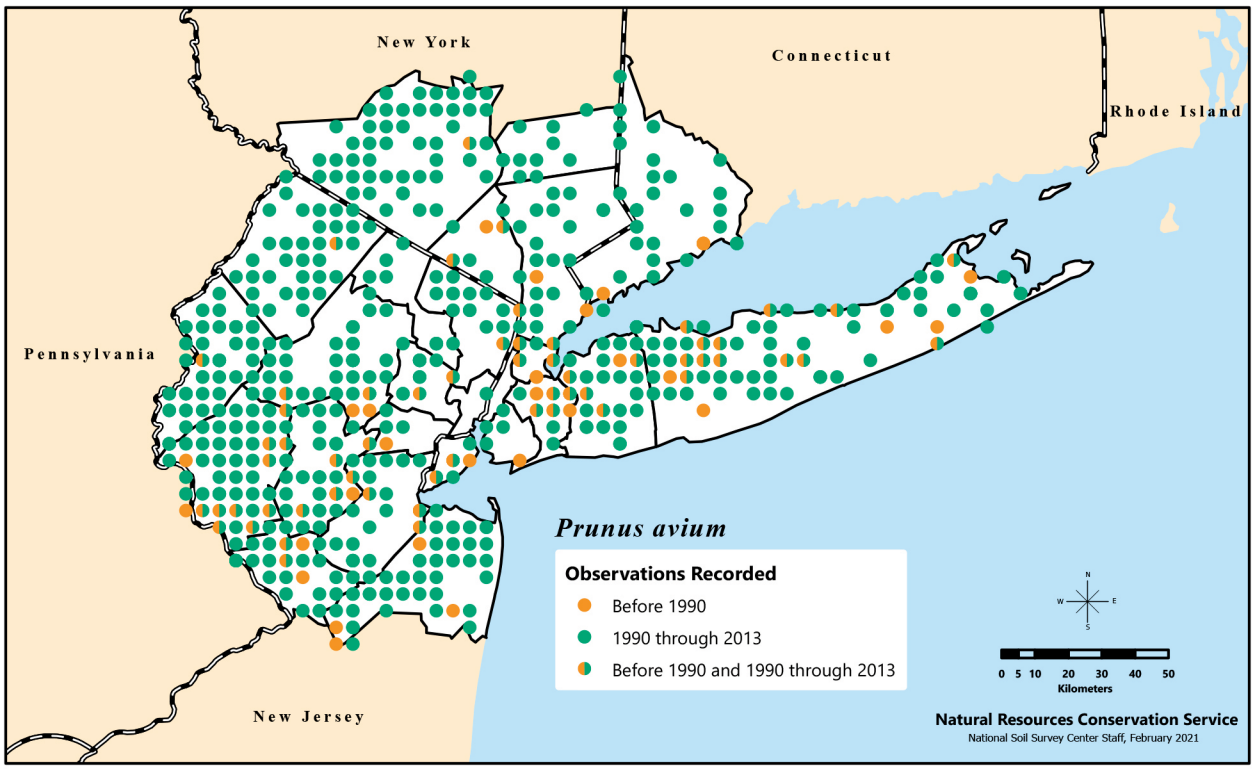
Prunus cerasus var. *avium* (L.) L.; *Cerasus avium* (L.) Moench.; *Cerasus nigra* Mill.

Tree. Flowering Apr.–May; fruiting June–July. Woodlands, woodland edges, fencerows, thickets, and fields. Native to Europe and western Asia. The only widespread, common nonnative *Prunus* in the region. Also cultivated and grown commercially in both its native region and the U.S. (Dirr 1998). Epithet from Latin means “of birds,” which eat the fruit.

Earliest fruit-bearing age 6–7 years. Cold stratification of seeds, with the endocarp removed, for 90–125 days required for germination (Grisez et al. 2008). One of the longer-lived and hardiest cherries (Dirr 1998). Self-incompatible (Vaughan et al. 2007), though self-compatible mutants have been found (Ushijima et al. 2004). Height at maturity 25 m; may live as long as 100 years (Vaughan et al. 2007). Clonal, using

root suckering; may colonize open areas quickly (Ducci and Santi 1997). Vegetative growth and sexual reproduction may be higher in unmanaged forests with periodic canopy gaps than in harvested forests, suggesting that a patchy network of openings enables this species to maintain a relatively high level of genetic diversity (Vaughan et al. 2007). Sexual reproduction in a group selection shelterwood (gaps formed by patchy tree removal gradually increased over time) and a coppice with standards cut (similar to a clearcut with residuals) is usually followed by clonal growth in both systems. But *P. avium* in the more severe coppice cut is more likely to have additional clonal growth and significantly less sexual reproduction. Despite this, genetic variation of the trees in the coppice stand is higher, possibly because a higher number of ramets per genet means there are more individuals of each ramet that may escape herbivory (Höltken and Gregorius 2006). This higher number of ramets may also explain observed heterozygote excess in *P. avium* populations (Stoeckel et al. 2006). Produces more extrafloral nectaries used by ants (family Formicidae) in response to herbivory, which may indicate a possible mutualism; ants may serve to defend the plant in return for more nectar (Pulice and Packer 2008).

A diploid; an ancient hybrid with *P. fruticosa* Pall. in eastern Europe or the Iranian Plateau is believed to have led to the origination of *P. cerasus* (Tavaud et al. 2004). *Prunus avium* has been in cultivation since ancient times; believed to have been introduced into North America in 1625 (Rehder 1940). At least 76 known cultivars; 72 are characterized as separate genotypes using microsatellite markers (Wünsch and Hormaza 2002). Cultivars originate in a variety of locations, including the native range and nonnative range. Stigma receptivity decreases (Hedhly et al. 2003), pollen germination decreases, and pollen tube growth accelerates in response to increasing temperature. Moreover, the pollen differences vary by cultivar, with a southern cultivar showing lower germination and higher tube growth rates



Distribution of *Prunus avium*, or bird cherry, recorded in the New York Metropolitan Region during three time categories.

P Q

compared to a northern cultivar. The implications are that different cultivars may respond differently, especially concerning reproductive behavior, to environmental changes (Hedhly et al. 2004). May benefit from vesicular arbuscular mycorrhizal associations and such associations may even help improve the success of propagation of *P. avium* using tissue culture (Pons et al. 1983). Responds positively to increases in carbon dioxide in terms of growth (roots and shoots) (Centritto et al. 1999a) and increased photosynthetic rates (Centritto et al. 1999b). Water-stress tolerance of *P. avium* is not likely to increase with increasing carbon dioxide (Centritto et al. 1999a, 1999b). Allergic responses to the fruit, including oral allergies affecting lips, mouth, and the pharynx, possibly could also differ by cultivar. However, there are no differences among 6 tested cultivars. Chemical peeling removes the lipid transfer protein responsible for most oral allergies to the sweet cherry fruit (Primavesi et al. 2006). There are also significant differences detected in sugar amounts, organic acids, and phenolic compounds found in 4 different sweet cherry cultivars (Kelebek and Selli 2011) as well as antioxidant activity in 13 cultivars (Usenik et al. 2008). An inverse relationship was found between melatonin and serotonin levels in 8 tested cultivars of sweet cherry; a different cultivar showed significantly higher levels of each ('Burlat' for melatonin and 'Ambrunés' for serotonin) (González-Gómez et al. 2009). These comparisons suggest that selection of "healthier" cultivars with lower sugar content, higher melatonin or serotonin levels (or both), and higher concentrations of phenolic compounds may be possible. Antioxidant activity of polyphenols associated with *P. avium* has been effective at inhibiting the growth of cancer cells (Serra et al. 2010). This species is a common host to the newly introduced spotted wing drosophila (*Drosophila suzukii*), which infests and damages the fruit (Maier 2012).

Assessed as moderately invasive in NY (Glenn and Moore 2009) and invasive in NJ (category 3, not prohibited).

The following five nonnative *Prunus* spp. are cultivated in the region and are rarely encountered as remnants from cultivation or escapes.

9. *Prunus cerasifera* Ehrh. – cherry plum, Myrobalan plum Ø

Small tree. Flowering May; fruiting July–Aug. Native to western Asia. Prefers well-drained soils and full sun. Like many *Prunus* spp., it is adaptable to a range of soil pH (Dirr 1998).

Earliest fruit-bearing age 3 years. Cold stratification for about 190 days required for germination (Grisez et al. 2008). Cultivated for centuries, with at least 14 cultivars. Introduced into the U.S. before or around 1500 (Rehder 1940). The purple or deep red leaves of many of its cultivars have made this species relatively popular and overused in landscaping, though apparently not in the NY Metropolitan Region. Relatively short-lived; suffers from many diseases, including tent caterpillars, leaf spot, scale, borers, and aphids (Dirr 1998). Though the distinctive color of this species' leaves is indicative of a high concentration of anthocyanins, the leaves tend to be thin, like many shade leaves. However, unlike shade leaves, the ratio of carotenoid to chlorophyll a+b and stomatal conductance were not lower in value compared to known sun leaves. Nonetheless, the anthocyanins in this species do not appear to provide much photoprotection either, at least in terms of chlorophyll fluorescence (Kyparissis et al. 2007).

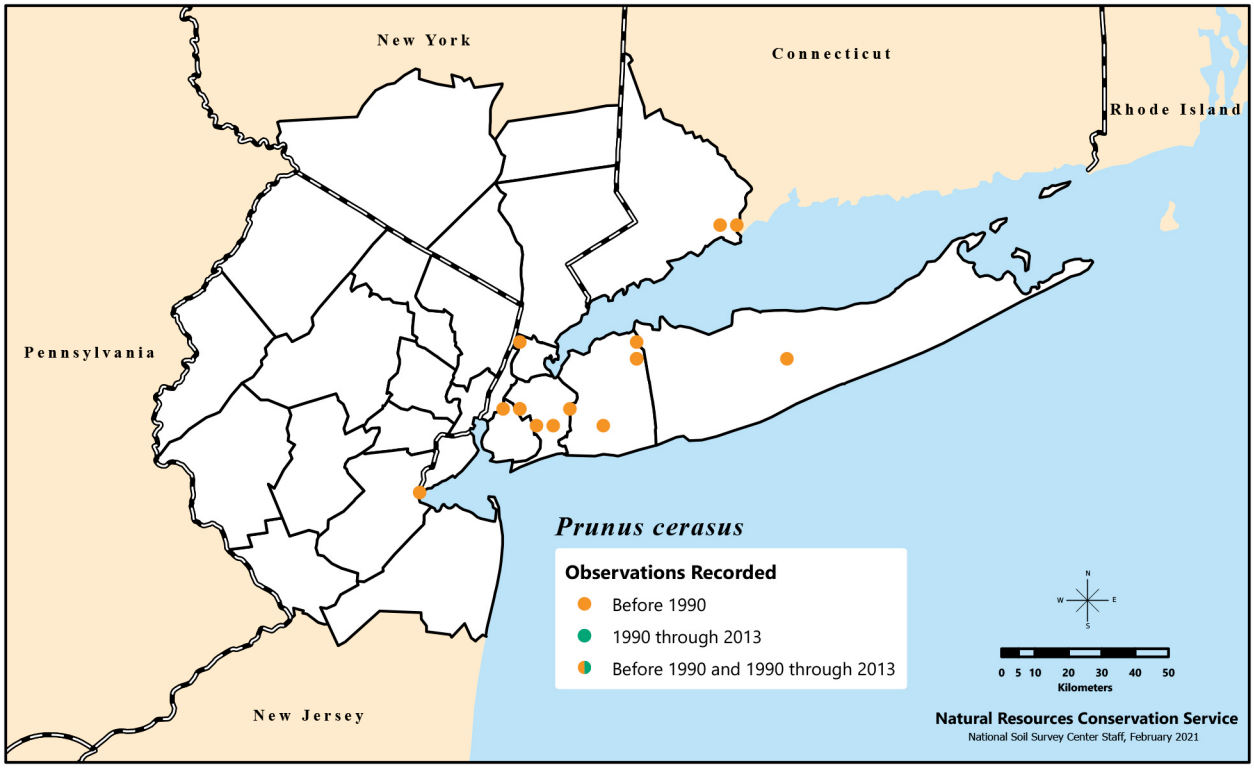
This species was never common in the region and has not been recently recorded there. One reported possible naturalized population from Nassau County (NY); status of reports of naturalizing populations from Hunterdon and Morris Counties (NJ) has not been determined.

10. *Prunus cerasus* L. – sour cherry ↓↓↓

Cerasus vulgaris Mill.; *C. hortensis* Mill.; *Prunus vulgaris* (Mill.) Schur

Small tree. Flowers in May; fruiting June–July. Native to southeastern Europe and western Asia (Grisez et al. 2008).

Cold stratification for 90–150 days required for germination (Grisez et al. 2008). Earliest fruit-bearing age 6–7 years. There is documented early flowering in urban areas in northwest France compared to rural areas (Mimet et al. 2009).



Distribution of *Prunus cerasus*, or sour cherry, recorded in the New York Metropolitan Region during three time categories.

P Q

Whole plants have been produced from cotyledon tissue using tissue culture, which may eventually lead to more rapid development and maintenance of particular cultivars (Mante et al. 1989). At least 31 cultivars (Tavaud et al. 2004). Is an allotetraploid and a hybrid between the diploid *Prunus avium* and *P. fruticosa*, an autotetraploid (Oldén and Nybom 1968, Tavaud et al. 2004). *Prunus avium* and *P. cerasus* also hybridize to form *P. ×gondouinii* or duke cherries. This hybrid is cultivated at a much smaller scale (Tavaud et al. 2004). Eight antioxidant polyphenols have been isolated from *P. cerasus*' fruit (Wang et al. 1999). At least 2 cultivars ('Balaton' and 'Montmorency') contain high levels of melatonin; levels can vary by individual tree within the same cultivar (Burkhardt et al. 2001). Melatonin functions as a free-radical scavenger and helps with sleep disorders. Free radicals may cause aging, inflammation, and cancer (Manchester et al. 2000). Fruit also contains high levels of anthocyanins, which have a strong antioxidant activity; levels do not vary among 3 tested cultivars (Blando et al. 2004).

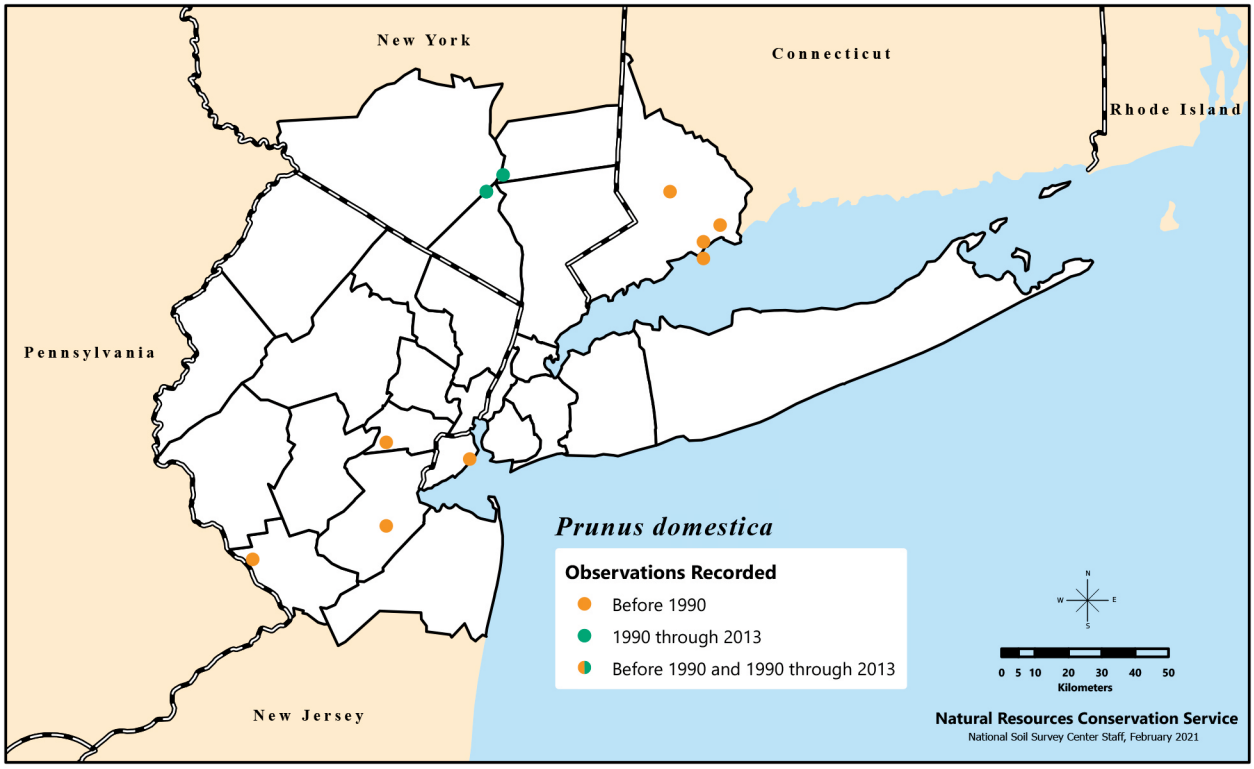
Cultivated and grown commercially as a fruit tree in its native range (Blando et al. 2004) and in the U.S. for its tart cherries (Wang et al. 1999). Though once found in several counties in the region, it apparently is no longer planted.

11. *Prunus domestica* L. – European plum, Damson plum ↓↓↓

Prunus communis Huds.; *Prunus insititia* L.

Flowering May; fruiting mature July–Oct. Native to Europe and western Asia (Grisez et al. 2008).

Small tree, shrub. Earliest fruit-bearing age 5 years. Moist cold stratification for 189 days required for germination, with a germination rate of 56 percent (Grisez et al. 2008). Cultivated for many years with no known cultivation start date (Grisez et al. 2008). Genetic origin of *Prunus domestica* is under dispute. Crane and Lawrence (1931) first suggested that it was derived from a cross between *P. cerasifera* (diploid) and *P. spinosa* (tetraploid). *Prunus domestica* is a hexaploid. However, there is evidence that



Distribution of *Prunus domestica*, called European or Damson plum, recorded in the New York Metropolitan Region during three time categories.

P Q

P. domestica simply evolved from variations of *P. cerasifera*, and it is suggested that these two species be combined as one with the appropriate name being *P. domestica* (Zohary 1992). Prunes are the dried fruit of particular cultivars of *P. domestica*. Concentrated prune juice has had positive health benefits, such as reducing the number of cancer cells associated with colon cancer (Fujii et al. 2006). Though macronutrient content did not vary between organically grown and conventionally grown *P. domestica*, antioxidants showed higher concentrations in organically grown *P. domestica*, but total polyphenols were higher in conventionally grown *P. domestica* (Lombardi-Boccia et al. 2004). Transgenic cultivars of *P. domestica* have been developed, including one that appears to have a defense response to fungal infections (El-kereamy et al. 2011) and others with possible resistance to the plum pox virus (*Potyvirus* spp.) (Scorza et al. 1994, Van Regenmortel 2000).

Has disappeared from most of the region aside from a few new occurrences, probably planted, in the northern part of the region.

12. *Prunus mahaleb* L. – Mahaleb cherry Ø

Cerasus mahaleb (L.) Mill.; *Padellus mahaleb* (L.) Vassilcz.; *Padus mahaleb* (L.) Borkh.

Small tree, shrub. Flowering Apr.–May; fruiting July. Native to western Asia and Europe; has naturalized in southwestern Canada and the northeastern U.S. (Grisez et al. 2008). Prefers mesic and cool sites in mountainous areas with deep limestone soils and rocky slopes in its native habitat (Jordano 1993).

A self-incompatible (Guitián 1994) gynodioecious species with some hermaphrodites and other functionally female flowers (sterile anthers) (Jordano 1993). Some self-fertile clones do exist (Moghadam and Khalighi 2007). Earliest seed-bearing age 3 years; large seed crops every 1–2 years. Cold stratification for 80–100 days required for germination (Grisez et al. 2008). This species is a suggested rootstock for commercial production of cherries in calcareous soils in arid climates because it is tolerant of lime-induced iron chlorosis and zinc deficiency (Moghadam

and Khalighi 2007). The kernels of the fruit are used for flavoring bread, as a component of some cosmetics, and as a medicinal against diarrhea. Oil from the kernel is also an important source of protein. The oil is used to prepare lacquers and varnishes (Mariod et al. 2010) as well as to provide antibacterial activity against some pathogenic bacteria including *Escherichia coli* (Seyyednejad and Motamedi 2010).

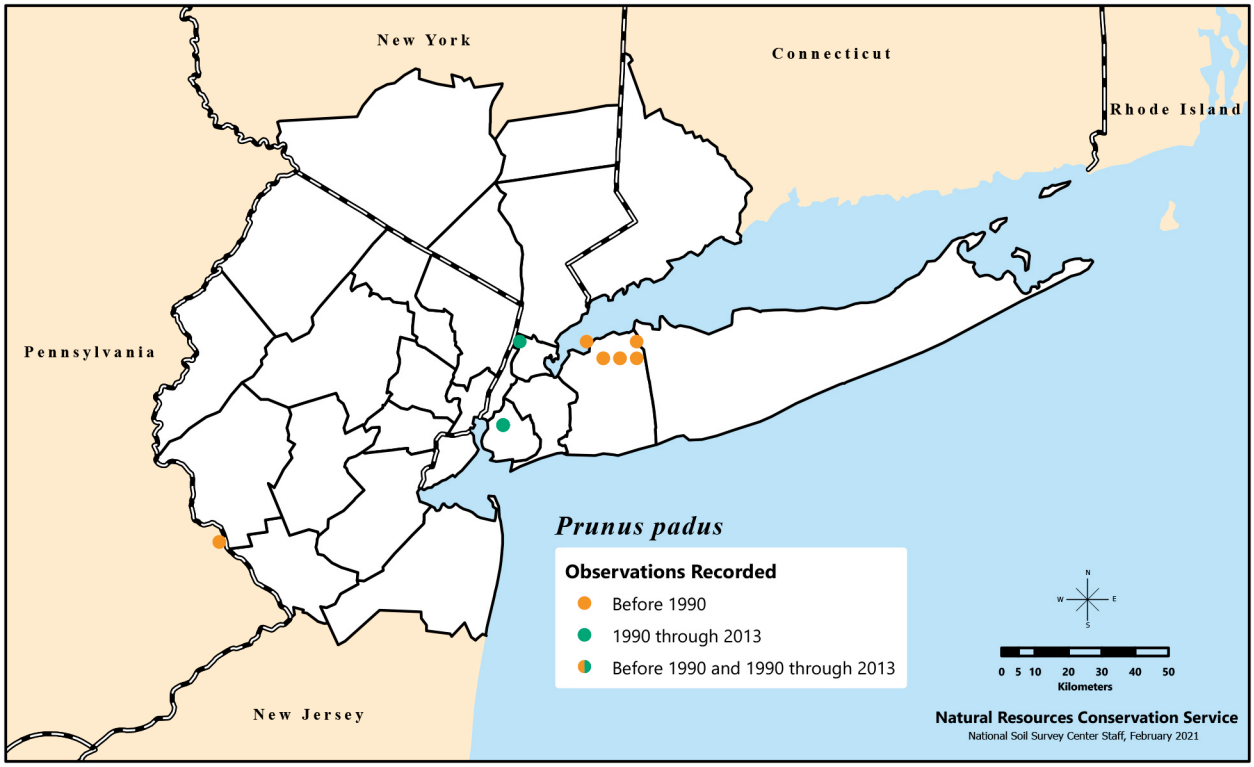
Has essentially disappeared from the region with no evident new plantings. Likely naturalized populations reported from Fairfield County (CT), Warren County (NJ), and New York, Richmond, and Westchester Counties (NY).

13. *Prunus padus* L. – European bird cherry Ø♥

Padus avium Mill.; *Cerasus padus* (L.) Delarbre; *Padus germanica* Borkh.; *Padus vulgaris* Borkh.; *Padus racemosa* (Lam.) Gilib.; *Prunus racemosa* Lam.

Small tree, shrub. Flowering late Apr.–May; fruiting late June–Aug. Disturbed open sites. Native to Europe and Japan, Korea, and northern Asia (Grisez et al. 2008). Epithet is the ancient Latin name for the Po River in northern Italy.

Prunus padus is close morphologically to the native *P. virginiana*. Some material examined from collection in NYC appears to be intermediate between *P. padus* and *P. virginiana*, suggesting it may represent the hybrid between the two species, *P. ×laucheana* Bolle. Some street trees planted in NYC under the name *P. virginiana* key to *P. padus*. Rohrer (2014) noted the closeness between the two species and the difficulty in distinguishing between them. More research is needed to better understand the taxonomic limits of the two species, and the extent to which *P. padus* and *P. ×laucheana* are established in the region.



Distribution of *Prunus padus*, or European bird cherry, recorded in the New York Metropolitan Region during three time categories.

One of the first *Prunus* spp. to leaf out in spring. At least 8 cultivars utilized in the U.S. (Dirr 1998), though more than 20 are described in the literature (Uusitalo 2004). Height at maturity 15 m. Large fruit crops produced every 2 years. Cold stratification for 100–120 days required for germination of fresh seeds; a longer time is required for stored seeds (Grisez et al. 2008). Seeds are dispersed by birds and possibly mammals (Leather 1996). The soil seed bank of this species lasts only up to 3 years in its native range (Granstrom 1987). In its native habitat, this species has a very broad distribution and tolerates warm summers in northern Europe and cold winters in northern Russia (Leather 1996). Prefers shade but is more likely to flower and fruit in high light areas (Uusitalo 2004). Occurs on a wide variety of soil types, but in Britain is most common along streams in limestone areas. Not likely to do well on very acidic soils (pH less than 5) or very wet or very dry soils. Adult trees are drought-tolerant, but establishing young trees are not. Tolerant of frost in both spring and fall. Spreads prolifically by root suckers and is rarely found as an isolated stem. Affected by several bacterial diseases causing shoot wilt, leaf and fruit spot, and cankers (Leather 1996). Supports many insects (Uusitalo 2004), though perhaps not as many as similar related species (Leather 1996); few cause mortality even after complete defoliation (Uusitalo 2004). Fruit and stems contain large amounts of tannins, which give the fruit a bitter taste and could potentially protect this species from pathogens and insects (Leather 1996). Its chemical makeup can work as a biocide against several disease-causing bacteria in humans, including *Escherichia coli* and methicillin-resistant *Staphylococcus aureus* (MRSA) (Kumarasamy et al. 2004). Rich in anthocyanins with antioxidant potential (Kucharska and Oszmiański 2002). Antioxidant activity was confirmed for phenolics isolated from its leaves and flowers (Olszewska and Kwapisz 2011). This species has traditionally been used for its diuretic, antirheumatic, antibiotic, antidiarrheal, sedative (Olszewska and Kwapisz 2011), and inflammation- and pain-reducing properties (Choi et al. 2012). Fruit used for jams, and young leaves have been eaten as a boiled vegetable (Facciola 1998).

Likely naturalized populations reported from Hunterdon County (NJ) and Bronx, Kings, and Suffolk Counties (NY).

14. *Prunus persica* (L.) Batsch – peach ↔

Amygdalus persica L.; *Persica platycarpa* Decne.; *Persica vulgaris* Mill.

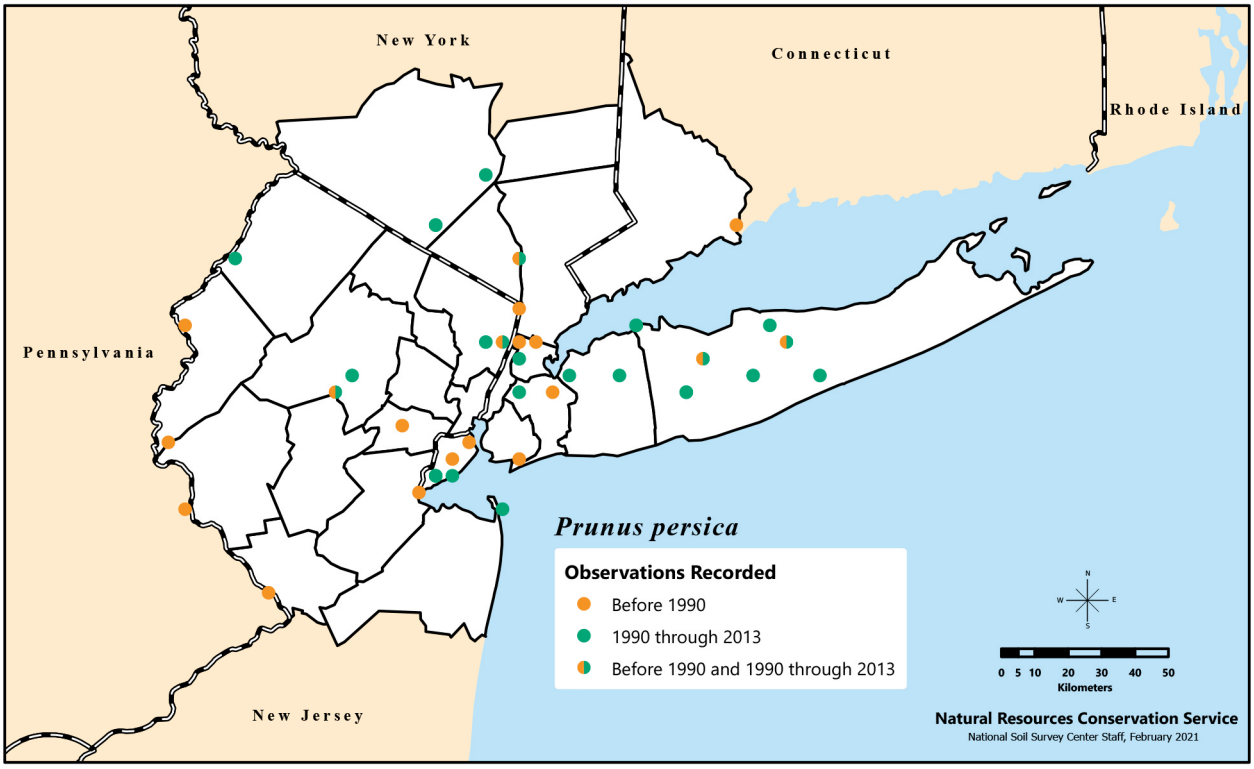
Small tree. Flowering mid-Apr.–May; fruiting July–Sept. Disturbed open areas, old homesteads, and remnants from past cultivation. Native to China. Currently no wild peaches are known from China (Lu and Bartholomew 2003). Prefers well-drained, acidic, moist soils and full sun (Dirr 1998). Epithet is an old genus name for peaches.

Earliest seed-bearing age 3 years; large fruit crops every 1–2 years. Moist cold stratification for 70–105 days required for germination, with a germination rate of about 82 percent (Grisez et al. 2008). Cultivated since ancient times, with more than 40 cultivars. Though some cultivars are less susceptible to insect and disease, in general this species is prone to disease and insect problems (Dirr 1998). Organically cultivated peaches are higher in antioxidant compounds than conventionally grown peaches, at least for one peach cultivar (Carbonaro et al. 2002). There is an interest in using genetic fingerprinting to preserve the genetic origins of cultivars (Testolin et al. 2000). Allergic reactions to the fruit of *P. persica* may be due to a lipid transfer protein that functions as part of a plant defense mechanism against microbial attack (Pastorello et al. 1999).

15. *Prunus spinosa* L. – blackthorn, sloe Ø

Small tree, shrub. Flowering Apr.–May; fruiting Aug.–Sept. Native to northern Africa, Europe, and western Asia. It has long been in cultivation (Grisez et al. 2008). Can grow in a wide range of environmental conditions, including calcareous soils and drought (Mohanty et al. 2003).

Is an amphidiploid (4×) hybrid and a cross between *Prunus cerasifera* and *P. microcarpa*. Self-incompatible (Nunes et al. 2006). May be an ancestor of *P. domestica*. Used for improving rootstocks and varieties via interspecific hybridization in part due to its ability to grow in a wide range of environments (Mohanty et al. 2003).

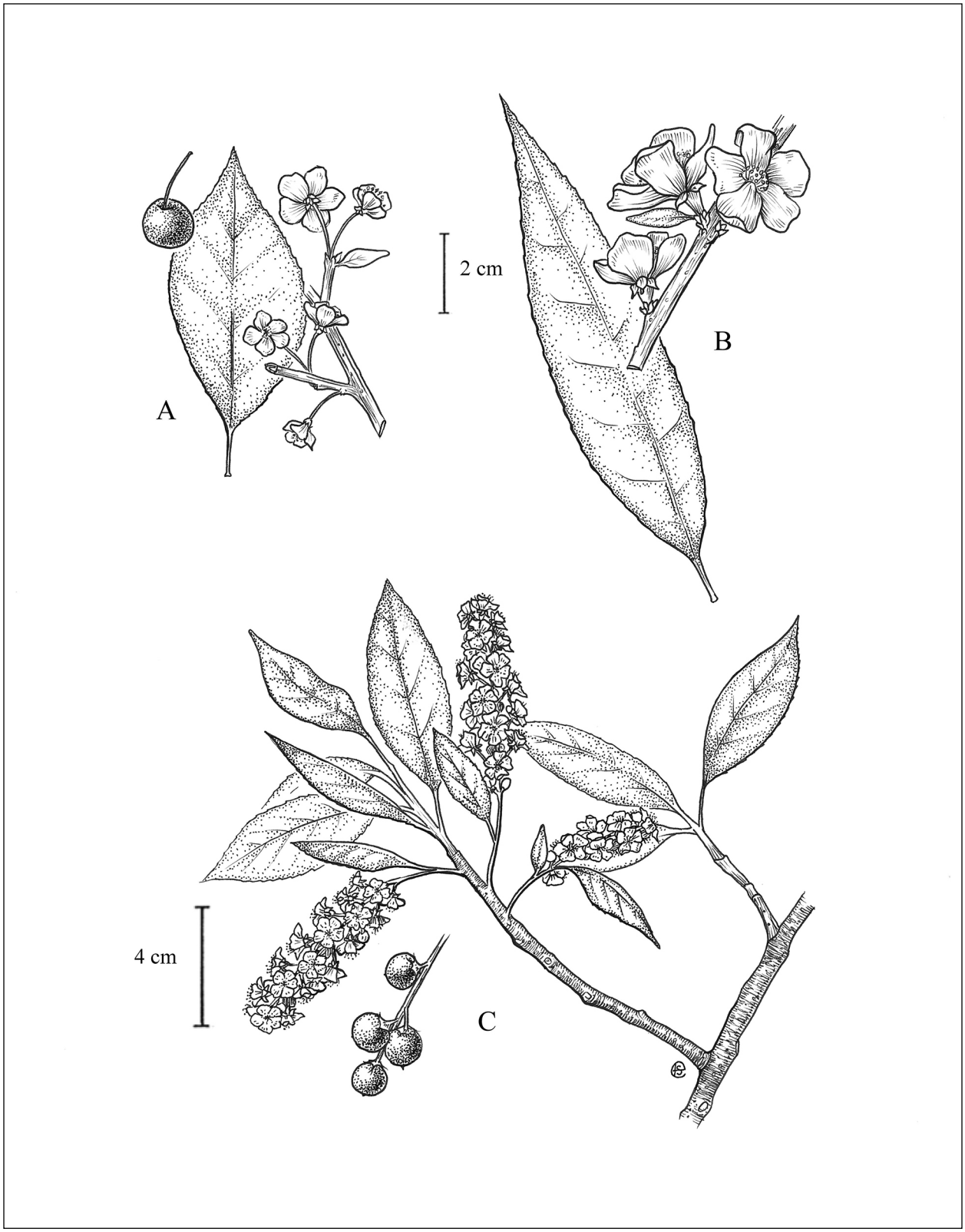


Distribution of *Prunus persica*, or peach, recorded in the New York Metropolitan Region during three time categories.

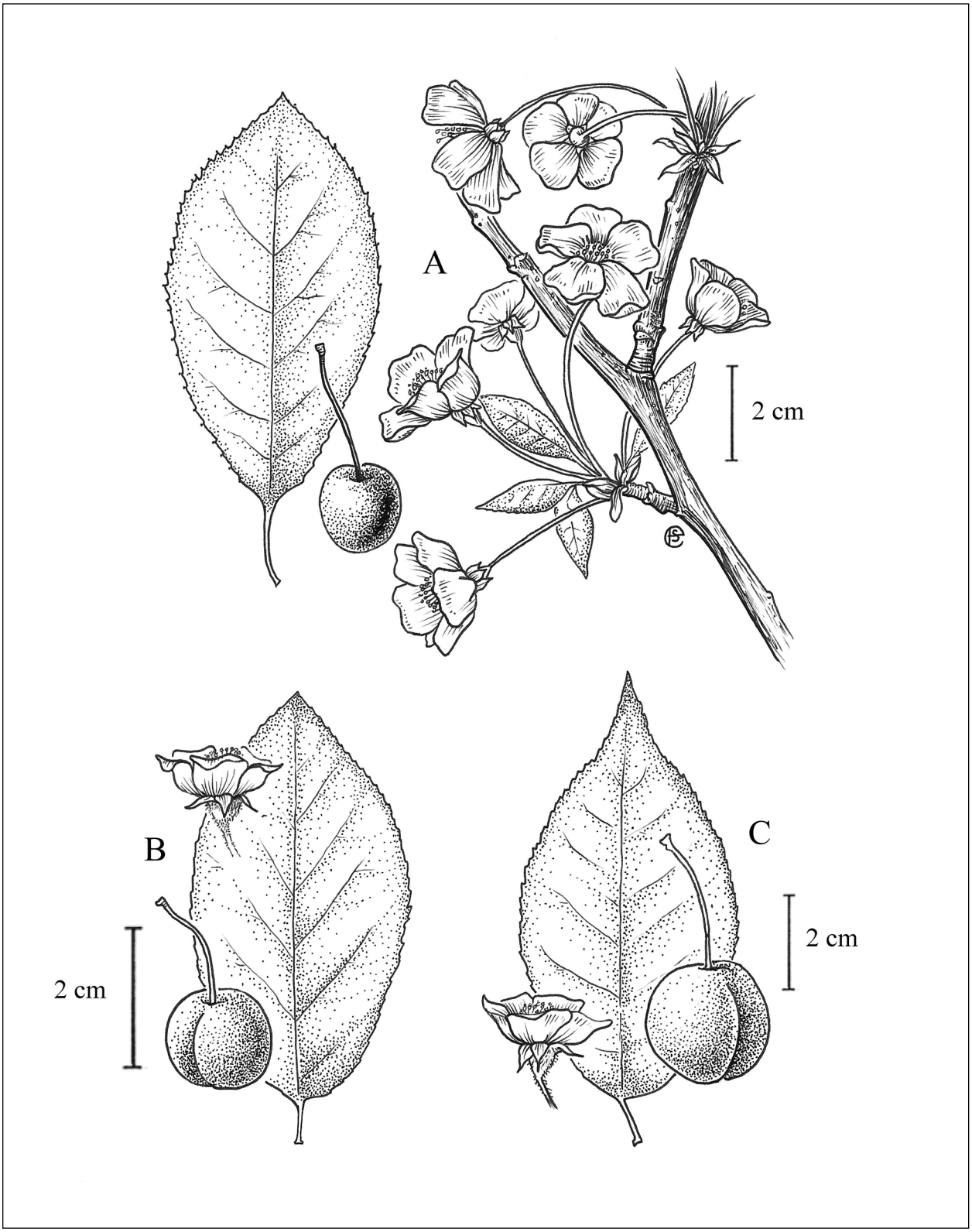
Few older occurrences of this species are noted; there is one new occurrence, which may suggest it is being planted occasionally. Likely naturalized populations reported from Hunterdon and Union Counties (NJ) and Richmond and Suffolk Counties (NY).

Management

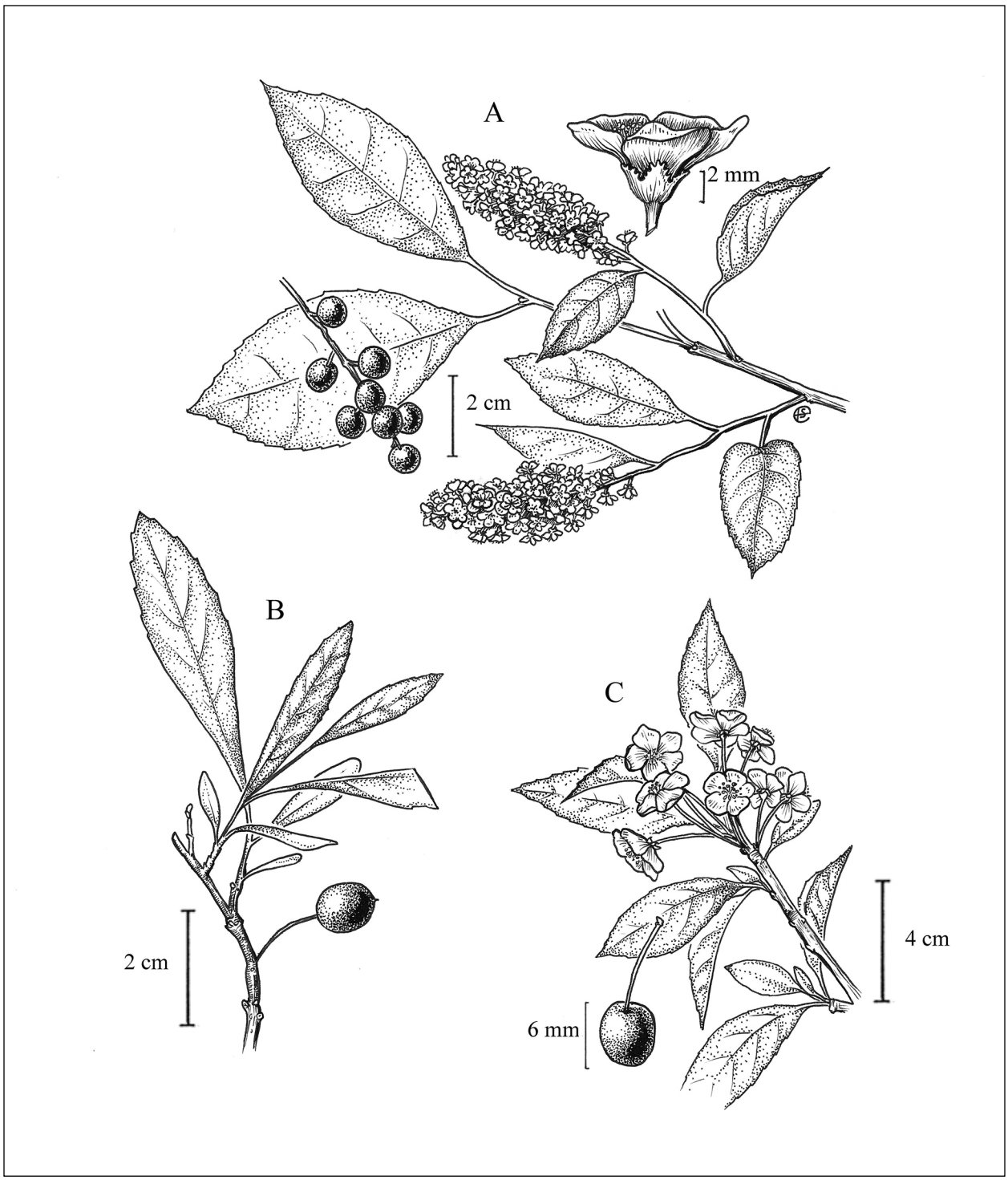
Prunus avium may be a nonnative species of concern whose plantings should be curtailed until we learn more about why this species is increasing in the region. *Prunus serotina*'s increases are likely due to once-open areas becoming reforested. Although this native species can become aggressive and spread, in its native range it usually succumbs to succession. Populations are kept relatively small due to soil-borne pathogens. The losses associated with *P. pensylvanica* may be due to a decrease in open areas. We should be concerned about the apparent loss of *P. americana* and the change in pattern of *P. virginiana* occurrences. Both native species should be considered instead of *P. avium* for ornamental plantings and possibly as a commercial food crop.



A) Fruit, leaf, and flowering twig of *Prunus alleghaniensis*; B) leaf and flowering twig of *Prunus persica*; C) flowering leafy twig and fruit of *Prunus serotina*. Illustration by Emma Skurnick.



A) Leaf, fruit, and flowering leafy twig of *Prunus avium*; leaf, flower, and fruit of B) *Prunus maritima* and C) *Prunus americana*. Illustration by Emma Skurnick.



A) Fruit, flowering leafy twig, and flower of *Prunus virginiana*; B) fruiting leafy twig of *Prunus pumila*; C) fruit and flowering leafy twig of *Prunus pensylvanica*. Illustration by Emma Skurnick.

P Q

Pseudotsuga Carrière – Douglas-fir

Pinaceae. Coniferous trees. Species up to 7: North America 3 (2 from the western U.S. and 1 from Mexico [Li and Adams 1989], which is sometimes combined with *Pseudotsuga menziesii* [Little 1952] or divided further into several Mexican species [Martínez 1949]), China 3, Japan 1. Those in China are sometimes placed under 1 species (Farjon 1990). Genus name is from the Greek "pseudo" ("false") and the genus name *Tsuga*, an indication of the relationship with hemlocks (*Tsuga*).

Nonnative Species

1. *Pseudotsuga menziesii* (Mirb.) Franco – Douglas-fir Ø

Abies menziesii Mirb.

Native to western North America. Occasionally planted and rarely encountered as a remnant from cultivation or casual escape. Readily distinguished from other conifers by the protruding 3-lobed (at apex) bracts of the seed cone. Possibly naturalized populations reported from Middlesex and Warren Counties (NJ) and Orange and Rockland Counties (NY). All material examined from region referable to *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco. Epithet honors Archibald Menzies (1754–1842), Scottish surgeon and botanist and participant in the Vancouver Expedition. Common name honors Frederick Douglas (1799–1834), Scottish botanist who brought the species into cultivation.

Ptelea L. – hoptree

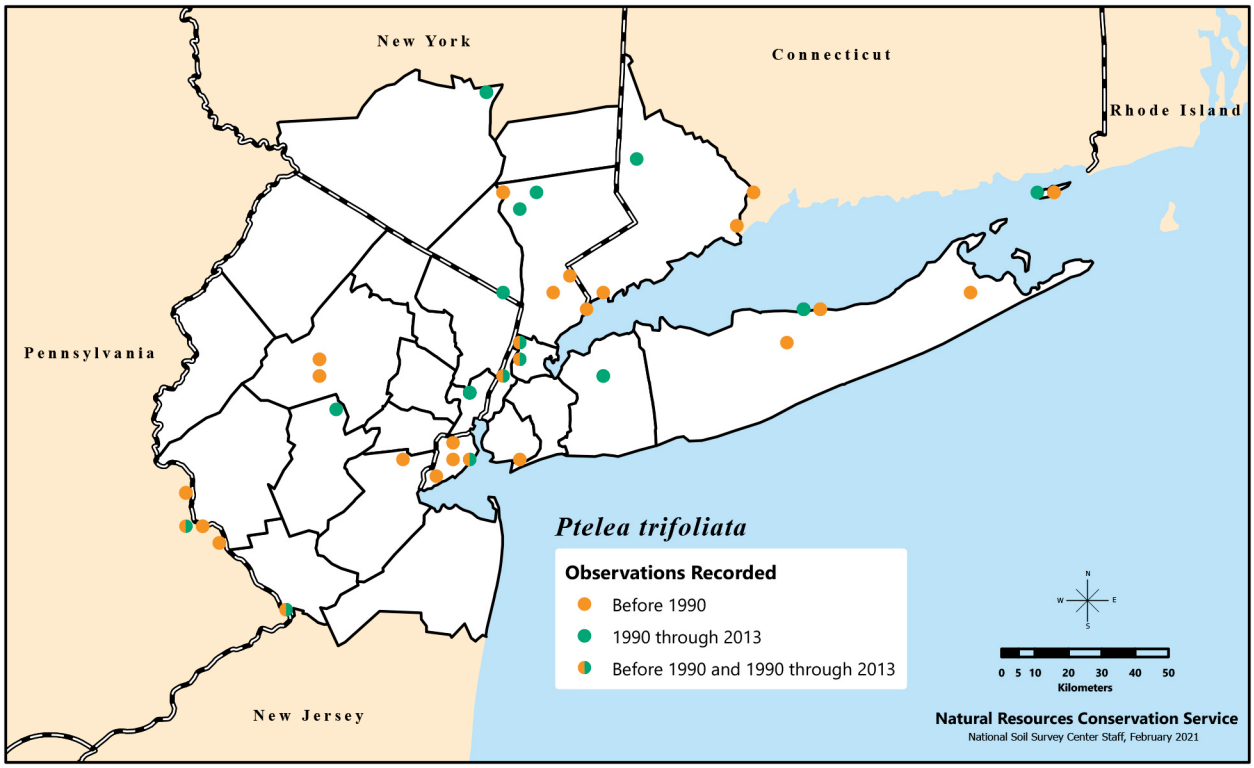
Rutaceae. Small trees, shrubs. Species about 3 in North America. Genus name is the Greek name for elm; Linnaeus applied it to the genus in reference to the similarity of *Ptelea*'s samaras to those of *Ulmus*.

Native and Nonnative Species

(see following discussion)

1. *Ptelea trifoliata* L. – common hoptree, wafer ash ↔

Flowering mid-May–mid-June; fruiting Sept.–Oct. Woodlands, thickets, and rocky slopes. Prefers well-drained soils, sun or shade, but



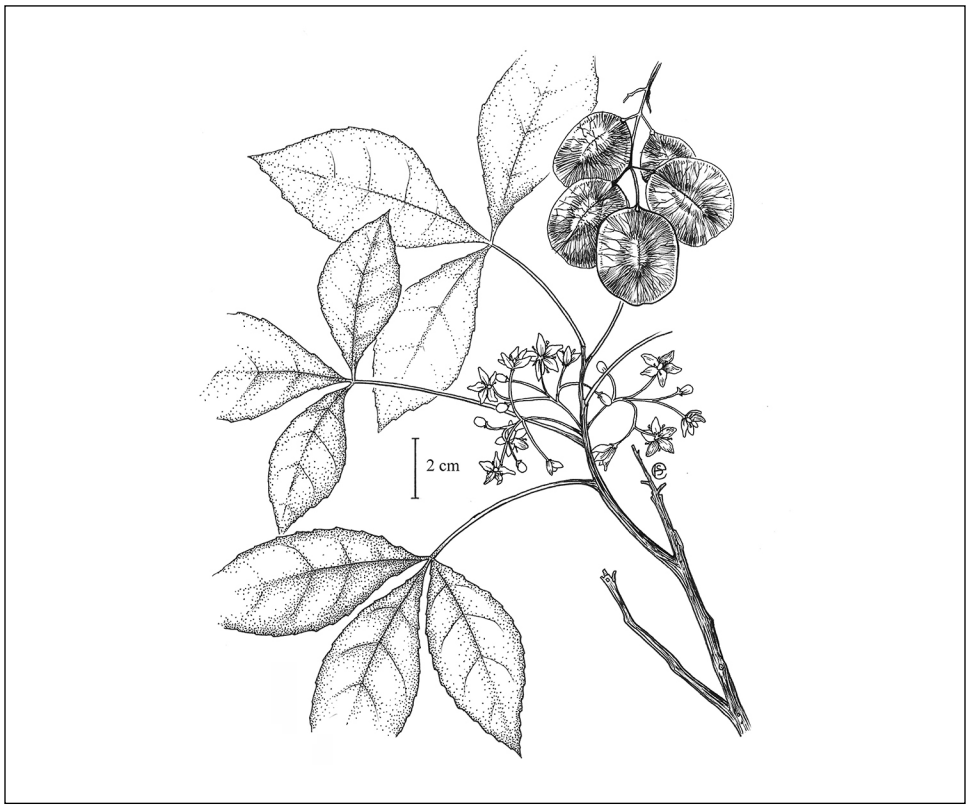
Distribution of *Ptelea trifoliata*, called common hoptree or wafer ash, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Bergen and Warren Counties (NY).

typically found in mesic woodlands as part of the understory (Dirr 1998).

Graves (1910) did not regard the material in CT to be native. Likewise, Weldy et al. (2020) concluded that material from NY in the metropolitan region is not native, stating: "The only native populations are restricted to the shores of Lake Erie and nearby inland locations. Those populations found elsewhere scattered throughout the state are considered escapes from cultivation. These escapes seem particularly common near the NY Botanical Garden[.]" Britton (1889) and Stone (1911) regarded the species to be native in NJ at some sites near the Delaware River in Burlington, Hunterdon, and Mercer Counties and introduced elsewhere. Stone (1911: 518) noted: "This tree has almost precisely the same distribution as the Judas [*Cercis canadensis*], both of them southern species, which find their northern limit in these river valleys, but which cannot establish themselves below the head of the tidewater, probably on account of the steep, wooded slopes." Taylor (1915) also regarded the species as primarily nonnative in the region, being native only in the area identified by Britton (1889) and Stone (1911). *Ptelea trifoliata* has been reported from Laurel Hill in the Hackensack Meadowlands in Hudson County, NJ (Quinn 1997), and Kiviat and MacDonald (2002: 35) noted that the population "should be protected until its origin can be determined through recourse to historical documents or other information." The species has also recently been observed in similar open rocky habitats in northern Central Park (Manhattan, NYC) near Blockhouse No. 1. Native material would be referable to *Ptelea trifoliata* subsp. *trifoliata* var. *trifoliata*. Further study of the naturalized material is needed to determine whether it represents other infraspecific taxa of *P. trifoliata*. We advise planting only confirmed native material.

Primarily dioecious and insect pollinated. Cold stratification with the samaras removed for about 180 days recommended for relatively good germination rates (Brinkman et al. 2008). Height at maturity 7.5 m. Cultivated since 1724, with at least 2 cultivars (Dirr 1998).

Native material listed as endangered in NJ (S1) and NY (S1S2).



Flowering leafy twig and fruit of *Ptelea trifoliata*. Illustration by Emma Skurnick.

Pueraria DC. – kudzu

Fabaceae. Twining vines, herbs. Species 20, native to Asia. Genus name honors Swiss botanist Marc Nicolas Puerari (1766–1845).

Nonnative Species

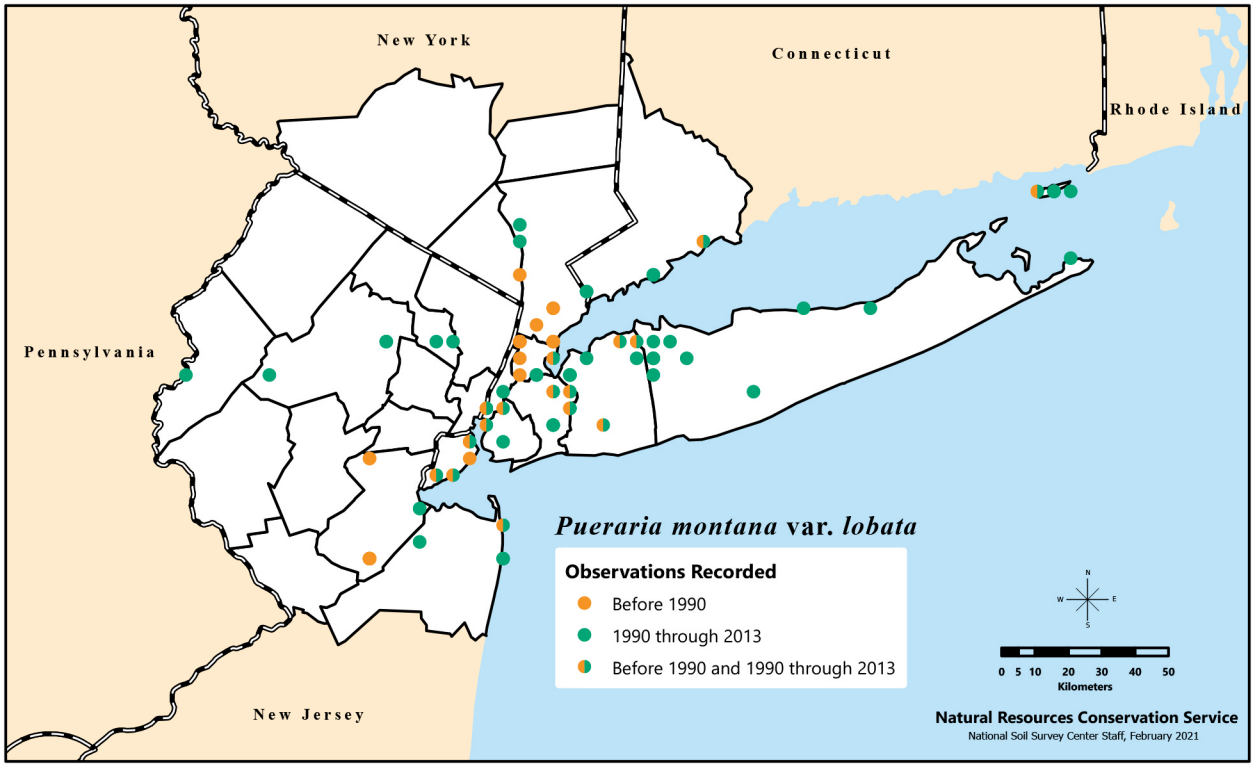
1. *Pueraria montana* var. *lobata* (Willd.) Maesen & S.M.Almeida ex Sanjappa & Predeep – kudzu vine ↔

Dolichos lobata Willd.; *Pachyrhizus thunbergianus* Siebold & Zucc.; *Pueraria lobata* (Willd.) Ohwi; *Pueraria thunbergianus* (Sieb. & Zucc.) Benth.

Flowering Sept.–late Oct. (some material in the region does not flower). Open disturbed areas, roadsides, and fields; often covers large areas. Reddish-purple flowers with strong fragrance of grapes. Only slightly woody; sometimes all aboveground material dies back in winter. Varietal epithet refers to the leaflets, which can be lobed. Originally introduced into the U.S. for fiber and its edible roots.

Pueraria montana was first reported from the region in 1988. Kudzu tubers and starch sometimes sold at Chinese and Japanese markets in NY (Frankel 1989). Seed collected from Long Island, Westchester, NY, and Beltsville, MD remained viable down to -40 ºC in laboratory freezer tests (Glenn and Moore 2008a). However, seed sometimes not set; the late flowering time of the species occurs when the region can experience frost. Fernald (1950) noted the species rarely flowered north of VA.

Introduced into the U.S. in 1876 from Japan (Gleason and Cronquist 1993) and eastern Asia (Rhodes and Block 2000) at the Centennial Exposition in Philadelphia, PA and later in 1884 at the New Orleans [LA] World Cotton Exposition (Forseth and Innis 2004, Miller and Edwards 1983). Marketed as an ornamental plant, with seeds widely available through mail-order catalogs. The USDA Soil Conservation Service recommended this species to control extensive soil erosion in the 1930s and 1940s, giving more than 85 million *P. montana* seedlings to landowners and



Distribution of *Pueraria montana* var. *lobata*, or kudzu vine, recorded in the New York Metropolitan Region during three time categories.

paying these landowners $19.75 per ha to plant them. The Civilian Conservation Corps planted *P. montana* on public lands. These efforts were very successful; by 1946, over 1.2 million ha had been planted with *P. montana*. During this period, *P. montana* was also promoted as good fodder for domestic livestock, so plantings increased. By the second half of the 20th century, the southern states were suffering from failed cotton farming due to the boll weevil (*Anthonomus grandis*). Large expanses of farmland were left fallow and reverted to forests, allowing decades of uncontrolled growth of *P. montana* plantings. First recognized as a potential problem in 1953 when the USDA removed *P. montana* from the list of permissible cover plants. But it was not until 1997 that it was listed as a Federal Noxious Weed (Forseth and Innis 2004). May be spreading by as much as 50,000 ha per year (Mitich 2000).

Survives in both light and shade habitats, but it is most productive in high-light forest edge sites (Forseth and Teramura 1987). Ability to fix nitrogen enables it to colonize sites with poor soil fertility (Forseth and Innis 2004), though phosphorus may be limiting (Lynd and Ansman 1990). The primary roots are succulent and capable of storing large amounts of starch, nitrogen, and water. Such water storage may enable this species to be drought-tolerant, though no studies have been conducted to confirm this possibility (Forseth and Innis 2004). May serve as a source of forage during intensive droughts (Mikhailova et al. 2013). Usually dies back in winter in colder climates (Follak 2011), though with climate change, its northern range appears to be expanding (Robinson et al. 1994, Waldron and Larson 2012).

Most of *P. montana*'s reproduction is vegetative; sexual reproductive effort measured on a biomass basis ranges from 0.02 to 2.1 percent, which is lower than other perennial plants. Plants may be pollinator limited; hand pollinating increases the reproductive effort to 14 percent, which is still relatively low. Seeds produced from these fertilizations have less than 10 percent chance of survival and establishment, with most being lost to fungal diseases prior to germination. Scarification (mechanical, fire, acid) required for germination, with a germination rate of 95 to 100 percent. Seeds without scarification have a germination rate of 17 percent. Given the physical dormancy, may form seed banks, but there is no information on seed longevity (Forseth and Innis 2004). Can allocate a large portion of its carbon budget to root tissue because it allocates very little to woody tissue. Connections between rooted nodes disintegrate rapidly, forming multiple layers of independent separate ramets, possibly tens of thousands per hectare (Forseth and Innis 2004). Has high levels of local genetic diversity, which reflect the multiple introductions over long periods of time from mixed genetic stock. Few genetic differences across regions (Forseth and Innis 2004, Sun et al. 2005). Local and regional genetic diversity may increase over time in response to certain types of management (e.g., mowing) that introduce stem or root propagules from different individuals (Kartzinel et al. 2015).

An intermediate to high isoprene emitter, with isoprene increasing as temperature increases. Isoprene is thought to be protective against thermal damage. Isoprene converts to compounds leading to poor air quality (Forseth and Innis 2004); *P. montana* has also been found to double nitric oxide levels and increase ozone pollution (Hickman et al. 2010). This species may be an important source of leached nitrogen because it is a nitrogen fixer and has been planted along streams (Forseth and Innis 2004). May have allelopathic properties associated with its leaf leachate; such leachate has reduced germination and growth of two other plants. This effect appears to be stable in soil systems (Rashid et al. 2010). Kudzu coverage can have a significant negative impact on bird diversity (Hudson and Aborn 2020). Disease, herbivory, and insect seed predation are common in *P. montana*, which differs somewhat from other introduced species. It shares many diseases, predators, and herbivores with the closely related soybean (*Glycine max*), an important cash crop (Forseth and Innis 2004). It may also be a host plant for diseases over winter months, such as soybean rust (*Phakopsora pachyrhizi* and *Phakopsora meibomiae*), that could have a negative economic impact on soybean production (Hershman et al. 2006, Sikora 2014). There are possible biocontrols, including the fungal pathogen *Myrothecium verrucaria* (Boyette

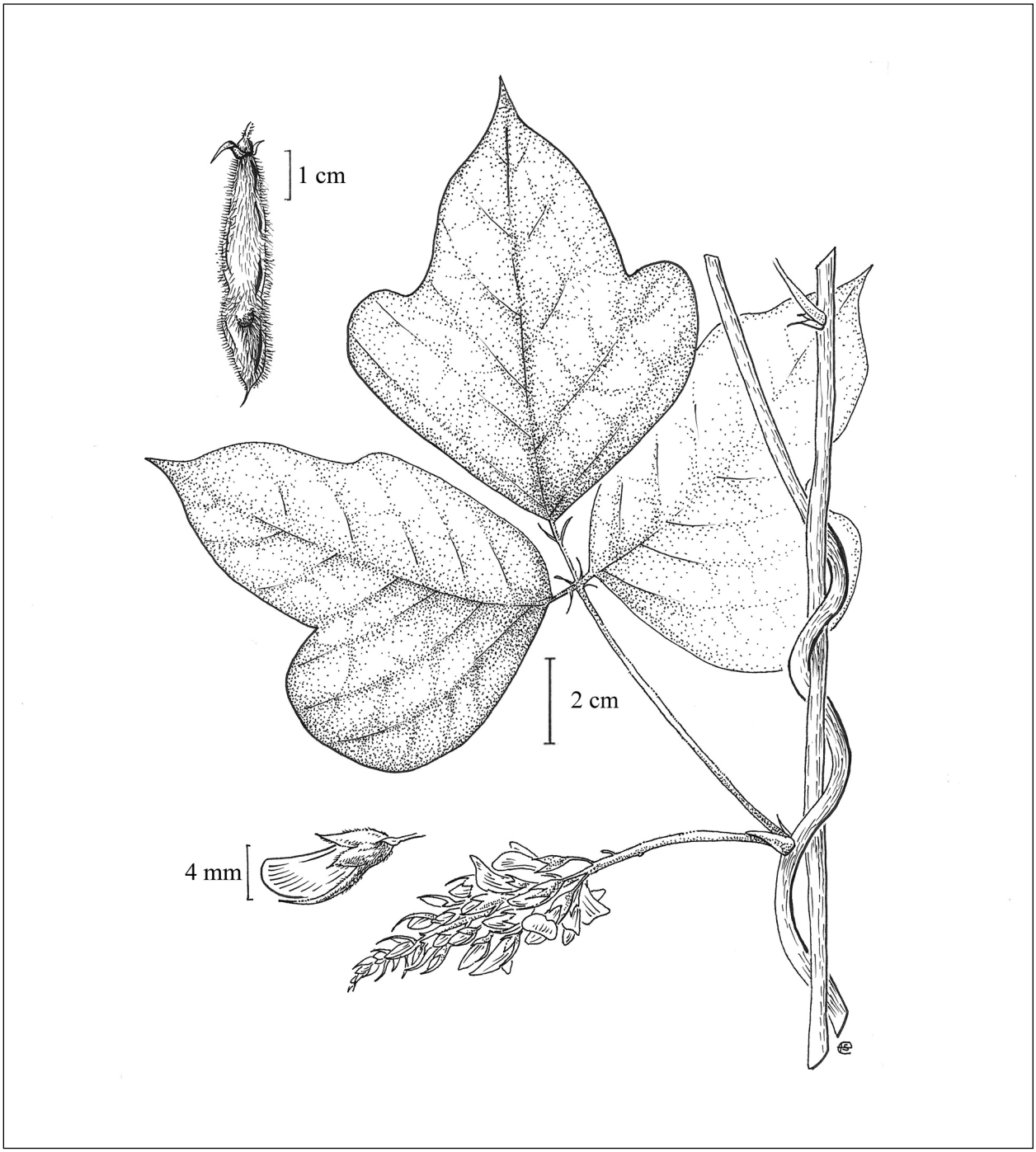
et al. 2002, Forseth and Innis 2004). However, this pathogen, a bioherbicide, produces mycotoxins that are highly toxic to mammals (Forseth and Innis 2004).

A potentially good source of carbohydrates for bioethanol production (Sage et al. 2009). Leaves, roots, and other parts have been ascribed several medicinal properties that may also be economically important, including treatment for alcoholism (Rezvani et al. 2003, Tomczyk et al. 2012); diabetes and cardiovascular disease (Wong et al. 2011); colds, asthma, diarrhea, fever, and anemia (Keung and Vallee 1998, Rezvani et al. 2003); and menopausal symptoms (Woo et al. 2003).

Listed as potentially invasive in CT (prohibited) and invasive in NY (prohibited); tracked as potentially invasive in NJ (category 2).

Management

Pueraria montana's ability to spread clonally at a rapid pace has made it difficult to manage. Solarization with translucent polyethylene sheeting has been used successfully on small populations; the thermal covering kills the root crowns (Newton et al. 2008). Several herbicides, including clopyralid, triclopyr, metsulfuron, picloram+2,4D, and tebuthiouron, reduce *P. montana* growth substantially, resulting in posttreatment *P. montana* coverages of less than 2–15 percent. Combining these herbicide treatments with competition from native species such as *Pinus* trees reduced the cover of *P. montana* even more, though it was never completely eradicated from the test plots. Burning stimulates vigorous sprouting of *P. montana* (Harrington et al. 2003). Use of aminocyclopyrachlor may have similar *P. montana* control at lower rates than other herbicides, but complete eradication even after 2 years of treatment has not been achieved (Minogue et al. 2011). Persistence in soils makes some of these herbicides a risk for contaminating shallow groundwater; tebuthiuron poses the highest risk, followed by picloram, metsulfuron, clopyralid, and finally triclopyr (Berisford et al. 2006). Use of metsulfuron (Escort® XP; Bayer Crop Science, Research Triangle Park, NC) via aerial application has been reported as the most cost-effective method to control *P. montana* on land to be reforested, though this study did not include comparisons with aminocyclopyrachlor (Grebner et al. 2011). The success of the bioherbicide *Myrothecium verrucaria* as a biocontrol agent varies with how it is prepared (growth medium used) and how it is applied; oil and surfactant increase efficacy percentages, sometimes reaching 100 percent (Hoagland et al. 2007). Though there appear to be many uses of *P. montana*, great care should be taken in decisions about marketing these uses. Additional deliberate planting of this species will probably lead to further expansion and reduce the likelihood of reclaiming areas already invaded. Eradication of this species is unlikely even with intensive herbicide treatments; however, herbicide treatments combined with supplemental plantings of competing native species are likely to improve the potential for reclaiming the native habitats. New areas of spread should be addressed diligently, and colder regions can no longer consider themselves immune to invasion in a warming climate.



Fruit (legume), leaf and inflorescence on a twining stem, and flower of *Pueraria montana* var. *lobata*. Illustration by Emma Skurnick.

P Q

Pyracantha M.Roem. – firethorn

Rosaceae. Evergreen to semi-evergreen thorny shrubs. Species 7 from northeastern Europe and southwestern Asia. Genus name from Greek for firethorn.

Nonnative Species

***Pyracantha coccinea* M.Roem. – scarlet firethorn**

Flowering May. Evergreen in mild environments; semi-evergreen to deciduous in colder climates. Native to southeastern Europe and southwestern Asia. Grows best in well-drained, fertile soils in full sun to partial shade. Can tolerate drought conditions and clay soils, but not harsh winters. Showy white flowers droop in clusters. Orange-red berries; needle-like spines. No confirmed escaped records in the region, but some observations; known to be planted and persistent. Epithet from Latin means "scarlet," a reference to the red fruit.

Pyrularia Michx. – buffalo nut

Cervantesiaceae (Santalaceae s.l.). Deciduous shrubs. Genus name from Latin is the diminutive of pear (*Pyrus*), a reference to the small, pyriform fleshy drupe fruit.

Nonnative Species

***Pyrularia pubera* Michx. – buffalo nut**

Native to south and west of the region in the Appalachian Mountains north to southwestern PA. Reported from Long Island; however, the reports are ambiguous about whether the plant was cultivated, a remnant from cultivation, or an escape. Further research is needed to determine whether this species is truly naturalizing in the region.

Pyrus L. – pear

Rosaceae. Trees, shrubs. Species 15–25 in northern Africa, Asia, and Europe. Distinguished from the closely related *Malus* (apple) in that its styles are distinct (basally connate in *Malus*) and flesh of ripe fruit contains abundant grit cells (grit cells absent in *Malus*, some sclereid cells adjacent to carpels and skin). Cultivated for ornament and edible fruit. Pear blossoms much less attractive to bees due to a lower sugar content; some pear species, such as *Pyrus calleryana*, have flowers with a fetid odor, attracting more fly (family Diptera) visitors. "Pirus" from Latin is the ancient name of pear (this spelling sometimes encountered in older publications).

Nonnative Species

1. *Pyrus calleryana* Dcne. – Callery pear, Bradford pear ↑↑↑

Flowering Apr.–early May; fruiting late Sept.–Oct. Woodland edges, fields, roadsides; also commonly planted street tree. Native to Korea and China. Gu and Spongberg (2003) recognized 4 varieties (*calleryana*; *integrifolia* T.T.Yu; *kohnei* (C.K.Schneid.) T.T.Yu; *lanceata* Rehder); Catling and Mitrow (2014) stated all can be found in material in North America. More work needed with local material to determine which varieties are present. Epithet honors French-Italian Joseph Maxine Marie Callery (1810–1862), scholar of the Chinese, Roman Catholic missionary, and plant collector.

Pyrus Key

1. Buds initially tomentose; flowers usually less than 2.5 cm across; sepals not persistent on fruit; styles 2–3; fruit less than 1.3 cm diameter, globose, brown dotted . . . . . ***Pyrus calleryana****
1. Buds glabrous; flowers usually greater than 2.5 cm across; sepals persistent on fruit; styles 3–5; fruit usually more than 1.3 cm diameter, pyriform to subglobose, usually not dotted 2
2. Leaf margins entire, crenulate, serrulate . . . . . ***Pyrus communis****
2. Leaf margins setose-serrate . . . . . ***Pyrus pyrifolia****

Earliest flowering age 3 years (Bell and Zimmerman 1990). Fruit ripens relatively late, after late Sept. (Hummer and Postman 2008). Introduced into the U.S. in 1908 (Dirr 1998, Rehder 1915). The 'Bradford' cultivar was introduced as seed purchased from China in 1919. This species was introduced primarily as a potential way of developing resistance to fire blight (caused by the bacterium *Erwinia amylovora*) in fruiting pears, but this was not successful. However, the 'Bradford' cultivar was and still is, though less so, planted as a popular street tree, despite its fetid odor (of which there are numerous media and blog reports with complaints), short life, the tendency of its wood to split (Dirr 1998, Kuser et al. 2001), and susceptibility to storm damage (Kuser et al. 2001). The abundant flowers produced in early spring are probably the appeal. At least 17 cultivars, many of which are more suitable as street trees than the 'Bradford.' Adaptable to many types of soil; tolerates drought and pollution and prefers full sun (Dirr 1998). However, it is not tolerant of very cold (below -28 °C; Phillips 2004) or very shady conditions (Culley and Hardiman 2007). Found in warm and humid climates in China (Liu et al. 2012).

Can hybridize with other pear species, producing fertile progeny. A likely hybrid between *Pyrus calleryana* and *P. communis* was recently reported from CT just outside the region (Connolly and Boutiette 2020). However, the 'Bradford' cultivar, if isolated from other pear cultivars and species, should set fruit at a very low rate. Moreover, both the Hansen pear and *Pyrus communis* are nearly completely incompatible with the 'Bradford.' The USDA claimed that the 'Bradford' cultivar would not set fruit if planted more than 65 m away from any other pear or if planted next to a common pear or Hansen pear. Nonetheless, planting several cultivars does enhance fruit set; there is evidence suggesting that even isolated 'Bradfords' produce seed (Vincent 2005). Individuals producing abundant seed are likely to be the product of hybridization between different cultivars (Culley and Hardiman 2009). This hybridization may occur through insect pollination or between root

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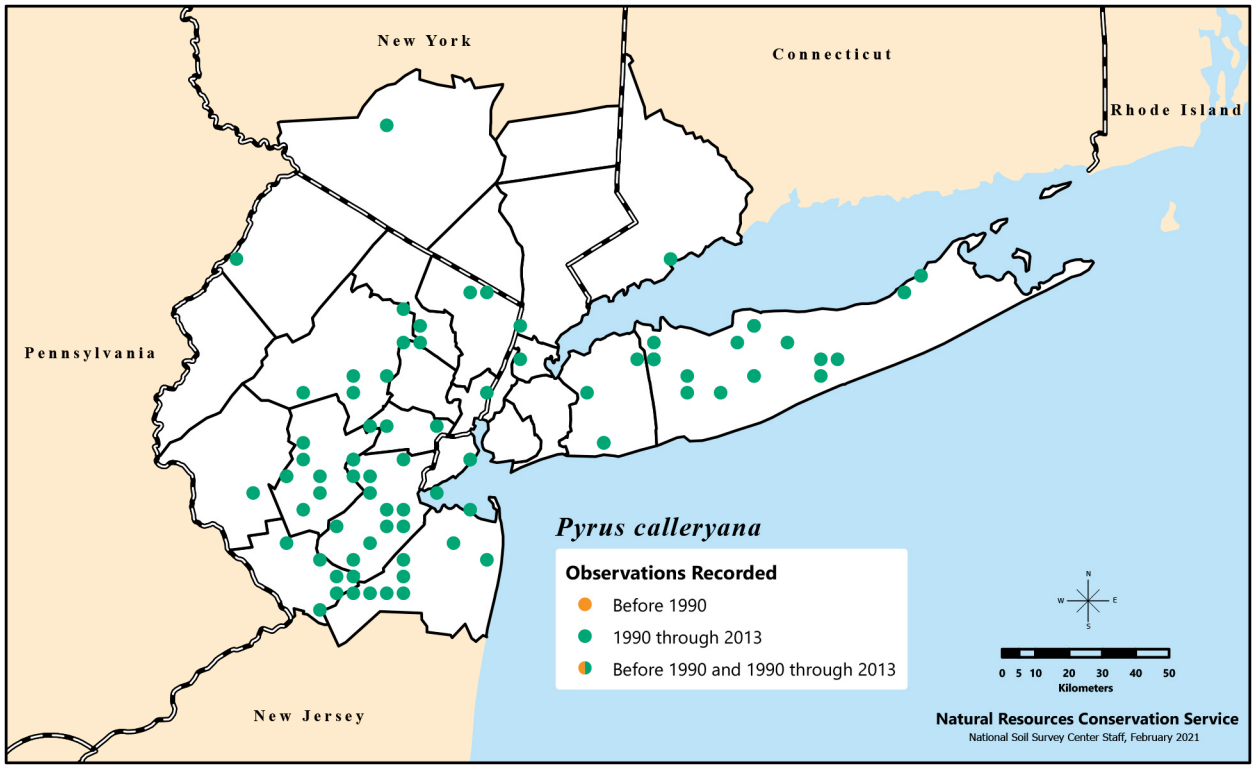


Distribution of *Pyrus calleryana*, called Callery or Bradford pear, recorded in the New York Metropolitan Region during three time categories.

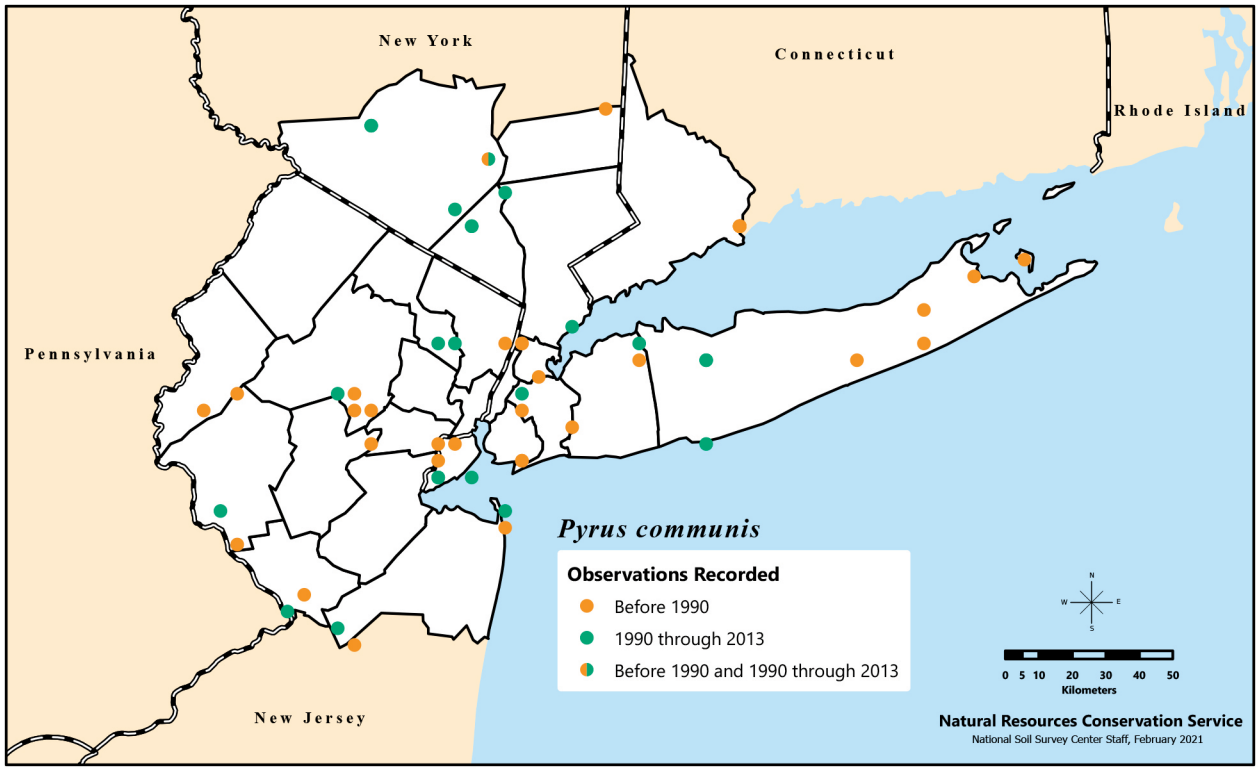
stocks and scions through grafting (Culley et al. 2011). Although these individuals appear to be producing more seed, no increased fitness could be documented for such hybrids. Instead, the invasion success of *P. calleryana* appears to be due to extensive planting of multiple cultivars and not to any hybrid superiority (Hardiman and Culley 2010). Birds disperse the seed (Fare 1987). Cold stratification for 60–90 days required for germination (Dirr 1998). Escaped individuals or thickets of individuals often have thorns, most likely because the progeny of the thornless cultivars now express this once latent gene (Vincent 2005). There are two distinct gene pools separated geographically (northeast and southwest) in China for *P. calleryana* (Liu et al. 2012). It is not yet known whether the planted *P. calleryana* came from one or the other or both of these regions. Secondary compounds, including calleryanin, a 3,4-dihydroxybenzyl alcohol, may protect this species from wood boring beetles (Morewood et al. 2004) and Japanese beetles (*Popillia japonica*) (Keathley et al. 1999). *Pyrus calleryana* is also resistant to root-knot nematodes (*Meloidogyne* spp.) (Santamour and Riedel 1993).

Tracked as potentially invasive in NJ (category 2?).

2. *Pyrus communis* L. – pear ↔

Flowering Apr.–mid-May; fruiting Aug.–Sept. Woodland edges, fields, roadsides. Native to Europe and western Asia but has been long cultivated as a fruit tree in the U.S. and world-wide (Dirr 1998).

Flowers the earliest among the *Pyrus* spp., starting as early as late Feb. in the southern U.S. (Dirr 1998). This species' stigmas have an asynchronous period of receptivity, which expands the period of stigma receptivity for the whole flower, potentially increasing the likelihood of pollination, especially in areas where conditions for successful pollination (available pollinators) are unreliable (Sanzol et al. 2003). Because of its high susceptibility to fireblight (caused by the bacterium *Erwinia amylovora*), it is not recommended as an ornamental tree (Dirr 1998). Cold stratification for 90–130 days required



Distribution of *Pyrus communis*, or pear, recorded in the New York Metropolitan Region during three time categories.

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for germination (Hummer and Postman 2008). The cultivated edible pears, which are derived from wild relatives, show relatively low genetic diversity and do not represent well the genetic make-up of the wild *P. communis* (Liu et al. 2015, Volk et al. 2006). This species has escaped from cultivation in the NY Metropolitan Region since at least 1979 (Frankel 1999). Found escaping as far north as southern ON. Dominates old fields and pastures in some areas but has also been found colonizing native woodland areas. Can grow in a variety of soils; seems to do especially well in drought-prone, shallow soils (Catling and Mitrow 2008). In central Europe, considered an example of a species with cultigens that have escaped and "run wild" (Bartsch et al. 1993). Has also escaped into different forests in parts of Russia (Borisova 2011). A host plant for the European grape vine moth (*Lobesia botrana*), which is relatively new to North America and is one of the most destructive pests on *Vitis* (grape) (Gilligan et al. 2011).

***Pyrus pyrifolia* (Burm. f.) Nakai – Chinese pear**

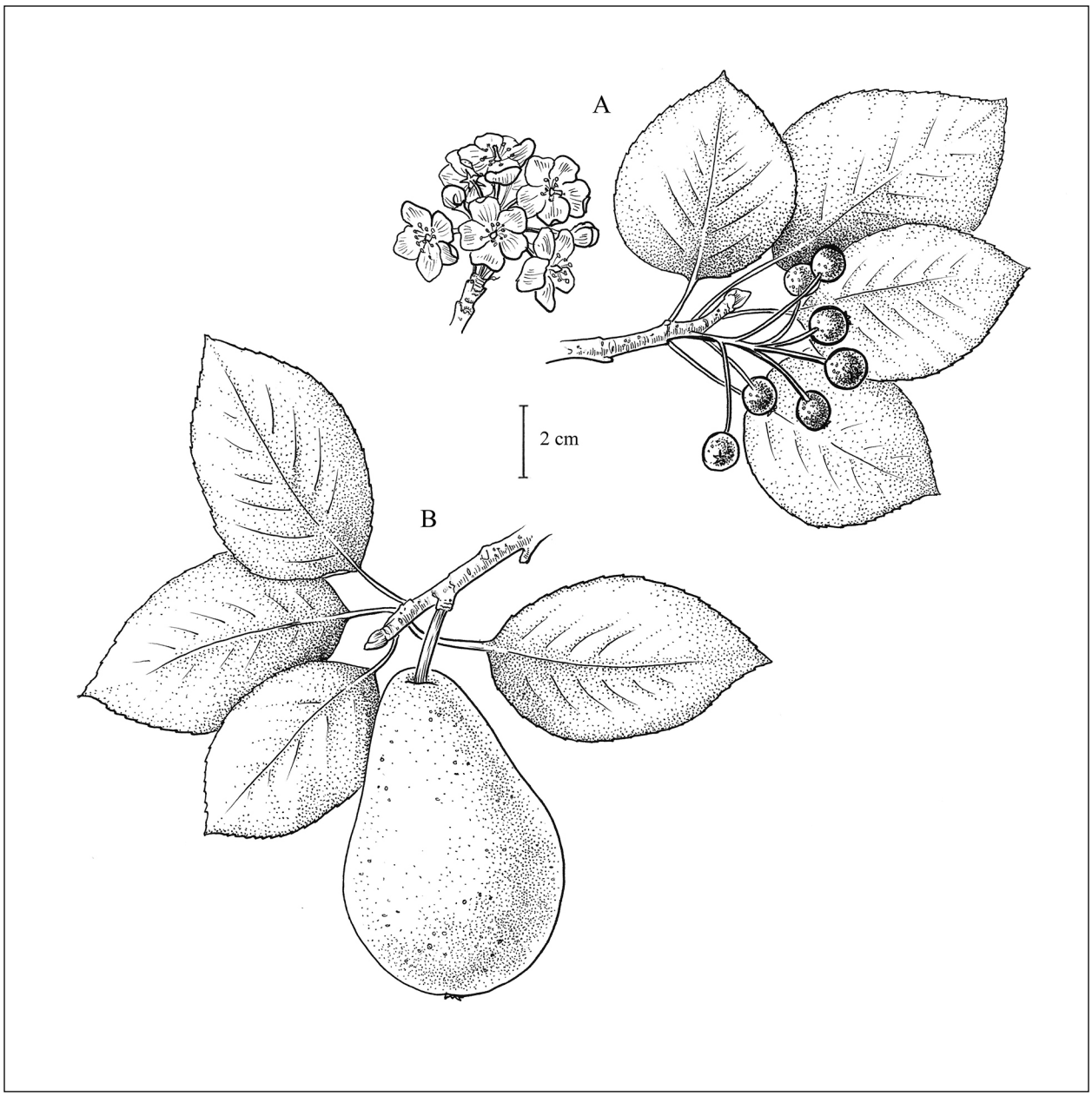
Ficus pyrrifolia Burm. f.; *Pyrus serotina* Rehder

Native to Asia. Cultivated and may be encountered as a remnant from cultivation. Epithet from Latin is redundant; the original describer of the species, the Dutch botanist Nicolaas Laurens Burman (1733 or 1734 to 1793), mistakenly identified it as a fig (*Ficus* L.) with leaves like that of a pear.

Management

The cultivar 'Aristocrat' is recommended as the best *Pyrus calleryana* cultivar for street tree uses due to its greater resistance to storm damage (wider branch angles) (Kuser et al. 2001). The cultivar 'Chanticleer' appears to be more popular now, despite having among the narrowest of branch angles (Dirr 1998, Kuser et al. 2001, Rahman et al. 2011). Street trees are planted for environmental reasons, such as producing a cooling effect in urban environments. Street trees planted in structural soils (e.g., a mixture of gravel, sand, and soil with sand being 70–80 percent of the mixture and with added organic matter and clay) grow faster, develop a wider crown, and provide a higher cooling effect than those in topsoil-filled pits cut out of the asphalt or trees on grass verges (Rahman et al. 2011). Nonetheless, the average annual net benefit of *P. calleryana* was found to be only $33.65 per tree, the lowest of 10 street trees commonly planted in CA. The comparison included a mixture of *P. calleryana* cultivars, of which 56 percent were Bradford (McPherson 2003). Because of the risk of hybridization and subsequent large production of seeds, which are then bird dispersed at long distances from the parent trees, planting any of the *P. calleryana* cultivars is not advisable. If all currently planted trees cannot be removed, it makes sense to thin them where possible in order to reduce the chances of cross pollination. Individuals that are products of grafts are just as likely to produce abundant seed.

Although *P. communis* does not appear on many, if any, invasive species lists, it has been documented as escaping into natural areas. Like *P. calleryana*, its seed can be dispersed long distances, perhaps even with vectors besides birds, including humans and large mammals. We suggest removal of any adventive individuals, where practical.



A) Flowers and fruiting leafy twig of *Pyrus calleryana*; B) fruiting leafy twig of *Pyrus communis*. Illustration by Emma Skurnick.

Quercus L. – oak

Fagaceae. Trees, shrubs. Species 500+ in northern Africa, Asia, Europe, North America, and South America. Without question the most significant genus of woody plants in the region ecologically and economically. Oaks in the region are contained in 2 sections: *Quercus* L. sect. *Quercus* (white oaks; acorn maturation annual), and *Q.* sect. *Lobatae* Loudon (red oaks; acorn maturation biennial). Small predators of acorns facilitate dispersal by dropping undamaged nuts and failing to recover cached nuts (Ivan and Swihart 2000, Johnson 1993). One study of fall-planted acorns in experimental seedbeds found germination rates of 50–100 percent across different U.S. provenances (Santamour and Schreiner 1961). Successful storage of acorns generally requires full hydration by overnight soaking before placement in cold storage (Connor 2004). Damaged acorns may still germinate successfully (Steele et al. 1993). Acorns are recalcitrant, meaning they are shed with relatively high moisture content and are highly sensitive to desiccation, with loss of viability when moisture content declines (Bonner 2008n). For a propagation protocol for growing bare-root oaks see Hoss (2004).

Quercus Key

1. Leaf margins entire 2
1. Leaf margins with lobes or teeth 3
2. Leaves broadly obovate, broadest near top . . . . . ***Quercus marilandica*** (in part)
2. Leaves linear to oblong, broadest near middle 4
3. Leaf lobes or teeth without bristle tips. 5
3. Leaf lobes or teeth with bristle tips 6
4. Leaves permanently and evenly pubescent beneath, 2.8 cm wide or more . . . . . ***Quercus imbricaria****
4. Leaves glabrous beneath (or few scattered hairs along main vein), 2.5 cm wide or less . . . . . ***Quercus phellos***
5. Leaves with some lobes 7
5. Leaves with teeth only 8
6. Most leaves with only 2 lobes toward apex, undersides with golden-yellow tomentum . . . . . ***Quercus marilandica*** (in part)
6. Most leaves with more than 2 lobes, underside tomentum not golden-yellow 9
7. Leaf undersides glabrous; current season twigs glabrous 10
7. Leaf undersides hairy; current season twigs hairy 11
8. Bark of 3-year-old and older twigs or branches exfoliating in large patches; acorn peduncle more than 20 mm long. . . . . ***Quercus bicolor***
8. Bark of twigs or branches not exfoliating; acorn peduncle less than 20 mm long 12
9. Leaf undersides uniformly covered with white to gray tomentum 13
9. Leaf undersides with scattered brown to tan tomentum 14
10. Petioles 10–25 mm; leaf bases acute-cuneate; acorn subsessile or on peduncles 1–20 mm . . . . . ***Quercus alba***
10. Petioles 2–7 mm; leaf bases cordate; acorn on peduncles 35–60 mm. . . . . ***Quercus robur****
11. Most leaves with only 2 lobes toward apex, undersides with golden-yellow tomentum . . . . . ***Quercus marilandica*** (in part)
11. Most leaves with more than 2 lobes, underside tomentum not golden-yellow 15
12. Leaf undersides with tufts of spreading hairs along midvein, with scattered, irregular, 2- to 4-rayed, microscopic hairs; bark deeply furrowed with large ridges; widespread throughout the region . . . . . ***Quercus montana***
12. Leaf undersides without tufts of spreading hairs along midvein, with scattered to dense, 6- to 10-rayed, microscopic hairs or with no hairs or tufts of hair only in the vein axils; bark thin, sometimes flaky 16

Quercus Key

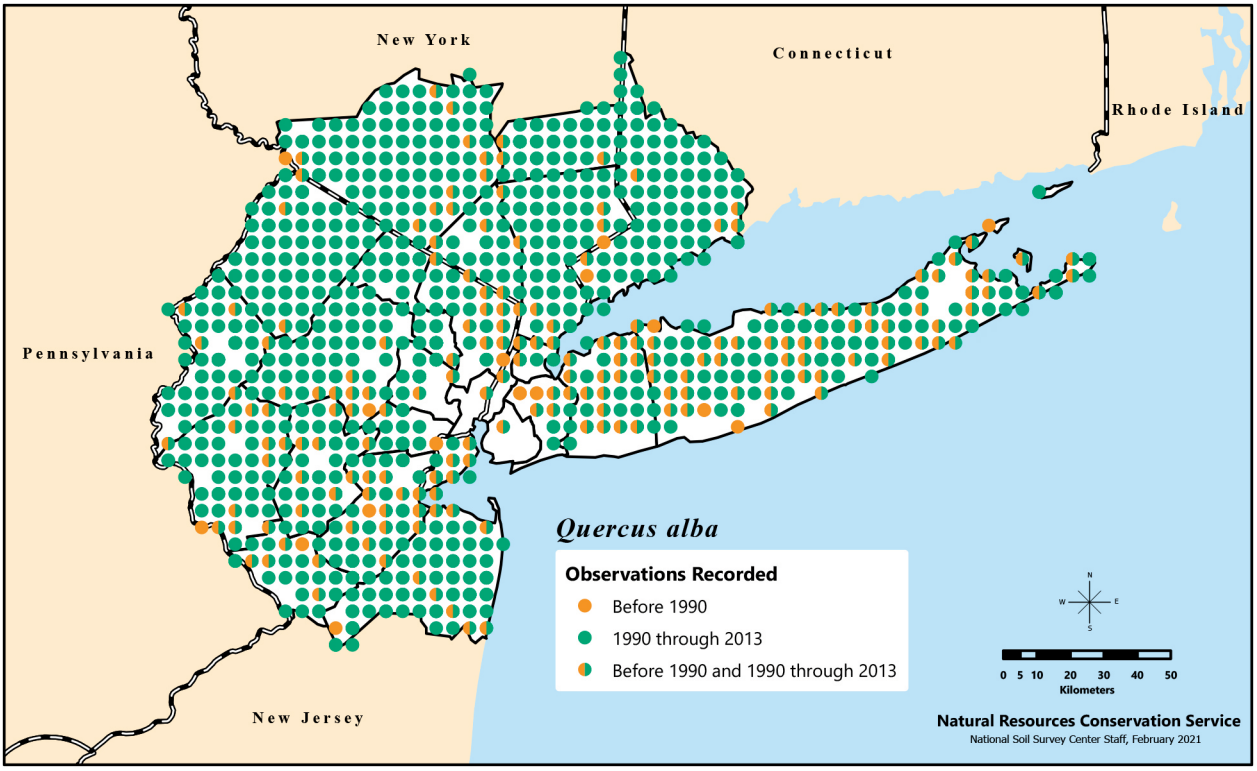
13. Most leaf blades 2–5 cm long and as long as wide; terminal leaf lobe elongate, narrow, somewhat hooked; large tree . . . . . ***Quercus falcata***
13. Most leaf blades 5–10 cm long with length-to-width ratio 1.5–2 or less; terminal leaf lobe broadly triangular; shrub or small tree . . . . . ***Quercus ilicifolia***
14. Terminal buds uniformly pubescent. . . . . ***Quercus velutina***
14. Terminal buds glabrous or pubescent only on distal half. 17
15. Leaf blade with a few deep sinuses (extending more than half the distance to the midrib); older twigs with corky wings or ridges . . . . . ***Quercus macrocarpa***
15. Leaf blade regularly lobed; twigs without corky wings or ridges . . . . . ***Quercus stellata***
16. Leaves with 9 or more pairs of lateral veins; tall tree; occurring in inland, isolated limestone or calcareous areas . . . . . ***Quercus muehlenbergii***
16. Leaves with 8 or fewer pairs of lateral veins; colonial shrub; occurring in coastal sandy areas as well as occasional inland dry sites . . . . . ***Quercus prinoides***
17. Terminal buds pubescent only on distal half 18
17. Terminal buds glabrous 19
18. Leaf sinuses extending more than half the distance to midrib; acorn cup turbinate . . . . . ***Quercus coccinea***
18. Leaf sinuses extending less than half the distance to midrib; acorn cup shallow, saucer-shaped. . . . . ***Quercus rubra*** (in part)
19. Leaf sinuses extending more than half the distance to midrib, underside with distinct tufts of hairs in the vein axils . . . . . ***Quercus palustris***
19. Leaf sinuses extending less than half the distance to midrib, underside glabrous . . . . . ***Quercus rubra*** (in part)

Native Species

1. *Quercus alba* L. – white oak ↑↑

Tree. Flowering late Apr.–late May; fruiting in fall of the same year. Usually mesic to dry (rarely wet) woods, slopes, and barrens. Linnaeus took the epithet from a polynomial that English naturalist and artist Mark Catesby (1683–1749) gave the species: *Quercus alba virginiana*. In Catesby's (1736) description of the species, the bark is reported to be white. White oak group.

Earliest seed-bearing age 20 years; acorn masts every 4–10 years. Cold stratification not required for germination (Bonner 2008n). Height at maturity 30 m. This species, as with many oak species, has shown evidence of decline in North America (Bruhn et al. 2000, McDonald et al. 2002, Pallardy et al. 1988, Rooney and Waller 2003) as well as throughout Europe (Jung et al. 2000); the decline has been attributed to fungal pathogens such as *Phytophthera* (Jung et al. 2000) or *Armillaria* species (Bruhn et al. 2000), climate (Rubino and McCarthy 2000), lack of fire (Abrams 2003), deer (*Odocoileus* spp.) herbivory (Rooney and Waller 2003), and general loss of habitat often associated with a loss of large-scale gaps in forested areas (Buchanan and Hart 2012). Compared to most North American oak species, *Q. alba* is more tolerant of drought and fire (Abrams 2003). Reaches the northern limit of its range in QC; this limit is not due to cold temperatures, but instead possibly to a lack of habitat and an inability to compete well in more mesic habitats (Tardiff et al. 2006). In fact, *Q. alba* can acclimate its leaf respiration rates rapidly to changing temperatures (Bolstad 2003). However, other factors associated with cooler climates, such as more severe storm events, especially during critical growth stages such as the seedling stage (Tardiff et al. 2006) or flowering and acorn



Distribution of *Quercus alba*, or white oak, recorded in the New York Metropolitan Region during three time categories.

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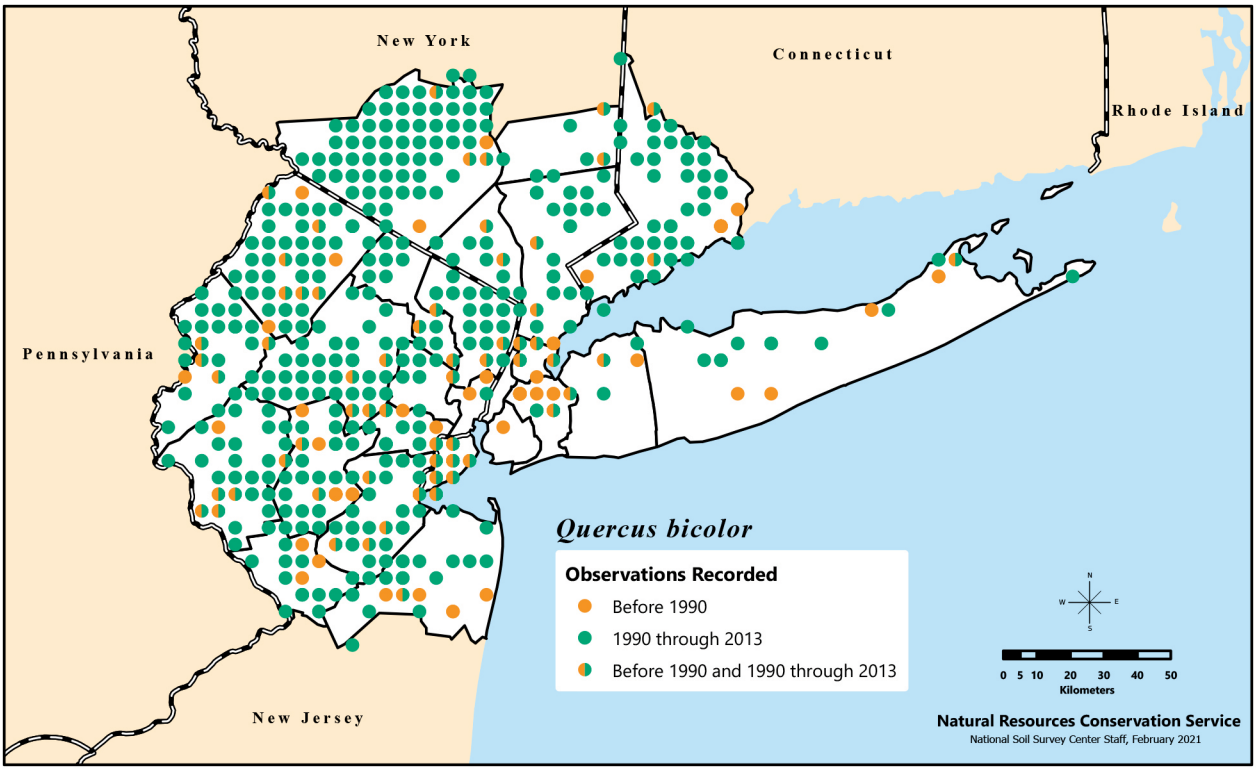
production stages (Cecich and Sullivan 1999), may play a role. Consequently, production of a large number of flowers cannot be used to predict a large acorn crop (Sork et al. 1993). In cultivation since 1724. However, its slow growth and problems with transplanting make it difficult to cultivate (Dirr 1998). In addition to the 3 hybrids found in the region (see Note on Oak Hybrids), *Q. alba* also hybridizes with *Q. macrocarpa* (*Q. ×bebbiana*) and *Q. stellata* (*Q. ×fernowii*) (Gleason and Cronquist 1993). Increases may be attributed to reforestation.

2. *Quercus bicolor* Willd. – swamp white oak ↑↑

Tree. Flowering late Apr.–late May; fruiting in fall of the same year. Mesic lowlands, woods, swamps, and marshes, and poorly drained upland areas. Epithet from Latin refers to the differences in color of the upper and lower leaf surfaces, the lower being pale. White oak group.

Earliest seed-bearing age 20 years; acorn masts every 3–5 years. Height at maturity 30 m. Prefers mesic environments; is found primarily in floodplains and poorly drained sites (Gleason and Cronquist 1993, Mitsch and Rust 1984). Morin et al. (2008) predict that this species will suffer greater than 20 percent extinction rate in response to climate change due to increasing drought and its phenology. Flowers later than the number of growing-degree days predicted for its northern boundaries, but also requires some chilling to break dormancy, which the predicted southern range would no longer be able to provide (Morin et al. 2007). Cultivated since 1800. May be easier to transplant than *Q. alba*. Requires acidic soil for optimal growth (Dirr 1998). Increases may be due to reforestation.



Distribution of *Quercus bicolor*, or swamp white oak, recorded in the New York Metropolitan Region during three time categories.

3. *Quercus coccinea* Muenchh. – scarlet oak ↑

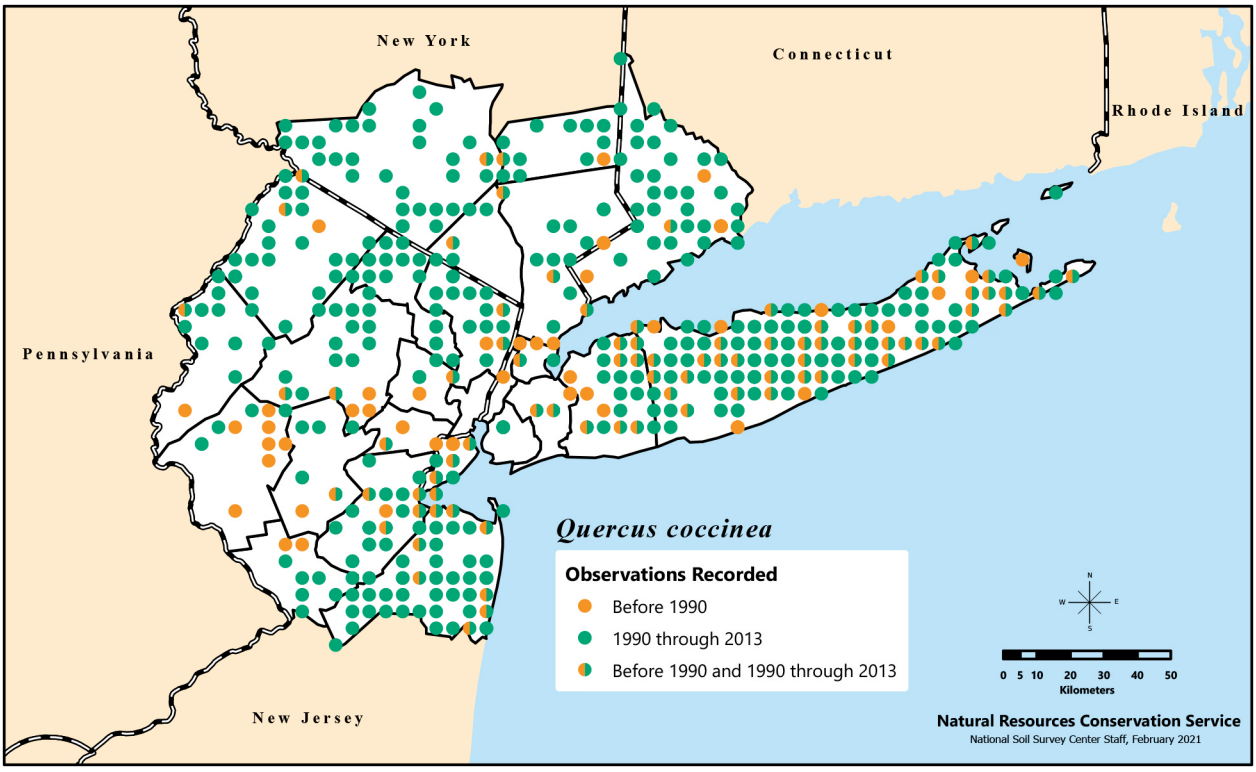
Tree. Flowering late Apr.–late May; fruiting in fall of the next year. Usually occurs on mesic to dry, well-drained substrates of barrens, slopes, ridges, mountain tops, and roadsides, usually in full sun. Epithet from Latin means "scarlet," a reference to the fall color of the foliage. Red oak group.

Earliest seed-bearing age 20 years; acorn masts every 2–3 years. Cold stratification for 30–60 days required for germination (Bonner 2008n). Height at maturity 30 m. Cultivated since 1691 (Bonner 2008n), but not frequently planted because its growth is often less attractive due to retention of dead branches. Grows well in xeric conditions such as ridge tops and southern exposures (Stephenson 1974). Increases may be due to reforestation.

4. *Quercus falcata* Michx. – southern red oak ↔

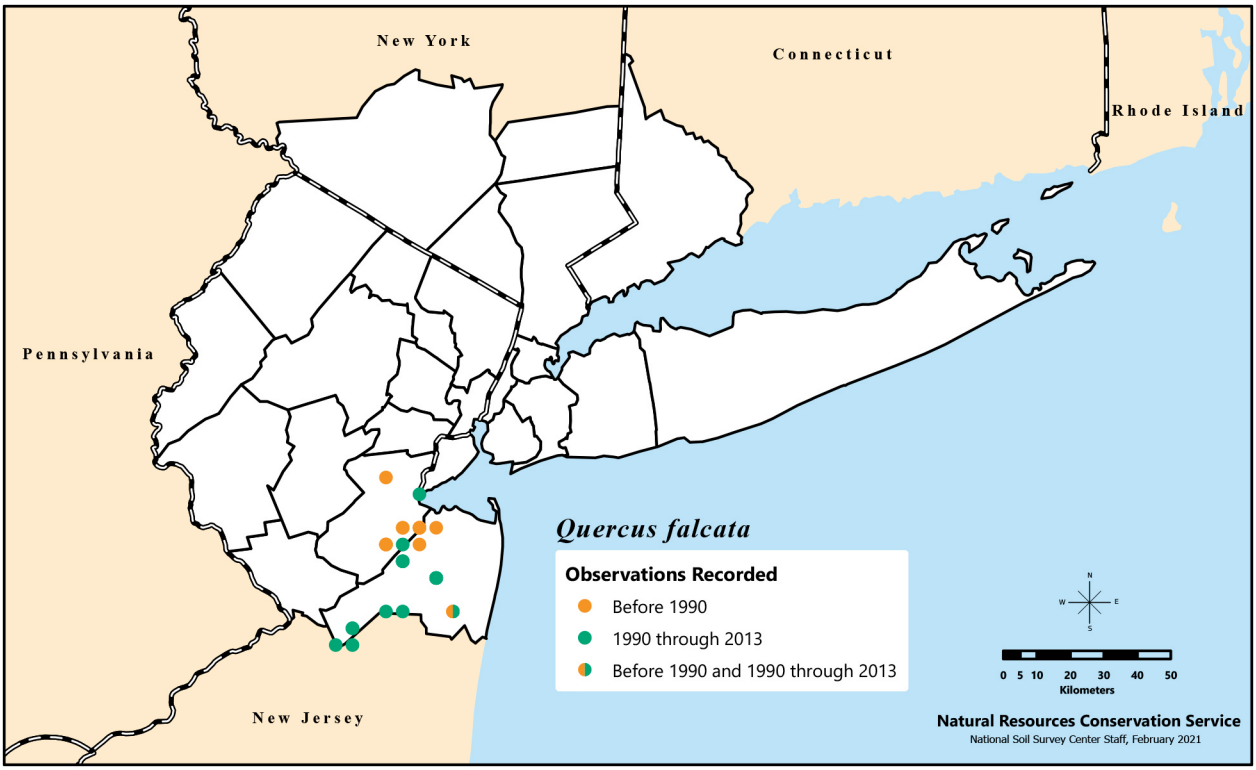
Tree. Flowering May; fruiting in fall of the next year. Usually occurs on mesic to dry, well-drained substrates of barrens, woods, and roadsides. Found on dry or sandy soils farther east and on wet soils farther west; found as far west as MO (Gleason and Cronquist 1993). Epithet derived from the Latin word for "sickle," a reference to the curved margins of the leaves. Red oak group.

Rare in the region, which is the northern boundary of *Quercus falcata*'s distribution. Common in southern NJ. Earliest seed-bearing age 25 years; acorn masts every 1–2 years. Cold stratification for 30–90 days required for germination (Bonner 2008n). Height at maturity 27 m. Cultivated since 1763. *Quercus pagoda* (= *falcata* var. *pagodifolia*) is also at the northernmost limit of its range in southern NJ; its leaves look more like those of *Q. coccinea* than of *Q. falcata*. *Quercus falcata*, though cultivated, is not common in the nursery trade (Dirr 1998).



Distribution of *Quercus coccinea*, or scarlet oak, recorded in the New York Metropolitan Region during three time categories.

P Q



Distribution of *Quercus falcata*, or southern red oak, recorded in the New York Metropolitan Region during three time categories.

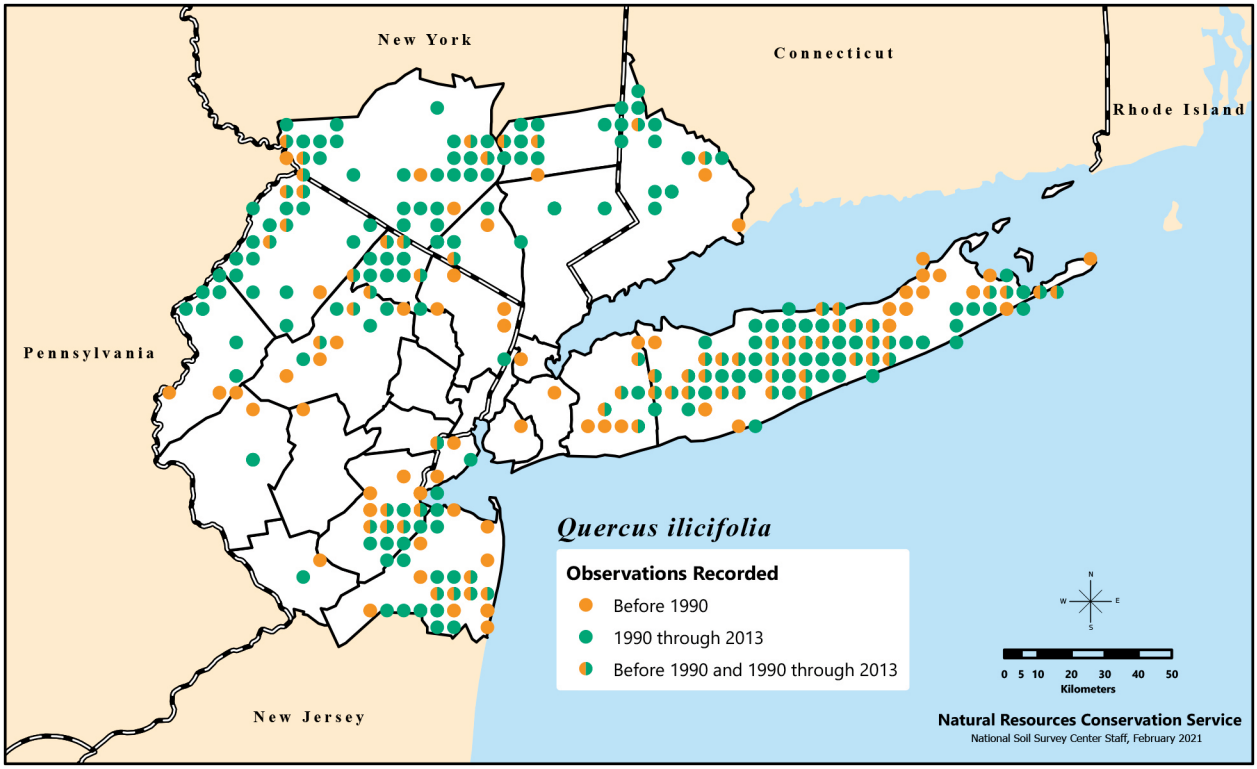
5. *Quercus ilicifolia* Wang. – bear oak ↔

Shrub, rarely small tree. Flowering late Apr.–late May or early June; fruiting in fall of the next year. Dry to mesic well-drained substrates of barrens, roadside banks, slopes, ridges, and mountain balds. Epithet from Latin refers to the similarity in outline of the species' leaves to those of some hollies (*Ilex*). Red oak group.

Cold stratification for 30–60 days required for germination. Height at maturity only about 6 m, which is somewhat unusual for most oaks in the northeastern U.S. Cultivated since 1800 (Bonner 2008n). Typically associated with barrens and other habitats with rocky, sterile soil (Gleason and Cronquist 1993). Though this species grows over an elevation and moisture gradient, it experiences greater herbivory at lower elevations, which may be due to the synchrony of leaf flushing and insect feeding (Aizen and Patterson 1995). Sex ratios also vary with topography. Male flower production declines with decreasing elevation, which is associated with increasing stress due to shorter growing season and higher probability of killing frosts. Male flowers are associated with taller stems at higher elevations, but there is no similar gender and stem size association at lower elevations (Aizen and Kenigsten 1990). Presence of this scrub oak is associated with frequent fire (Milne 1985).

6. *Quercus macrocarpa* Michx. – bur oak Ø♥

Tree. Flowering May; fruiting in fall of the same year. Mesic to dry bottomlands to uplands, forests, slopes, and bluffs, often in poorly drained calcareous substrates. Native populations known from Sussex County (NJ) and Orange County (NY) and from outside the region in CT; the few reports from elsewhere in the region, such as Hunterdon and Passaic Counties (NJ) and Suffolk and Westchester Counties (NY), are likely to represent remnants or escapes from cultivation. Epithet from Latin refers to the large acorns of this species. White oak group.



Distribution of *Quercus ilicifolia*, or bear oak, recorded in the New York Metropolitan Region during three time categories.

Earliest seed-bearing age 35 years; acorn masts every 2–3 years. Cold stratification for 30–60 days required for germination. Height at maturity 30 m. Can adapt to more xeric conditions by increasing its tap root depth and root elongation rate (Danner and Knapp 2001). Pollination often occurs with pollen that comes from at least 200 m away, suggesting a great deal of gene flow within this species and the possibility of successful reproduction with individuals that are relatively remote from one another (Dow and Ashely 1998). Cultivated since 1811 (Bonner 2008n). Hybridizes with *Quercus alba* (*Q.* ×*bebbiana*), *Q. michauxii* (*Q.* ×*byarsi*), *Q. muehlenbergii* (*Q.* ×*deamii*), *Q. stellata* (*Q.* ×*guadelupensis*), *Q. bicolor* (*Q.* ×*schuettei*) (Gleason and Cronquist 1993), and the western species *Q. gambelii* (Maze 1968, Nixon and Muller 1997), but none of these occurs in the region. Difficult to transplant, but is adaptable to many soil types, including sandy plains, moist alluvial bottoms, and dry clay soils. On uplands, it prefers more alkaline conditions. Prefers full sun and tolerates urban conditions better than most oaks (Dirr 1998).

Tracked as a species of special concern in CT. Listed as endangered in NJ (S1.1); only known location in the region is Sussex County.

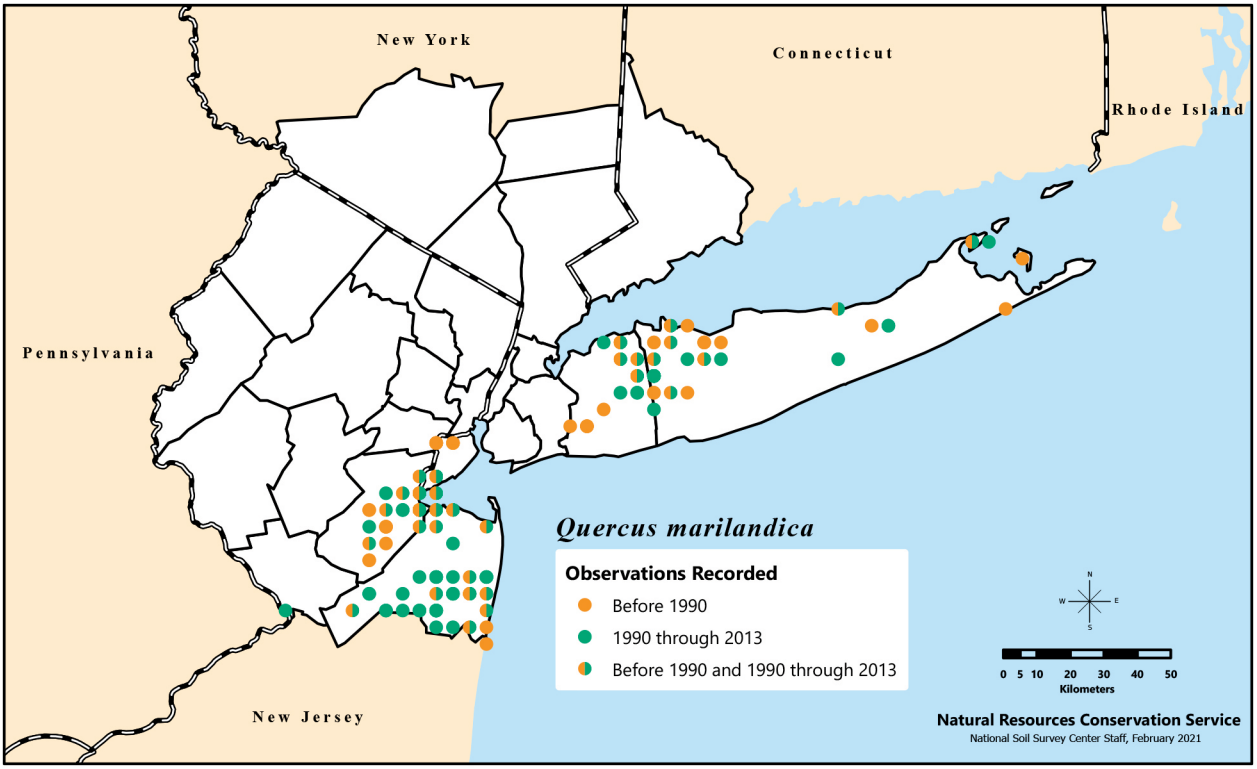
7. *Quercus marilandica* Muenchh. – blackjack oak ↔

Tree, shrub. Flowering May; fruiting fall of the next year. Usually occurs on mesic to dry, well-drained substrates of barrens, woods, ridges, and roadsides. Often found on barren, infertile soils, and is a good indicator of site quality (or lack thereof) (Dirr 1998). Red oak group.

Cold stratification for 90 days required for germination (Bonner 2008n). Height at maturity 15 m. One of the few oaks that have not been cultivated. Disturbance and stressful conditions, such as drought, increase sprouting as a form of reproduction in this species (Clark and Hallgren 2003).

Listed as rare in NY (S3).

P Q



Distribution of *Quercus marilandica*, or blackjack oak, recorded in the New York Metropolitan Region during three time categories.

8. *Quercus montana* Willd. – chestnut oak ↑↑

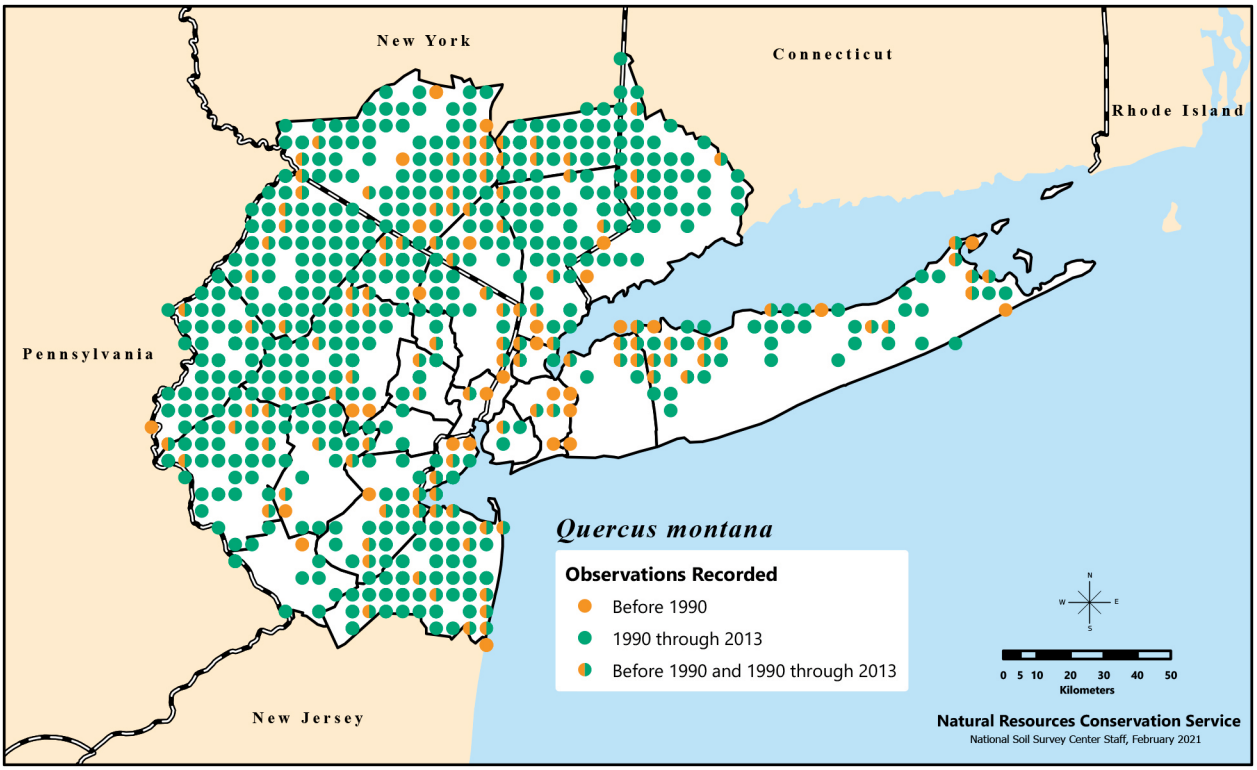
Tree. Flowering early May–early June; fruiting in fall of the same year. Usually occurs on mesic to dry rocky and sandy substrates of forests, ridges, and barrens. Found primarily on dry upland sites (Dirr 1998). *Quercus prinus* L., another name frequently applied to this species, has been formally rejected; the type specimen of *Q. prinus* in the Linnean herbarium is debatable and may represent *Q. montana* or *Q. michauxii* (swamp chestnut oak). White oak group.

Capable of maintaining similar photosynthetic levels on xeric sites as on mesic sites (Turnbull et al. 2002). Earliest seed-bearing age 20 years; acorn masts every 2–3 years. Cold stratification not required for germination. Cultivated since 1688 (Bonner 2008n). Increases may be due to reforestation.

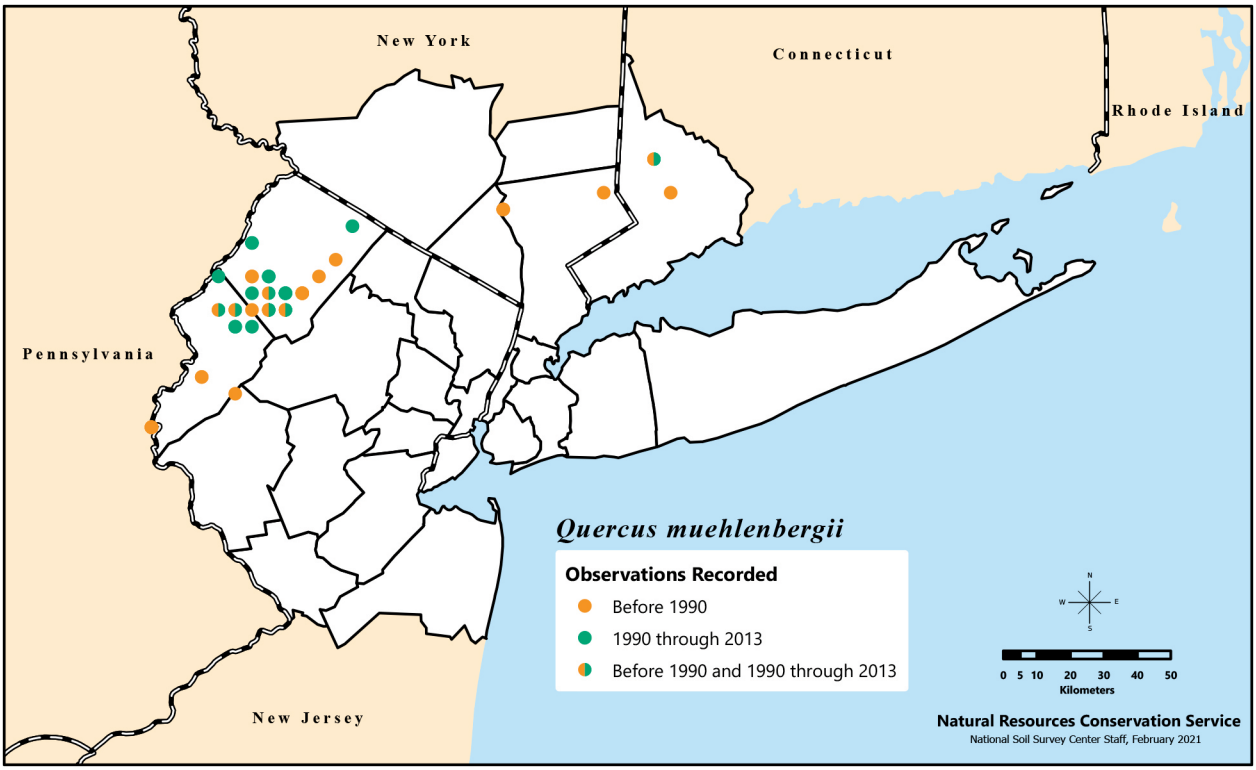
9. *Quercus muehlenbergii* Engelm. – chinquapin oak ↔

Tree. Flowering May; fruiting in fall of the same year. Usually occurs on mesic calcareous substrates of forests, slopes, and thickets. Primarily found on limestone outcrops or high alkaline soils; prefers rich bottomlands (Dirr 1998). Epithet honors American botanist Gotthilf Henry Ernest Muhlenberg (1753–1815). White oak group.

Height at maturity 24 m. Cold stratification not required for germination. Cultivated since 1822 (Bonner 2008n). *Quercus muehlenbergii* seedlings, like those of *Q. macrocarpa*, can respond to drought conditions by increasing the depth of their tap root and increasing the rate of their root elongations. However, *Q. muehlenbergii* is more drought-tolerant than *Q. macrocarpa* (Bragg et al. 1993).



Distribution of *Quercus montana*, or chestnut oak, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Quercus muehlenbergii*, or chinquapin oak, recorded in the New York Metropolitan Region during three time categories.

P Q

10. *Quercus palustris* Muenchh. – pin oak ↑↑

Tree. Flowering late Apr.–late May; fruiting in fall of the next year. Usually occurs in mesic poorly drained substrates of woods, swamps, and roadsides; very intolerant of shade. One of the most widely planted native oaks. Prefers moist, acidic conditions and is highly tolerant of wet soils. However, it may suffer from chlorosis in very alkaline soils (Dirr 1998). Red oak group.

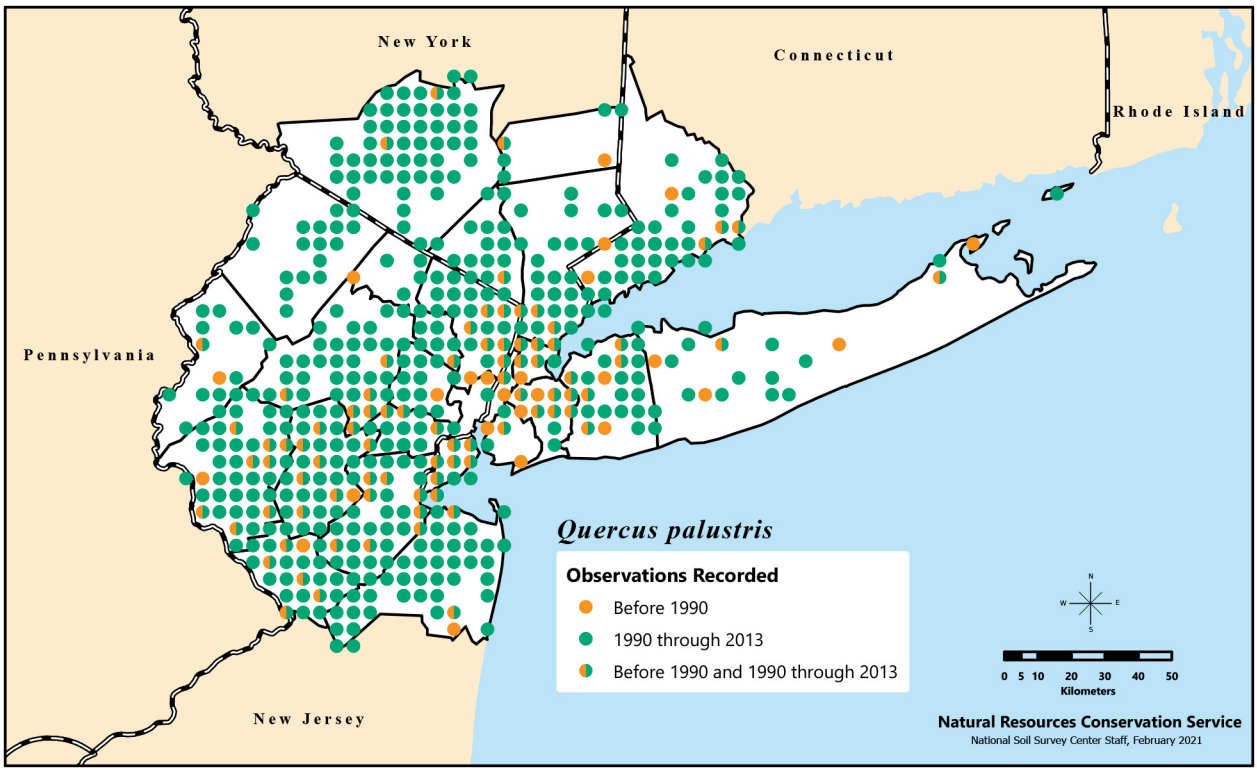
Earliest seed-bearing age around 20 years; acorn masts every 1–2 years (Bonner 2008n). Cold stratification for 30–45 days required for germination (Dirr 1998). Cultivated since 1770 (Bonner 2008n), with at least 3 cultivars (Dirr 1998). Though *Q. palustris* is tolerant of floods, flooding in the growing season shows evidence of reducing its reproductive fitness (fewer flowers produced, and previous year immature fruit abort) (Black 1984). Known for invading abandoned agricultural fields (Meiners et al. 2000), which may explain some of the increase noted in the region. Street and landscape plantings may also be a factor. Susceptible to galls (Dirr 1998).

11. *Quercus phellos* L. – willow oak ↑

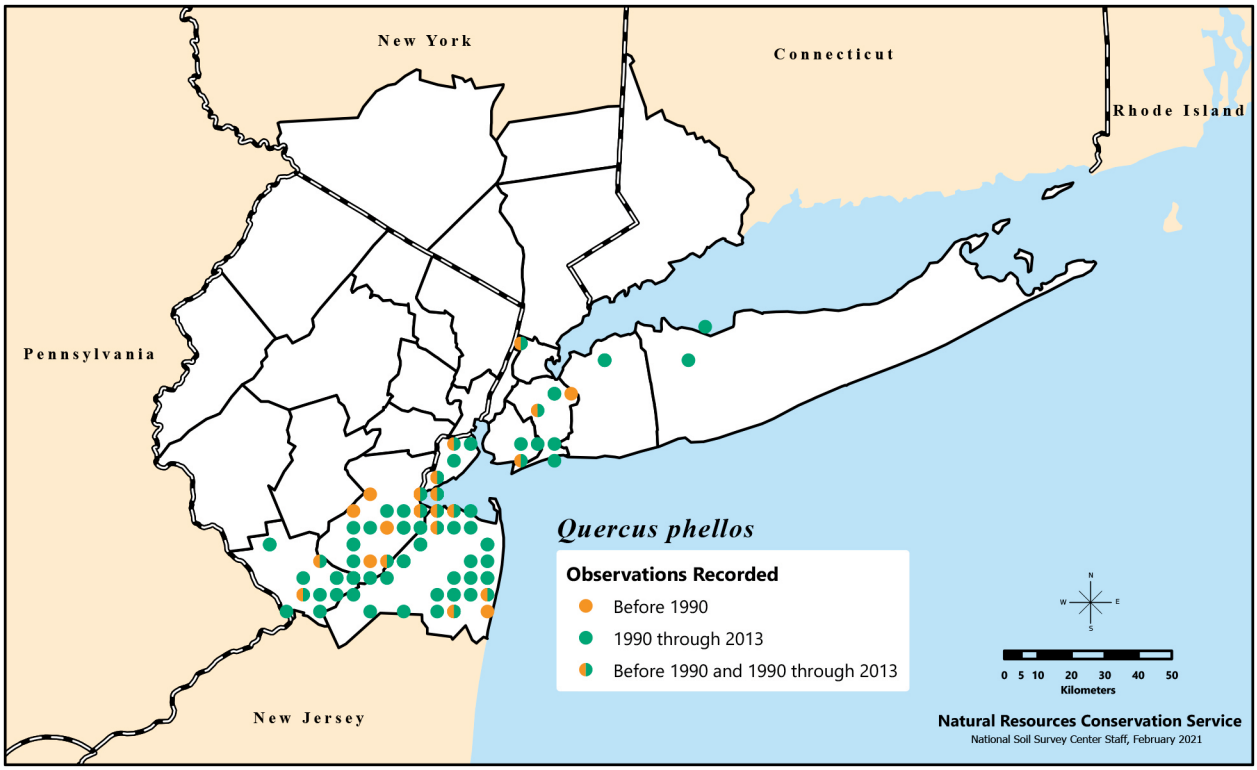
Tree. Flowering late Apr.–late May; fruiting in fall of the next year. Occurs usually in mesic woods and floodplains, and occasionally in poorly drained upland areas. *Quercus phellos* prefers mesic bottomlands, floodplains, slopes, and uplands (Dirr 1998). Epithet is the Greek name for the cork oak, *Q. suber* L. Red oak group.

Earliest seed-bearing age 20 years; bears seed annually. Cold stratification for 30–90 days required for germination (Bonner 2008n). Among the easiest of the oak species to root from cuttings (Dirr 1998). Cultivated since 1723 (Bonner 2008n), with at least 1 cultivar (Dirr 1998). Increases are most likely landscape plantings.

Listed as endangered in NY (S1), where it reaches the northern limit of its range, although some material from there may represent escapes from cultivation.



Distribution of *Quercus palustris*, or pin oak, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Quercus phellos*, or willow oak, recorded in the New York Metropolitan Region during three time categories.

12. *Quercus prinoides* Willd. – dwarf chestnut oak ↔

Shrub. Flowering early May–mid-June; fruiting in fall of the same year. Occurs on mesic to dry well-drained sandy and rocky substrates of scrublands, barrens, mountain balds and ridges, and roadside banks. Epithet refers to the similarity of the leaves to those of *Q. prinus* L. (a rejected name; see *Q. montana*). White oak group.

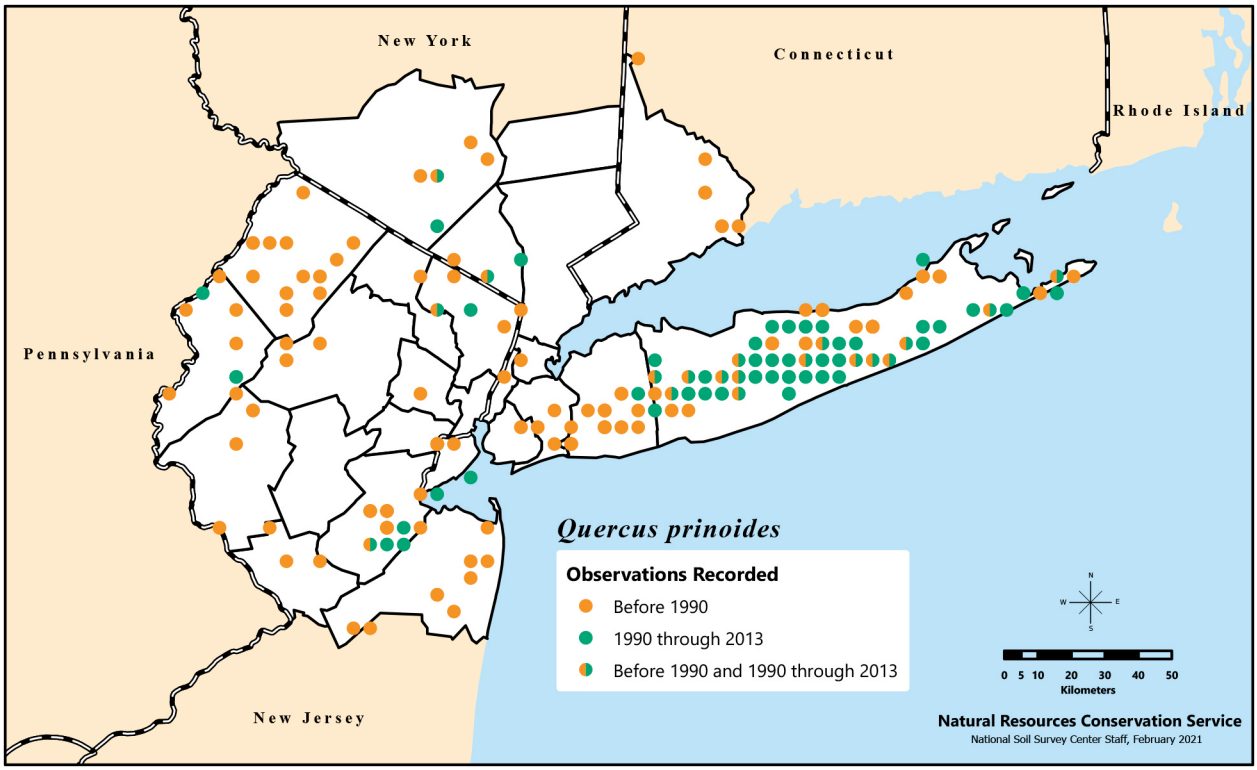
Although this species appears not to be extensively cultivated, it is possible to purchase this species from several online companies, which suggests it has been under cultivation for some years. Loss of mountain balds and barrens in the region may explain the decrease in abundance of this species (Bried et al. 2014). in the region's interior; there are gains in Suffolk County (NY).

13. *Quercus rubra* L. – northern red oak ↑↑

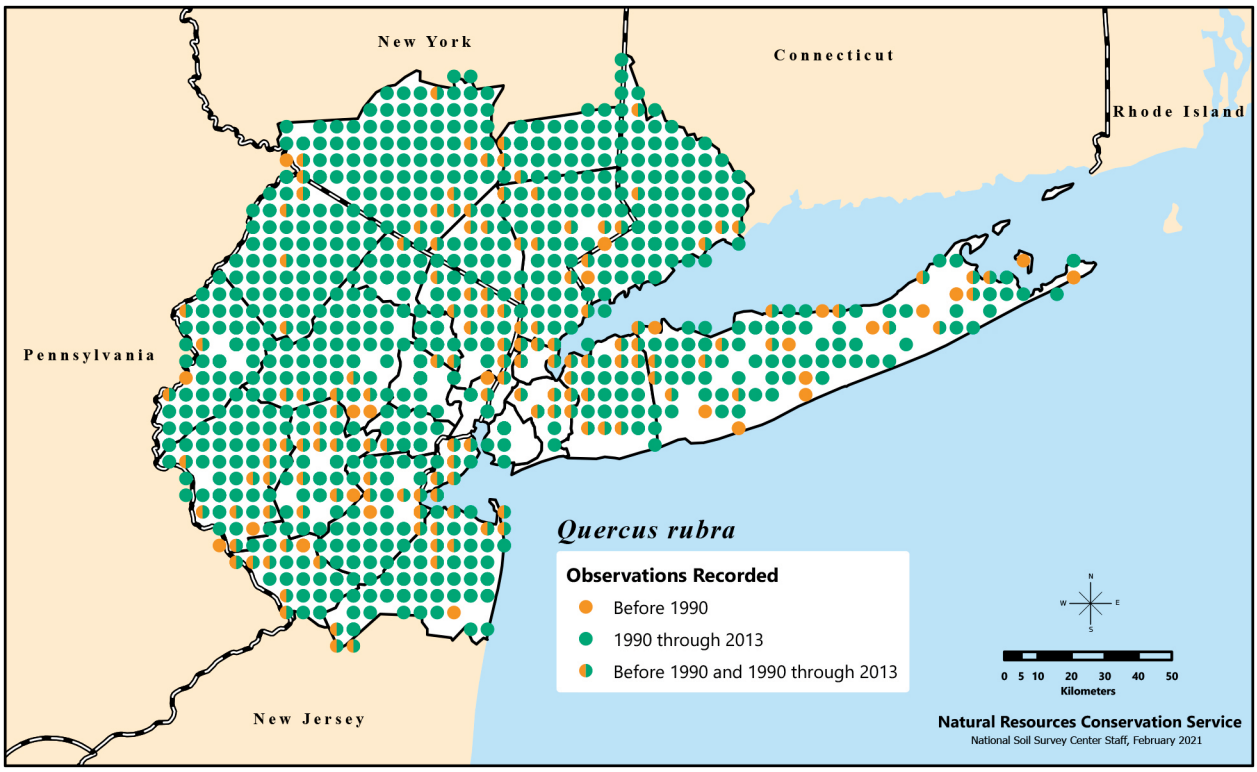
Tree. Flowering late Apr.–late May; fruiting in fall of the next year. Usually occurs on mesic to dry well-drained substrates of woods, slopes, and roadsides. Prefers well-drained sandy loam soils that are somewhat acidic, but is not drought-tolerant; often associated with more mesic sites (Dirr 1998). Red oak group.

Earliest seed-bearing age 25 years; acorn masts every 3–5 years. Cold stratification for 30–45 days required for germination. Among the best studied eastern native oak species. Its decline has been attributed to a lack of fire, a lack of general disturbance that provides added light, and deer (*Odocoileus* spp.) herbivory. Spongy moth (*Lymantria dispar*) is another factor that has impacted this species more than other oak species, because of *Q. rubra*'s dominance and wide distribution. Height at maturity 20–30 m (Sander 1990). Cultivated since 1724 (Bonner 2008n),

P Q



Distribution of *Quercus prinoides*, or dwarf chestnut oak, recorded in the New York Metropolitan Region during three time categories.



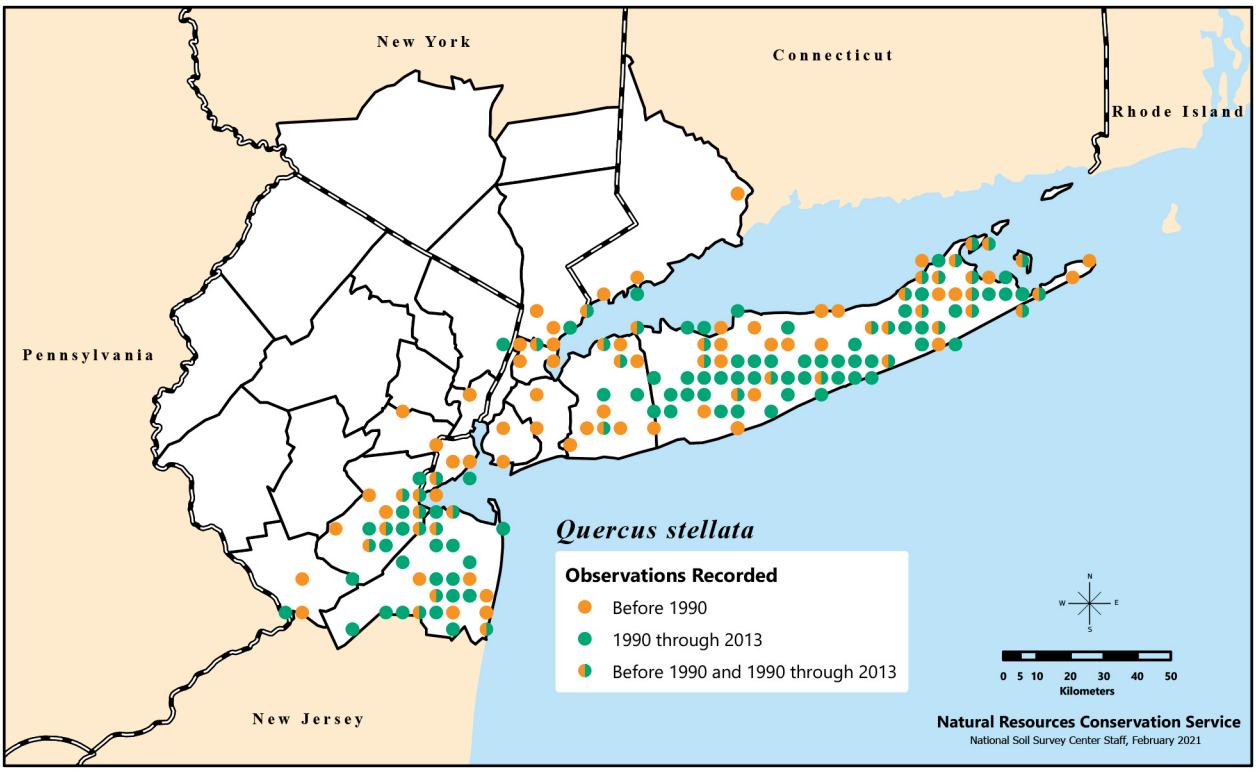
Distribution of *Quercus rubra*, or northern red oak, recorded in the New York Metropolitan Region during three time categories.

with at least 2 cultivars. Easily transplanted due to a relatively negligible tap root (Dirr 1998). The type of mycorrhizal infection (endomycorrhizal or ectomycorrhizal) on *Q. rubra* depends on its neighbors. If *Q. rubra* is more closely associated with *Acer rubrum*, it is more likely to develop vesicular-arbuscular mycorrhizal [VAM] infections; if it is more closely associated with *Q. montana*, ectomycorrhizal infections will dominate. No evidence of any benefits of the VAM infections on *Q. rubra* (Dickie et al. 2001). If future research confirms there are no benefits for *Q. rubra*, it could suggest that the increasing *A. rubrum* populations could also be a factor in *Q. rubra*'s decline. Extensive research has been conducted on oak regeneration using combined harvesting (e.g., shelterwoods) and prescribed fire methods; most of this research has focused on *Q. rubra* (Brose 2010, Brose et al. 1999). Much of this research has highlighted the need to control deer herbivory in order to improve any chance of regaining lost oak stock (Miller et al. 2004, Oswalt et al. 2006). In addition to the 2 hybrids found in the region (see Note on Oak Hybrids), *Q. rubra* also hybridizes with *Q. ilicifolia* (*Q.* ×*fernaldii* (*Q.* ×*lowellii* Sarg., nomen nudum)) and *Q. palustris* (*Q.* ×*richteri*) (Gleason and Cronquist 1993). Increases in this species may be due to reforestation.

14. *Quercus stellata* Wang. – post oak ↔

Tree. Flowering in May; fruiting in fall of the same year. Usually occurs on dry substrates of fields, barrens, ridges, and woods. Typically found on dry sandy, rocky soils (Dirr 1998). Epithet from Latin refers to the stellate (star-shaped) hairs that occur on the leaf undersides. White oak group.

Earliest seed-bearing age 25 years; acorn masts every 2–3 years. Cold stratification not required for germination (Bonner 2008n). Height at maturity 18 m (Bonner 2008n). Cultivated since 1819, but seldom used as a landscape plant (Dirr 1998). Like *Q. marilandica*, more likely to sprout under more stressful xeric conditions (Clark and Hallgren 2003).



Distribution of *Quercus stellata*, or post oak, recorded in the New York Metropolitan Region during three time categories.

P Q

15. *Quercus velutina* Lam. – black oak ↑↑

Tree. Flowering early May–early June; fruiting in fall of the next year. Usually occurs on mesic to dry, well-drained substrates of barrens, woods, slopes, ridges, and roadsides. Prefers moist, rich, well-drained soils, but is most often found on poor, dry, sandy or clay soils (Dirr 1998). Epithet from Latin means "velvety," a reference to the pubescence on the buds and young leaves. Red oak group.

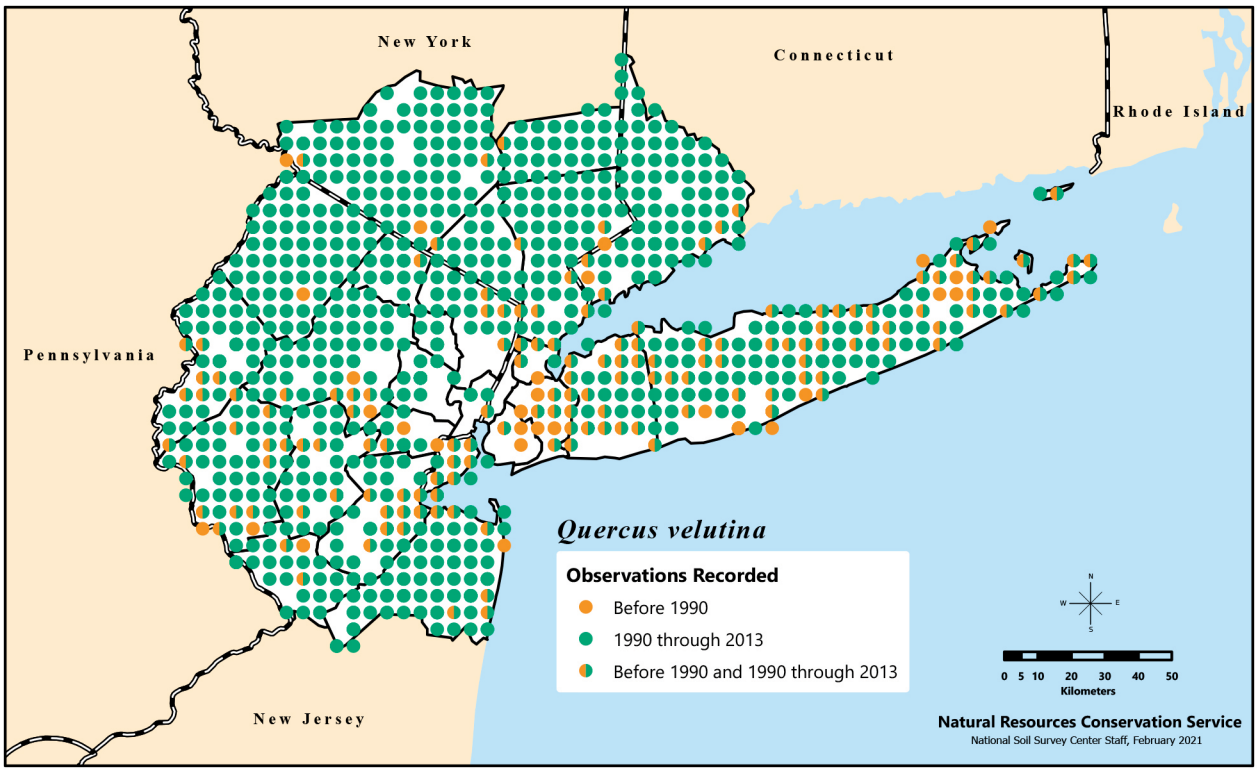
Earliest seed-bearing age 20 years; acorn masts every 2–3 years. Cold stratification for 30–60 days required for germination. Height at maturity 27 m. First cultivated in 1905 (Bonner 2008n), but not a popular landscape tree because it is difficult to transplant due to an extensive tap root (Dirr 1998). Increases may be due to reforestation.

Nonnative Species

Quercus acutissima Carruthers – sawtooth oak

Flowering Mar.–Apr. Native to China, the Himalayas, Japan, and Korea. Introduced into the U.S. in 1862 (Dirr 1998).Planted in the region but not yet reported to escape. It has been observed escaping outside of the region in southern NJ, as well as DE (William McAvoy, DE Natural Heritage Program, pers. comm., 2021), MD (Knapp and Naczi 2021), and PA (Rhoads and Block 2007). This species has leaf undersides without tufts of spreading hairs along midvein and with scaly bark or deeply ridged and furrowed bark, appearing corky, as well as lanceolate leaves and acorn cups with prolonged and long-tapered scales. Epithet from Latin means "very sharp," a reference to the serrate margins of the leaf.

Earliest fruit-bearing age 5 years. Cold stratification not required for germination (Bonner 2008n). Like *Quercus velutina*, it has biennial fruit maturation; it takes about 13 months between pollination and fertilization (Borgardt and Nixon 2003). Nonetheless, acorn



Distribution of *Quercus velutina*, or black oak, recorded in the New York Metropolitan Region during three time categories.

production is prolific (Dirr 1998). Thus has intermediate characteristics of the white and red oak groups (Borgardt and Nixon 2013). Height at maturity 15 m. This species has several insect herbivores (leaf miners), but mortality caused by these herbivores is unlikely because parasitoids associated with a number of native oaks also prey on the herbivores (Auerbach and Simberloff 1988). Recommendations to plant this tree in urban areas still exist (Arbor Day Foundation 2020; McMullen, n.d.). *Quercus acutissima*'s invasive behavior has been most evident in the Southeast, suggesting that it may grow more rapidly in warmer climates. Prefers acidic soils, but can grow in a variety of habitats. At least 2 known cultivars (Dirr 1998). This species forms associations with arbuscular mycorrhizae (Wu et al. 2002). The fungal pathogen *Raffaelea quercivora* is known to infect *Q. acutissima* and cause mortality in its native range in Japan. However, mortality rates are much less severe compared with other deciduous oak species native to the region (Murata et al. 2005). This species, grown in AL, benefits from being enclosed in a tree shelter, showing 95 percent survival compared to 46 percent survival of unsheltered trees; survival rates are similar to or better than those of native oaks also tested (West et al. 1999). This suggests that *Q. acutissima* may suffer from deer and wildlife browse much like native oak species. The distribution of *Q. acutissima* in Monsoon Asia (which includes Bangladesh, China, India, Indonesia, Japan, and Pakistan) has been associated with fire (Nakashizuka and Iida 1995).

Quercus imbricaria Michx. – shingle oak

Native to the eastern and central U.S.; much more common west of the Appalachian Mountains. Only known local native population is in southern NJ in Gloucester County (Snyder 1994). All reports from the region in NJ and NY are based on misidentified material or are cultivated remnants. Epithet from Latin means "overlapping," a reference not to anything imbricate on the plant, but rather to the use of the wood for making shingles as observed by Michaux (1803) in 1801 when he described the species. Red oak group.

Listed as endangered in NJ (S1.1).

16. *Quercus robur* L. – English oak Ø

Flowering in May. Native to northern Africa, Europe, and western Asia. Planted as an ornamental and street tree. Rarely found naturalized in the region; possible or likely naturalized populations reported from Orange, Queens, Rockland, and Suffolk Counties (NY). Prefers well-drained soils. Epithet is the ancient Latin name for the species. White oak group,

Earliest seed-bearing age 20 years; acorn masts every 2–4 years. Cold stratification not required for germination (Bonner 2008n). Height at maturity 34 m. Trees and saplings have a low tolerance of shade but a high tolerance of drought. Seedlings are tolerant of both shade and drought (van Hees 1997), but only for the first year, when they apparently are aided by seed resources. For subsequent growth to occur after the first year, light must increase to as much as 43 percent of full sunlight. Seedlings grown in shade can acclimate easily to higher light conditions; however, seedlings grown in high light do not acclimate well to low light conditions (Valladares et al. 2002, Welander and Ottoson 1998). Acorns of this species showed improved germination after being flooded for up to 12 weeks. Seedlings also survived after 12 weeks of flooding but showed a significant reduction in growth (Kühne and Bartsch 2007). Long cultivated (Bonner 2008n), with at least 14 cultivars. Hybrids that are crosses between the 'Fastigiata' cultivar and *Quercus bicolor* and *Q. montana* have been documented. Easily transplanted. Its habit, hardiness, and growth are not superior to many native oaks, though the 'Fastigiata' cultivar may be considered a reasonable substitution in the region (but *Q. phellos* still performs better). This species as well as the 'Fastigiata' cultivar suffer from mildew. However, hybrids with the 'Fastigiata' cultivar show some resistance to mildew (Dirr 1998). Such hybrids may be of concern, if they increase in number and begin to spread. *Quercus robur* is considered a pioneer species in its native range (Petit et al. 2003).

Note on Oak Hybrids

Some oak species may hybridize using cytoplasmic sharing, especially between sympatric species. Cytoplasmic sharing results when cytoplasmic DNA is exchanged, but nuclear DNA is not, and this is done via pollen swamping (overwhelming with pollen such that traits migrate between species without colonization by seed). Because most hybrids and their offspring are male sterile, they transmit cytoplasmic DNA without diffusing too many nuclear genes. This process is documented between *Q. robur* and *Q. petraea*, both native to Europe and found commonly in mixed stands. The result is a hybrid with traits of both species that has migrated via pollen swamping, bypassing colonization by seed. Thus, oaks (or at least characteristics of those oak species) may invade new areas using pollen alone (Petit et al. 2003).

The following hybrids have been reported from the region; they share intermediate characteristics of their parents (Allard 1932, 1942, 1949; Britton 1882; Burk 1965; Cooperrider 1957; Davis 1892a, 1892b, 1892c, 1905, 1914; Hardin 1975; Knops and Jensen 1980; Ledig et al. 1969; MacDougal 1907; Rehder 1901; Silliman and Leisner 1958; Stebbins et al. 1947; Vasey 1883) unless otherwise noted.

Quercus ×*brittonii* W.T.Davis (*Q. ilicifolia* × *Q. marilandica*): Epithet honors Nathaniel Lord Britton (1859–1934), noted NYC botanist and first director of the New York Botanical Garden; frequent.

Quercus ×*bushii* Sarg. (*Q. marilandica* × *Q. velutina*): Epithet honors Benjamin Franklin Bush (1858–1937), Missouri botanist and ornithologist who studied the flora of Jackson County, MO for much of his life; frequent.

Quercus ×*faxonii* Trel. (*Q. alba* × *Q. prinoides*) (Gleason and Cronquist 1993): Epithet honors Charles Edward Faxon (1864–1918), botanical illustrator and instructor at Harvard University's Bussey Institution; one historical record (Hardin 1975).

Quercus ×*filialis* Little (*Q. phellos* × *Q. velutina*): Epithet refers to the original material being from the filial generation of the cross between the parent species. Leaves are tomentose abaxially and often appear linear to narrowly elliptic (length-to-width ratio 6:1; blades usually wider than those of *Q. phellos*) with two or more small teeth (Little 1943, Palmer and Steyermark 1935); frequent.

Quercus ×*giffordii* Trel. (*Q. ilicifolia* × *Q. phellos*): Epithet honors botanist John Clayton Gifford (1870–1949), forester from Cornell University and advocate of "reclaiming" the Florida Everglades through the planting of nonnative trees, like the invasive punktree (*Melaleuca quinquenervia* (Cav.) S.F. Blake), that would absorb the water; infrequent.

Quercus ×*heterophylla* Michx. (*Q. phellos* × *Q. rubra*) (Gleason and Cronquist 1993): Epithet from Greek means "various-leaved." Leaves are essentially glabrous and often appear linear to narrowly elliptic (length-to-width ratio 6:1; blades usually wider than those of *Q. phellos*) with two or more small teeth (Andresen 1956; Davis 1922, 1929; Hollick 1920; MacDougal 1907; Martindale 1880; Meehan 1875; Sargent 1918); frequent.

Quercus ×*jackiana* Schneid. (*Q. alba* × *Q. bicolor*): Epithet honors John George Jack (1861–1949), noted dendrologist with Harvard University's Arnold Arboretum; infrequent.

Quercus ×*porteri* Trel. (*Q. hawkinsiae* Sudw.) (*Q. rubra* × *Q. velutina*) (Gleason and Cronquist 1993): Epithet honors Mrs. Eugene Hawkins, who discovered the hybrid on her property in Carroll County, TN in 1912; infrequent.

Quercus ×*rehderi* Trel. (*Q. ilicifolia* × *Q. velutina*): Epithet honors Alfred Rehder (1863–1949), noted botanist and horticulturist with the Arnold Arboretum; infrequent.

Quercus ×*robbinsii* Trel. (*Q. coccinea* × *Q. ilicifolia*): Epithet honors American botanist and physician James Watson Robbins (1801–1879); one record from Staten Island.

Quercus ×*rudkinii* Britton (*Q. marilandica* × *Q. phellos*): Epithet honors William Henry Rudkin (1836–1896), New York City businessman and early, active member of the Torrey Botanical Club (Allard 1942, Britton 1882, Burk 1965, MacDougal 1907, Stebbins et al. 1947); frequent.

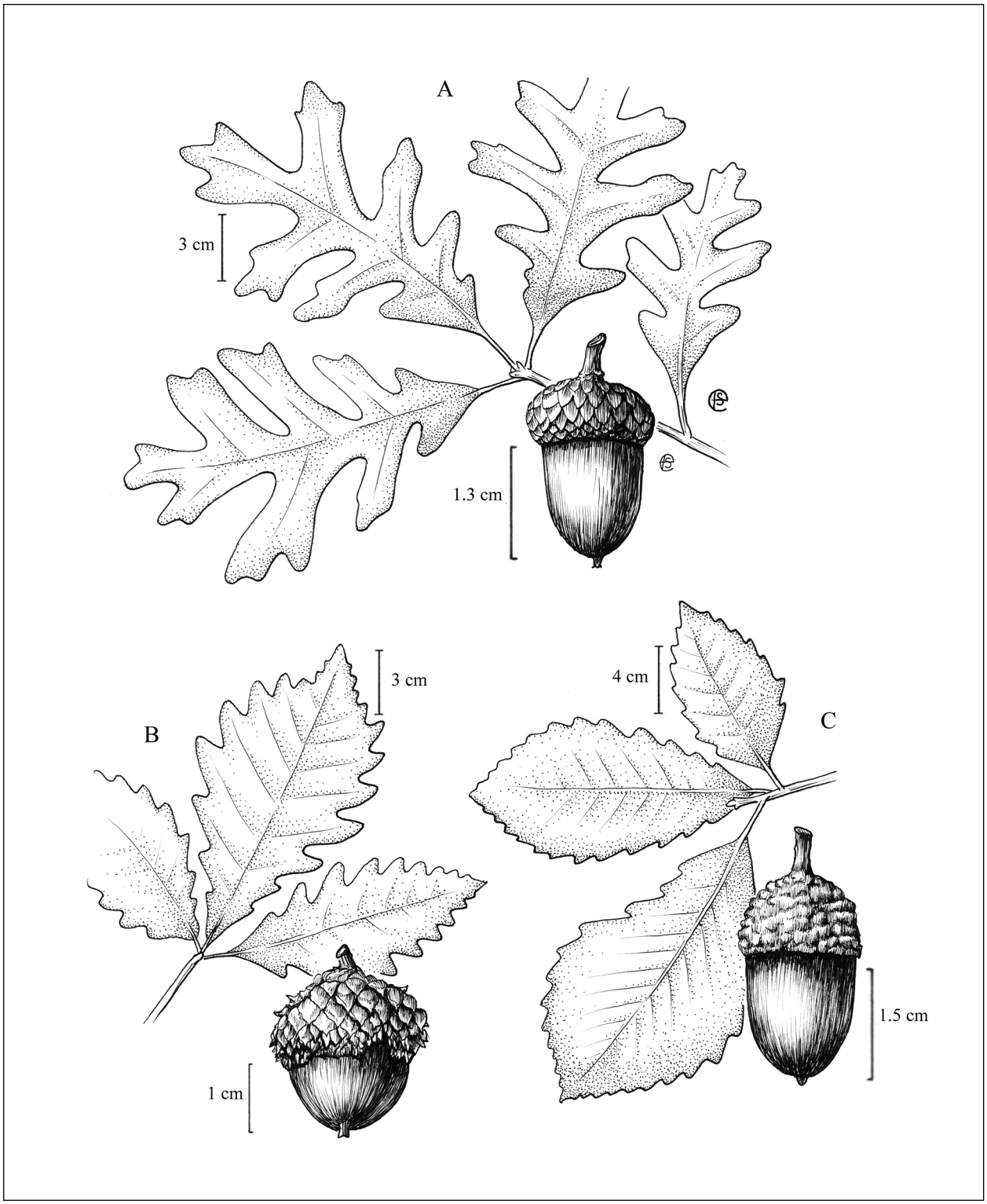
Quercus ×*saulii* Schneid. (*Q. alba* × *Q. montana*): Epithet honors American horticulturist John Saul (1819–1897) (Allard 1932, 1949; Hardin 1975; Ledig et al. 1969; Silliman and Leisner 1958; Vasey 1883); frequent.

Management

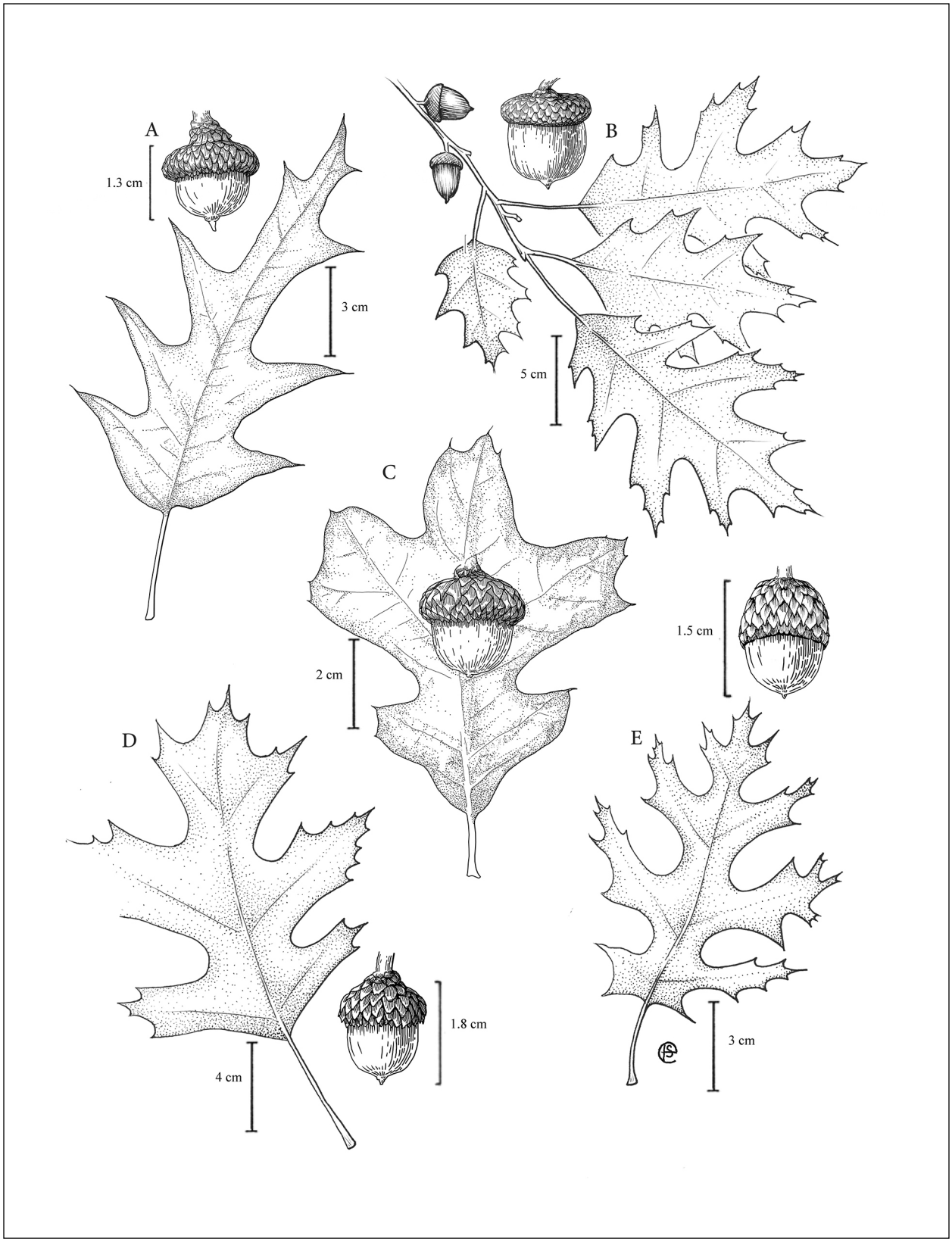
Oak wilt, caused by *Ceratocystis fagacearum*, is a serious disease especially within *Quercus* Sect. *Lobatae*. First detected in NY in 2008 and spreading. For a detailed overview of management options and their efficacy see Koch et al. (2010). Sudden oak death, caused by the fungus *Phytophthora ramorum*, is a destructive disease that first appeared in the western U.S. in 1995 and is spreading. This disease poses a serious threat, especially to *Quercus* Sect. *Lobatae* in forests of the eastern U.S. if the pathogen is able to establish and spread in this region (Haller and Wimberly 2020). The occurrence of *P. ramorum* should continue to be monitored, especially in nursery stock, including other host species such as *Rhododendron* spp. In addition to many of the region's oak species such as *Q. rubra*, several native species have been shown to be susceptible to *P. ramorum* (Linderman et al. 2007). Management of commercially important oaks, such as *Q. rubra*, remains a concern for many land managers. Deer exclusion and the use of harvesting techniques followed by fire are often required to keep the canopy open and competition low until the oak trees grow above the browse line.

Because the region has several native *Quercus* spp. and the currently planted nonnative oak species appear to share some of the same pathogens (e.g., mildew), herbivores (e.g., deer and leaf miners), and climatic limitations (e.g., shade-intolerance and slow growth, at least in colder climates for *Q. acutissima*), the threat of invasion may be considered relatively small compared to some other nonnative woody species. Cessation of planting these species as urban street, parking lot, and park trees may be enough to thwart the spread of the current populations. However, the abundant acorn production of *Q. acutissima* should not be ignored. If removal of this species is a viable option, we suggest doing so. Further, if hybrids between either species become increasingly common, we suggest removal of *Q. acutissima* and *Q. robur*. Increased knowledge about the distribution of *Q. robur* cultivars is likely to be useful information, especially if hybridization becomes prevalent. It will also be useful to document any patterns of mast years for both species for the region to help in planning

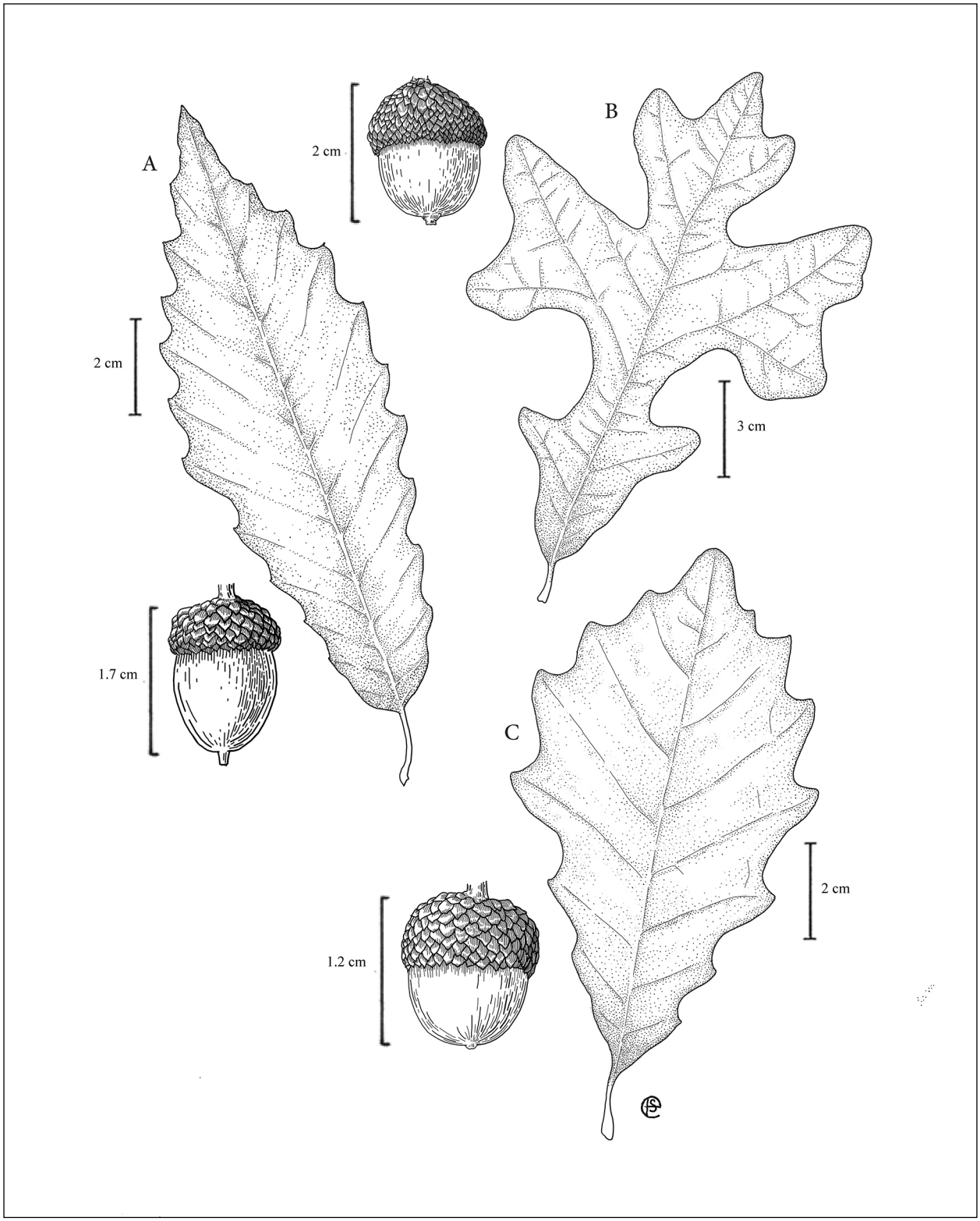
treatments or predicting when spread (via acorn dispersal) is most likely to occur. Like all oaks, *Q. acutissima* will resprout if cut, so application of a herbicide, such as glyphosate, is recommended.



Leafy twig and fruit (acorn) of A) *Quercus alba*, B) *Quercus bicolor*, and C) *Quercus montana*. Illustration by Emma Skurnick.



A) Fruit (acorn) and leaf of *Quercus falcata*; B) fruiting leafy twig with terminal bud, and acorn of *Quercus rubra*; and leaf and acorn of C) *Quercus ilicifolia*, D) *Quercus velutina*, and E) *Quercus coccinea*. Length of the acorn for *Q. ilicifolia* is 1 cm. Illustration by Emma Skurnick.



Fruit (acorn) and leaf of A) *Quercus muehlenbergii*, B) *Quercus stellata*, and C) *Quercus prinoides*. Illustration by Emma Skurnick.

P Q

Rhamnus L. – buckthorn

Rhamnaceae. Trees, shrubs. Species 70–100 in temperate and tropical Africa, Asia, Europe, and North America. Flowers pollinated by bees (order Hymenoptera) and flies (order Diptera); seeds most likely dispersed by birds. Occasionally grown for wood, dyes, and medicinal purposes. *Frangula* Mill. sometimes included in this genus; treated here as a separate genus. Genus name is the ancient Greek name for the group.

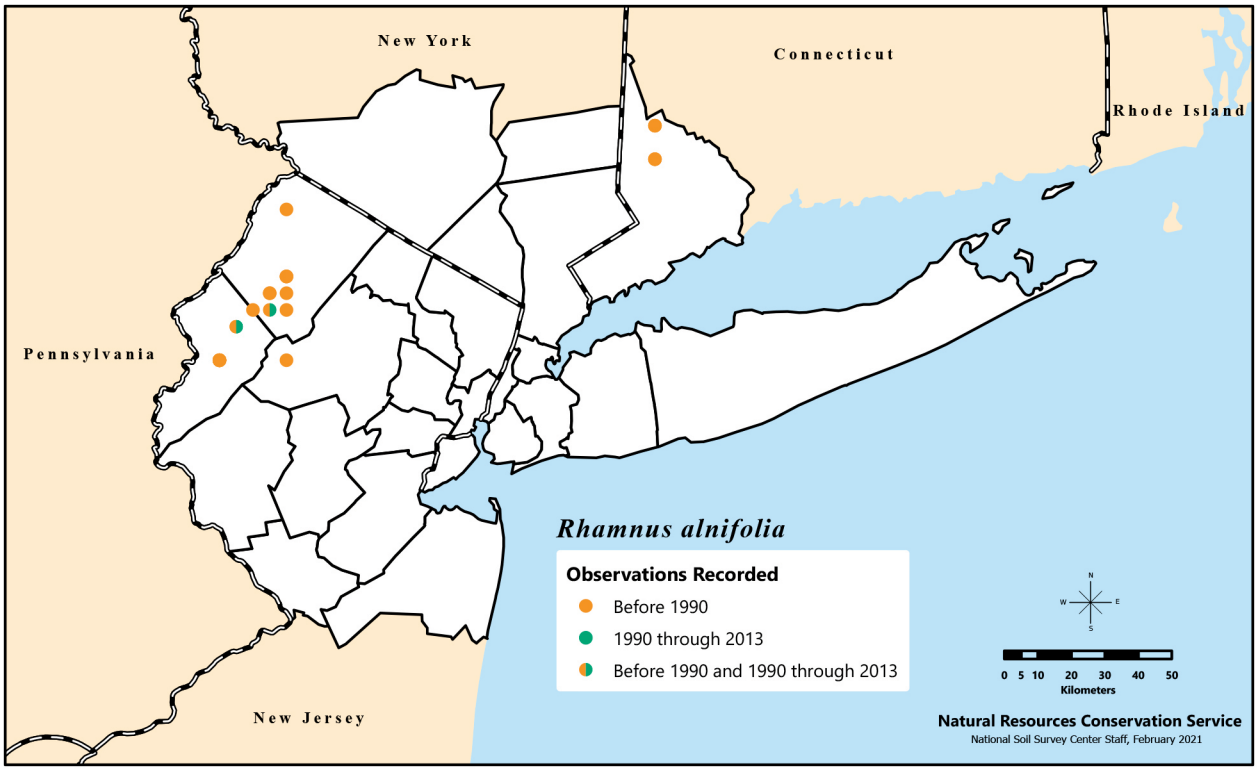
Native Species

1. *Rhamnus alnifolia* L'Her. – alder-leaf buckthorn ↓↓↓

Flowering May–June; fruiting July–Aug. Fens, swamps, and bogs (Gleason and Cronquist 1993); rarely in drier areas. Often on calcareous soils. A rare boreal, northern species (Locky et al. 2005) that is declining in the region. Epithet from Latin refers to the leaves' similarity to those of alder (*Alnus*).

Rhamnus Key

1. Twigs not spine-tipped; leaves alternate; 5 calyx lobes and stamens . . . . . ***Rhamnus alnifolia***
1. Twigs often spine-tipped; leaves mostly opposite or subopposite; 4 calyx lobes and stamens 2
2. Leaves papery, 3–7 cm long, length-to-width ratio 2:1 or less, with 3 (rarely 2 or 4) lateral veins on each side; fruit usually with 4 stones . . . . ***Rhamnus cathartica****
2. Leaves leathery, 6–13 cm long, usually with more than 3 lateral veins on each side; fruit with 2 stones . . . . . ***Rhamnus davurica****



Distribution of *Rhamnus alnifolia*, or alder-leaf buckthorn, recorded in the New York Metropolitan Region during three time categories.

Moist cold stratification for 90 days required to improve germination rates. Germination improves the longer the fruits remain on the mother plant, allowing for seed maturation. Does well in shady conditions (Sharma and Graves 2005). Can be propagated from softwood cuttings, with greater success using IBA (indole-3-butyric acid) treatments (Sharma and Graves 2005). An overwintering host to the soybean aphid (*Aphis glycines*) (Voegtlin et al. 2004). However, *Rhamnus cathartica* (a nonnative species described below) supports greater longevity and oviposition rates and, consequently, is probably a more important overwintering host than *R. alnifolia* (Yoo et al. 2005). The tissue of *R. alnifolia* contains emodin, a secondary compound that may inhibit some herbivory as well as protect plant tissue from high light levels. Possibly some allelopathic effects on adjacent plants (Izhaki 2002). Given that the two species share this secondary compound, they may share additional characteristics described next for *R. cathartica*. Additional research needed on the species. Decline may be because species is at the southernmost edge of its range.

Nonnative Species

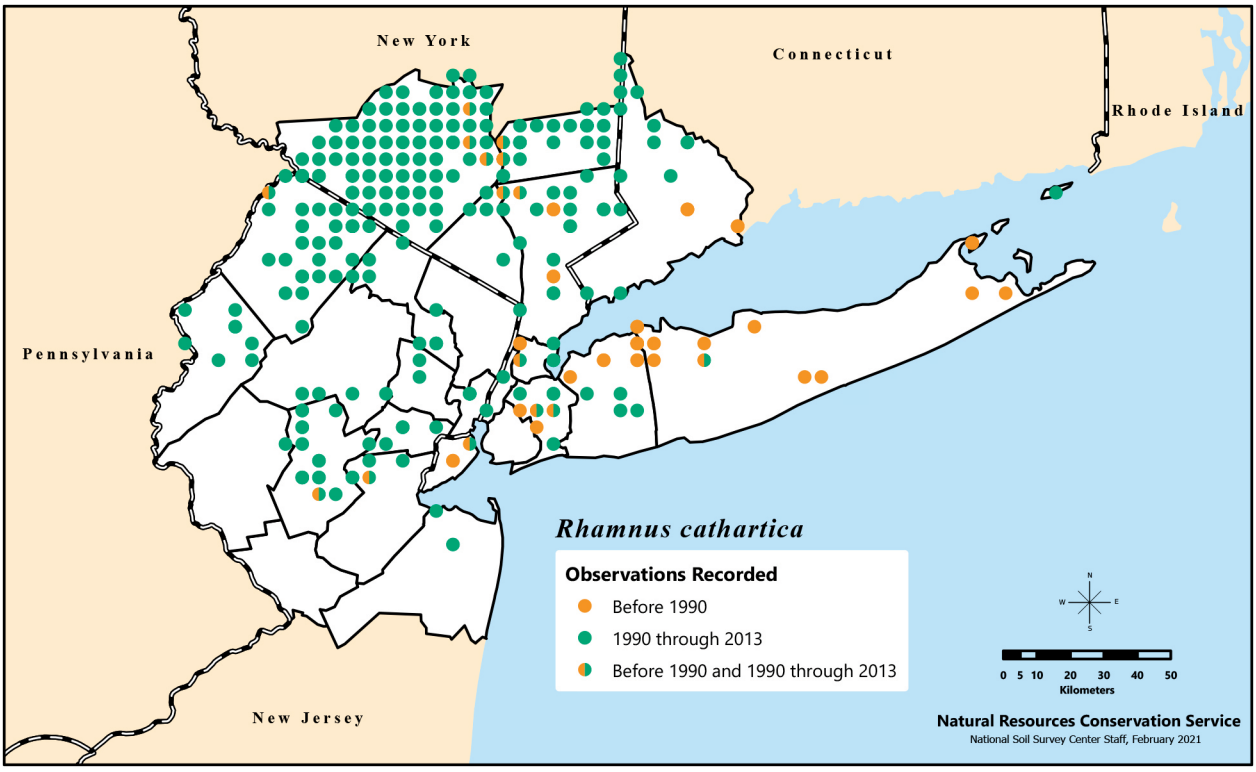
2. *Rhamnus cathartica* L. – common buckthorn ↑↑↑

Flowering May–early June; fruiting July–Oct. Native to northern Africa, Asia, and Europe. Found in the region in dry to mesic woodlands, woodland edges, pastures, and roadsides; often on calcareous soils (Dirr 1998).

First brought to the U.S. as a medicinal plant (used as a purgative, laxative, or cathartic) (Kurylo and Endress 2012) and then as an ornamental shrub in the early 1800s or earlier (Torrey 1824). Grows well in extreme environments, including urban areas (Dirr 1998). Prefers fertile, calcium-rich soils in open moist areas (Gourley 1985, Schulte et al. 2011), though it can tolerate both drought and partially flooded conditions (Glenz et al. 2006, Stewart and Graves 2004). Tolerates shady environments (Henry and Aarssen 2001), but grows faster and reproduces more prolifically in high-light areas (Gourley and Howell 1984, Harrington et al. 1989, Kurylo et al. 2007, McCay et al. 2009) with ample water (Gourley and Howell 1984). Indeed, one study showed low survival of seedlings transplanted in *Acer* (maple) forests in NY, relative to adjacent old fields and plantations (McCay and McCay 2009). Can survive growing under conspecifics depending on the light level; there are conditions where the light level appears to be too low to support *Rhamnus cathartica* seedlings and saplings (Gourley 1985, Knight et al. 2007).

Generally dioecious (Gleason and Cronquist 1993), with females greater in number than males (Godwin 1943), though sex ratios in North America have not been researched. Seed-bearing age as early as 4 years (Grubb et al. 1999), though no North American individuals have been reported to produce seed earlier than 9 years of age (Gourley 1985). Fruit dispersed by birds (Dirr 1998). However, 90 percent of seeds have been shown to fall below the parent plant, suggesting that birds do not prefer the fruit (Archibold et al. 1997) or they prefer native species (Shahid et al. 2009). Seeds more likely to be dispersed to old fields than forested areas; seed rain is closely correlated with abundance of seedlings, but not saplings (McCay et al. 2009), suggesting that survival into maturity under parent plants may be low. Rodents (order Rodentia) may also disperse the seed (if not consumed) (Godwin 1936). Moist cold stratification for 60–90 days required for germination; does not propagate well from cuttings (Dirr 1998). Seeds germinate only once the pulp is removed (Godwin 1943) and germinate best when fresh and not dried prior to planting (Godwin 1936). Passage through a bird's digestive tract (or treatment in acid for less than 15 minutes) may speed up germination by about 15 days (Gourley 1985). There is evidence of greater fecundity compared to at least one native species in the same family (Stewart and Graves 2006).

In a forest understory, *R. cathartica* takes on tree-like or more vertical architecture, whereas in open areas it grows as a shrub with a more horizontal architecture (Charles-Dominique 2012). This horizontal, compact architecture in open areas can be detrimental to birds or other animals that utilize the branches for nesting; these



Distribution of *Rhamnus cathartica*, or common buckthorn, recorded in the New York Metropolitan Region during three time categories.

branches tend to hang low to the ground, making the nests more susceptible to predation (Schmidt and Whelan 1999). Forms associations with vesicular arbuscular mycorrhizal fungi (Gourley 1985, Knight 2006), but unlike other members in its family, does not associate with *Frankia*, a nitrogen-fixing actinomycete (Knight et al. 2007). Suffers somewhat from leaf spots, rust, powdery mildews, aphids, and scale. Serves as an overwintering host to the oat crown rust (*Puccinea coronata*) and the soybean aphid (*Aphis glycines*) (Heimpel et al. 2010). The rust (Dirr 1998) and aphids may also impact nearby wheat (*Triticum aestivum*) and soybean (*Glycene max*) fields, respectively. Leaves open in the spring earlier than many native species (Barnes 1972). This early vernal budbreak is possible in part because of *R. cathartica*'s cold hardiness and tolerance to freezing (Stewart et al. 2006). Extended leaf longevity is a better explanation for *R. cathartica*'s persistence in understories; appears to benefit little in terms of carbon gain due to early leaf emergence in open habitats (Harrington et al. 1989). Growth and photosynthesis rates exceed those of at least one related native species (Stewart and Graves 2006). The tissue (leaves, fruit, and roots) contains emodin, a secondary compound that may inhibit some herbivory as well as protect plant tissue from high light levels.

Possibly some allelopathic effects on adjacent plants (Izhaki 2002). Soil from areas with *R. cathartica* had a negative effect on germination and growth of other plants, especially less common species (Klionsky et al. 2011). May experience less herbivory than associated native plants (Heneghan et al. 2006). Leaves (Kennedy 2000; Heneghan et al. 2002, 2004) and fruit (Sherburne 1972) are high in nitrogen and the leaves decompose rapidly compared with associated native species (Heneghan et al. 2002). Such additions of nitrogen to the soil may promote increased growth of species that can utilize it rapidly. High nutrient content of *R. cathartica* leaves may also promote earthworm (order Lumbriculida) invasions, which in turn

promote increased litter decomposition (Heneghan et al. 2007), and may lead to increased seedling establishment of *R. cathartica* and other invasive species (Bisikwa 2005). May hybridize with other *Rhamnus* spp., including *R. utilis* (originating from China) (Gil-ad and Reznicek 1997, Kurylo et al. 2007) and may be able to hybridize with North American natives or other related species invading North America, such as *Frangula alnus* (glossy buckthorn) (Culley and Stewart 2010).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as potentially invasive in NJ (category 2).

Rhamnus davurica Pall. – Dahurian buckthorn

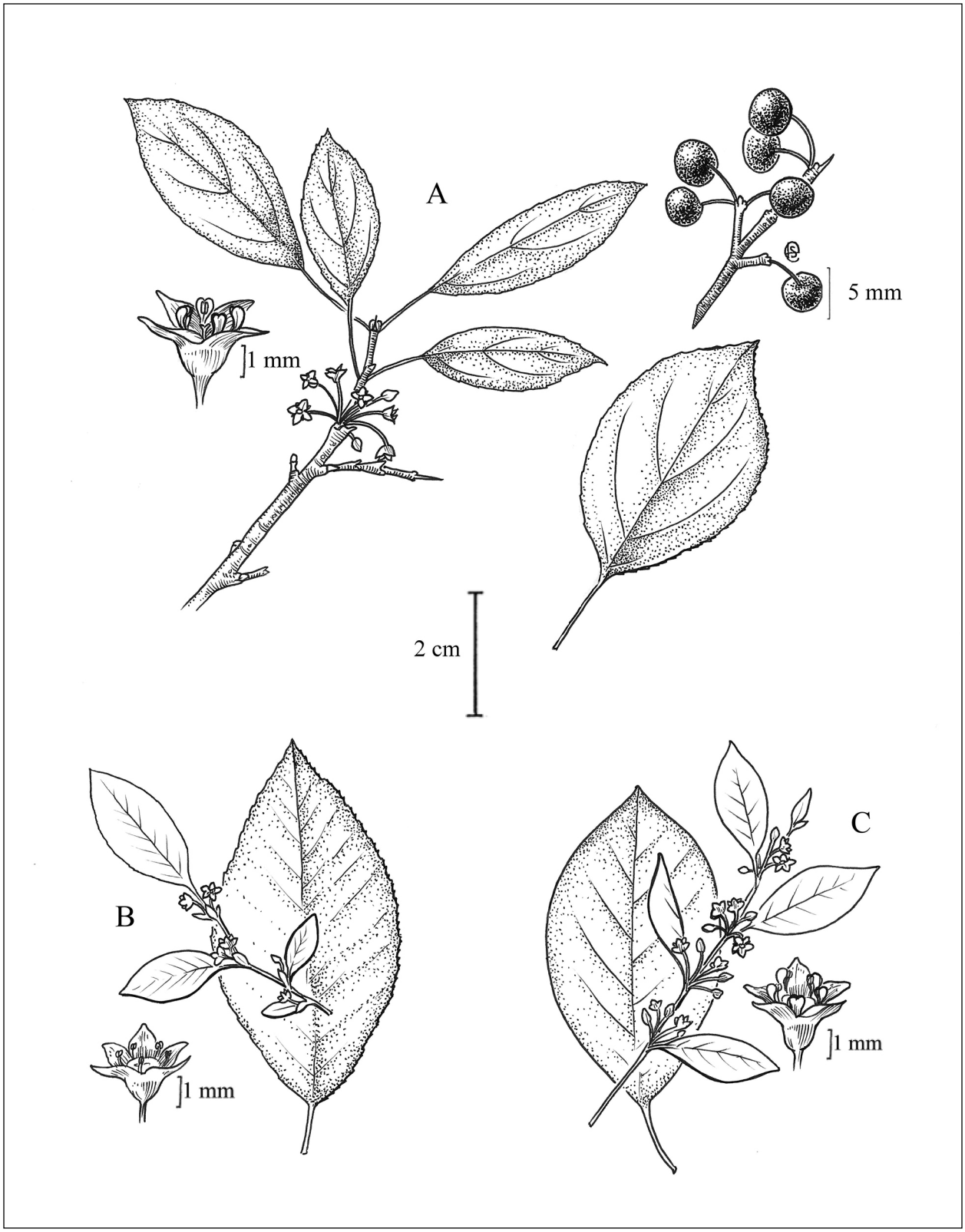
Flowering late Apr.–May; fruiting July–onward. One large population known from Somerset County (NJ). Reported from just outside the region in CT, PA, and NY (Nesom and Sawyer 2016). Native to China, Japan, Korea, and Mongolia. Introduced into the U.S. in 1817 (Dirr 1998), primarily RI (Youngblood 2008b). Epithet a latinization of Davuria (Dahuria, Dauria; also now known as Transbaikal), a region in Siberia, Russia that is in the native range of the species.

Rhamnus davurica is very similar to *R. cathartica* and possibly even more aggressive. Well adapted to extreme conditions. However, the reproductive success of this dioecious species, at least in its native region, is limited by pollen availability (Wang et al. 2013). Its availability for purchase appears to be limited (Dirr 1998), possibly because it is a primary host of the soybean aphid in its native regions (Kim et al. 2010). Nonetheless, there is no current APHIS pest risk assessment for this species.

Management

Planting of the rare native species is encouraged, especially in shady, wetter areas. However, its potential as a host for the soybean aphid makes it a less appealing ornamental in areas near soybean fields. There is no documentation of hybridization with the more prolific nonnative *Rhamnus* spp., such as *R. cathartica*, but one should be aware of the potential (Culley and Stewart 2010).

Rhamnus cathartica can be successfully removed by cutting the stem and spraying the stump with herbicides such as glyphosate or by direct basal bark spray application to the stem with triclopyr or similar herbicides. Both are effective, and the latter method saves on labor costs. Fall is the ideal time to apply herbicide (Delanoy and Archibold 2007). Others found that glyphosate, picloram, and imazapyr were more effective than triclopyr and that cutting followed by herbicide application or girdling a single stem with direct basal bark application of a multiple stemmed shrub resulted in the death of the entire shrub. Direct application of glyphosate or picloram to the bark is not advised, though it is possible for imazapyr (and triclopyr) (Pergams and Norton 2006). If funds are limited, focusing on female shrubs and trees could save some money and reduce seed production in subsequent years, especially if there are more female trees than males, as predicted by sites where sex ratios have been evaluated. Several potential biocontrol agents have been evaluated for *R. cathartica* and have been narrowed down to a few sap-sucking psyllids (*Trichochermes walkeri*, *Cacopsylla thamnicolla*, and *Trioza rhamni*) and the seed-feeding fly (*Wachtiella krumbholzi*). The pathogen *Phytoplasma rhamni* has been found in *T. walkeri*, which may be an additional biocontrol agent if *T. walkeri* can transmit this pathogen (Gassmann et al. 2011). However, more research is necessary before any test releases are possible. Proximity to wheat and soybean fields may make certain *R. cathartica* populations a priority. Until more information is known about *R. davurica*, we advise not planting this apparently aggressive species.



A) Flower, flowering leafy twig, leaf, and fruit of *Rhamnus cathartica*; flower, flowering leafy twig, and leaf of B) *Rhamnus alnifolia* and C) *Frangula alnus*. Illustration by Emma Skurnick.

Rhododendron L. – azalea, rhododendron

Azalea L.; *Ledum* L.; *Rhodora* L.

Ericaceae. Shrubs, small trees; rarely epiphytic, but only in Asia. Species 1,000+ in Asia, Australia (2), Europe (7), and North America (25). Flowers chiefly pollinated by bees (order Hymenoptera) and sometimes beetles (order Coleoptera), butterflies (order Lepidoptera), and flies (order Diptera). Many widely planted for their exceptionally showy flowers. Most require acidic soils. No seed dormancy, but seeds can be stored for at least 5 years if kept between -18 and 4 ºC (Blazich and Rowe 2008). Most species contain the neurotoxin grayanotoxin (named for American botanist Asa Gray [1810–1888] and also known as andromedotoxin), though often not at high levels; honey made from the pollen can be toxic, causing mad honey poisoning (Koca and Koca 2007). Local material falls into four readily distinguished groups: Labrador tea (only *R. groenlandicum*, formerly placed in the genus *Ledum*); rhodora (only *R. canadense*, formerly placed in the genus *Rhodora* L.), true rhododendrons (represented only by *R. maximum*), and azaleas (represented by the rest of the species). Genus name from the Greek "rhodon" and "dendron," meaning "rose tree."

Rhododendron Key

1. Leaves somewhat thick, margins smooth or revolute 2
1. Leaves papery, margins ciliate 3
2. Leaves with dense orange or white pubescence below; corolla deeply divided and appearing to have 5 separate petals; capsule opening from base upward. . . . . ***Rhododendron groenlandicum***
2. Leaves glabrous or slightly pubescent below; petals united, corolla campanulate; capsule opening from apex to base . . . . . ***Rhododendron maximum***
3. Floral bud scales few, soon falling off; corolla irregular, divided anteriorly nearly to the base; stamens 10; capsules glaucous-puberulent . . . . . ***Rhododendron canadense***
3. Floral bud scales numerous, imbricate, persistent during flowering; corolla more or less regular, funnelform; stamens 5; capsules setose 4
4. Stamens not exserted; corolla broadly funnelform . . . . . ***Rhododendron molle****
4. Stamens long exserted; corolla narrowly funnelform 5
5. Flowers appearing in mid-summer, after the leaves have expanded (essentially all of the leaves unfolded, and the vegetative bud scales absent) 6
5. Flowers appearing before or with the leaves (at least some of the leaves still folded or the vegetative bud scales still present 7
6. Sepals more than 1 mm long; pedicels puberulent and glandular . . . . . ***Rhododendron viscosum***
6. Sepals 1.6–3 mm long; pedicels glandular but not puberulent . . . . . ***Rhododendron arborescens***
7. Flowers yellow or orange. . . . . ***Rhododendron calendulaceum****
7. Flowers white to pink. 8
8. Floral bud scales glabrous; pedicels without short pubescence and long hairs, usually only with long hairs; leaves glabrous or only sparsely unicellular-pubescent . . . . . ***Rhododendron periclymenoides***
8. Floral bud scales densely covered with unicellular hairs; pedicels with both short pubescence and long hairs; leaves abaxially moderately to densely covered with unicellular hairs . . . . . ***Rhododendron prinophyllum***

Native Species

Rhododendron arborescens (Pursh) Torr. – smooth azalea

Azalea arborescens Pursh

Reports from the region likely errors (see Weldy et al. 2020). Native farther south, reaching northern limit of range in PA.

1. *Rhododendron canadense* (L.) Torr. – rhodora ↓↓↓

Rhodora canadensis L.

Flowering May. Cool bogs and pine swamps; occasionally dry banks in soils. Extremely rare in the region; a northern, high-elevation (Karlin and Lynn 1988) species, reaching the southern limits of its range. May be decreasing because it is at the southernmost edge of its range, suggesting climate change may play a role.

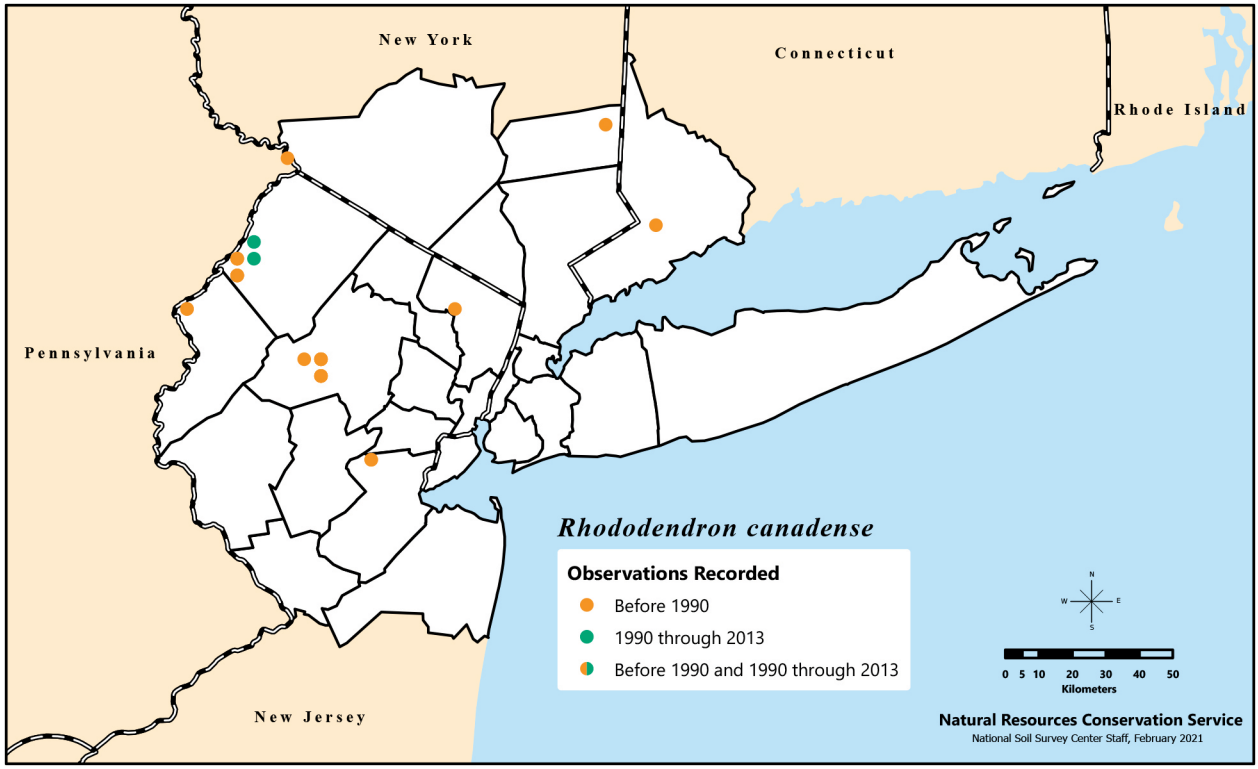
Listed as endangered in NJ (S1) and threatened in NY (S2).

2. *Rhododendron groenlandicum* (Oeder) Kron & Judd – Labrador tea Ø

Ledum groenlandicum Oeder

Flowering late May–June. Open sphagnum bogs and larch swamps; occasionally in closed coniferous forests of high humidity. Leaves once used to make a tea; still popular with the Cree Nation native people of Quebec (Leduc et al. 2006). Evergreen (Gleason and Cronquist 1993). Long thought to be extirpated from the region; was rediscovered in 2000 (Glenn 2001) in Sussex County (NJ); also historically reported from Morris County (NJ), the last record being from 1958. Epithet is a latinization of the name Greenland, from which the species was reported in early records.

Listed as endangered in NJ (S1) and threatened in CT (S2).



Distribution of *Rhododendron canadense*, or rhodora, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Westchester County (NY).

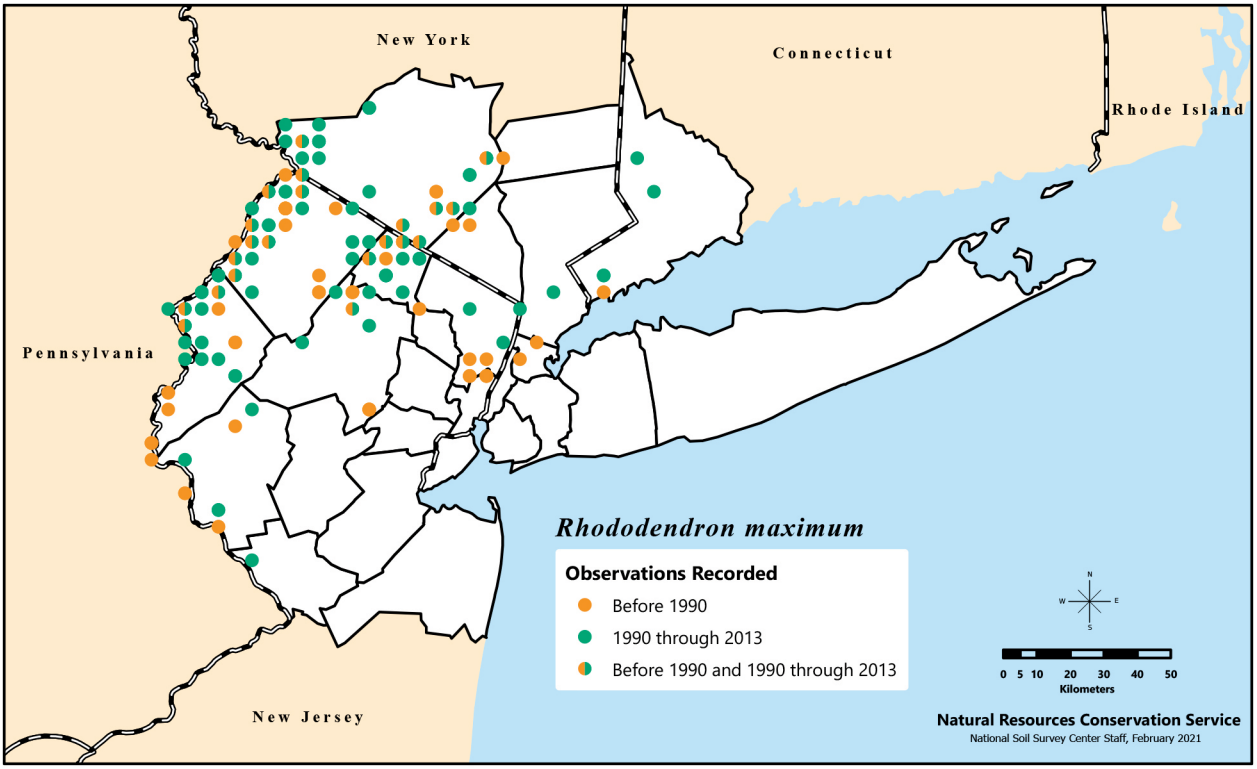
3. *Rhododendron maximum* L. – great laurel, rosebay ↔

Flowering late May–July. Mesic woods, and swamps. Rare on the Coastal Plain. Evergreen. An invasive native species that can prevent forest regeneration in some eastern forests, especially in acidic soils (Nilsen et al. 2001). Cultivated since 1736, with at least 6 cultivars (Dirr 1998).

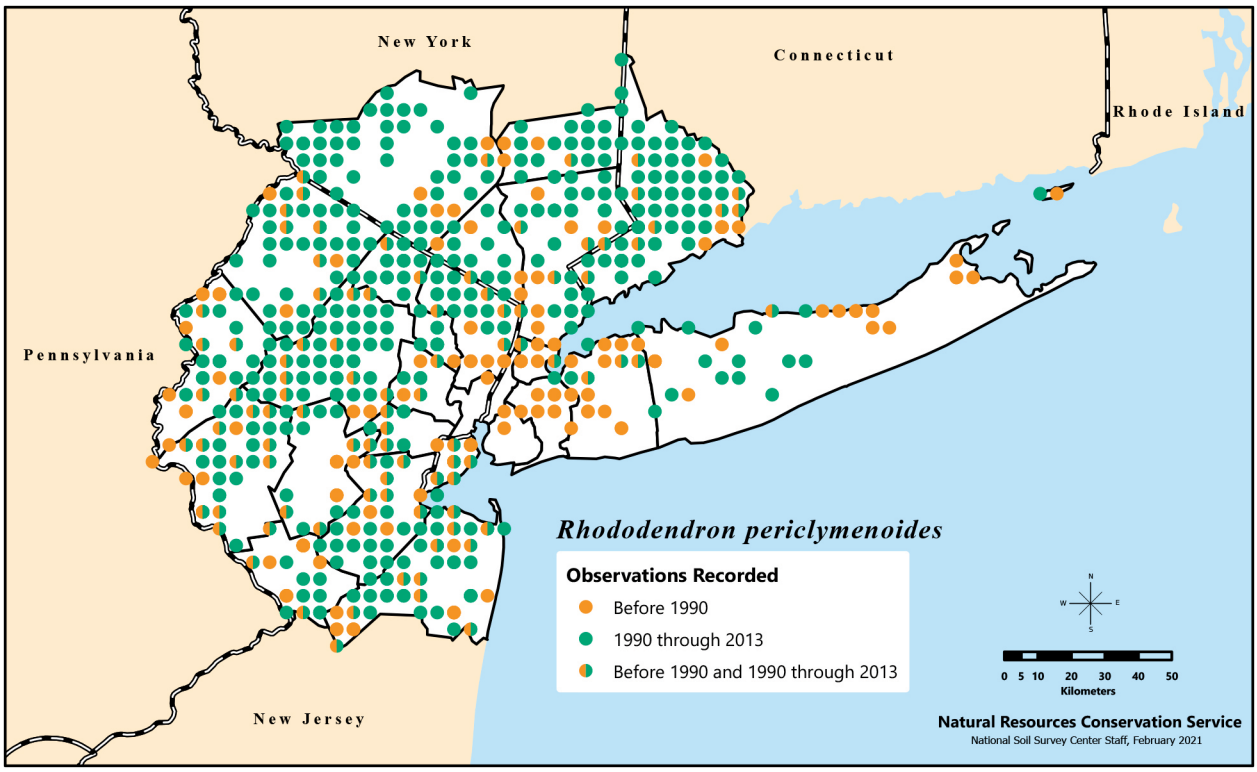
4. *Rhododendron periclymenoides* (Michx.) Shinners – pinxster-flower, election pink ↑

Azalea periclymenoides Michx.; *Azalea lutea* L.; *Azalea nudiflora* L. (illegitimate superfluous name); *Rhododendron luteum* (L.) C.K.Schneid. non Sweet (illegitimate later homonym); *Rhododendron nudiflorum* Torr. (based on *Azalea nudiflora*)

Nomenclature complicated. Species first described by Linnaeus in 1753 as *Azalea lutea*, although original description was probably based on two species: a pink-flowered one (now known as *R. periclymenoides*) and an orange-yellow-flowered one (now known as *R. calendulaceum* (Michx.) Torr.), the latter species explaining Linnaeus' choice of "lutea" for the epithet. Pink-flowered species later renamed *Azalea nudiflorum* by Linnaeus (1762), this epithet a reference to the flowering occurring before the appearance of the leaves, the flowers thus appearing nude. The name *A. nudiflorum*, however, is illegitimate because it is a renaming of *A. lutea*, which, despite its epithet, is typified by the pink-flowered species. *Rhododendron luteum* (L.) C.K.Schneid. (based on *A. lutea*) is an illegitimate later homonym of *R. luteum* Sweet, an Asian species. *Rhododendron periclymenoides* is the earliest available legitimate name in *Rhododendron* for the North American pink-flowered species (see Blake 1918, Shinners 1962). Epithet derived from the genus name *Periclymenum* Mill. (a synonym of *Lonicera* L.), a reference to the flowers' similarity to honeysuckle flowers. This superficial similarity with true honeysuckle (*Lonicera* L.) has also resulted in some species having alternate common names referencing honeysuckle, such as



Distribution of *Rhododendron maximum*, called great laurel or rosebay, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rhododendron periclymenoides*, called pinxster-flower or election pink, recorded in the New York Metropolitan Region during three time categories.

purple honeysuckle for this species and swamp honeysuckle for *R. viscosum*.

Flowering May. Upland mesic woodlands and woodland edges. Common name a reference to its blooming during municipal elections traditionally held in May in many northeastern states, including at least NJ in the region. Some material from the region misidentified as *R. canescens* (Michx.) Sweet, a species that does not occur north of NC (Kron and Judd 1990). Cultivated since 1730; was used with *R. viscosum* and *R. calendulaceum* to develop the Ghent hybrids (Dirr 1998). Increases in the area may be due to upland reforestation.

5. *Rhododendron prinophyllum* (Small) Millais – early azalea, mountain azalea ↓↓↓

Azalea prinophylla Small

Flowering May–June. Dry to mesic woodlands, often on rocky soils. Epithet is a reference to the toothed leaf margins. The name *R. roseum* Rehder, a synonym of *R. canescens*, sometimes misapplied to this species. Some material from the region misidentified as *R. canescens* (Michx.) Sweet, a species that does not occur north of NC (Kron and Judd 1990).

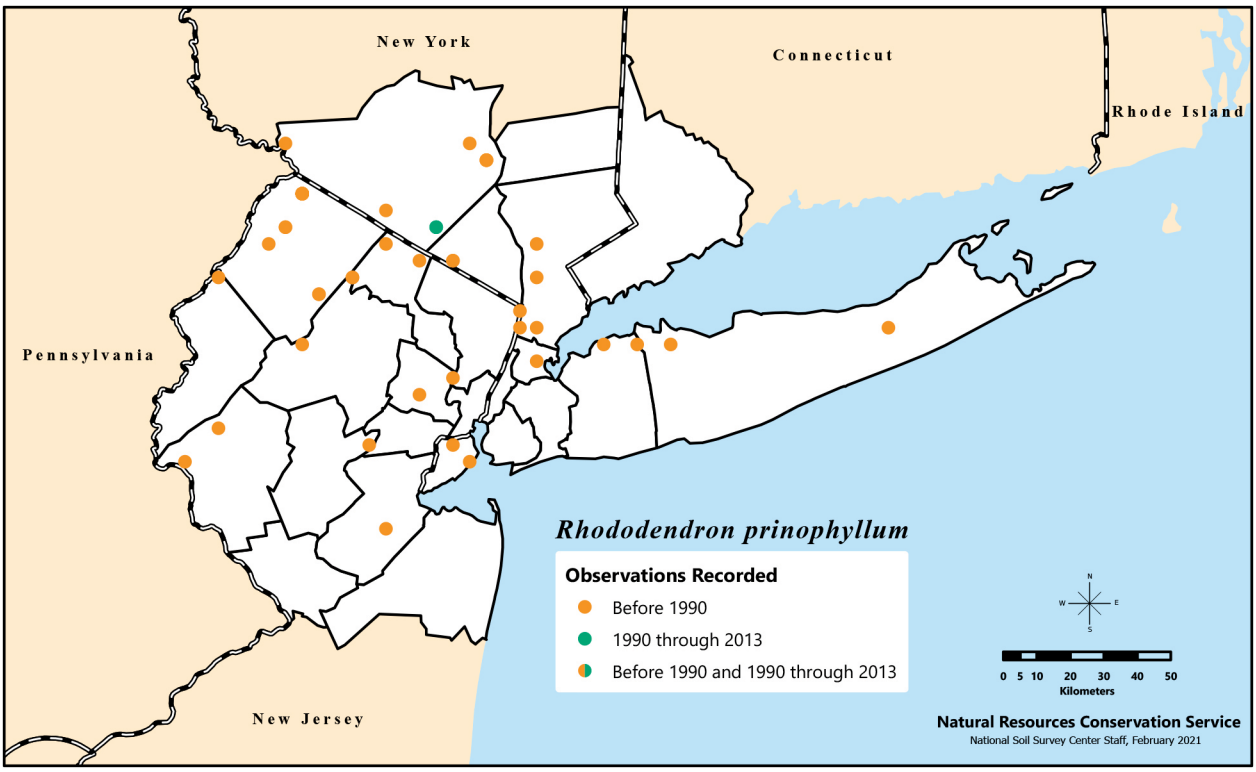
Declining significantly in the region. Its preference for colder, northern climates and high elevations (Kalberer et al. 2007, Tucker 1972) may explain its decrease in abundance, due to a reduction in available habitat in the region.

Tracked as rare in NJ (S3).

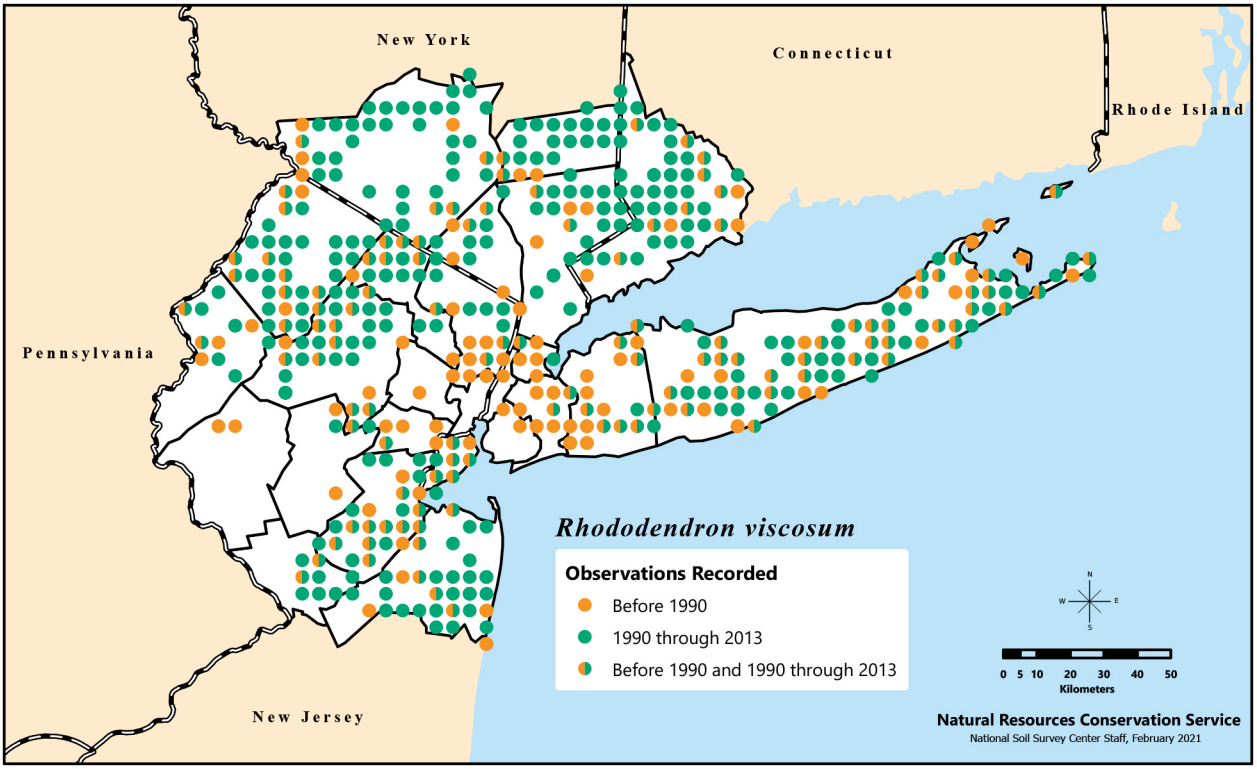
6. *Rhododendron viscosum* (L.) Torr. – swamp azalea ↔

Azalea viscosa L.

Flowering June–July. Mesic woodlands, edges of woodlands, swamps, and edges of bogs. Flowers strongly fragrant; usually white and rarely pink to rose. Cultivated since 1731, with at least 9 cultivars (Dirr 1998). Appears to be maintaining populations, though decreases in the region may be associated with urbanization.



Distribution of *Rhododendron prinophyllum*, called early azalea or mountain azalea, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rhododendron viscosum*, or swamp azalea, recorded in the New York Metropolitan Region during three time categories.

R

Nonnative Species

***Rhododendron calendulaceum* (Michx.) Torr. – flame azalea**

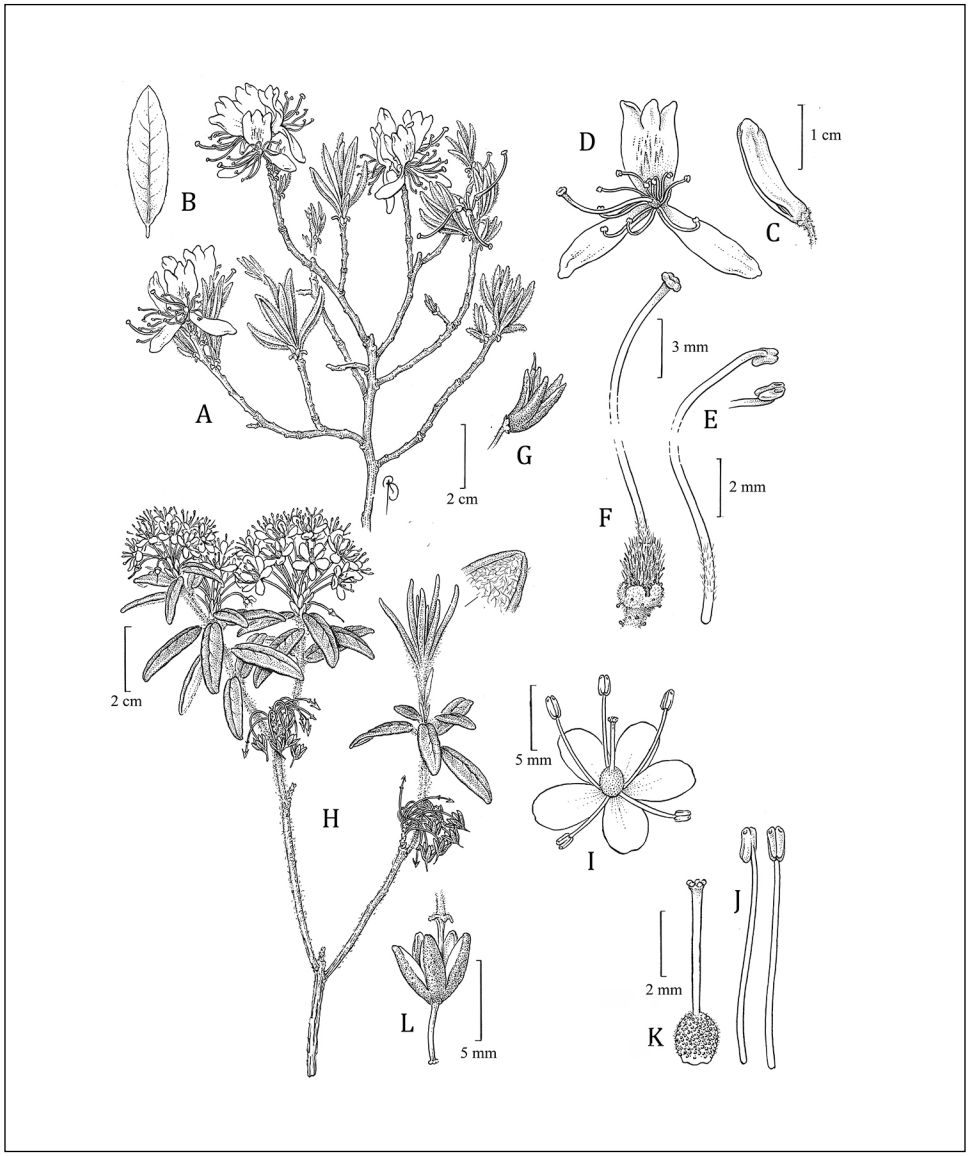
Azalea calendulacea Michx.

Native to the southeastern U.S. north to PA (where now extirpated). Planted in the region; may occur as a remnant from cultivation or escape. Only a handful of records, all likely cultivated specimens; no confirmed naturalizations to date. Cultivated since 1800, with at least 14 cultivars (Dirr 1998).

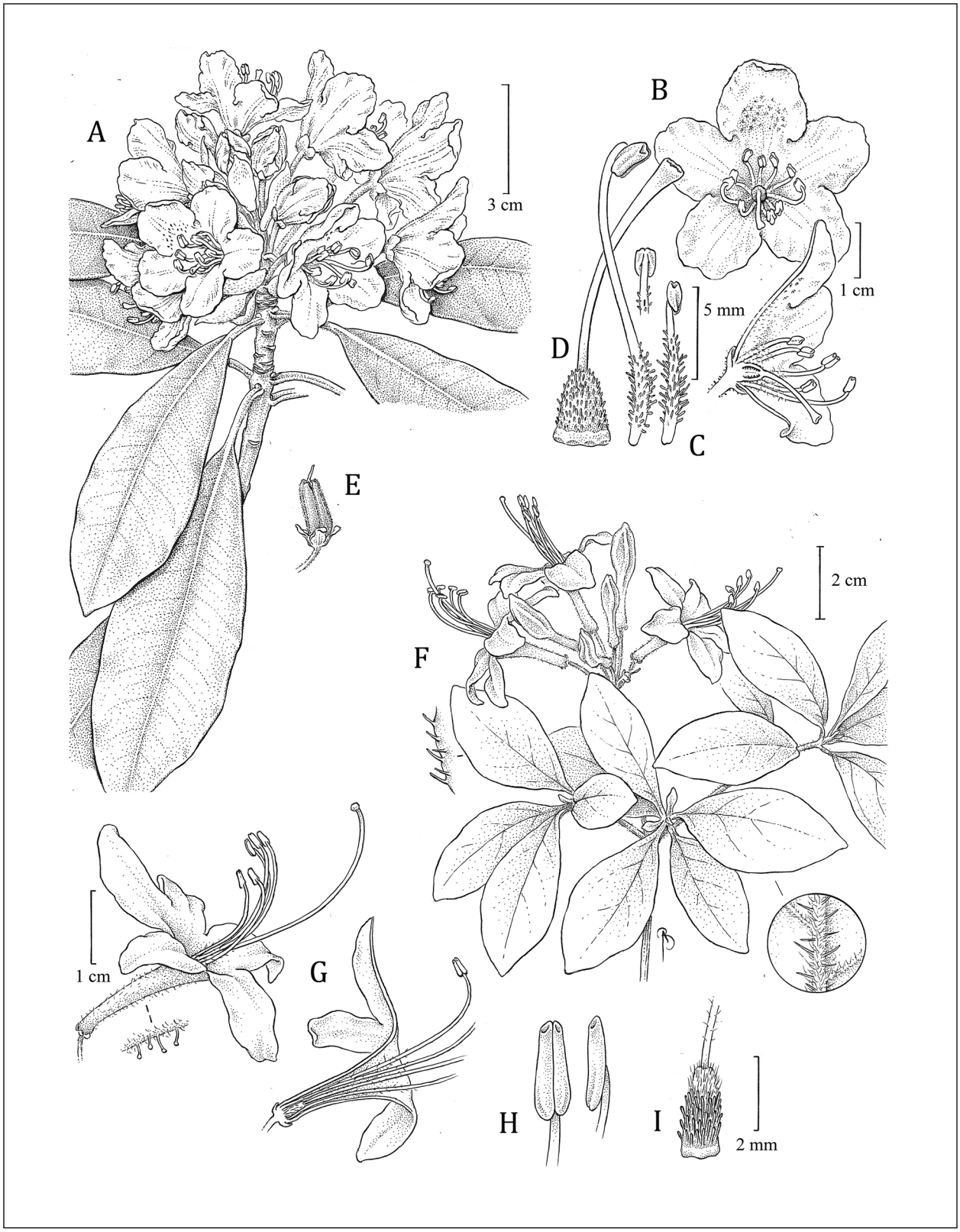
***Rhododendron molle* (Blume) G.Don**

Azalea mollis Blume

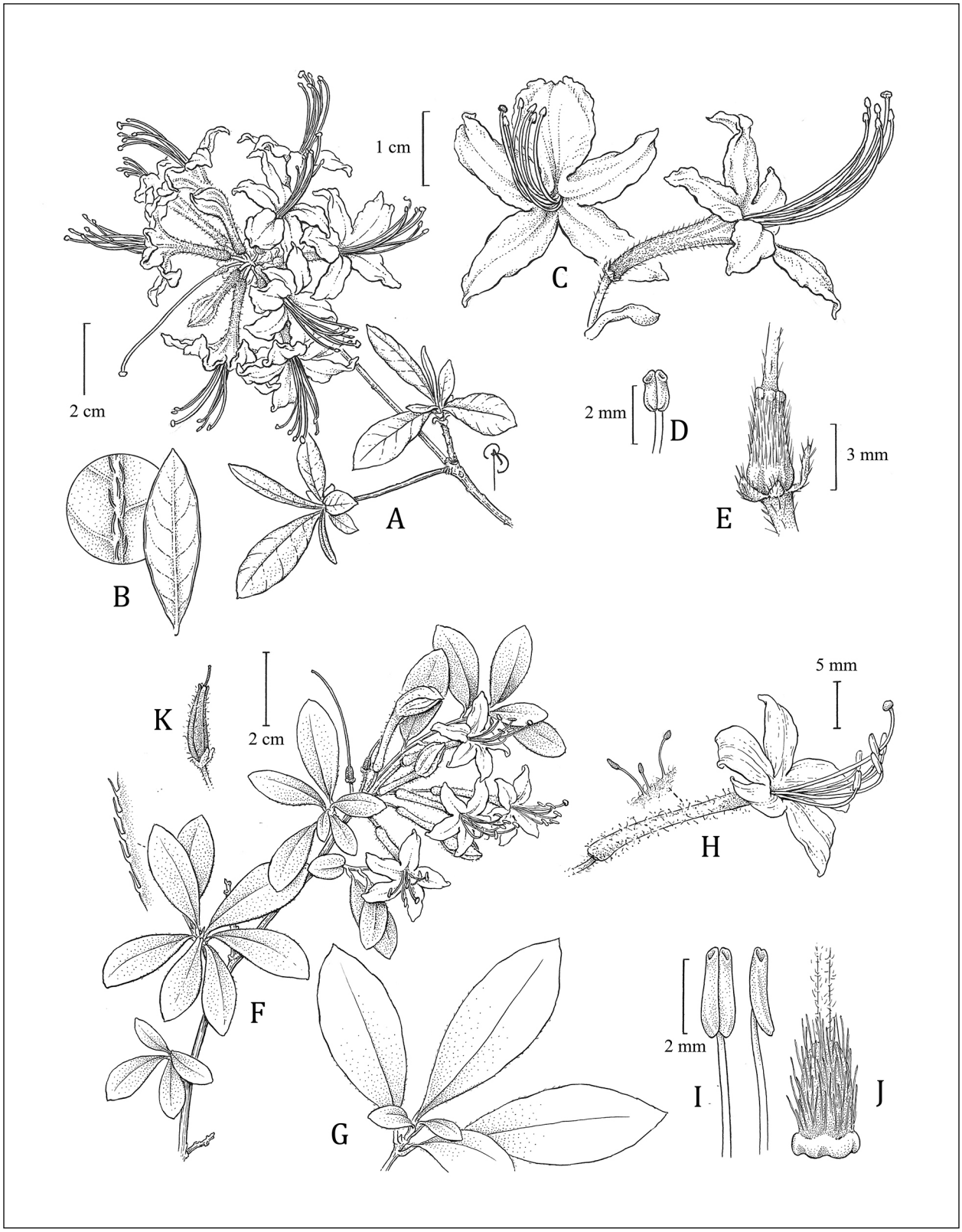
Native to China. Widely cultivated; rarely found as a remnant from cultivation or casual escape.



A) Flowering leafy twig, B) leaf, C) flower bud, D) flower, E) stamens, F) pistil, and G) opening fruit of *Rhododendron canadense*; H) flowering leafy twig and enlarged view of leaf tip with enrolled margin; I) flower, J) stamens, K) pistil, and L) opening fruit (capsule) of *Rhododendron groenlandicum*. Illustration by Bobbi Angell.



A) Flowering leafy twig, B) flower and its cross-section, C) stamens, D) pistil, and E) fruit of *Rhododendron maximum*; F) flowering leafy twig, showing enlarged views of leaf midrib and margin with hairs and setae, G) flower, glands on corolla tube, and cross-section of corolla tube, H) stamens, and I) ovary (base of pistil) of *Rhododendron prinophyllum*. Illustration by Bobbi Angell.



A) Flowering leafy twig; B) leaf and enlarged view of midrib with appressed setae, C) flower (frontal and side view), D) anther, and E) ovary (base of pistil) of *Rhododendron periclymenoides*; F) flowering twig and enlarged view of leaf margin, G) leaves, H) flower showing glandular corolla tube and stamens, I) stamens, J) ovary (base of pistil), and K) fruit of *Rhododendron viscosum*. Illustration by Bobbi Angell.

Rhodotypos Seibold & Zucc. – black jetbead

Rosaceae. Shrub. Species 1 in Asia (China, Japan, Korea). Readily distinguished from other shrubs in the rose family by its opposite leaves and showy, white 4-petaled flowers, both rare character states in the Rosaceae. Flowers are perfect and most likely pollinated by insects, but there is no information available on self-compatibility or lack thereof. Fruit also unusual; technically a drupelet or cluster of 2–4 (appearing as an aggregate). Drupelets dry at maturity; shiny black exocarp remains attached to the stone. Closely related and morphologically similar to the North American *Coelogyne* Torr. and *Neviusia* A.Gray and the Asian *Kerria* DC.; these four genera are grouped in the tribe Kerriae Focke. Occasionally cultivated for ornament. Genus name derived from the Greek "rhodon" ("rose") and "typos" ("pattern"), in reference to the similarity with roses (*Rosa*).

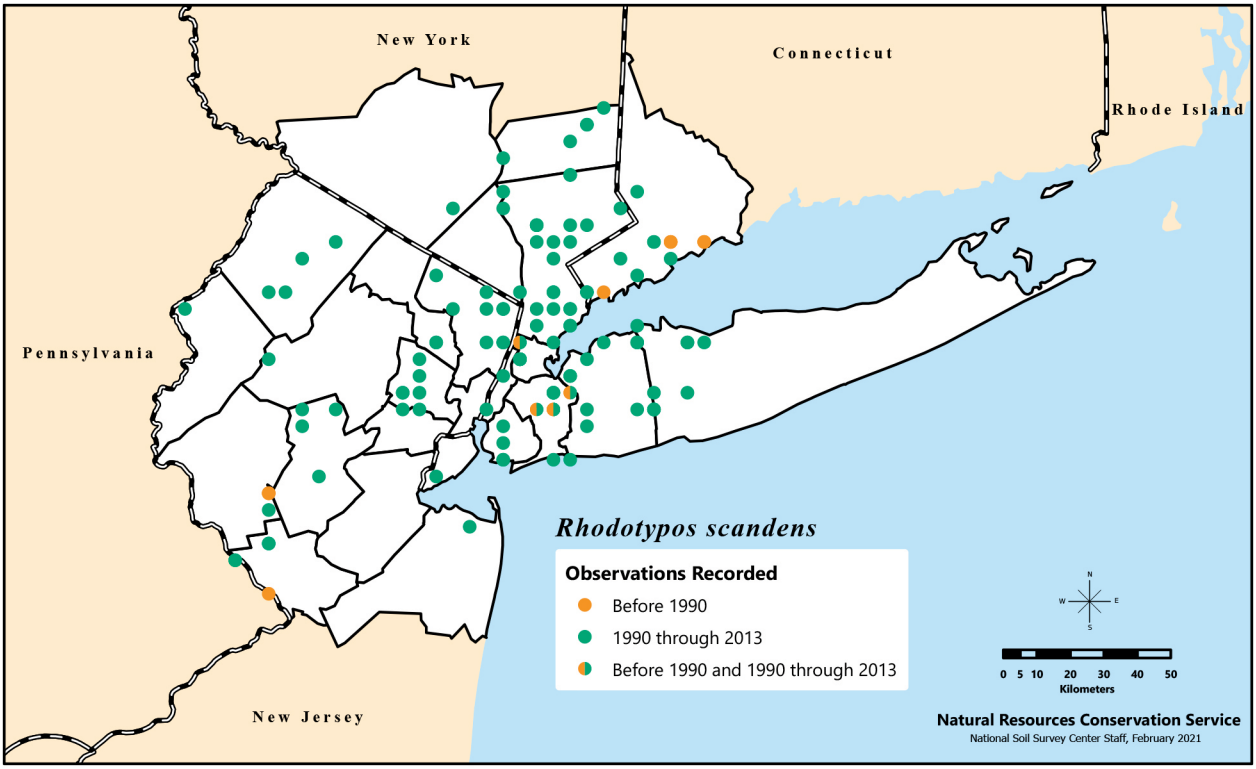
Nonnative Species

1. *Rhodotypos scandens* (Thunb.) Makino – black jetbead ↑↑↑

Corchorus scandens Thunb.; *Kerria tetrapetala* Siebold; *Rhodotypos kerrioides* Siebold & Zucc.; *R. tetrapetala* (Siebold) Makino

Flowering mid-Apr.–early May; fruiting Sept.–Oct, persisting into subsequent season. Upland woodlands, woodland edges, open disturbed areas. Introduced into the U.S. in 1866 (Dirr 1998).

Seeds have a combined dormancy requiring warm moist stratification, followed by cold stratification. Acid scarification plus cold stratification may work as well (Rudolf and Owston 2008). One of the first shrubs to leaf out in spring. Roots easily from stem cuttings with leaves. Tolerant of various soil conditions, light levels, and pollution. Impacted by few if any diseases or herbivores.



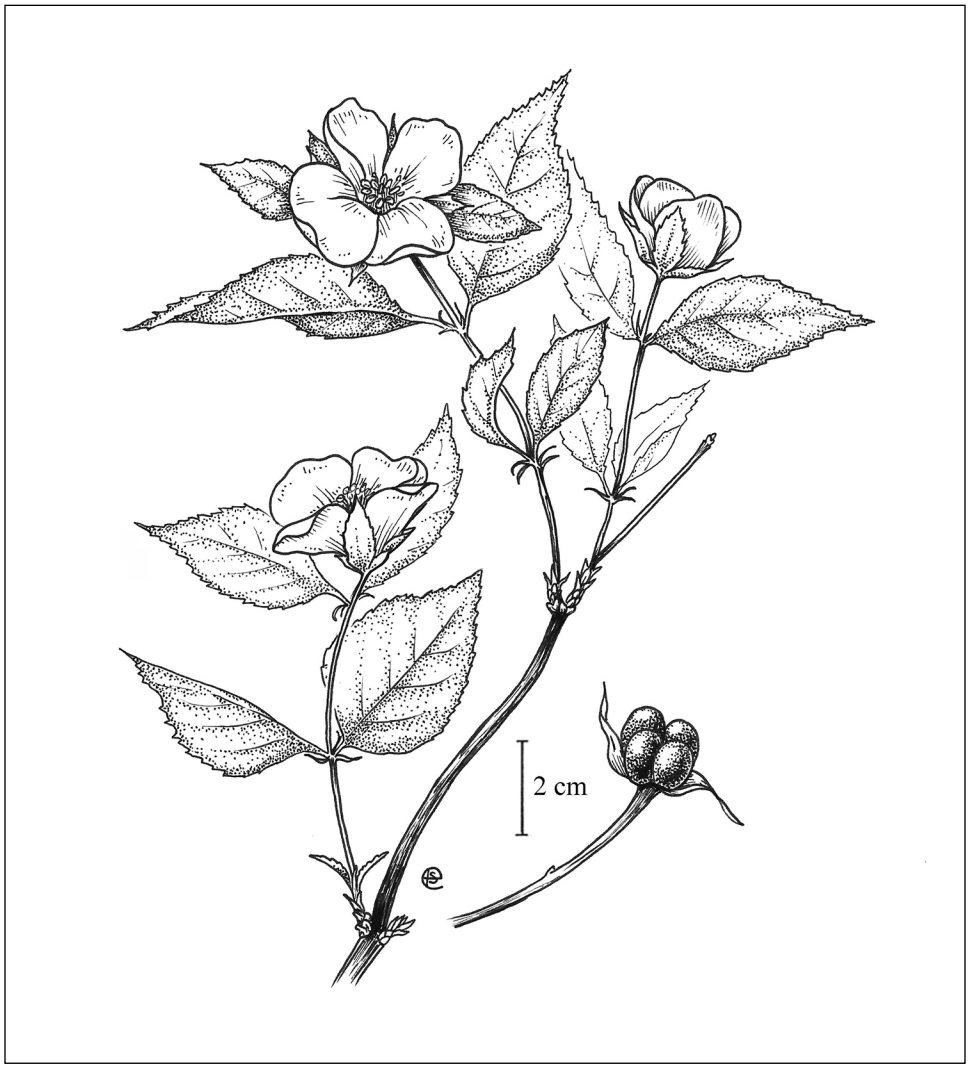
Distribution of *Rhodotypos scandens*, or black jetbead, recorded in the New York Metropolitan Region during three time categories.

Because there are many shrubs superior in both fall color and flower and fruit showiness, this species is not used extensively as an ornamental (Dirr 1998). Consistently listed among species with high potential to become invasive; however, given its distribution in the midwestern and eastern states, it may be more prudent to classify it as invasive (Lamont and Young 2002) and expanding (Fitzgerald and Loeb 2008). Tissue is relatively high in sorbitol, which is used as a sugar substitute. There is a distinct correlation between chromosome number and rose species with sorbitol. The principal basic chromosome number of many species in the rose family is 7; those with different chromosome numbers, such as 9 for *R. scandens*, typically accumulate sorbitol (Wallaart 1980). Nitrile glucosides and one cyanogenic glucoside have been isolated from *R. scandens* leaves (Lechtenberg et al. 1996), which may indicate a certain degree of toxicity.

Assessed as invasive in NJ (category 2/3; not prohibited) and moderately invasive in NY (not prohibited) (Clemants and Moore 2009).

Management

Seeds of *Rhodotypos scandens* may be dispersed by birds, but this has not been documented and fruit appear to be poisonous (Smith 2019). Whether or not the poisonous fruit may affect birds depends on whether the seeds or the fleshy fruit parts are poisonous and which portion is consumed. If the seeds, rather than the fleshy portion, are poisonous, which is common in



Flowering leafy twig and fruit of *Rhodotypos scandens*. Illustration by Emma Skurnick.

some Rosaceae family members, seed dispersal by birds and small animals may be enhanced because the seed is unlikely to be consumed or digested. Seedling establishment may be limited based on the germination requirements. Asexual reproduction by stem sprouting could be a successful means of spread, though not documented as the primary means of reproduction. Due to the lack of basic biological information about this species, the mechanisms behind *R. scandens*' expanding range are currently unknown. We recommend not planting this species and removing any escaping individuals where practical. Removal should include taking all plant parts from the site, given this plant's ability to root from stem cuttings.

Rhus L. – sumac

Anacardiaceae. Shrubs, trees. Species 200–250 species in Africa, Australia (1), Asia, Europe (3), North America, and South America. Species in the region are mostly dioecious. Seeds of all species have a physical dormancy requiring scarification as well as a cold stratification for about 2 months (Rowe and Blazich 2008a). Increases in all the species in the region may indicate an increase in old field habitats.

Native Species

1. *Rhus aromatica* Aiton – fragrant sumac ↑↑↑

Flowering Apr.–May. Open upland fields and woodland edges, often on sandy or rocky ground. Some material may represent escapes from cultivation; recently the species has been planted more frequently. Epithet refers to the aromatic leaves and twigs.

Scarification required prior to the stratification period (Rowe and Blazich 2008a). Cultivated since 1759, with at least 3 cultivars (Dirr 1998). Increases may be due to increased use in horticultural landscaping (Rupp et al. 2011).

Native populations listed as a species of special concern in CT (SH).

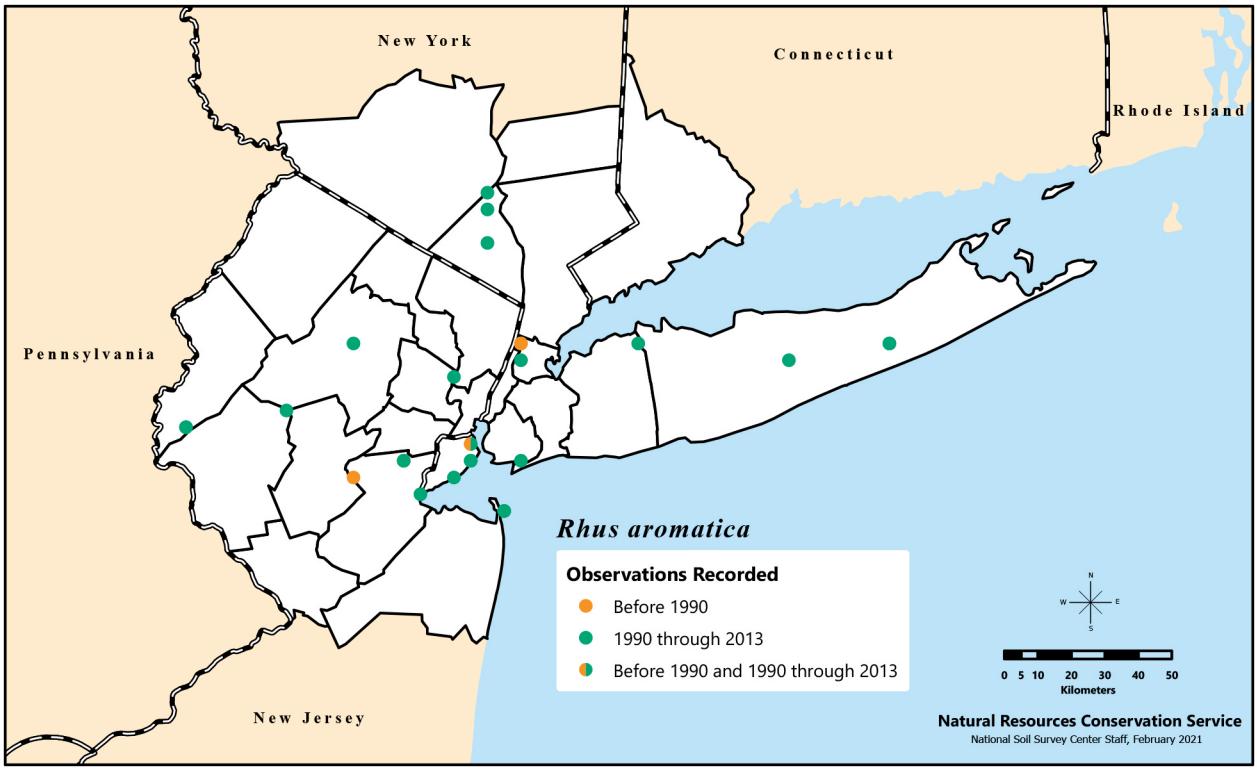
2. *Rhus copallina* L. – winged sumac ↑

Flowering July–Sept. Open upland fields, woodland edges, often on sandy ground; most abundant on the Coastal Plain. Epithet from Latin refers to the resin exuded, which resembles the resin, or copal, of tropical trees.

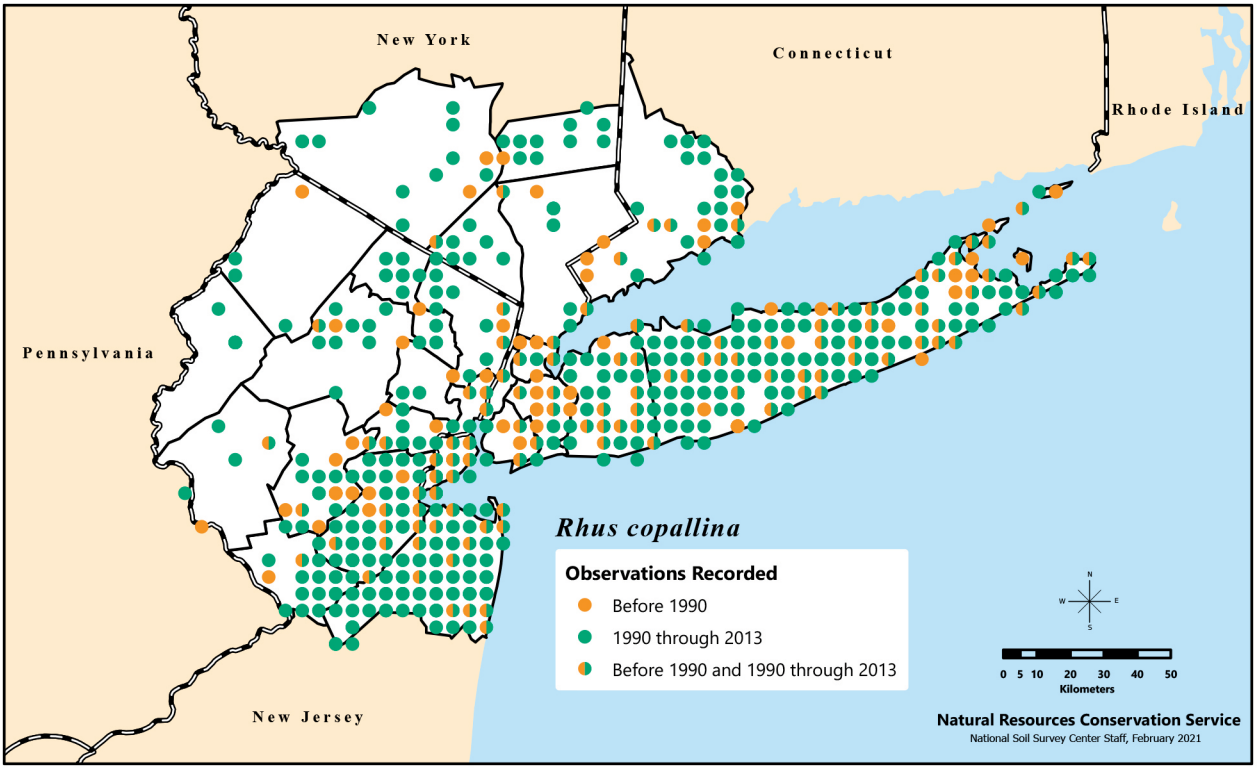
Cultivated since 1688, with at least 1 cultivar. Though the most ornamental of the native sumacs, it does not exhibit uniform growth and can form large colonies. The cultivar 'Creel's Quintet' may be among the more tamed cultivars in terms of being able to restrain its growth (Dirr 1998). Increases may be due to its use in horticultural landscaping.

Rhus Key

1. Leaflets 3; inflorescences small clusters of flowers (*R.* sect. *Lobadium* DC) . . . . . ***Rhus aromatica***
1. Leaflets 8+; inflorescences large, erect, paniculate (*R.* sect. *Rhus*) 2
2. Petioles and rachises with winged margins . . . . . ***Rhus copallina***
2. Petioles and rachises without wings 3
3. Stems, petioles, inflorescence branches glabrous (sometimes glaucous) or slightly puberulent; drupes with appressed pubescence . . . . . ***Rhus glabra***
3. Stems, petioles, inflorescence branches velvety pubescent (not glaucous); drupes villous, hairs spreading . . . . . ***Rhus typhina***



Distribution of *Rhus aromatica*, or fragrant sumac, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rhus copallina*, or winged sumac, recorded in the New York Metropolitan Region during three time categories.

R

3. *Rhus glabra* L. − smooth sumac ↑↑

Flowering June–July. Open upland fields and woodland edges; common throughout the region.

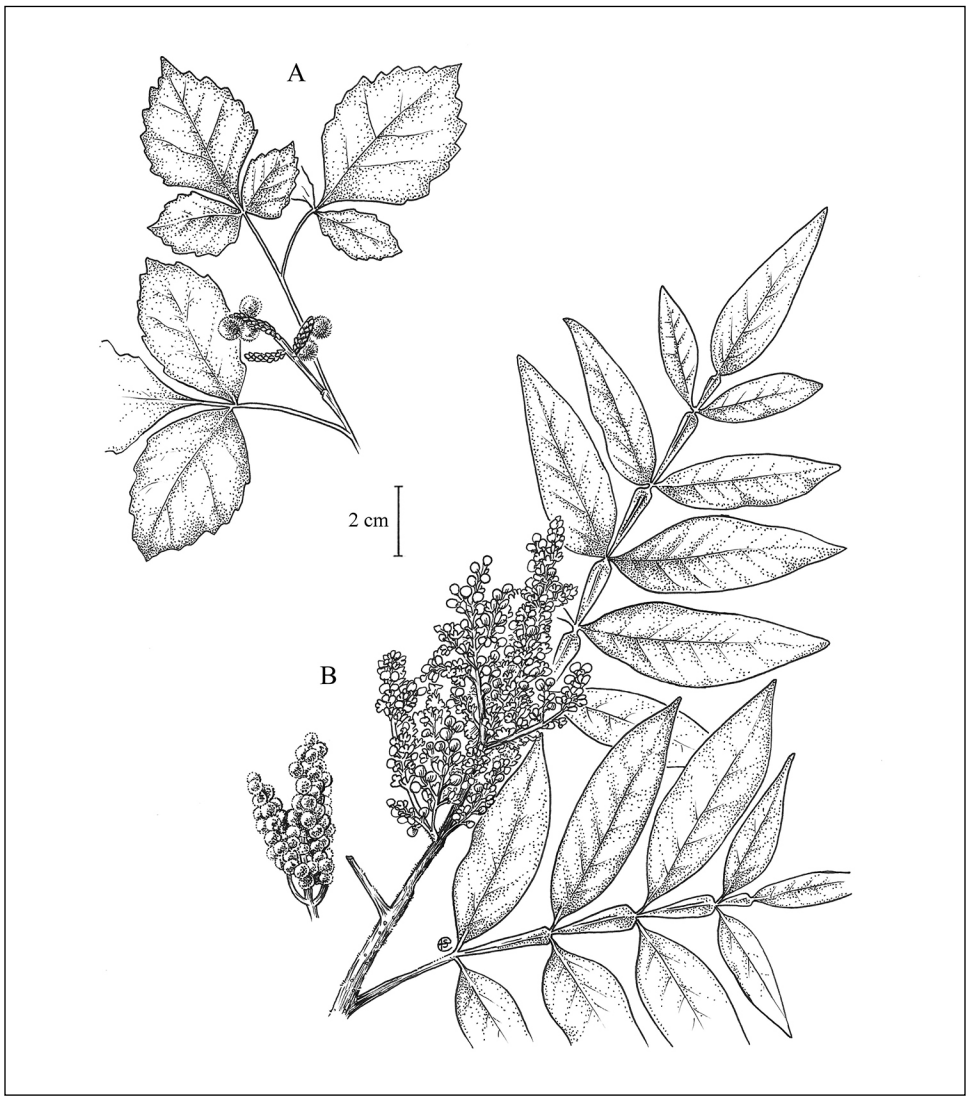
Cultivated since 1620, with at least 3 cultivars. Early successional tree, often found in disturbed areas; able to tolerate dry, sterile soils (Dirr 1998). Increases may be due to increases in disturbed habitat.

4. *Rhus typhina* L. − staghorn sumac ↑↑↑

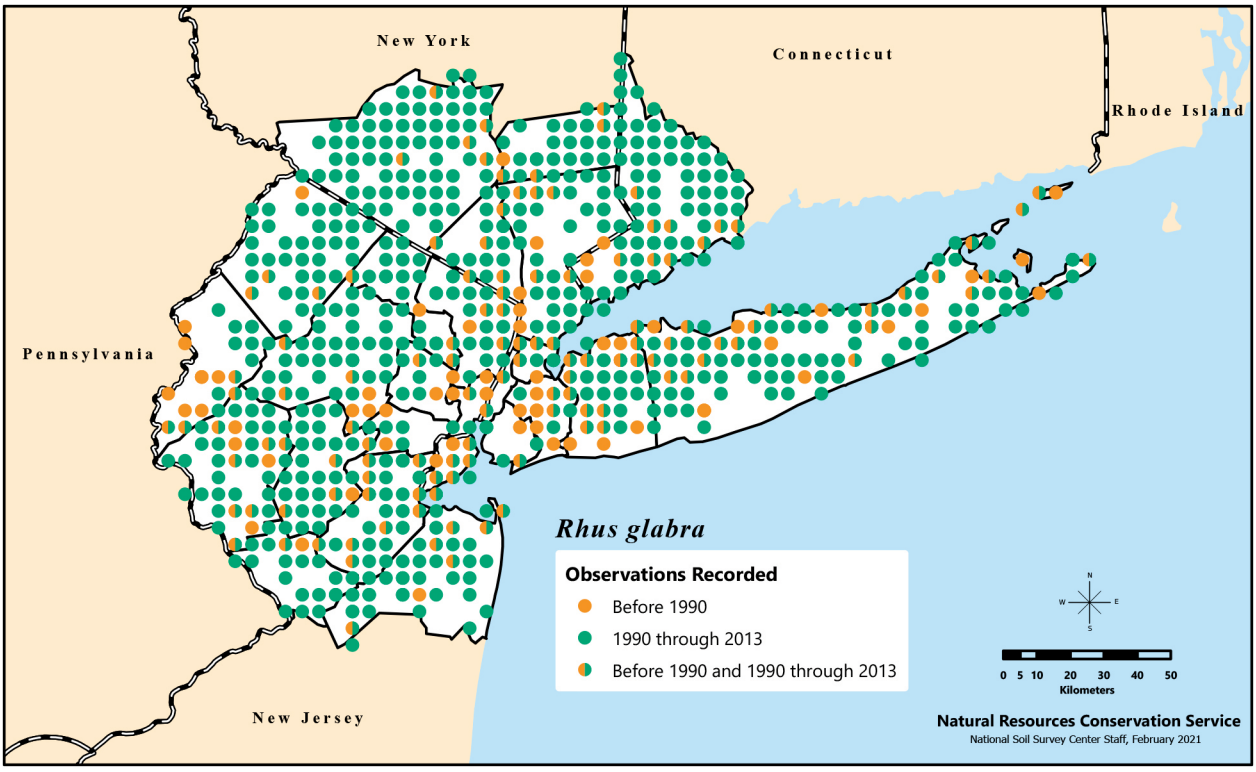
Datisca hirta L. (rejected name); *Rhus hirta* (L.) Sudw. (rejected name)

Flowering June–July. Open upland fields and woodland edges; common throughout the region. Most abundant off the Coastal Plain. Epithet is a reference to the velvety branches' (and possibly inflorescences') superficial similarity to the inflorescences of *Typha* (cattail).

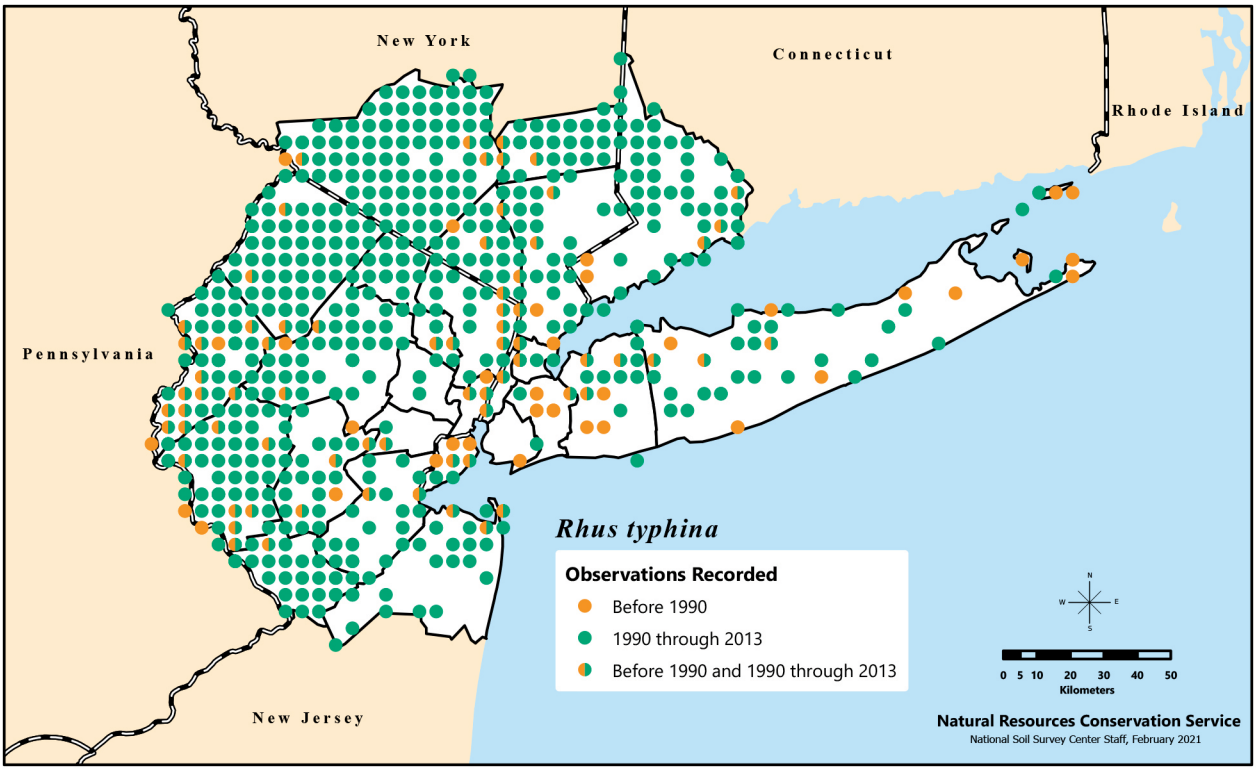
Cultivated since 1629, with at least 2 cultivars. Early successional tree, often found in disturbed areas; able to tolerate dry, sterile soils (Dirr 1998). Increases may be due to increases in disturbed habitat.



A) Fruiting leafy twig of *Rhus aromatica*; B) flowering leafy twig and infructescence of *Rhus copallina*. Illustration by Emma Skurnick.



Distribution of *Rhus glabra*, or smooth sumac, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rhus typhina*, or staghorn sumac, recorded in the New York Metropolitan Region during three time categories.

R



Fruiting twig with leaves of A) *Rhus glabra* and B) *Rhus typhina*. Illustration by Emma Skurnick.

Ribes L. – currant, gooseberry

Grossularia Mill.

Grossulariaceae. Shrubs. (Previously *Ribes* was included in a broadly circumscribed Saxifragaceae. Grossulariaceae is now generally treated as monogeneric, consisting only of *Ribes*; all other genera have been moved to other families, including Celastraceae, Haloragaceae, Iteaceae.) Species about 150–200 in northern Africa, Asia, Europe, North America, and South America. Despite the presence of many species in the region (7 native, 5 nonnative species), none is frequent. Name may be derived from the Danish "ribs," the common name for the red currant *Ribes rubrum* (Fernald 1950), or possibly derived from the Arabian "ribas," the common name for Syrian rhubarb (*Rheum ribes* L.; Polygonaceae) (Rehder 1949). Those without spines or prickles (unarmed) are known as currants and those with spines or prickles (armed) are known as gooseberries. Earliest seed-bearing age generally 3–5 years, with

Ribes Key

1. Stems with hard spines at the nodes, internodes bristly (especially when young); peduncles 1–7 flowered; pedicels jointed at summit; fruits not disarticulating away from pedicels (gooseberries; *R.* subg. *Grossularia* (Mill.) Rich.) 2
1. Stems with or without nodal spines and internode bristles; peduncles with several many-flowered racemes; pedicels jointed at summit; fruits disarticulating away from pedicels (currants) 3
2. Calyx lobes shorter than tube; ovary and fruit prickly . . . . . ***Ribes cynosbati***
2. Calyx lobes longer than tube; ovary and fruit not prickly 4
3. Stems bristly and prickly; racemes pendulous; fruits black, bristly, glandular (*Ribes* subg. *Grossularioides* Jancz.) . . . . . ***Ribes lacustre***
3. Stems without bristles and prickles; racemes ascending to pendulous; fruits various 5
4. Stamens much exceeding calyx lobes at anthesis; peduncles and pedicles elongate 6
4. Stamens shorter to barely exceeding calyx lobes at anthesis; peduncles and pedicles short. 7
5. Leaves convolute in bud; calyx salverform; tube many times longer than lobes; fruit yellow-black (*R.* subg. *Symphocalyx* Berl.) . . . . . ***Ribes aureum* var. *villosum****
5. Leaves plicate in bud; calyx saucer-shaped to campanulate; tube not elongate; fruit various (*R.* subg. *Ribes*; =*R.* subg. *Ribesia* Berl.) 8
6. Nodal spines more than 7 mm long; flowers whitish; filaments 10 mm or longer . . . . . ***Ribes missouriense***
6. Nodal spines less than 5 mm long; flowers greenish-purplish; filaments shorter than 10 mm . . . . . ***Ribes rotundifolium***
7. Calyx glabrous; fruit glabrous to sparsely setose . . . . . ***Ribes hirtellum***
7. Calyx pilose; fruit appressed pilose (also sometimes glandular and glabrate) . . . . . ***Ribes uva-crispa****
8. Leaves with resinous dots; calyx campanulate; fruit black (*R.* sect. *Eucoresoma* Jancz.) 9
8. Leaves without resinous dots; calyx saucer-shaped; fruit red (yellow). 10
9. Bracts longer than pedicels; flowers whitish-yellowish; glabrous. . . . . ***Ribes americanum***
9. Bracts shorter than pedicels; flowers dull white-greenish-purplish; pubescent. . . . . ***Ribes nigrum****
10. Racemes ascending; ovary and fruit glandular, bristly; flowers white-pinkish (*R.* sect. *Heritiera* Jancz.) . . . . . ***Ribes glandulosum***
10. Racemes spreading to pendulous; ovary and fruit glabrous; flowers green, yellowish, purplish (*R.* sect. *Ribes*; = *Ribes* sect. *Ribesia* Berl.) 11
11. Decumbent; middle leaf lobe deltoid; pedicels glandular; flowers purplish . . . . . ***Ribes triste***
11. Erect-ascending; middle leaf lobe ovate; pedicels eglandular; flowers greenish-yellowish . . . . . ***Ribes rubrum****

large seed crops every 2–3 years. All native *Ribes* fruit is an important wildlife food source (Pfister and Sloan 2008).

Native Species

1. *Ribes americanum* Mill. – eastern black currant ↔

Flowering late Apr.–late May; fruiting July–Sept. Rich open woodlands, woodland edges, and slopes.

Height at maturity 0.6–1.8 m. A showy species cultivated for its colorful fruit, flowers, and foliage. The berries are made into jams, syrups, pies, juice, and jellies. Cultivated since 1727 (Pfister and Sloan 2008). Though species is stable, its occurrences have shifted to more western locations in the region.

2. *Ribes cynosbati* L. – dogberry, pasture gooseberry ↓

Flowering late Apr.–late May; fruiting July–Sept. Rich mesic open woodlands, woodland edges, and slopes on rocky soils. Epithet is a compound of the Greek word "cynos" ("dog") and "bati" ("berry").

Height at maturity 1.5 m. Cultivated since 1759, though it may be less appealing ornamentally due to the prickles (Pfister and Sloan 2008).

Tracked as critically imperiled in NJ (S1).

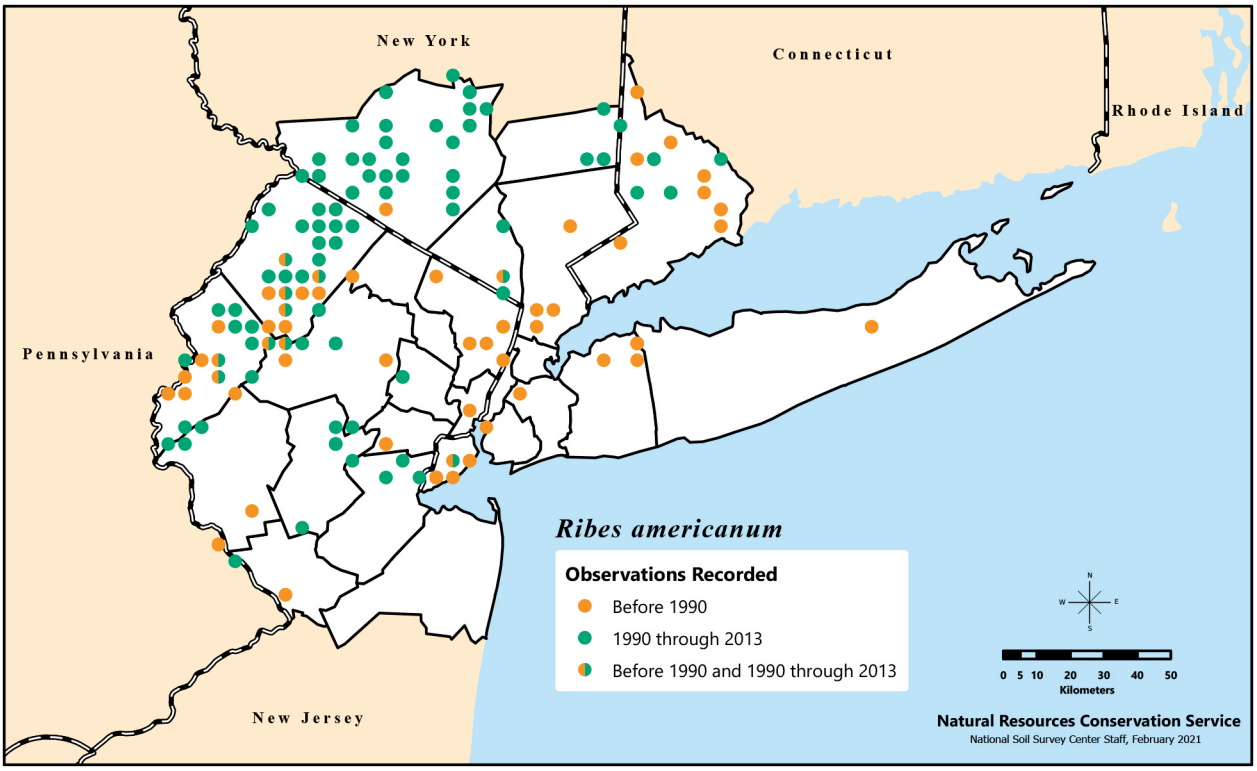
3. *Ribes glandulosum* Grauer – skunk currant Ø

Flowering late May–Aug.; fruiting June–Sept. Wet open woodlands (usually coniferous), woodland edges, and slopes. Extremely rare in the region; known only from Sussex County (NJ). Reported from just outside the region in Litchfield County (CT) and Sullivan and Ulster Counties (NY). Epithet from Latin refers to the fruit with glands.

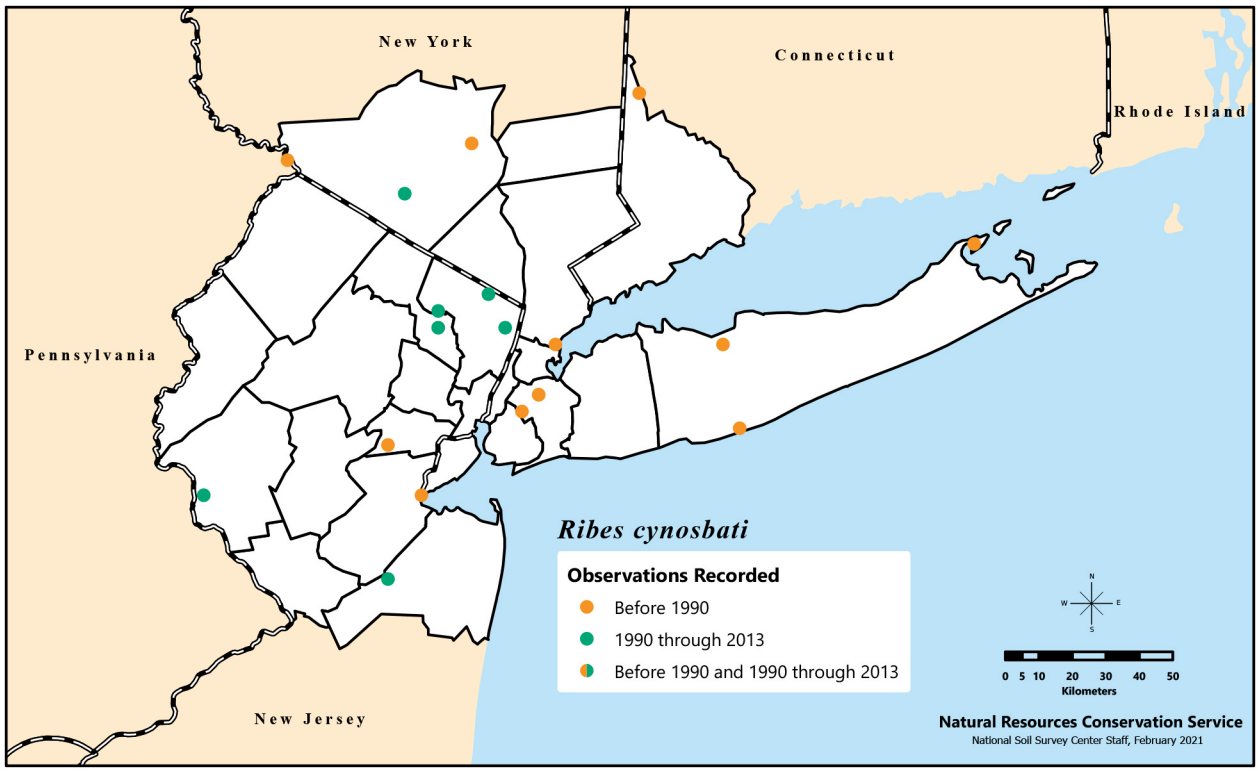
Listed as a species of special concern in CT (S3) and endangered in NJ (S1.1).

4. *Ribes hirtellum* Michx. – northern gooseberry ↔

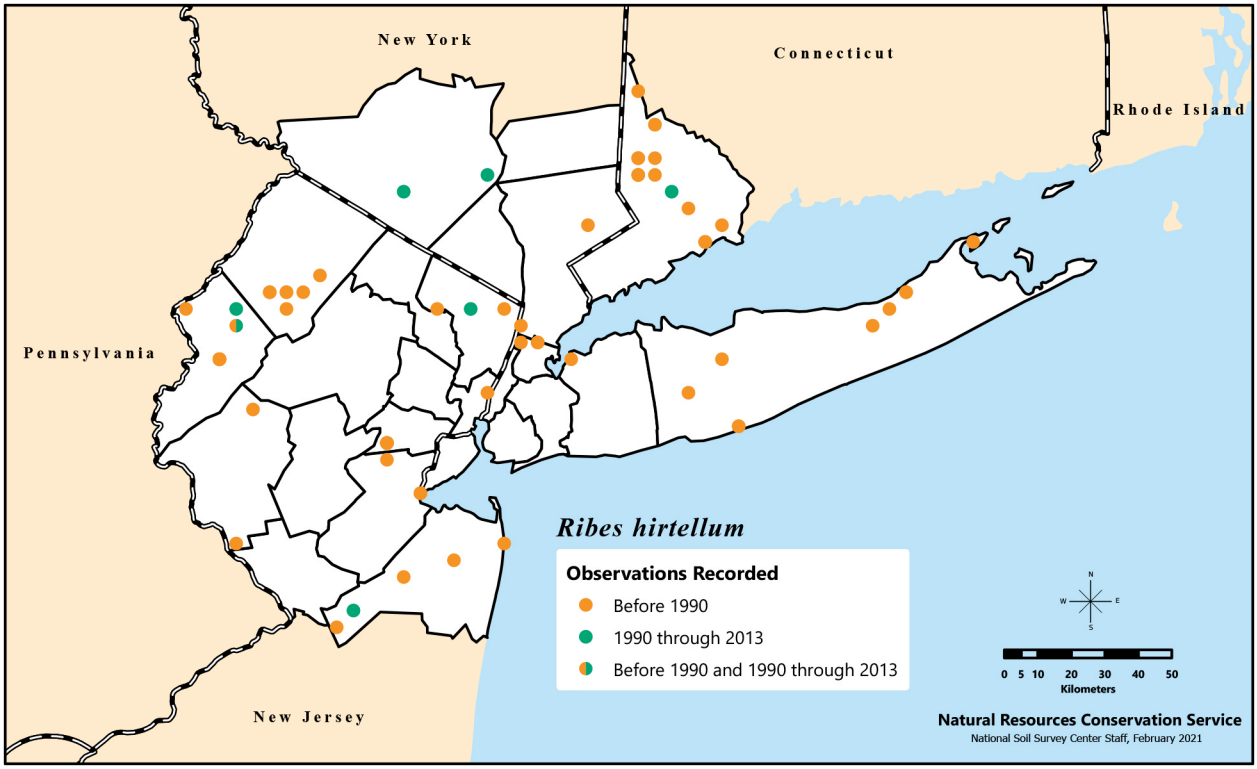
Flowering late Apr.–June; fruiting July–Sept. Wet open woodlands, woodland edges, and slopes. Epithet from Latin refers to the short, relatively stiff hairs or pubescence on the stems.



Distribution of *Ribes americanum*, or eastern black currant, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Ribes cynosbati*, called dogberry or pasture gooseberry, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Hudson and Warren Counties (NJ) and Westchester County (NY).



Distribution of *Ribes hirtellum*, or northern gooseberry, recorded in the New York Metropolitan Region during three time categories.

5. *Ribes lacustre* (Pers.) Poir. – bristly black currant Ø

Ribes oxyacanthoides var. *lacustre* Pers.

Flowering late Apr.–late May; fruiting July–Sept. Rich open woodlands, woodland edges, rocky slopes, and bogs. Exceptionally rare in the region. Known recently only from Fairfield County (CT); historically reported from Nassau and Suffolk Counties (NY).

Height at maturity 0.3–1.8 m. Cultivated since 1812 (Pfister and Sloan 2008).

Tracked as a species of special concern in CT.

6. *Ribes missouriense* Nutt. – Missouri gooseberry Ø

Flowering late Apr.–June; fruiting June–Aug. Thickets and roadsides; persistent or rare escape from cultivation. Exceptionally rare in the region; reported only from Fairfield County (CT), Hunterdon and Morris Counties (NJ), and Suffolk County (NY).

Height at maturity 0.3–1.8 m. Cultivated since 1907 (Pfister and Sloan 2008).

Listed as endangered in NJ (S2); treated as nonnative in CT and NY.

7. *Ribes rotundifolium* Michx. – round-leaf gooseberry ↔

Flowering late Apr.–June; fruiting July–Sept. Rich open woodlands, woodland edges, and rocky slopes.

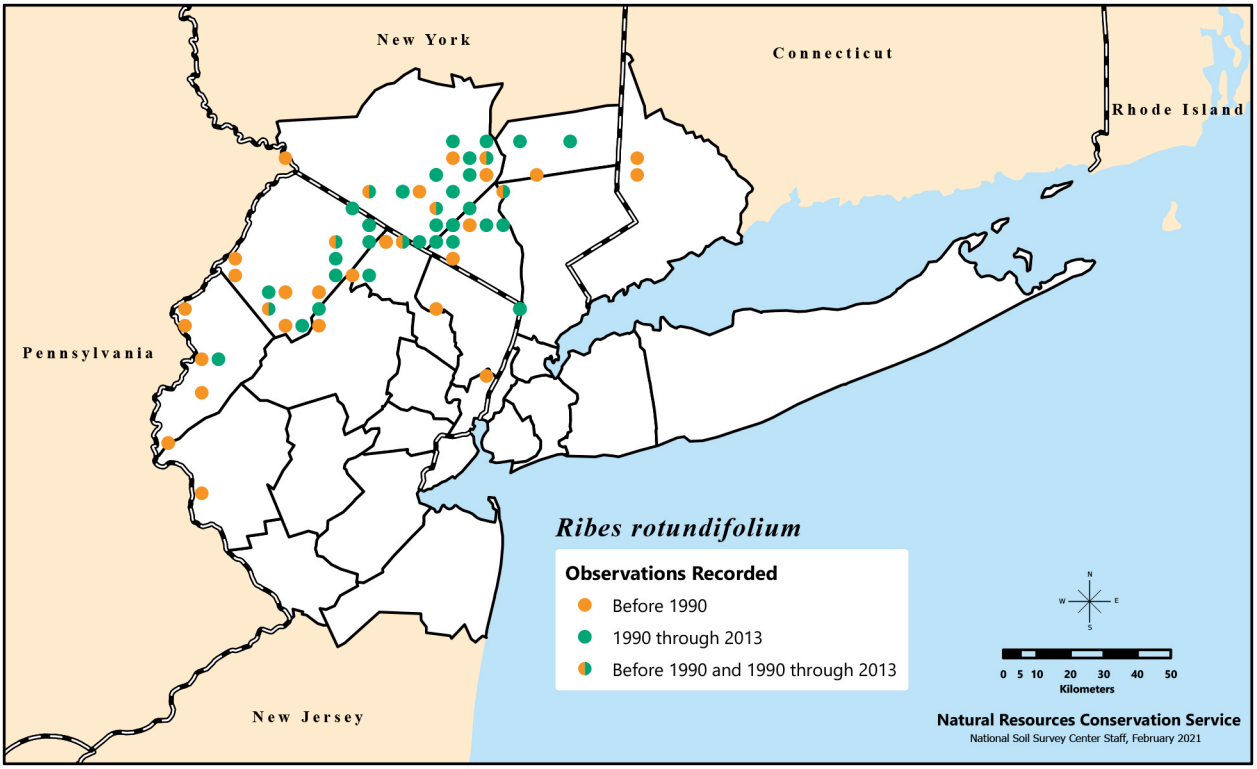
Height at maturity 0.9 m. Cultivated since 1809 (Pfister and Sloan 2008).

Listed as a species of special concern in CT (S1).

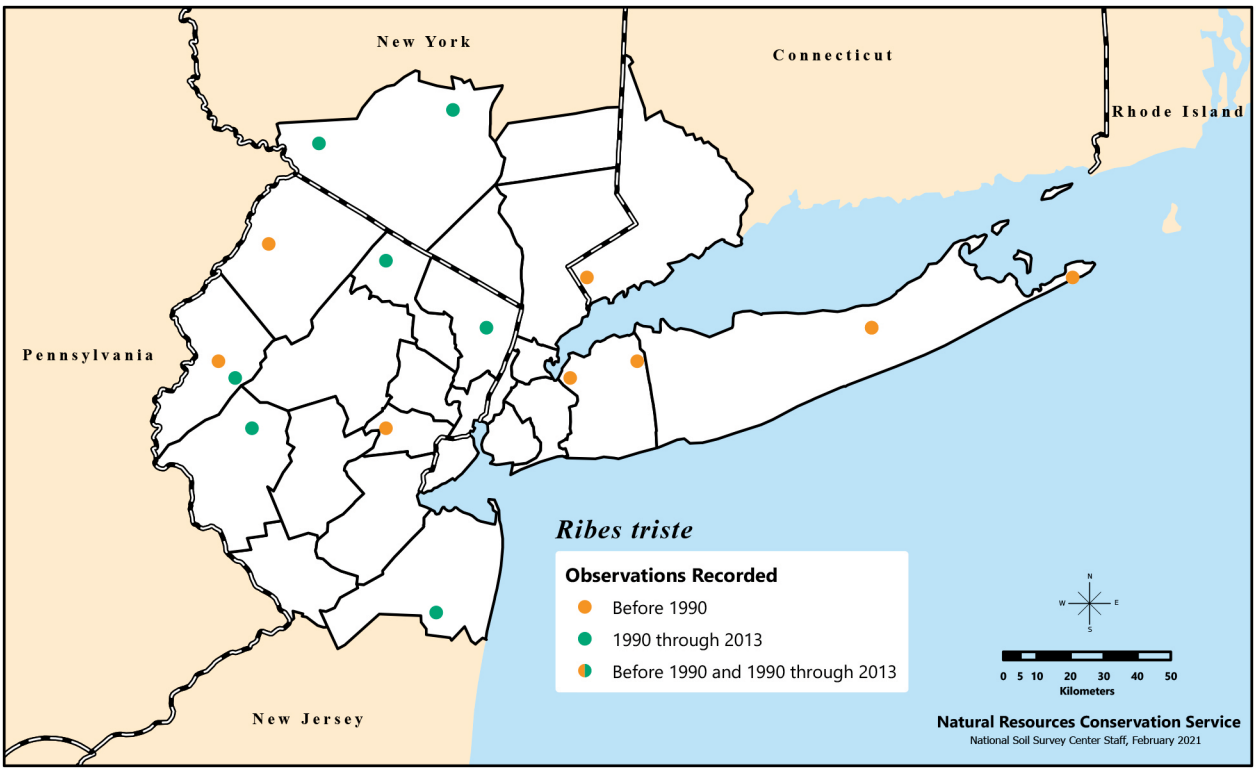
8. *Ribes triste* Pallas – swamp red currant ↔

Flowering late May–June; fruiting July–Sept. Wet coniferous woodlands, woodland edges, rocky slopes, and bogs. Epithet is from Latin “tristis,” meaning “sad,” possibly a reference to the drooping racemes.

Listed as endangered in CT (S1); rarity status undetermined in NJ (SU).



Distribution of *Ribes rotundifolium*, or round-leaf gooseberry, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Monmouth and Somerset Counties (NJ) and Richmond County (NY).



Distribution of *Ribes triste*, or swamp red currant, recorded in the New York Metropolitan Region during three time categories.

Nonnative Species

9. *Ribes aureum* var. *villosum* DC – buffalo currant, clove currant Ø

Flowering late Mar.–Apr.; fruiting May–Aug. Thickets and roadsides; persistent or rare escape from cultivation. Native west of the Mississippi River. Possible or likely naturalized populations reported from Fairfield County (CT), Union County (NJ), and Kings, Nassau, and Suffolk Counties (NY). Species epithet from Latin refers to the golden color of the fruit; varietal epithet from Latin means "softly hairy," a reference to the stems.

Height at maturity 0.9–3 m. Cultivated since 1806. Used in shelterbelt plantings in the Plains and Intermountain Regions (Pfister and Sloan 2008).

10. *Ribes nigrum* L. – garden black currant Ø

Flowering late May–June; fruiting June–Aug. Wet thickets and roadsides; persistent or rare escape from cultivation. Native to northern Asia and Europe.

This is the source of the cultivated black currant; plants are malodorous. Under cultivation for 400 years with many European, Asian, and New Zealand cultivars, but few are popular in the U.S. Very high in ascorbic acid (vitamin C), though cultivars vary (Brennan 1991). Its lack of popularity in the U.S. may be because it is an important host of the fungus *Cronartium ribicola*, which causes white pine blister rust. Active attempts at eradications of *Ribes nigrum* crops have reduced the abundance of black currant but have been ineffective against blister rust (Maloy 1997).

11. *Ribes rubrum* L. – garden red currant ↑

Flowering late Apr.–May; fruiting May–July. Thickets and roadsides; persistent or escape from cultivation. Native to Europe.

Cultivated much longer than *Ribes nigrum*; the 'Red Lake' cultivar, introduced into the U.S. in 1933, has long been popular in the U.S. and

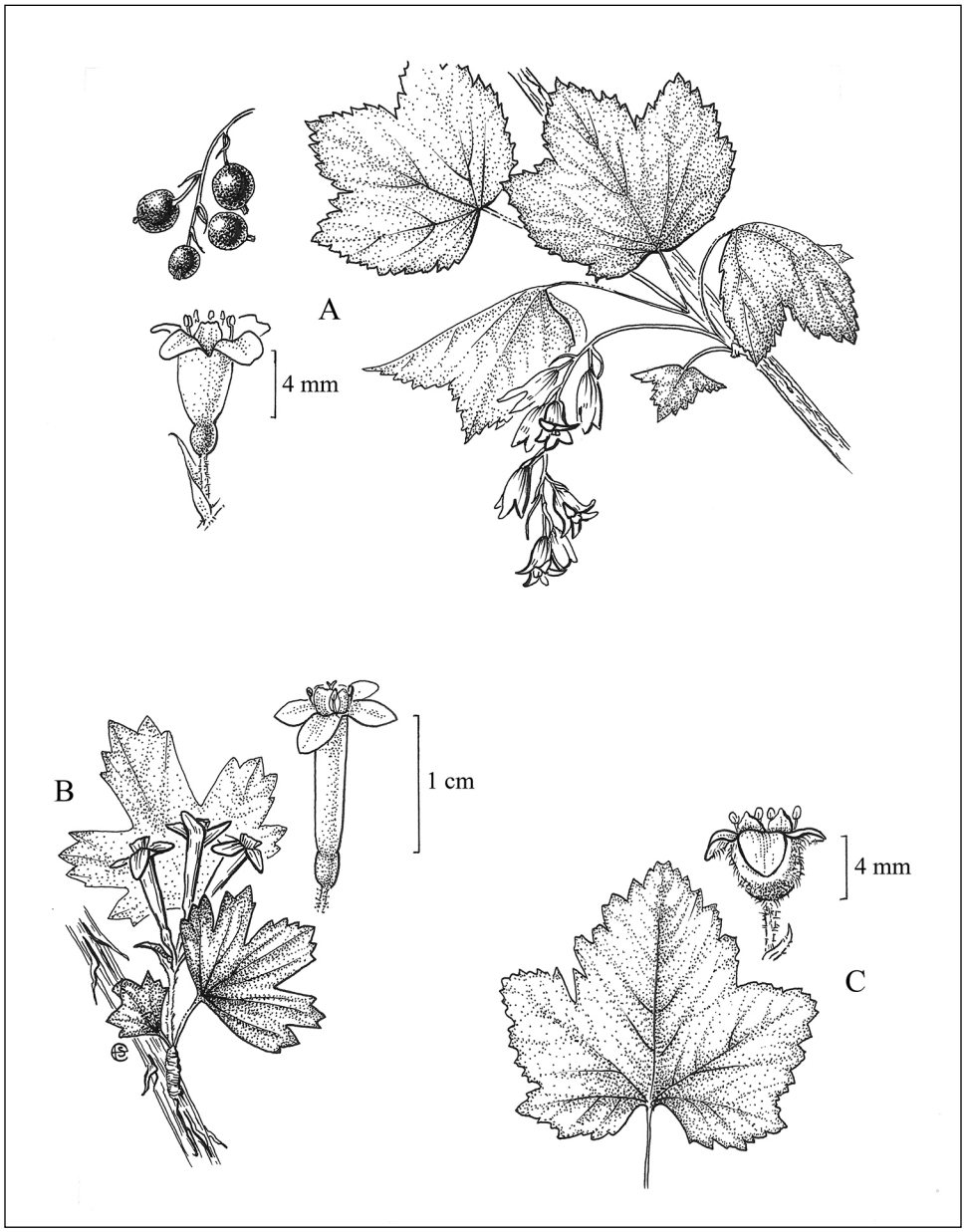
Europe (Brennan 1991). Like *R. nigrum*, is associated with white pine blister rust (Maloy 1997).

12. *Ribes uva-crispa* L. – English gooseberry ↓↓↓

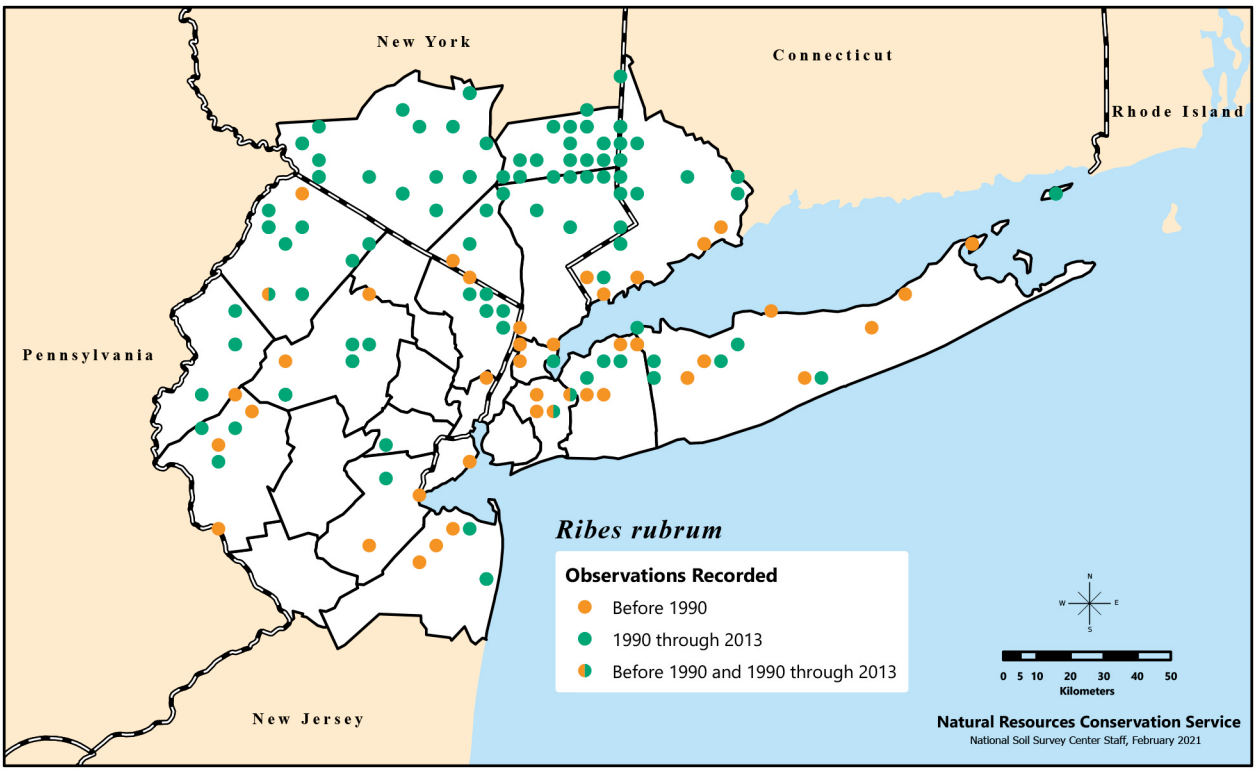
Flowering late Mar.–Apr.; fruiting May–Aug. Thickets and roadsides; persistent or rare escape from cultivation. Native to northern Africa and Europe.

Management

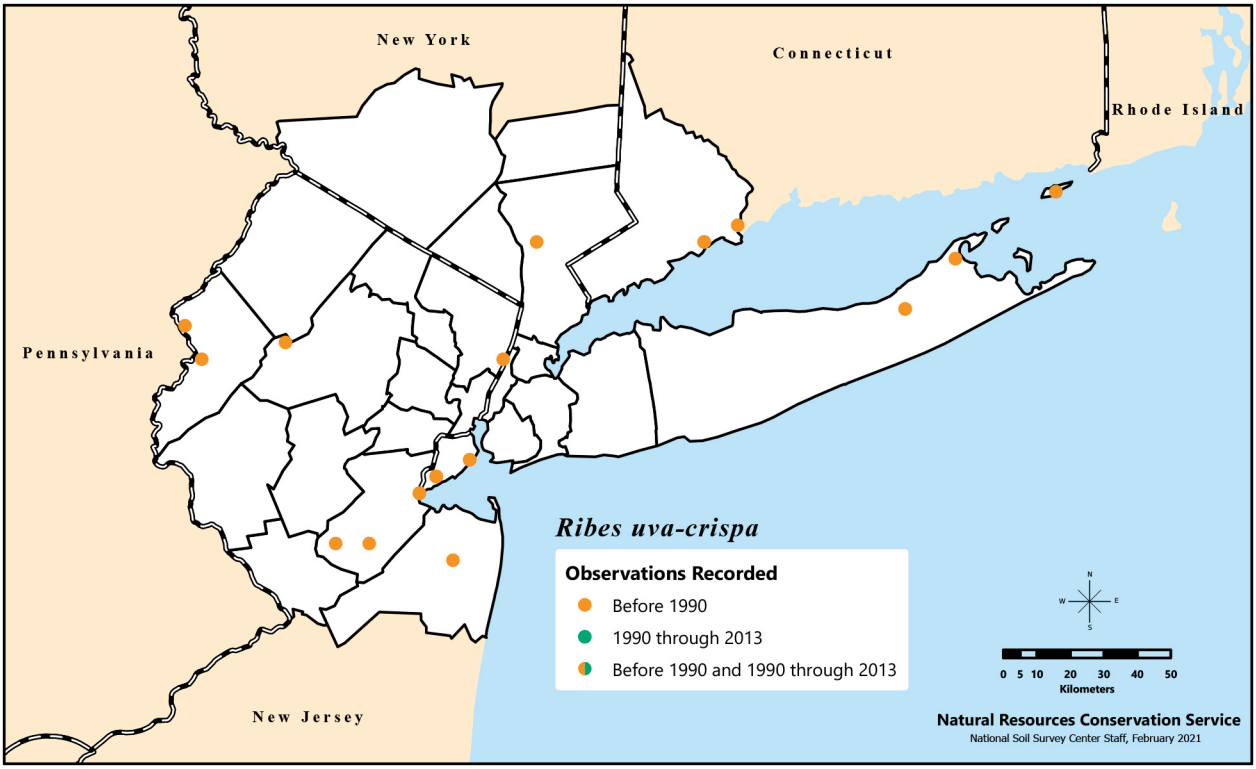
The native *Ribes* spp. appear to be uncommon, stable, or slightly decreasing in the region. One nonnative *Ribes*, *R. rubrum*, has increased slightly, whereas another nonnative *Ribes*, *R. uva-crispa*, has decreased substantially. We encourage planting the cultivated, native *R. americanum* for commercial production of currants, instead of the nonnative *R. rubrum*. *Ribes* is the alternate host for *Cronartium ribicola* (white pine blister rust), so planting of *Ribes* is discouraged near areas where *Pinus strobus* is desired.



A) Flowering leafy twig, fruit, and flower of *Ribes americanum*; B) flowering leafy twig and flower of *Ribes aureum* var. *villosum*; C) leaf and flower of *Ribes nigrum*. Illustration by Emma Skurnick.

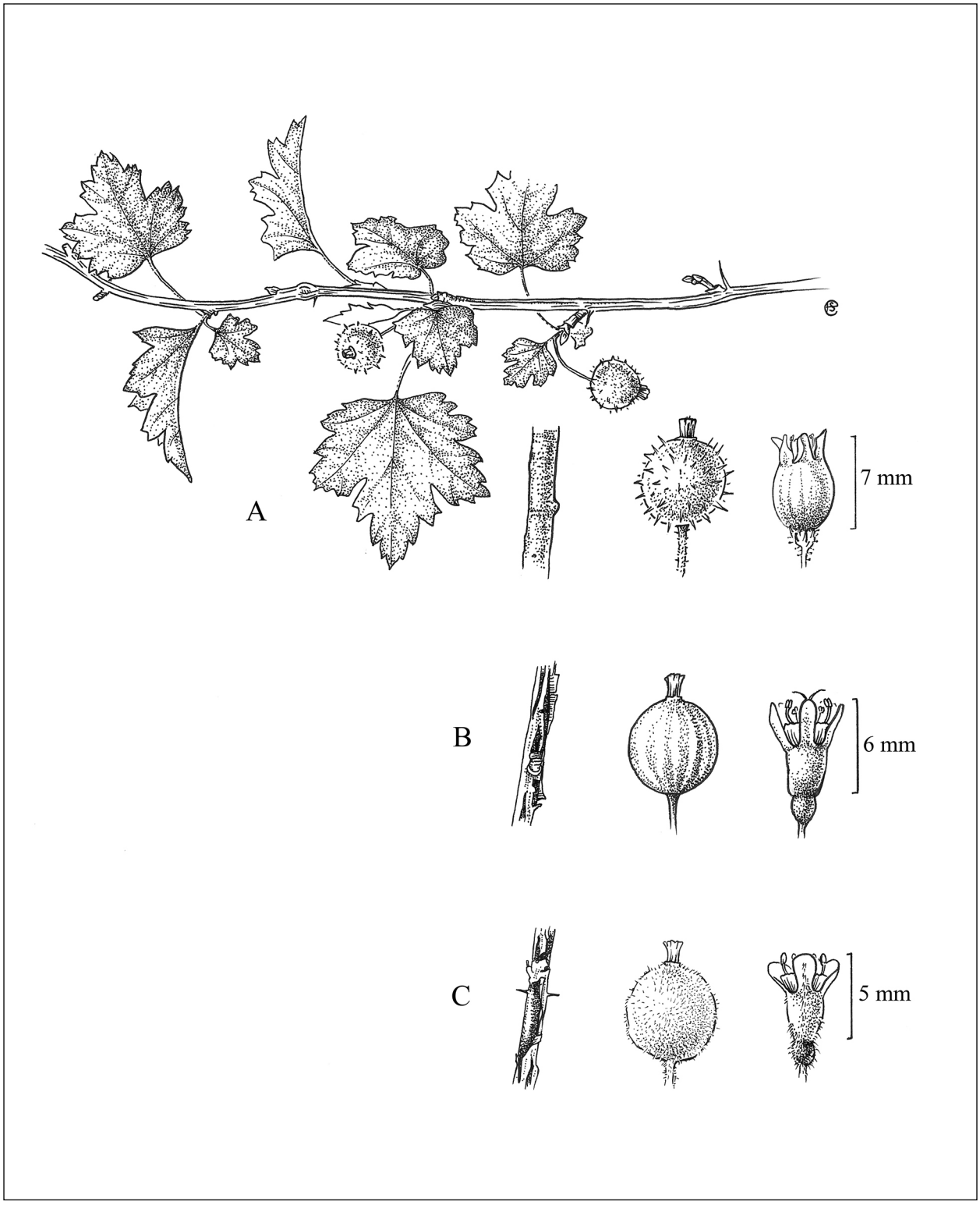


Distribution of *Ribes rubrum*, or garden red currant, recorded in the New York Metropolitan Region during three time categories.

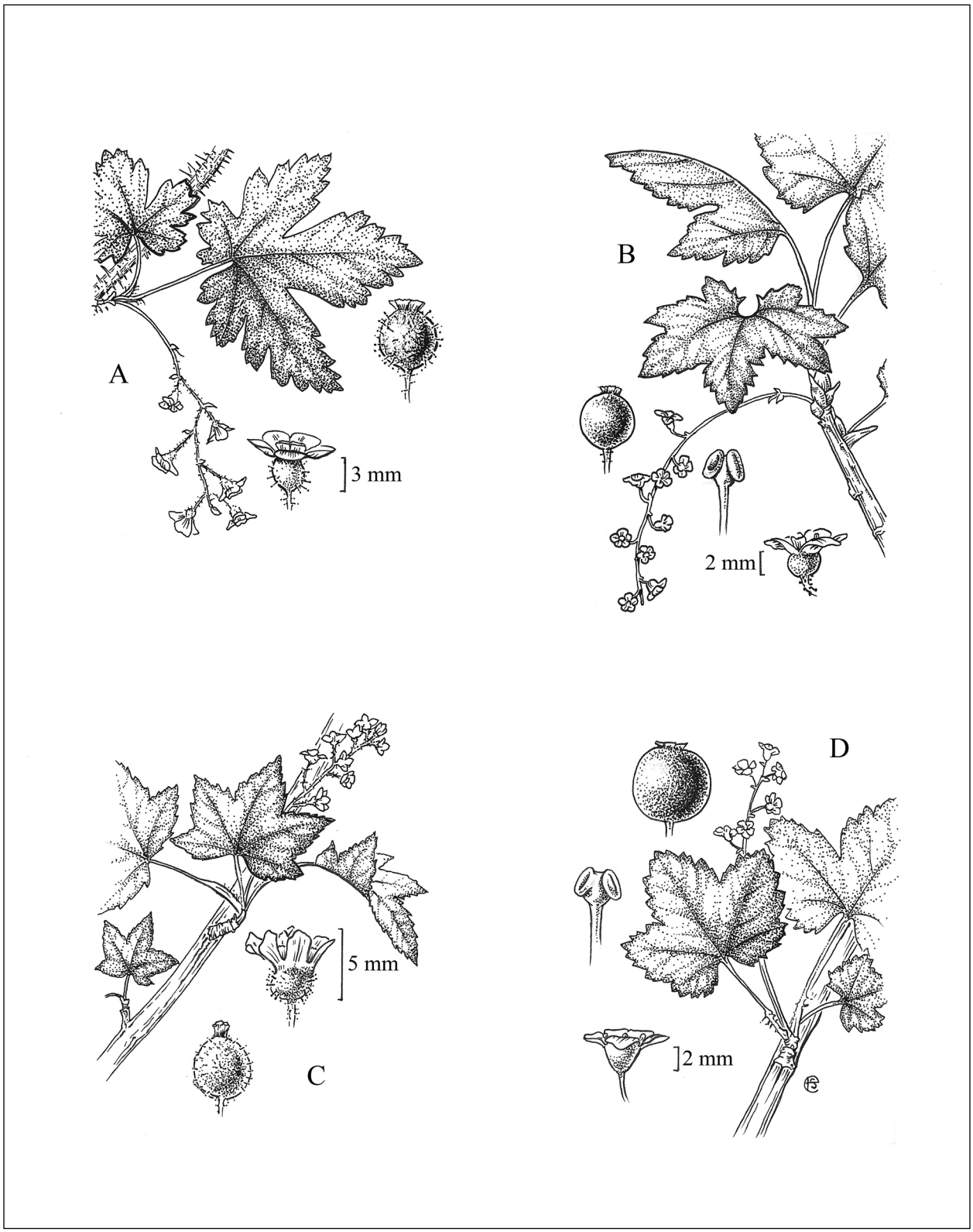


Distribution of *Ribes uva-crispa*, or English gooseberry, recorded in the New York Metropolitan Region during three time categories.

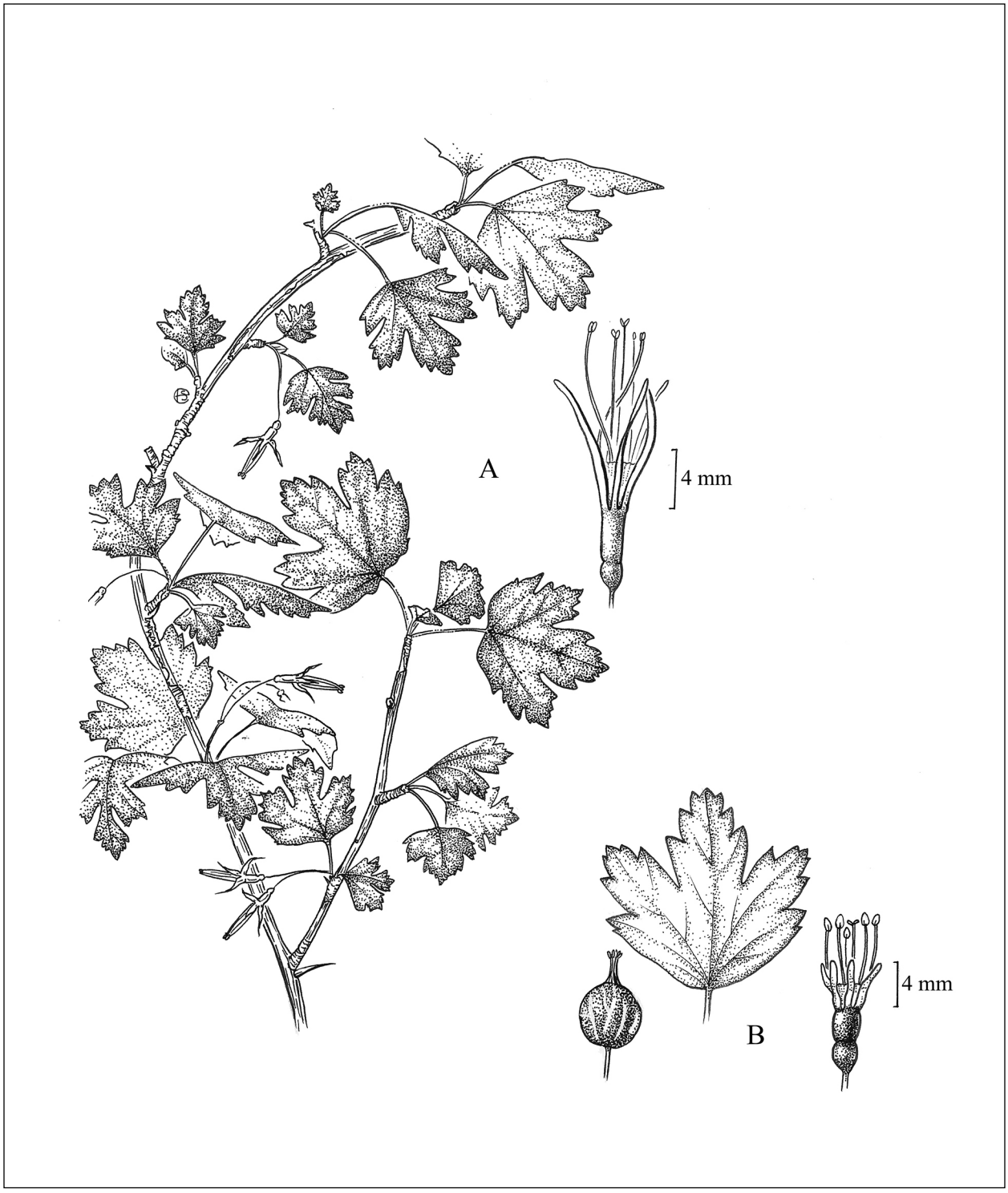
R



A) Fruiting leafy twig, stem, fruit, and flower of *Ribes cynosbati*; stem, fruit, and flower of B) *Ribes hirtelllum* and C) *Ribes uva-crispa*. Illustration by Emma Skurnick.



Flowering leafy twig, fruit, and flower of A) *Ribes lacustre* and C) *Ribes glandulosum*; flowering leafy twig, fruit, flower, and stamen of B) *Ribes triste* and D) *Ribes rubrum*. Illustration by Emma Skurnick.



Twig with leaves, and flower of *Ribes missouriense*; B) fruit, leaf, and flower of *Ribes rotundifolium*. Illustration by Emma Skurnick.

Robinia L. – locust

Fabaceae. Trees, shrubs. Species 4–10 in North America, all cultivated as ornamentals. Leaves pinnately compound; stipules spine-like. Flowers showy in pendulous racemes. Important food plant for many butterflies and moths (order Lepidoptera). Genus name honors French herbalist Jean Robin (1550–1629) and his son Vespasian Robin (1579–1662), the latter introducing *Robinia pseudoacacia* into Europe in 1601.

All of the species are taken as nonnative; their true native ranges are south and west of the region. None was reported as native in early floristic works of the region (Britton 1889, Stone 1911, Taylor 1915).

Nonnative Species

1. *Robinia hispida* L. – bristly locust ↔

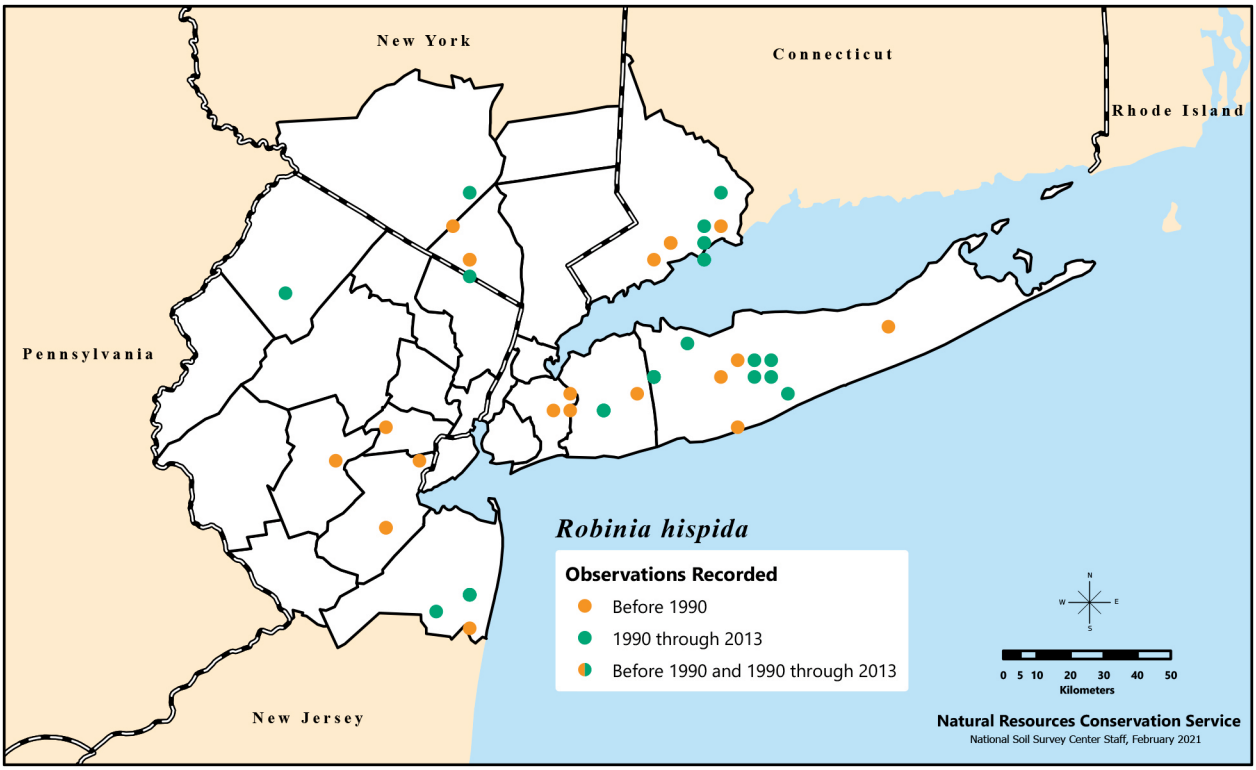
Shrub. Flowering May–June; fruiting July–Sept. Occasional in dry open sandy areas.

This species is mostly sterile (Isely and Peabody 1984) and, thus, is thought not to set seed. However, this is the most variable taxon of this genus; it includes fertile forms (Peabody 1984), which may be known as *Robinia fertilis*. *Robinia hispida* and *R. fertilis* look alike except that *R. fertilis* produces seed, though *R. hispida* may produce seed sparingly (Dirr 1998). Others consider *R. fertilis* a variety of *R. hispida* called *R. hispida* var. *fertilis*; there are 3 other recognized varieties: *R. hispida* var. *kelseyi*, *R. hispida* var. *nana*, and *R. hispida* var. *hispida*. Both *R. hispida* var. *fertilis* and var. *kelseyi* set abundant fruit. *Robinia hispida* var. *fertilis* is widely cultivated and densely bristly. It is native to higher elevations of western NC and eastern TN (Peabody 1984). *Robinia hispida* var. *fertilis* is likely to be the variety described in the natural vegetation of the Great Smoky Mountains in NC and TN, occurring in *Castanea* (chestnut) woods and *Pinus* (pine) heaths (Cain 1931). It is found in northeastern states (NY, PA, MD, VA, OH, IN, and WI) as well as UT, forming some established escaped populations. *Robinia hispida* var. *hispida* is an infertile triploid and it is native to almost the entire range of the species throughout the southeastern U.S., including VA, the southern tip of WV, the southeastern side of KY, NC and SC, GA, eastern AL, and northern FL. One or more of these varieties may be found as far north as ME (Gleason and Cronquist 1993).

This species (including all possible varieties) has spread as far north as MA and as far west as CA. It has become established in northeastern states and the midwestern states but does not appear to spread as well in the more western states. A prolific root sprouter (Peabody 1984). The varieties found in the region may be either the sterile *R. hispida* var. *hispida* or the fertile *R. hispida* var. *fertilis*. This species can grow in soils with low pH and infertile and dry soils (Peabody 1984). *Robinia hispida* (variety not clear) is considered potentially invasive and can hybridize with *R. pseudoacacia*, forming *Robinia* ×*margarettiae*, which has been recorded in four southeastern states (Martine et al. 2008). This species is considered a potentially good source of biofuel because of its relatively high protein,

Robinia Key

1. Branches glabrous or slightly pubescent, not bristly or glandular;
   leaflets glabrous or glabrate; flowers white; fruit glabrous . . . . . ***Robinia pseudoacacia****
1. Branches hispid or glandular viscid; leaflet undersides pubescent;
   flowers pale pink to roseate; fruit hispid. 2
2. Shrub to 2 m tall; twigs hispid; leaflets 7–13;
   flowers usually more than 8 in crowded racemes, roseate . . . . . ***Robinia hispida****
2. Large shrub or small tree to 5 m tall; twigs glandular viscid;
   leaflets 13–25; flowers 3–8 in loose racemes, pale pink. . . . . .***Robinia viscosa****



Distribution of *Robinia hispida*, or bristly locust, recorded in the New York Metropolitan Region during three time categories.

polyphenol, and hydrocarbon content as well as relatively high oil content (Roth et al. 1984).

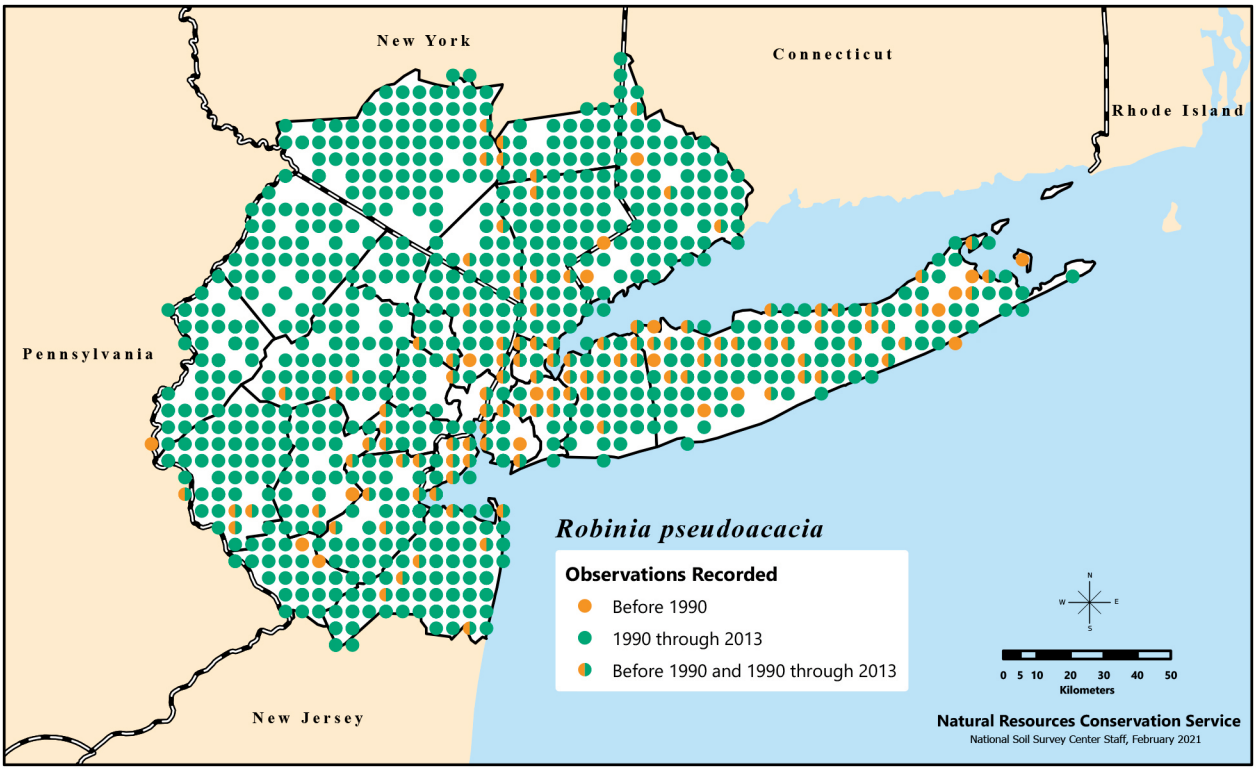
R

2. *Robinia pseudoacacia* L. – black locust ↑↑↑

Tree. Flowering May–June; fruiting July–Sept. Common in disturbed areas, including open woodlands, woodland edges, riverbanks, and fields, on variable soil types from limestone to sand. Epithet a pre-Linnean genus name meaning "false acacia."

This species is native to the Appalachian and Ozark Mountains, connected by the Ohio and Mississippi Rivers. Native range thought to be as far northeast as central PA (Little 1971) or southeastern PA and southwestern NJ (Peabody 1984). Resistance to wood rot has made this species economically important. It has been used for fence posts, construction, and specialty uses requiring a high-density wood with low shrinkage. Because of its high-density wood, it has been considered as a biofuel (Peabody 1984). Historically, this species, a drought-tolerant nitrogen-fixer (Dirr 1998) has been used to restore degraded areas such as strip-mined areas. Drought tolerance may be due in part to its ability to utilize paraheliotropism (leaf movement to minimize exposure to sunlight) to optimize photosynthesis and minimize photoinhibition (Arena et al. 2008, Xu et al. 2009). Also promoted to stabilize soil in the 1930s (Cooper 1950), but the locust borer (*Megacyllene robinae*) made effectiveness unlikely (Peabody 1984). The locust borer attacks the trunk and twigs of *R. pseudoacacia* and causes severe damage and loss of wood quality. Mortality from locust borer more likely on xeric, nutrient-poor sites (Boring and Swank 1984a). The locust borer is still confined to North America (Nicolescu et al. 2020).

The locust leaf miner (*Odontota dorsalis*) also impacts this species. Death can occur if a tree is infested with this insect and two flushes of leaf growth are consumed by the beetle. Trees with relatively high foliar nitrogen concentration are more likely to receive the highest levels of herbivory by the locust leaf miner (Athey and Connor 1989). Further, locust twig borers



Distribution of *Robinia pseudoacacia*, or black locust, recorded in the New York Metropolitan Region during three time categories.

(*Ecdytolopha insiticiana*) are caterpillars that feed on the vascular tissue of twigs, causing the twigs to swell and crack. Repeated attacks from this caterpillar can kill small seedlings of *R. pseudoacacia*. Finally, there is a heart rot fungus (*Phellinus robineae*), which enters the tree through wounds (possibly made by the aforementioned insects) and causes the heartwood to become brown (DeGomez and Wagner 2001). The bark, which absorbs several heavy metal pollutants, may be used as an indicator of long-term pollution in a given area (Samecka-Cymerman et al. 2009).

Planted outside its native range extensively; has escaped and become established as far north as southern QC and ON, as far west as CA, and as far south as FL. No known geographical or ecological varieties (Peabody 1984), though there are at least 13 cultivars. Cultivated in the U.S. since 1635 (Dirr 1998). A diploid with 22 chromosomes (Liu et al. 2006). Introduced into parts of Europe (Hungary) between 1710 and 1720; several specialized cultivars have been developed, especially for forestry and beekeeping. Planned production of this species in 1984 of 8 million plants covered only two-thirds of the demand. Propagation of key cultivars is generally done vegetatively using root cuttings. Plantations of the species in Europe and Asia, excluding China, grew from 337,000 ha to 1,890,000 ha in 20 years (Keresztesi 1983). The production of *R. pseudoacacia* as a biofuel, without application of agrochemicals and extra irrigation, is being promoted in parts of Europe as environmentally sound. Not having to fertilize or irrigate may overcome the negative impacts associated with ethanol compared with conventional gasoline (González-García et al. 2011, Grünewald et al. 2009). In Europe, this species is valued for its honey production; in eastern Europe this honey is valued over other honey types (Peabody 1984). It is marketed as a unifloral honey in Italy and typically is light in color with low conductivity and ash values but high ratios of fructose to glucose with a vanilla flavor (Oddo et al. 1995).

This species was introduced into Korea in the 19th century and promoted in the 1960s under large-scale tree-planting campaigns to reforest denuded landscapes after deforestation during the Japanese occupation period (1910–1945) and the Korean War (1950–1953). Now one of the most extensively established nonnatives in South Korea. More than $83,333 per ha has been spent in an attempt to eliminate this species and restore native vegetation but with little effect (Lee et al. 2004). However, *R. pseudoacacia* can succeed to native vegetation, if no additional disturbances occur (Lee et al. 2004, Motta et al. 2009).

Seeds of different individual trees may vary in type of dormancy. Some show a physical dormancy requiring scarification with acid or heat shock. Others show no physical dormancy or a weak physical dormancy that breaks down over time. Those that show no physical dormancy respond positively to cold moist stratification for 120 days and germinate quickly at a variety of day and nighttime temperatures. Those with physical dormancy could not soak up any water and, thus, did not respond to cold stratification. Those with less physical dormancy over time responded positively to cold stratification with seed age. All three types exist in Japan, where *R. pseudoacacia* has invaded (Masaka and Yamada 2009). This species has also invaded China and Europe. Further research is needed to see whether all three germinating types exist in the U.S. Asexual reproduction through the formation of ramets is the primary means of reproduction in Japan; ramets may not produce viable seed. Ramets may be able to receive photosynthates from the parent tree for only a few years (Jung et al. 2009), but may receive other resources, such as nitrogen and phosphorus, for several years (Jung et al. 2009, Zhang et al. 2006). Small new ramets of this clonal species may be dependent on the parent ramet. More ramets form in high light and more alkaline soil patches than in low light and more acidic patches (Zhang et al. 2006). All three seed-germinating types may also exist in the U.S.

Despite its clonal nature and limited seed dispersal, *R. pseudocacia* is highly outcrossed, possibly because of insect pollination, though it has lower outcrossing rates than other wind-pollinated trees (Surles et al. 1990a). Due to self-fertilization and high levels of vegetative reproduction, individuals may have fewer alleles in common than would be expected for half-sibs. Populations are expected to be composed of at least 20 effective pollen donors in order to be composed of half-sibs (Surles et al. 1990b). There are few geographic patterns associated with the apparent high genetic diversity found in U.S. *R. pseudoacacia* populations. This lack of geographic pattern is most likely due to the widespread planting in the U.S. (Surles et al. 1989). A transgenic form of *R. pseudoacacia* has been developed, using *Agrobacterium tumefaciens*. This transgenic form could lead to selected changes in single traits by the introduction of relevant genes (e.g., morphology, resistance to insects and disease) (Igasaki et al. 2000).

Contains a poison, robinin or robitin, and human and animal poisonings have occurred from eating the bark, seeds, or leaves (Peabody 1984). The highest levels of robinin are found mainly in the bark. Given the high nutritive and digestibility values of the leaves, *R. pseudoacacia* leaves could be good forage for goats (*Capra hircus*) (Burner et al. 2008) and cattle (*Bos taurus*) (Burner et al. 2005) during months when herbaceous forage is limited (e.g., due to drought). Produces allelopathic compounds, including robinetin, myricetin, and quercetin, that may inhibit the growth of other trees and itself (Iqbal et al. 2004, Nasir et al. 2005). The same allelopathic effect against other species may not be found in its native environment. Seeds contain antibacterial proteins that inhibit bacterial growth of at least seven bacteria, including *Pseudomonas syringae* pv *syringae*, *Staphylococcus aureus*, and *Escherichia coli* (Talas-Oğraş et al. 2005).

Flavonoids found in the young roots may help *R. pseudoacacia* establish symbiotic relationships with *Rhizobium* (Scheidemann and Wetzel 1997). A diverse group of *Rhizobia* associate with *R. pseudoacacia* across its native and nonnative range and strains could be selected for efficiency (McCray Batzli et al. 1992). May also form symbiotic interactions with other bacteria in its nonnative range, including *Mesorhizobium amorphae* and *Sinorhizobium meliloti*. Indeed,

most Chinese symbionts may originate from local bacteria that acquired symbiotic genes from the native *Rhizobia* (Wei et al. 2009). Also forms symbiotic relationships with ectomycorrhizae and arbuscular mycorrhizae (Tian et al. 2003) and the relatively rare white truffle, *Terfezia terfezioides*, in Hungary and Italy (Bratek et al. 1996). The mycorrhizal relationships assist in the nitrogen fixation process by providing adequate phosphorus (Tian et al. 2003). The overall impact of native soil biota on *R. pseudoacacia* is negative compared to the soil biota that this species encounters in its nonnative range. The lack of negative soil biota impacts may give *R. pseudoacacia* an advantage and allow it to be more aggressive in its nonnative range both in Europe and in the U.S. than in its native range in the U.S. (Callaway et al. 2011). A 4-year-old stand of *R. pseudoacacia* in its native range was estimated to have fixed nitrogen at a rate of 30 kg per ha per year, which is more than nitrogen inputs from the atmosphere and nitrogen fixation by free-living bacteria. Nodule biomass is mostly concentrated in the upper 15 cm of soil (Boring and Swank 1984b). Danso et al. (1995) estimated nitrogen fixation at 220 kg per ha over 2 years in a 2-year old site in its nonnative range in Austria. The difference could indicate more nitrogen fixation in a nonnative range or other possible site differences including site age.

Planting *R. pseudoacacia* can change soil properties. Increases in nutrient (including calcium, phosphorus, and nitrogen) availability in soils associated with *R. pseudoacacia* (Rice et al. 2004) may facilitate invasion by other nonnative plants, including *Ailanthus altissima* (Call and Nilsen 2003, Von Holle et al. 2006). Although sites that have been restored by the removal of the nonnative *R. pseudoacacia* show a reduction in nitrogen concentration and total nitrogen-mineralization rates as well as a reduction in potassium, calcium, and magnesium after 4 years, net nitrification rates and phosphorus concentrations remain higher than preinvasion levels. Carbon addition may be necessary to ensure complete restoration of the native community, which may respond to the high levels of nitrate and phosphorus with a community dominated by perennial grasses and nonnative weeds (Malcolm et al. 2008). *Robinia pseudoacacia* responds to increases in carbon dioxide by increasing carbon uptake and nitrogen fixation (Feng 2004) with higher increases if arbuscular mycorrhizae are present (Olesniewicz and Thomas 1999).

Listed as invasive in CT (not prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

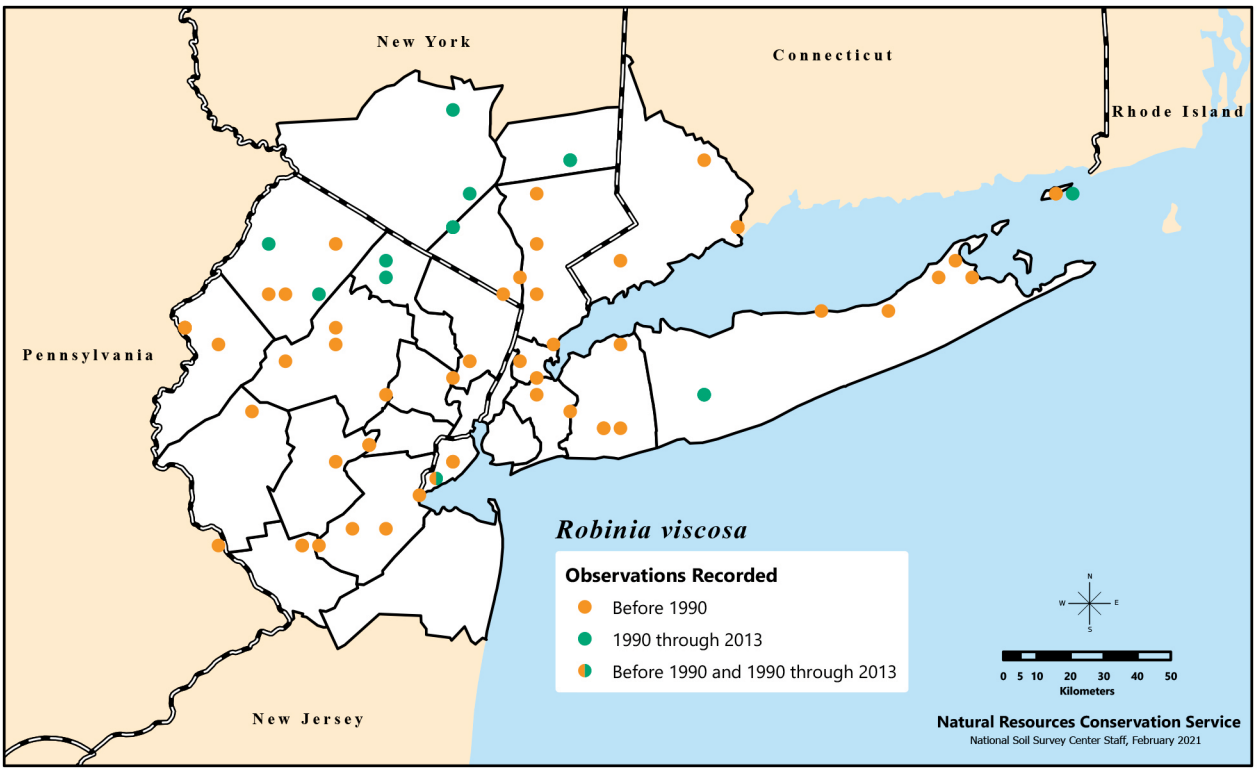
3. *Robinia viscosa* Vent. ex Vauq. – clammy locust ↓↓

Small tree, shrub. Flowering May–June; fruiting July–Sept. Dry open areas. Native range is restricted to the Appalachian Mountains of western NC at elevations between 915 and 1,400 m (Peabody 1984). However, Gleason and Cronquist (1993) state that its native range is in the mountains of PA to AL but that it is also found as an escape from cultivation in other locations throughout the Midwest and Northeast.

There are 2 varieties: *viscosa*, which rarely sets fruit, and *hartwiggi*, which sets many fruit; they are easily distinguished. The variety *viscosa* has sessile viscid glands, whereas the viscid glands of variety *hartwigii* are on short trichomes. *Robinia viscosa* var. *viscosa* is usually less than 2 m tall; *R. viscosa* var. *hartwigii* is usually 4–6 m tall. *Robinia viscosa* var. *hartwigii* is endemic to south-facing slopes in Macon and Jackson Counties (NC) at elevations above 1,200 m. It has not been found elsewhere. Some have suggested that this variety is a hybrid between *R. hispida* and *R. viscosa* (Peabody 1984). It seems counterintuitive that the variety that sets the most seed has spread the least; *R. viscosa* var. *viscosa* may have been selectively planted and then spread vegetatively. The variety most likely found in the region is *R. viscosa* var. *viscosa*. Like *R. pseudoacacia*, *R. viscosa* has been found to contain robinin (Farkas et al. 1976).

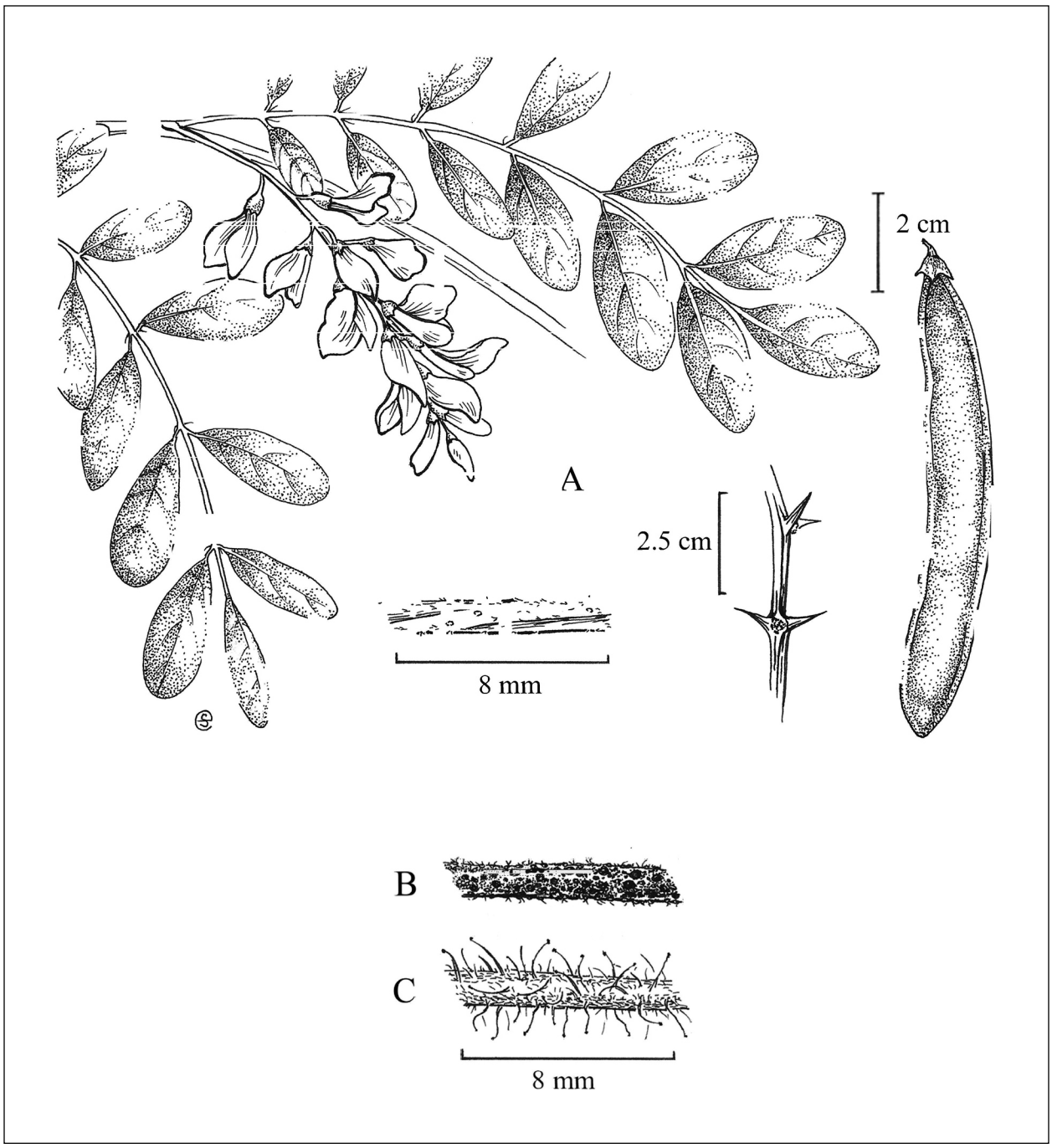
Management

Robinia pseudoacacia has, somewhat insidiously, spread into the region as a nonnative, or some may prefer to call it a native that has expanded outside its range. Some evidence suggests that this expansion is into soils with biota that give



Distribution of *Robinia viscosa*, or clammy locust, recorded in the New York Metropolitan Region during three time categories.

R. pseudoacacia a net growth response, unlike the net negative response in its native range (Callaway et al. 2011). Consequently, we should be concerned that this species may have other advantages over native species in its nonnative range. The ability to facilitate an invasional meltdown (Simberloff and Von Holle 1999) is evident. Removal of the trees is not enough to mitigate their impact on the soil nutrients; their legacy effect requires additional amendments in order to achieve preinvasion soil conditions. Nonetheless, there are many economic reasons (wood, honey, biofuel) to promote the growth of this species. Despite unexpected spread of *R. pseudoacacia* in Europe and Asia, this species is still being exploited economically. How do we capitalize on the economic benefits of this species but not promote its excessive spread? In the U.S., a solution may be as simple as planting only in its native range. Considering its extensive spread in its nonnative range, aggressive control efforts are not realistic. Where possible, disturbance should be reduced if *R. pseudoacacia* is present; then this species can succeed to more shade-tolerant species, probably with the help of the many insects and diseases that can kill it. We advise against using any of the described *Robinia* as a landscape or horticultural tree. The confusion over the varieties of *R. hispida*, especially between *R. hispida* var. *fertilis* and *R. hispida* var. *hispida*, adds uncertainty about possible spread. Given that one variety is fertile and the other is not (or is not very fertile), unplanned spread by seed may be a result. Because all the described *Robinia* are prolific sprouters, even planting an infertile variety could result in unintentional spread. Any removals should include herbicide application to prevent resprouting.



A) Flowering leafy twig, fruit (legume), and thorns and stem of *Robinia pseudoacacia*; stem of B) *Robinia viscosa* and C) *Robinia hispida*. Illustration by Emma Skurnick.

Rosa L. – rose

Rosaceae. Shrubs, some climbing. Species about 150 in northern Africa, Asia, Europe, and North America; most abundant in temperate areas. Readily distinguished from other genera in the rose family by its accessory fruit (commonly called a hip) composed of a fleshy or hard calyx tube (hypanthium) enclosing numerous bony achenes. Flowers visited by a wide range of insects; bumble bees (*Bombus* spp.), and honey bees (*Apis* spp.) are most likely the main pollinators (Bruun 2005, Jesse et al. 2006b, Kevan 2003, MacPhail and Kevan 2007). Self-pollination also reported (Kevan 2003, Ueda and Akimoto 2001). Widely cultivated for ornament; some, especially *Rosa canina*, cultivated for edible fruits that are rich in vitamins (especially C). "Rosa" is the ancient Latin name for the genus.

Rosa Key

1. Styles united into a column, protruding from the orifice of the hypanthium; stems climbing or trailing 2
1. Styles distinct, only slightly if at all exserted, with usually only the stigma exserted; erect to arching, usually colonial shrubs. 3
2. Flowers pink; leaflets 3 or 5; stipules entire or nearly so . . . . . ***Rosa setigera****
2. Flowers white; leaflets 7 or 9 4
3. Outer sepals pinnatifid or at least with narrow lateral lobes 5
3. Outer sepals entire 6
4. Stipules dentate . . . . . ***Rosa luciae* var. *luciae****
4. Stipules pectinate and glandular-toothed . . . . . ***Rosa multiflora****
5. Lower leaf surfaces glabrous or nearly so; leaf teeth glandless. . . . . ***Rosa canina****
5. Lower leaf surfaces glandular; leaf teeth glandular 7
6. Leaflets rugose, densely soft-pubescent beneath; young branches, thorns, leaf rachises, and pedicels densely pubescent . . . . . ***Rosa rugosa****
6. Leaflets not rugose, glabrous, or slightly pubescent beneath; young branches, prickles, and often other parts glabrous or stipitate-glandular 8
7. Styles glabrous; sepals soon deciduous . . . . . ***Rosa micrantha****
7. Styles pubescent; sepals erect and persistent in fruit . . . . . ***Rosa rubiginosa****
8. Infrastipular prickles absent or straight; internodal spines often of similar shape and size 9
8. Infrastipular prickles strong and slightly curved toward the base of the plant; internodal prickles absent or occasional at base of plant 10
9. Sepals persistent and connivent as a beak on fruit; flowers borne on lateral branches from stems of previous year; prickles absent or confined to base . . . . . ***Rosa blanda***
9. Sepals deciduous in fruit; flowers borne on current year's stems; prickles found throughout the stem 11
10. Pedicels and hypanthia smooth, glabrous; sepals erect on the mature fruit. 12
10. Pedicels and hypanthia glandular-hispid; sepals widely spreading on mature fruit 13
11. Stems with few prickles; stipules fine, linear. . . . . ***Rosa carolina***
11. Stems with hundreds or thousands of prickles; stipules herbaceous, expanded above . . . . . ***Rosa nitida***
12. Flowers single . . . . . ***Rosa cinnamomea****
12. Flowers double. . . . . ***Rosa majalis****
13. Leaves finely serrate; stipules firm, linear, or with parallel sides . . . . . ***Rosa palustris***
13. Leaves coarsely serrate; stipules herbaceous, dilated toward the apex . . . . . ***Rosa virginiana***

1. *Rosa blanda* Aiton − meadow rose ↓↓↓

Recognized as occurring in NY (Peck 1897, Weldy et al. 2020) and CT (Graves 1910) but not in the NY Metropolitan Region. Britton (1889: 98) reported this species from NJ from Hunterdon and Sussex Counties but noted, "[B]oth specimens referred to this species with hesitation." The NJ Natural Heritage Program regards its status in the state as undetermined (Snyder 2016). Taylor (1915) also did not definitively report this species from the region, instead using the name *R. solanderi* Tratt. Further research is needed to determine the species' status for the region. Epithet from Latin refers to the lack of prickles or prickles confined to the base of the stem or widely scattered above the base.

2. *Rosa carolina* L. – pasture rose ↑

Flowering June–July. Dry, sandy, or rocky open areas. Common throughout the region but largely absent from urbanized areas. May also be found on low wet ground and borders of swamps and streams (Dirr 1998).

Height at maturity 2 m; freely suckers and forms dense thickets. Cultivated since 1826 (Dirr 1998).

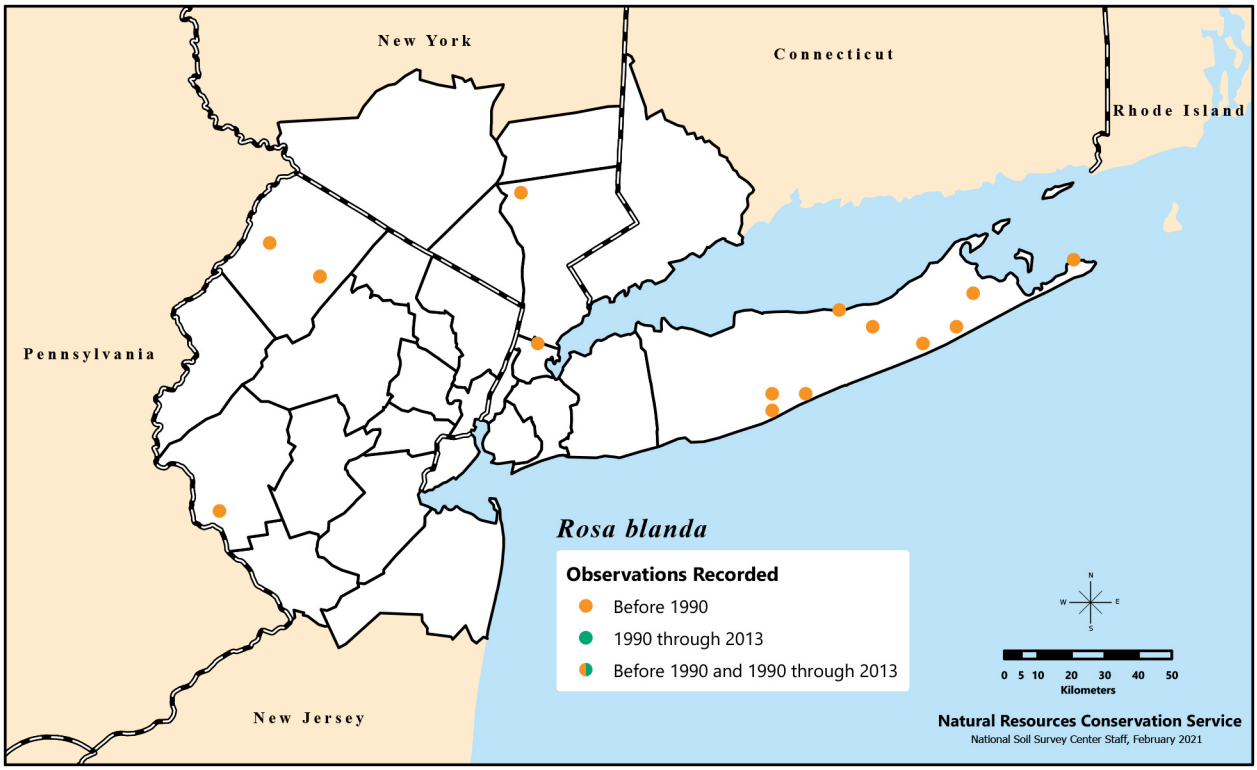
***Rosa nitida* Willd. – New England rose**

Early floras (Britton 1889, Fernald 1950, Graves 1910, Peck 1897, Taylor 1915) did not report this species from the region. It was reported from CT, where it is currently tracked as a species of special concern, and outside the region but not from NJ or NY. Reports of this species from the region need further review before the species is accepted as having occurred in the region. Epithet is from the Latin "nitidus," meaning "shining," a reference to the plant's lustrous leaves.

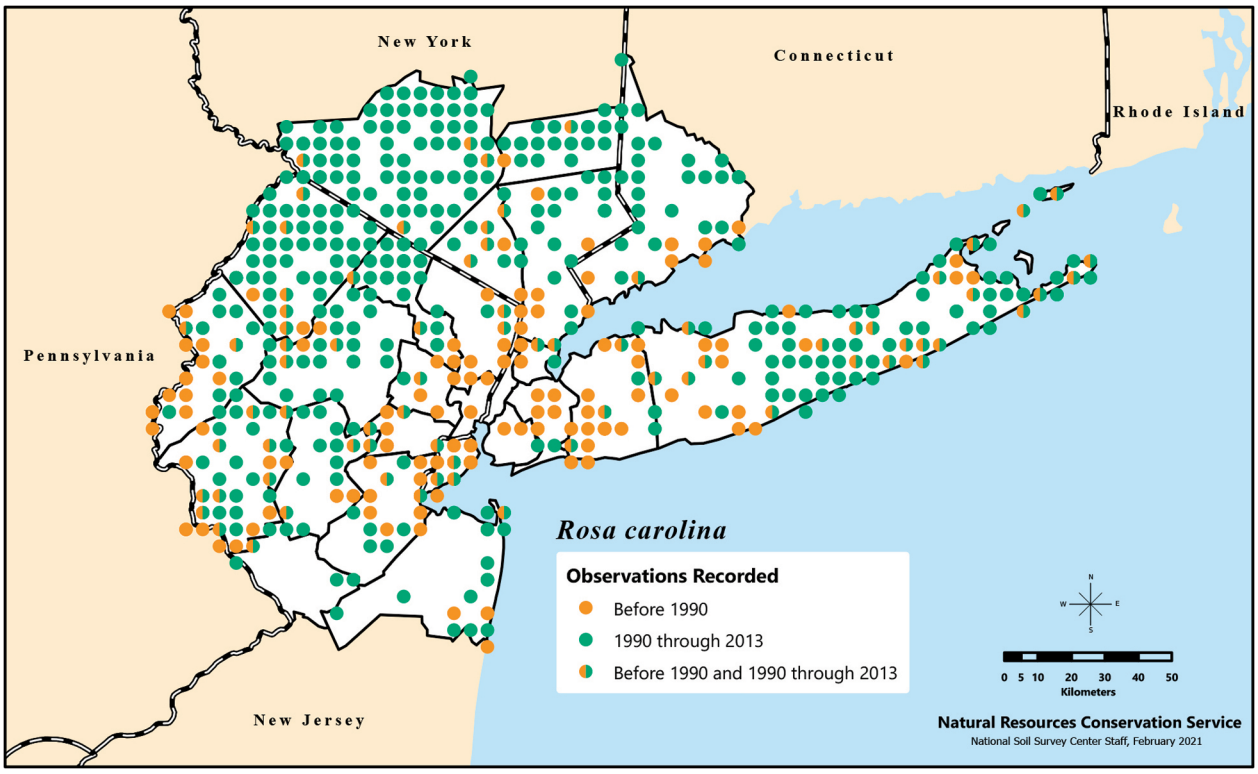
3. *Rosa palustris* Marshall – swamp rose ↑↑

Flowering June–early Aug. Open swamps and marshes. Common throughout the region, but largely absent from urbanized areas.

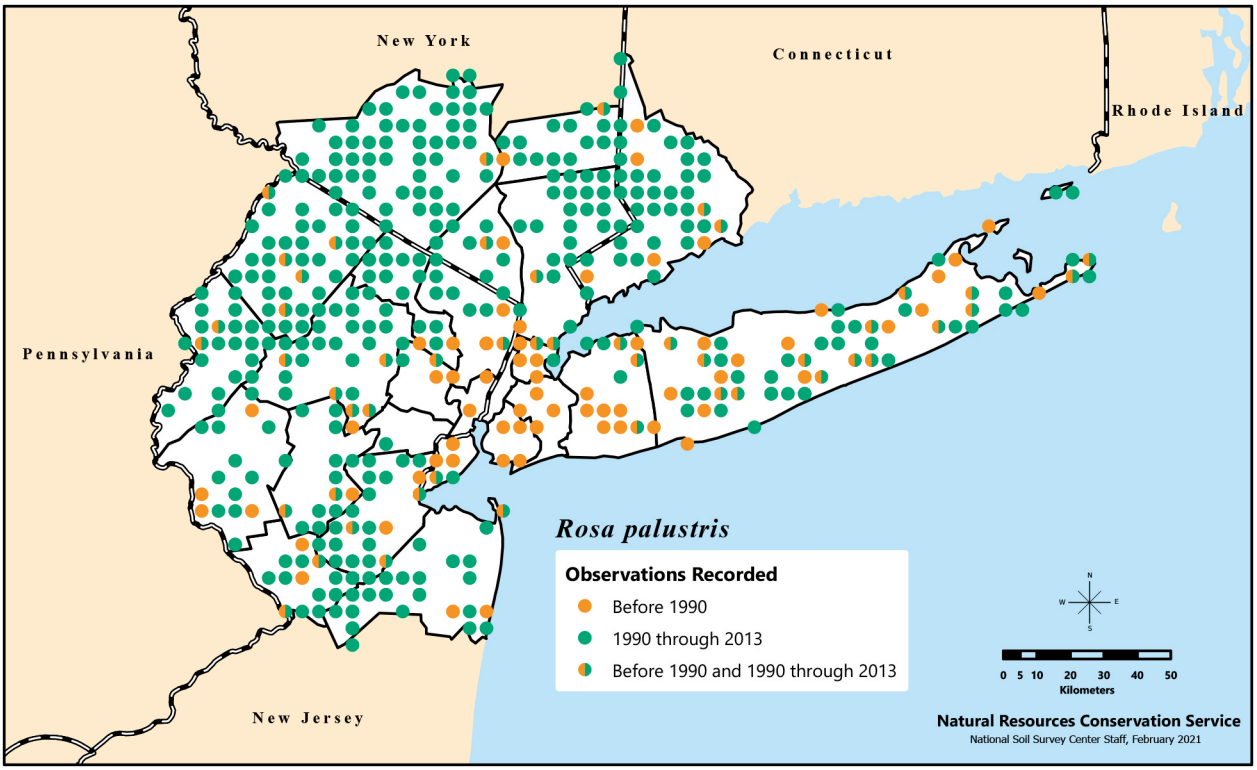
Height at maturity 2 m (Gleason and Cronquist 1993). Considered a good indicator species of high-quality wetland habitats (Stapanian et al. 2013). Though *R. palustris* and *R. nitida* are



Distribution of *Rosa blanda*, or meadow rose, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rosa carolina*, or pasture rose, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rosa palustris*, or swamp rose, recorded in the New York Metropolitan Region during three time categories.

R

easy to distinguish morphologically, they do not differ genetically, suggesting a recent origin or split of the two species (Joly and Bruneau 2006). Increases in the region are not readily explained.

4. *Rosa virginiana* Mill. – wild rose ↔

Flowering June–July. Dry, sandy, or rocky open areas. Occasional throughout the region, but not as common as *R. carolina* or *R. palustris*.

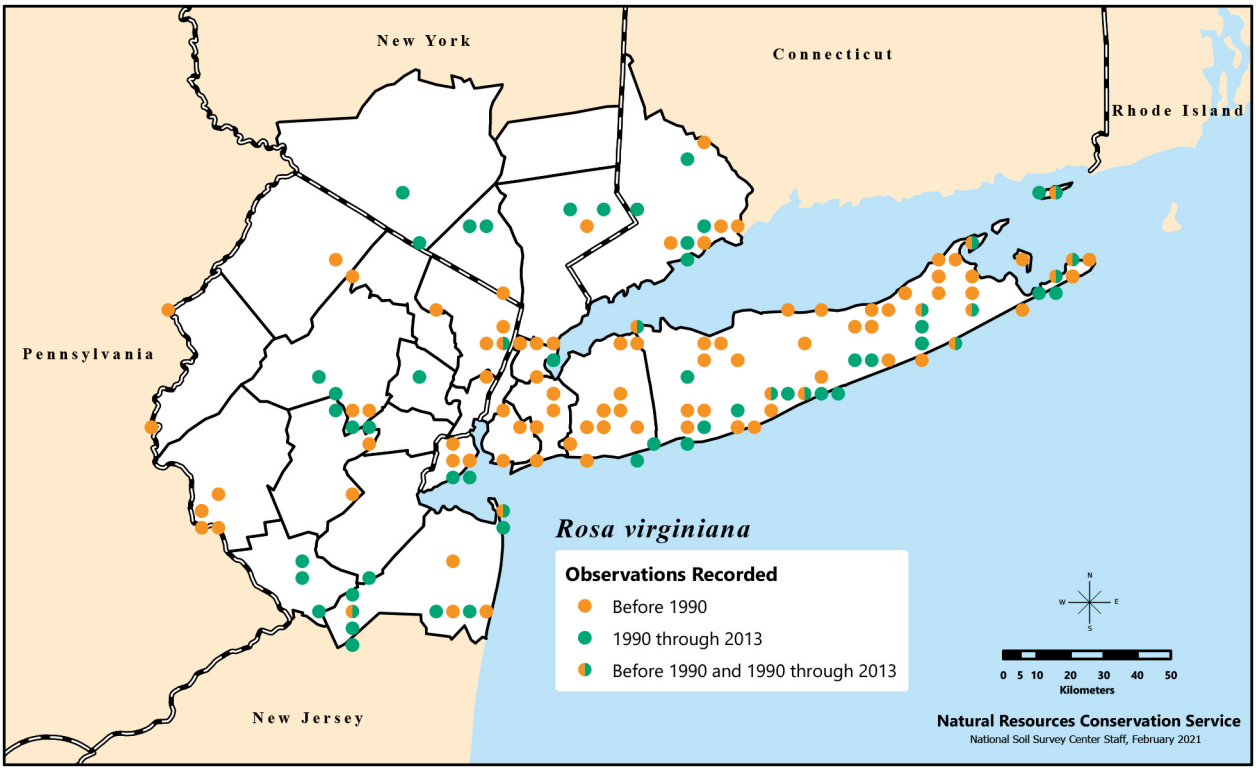
Height at maturity 2 m; suckering forms dense mats. Has excellent form, and its summer and fall foliage are attractive, making this a good landscape shrub that also serves as an effective barrier or low hedge (Dirr 1998). The three native roses (*R. carolina*, *R. palustris*, *R. virginiana*) are closely related and where they occur together, intermediate material that presumably reflects hybrid material can be found. Honey bees prefer the first-day flowers over the second-day flowers, despite having equal pollen rewards, due to the visual attractiveness. Second-day flowers are paler, and anthers darker (MacPhail et al. 2007). Cultivated since 1807 (Dirr 1998).

Nonnative Species

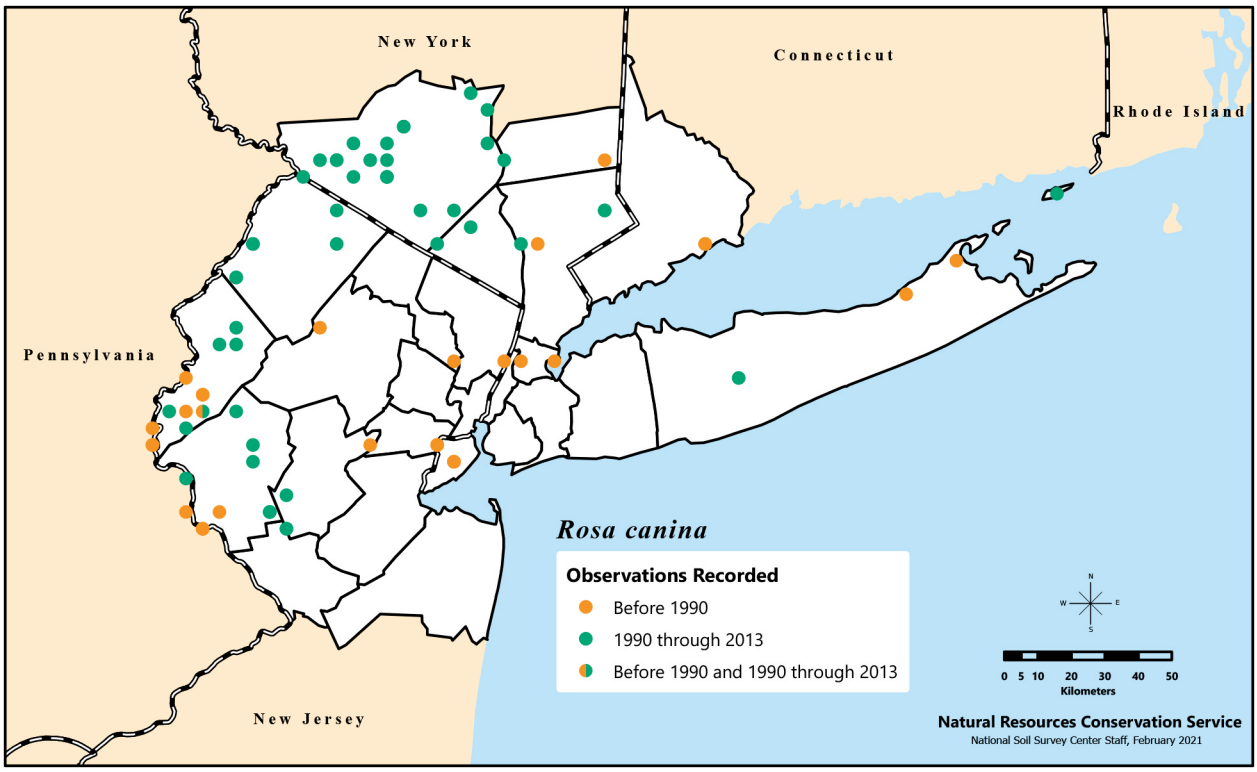
5. *Rosa canina* L. – dog rose ↑

Flowering June–July. Native to Europe. Occasionally naturalized in upland woods and thickets. Species epithet from Latin presumably is a reference to the biting nature (like a dog) of the prickles (Howard 1987) or its lower garden value compared to other roses (Vedel and Lange 1971).

Arching shrub (Gleason and Cronquist 1993). Considered an invasive nonnative plant in New Zealand, though not ranked among the greatest conservation threats. However, it is documented as displacing native species as early as 1895 in New Zealand (Kirk 1895). Though nonnative and noted as escaping, it is not described as an invasive in NY or NJ in state records. It is reported in NJ and NY as well as 27 other states (University of Georgia 2018). MD reports it as an invasive plant (University of Georgia 2018). The public records are likely to be less accurate, but its presence in several states indicates an invasive tendency. Further evaluation is needed.



Distribution of *Rosa virginiana*, or wild rose, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rosa canina*, or dog rose, recorded in the New York Metropolitan Region during three time categories.

There are vouchered specimens of this rose from NY from as early as 1910 (Weldy et al. 2020). Several medicinal properties associated with *R. canina*, including possible anti-weight gain effects (Ninomiya et al. 2007), treatment of osteoarthritis (Chrubasik et al. 2006), and an activated carbon source from its seeds (Gurses et al. 2006). A pentaploid; its genetics are unusual in that this species is described as having permanent odd polyploidy (7 bivalents divide during meiosis, but 21 univalents are retained at 1 pole during meiosis, remaining intact). The latter may help conserve any existing fitness (Lim et al. 2005). During the formation of pollen, the univalents are eliminated (resulting in 7 chromosomes), but this is not true for the egg-cells, in which there are 28 chromosomes (both univalents and bivalents). Hybrids with 35 chromosomes are fertile, with the mother plant's characteristics dominating (Kroon and Zeilinga 1974). The permanence of the univalents may eventually result in mutational degradation; however, there is no evidence for this yet, possibly due to the relatively recent evolutionary origin of the *R. canina* meiotic system (Lim et al. 2005).

Both a warm (20 °C for 60–90 days) and a cold stratification (4 °C for 60–150 days) improve germination of this species (Meyer 2008c). *Rosa canina* is a rootstock variety associated with popular hybrid tea varieties of roses (*Rosa hybrida* L.), of which there are more than 10,000 varieties; about 80 new ones are submitted annually (Esselink et al. 2003). In New Zealand, *R. canina* may suffer from infections by *Megastigmus aculeatus*, a seed chalcid, which also infects *R. rubiginosa*, *R. multiflora*, and *R. virginiana* in Europe (Syrett 1990). Forms seed banks of unknown duration (Bakker et al. 1996).

6. *Rosa cinnamomea* L. – cinnamon rose Ø

Flowering June–July. Native to Asia and Europe. Rarely found naturalized in the region in disturbed open uplands. Possible or likely naturalized populations reported from Fairfield County (CT), Mercer County (NJ), and Queens and Suffolk

Counties (NY). Epithet refers to the supposed spicy fragrance of the flowers.

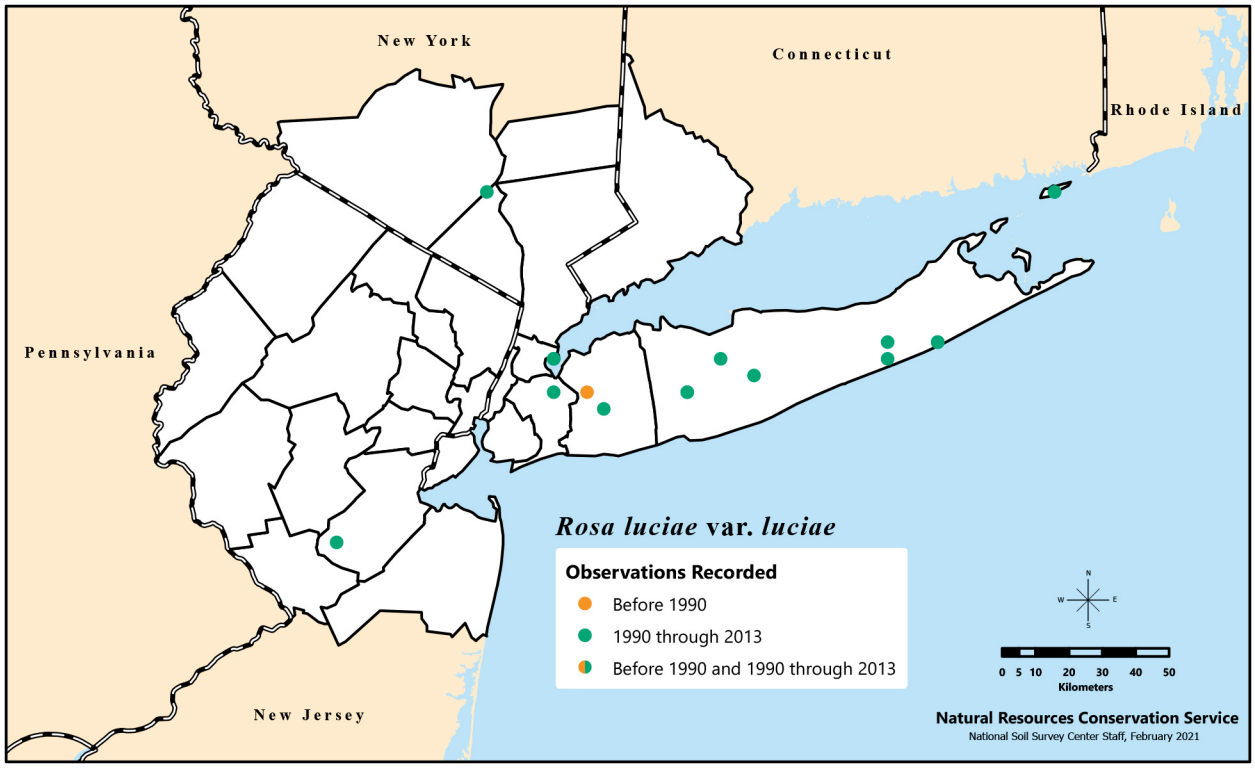
Rosa cinnamomea has been in NY since at least 1914 (Weldy et al. 2020). Potentially invasive (Reichard 1994, University of Georgia 2018). Suggested as suitable for planting in woodlands (NatureGate, n.d.), which is of concern if an invasive tendency associated with this nonnative can be confirmed.

7. *Rosa luciae* Franch. & Rochebr. var. *luciae* – memorial rose ↑↑↑

Rosa wichuraiana Crép.

Flowering May–July. Native to eastern Asia. Occasionally encountered in the region; naturalized in open disturbed areas. Epithet honors Madame Lucie Savatier, wife of Paul Amédée Ludovic (1830–1891), a French physician and noted collector of plants in Japan.

Like *Rosa multiflora*, *R. luciae* is aggressively colonial. Instead of having fringed stipules, it has dentate, jagged stipules (Gleason and Cronquist 1993) and is semi-evergreen (Dirr 1998, Gleason and Cronquist 1993). Has invaded primarily the eastern U.S.; found as far west as AR (USDA NRCS 2019). Introduced into the U.S. in 1891; still advertised as making excellent groundcover, easy to cultivate, and suffering from few diseases. Primarily found along beaches and coastal hills in its native habitat of Japan (Dirr 1998), which suggests some similarity with the maritime species, *R. rugosa*. Like *R. rugosa*, *R. luciae* is also diploid (Crespel et al. 2006) but self-fertile. Can form a fertile tetraploid when crossed with *R. rugosa* (Ma et al. 2000). Both recurrent and nonrecurrent flowering plants are found, though the nonrecurrent gene is dominant (Semeniuk 1971). *Rosa luciae* is a preferred browse species in Japan (Okuda and Nakane 1990). While being a preferred food source may help control this species, it may also indicate that the seed will be dispersed by deer (*Odocoileus* spp.) as well. Cold stratification for 60 days required for germination (Meyer 2008c).



Distribution of *Rosa luciae* var. *luciae*, or memorial rose, recorded in the New York Metropolitan Region during three time categories.

8. *Rosa majalis* Herrm. – double cinnamon rose Ø

Flowering June–July. Native to Asia and Europe. Rarely found in the region.

Rosa majalis has been in NY since at least 1990 based on herbarium records (Weldy et al. 2020), and appears to have originated from Europe and perhaps Siberia (Gleason and Cronquist 1993). Possible or likely naturalized populations reported from Fairfield County (CT) and Rockland County (NY). Has a colonial growth form (Gleason and Cronquist 1993). Very little information exists on this species; whether or not it exhibits invasive behavior is not documented in the literature.

9. *Rosa micrantha* Sm. – smallflower sweetbriar ↓↓↓

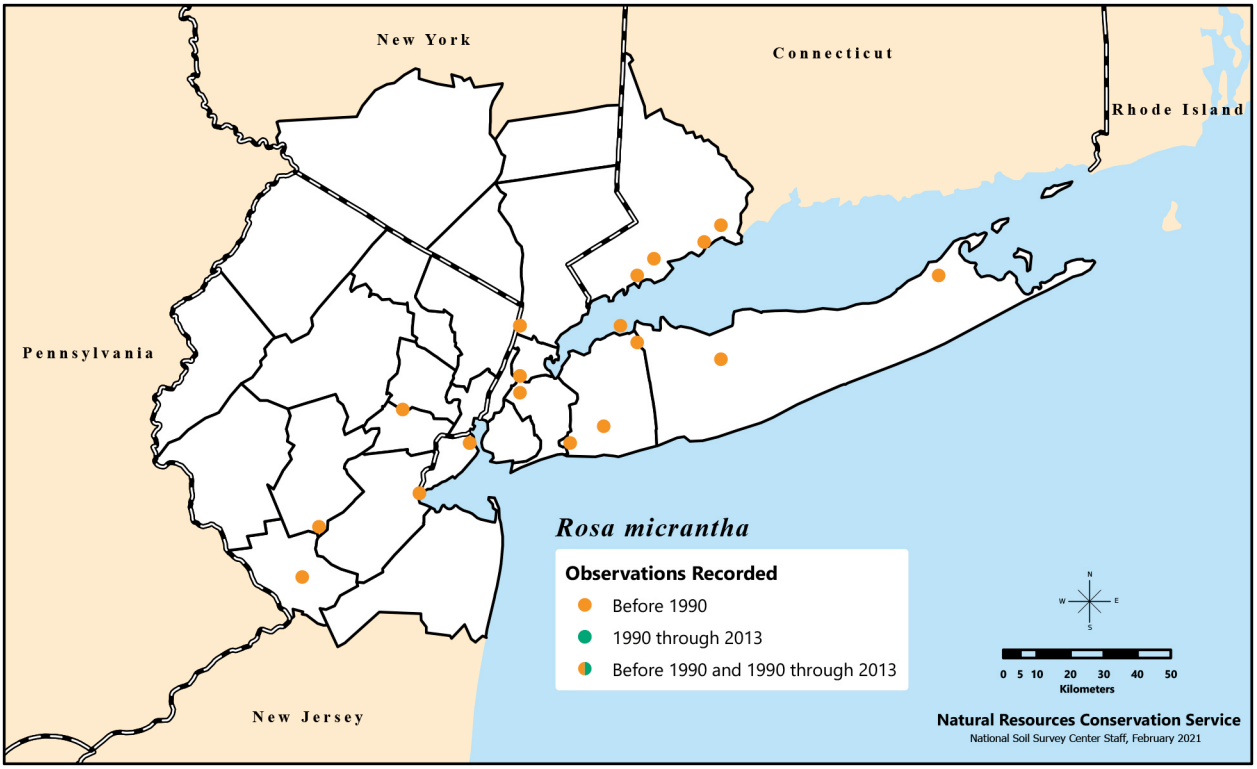
Flowering June–July. Native to Europe. Historically reported from the region in open uplands. Current sites are not known. The species is close to *R. rubiginosa*. Species epithet refers to the flowers' small size.

Rosa micrantha has erect stems (Gleason and Cronquist 1993). Present in NY since at least 1864 (Weldy et al. 2020). Little information about this species; invasive behavior has not been documented in the literature.

10. *Rosa multiflora* Thunb. – multiflora rose ↑↑↑

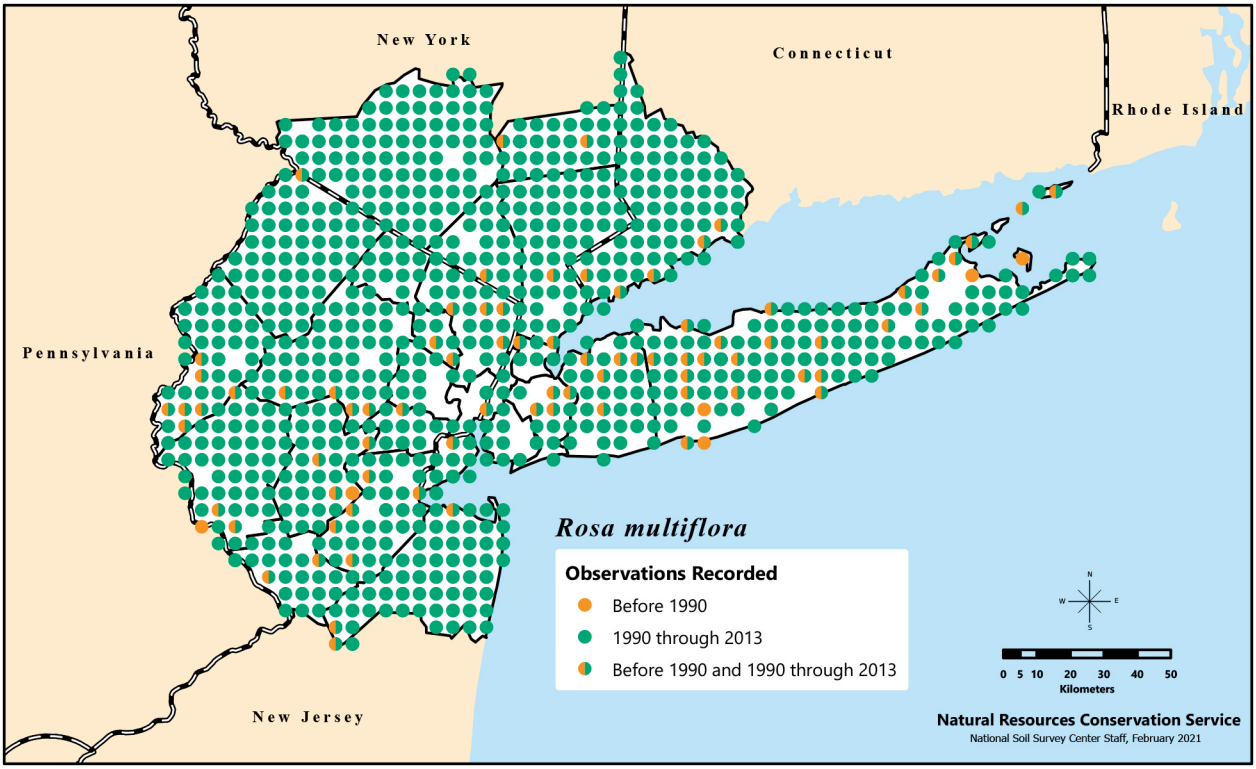
Flowering May–June. Native to Asia. One of the region's most serious invasive plant species; occurs in a wide variety of habitats, including forests (Huebner 2003) and pastures (Rhoads and Block 2007), but prefers open, disturbed dry to mesic habitats. The invasive material usually has simple (i.e., 5-petaled) white flowers, although some material can have simple pink flowers. Material with "double" (i.e., many petals) pink flowers, which may be referable to *Rosa multiflora* var. *carnea* Thory, is occasionally encountered in the region as a remnant from cultivation or naturalized (but not invasive).

Introduced into the U.S. from Japan in 1868 (Dirr 1998). Aggressively colonial (Gleason and Cronquist 1993). Promoted as a "living



Distribution of *Rosa micrantha*, or smallflower sweetbriar, recorded in the New York Metropolitan Region during three time categories.

fence," soil stabilizer, and wildlife food and cover in the 1930s (Derr 1992, Dugan 1960) and thus was planted widely, especially along field edges. An obligate outcrosser; utilizes a variety of common generalist pollinators (Jesse et al. 2006a). Cold stratification for 90–120 days required for germination (Meyer 2008c, Dirr 1998). Seeds are dispersed by several animals including turkeys (*Meleagris gallopavo*) and other birds, and mice (*Mus* spp.) (McDonnell 1986, Nalepa and Piper 1994). Seed bank viable for at least 20 years (Kay et al. 1995, Luginbuhl et al. 1999), which is probably true for most *Rosa* spp., though conditions required to break dormancy vary (Meyer 2008c). Used as a rootstock for other roses, with 371 rose species considered its progeny (Paris and Maney 1939, Rosu et al. 1995, Shepherd 1954). At least 3 cultivars (Dirr 1998). Repeated herbivory (Bryan and Mills 1988, Luginbuhl et al. 1999) and infection by rose rosette disease can be lethal (Di et al. 1990, Epstein et al. 1997, Hindal and Wong 1988). The causative agent of rose rosette disease is yet to be identified. An eriophyid mite (*Phyllocoptes fructiphilus*) is thought to be the vector of the disease. However, several other arthropods have been found to be associated with diseased plants and could also serve as possible vectors (Jesse et al. 2006a). Infection appears to be more likely in open habitats (Epstein and Hill 1995); the eriophyid mite is more abundant on diseased plants in open habitats (Jesse et al. 2006a). Native and other cultivated *Rosa* spp. are also known to be susceptible to rose rosette disease (Crowe 1983, Epstein and Hill 1999). May suffer from infections by *Megastigmus aculeatus*, a seed chalcid or adult wasp, which is also known to infect *R. rubiginosa* (Syrett 1990). May be infected by *Phragmidium mucronatum* and *P. tuberculatum*, both rust fungi, but often at a much lower rate than other *Rosa* spp. (Ritz et al. 2005). Responds well to vesicular-arbuscular (VA) mycorrhizal inoculations (Davies et al. 1987, Paterson et al. 1986), and it forms *Arum*-type associations (Ahulu et al. 2007). It serves as a preferential nest site for some native birds (Heckscher 2004, Stoleson and Finch 1999). Seed predation has been documented as



Distribution of *Rosa multiflora*, or multiflora rose, recorded in the New York Metropolitan Region during three time categories.

being higher under this shrub, possibly because it serves as cover for the predators (Meiners and LoGiudice 2003). *Rosa multiflora* declines as a pasture undergoes succession, converting to forest (Banasiak and Meiners 2009). Despite this, *R. multiflora* has increased substantially in the region.

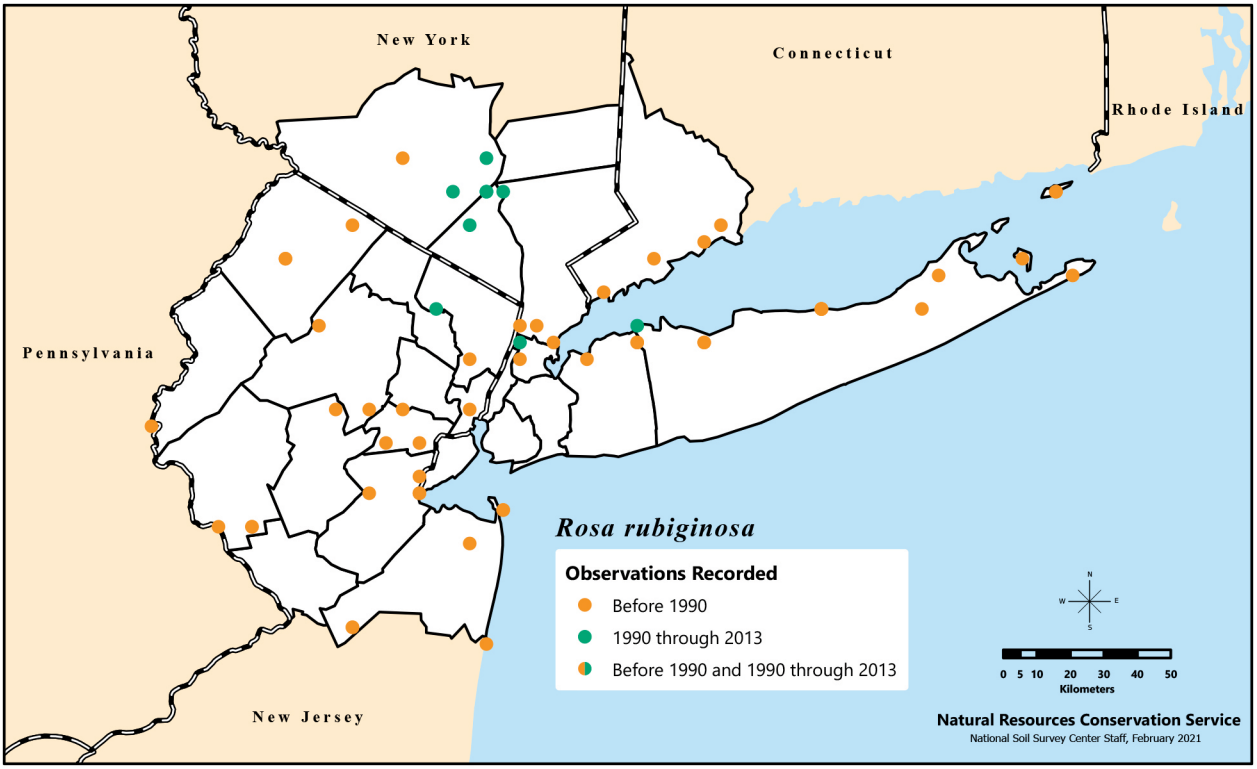
Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

11. *Rosa rubiginosa* L. – sweetbriar rose ↓↓↓

Rosa eglanteria L. (formally rejected name)

Flowering June–July. Native to Europe. Rarely encountered in the region, but prefers open, disturbed uplands. Reasons for its substantial decline unclear.

May be as invasive in Argentina as *Rosa multiflora* in the U.S. (Aguirre et al. 2009) and in New Zealand, where it is considered naturalized (Bellingham et al. 2004). Has also invaded parts of Africa, Indonesia, and Australia (De Pietri 1992). Dispersed successfully by wild and domestic animals. Has a deep tap root; roots also spread horizontally underground and on the surface. Both erect and scrambling in habit; has a unique sweet apple fragrance when the leaves are crushed (Aguirre et al. 2009). May be somewhat salt-tolerant (Wahome et al. 2001). Attempts to remove the shrubs may stimulate new shoot formation. However, application of herbicides has not been successful because of the required multiple repeat treatments and the consequent negative impact on native flora. Ironically, this species also serves as a nurse plant for regenerating native woody trees, protecting such seedlings and saplings from herbivory (De Pietri 1992), but protection from herbivory decreases with increasing grazing pressure (Smit et al. 2007). Serving as nurse plants may increase the rate of woody species encroachment in pastures, but it may also speed up the rate of forest succession.



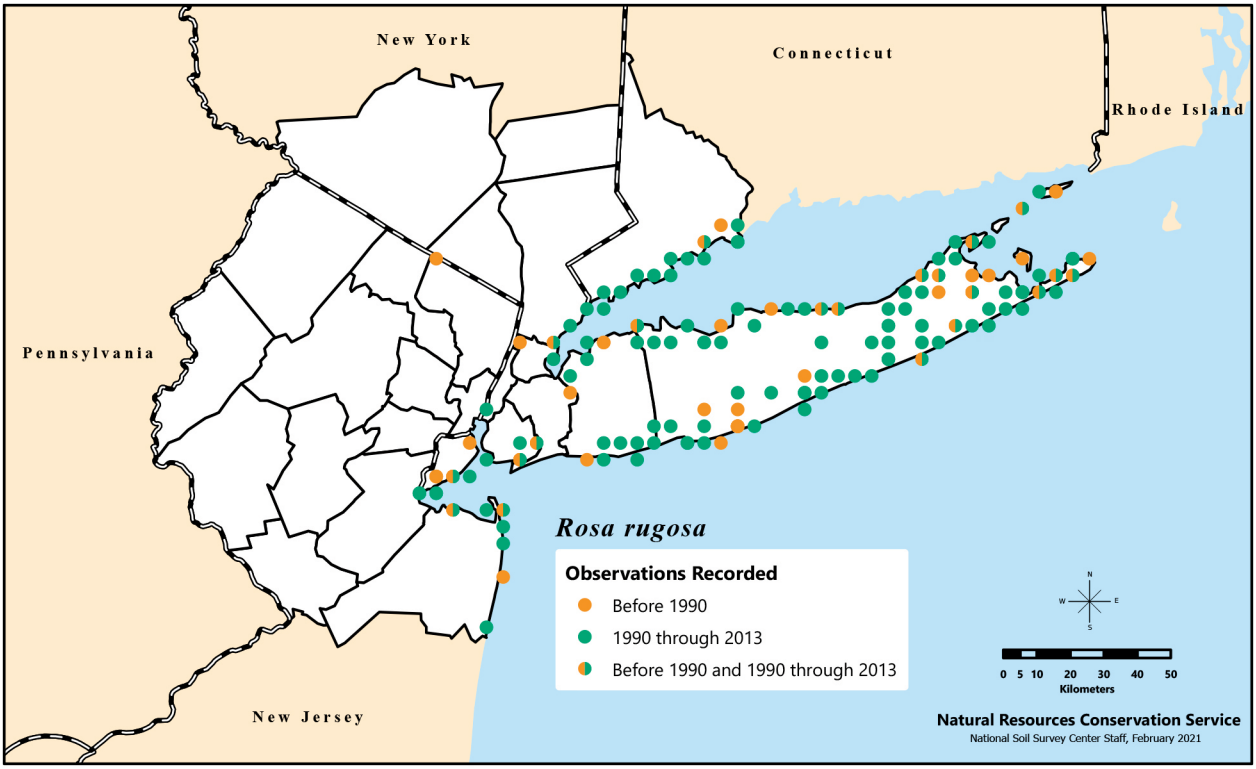
Distribution of *Rosa rubiginosa*, or sweetbriar rose, recorded in the New York Metropolitan Region during three time categories.

Like *R. canina*, it is a pentaploid with canina meiosis, in which only 7 bivalents are formed. The univalents are never included in the pollen, which give these species the name hemisexual because only 7 chromosomes are inherited from the male parent while 21, 28, or 35 chromosomes could be inherited from the female parent. The latter is called matroclinal inheritance. When *R. rubiginosa* individuals are crossed, bivalent formation occurs primarily between chromosomes that share the same alleles, while the species-specific alleles occur primarily on the univalents and, thus, are inherited only via the mother plant (Nymbom 2004). Such maternal lineages tend to be highly conservative with new lineages possible only through mutations. In fact, there appear to be three clearly separate maternal lineages within the dog roses, and *R. canina* and *R. rubiginosa* are in separate lineages (Olsson et al. 2000). *Rosa rubiginosa* shows evidence of being facultatively apomictic (capable of seed formation without fertilization) when there are no pollen donors (possibly due to low pollen viability or being more distantly related) or when environmental conditions are stressful (Werlemark 2000).

Rosa rubiginosa has at least 1 rootstock variety associated with popular hybrid tea varieties of roses (*R. hybrida* L.), of which there are more than 10,000 varieties with about 80 new ones being submitted annually (Esselink et al. 2003). Two rodent species known to be vectors of the Hantavirus (family Bunyaviridae) can be found in close association with this invasive nonnonative shrub in northwestern Patagonia, Argentina. Indeed, *R. rubiginosa* may be helping to spread the Hantavirus in Argentina (Lozada et al. 2000). May suffer from infections by *Megastigmus aculeatus*, a seed chalcid or adult wasp (Syrett 1990).

12. *Rosa rugosa* Thunb. – Japanese rose ↑

Flowering June–Sept. Native to northern China, Korea, and Japan (Dirr 1998). Common in coastal areas of the region in open sandy habitats, including dunes. Also established in Long Island, where it is a characteristic dune species. In the native part of its range in China, it is reported as endangered (Fu 1992). Also cultivated and naturalized in Asia (outside of its native range) and Europe.



Distribution of *Rosa rugosa*, or Japanese rose, recorded in the New York Metropolitan Region during three time categories.

One of the most popular roses because it can grow in difficult conditions (sand, saline soils, drought, frost, and heat) and is considered a maritime species (Bruun 2005), is exceptionally fragrant, and has large orange-red fruit (Dirr 1997). Introduced into the U.S. in 1845. The first report of escape in the U.S. was in 1899, and it spread rapidly within 10 years. Now fully naturalized on the Atlantic coast of New England. Introduced into England earlier, possibly 1796, and reintroduced in the 1870s; has become a prolific invader, especially in coastal dune systems. Introduced several times into Europe; first naturalizations reported in the early 20th century (Bruun 2005). At least 50 cultivars in the U.S.; about 10 are recommended as landscape plants (Dirr 1998), despite the species' invasive tendencies. Cold stratification at 3 °C for 90 days required for optimal germination (Meyer 2008c). Diploid (Bruun 2005). *Rosa rugosa* is a nectarless rose and its petals contribute most of the floral fragrance, but its pollen has a chemically distinctive odor. Bumble bees primarily respond to the pollen when discriminating between first-day flowers (pollen reward) and second-day flowers (no pollen reward); flowers bloom for 2 days (Dobson et al. 1999). *Rosa rugosa*, which has hermaphroditic flowers like other roses, is often reported to be self-incompatible and, thus, an obligate outcrosser. However, *R. rugosa* flowers bagged before opening and bagged flowers in which the stamens were removed beforehand also produced some smaller fruit, suggesting this species could be somewhat self-compatible as well as apomictic (Bruun 2005). Adapted to lower light conditions; shows signs of being shade-tolerant (Ueda et al. 2000). It is also a Chinese medicinal herb, which may have its basis in the flower extracts' antioxidant activity (Ng et al. 2005). Also cultivated in China for its oils to make perfumes (Ueyama et al. 1990).

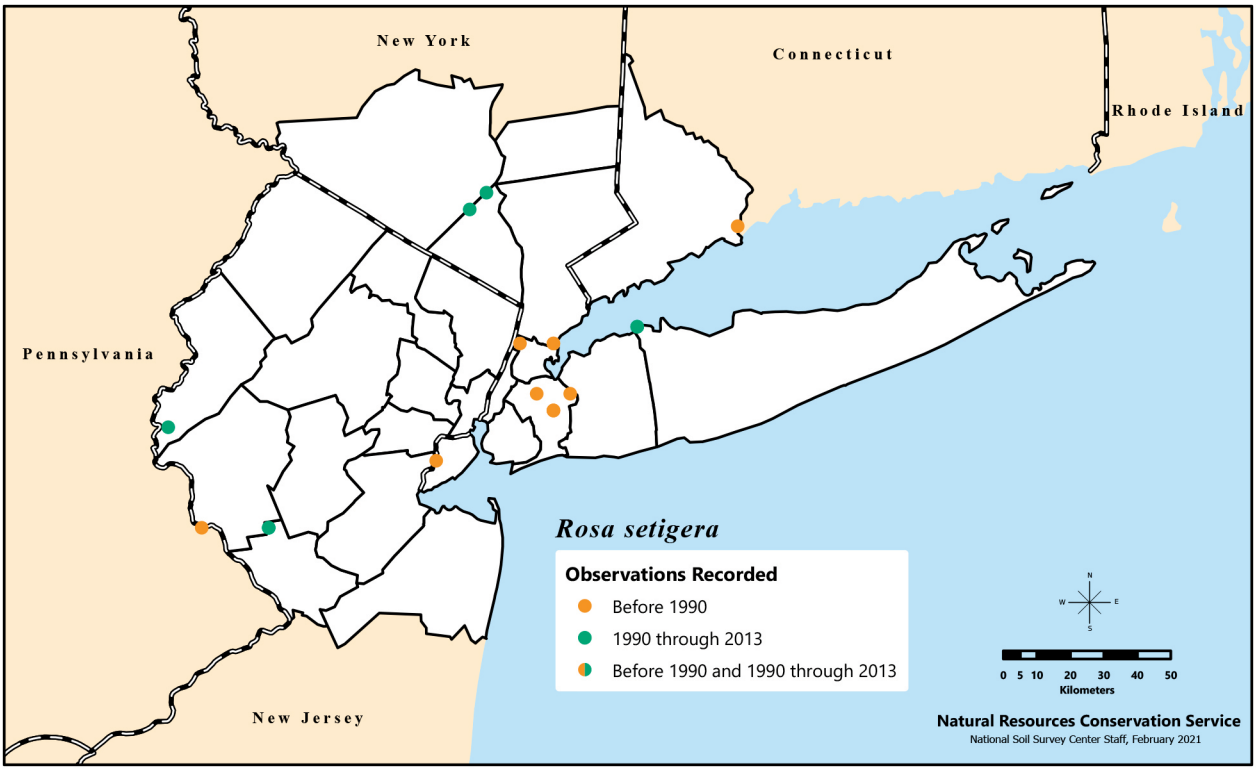
Like *R. rubiginosa*, *R. rugosa* has proven difficult to control even with herbicides because of its ability to resprout from the roots as well as from its creeping stolons, which can be several meters long. Many insects and pathogens are associated with *R. rugosa* in its native and nonnative ranges. A few in the native range may be specific to *R. rugosa* and show a significant effect on its growth and reproduction, but much more research is needed before a biocontrol can be developed (Bruun 2006). There are noted increases in topsoil nutrients in sites invaded by *R. rugosa*, which may indicate a more rapid turnover rate of nutrients compared to uninvaded sites (Vanderhoeven et al. 2005). *Rosa rugosa* also takes up heavy metal pollutants (lead, cadmium, chromium, nickel, and mercury) and has been suggested as a biomonitoring tool, with pollen abortiveness or viability as the most reliable measure for detecting contaminated sites (Calzoni et al. 2007).

Listed as potentially invasive in CT (not prohibited); tracked as potentially invasive in NJ (category 2).

13. *Rosa setigera* Michx. – prairie rose ↓

Flowering June–July. Native farther north, west, and south, including Canada, western NY, and FL. Occasionally adventive or naturalized in the region in open disturbed areas. Arching rose that is found in woods, roadsides, and riverbanks (Lewis 1958). Epithet implies that the species has bristles (setae), which it does not; the term probably refers to the prickles.

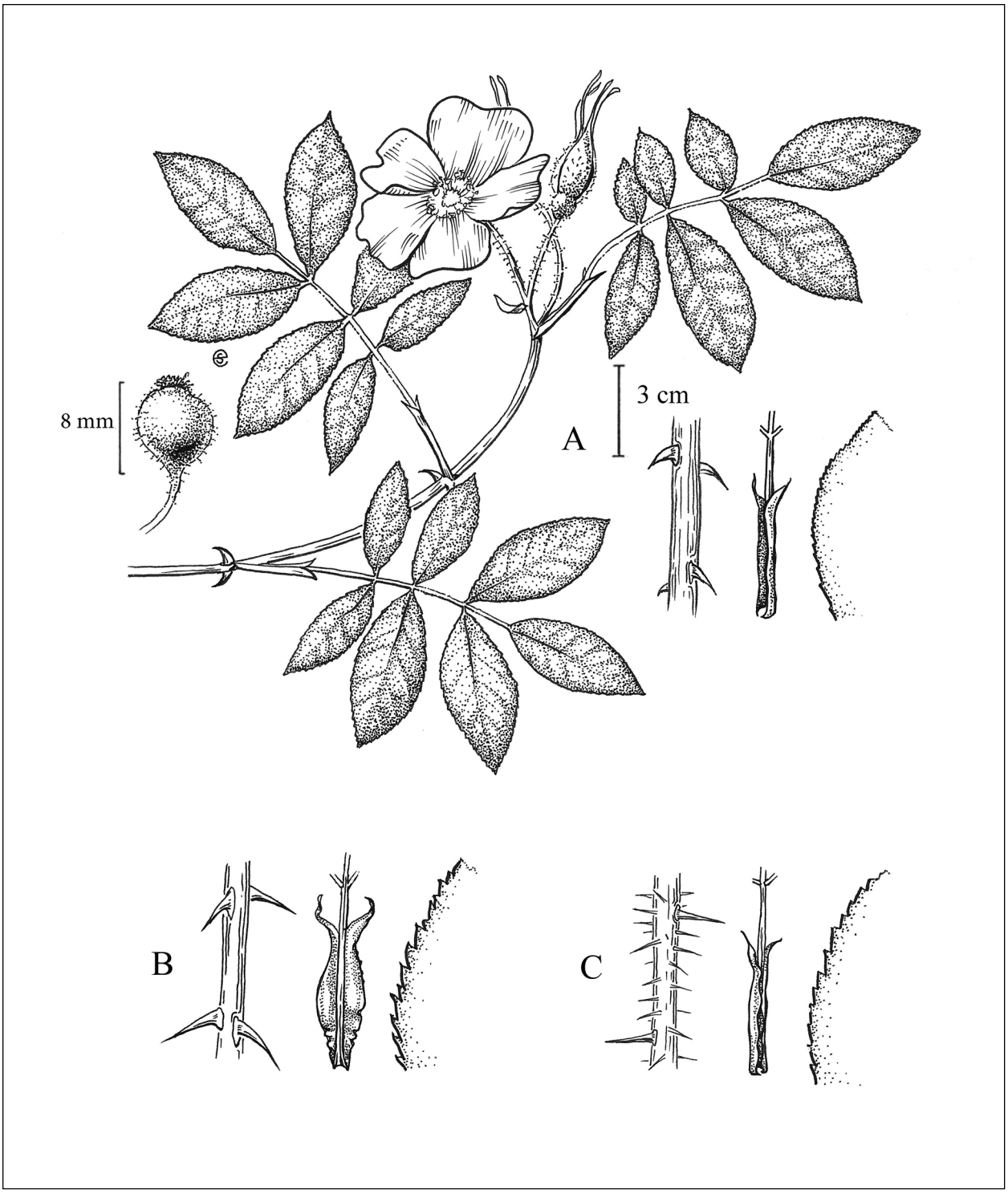
One of the latest flowering roses. Cultivated since 1810 (Dirr 1998). Cold stratification for 90–120 days required for germination (Meyer 2008c). Only known rose to exhibit dioecy, yet the flowers are difficult to sex. Male plants tend to have more flowers per inflorescence; female flowers have greater petal expansion. Pollen in female flowers does not germinate. Pollinators do not appear to discriminate between the sexes upon landing but do spend more time on the male flowers. The smaller inflorescences and lack of viable pollen of the female flowers, appear to cause pollinators to visit more individual female flowers, while spending more time on each male flower, thus helping to ensure pollen transfer (Kevan et al. 1990).



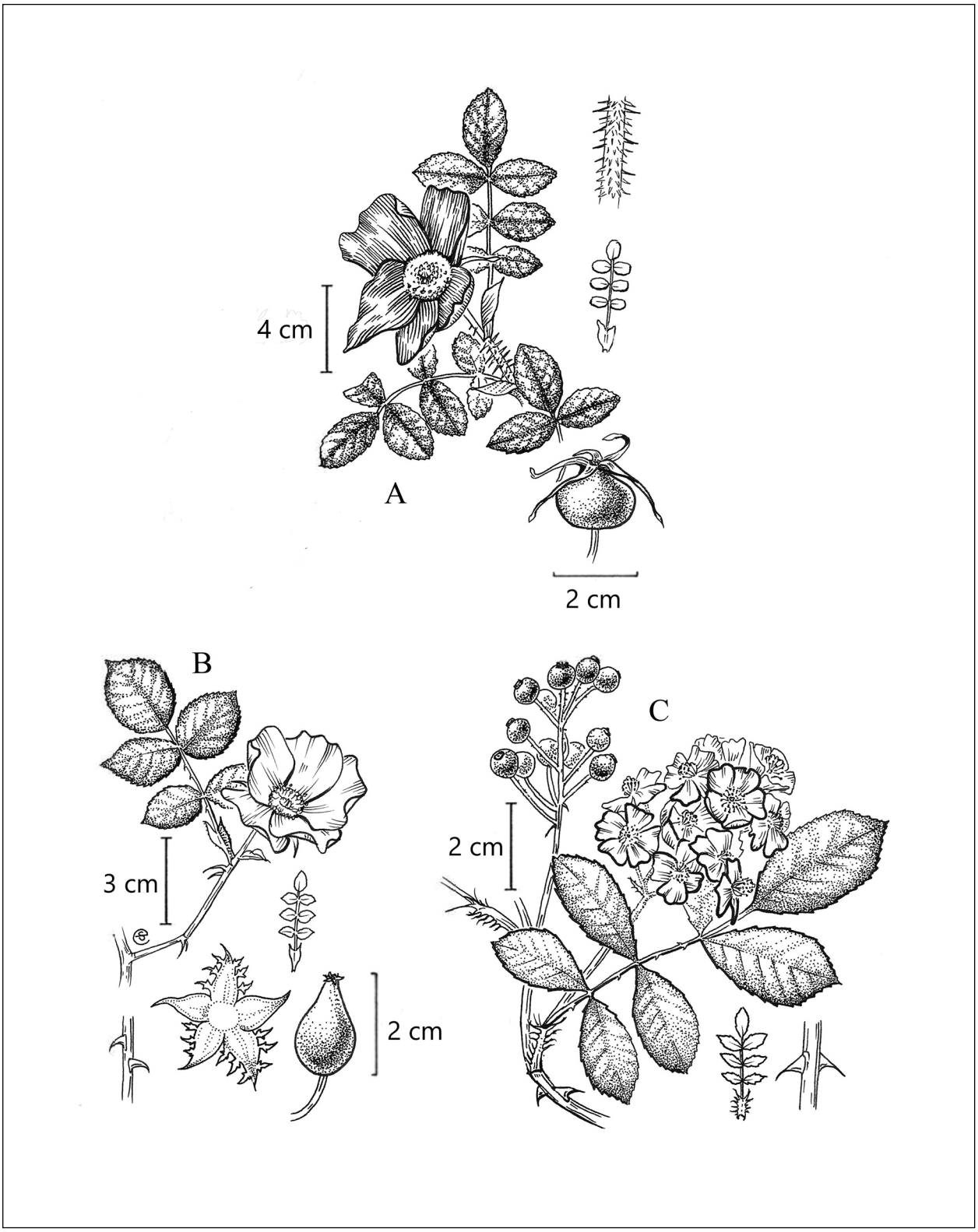
Distribution of *Rosa setigera*, or prairie rose, recorded in the New York Metropolitan Region during three time categories.

Management

The most problematic invasive roses (*Rosa multiflora*, *R. canina*, *R. rugosa*, and *R. luciae*) have been in the U.S. for some time. Perhaps because of this duration and the loss of some of our native shrubs, some native fauna have grown dependent on these nonnative roses. Consequently, it is important that a landowner know the potential impact that removal of these species could have on other trophic levels, including native birds, pollinators, mammals, and rodents. Nonetheless, efforts to prevent and curtail early invasions of the nonnative roses are advised. Because these species can resprout, herbicide application is likely to be required. However, repeat mowing could help weaken some of these species, such as *R. multiflora*, enough to reduce the number of repeat herbicide applications. Of course, having to repeat herbicide applications increases the negative effects on any native nontarget vegetation that may regenerate once the roses are removed, making restoration less likely. It is also conceivable that controlling for deer may help control some of these roses. *Rosa multiflora* is less likely to grow and reproduce under low-light conditions. This also may be true for many of the other nonnative roses. Nonetheless, succession to forested conditions from old field conditions is possible, in part because these roses serve as nurse plants to some of the reestablishing trees. Managers should also keep in mind that many rose cultivars may originate from rootstocks of one or more of these invasive species. Depending on the characteristics for which the cultivars were bred, it is conceivable that one or more invasive characteristics, such as the rapidly spreading stolons and roots, could also be included in the new cultivar. Control of such cultivars may be even more difficult because of the increased complexity of their genetic make-up.



A) Fruit, flowering twig with leaves, stem with prickles or bristles, petiole with stipule, and leaf margin of *Rosa palustris*; B) stem with prickles, petiole with stipule, and leaf margin of *Rosa virginiana*; C) stem with prickles or bristles, leaf margin, and petiole with stipule of *Rosa carolina*. Illustration by Emma Skurnick.



A) Flowering leafy twig, stem with prickles or bristles, leaf with stipule, and fruit of *Rosa rugosa*; B) flowering leafy twig, stem with prickles, calyx, leaf with stipule, and fruit of *Rosa canina*; C) fruit, flowering leafy twig, leaf with stipule, and stem with prickles of *Rosa multiflora*. Illustration by Emma Skurnick.

Rubus L. – bramble, blackberry, raspberry

Rosaceae. Shrubs, creeping half shrubs (low-growing shrubs), and herbs. Species 250–700 in Africa, Asia, Central America, Europe, North America, the Pacific Islands (Hawaii), South America, and the West Indies; most abundant in the Northern Hemisphere. *Rubus* has also been introduced into Bermuda and Australia. In the NY Metropolitan Region, there are three subgenera of woody *Rubus*: *Rubus* L. subg. *Rubus* (blackberries), *Rubus* subg. *Idaeobatus* Focke (true raspberries), and *Rubus* subg. *Anoplobatus* Focke (flowering raspberries). Numerous species are apomictic or self-fertilizing and do not require pollinators; those that do require pollination are frequently pollinated by bees (Cane 2005). All produce edible fruit, which are commonly taken by birds and other animals (Stiles 1980, Willson 1991). Name derived from the Latin "ruber" ("red"), a reference to the color of the fruit of some species (most notably raspberries).

Rubus is economically important; many cultivars of blackberries and raspberries are grown for their edible fruits. Cultivars of blackberries have parentages or origins that include many species native to North America and Europe, as well as red raspberry (e.g., *R. idaeus* subsp. *idaeus* and subsp. *strigosus*) (Clark et al. 2007). Cultivars of red and black raspberries are chiefly derived from *R. idaeus* and *R. occidentalis*, respectively. Purple raspberry cultivars are derived from the crossing of red and black raspberries. In both black and red raspberries, a lack of anthocyanin pigments can lead to the production of yellowish fruit. Cultivars of *R. idaeus* with yellowish fruit are sold as golden or amber raspberries. Some species of flowering raspberries are also occasionally grown for their showy flowers.

Dried seeds of *Rubus* can be stored for several years if refrigerated (Zasada and Tappeiner 2008). Seeds of *Rubus* can be difficult to germinate because of their exceptionally hard seed coats (endocarp) (Zasada and Tappeiner 2008). Seeds of true raspberries and flowering raspberries require cold stratification for 120 days or more; blackberries usually require warm stratification for 90 days, followed by 90 days of cold stratification. Acid scarification can also improve germination (Zasada and Tappeiner 2008).

Due to polyploidy, apomixis, and hybridization, the species limits in *Rubus*, especially the blackberries, are especially challenging, with significant differences of opinion regarding the number of species that should be recognized in a given region. For example, Fernald (1950) and Gleason and Cronquist (1993) recognized 205 and 25 species, respectively, from the northeastern U.S. The treatment followed here, and based on Alice et al. (2014), is exceptionally conservative with only 1 native blackberry species recognized for each of the 8 sections recognized and described by Bailey (1941–1945; *Rubus* sect. *Alleghenienses*, *Arguti*, *Canadenses*, *Cuneifolii*, *Flagellares* (*Procumbentes*), *Hispidi*, *Setosi*) and reported from the region. See Bailey (1941–1945), Rydberg (1913), Davis et al. (1967, 1968, 1969, 1970), Widrlechner (1998), and Davis (1990) for treatments that recognize more species.

Some morphological structures are unique to *Rubus*. The stems or canes in *Rubus* are usually biennial. In their first year of growth, the canes are usually sterile and are called primocanes. In the second year of growth, the canes flower and fruit and are called floricanes. The armature and leaves can often appear much different on primocanes and floricanes from the same individual plant. Occasionally a fertile branch will appear on a cane that is otherwise a primocane; such branches are called novirames. Occasionally a sterile branch will appear as part of the second-year growth, and these branches are called parcifronds. Descriptions in this treatment are based on floricane and primocane material and not parcifronds and novirames, which can often exhibit aberrant morphology. The descriptions of leaves are primarily based on leaves of the primocane or lower down on the floricane. Leaves farther up the floricane, especially the bracteal leaves within the inflorescence axes, are often reduced in size and in number of leaflets.

The diversity of armature in *Rubus* also warrants explanation. Prickles can range from stout and usually broad-based to weak and usually not

Rubus Key

1. Leaves simple; stems unarmed . . . . . ***Rubus odoratus***
1. Leaves compound; stems armed or unarmed. 2
2. Stems strongly glaucous; fruit separating free from torus. 3
2. Stems not glaucous or some (but not all) stems weakly glaucous;
fruit separating free from torus or with torus attached 4
3. Primocane leaves pinnately compound; fruit red or whitish (sometimes amber),
pubescent but without dense bands of white hairs between individual drupelets . . . . . ***Rubus idaeus***†
3. Primocane leaves palmately compound or ternate; fruit purple-black,
pubescent, dense bands of white hairs between individual drupelets. . . . . ***Rubus occidentalis***†
4. Stems low, 30 cm or less 5
4. Stems taller, more than 30 cm tall 6
5. Abaxial surface closely, densely pubescent, entire surface whitish. . . . . ***Rubus bifrons**** (in part)
5. Abaxial surface glabrous to pubescent but surface not strongly whitish. 7
6. Abaxial surface closely, densely pubescent, entire surface whitish to grayish 8
6. Abaxial surface glabrous to pubescent but surface not strongly whitish to grayish 9
7. Leaflets (at least some) deeply toothed or lobed or compound;
inflorescence a terminal thyrse . . . . . ***Rubus laciniatus**** (in part)
7. Leaflets toothed or lobed but not deeply so; inflorescence various but not a terminal panicle 10
8. Primocane leaflets palmately arranged; fruit black, separating with torus attached 11
8. Primocane leaflets pinnately arranged or ternate. 12
9. Leaflets (at least some) deeply toothed or lobed or compound;
inflorescence a terminal thyrse . . . . . ***Rubus laciniatus**** (in part)
9. Leaflets toothed or lobed but not deeply so; inflorescence various but not a terminal thyrse. 13
10. Bristles absent (stipitate glands may be present). . . . . ***Rubus flagellaris***
10. Bristles present. 14
11. Terminal leaflets elliptic, ovate to suborbiculate;
inflorescence large terminal panicle . . . . . ***Rubus bifrons**** (in part)
11. Terminal leaflets cuneate to obovate;
inflorescence few-flowered (to 12-flowered) cyme . . . . . ***Rubus cuneifolius*** (in part)
12. Stems lacking reddish-purple setae;
fruit black, separating with torus attached . . . . . ***Rubus cuneifolius*** (in part)
12. Stems densely setose, reddish-purple;
fruit red, separating free from torus . . . . . ***Rubus phoenicolasius****
13. Stems lacking prickles or prickles widely scattered;
any prickles usually narrow-based and weak 15
13. Stems strongly armed with broad-based prickles 16
14. Stems tip-rooting; leaves evergreen or semipersistent; leaflets obovate to suborbiculate,
1.7–6.5 cm × 1–5.2 cm; chiefly northern . . . . . ***Rubus hispidus*** (in part)
14. Stems not tip-rooting; leaves deciduous northern . . . . . ***Rubus setosus*** (in part)
15. Bristles present on stems . . . . . ***Rubus setosus*** (in part)
15. Bristles absent 17
16. Stipitate glands absent 18
16. Stipitate glands present, especially in inflorescence 19
17. Stipitate glands present, especially in inflorescence;
leaves not lustrous; eastern . . . . . ***Rubus allegheniensis*** (in part)
17. Stipitate glands absent; leaves lustrous; northern . . . . . ***Rubus canadensis***

Rubus Key

18. Terminal leaflets or primocane cuneate to obovate; inflorescence few-flowered (to 12-flowered) cyme . . . . . ***Rubus cuneifolius*** (in part)
18. Terminal leaflets ovate, to lanceolate; inflorescence a few to many (greater than 12-flowered) . . . . . ***Rubus pensilvanicus*** (in part)
19. Inflorescence an elongate, usually cylindric, raceme. . . . . ***Rubus allegheniensis*** (in part)
19. Inflorescence a flattish cyme . . . . . ***Rubus pensilvanicus*** (in part)

†See discussion at *Rubus* ×*neglectus* Peck for raspberry with light purple fruit.

broad-based; they are always exceptionally resistant to touch. Bristles can be stiff, the points somewhat noticeable or resistant to touch. Stems with these types of bristles are said to be setose. Other bristles are slenderer and weaker, the points not noticeable or resistant to touch. Stems with these bristles are said to be hispid. Prickles and bristles also range from straight to retrorse. Some bristles are also gland-tipped.

Besides the 10 species of native blackberries recognized in this treatment, material is often discovered in the field that appears intermediate between these main species and thus possibly of hybrid origin. Many of these appear to represent stable populations (possibly through apomixis) and have often been described, especially by L.H. Bailey, as distinct species. Names believed to represent hybrids between *Rubus* spp. and reported from or adjacent to the region are presented here along with the hypothesized parental species. Those with a question mark have uncertain parentage.

The following are putative hybrids:

Rubus acer L.H. Bailey (*R. cuneifolius* × *R. pensilvanicus*)

Rubus acer L.H. Bailey var. *subacer* (*R. cuneifolius* × *R. pensilvanicus*)

Rubus ascendens Blanchard (*R. allegheniensis* × *R. setosus*; tracked as imperiled in NJ [S1])

Rubus avipes L.H. Bailey (*R. allegheniensis* × *R. pensilvanicus*)

Rubus bigelovianus L.H. Bailey (*R. flagellaris* × *R. setosus*)

Rubus brainerdii Rydberg L.H. Bailey (*R. canadensis* × *R. pensilvanicus*)

Rubus clausenii L.H. Bailey (*R. allegheniensis* × *R. setosus*)

Rubus elegantulus Blanch. (*R. canadensis* × *R. pensilvanicus*)

Rubus janssonii L.H. Bailey (*R. flagellaris* × *R. pensilvanicus*?)

Rubus novanglicus L.H. Bailey (*R. flagellaris* × *R. hispidus*)

Rubus novocaesarius L.H. Bailey (*R. flagellaris* × *R. hispidus*; listed as endangered in NJ [S1.1]), known only from southern NJ)

Rubus orarius Blanch. (*R. allegheniensis* × *R. pensilvanicus*)

Rubus ostryifolius Rydberg (*R. allegheniensis*? × *R. flagellaris*; tracked as historical in NJ [SH.1])

Rubus pergratus Blanch. (*R. canadensis* × *R. pensilvanicus*)

Rubus permixtus Blanch. (*R. flagellaris* × *R. hispidus*)

Rubus recurvicaulis Blanch. (*R. flagellaris* × *R. pensilvanicus*; tracked as historical in NJ [SH.1])

Besides these named entities, intermediate material has also been observed that may represent the following crosses: *R. cuneifolius* × *R. hispidus*, *R. cuneifolius* × *R. pensilvanicus*, *R. flagellaris* × *R. hispidus*, *R. hispidus* × *R. setosus*.

Two native species of *Rubus*, *R. chamaemorus* L. (cloud berry, baked apple berry) and *R. pubescens* Raf. (plumboy), are not treated here because they

are herbaceous (although they may be slightly lignified towards their bases). *Rubus chamaemorus* was reported only once from eastern Long Island in Suffolk County (NY), and is now listed as extirpated in NY (SX). The nearest known extant site for the species is now Coos County (NH). *Rubus pubescens*, a northern and high-elevation species, is still occasionally found in cool bogs in northern NJ.

Native Species

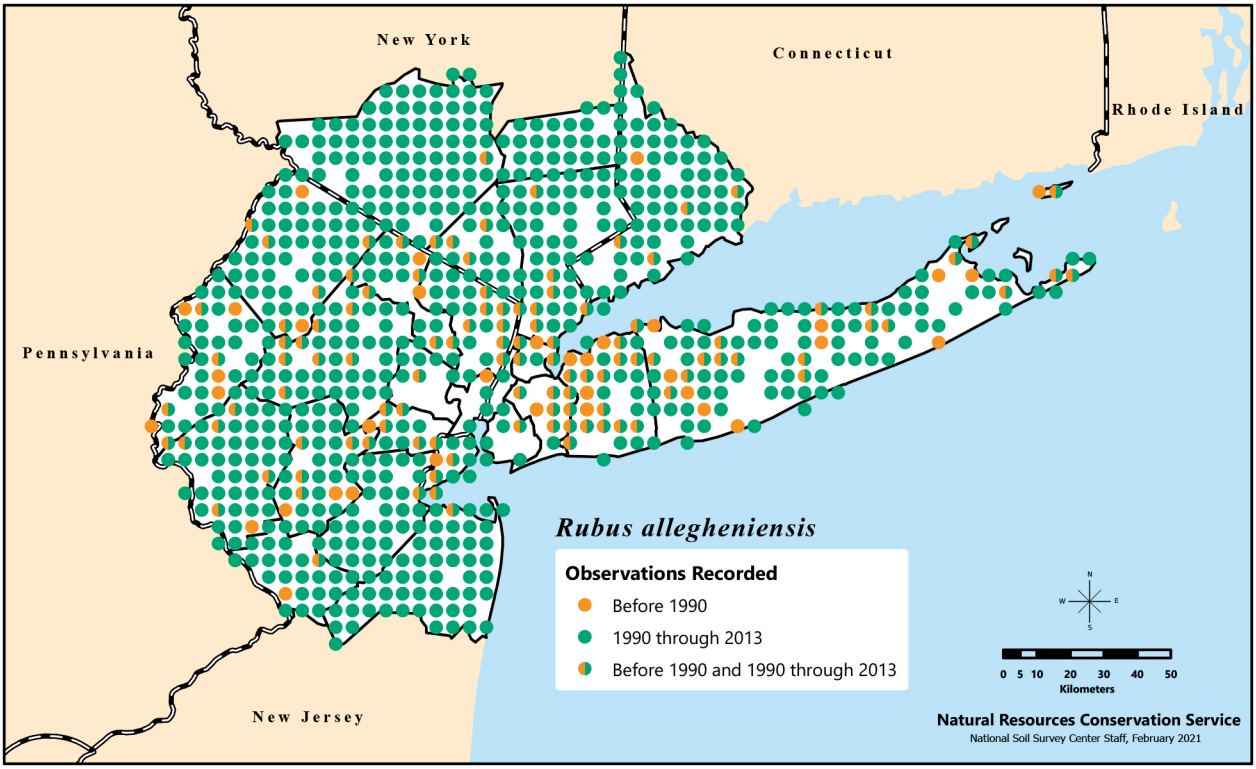
1. *Rubus allegheniensis* Porter s.l. – Allegheny blackberry, common blackberry, sow teat ↑↑↑

Rubus allegheniensis var. *albinus* L.H.Bailey; *Rubus allegheniensis* var. *gravesii* Fernald; *Rubus allegheniensis* var. *plausus* L.H.Bailey; *Rubus bigelovianus* L.H.Bailey; *Rubus fissidens* L.H.Bailey; *Rubus gnarus* L.H.Bailey; *Rubus inclinis* L.H.Bailey; *Rubus irregularis* L.H.Bailey; *Rubus licitus* L.H.Bailey; *Rubus nuperus* L.H.Bailey; *Rubus paulus* L.H.Bailey; *Rubus pugnax* L.H.Bailey; *Rubus rosa* L.H.Bailey; *Rubus saltuensis* L.H.Bailey; *Rubus separ* L.H.Bailey

Flowering late Apr.–early July; fruiting July–Aug. Woodlands, meadows, rock outcrops, and disturbed areas; in dry to damp soil.

Rubus allegheniensis and *R. pensilvanicus* are the two most common tall, arching thicket-forming native blackberry species of the region. *Rubus allegheniensis* is readily distinguished from *R. pensilvanicus* by its usually elongate, cylindric racemes, which are generally densely stipitate-glandular with flattened to cup-shaped glands.

An early successional, colonizing species that responds positively to disturbances such as canopy openings (Goldblum 1997) and fire (Reich et al. 1990, Whittle et al. 1997). Its rapid response to such disturbances is due in part to having seeds with hard endocarps, making dormancy difficult to break and resulting in a long-lived seed bank. It is common to find this species in seed banks of old fields as well as mature forests (Beatty 1991), but less so in the latter (Peterson and Carson 1995). Several wildlife species depend on *R. allegheniensis* throughout the year, including



Distribution of *Rubus alleghaniensis*, variously called Allegheny blackberry, common blackberry, and sow teat, recorded in the New York Metropolitan Region during three time categories.

deer (*Odocoileus* spp.) (Healy 1971), birds (Stiles 1980), arthropods, and small rodents (Schwantes Boman and Casper 1995). Fruit consumption probably promotes needed seed scarification for germination (Zasada and Tappeiner 2008), though this may be less likely for the seed individually consumed by rodents or arthropods. Cultivated since 1905 (Zasada and Tappeiner 2008). *Rubus allegheniensis* has escaped from cultivation in Finland and Denmark, is considered an agricultural weed in the U.K. and Canada, and is considered naturalized in the Czech Republic and Japan (AgWest and Hawaiian Ecosystems at Risk Project [HEAR] 2010). The Menominee, Meskwaki, and Potawatomi used root extracts to treat eye irritation (Smith 1923, 1928, 1933). The Ojibwa used boiled extracts of the canes as a diuretic, and a root extract for treating diarrhea (Smith 1932).

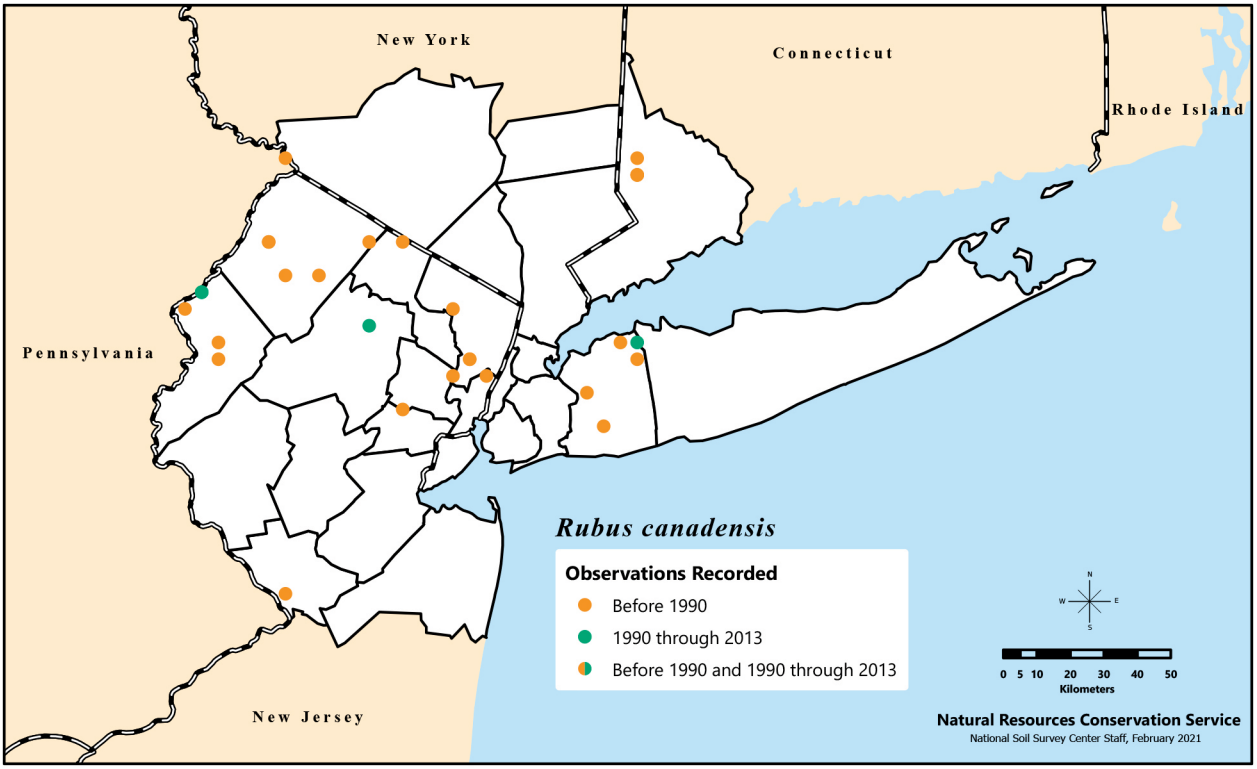
Rubus gnarus, treated as a synonym here, is tracked as imperiled in NJ (SH.1).

2. *Rubus canadensis* L. s.l. – smooth blackberry ↓↓↓

Rubus argutus Link var. *randii* (L.H.Bailey) L.H.Bailey; *Rubus canadensis* var. *imus* L.H.Bailey; *Rubus canadensis* var. *pergratus* (Blanchard) L.H.Bailey; *Rubus canadensis* var. *terrae-novae* (Fernald) L.H.Bailey; *Rubus irregularis* L.H.Bailey; *Rubus montensis* L.H.Bailey; *Rubus proprius* L.H.Bailey

Flowering late May–July; fruiting July–Aug. Mountainous highlands, deciduous and boreal forests (Boner 1979), and margins of lakes and woods. *Rubus canadensis* is distinguished from the other highbush blackberries (*R. allegheniensis*, *R. pensilvanicus*) in the region on the basis of its lack of (or sparse) armature, pubescence, and glands, and its lustrous leaves.

The fruit of *R. canadensis* is usually tarter than the other highbush blackberries and less palatable. Thus, development of pomological cultivars less



Distribution of *Rubus canadensis*, or smooth blackberry, recorded in the New York Metropolitan Region during three time categories.

R

often involves *R. canadensis*, despite its absence of or reduced armature, a desirable trait (Bailey 1944, Coyner et al. 2005).

Cultivated since 1727 (Zasada and Tappeiner 2008). Though *R. canadensis* is relatively rare in the region, it has escaped from cultivation in the U.K. and is considered naturalized in the Czech Republic (AgWest and HEAR 2010). Though being relatively free of spines and winter-hardy makes this species desirable for cultivation, it is an unusual breeding parent because it is a triploid and undergoes a type of apomixis that requires pollination but does not involve male inheritance. However, this species can be crossed with commercial blackberries to form fertile hybrids (Craig 1960). This species is more common in northern and high-elevation areas and is declining in the region.

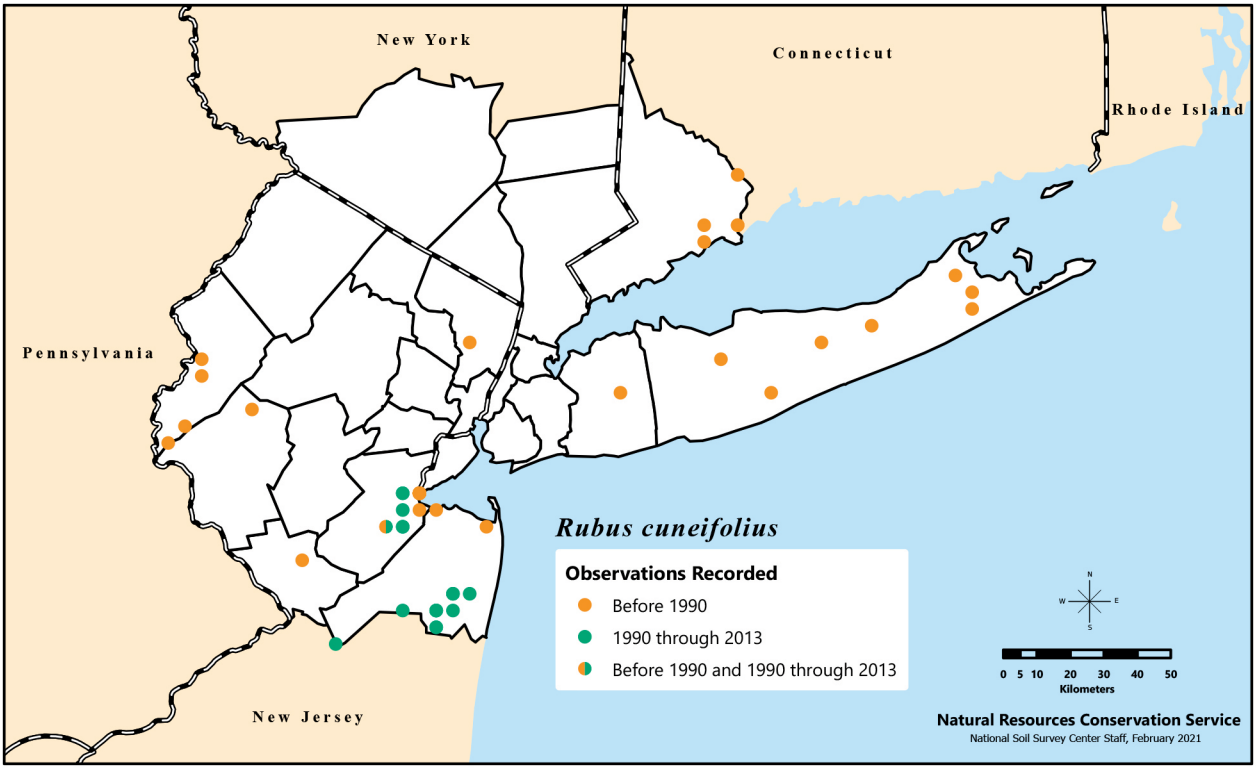
Listed as endangered in NJ (S1).

3. *Rubus cuneifolius* Pursh – sand blackberry ↓

Rubus cuneifolius var. *angustior* L.H.Bailey;
Rubus cuneifolius var. *spiniceps* L.H.Bailey;
Rubus longii Fernald

Flowering late May–early July; fruiting July–Aug. Dry open areas, usually on sandy soils. Known chiefly from the Coastal Plain. Epithet from Latin refers to the leaflets of the plant, which tend to be cuneate in shape.

Distinguished from the other blackberries described in that it is usually strongly erect and shrub-forming and has abaxial leaflet surfaces often with dense white to gray pubescence. Species is exceptionally scarce in the region, although it is frequent just outside the region in southern NJ. Often occurs in dry habitats; the fruit is also very dry. However, if adequate moisture is available, the fruit can be exceptional, and several



Distribution of *Rubus cuneifolius*, or sand blackberry, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Sussex County (NJ) and New York County (NY). This species was rediscovered recently from Richmond and Suffolk Counties (NY); locations are not mapped.

pomological cultivars have been developed from *R. cuneifolius* (Bailey 1943).

Listed as a noxious weed in South Africa (AgWest and HEAR 2010); although the precise identity of this material remains uncertain, but most likely represents material of North American origin or a hybrid involving a North American species (Alice et al. 2014). There is evidence that exclusion of fire and grazing increases abundance of this material in South African grasslands (Titshall et al. 2000). The material is highly sensitive to ozone (which may be true of many or all *Rubus* spp.), showing decreases in growth and fruit production when exposed to ozone (Chappelka 2002). This finding may indicate that *Rubus* spp. may be less likely to become an invasive problem in highly urbanized areas.

Another species, tentatively identified as *R. pascuus* L.H.Bailey, has been confirmed from the region in Richmond County (NY); it is also known from southern NJ and southeastern PA. It is similar to *R. cuneifolius* in having leaves with strongly whitish abaxial surfaces. However, it differs from *R. cuneifolius* in being much taller, often with overarching canes, and having petals that are usually pinkish (increasingly so with age). It is not yet clear whether this other species has affinities with *R. cuneifolius*, possibly representing an escaped cultivar derived from *R. cuneifolius* or a cross involving *R. cuneifolius* (or another native blackberry species) and a nonnative species (as no local native blackberry species have pink petals), or whether it is more closely allied with the European blackberries (*Rubus* subg. *Rubus* sect. *Rubus*), such as *R. bifrons* (see later discussion). This unidentified species appears to be spreading rather rapidly throughout much of the eastern U.S. (see Alice et al. 2014).

Listed as a species of special concern in CT (S3) and endangered in NY (SH); tracked as a species of special concern in CT. *Rubus longii*, treated as a synonym here, is tracked as critically imperiled in NY (S1). *Rubus pascuus* is currently tracked as critically imperiled in NY (S1) but also classified as a native pioneer species, indicating that it is expected to increase in the state.

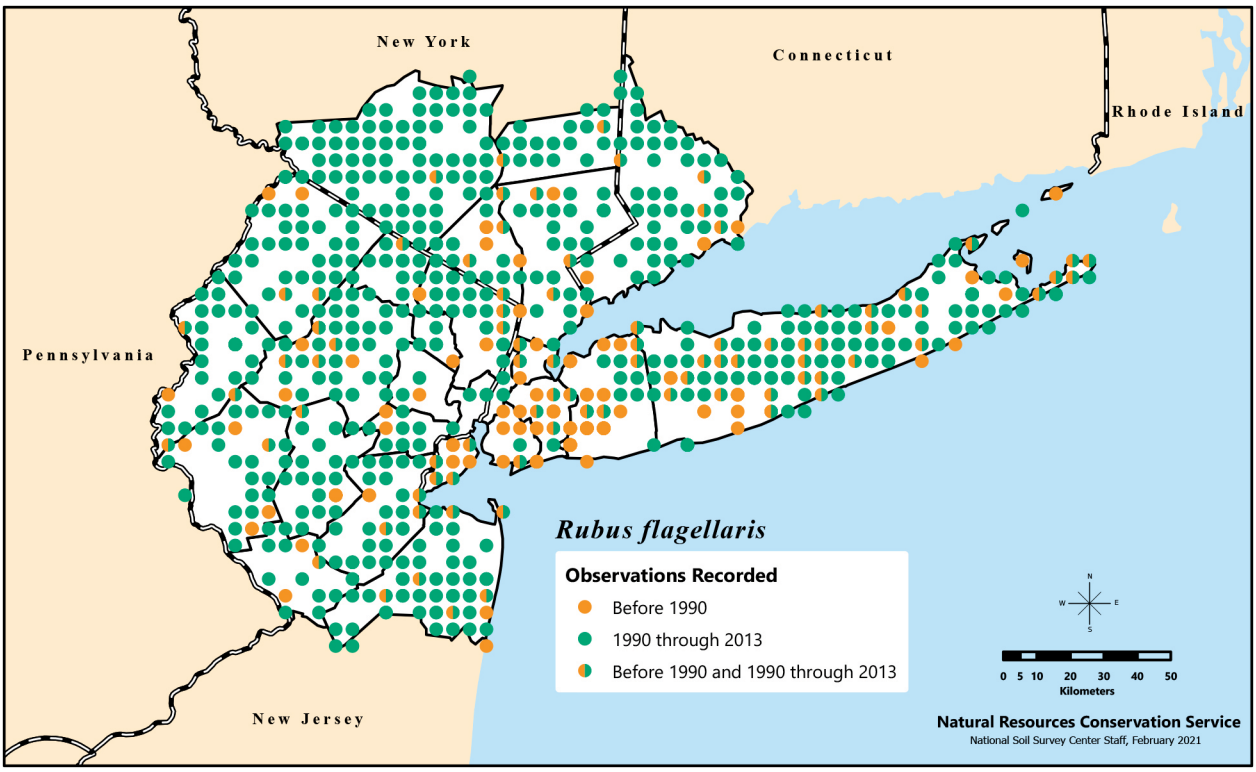
4. *Rubus flagellaris* Willd. s.l. – northern dewberry ↑↑

Rubus alius L.H.Bailey; *Rubus aptatus* L.H.Bailey; *Rubus arundelanus* Blanchard; *Rubus baileyanus* Britton; *Rubus brevipedalis* L.H.Bailey; *Rubus coloniatus* L.H.Bailey; *Rubus cordifrons* (L.H.Bailey) L.H.Bailey; *Rubus depavitus* L.H.Bailey; *Rubus eflagellaris* L.H.Bailey; *Rubus enslenii* Tratt.; *Rubus felix* L.H.Bailey; *Rubus housei* L.H.Bailey; *Rubus invisus* (L.H.Bailey) Britton; *Rubus jaysmithii* var. *angustior* L.H.Bailey; *Rubus jaysmithii* L.H.Bailey var. *jaysmithii*; *Rubus nefrens* L.H.Bailey; *Rubus obsessus* L.H.Bailey; *Rubus pityophilus* S.J.Sm. ex L.H.Bailey; *Rubus plicatifolius* Blanch.; *Rubus prosper* L.H.Bailey; *Rubus redundans* L.H.Bailey; *Rubus rhodinsulanus* L.H.Bailey; *Rubus roribaccus* (L.H.Bailey) Rydberg; *Rubus scambens* L.H.Bailey; *Rubus tetricus* L.H.Bailey

Flowering Apr.–June; fruiting July–early Aug. Woodlands, pine barrens, meadows, rock outcrops, and disturbed areas, in dry to seasonally wet soil. Epithet from Latin refers to the whip-like trailing canes.

Highly variable, ranging from plants with low arching stems and relatively few prickles to low, creeping plants with abundant prickles. Individuals have been observed with abundant, arching, poorly armed stems in some years, and in other years, with creeping, well-armed stems. Prickle shape also varies in these plants both within a year and among different years. Furthermore, local variants seem to readily intergrade with other variants, so over the entire North American range of what would be known as *Rubus* sect. *Flagellares* (=*Procumbentes*; herein treated as the single species *R. flagellaris*), a continuous blur of variation seems to be the norm.

Consistent features in *R. flagellaris* are terete primocanes 7 mm diameter or less near the base; the presence of rigid, hooked to retrorse primocane prickles 4 mm long or less; and few flowers per inflorescence (1–3 or rarely to 5). Primocanes that tip-root and are low and long-running are nearly consistent features of this species. A dewberry,



Distribution of *Rubus flagellaris*, or northern dewberry, recorded in the New York Metropolitan Region during three time categories.

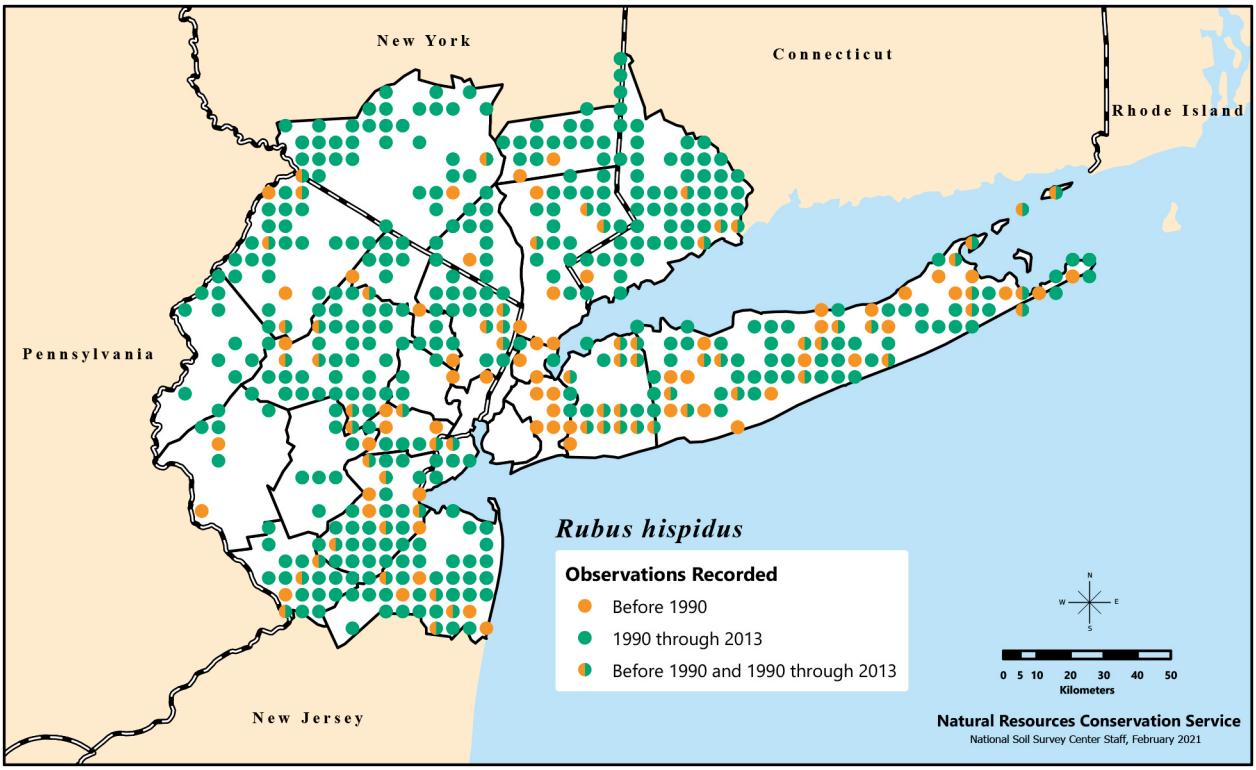
so named because the plants are generally low and trailing so fruits are prone to being covered with dew. Plants can produce exceptional fruit when grown in areas with adequate moisture, and numerous pomological cultivars have been developed (Bailey 1943). Differs from *R. hispidus* (swamp dewberry) by its stronger armature and dull, non-shiny leaves. Based on its low, trailing nature, the European *R. caesius* (*Rubus* subg. *Rubus* sect. *Sylvatici*) may key here. *Rubus caesius* differs from *R. flagellaris* (and the other native blackberries) in having glaucous stems and few, blue-black, large drupelet fruit with a whitish waxy bloom (like the covering often found on blueberries). *Rubus caesius* has not been reported from the region, but it has been reported in upstate NY (Onondaga, Tompkins, and Yates Counties) (Weldy et al. 2010).

Though *R. flagellaris* is capable of inhabiting areas of low soil fertility, including serpentine sites (Tyndall and Far 1990) and barrens (McCormick and Buell 1957), it also responds well to the addition of nutrients in otherwise fertile sites by growing more quickly than other associated species (Reynolds et al. 2007). The Karner blue butterfly (*Lycaeides melissa samuelis*), a Federally endangered species, preferentially selects *R. flagellaris* flowers for nectar over several other species; this preference was not related to flower abundance (Grundel et al. 2000). Considered naturalized in New Zealand and Japan, escaped from cultivation in South Africa and Canada, and a weed in the U.S. (AgWest and HEAR 2010).

5. *Rubus hispidus* L. s.l. – swamp dewberry ↑↑

Rubus hispidus var. *obovalis* (Michx.) Fernald; *Rubus parlinii* L.H.Bailey; *Rubus pervarius* (L.H.Bailey) L.H.Bailey; *Rubus porteri* L.H.Bailey; *Rubus tardatus* Blanch.

Flowering late May–July. Mesic woodlands, meadows, openings, bogs, fens, and disturbed areas; in wet to occasionally dry soil.



Distribution of *Rubus hispidus*, or swamp dewberry, recorded in the New York Metropolitan Region during three time categories.

R

Best identified by its creeping canes with somewhat lustrous (shiny), leathery leaves that persist through the winter until early spring, and armature of hispid hairs or, rarely, weak, slender prickles. Deciduous or weakly evergreen plants may be evidence of introgression with *Rubus flagellaris* or *R. setosus*. On the Coastal Plain in NJ, *R. hispidus* has been shown to intergrade with *R. cuneifolius*. See discussion under *R. flagellaris* regarding the superficially similar *R. caesius* (Alice et al. 2014).

In the region, most material is very slender with stems of the canes weak (1–2 mm diameter); found in moist areas. If recognized, this material would be referable to *R. hispidus* var. *obovatus* (Michx.) Fernald. In the northern parts of the region (and farther north beyond the region), material with much larger, less weak stems can be found that is often growing in drier areas. Much of this material would represent *R. hispidus* L. var. *hispidus*. Fruit is generally very small, sour, and not exceptionally palatable. *Rubus hispidus* has not been used in the development of pomological cultivars (Bailey 1941).

Capable of changing its reproductive strategy depending on habitat. In more mature forests, it invests its efforts in the survival of reproductive structures (K-strategy) rather than total reproductive effort (r-strategy; measured as reproductive organ biomass per total biomass) compared to populations of *R. hispidus* found in old fields or sites of intermediate successional stages. Similarly, plants growing in drier habitats invest less in reproductive effort than plants growing in wetter conditions (Abrahamson 1975b). This species also puts greater reproductive effort into dense intraspecific populations than sparse intraspecific populations, which suggests limited resources may signal the plant to sexually reproduce rather than increase in size vegetatively. Moreover, *R. hispidus* appears not to be apomictic (Abrahamson 1975a). Prefers soils high in nutrients in peat bog conditions; potentially could overtake other bog species, such as ericads (heaths; family Ericaceae), in response to higher nutrient loading in the bogs due to eutrophication (Stewart and Nilsen 1993).

Rubus pervarius, treated as a synonym here, is tracked as imperiled in NJ (SH.1).

6. *Rubus idaeus* L. – red raspberry ↓↓

Epithet from Latin refers to Mount Ida; it is unclear how the reference helps describe this species.

Rubus idaeus is the source of most of the cultivated red and amber raspberries. Used by the Cherokee and Cree peoples and more generally as an infusion of dried leaves in water to prepare the uterus for childbirth and help women recover after childbirth (Hoffman 2003, Moerman 1998, Ramasubramaniam et al. 2015). Two subspecies in the region. Most of the records in the general (no differentiation to subspecies) are likely to be of subspecies *strigosus*.

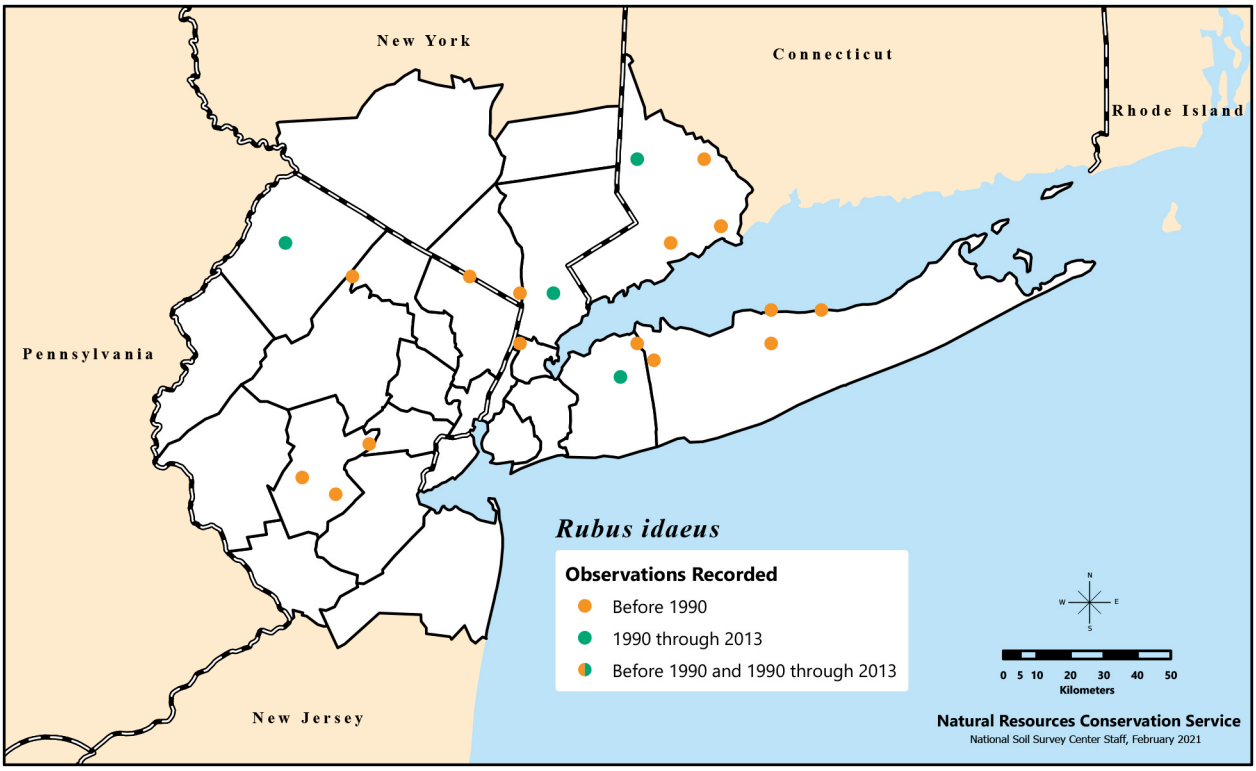
6a. *Rubus idaeus* L. subsp. *idaeus* – red raspberry Ø

Flowering May–July; fruiting late June–July. Fields, roadsides, and disturbed areas; in dry soils; at elevations of 0–2,000 m. Introduced from Europe and Asia.

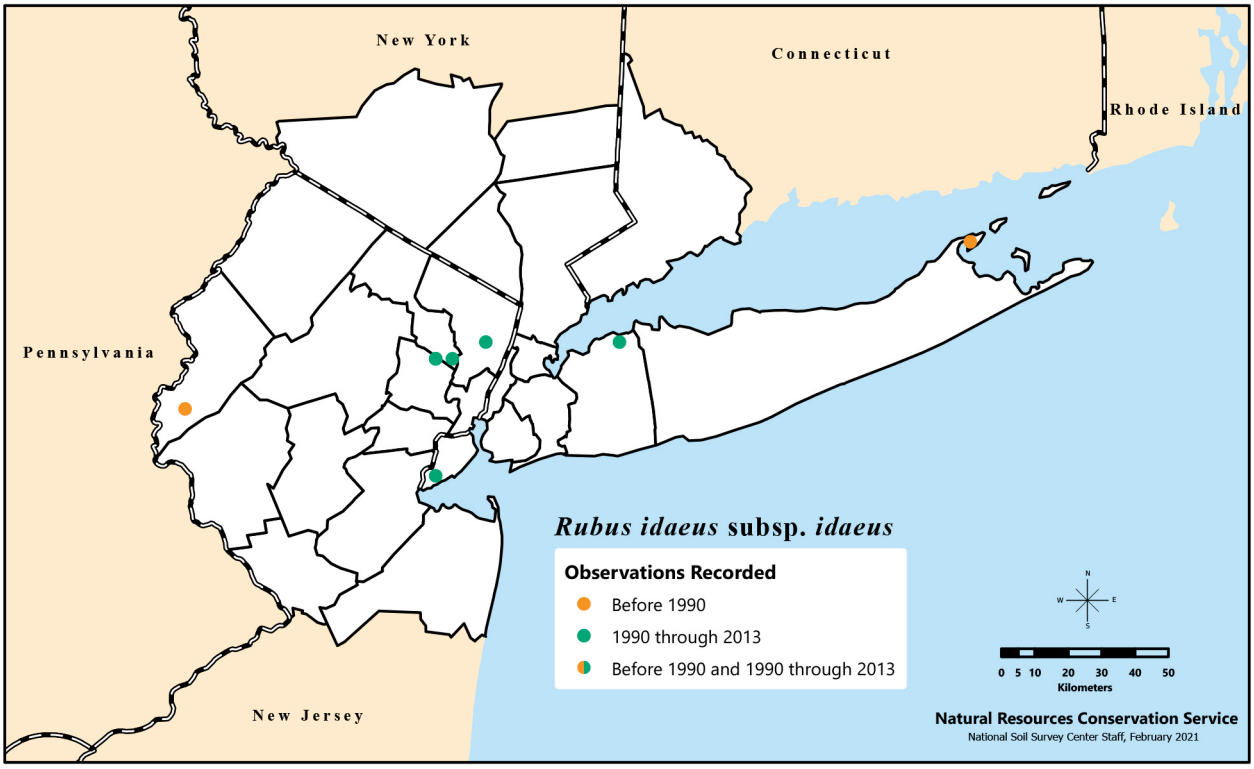
In the region, *Rubus idaeus* subsp. *idaeus* is generally found as an escape or persistent from cultivation, especially near old homesteads. Possible or likely naturalized populations reported from Fairfield County (CT), Bergen, Essex, Passaic, and Warren Counties (NJ), and Nassau, Richmond, and Suffolk Counties (NY). Though widely thought to be native to the Old World, *R. idaeus* subsp. *idaeus* may be native to the extreme northern regions of North America, according

Rubus idaeus Key

1. Bristles and glands absent on stems. . . . . .***Rubus idaeus* subsp. *idaeus****
1. Bristles and glands present on stems (though occasionally sparse). . . . . .***Rubus idaeus* subsp. *strigosus***



Distribution of *Rubus idaeus*, or red raspberry, recorded in the New York Metropolitan Region during three time categories. Map represents only those records that were identified to species with no subspecies designation.



Distribution of *Rubus idaeus* subsp. *idaeus*, also called red raspberry, recorded in the New York Metropolitan Region during three time categories.

to Bailey (1945). Most of the records in the distribution map belong to the next subspecies.

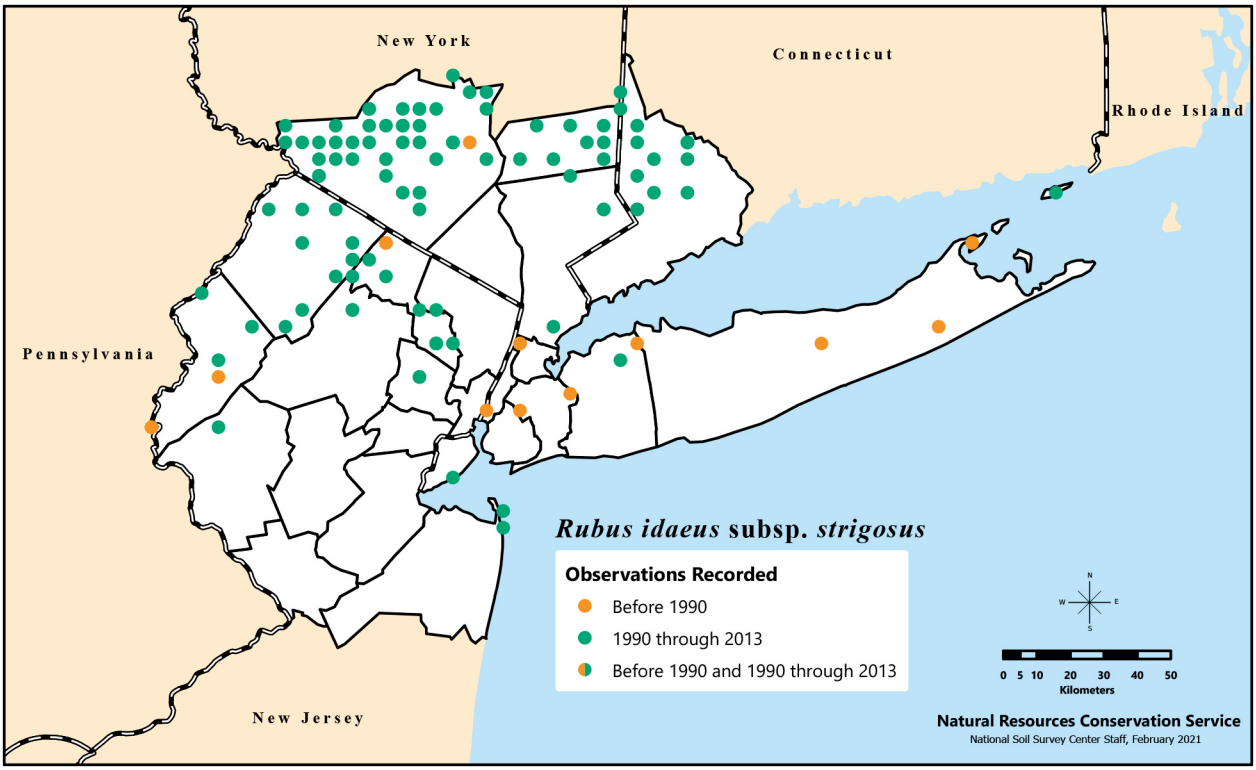
6b. *Rubus idaeus* subsp. *strigosus* (Michx.) Focke – grayleaf red raspberry ↑↑↑

Rubus strigosus Michx.; *Rubus idaeus* var. *strigosus* (Michx.) Maxim.; *Rubus strigosus* var. *tonsus* (Fernald) L.H.Bailey; *Rubus idaeus* subsp. *melanolasius* (Dieck) Focke

Flowering May–July; fruiting late June–July. Fields, woodlands, roadsides, and disturbed areas; in dry to moist soils. Subspecific epithet from Latin refers to the strigose (stiff) hairs commonly found on the stems. Native to the U.S. as well as eastern Asia (Gleason and Cronquist 1993).

More common in northern and high-elevation regions; increasing in the region, where it is found mainly in the north. Farther north, outside of the region, it is even more common. Considered among the 20 most aggressive native weeds of forests in Canada; possible biocontrols (*Fusarium avenaceum*) have been developed and patented (Shamoun 2000). There is some evidence that *Rubus idaeus* subsp. *strigosus* can outcompete *Picea mariana* (Küssner et al. 2000) and may even exhibit allelopathic properties against *Pinus resinosa* seedlings (Norby and Kozlowski 1980). Nonetheless, though *R. idaeus* subsp. *strigosus* is abundant for 10 years after a forest harvest, it nearly completely disappears from the flora beyond 10 years in *Abies balsamea-Betula alleghaniensis* (balsam fir-yellow birch) forests of eastern QC (Archambault et al. 1998). Hence, this species appears to be fairly shade-intolerant and incapable of surviving in closed-canopy forests.

The nonnative *Rubus illecebrosus* Focke would also key here. This species is native to Japan and has been reported once in the region in Fairfield County (CT), and a few other times just outside the region, including several upstate NY counties. It differs from *R. idaeus* in having stems that bloom the first year; leaves with 2–4 pairs of remote, strongly lance-attenuate leaflets; large flowers (3–4 cm broad) with clawed petals; and



Distribution of *Rubus idaeus* subsp. *strigosus*, or grayleaf red raspberry, recorded in the New York Metropolitan Region during three time categories.

exceptionally large fruit (2–3 cm) that somewhat resembles a strawberry (the epithet "illecebrosus" is Latin for "enticing").

Rubus ×*neglectus* (possibly = *R. occidentalis* × *R. idaeus*) Peck – purple raspberry

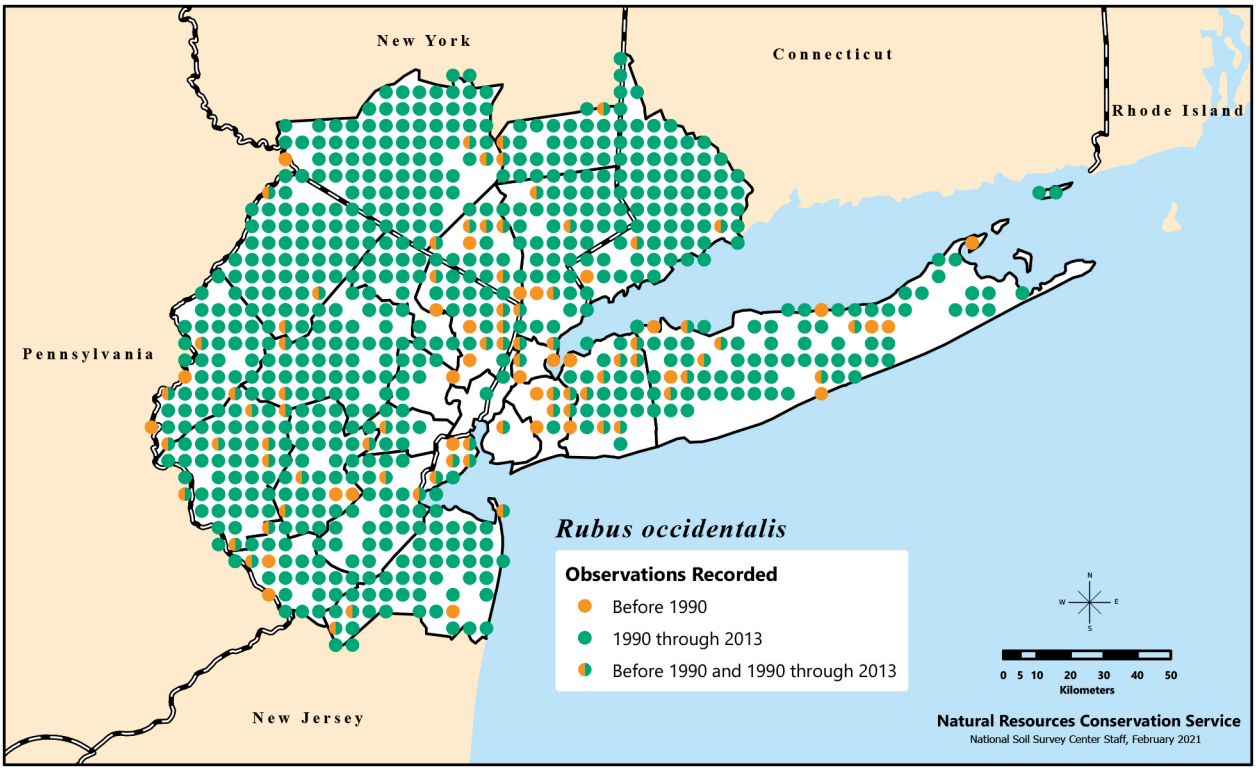
Hybrids between *Rubus idaeus* subsp. *strigosus* and *R. occidentalis*, including the cultivated purple raspberries, have usually gone under the name *R.* ×*neglectus* Peck. However, Peck (1869) did not treat *R. neglectus* as a hybrid, although his description, based on material from northeastern NY, acknowledged the material to be intermediate between the two species. Bailey (1945: 889) suspected *R. neglectus* to be a "distinct species of local range" with no "real resemblance" to the cultivated purple raspberries. G. Moore (pers. observ., 2004) has observed wild purple-fruited material from northeastern NY near the type locality and concurs with Bailey. The fruit of this material has a distinctive taste, and Peck (1869) noted that the local people referred to them as "cream berries." Further study of this material is needed to better understand the proper application of the name *R. neglectus*, including whether this name can be applied to hybrids between *R. idaeus* subsp. *strigosus* and *R. occidentalis*.

7. *Rubus occidentalis* L. – black raspberry ↑↑↑

Flowering late Apr.–early June; fruiting June–July. Disturbed woodlands, woodland edges, roadsides, and fields; in dry to moist soils. Epithet from Latin refers to its occurrence in the Western Hemisphere.

The most common raspberry in the region. Has also served as the source for most of the black raspberries currently in cultivation (Bailey 1945).

Cultivated since 1696 (Zasada and Tappeiner 2008). Considered a weed in the U.S., an agricultural weed or escape from cultivation in Canada, and a casual nonnative in the Czech Republic (AgWest and HEAR 2010). May have slightly higher germination probabilities than *R. allegheniensis* (and perhaps other *Eubatus* members) because it is less selective in terms of safe-site conditions.



Distribution of *Rubus occidentalis*, or black raspberry, recorded in the New York Metropolitan Region during three time categories.

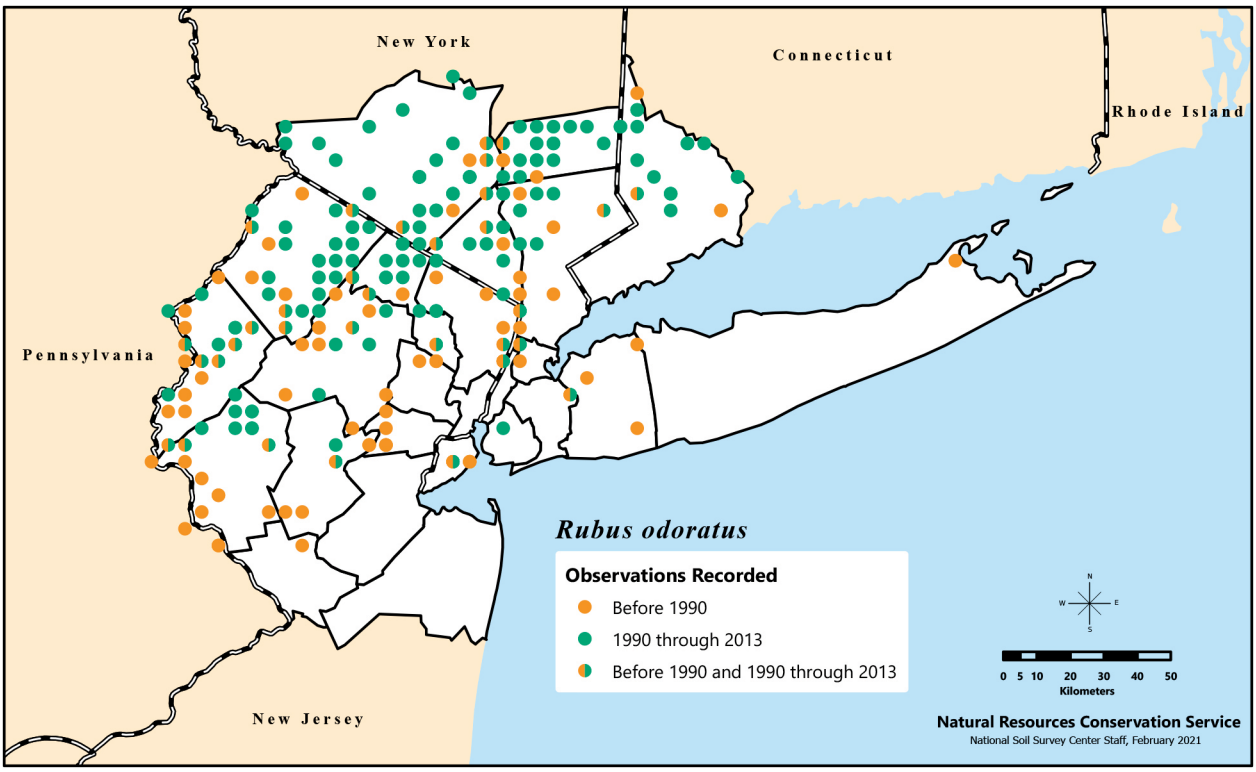
Rubus occidentalis and hybrid black raspberries have the highest concentrations of anthocyanins as well as higher values of oxygen radical-absorbing capacity and ferric-reducing antioxidant power than all other *Rubus* spp. as well as most *Vaccinium* spp. (Moyer et al. 2002). Extracts containing these anthocyanins and other phenolics found in *R. occidentalis* have been shown to inhibit growth of human cancer cells in vitro (Seeram et al. 2006).

8. *Rubus odoratus* L. – flowering raspberry ↔

Rubus odoratus var. *albidus* L.H. Bailey

Flowering May–June; fruiting late June–July. Mesic shady sites in deciduous forests, margins of woods, rocky slopes, wooded talus, streambanks, and roadsides. Epithet from Latin refers to the fragrant flowers.

There are 7 varieties recognized for *R. odoratus*. Those found at higher latitudes in its range (NS, QC, and MI to GA and TN) tend to have more glabrous leaves. This is opposite of the trend found for *R. idaeus*. The varieties show other geography-associated differences in terms of whether the glands are stalked (farther east) or subsessile (IN or farther west) (Fassett 1941). The Cherokee people used leaf infusions for labor pains and the Iroquois used plant infusions for miscarriages (Bergner 1997). Grown as an ornamental for its large fragrant magenta flowers and its edible, though sometimes dry and insipid, fruit. Cultivated since 1635. Found in the U.K., Finland, and Denmark; escapes from cultivation occasionally. Included on the invasive species list of Lithuania (AgWest and HEAR 2010).



Distribution of *Rubus odoratus*, or flowering raspberry, recorded in the New York Metropolitan Region during three time categories.

9. *Rubus pensilvanicus* Poir. ex Lam. s.l. – Pennsylvania blackberry ↔

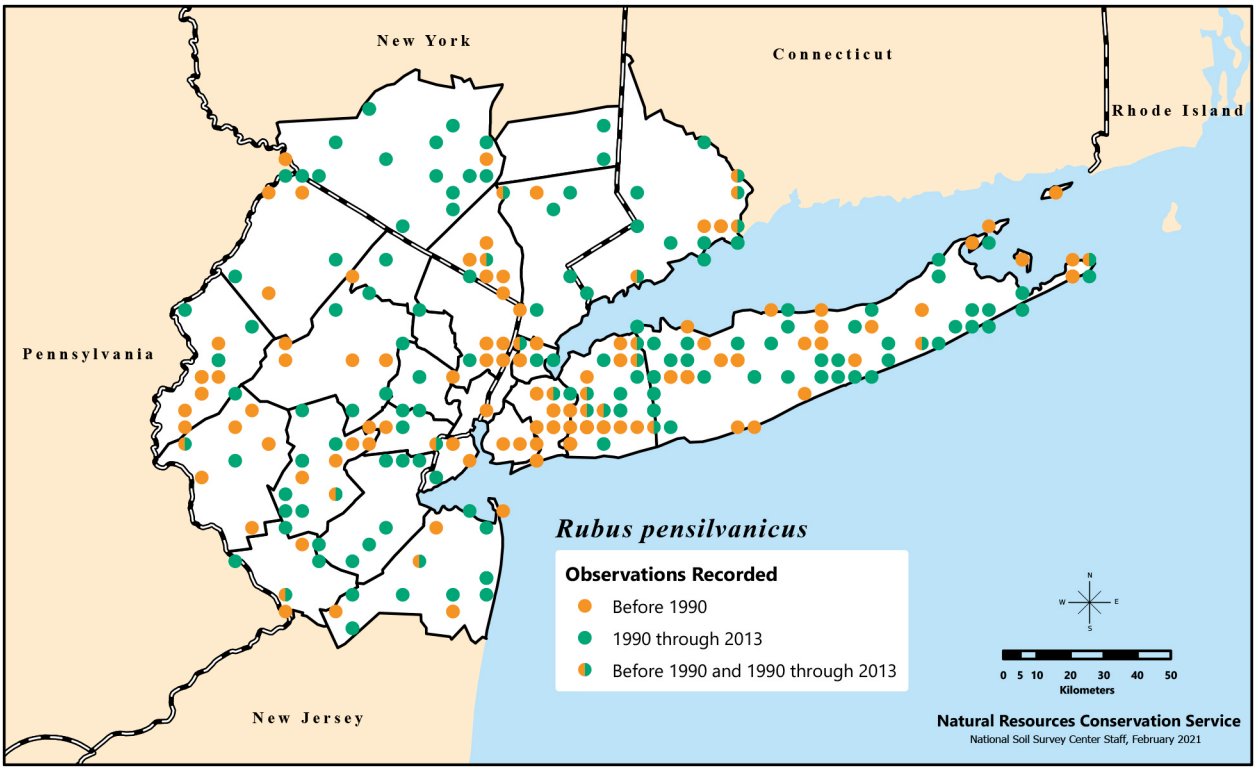
Rubus andrewsianus Blanchard; *Rubus argutus* Link; *Rubus avipes* L.H.Bailey; *Rubus barbarus* L.H.Bailey; *Rubus bellobatus* L.H.Bailey; *Rubus blakei* L.H.Bailey; *Rubus facetus* L.H.Bailey; *Rubus floricomus* Blanchard; *Rubus frondosus* Bigel.; *Rubus heterogeneus* L.H.Bailey; *Rubus honorus* L.H.Bailey; *Rubus humilior* L.H.Bailey; *Rubus incisifrons* L.H.Bailey; *Rubus insons* L.H.Bailey; *Rubus insulanus* L.H.Bailey; *Rubus jugosus* L.H.Bailey; *Rubus litoreus* L.H.Bailey; *Rubus multispinus* Blanchard; *Rubus originalis* L.H.Bailey; *Rubus par* L.H.Bailey; *Rubus parcifronder* L.H.Bailey; *Rubus pauper* L.H.Bailey; *Rubus perpauper* L.H.Bailey; *Rubus philadelphicus* Blanch.; *Rubus recurvans* Blanch.; *Rubus rossbergianus* L.H.Bailey; *Rubus rydbergianus* L.H.Bailey; *Rubus subtractus* L.H.Bailey

Flowering May–June; fruiting late June–early Aug. Woodlands, woodland edges, fields, meadows, swamps, rock outcrops, sand dunes, sandy soils, and disturbed areas; in dry to wet soils. Has been documented in the few *Quercus-Carya-Cornus* (oak-hickory-dogwood) forests (drier sites) of Long Island (Greller et al. 1982).

Highly variable in the region, with numerous microspecies, based on leaf shapes and flower size as described by Bailey (1945; names given in preceding synonymy). Species is distinguished from the other common species of highbush blackberry (*Rubus allegheniensis*) by its lack of (or sparse) glands and inflorescences of somewhat flat cymes (as opposed to elongate racemes). Numerous pomological cultivars have been developed from *R. pensilvanicus* (Bailey 1945).

Apparently, *R. pensylvanicus* has escaped from cultivation in CA, where it is not native, and has become naturalized in Kern County (CA). Has also escaped from cultivation in ON, but this province is part of its native range (AgWest and HEAR 2010).

Rubus originalis, treated here as a synonym, is tracked as imperiled in NJ (S2).



Distribution of *Rubus pensilvanicus*, or Pennsylvania blackberry, recorded in the New York Metropolitan Region during three time categories.

10. *Rubus setosus* Bigel. s.l. – setose blackberry ↓↓↓

Rubus apparatus L.H.Bailey; *Rubus benneri* L.H.Bailey; *Rubus condignus* L.H.Bailey; *Rubus semisetosus* Blanch.; *Rubus vermontanus* Blanch.

Flowering June–July; fruiting July–Aug. Open woodlands, woodland edges, meadows, and disturbed areas; in dry to wet soil. Epithet from Latin refers to the bristles that are commonly found on the stems and inflorescence axes.

Identified by erect to arching (rarely creeping) but not tip-rooting, terete primocanes, always setose but in variable density, and deciduous primocane leaves that are often palmately compound with five leaflets. Plants observed in cultivation have alternated between erect and creeping in successive years (Alice et al. 2014). The fruit of *Rubus setosus* is not exceptionally palatable and has not yielded pomological cultivars. *Rubus setosus* is a species more common in northern and high-elevation regions that has severely declined in the NY Metropolitan Region.

In ME, where both *R. allegheniensis* and *R. setosus* are found growing together, the flowers of *R. setosus* are delayed for 23 days; this may ensure pollination of both species (Heinrich 1975).

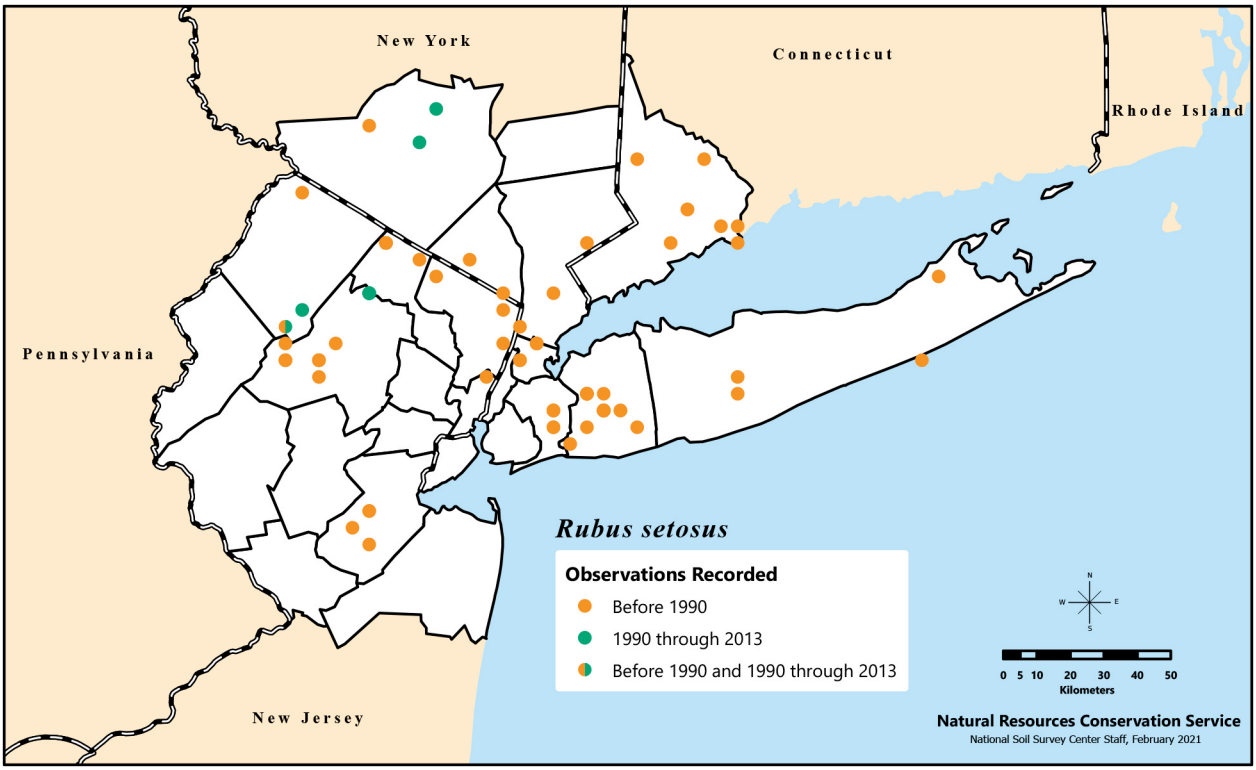
Tracked as historical (SH.1) in NJ; however, unlike this treatment, the NJ Natural Heritage Program uses a narrower description of this species, with other segregates (e.g., *R. semisetosus*) recognized as distinct species.

Nonnative Species

11. *Rubus bifrons* Vest. – blackberry Ø

Rubus armeniacus Focke

Flowering May–July; fruiting July–Aug. Woodland edges, dry or mixed woods, and open areas, often disturbed; roadsides; in dry to moist soils. Possible or likely naturalized populations reported from Fairfield County (CT) and Richmond and Suffolk Counties (NY). Introduced from Europe. Epithet from Latin refers to the two kinds of leaves (ternate, or arranged in threes; and



Distribution of *Rubus setosus*, or setose blackberry, recorded in the New York Metropolitan Region during three time categories.

quinate, or arranged in fives) that are often present on a stem; the ternate leaves are higher up the stem closer to the inflorescence. (This trend is fairly typical in most blackberry species.)

Material treated here represents the main group of European blackberries (*Rubus* L. subg. *Rubus* sect. *Rubus*) that occasionally escapes from cultivation. Bailey (1945), Fernald (1950), Heslop-Harrison (1968), and Gleason and Cronquist (1993) distinguished between *R. bifrons* and another species (referred to as *R. discolor* Weihe & Nees or *R. procerus* P.J.Muell ex Genev.), using stem shape and pubescence, prickle shape and angle, leaf shape and margins, inflorescence shape, and petal color. Plants in North America identified as either *R. bifrons* or *R. discolor* (or *R. procerus*) can have considerable variation in any of these characters, even within individual stems, making it essentially impossible to distinguish between them. *Rubus discolor*'s name often has been misattributed as a synonym of *R. armeniacus* in the region, whereas it is a synonym of *R. ulmifolius* (Weber 1985).

Rubus bifrons lacks the strongly glaucous stems of the closely related, nonnative *R. ulmifolius* Schott (which would key to here and has been confirmed from NJ), and has leaves that are usually much larger. *Rubus bifrons*, like *R. ulmifolius*, can have extremely long floricane branches, sometimes in excess of 1 m, that end in flowering cymes. Material in this European blackberry species complex is also sometimes treated as one broadly circumscribed species (basically covering the whole of *Rubus* L. subg. *Rubus* sect. *Rubus*), under the name *R. fruticosus* L. (Heslop-Harrison 1968). A currently unidentified species, tentatively called *R. pascuus*, may also be properly placed with *R. bifrons*' European blackberry species complex instead of with *R. cuneifolius*. Material from this species complex with double flowers is occasionally noted. This material has been referred to as *R. linkianus* Seringe, although the correct identification of this material and the proper application of the name *R. linkianus* remain uncertain.

In the region, the *R. bifrons* spp. complex is only occasionally encountered, although it may be increasing. Elsewhere in the U.S. (West Coast) this species is a problematic weed, and can grow in great densities over large areas, often to the exclusion of all other vegetation. The European blackberry complex is used in cultivation; however, it is also listed by APHIS as a noxious weed, under the name *Rubus fruticosus* (USDA-APHIS 2010).

Rubus discolor (see preceding discussion) is tracked as a potentially invasive species in NJ (category 2).

Rubus idaeus* L. subsp. *idaeus

See the entry under *Rubus idaeus* in the Native Species section for this nonnative subspecies.

12. ***Rubus laciniatus* Willd. – cutleaf blackberry, evergreen blackberry ↔**

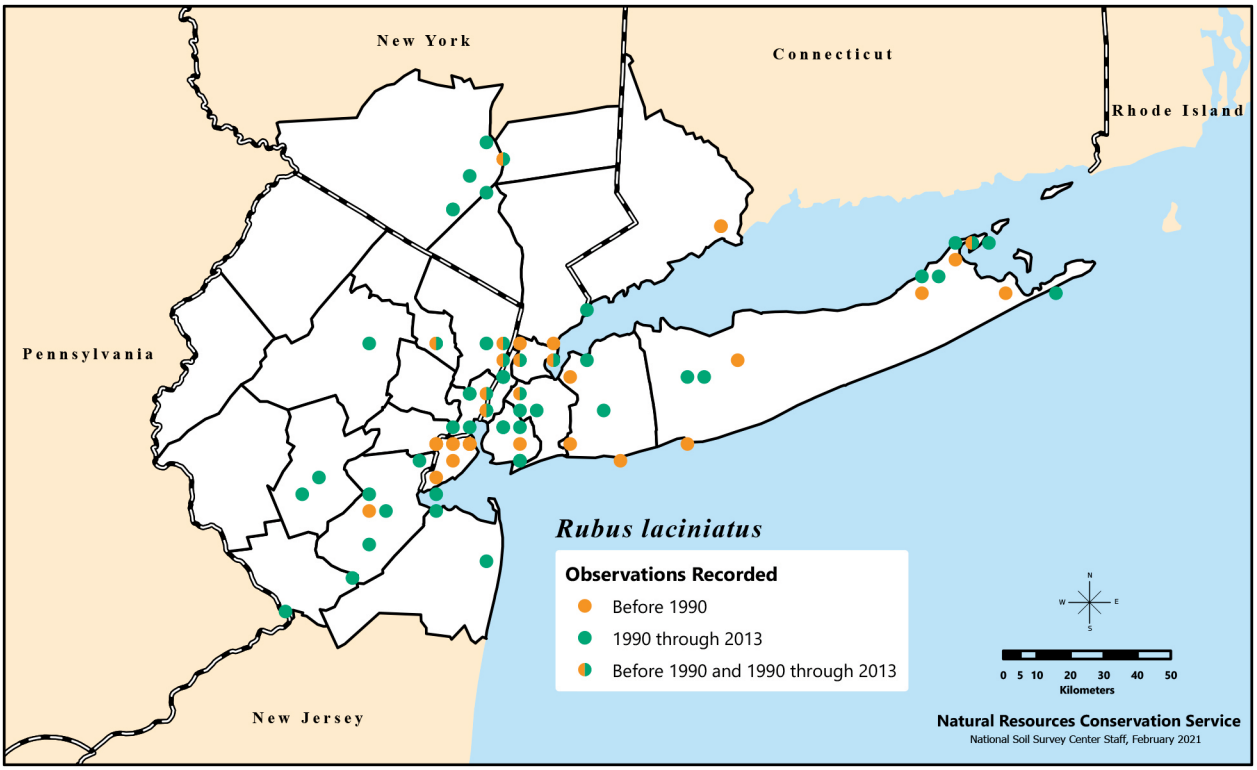
Flowering June–July; fruiting July–Aug. Woodland edges, semiopen woods, rocky soils, roadsides, and open areas, often disturbed; often in moist soils. Epithet from Latin refers to the deeply cut or dissected leaves that are typical of this species.

Probably native to Europe, although it has long been in cultivation. In the U.S., this species has been cultivated as an ornamental as well as for its fruit. No other *Rubus* sp. within the region has leaflets so deeply lobed or dissected. Although widely introduced and escaped, *R. laciniatus* is generally not an exceptionally aggressive invasive species in the region.

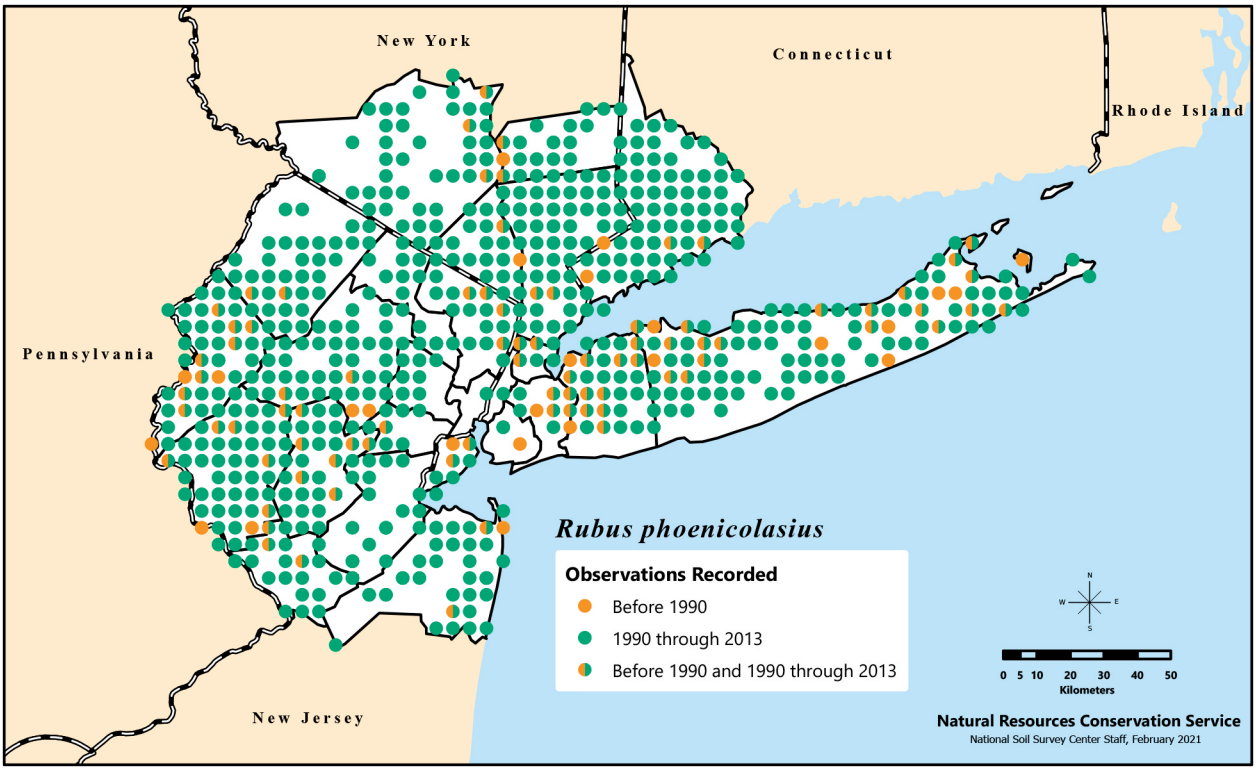
Tracked as potentially invasive in NJ (category 2).

13. ***Rubus phoenicolasius* Maxim. – wineberry ↑↑↑**

Flowering May–July; fruiting late June–July. Woodlands, woodland edges, roadsides, and disturbed open areas, in dry to moist soil. Native to eastern Asia (China, Japan, Korea). Epithet refers to the reddish-purple ("phoenico-") hairs ("-lasius") present on the stems.



Distribution of *Rubus laciniatus*, called cutleaf or evergreen blackberry, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Rubus phoenicolasius*, or wineberry, recorded in the New York Metropolitan Region during three time categories.

Introduced into North America for edible raspberry fruit and breeding stock, and to a lesser extent for ornament. An attractive species for its reddish-purple glandular hairs, but it can be aggressively invasive. Tree-fall gaps appear to be required for *R. phoenicolasius* seedling establishment, vegetative reproduction, and fruiting in mature forests (Gorchov et al. 2011). Seed of this species is actively dispersed by white-tailed deer (*Odocoileus virginianus*), which may result in even longer-distance dispersal (about a 10-ha range) than is found with birds, which also disperse this and other *Rubus* spp. fruits (Williams and Ward 2006).

Listed as invasive in CT (prohibited) and NY (prohibited); tracked as invasive in NJ (category 1).

Management

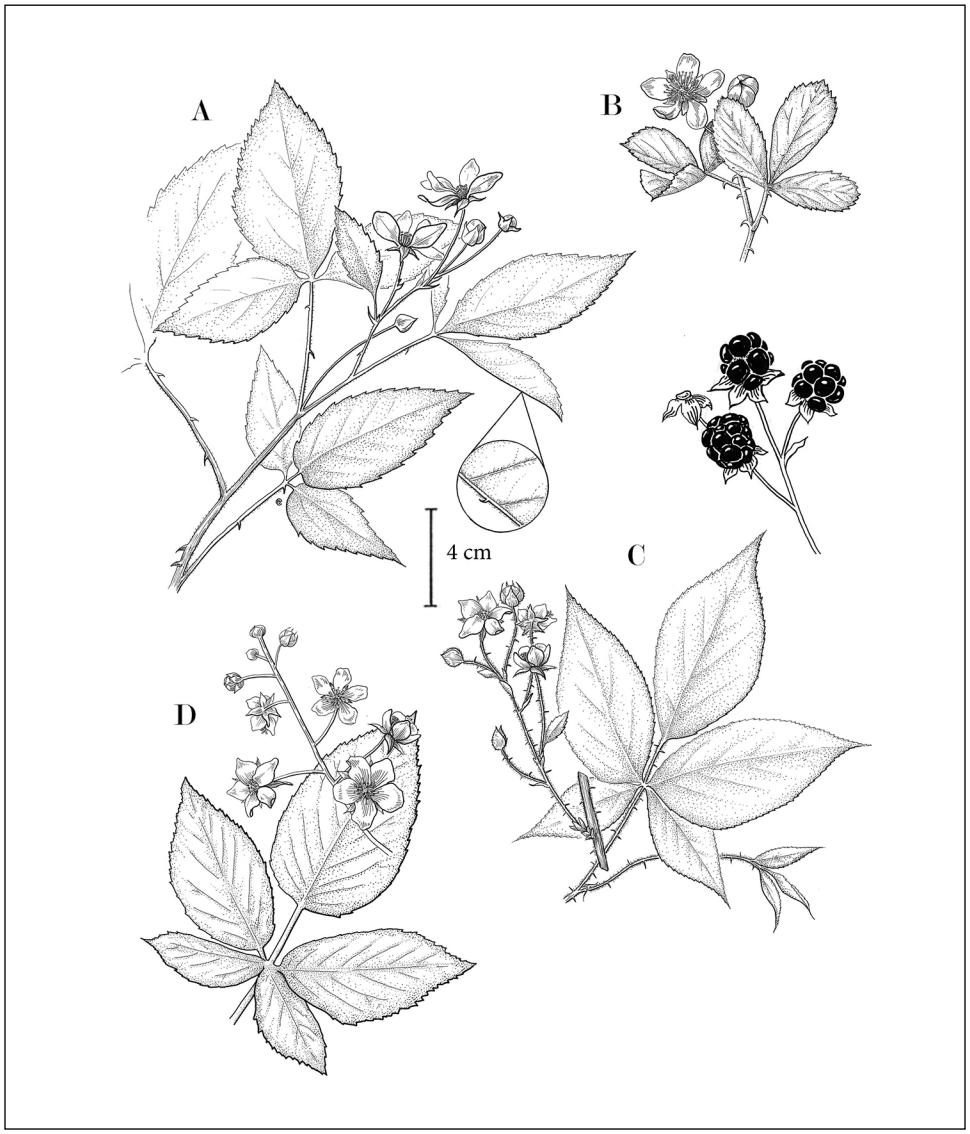
Both native and nonnative *Rubus* spp. tend to dominate disturbed habitats as early successional colonizers, and increases in abundance for some species may reflect an increase in disturbed habitats in the region. In some cases, this dominance is beneficial to other native species. For instance, *Quercus* (oak) tree seedlings are protected from deer herbivory in dense layers of *Rubus* spp. (Gordon et al. 1995). Conversely, there is also evidence of increases in seed predation of large-seeded species by small rodents (order Rodentia) that hide under the *Rubus* thicket (Schwantes Boman and Casper 1995); such predation may decrease regeneration of some native species.

Greater photosynthetic and water-use efficiency (McDowell 2002, McDowell and Turner 2002) for some of the invasive *Rubus* spp. (*R. discolor* and *R. laciniatus*, the latter of which is in the region) may give them a competitive advantage over native species (*R. ursinus* and *R. leucodermis*, neither of which is in the region) in disturbed sites and early successional forests. Many invasive *Rubus* spp., like their native counterparts, do not grow or reproduce well in closed-canopy forests. Consequently, if some regeneration of tree species is possible and canopy closure occurs, the impact

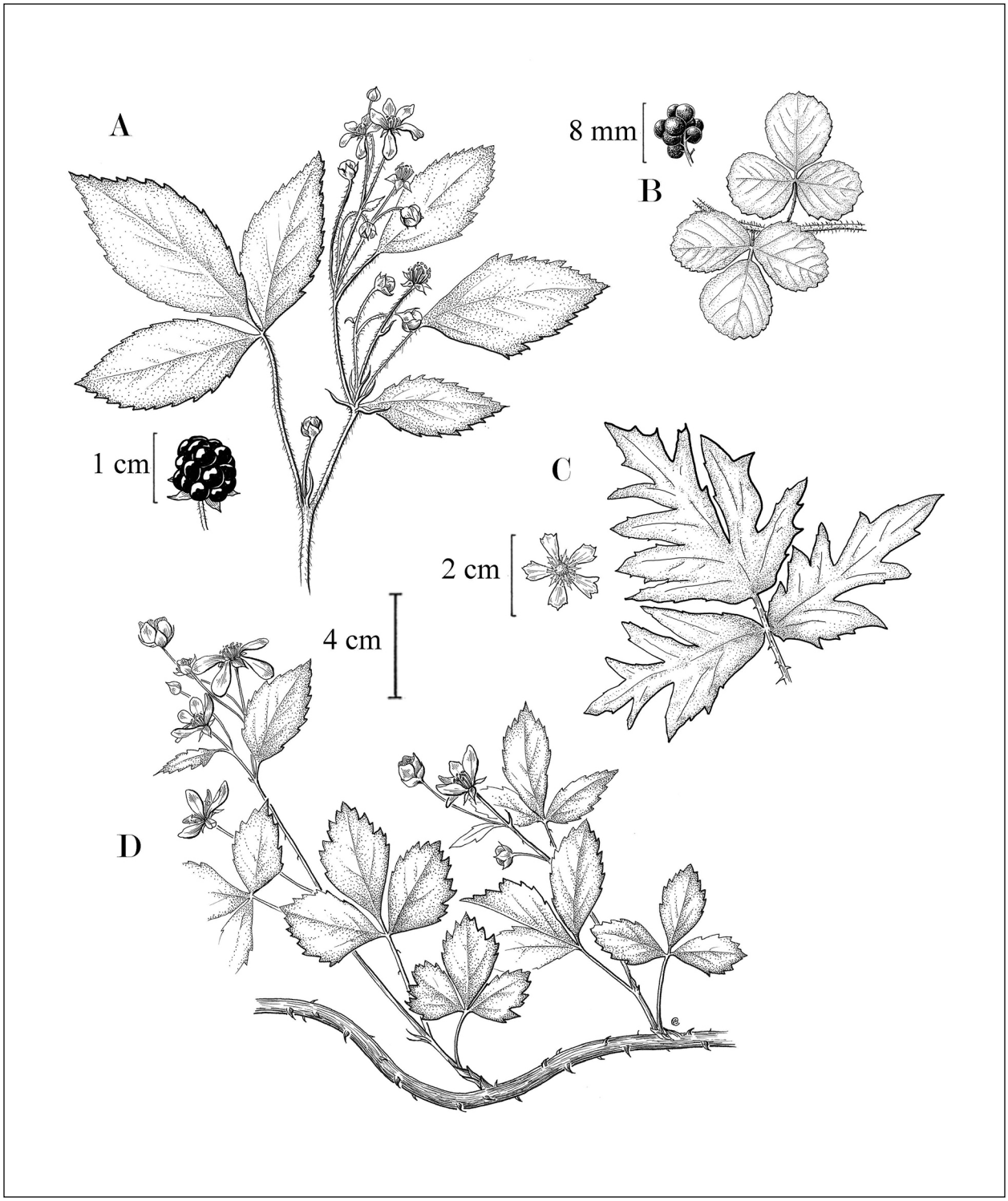
of these *Rubus* spp. is expected to decrease, but *Rubus* individuals may be continually present due to naturally occurring tree-fall gaps (Gorchov et al. 2011). Decreasing impact over time has been noted for the related rosaceous species *Rosa multiflora* (Banasiak and Meiners 2009). Whether the successional direction of a forest gap is to be colonized by *Rubus* spp. first or by *Prunus serotina*, may depend on the degree of shade available (e.g., from other trees). *Prunus serotina* seedlings can germinate and survive in more shady conditions than *Rubus* spp. (Smith 1975).

Prolific *Rubus* seed production in disturbed sites and a long-lived seed bank (20 or more years for many *Rubus* spp.; Hill and Stevens 1981) ensure that any management is likely to be a long-term endeavor. Likewise, multiple seed dispersal mechanisms in which large amounts of seed are found near the maternal plants, and long-distance dispersal via small rodents, larger mammals (including deer), and birds, make propagule pressure of *Rubus* spp. both a local and a landscape-scale problem.

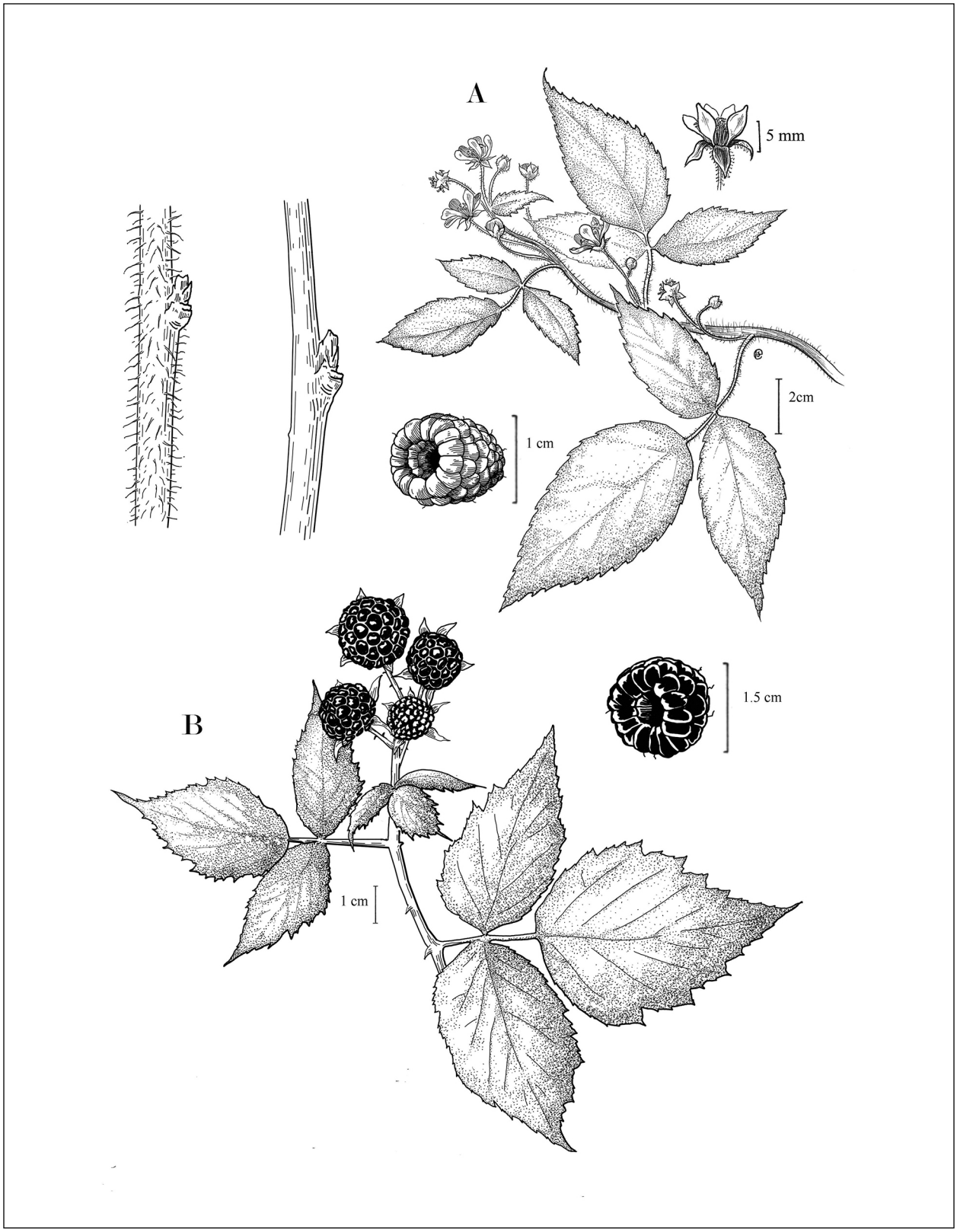
The most successful removal methods include 1) grazing by goats (*Capra hircus*) (Dellow et al. 1988) and 2) herbicide application (including metasulfuron or triclopyr). Fire and mowing often increase *Rubus* cover because of the species' ability to resprout from root suckers (DiTomaso et al. 2006). However, repeated mowing or herbicide application may eventually deplete the roots of enough resources that resprouting stops.



A) Flowering twig with leaves and enlarged view of leaf underside showing midrib of *Rubus pensilvanicus*; B) flowering twig and fruit of *Rubus cuneifolius*; and leaves and flowering twig of C) *Rubus allegheniensis* and D) *Rubus canadensis*. Illustration by Emma Skurnick.



A) Flowering twig with leaves, and fruit of *Rubus setosus*, B) fruit and twig with leaves of *Rubus hispidus*; C) flower and leaves of *Rubus laciniatus*; D) flowering twig with leaves of *Rubus flagellaris*. Illustration by Emma Skurnick.



A) Stems (with and without bristles for subsp. *strigosus* [at left] and subsp. *idaeus*), fruit, flowering twig with leaves, and flower of *Rubus idaeus*; B) fruiting stem with leaves, and fruit of *Rubus occidentalis*. Illustration by Emma Skurnick.

Salix L. – willow, osier

Salicaceae. Trees, shrubs. Species approximately 450 in Africa, Asia, Europe, North America, South America, and the West Indies. Introduced and sometimes invasive in Oceania; diversity greatest in boreal regions. Dioecious. Gender is most likely genetically determined by a few shared loci. Similar genes may be operating to control sex (Gunter et al. 2003). There are often higher ratios of males than females earlier in development (Falinski 1980). Most are adapted to disturbance and do best in early successional habitats. Pollination by wind and insects; nectaries present on staminate and pistillate flowers. Seeds dispersed by wind; fine hairs on coat aid wind transport. Seeds usually remain viable for only a short time. Long-term storage may be possible through cryopreservation (Popova et al. 2012, Wood et al. 2003). Taxonomy complicated by hybridization and polyploidy, especially allopolyploidy (hybridization and subsequent chromosome multiplication); most current species believed to be allopolyploids (Argus 2010). Only hybrids reported between species in the NY Metropolitan Region are discussed here. Many species planted as ornamentals. Used by Native Americans for basketry, construction, and medicine. Salicin, a compound similar to aspirin (acetylsalicylic acid) with similar properties, first obtained from *Salix*. Some native species, including many in the region, declining significantly, likely due to loss of successional habitats and contraction in the southern limits of the ranges of boreal species. Conversely, some nonnative willows are invasive and spreading rapidly. Besides "willow," the name "osier" is applied to some species, especially species in Europe used for basketry. In North America "osier" refers to some *Cornus* spp. used in basketry.

Two keys follow. The first is diagnostic (artificial) and focuses on vegetative characters. The second is synoptic (natural) and focuses on reproductive characters.

Salix Diagnostic Key

1. Leaf margins without apparent sharp teeth 2
1. Leaf margins toothed 3
2. Leaf undersides mostly glabrous, excluding some pubescence along main vein 4
2. Leaf undersides pubescent throughout. 5
3. Leaf undersides glabrous, sometimes with pubescence along main vein 6
3. Leaf undersides pubescent throughout. 7
4. Small shrub, to 1.2 m; finely reticulate venation (third-level veins apparent); fruit glabrous; rare in region . . . . . ***Salix pedicellaris***
4. Large shrub, taller than 1.2 m; without finely reticulate venation (third-level veins not readily visible); fruit pubescent; common . . . . . ***Salix discolor*** (in part)
5. Leaf undersides with white pubescence. . . . . ***Salix candida***
5. Leaf undersides with gray or red pubescence 8
6. At least some leaves opposite or subopposite . . . . . ***Salix purpurea****
6. All leaves alternate. 9
7. Leaves mostly less than 1.8 cm wide. 10
7. Leaves mostly more than 1.8 cm wide. 11
8. Leaf margins inrolled. . . . . ***Salix humilis***
8. Leaf margins not inrolled. 12
9. Petioles glandular (especially toward blade) 13
9. Petioles eglandular. 14

Salix Diagnostic Key

10. Current year's twigs yellow-tan; fruit glabrous . . . . . ***Salix alba****
10. Current year's twigs brown-gray; fruit pubescent . . . . . ***Salix sericea***
11. Leaf undersides sparsely red or gray pubescent. . . . . ***Salix discolor*** (in part)
11. Leaf undersides gray pubescent 15
12. Leaf undersides sparsely red or gray pubescent . . . . . ***Salix discolor*** (in part)
12. Leaf undersides gray pubescent 16
13. Leaf apices long-acuminate . . . . . ***Salix lucida***
13. Leaf apices with acute or short-acuminate. 17
14. Leaf undersides glaucous 18
14. Leaf undersides green 19
15. Leaves mostly less than 2.6 cm wide; scales subtending fruit pale . . . . . ***Salix bebbiana*** (in part)
15. Leaves mostly 2.6 cm wide or more; scales subtending fruit dark 20
16. Leaves mostly less than 2.5 cm wide; scales subtending fruit pale . . . . . ***Salix bebbiana*** (in part)
16. Leaves mostly 2.5 cm wide or more; scales subtending fruit dark 20
17. Scales subtending fruit pubescent throughout . . . . . ***Salix serissima***
17. Scales subtending fruit pubescent chiefly near the base . . . . . ***Salix pentandra****
18. Leaf margins with fewer than 4 teeth per cm. . . . . ***Salix discolor*** (in part)
18. Leaves with 4 teeth or more per cm. 21
19. Leaf margins with fewer than 6 teeth per cm;
usually lacking stipules; fruit pubescent. . . . . ***Salix interior***
19. Leaf margins with 6 teeth or more per cm;
usually with prominent stipules; fruit glabrous . . . . . ***Salix nigra***
20. Shrubs or small trees, 5–12 m tall;
lower surfaces of blades with white and russet hairs . . . . . ***Salix atrocinerea****
20. Shrubs, 3–7 m tall; lower surfaces of blades with white hairs. . . . . ***Salix cinerea****
21. Leaves mostly 1.8 cm wide or more 22
21. Leaves mostly less than 1.8 cm wide. 23
22. Stipules large, persistent; teeth on leaf margins eglandular
or with small glands; pistillate scales persistent, dark . . . . . ***Salix eriocephala***
22. Stipules small or lacking; teeth on leaf margins eglandular or glandular;
pistillate scales deciduous or persistent 24
23. Leaf apices long-acuminate, often falcate;
branches pendulous; fruit glabrous. 25
23. Leaf apices acute or short-acuminate;
branches not pendulous; fruit pubescent. . . . . ***Salix petiolaris***
24. Teeth on leaf margins eglandular; pistillate scales deciduous . . . . . ***Salix amygdaloides***
24. Teeth on leaf margins glandular; pistillate scales persistent, pale . . . . . ***Salix ×fragilis****
25. Catkins stout, loosely flowered, 7–11 mm thick; nectaries connate . . . . . ***Salix ×pendulina****
25. Catkins slender, densely flowered, 3–9 mm thick; nectaries distinct . . . . . ***Salix ×sepulcralis****

Salix Synoptic Key

1. Bracts of catkin whitish-yellowish, early deciduous falling before withering of catkins; catkins on short lateral vegetative branches, expanding with or after leaf expansion; stamens 2–12, filaments free, pubescent at base; style short or absent (stigma sessile), stigmas emarginate or bifid. 2
1. Bracts of catkin yellow or brown to black (or at least black-tipped), tardily deciduous persisting until shriveling off catkin; stamens (1)2 3
2. Stamens 3–12. 4
2. Stamens 2. 5
3. Shrub, erect or decumbent to 1.5 m; ovaries glaucous (*S.* subg. *Chamaetia* sect. *Myrtilloides* (Borrer) Andersson) . . . . . ***Salix pedicellaris***
3. Shrub, erect, 1.5 m or taller; ovaries not glaucous (*S.* subg. *Vetrix* (Dumort.) Dumort.) 6
4. Bud scale margins distinct, overlapping; petioles eglandular at summit; anther filaments arching (*S.* subg. *Protitea* sect. *Humboldtianae* Andersson) 7
4. Bud scale margins connate; petioles glandular at summit, sometimes at junction with blade; anther filaments straight (*S.* subg. *Salix* sect. *Salicaster* Dumort.) 8
5. Stoloniferous shrubs or small trees; leaves sessile to subsessile, linear to oblong-lanceolate, margins remotely denticulate, apices acute to short-acuminate; catkins clustered at branchlet ends; pistillate bracts deciduous after flowering (*S.* subg. *Longifoliae* (Andersson) Argus) . . . . . ***Salix interior***
5. Trees; leaves petiolate, lanceolate to ovate, margins remotely denticulate, apices long-acuminate; catkins scattered on short leafy shoots; pistillate bracts persistent after flowering (*S.* subg. *Salix*) 9
6. Filaments, 2, united, anthers, red, also often united; at least some of the leaves opposite or subopposite (*S.* subg. *Vestrix* sect. *Helix* Dumort.). . . . . ***Salix purpurea****
6. Filaments separate; leaves alternate. 10
7. Branchlets flexuous; leaf undersides glaucous (at least large medial blades) . . . . . ***Salix amygdaloides***
7. Branchlets brittle, especially at base; leaf undersides not glaucous . . . . . ***Salix nigra***
8. Lower leaf surface pale to slightly glaucous; staminate catkins 1–2 cm long, pistillate catkins 2.0–3.5 cm long; capsules 7–10 mm long, valves indurated, opening in late summer . . . . . ***Salix serissima***
8. Leaf surfaces green and lustrous; staminate catkins 2–6 cm long, pistillate catkins 2–5 cm long; capsules 5–7 mm long, valves opening late spring to early summer 11
9. Branches pendulous; pistillate bracts persistent after flowering; stamens 2; ovules 2–8; capsules 1–3.5 mm long (*S.* subg. *Salix* sect. *Subalbae* Koidz.). 12
9. Branches erect (not pendulous); pistillate bracts deciduous after flowering; stamens 2–10; ovules 8–30; capsules 3–12 mm long (*S.* subg. *Salix* sect. *Salix*) 13
10. Stipules on leaves absent or rudimentary (*S.* subg. *Vetrix* sect. *Cinerella* Ser. in part) 14
10. Stipules on leaves (at least early leaves) present, foliaceous. 15
11. Branchlets pubescent (sometimes glabrescent); leaf apices long, attenuate; stipules of early leaves foliaceous; capsule conical to ovoid, pedicel about 4 times as long as upper gland . . . . . ***Salix lucida***
11. Branchlets glabrous; leaf apices short, acuminate; stipules of early leaves absent or rudimentary; capsule conical to subulate, pedicel about 2 times as long as upper gland . . . . . ***Salix pentandra****

Salix Synoptic Key

12. Catkins stout, loosely flowered, 7–11 mm thick, nectaries connate . . . . . ***Salix ×pendulina****
12. Catkins slender, densely flowered, 3–9 mm thick, nectaries distinct. . . . . .***Salix ×sepulcralis****
13. Twigs with silky hairs, flexuous to slightly brittle at base;
young petioles glandless, larger blades with persistent silky hairs
on both surfaces, margins with 7–10 teeth per cm;
pistillate flowers with one gland, styles 0.2–0.4 mm,
ovary sessile to subsessile; capsules ovoid to conical . . . . . ***Salix alba****
13. Twigs glabrous, highly brittle at base; young petioles glandular,
larger blades glabrous to glabrescent, margins with 4–6 teeth per cm;
pistillate flowers with two glands, styles 0.4–1 mm, ovary stalked;
capsules subulate . . . . . .***Salix ×fragilis****
14. Stems erect, plants usually not clonal; leaf undersides glabrous
or soon glabrate, margins flat (not undulate); style present;
capsules 7–12 mm long . . . . . ***Salix discolor*** (in part)
14. Stems decumbent to erect, plants usually clonal;
leaf undersides pubescent, margins undulate; style absent (or nearly so) . . . . . .***Salix humilis*** (in part)
15. Flowering before leaves appear (*S.* subg. *Vetrix* sect. *Cinerella* Ser. in part) 16
15. Flowering after leaves appear 17
16. Ovaries glabrous (*Salix* subg. *Vetrix* sect. *Cordatae* Barratt ex Hooker). . . . . ***Salix eriocephala***
16. Ovaries pubescent 18
17. Stipules on late leaves foliaceous 19
17. Stipules on late leaves absent or rudimentary 20
18. Leaf margins flat . . . . . ***Salix discolor*** (in part)
18. Leaf margins slightly to strongly revolute. 21
19. Twigs, petioles, blades (especially lower surface),
glabrous or pubescent, the pubescence of silky hairs
(*Salix* subg. *Vetrix* sect. *Fulvae* Barratt) . . . . . ***Salix bebbiana***
19. Twigs, petioles, blades (especially lower surface) tomentose
(*Salix* subg. *Vetrix* sect. *Candidae* C.K.Schneid.). . . . . ***Salix candida***
20. Twigs flexuous; blade margins entire or nearly so at base;
stipe of pistillate flowers 1.5–4 mm, styles absent or rudimentary (>0.3 mm),
ovaries pyriform; capsules 5–9 mm (*S.* subg. *Vetrix* sect. *Griseae* (Borrer) Barratt). . . ***Salix petiolaris***
20. Twigs brittle, especially at base; blade margins toothed to base;
stipe of pistillate flowers 0.5–1.5 mm, styles present 0.2–0.4 mm,
ovaries pyriform; capsules 2–5 mm (*S.* subg. *Vetrix* sect. *Geyerianae* Argus). . . . . ***Salix sericea***
21. Low shrubs 3 m tall or less . . . . . .***Salix humilis*** (in part)
21. Tall shrubs, usually more than 3 m 22
22. Shrubs or small trees, 5–12 m tall;
lower surfaces of blades with white and russet hairs . . . . . ***Salix atrocinerea****
22. Shrubs, 3–7 m tall; lower surfaces of blades with white hairs. . . . . .***Salix cinerea****

Native Species

Salix amygdaloides Andersson – peach-leaved willow

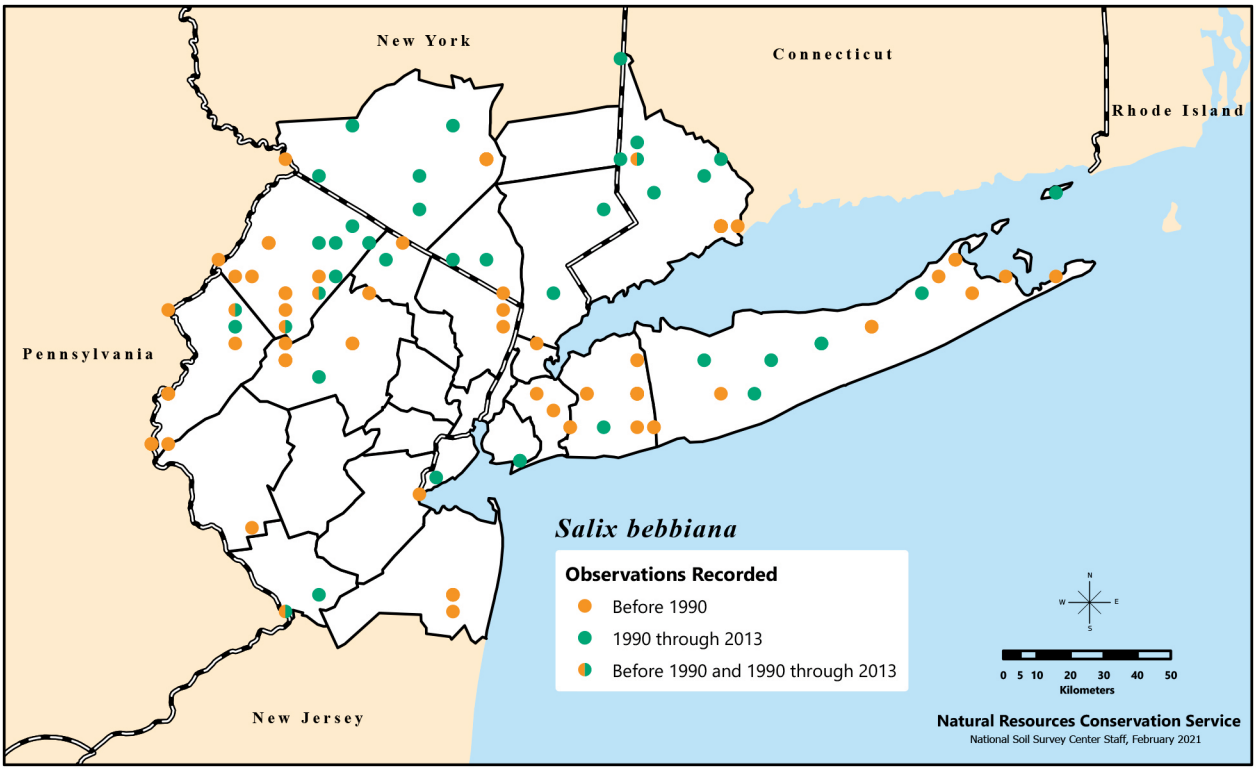
Flowering Apr.–May; fruiting May–June. Open swamps, bogs, shorelines. Epithet derived from the Greek “amygdalus” (“peach”) and “-oides” (“like”), in reference to the peach-like leaves.

Unconfirmed report from Long Island in Nassau County (NY). Also reported from just outside the region in eastern PA and Ulster County (NY). Reported to hybridize with *S. eriocephala* (Fernald 1950; questioned by Argus 2010) and *S. nigra* (*S.* ×*glatfelteri* Schneid., named in honor of its discoverer, Noah Miller Glatfelter [1837–1911], an American physician and botanist).

1. _Salix bebbiana_ Sarg. – beaked willow, Bebb’s willow ↔

Tree, shrub. Flowering Apr.–May; fruiting May–early June. Mesic, often disturbed, open areas, including thickets, streambanks, lakeshores, fields, woodland edges, riparian forests, and coniferous forests. Named in honor of botanist Michael Schuck Bebb (1833–1895), a specialist in *Salix*.

Reported to hybridize with *Salix candida* (*S.* ×*cryptodonta* Fernald; epithet from Greek, meaning “hidden teeth”), *S. discolor*, *S. eriocephala*, *S. humilis*, and *S. petiolaris* (Argus 2010, Fernald 1950, Schneider 1921; hybridization with *S. discolor*, *S eriocephala* questioned by Argus). A habitat generalist (growing in both wet and dry habitats); may experience less stress during droughts (Savage et al. 2009). Like many willows, *S. bebbiana*’s seeds are dispersed in summer, and thus show no dormancy (Densmore and Zasada 1983, Smart et al. 2005). Questionable as a riparian species because it is unlikely to root from stem fragments (Densmore and Zasada 1978). Thought to be both wind and insect pollinated, but more dependent on insect pollination (Argus 1974).



Distribution of *Salix bebbiana*, called beaked or Bebb’s willow, recorded in the New York Metropolitan Region during three time categories.

STU

2. *Salix candida* Flüggé ex Willd. – sage willow, sage-leaved willow ↓↓↓

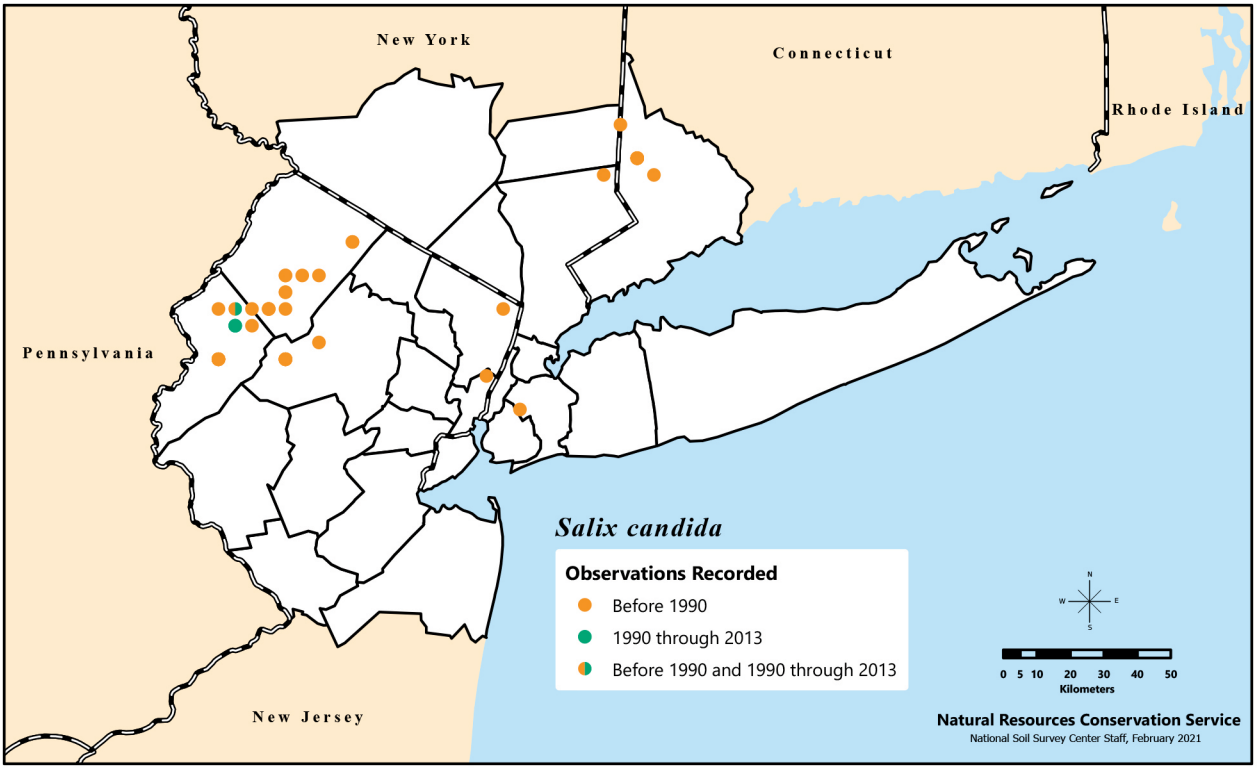
Shrub. Flowering May–June; fruiting July. Mesic to wet open areas, including bogs, fens, floodplains, swamps, and woodland edges, on calacareous soils. Epithet from Latin means "white" and refers to the whitish pubescence usually present on young branches and leaves.

Reported to hybridize with *Salix bebbiana* (*S.* ×*cryptodonta* Fernald), *S. discolor*, *S. eriocephala* (*S.* ×*rubella* Bebb ex C.K.Schneid.), *S. petiolaris* ("*S.* ×*clarkei*" Bebb, an invalidly published name, applied to this hybrid by Fernald 1950) and *S. sericea* (Argus 2010, Fernald 1950, Schneider 1921, Rowlee and Wiegand 1896); hybridization with *S. discolor* and *S. sericea* questioned or not acknowledged by Argus). *Salix candida* has always been infrequent but is significantly declining in the region.

Salix viminalis L. (*S.* subg. *Vetrix* sect. *Viminella* Ser.; epithet from Latin meaning with a slender, flexible branch), silky osier, native to Europe and occasionally escaped in Canada and the U.S., would key here. Differs from *S. candida* in having dimorphic buds, different size and shape of floral and vegetative characters (buds more or less monomorphic in *S. candida*; Alstrom-Rapaport 1997, 1998). Reported from CT, NJ, and NY (Argus 2010) but not known from the region. Recent hybrids between *S. caprea* and *S. viminalis* also reported from North America (Argus 2010).

Like *S. viminalis*, *S.* ×*smithiana* Willd. (*S. caprea* × *S. viminalis*; honoring Sir James Edward Smith [1760–1840], English botanist and founder of Linnean Society) is often confused with *S. candida*. Cultivated in Canada for basketry; known to escape there (Argus 2010, Fernald 1950).

Salix candida is tracked as imperiled in NJ (S2).



Distribution of *Salix candida*, called sage or sage-leaved willow, recorded in the New York Metropolitan Region during three time categories.

STU

3. *Salix discolor* Muhl. – large pussy willow, glaucous swamp pussy willow ↑↑

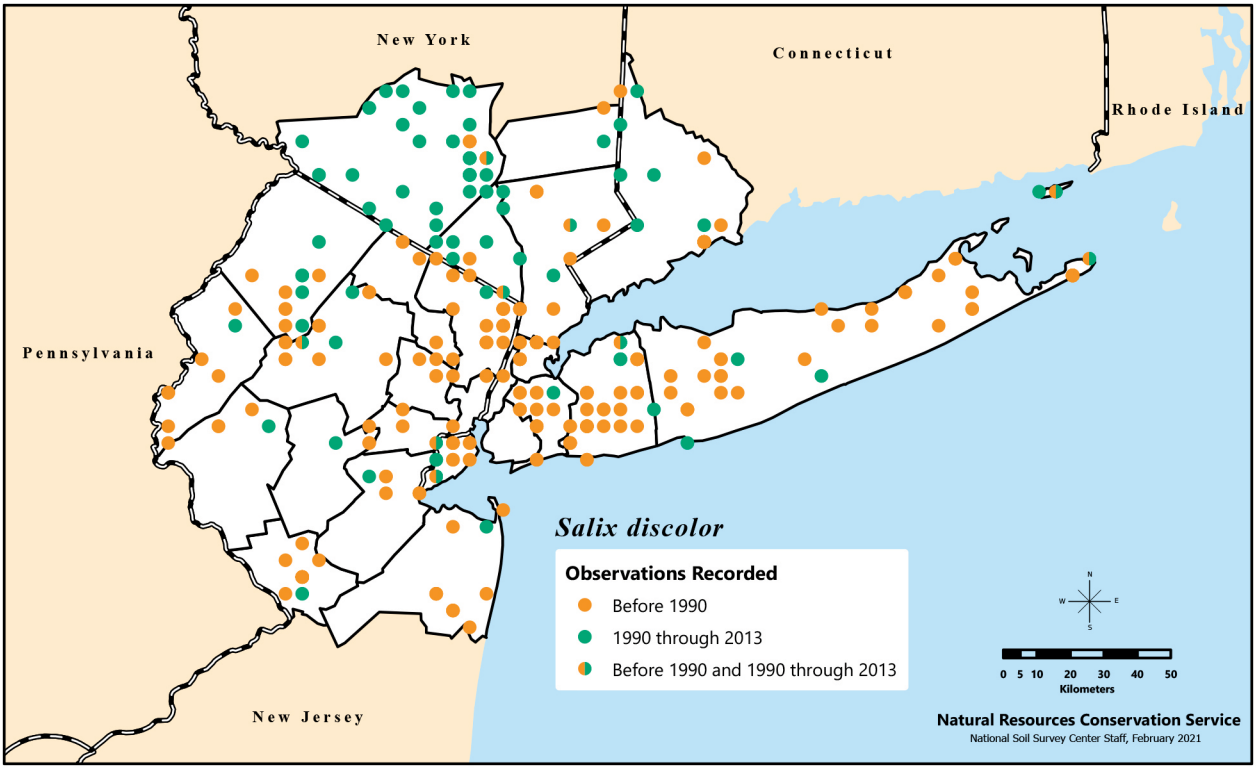
Small tree, shrub. Flowering Apr.–May; fruiting May–early June. Mesic to wet open areas, including floodplains, streambanks, fens, swamps, alluvial woodlands, and woodland edges. Epithet from Latin refers to the bicolor nature of the leaves; upper surface is green and lower surface glaucous and bluish.

Reported to hybridize with *Salix bebbiana*, *S. candida*, *S. eriocephala*, *S. humilis*, *S. interior*, and *S. petiolaris* (Argus 2010, Fernald 1950, Schneider 1921). Hybridization with *S. bebbiana*, *S. candida*, *S. eriocephala*, and *S. petiolaris* questioned or not acknowledged by Argus. Artificial crosses with *S. bebbiana* could not be successfully produced (Argus 1974), and artificial crosses with *S. eriocephala* had very low seed viability (Argus 2010). All three of these *Salix* spp. are considered early flowering willows (Mosseler and Papdopol 1989). Despite being able to readily hybridize with *S. humilis*, *S. discolor* is usually located in different habitats; *S. humilis* prefers dry, sandy upland forests (Argus 2010). However, *S. discolor* may also have an affinity for drier sites or sites that at least vary seasonally in water availability. Considered a habitat generalist; it has higher water-use efficiency and a faster growth rate than wet habitat specialists (Savage and Cavender-Bares 2011). Some researchers consider it sympatric with *S. bebbiana* and *S. eriocephala* (Mosseler and Papadopol 1989). This species is being considered as a source of biomass for biofuel (Arevalo et al. 2007).

4. *Salix eriocephala* – diamond willow ↑

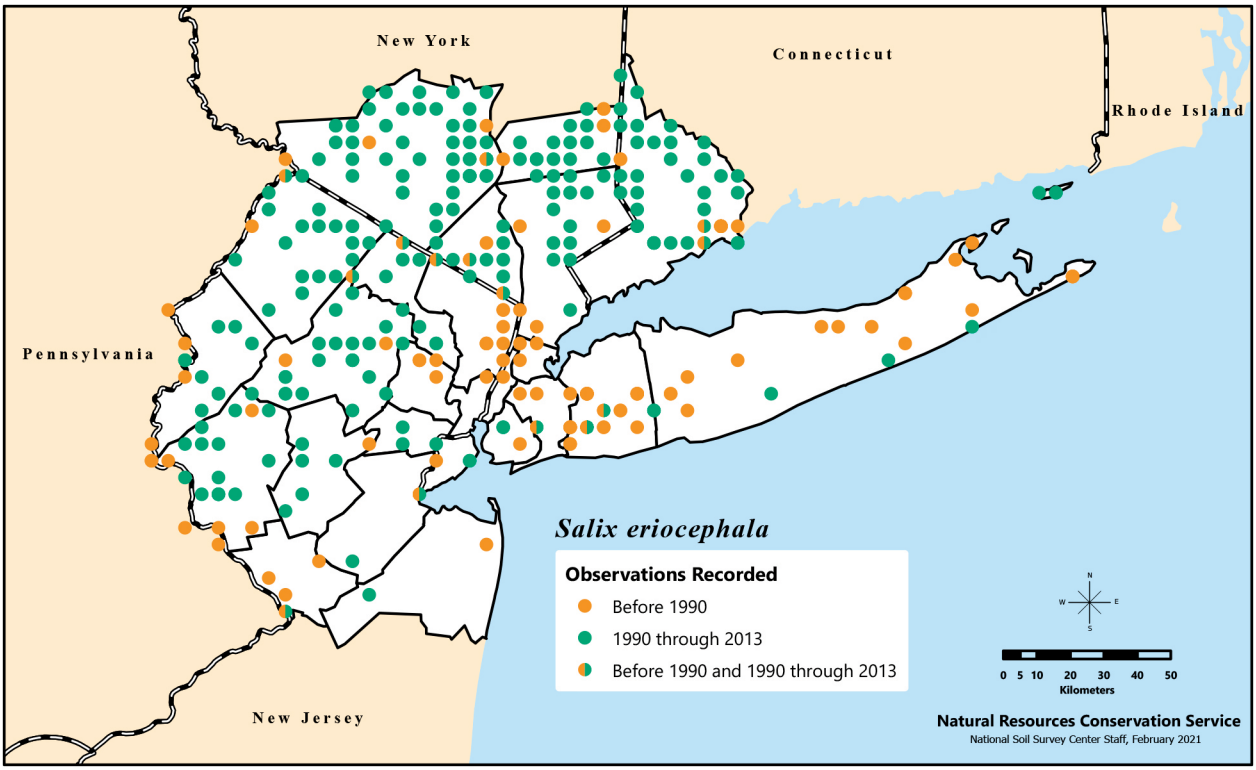
Salix cordata Muhl. non Michx.; *Salix rigida* Muhl.; *Salix squamata* Rydb.

Shrub. Flowering Apr.–early May; fruiting May–early June. Mesic to wet open areas, including ditches, streambanks, swamps, woodlands, and woodland edges; often on gravelly or rocky soils. Possibly declining on the Coastal Plain and increasing elsewhere. Epithet derived from the



Distribution of *Salix discolor*, called large pussy willow or glaucous swamp pussy willow, recorded in the New York Metropolitan Region during three time categories.

STU



Distribution of *Salix eriocephala*, or diamond willow, recorded in the New York Metropolitan Region during three time categories.

Greek “erion” (“wool”) and “cephale” (“head”), in reference to the catkins.

Based on the description, *Salix squamata* Rydb. is best taken as a synonym of *S. eriocephala* pending review of the type material. *Salix squamata* Rydb. is described and reported from NJ and PA (Britton 1905; type material collected at Sparta Junction, Sussex County [NJ]). Name was accepted by Taylor (1915) but ignored by all later floristic works (e.g., Argus 2010, Fernald 1950, Gleason and Cronquist 1993, Rhoads and Block 2007, Stone 1911).

Salix eriocephala is reported to hybridize with *S. amygdaloides*, *S. bebbiana*, *S. candida*, *S. discolor*, *S. humilis*, *S. interior*, *S. pedicellaris*, *S. petiolaris*, and *S. sericea* (Argus 2010, Fernald 1950, Schneider 1921). Hybridization with *S. amygdaloides*, *S. bebbiana*, *S. dicolor*, and *S. pedicellaris* questioned or not acknowledged by Argus. Crosses of *S. eriocephala* and other *Salix* spp., with *S. eriocephala* as the maternal plant, are rarely successful because *S. eriocephala*’s stigma exhibits a strong inhibition of foreign pollen tube growth (Mosseler 1989). A diploid with rapid growth; one of the most vigorous native willows, growing 3–4 m in height in 1 growing season. May reach sexual maturity in as early as 1 year (Aravanopoulos et al. 1994). Leaf tissue contains high concentrations of condensed tannins but no phenolic glycosides, which makes it more likely to attract generalist herbivores (Orians et al. 1997). Hybrids with *S. sericea*, which is high in phenolic glycosides but low in condensed tannins, tend to have intermediate levels of tannins but lower amounts of the phenolic glycosides, suggesting introgression and the hybrids’ possible tendency to attract generalist herbivores. However, the hybrids vary greatly (Hardig et al. 2000, Orians et al. 2000).

Because of its rapid growth and ease of regenerating in marginal sites, it is considered the best candidate willow species for short-rotation intensive culture plantations for energy, chemicals, and fiber (Smart et al. 2005, Stott 1984, Zsuffa and Aravanopoulos 1989). Moreover, individuals that

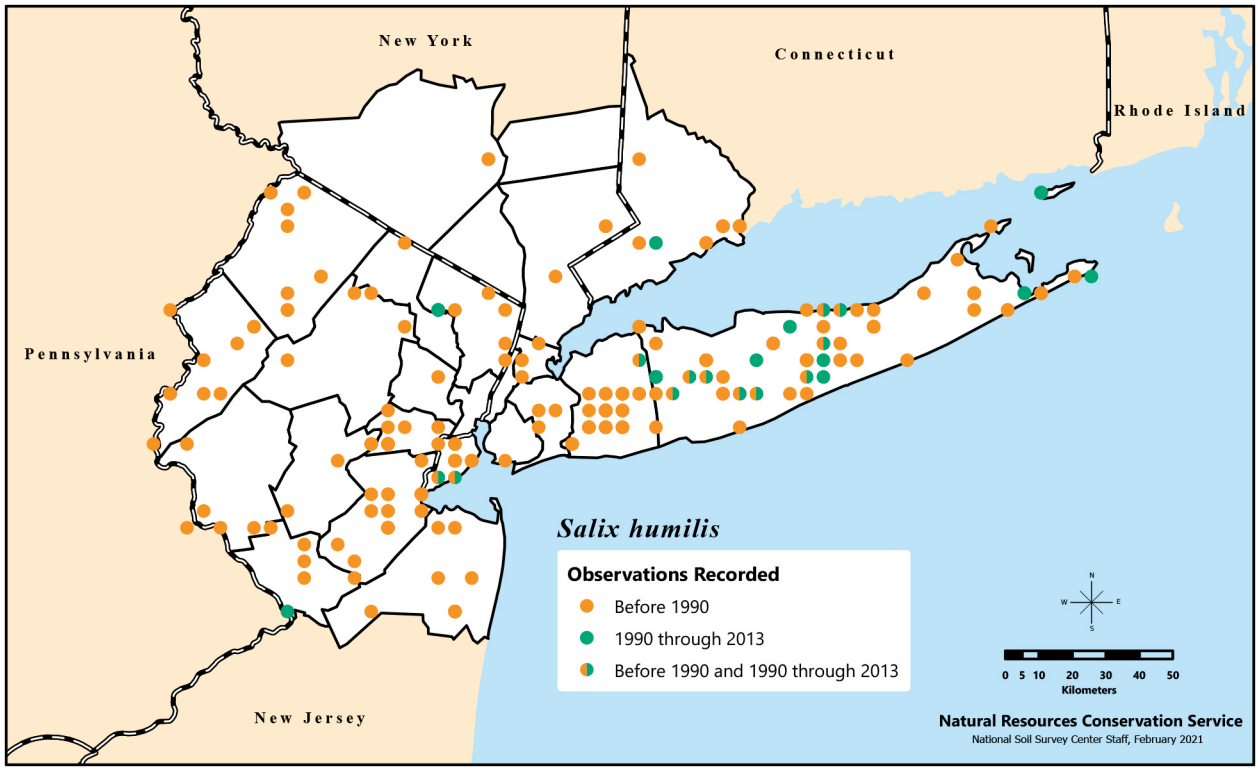
are heterozygous at a locus (one or more) tend to produce more biomass (Aravanopoulos and Zsuffa 1998).

There may be clones that are more resistant to freezing and there is a potential to breed for planting in more northern locations (Tsarouhas et al. 2000). Though *S. eriocephala* tends to be found in wetter areas than *S. sericea*, suggesting the latter species may be more drought-tolerant, there is no apparent difference in their response to a controlled drought treatment. However, their F1 hybrid showed a much more severe response to drought (Orians et al. 1999), which may limit its habitat choices even more than the two-parent species. Though *S. eriocephala* can regenerate well vegetatively, it apparently does not do so as often as a sympatric nonnative species, *S. purpurea*. *Salix eriocephala* is much less clonal and has higher genetic diversity than *S. purpurea* growing in the same area in NY (Lin et al. 2009). Introduced into Germany, Poland, and Spain (Kuzovkina et al. 2008), but no documented cases of invasions have been found.

5. *Salix humilis* Marshall – upland willow, prairie willow ↓↓↓

Shrub. Flowering Apr.–early May; fruiting May–early June. Dry to mesic open areas, including open woodlands, fields, and roadsides. Epithet derived from the Latin word for "low," in refererence to the plant's short stature.

Readily divided into two taxa (often recognized as separate species, *Salix humilis* s.s., *S. occidentalis* Walter). *Salix humilis* var. *humilis* has foliaceous stipules, longer leaf blades (50–90 mm) with longer petioles (3–7 mm), and longer staminate (1.4–3.5 cm) and pistillate (more than 2 cm) catkins. *Salix humilis* var. *tristis* (Aiton) Griggs) (=*S. tristis* Aiton; =?*S. occidentalis* Walter,=*S. humilis* var. *microphylla* (Andersson) Fernald) has absent or rudimentary stipules, shorter leaf blades (20–50 mm) with shorter petioles (0.5–3 mm), and shorter staminate (0.6–1 cm) and pistillate (less than 2 cm) catkins. Both varieties reported from the region, but precise ranges for each not currently known.



Distribution of *Salix humilis*, called upland or prairie willow, recorded in the New York Metropolitan Region during three time categories.

STU

Salix humilis var. *humilis* reported to hybridize with *S. bebbiana*, *S. discolor*, *S. eriocephala*, *S. petiolaris*, and *S. sericea* (Argus 2010, Fernald 1950). Hybridization with *S. petiolaris* and *S. sericea* not acknowledged by Argus. *Salix humilis* var. *tristis* reported to hybridize with *S. eriocephala* and *S. petiolaris* (Argus 1986b, 2010). The 2 varieties are also reported to hybridize (Argus 1986b, 2010). Significant decreases in the region are not readily explained but could be due in part to hybridization or loss of habitat.

Under review as possibly being rare in NY.

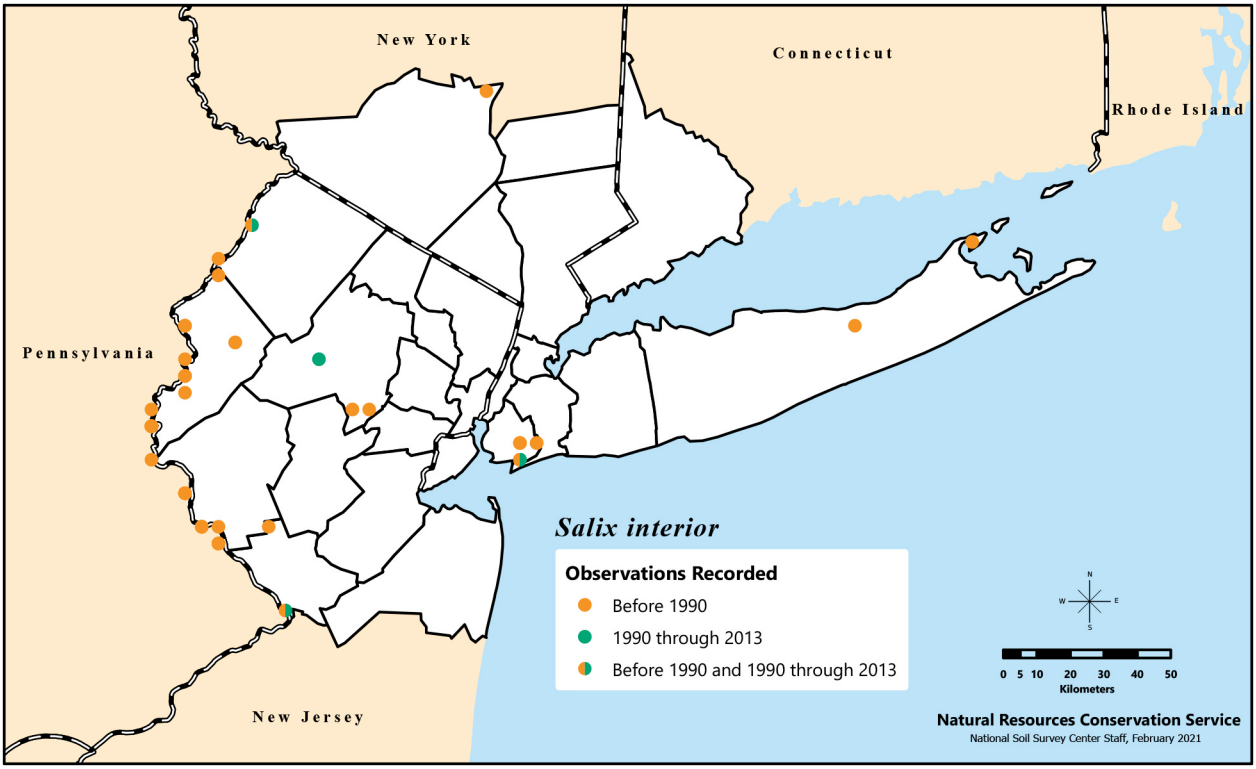
The nonnative *Salix elaeagnos* Scop. (*S.* subg. *Vetrix* sect. *Canae* A. Kern.; native to Asia and Europe) would key here (see *S. elaeagnos* in Nonnative Species section). It was reported once from Nassau County (NY) in the 1920s.

6. *Salix interior* Rowlee – sandbar willow, long-leaf willow ↓↓↓

Salix exigua var. *exterior* (Fernald) C.F.Reed; *Salix exigua* subsp. *interior* (Rowlee) Cronquist; *Salix exigua* var. *sericans* (Rowlee) Dorn; *Salix fluviatilis* var. *sericans* (Nees) B.Boivin; *Salix interior* var. *exterior* Fernald; *Salix interior* var. *pedicellata* (Andersson) C.R.Ball; *Salix linearifolia* Rydb.; *Salix longifolia* Muhl. (1803) non Lam. (1778) (illegitimate later homonym); *Salix longifolia* var. *interior* (Rowlee) M.E.Jones; *Salix longifolia* var. *sericans* Nees; *Salix rubra* Richardson (1823) non Huds. (1762)

Shrub. Flowering May; fruiting June. Flowering and fruiting can occur later in the season in individuals with sylleptic catkins. Wet to mesic open areas, including sandbars, watersides, beach margins, lake and pond margins, and floodplains of large river valleys (e.g., Delaware River); mostly on sandy or gravelly soils.

Leaves on sylleptic shoots are often densely pubescent with silky hairs. Successful artificial crosses with *Salix bebbiana*, *S. discolor*, *S. eriocephala*, and *S. petiolaris*, but with low seed production except for the cross with *S. discolor* (Argus 2010). *Salix interior* relies



Distribution of *Salix interior*, called sandbar or long-leaf willow, recorded in the New York Metropolitan Region during three time categories. There is also an unmapped historical (pre-1990) record from Monmouth County (NJ).

almost exclusively on root suckering to colonize sites, especially after a disturbance (Krasny et al. 1988). Species has appeared to decline in the area, including in the Delaware River Valley, the area with the most records. The species is not boreal, and the cause for decline may be a loss or degradation of early successional habitats.

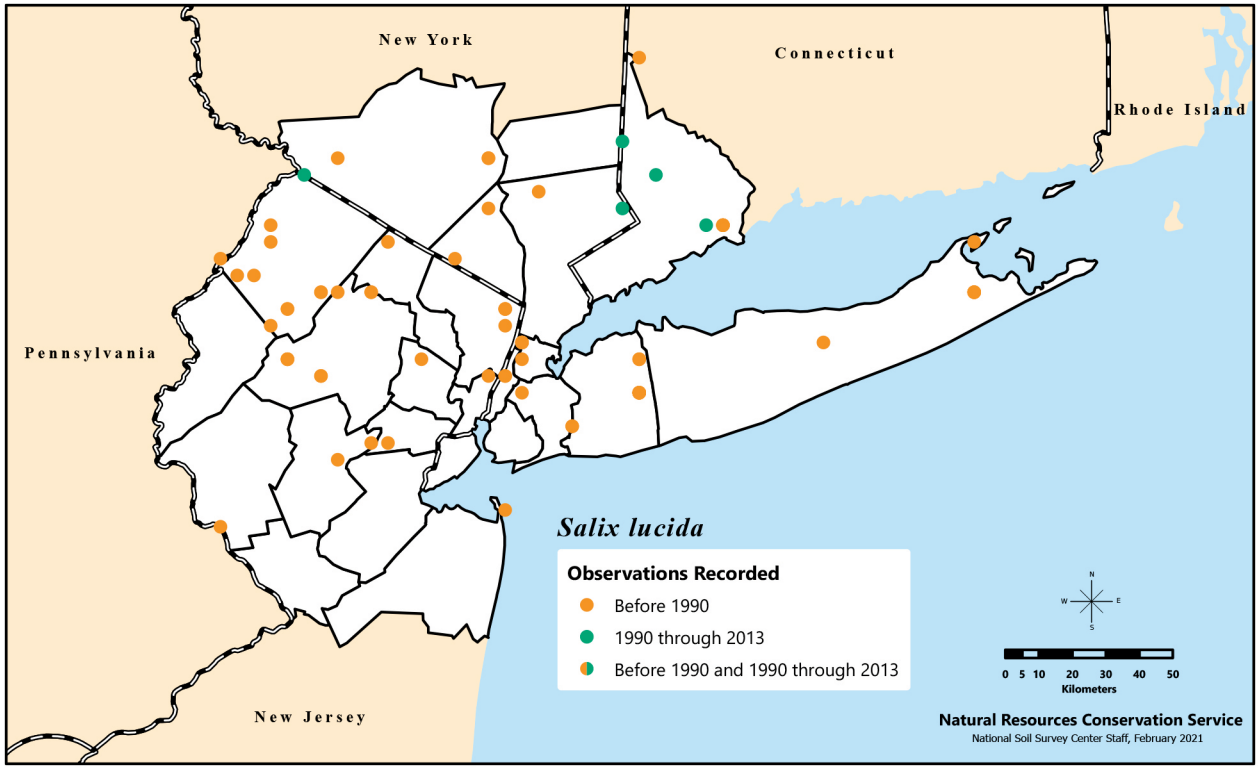
Listed as endangered in CT (S1S2) under the name *Salix exigua*.

7. *Salix lucida* Muhl. – shining willow ↓↓↓

Small tree, shrub. Flowering late Apr.–June; fruiting July–Aug. Mesic open ground, bogs, fens, floodplains, swamps, and watersides. Epithet from Latin refers to the shining leaves.

Reported to hybridize with *Salix alba* (*S.* ×*jesupii* Fernald, named for its discoverer, Henry Griswold Jesup [1826–1903], professor of botany at Dartmouth College), *S. nigra* (*S.* ×*schneideri* B. Boivin), and *S. serissima* (Argus 2010, Fernald 1950). Hybridization with *S. serissima* questioned by Argus. This species, like *S. cinerea*, has sex chromosomes and is a tetraploid (Harrison 1926). *Salix lucida* is considered one of the most handsome New England willows due to its lustrous foliage and closely flowered golden staminate catkins (Fernald 1904). There may be three geographical races of *S. lucida*—northeastern North America (subspecies *lucida*), western North America extending to CA and north to AK (subspecies *lasiandra*), and the southern Rocky Mountains of North America (subspecies *caudata*) (Argus 1986b). The *S. lucida* × *S. alba* hybrid is often mistaken for *S. alba*, *S. fragilis* (now *S. euxina*), *S.* ×*rubens* (now *S.* ×*fragilis*), and *S. lucida* (Argus 2006). This boreal and high-elevation species has significantly declined in the region.

Tracked as critically imperiled in NJ (S1).



Distribution of *Salix lucida*, or shining willow, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Warren County (NJ) and Richmond County (NY).

STU

8. *Salix nigra* Marshall – black willow ↑↑

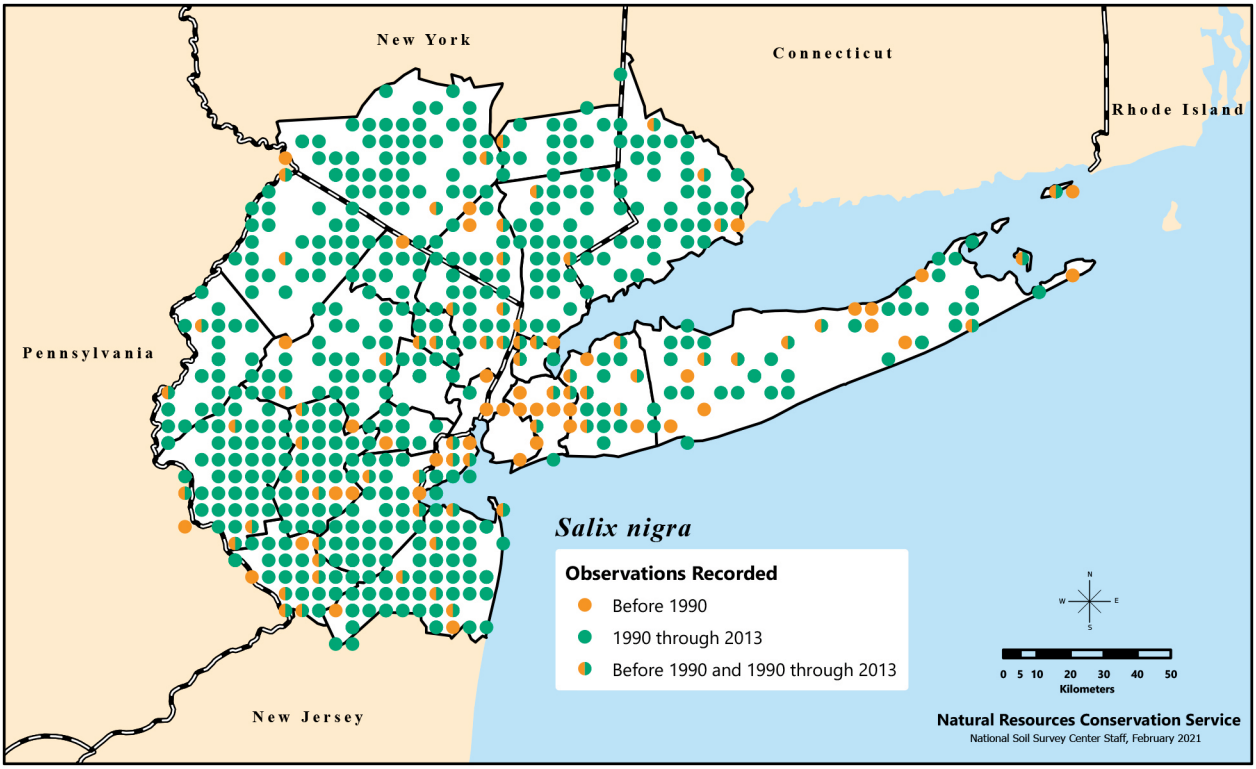
Salix nigra var. *falcata* (Pursh) Torrey

Tree. Flowering late Apr.–May; fruiting June–early July. Lakeshores, streambanks, swamps, and low open woodlands. Epithet from Latin refers to the bark, which although not black is dark colored.

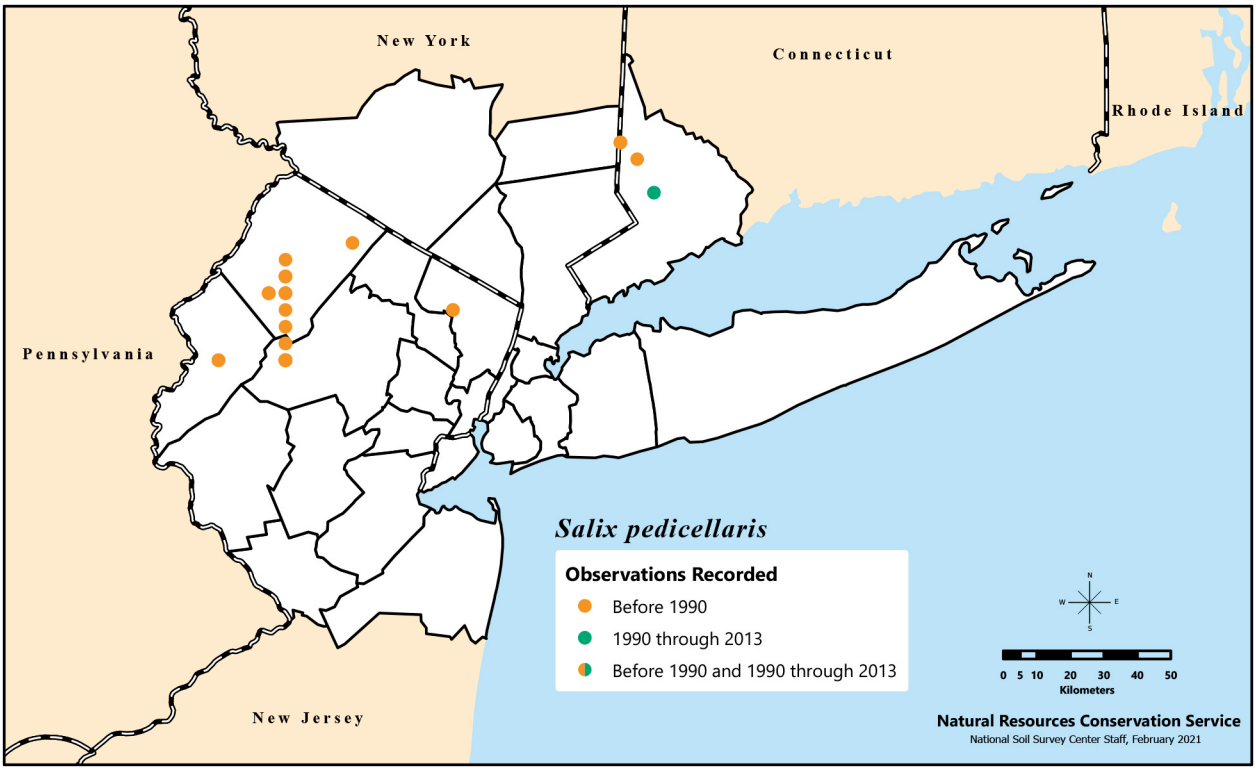
The most common willow of the region. Reported to hybridize with *Salix alba* (see discussion under *S. alba* entry), *S. amygdaloides* (*S.* ×*glatfelteri* Schneid.), and *S. lucida* (*S.* ×*schneideri* B.Boivin) (Argus 2010, Fernald 1950), the last representing a rare intersubgeneric cross involving *S.* subg. *Protitea* (*S. nigra*) and *S.* subg. *Salix* (*S. lucida*). Of the 90 native willow species in the U.S., *S. nigra* is the only commercially important species. Moisture and nutrients do not limit mature individuals but do limit germination and seedling establishment (McLeod and McPherson 1973). The need for moisture is also noted for establishment from cuttings (Pezeshki et al. 2007). *Salix nigra* (likely true for most willows) produces new shoot material throughout the summer, making it more susceptible to herbivory (Barbosa et al. 2000). Tolerant of water-logged soils and less tolerant of drought than other *Salix* spp. (Dionigi et al. 1985). The combined effects of continuous flooding and low levels of herbivory stimulate root formation from cuttings (Li et al. 2005). Root porosity or aeration of this species increases with partial flooding (Li et al. 2006). Takes up heavy metals, which can be detected in its annual rings (Punshon et al. 2003). Extracts from *S. nigra*'s bark have been successfully used to treat inflammation and oxidative stress caused by collagen-induced arthritis (Sharma et al. 2011). An invasive species in Australia (Stokes 2008). Has spread outside its native range in the U.S. (Argus 2007, Randall 2001).

9. *Salix pedicellaris* Pursh – bog willow ↓↓↓

Shrub. Flowering late Apr.–May; fruiting June–early July. Bogs and fens, often associated with *Picea mariana* (black spruce).



Distribution of *Salix nigra*, or black willow, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Salix pedicellaris*, or bog willow, recorded in the New York Metropolitan Region during three time categories.

Reported to hybridize with *Salix candida* and *S. eriocephala* (Fernald 1950; hybridizations questioned by Argus 2010). If recognized, local material referable to *S. pedicellaris* var. *hypoglauca* Fernald, the leaf undersides glaucous. Early works (e.g., Britton 1889) treated *S. pedicellaris* as conspecific with the Asian-European *S. myrtilloides* L. Reported to be both a tetraploid and a triploid, but most are thought to be tetraploids (Suda and Argus 1969). Can occur in sites that remain wet year-round. This wetland specialist has slower rates of photosynthesis and growth rates than *Salix* generalist species found in more general habitats (Savage and Cavender-Bares 2011). A boreal and high-elevation species at the southern limit of its range in the eastern states. Extremely rare in the region and decreasing.

Listed as endangered in CT (S1) and NJ (S1).

10. *Salix petiolaris* Sm. – meadow willow ↓↓↓

Salix gracilis Andersson; *Salix gracilis* var. *textoris* Fernald

Small tree, shrub. Flowering May–June; fruiting July. Mesic to wet open areas, including streambanks and swamps. Reported to hybridize with *Salix alba*, *S. bebbiana*, *S. candida*, *S. discolor*, *S. eriocephala*, *S. humilis* var. *humilis*, and *S. sericea* (Argus 2010, Fernald 1950). Hybridization with *S. alba* questioned by Argus. Fernald reported the cross between *S. petiolaris* (*S. gracilis* in Fernald 1950) and *S. sericea* as *S.* ×*subsericea* (Andersson) C.K.Schneid.; however, Argus (2010) reported that *S. subsericea* represented a densely sericeous variant of *S. petiolaris* and not a hybrid.

This species was once thought to be native to the British Isles too, but instead was most likely brought over by tradespeople for use in basketry and planted in private botanic gardens (Ball 1948). Contains several phenolic glycosides (Steele et al. 1972). Can form large clonal patches and may dominate some sites (Houlahan and Findlay 2004). Has declined considerably in the region.

Listed as a species of special concern in CT.

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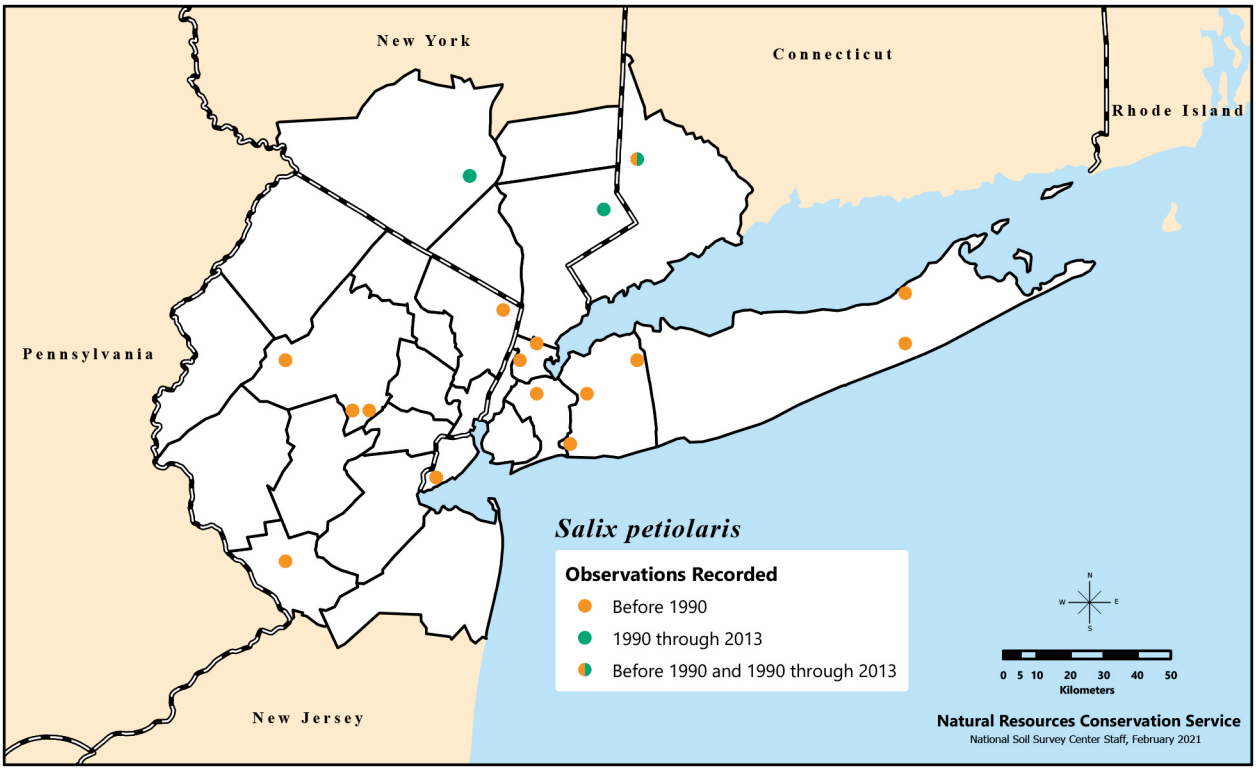


Distribution of *Salix petiolaris*, or meadow willow, recorded in the New York Metropolitan Region during three time categories.

11. *Salix sericea* Marshall – silky willow ↔

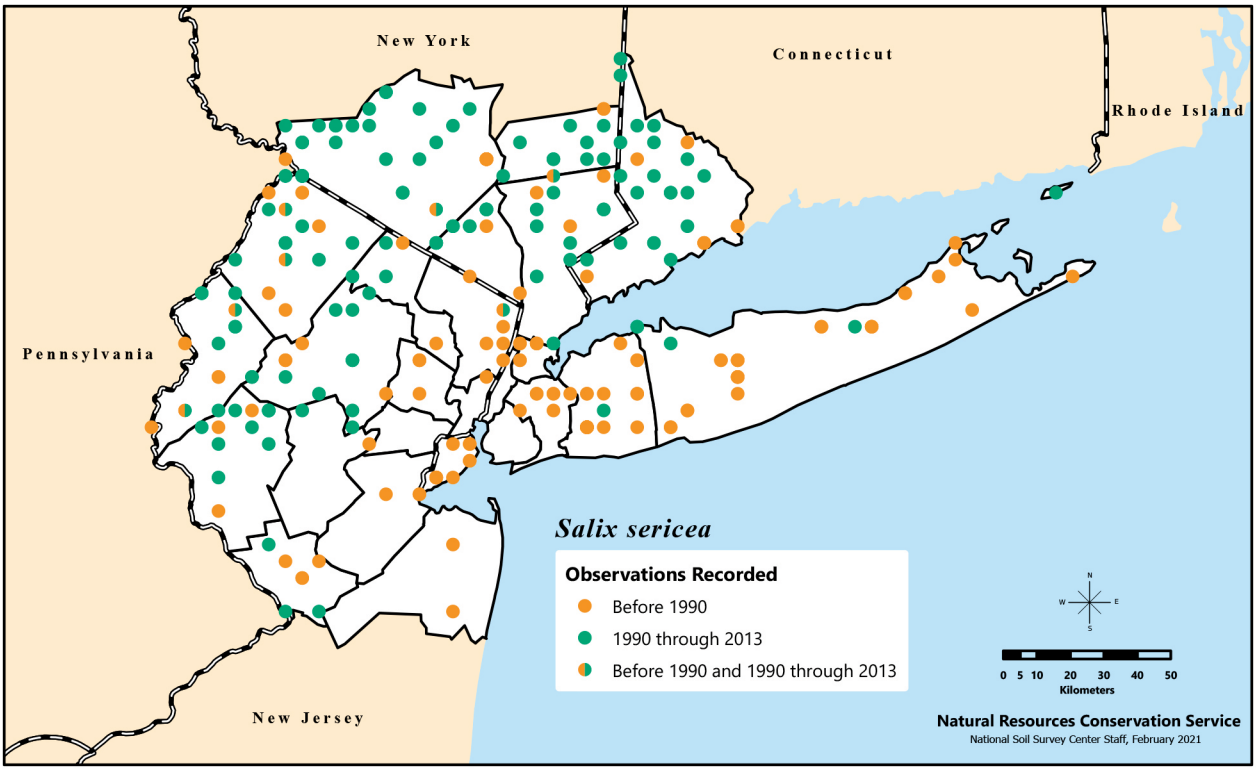
Small tree, shrub. Flowering Apr.–early May; fruiting May–early June. Mesic to wet open areas, including riversides, streambanks, and swamps, usually in lower elevations. Epithet derived from the Greek word for "silky," a reference to its pubescence.

Reported to hybridize with *Salix candida*, *S. eriocephala*, *S. humilis* var. *humilis*, and *S. petiolaris* (see discussion under *S. petiolaris*) (Argus 2010, Fernald 1950; hybridization with *S. humilis* var. *humilis* questioned by Argus). Contains low concentrations of condensed tannins but high concentrations of phenolic glycosides, which makes it more susceptible to specialist herbivores (Orians et al. 1997). Although *S. sericea* is found in drier conditions than *S. eriocephala*, they respond similarly to drought. However, their hybrid responds much more severely to drought than the two parents (Orians et al. 1999). Though the concentration of phenolic glycosides does not appear to differ between sexes, it does differ among clones, with faster growing clones having lower concentrations (Nichols-Orians et al. 1993). Increased soil fertility is also correlated with higher growth rates and lower concentrations of some phenolic compounds, but having high concentrations of phenolic compounds is not at the expense of growth rate (Orians et al. 2003). Appears to develop resistance to some herbivores (Roche and Fritz 1997). Herbivory induces phenolic glycoside production in this species, but increased herbivory does not induce higher production of the compounds (Fields and Orians 2006). Recommended as a good candidate native species to be used in the restoration of streams. Has declined considerably on the Coastal Plain; has increased elsewhere in the region.

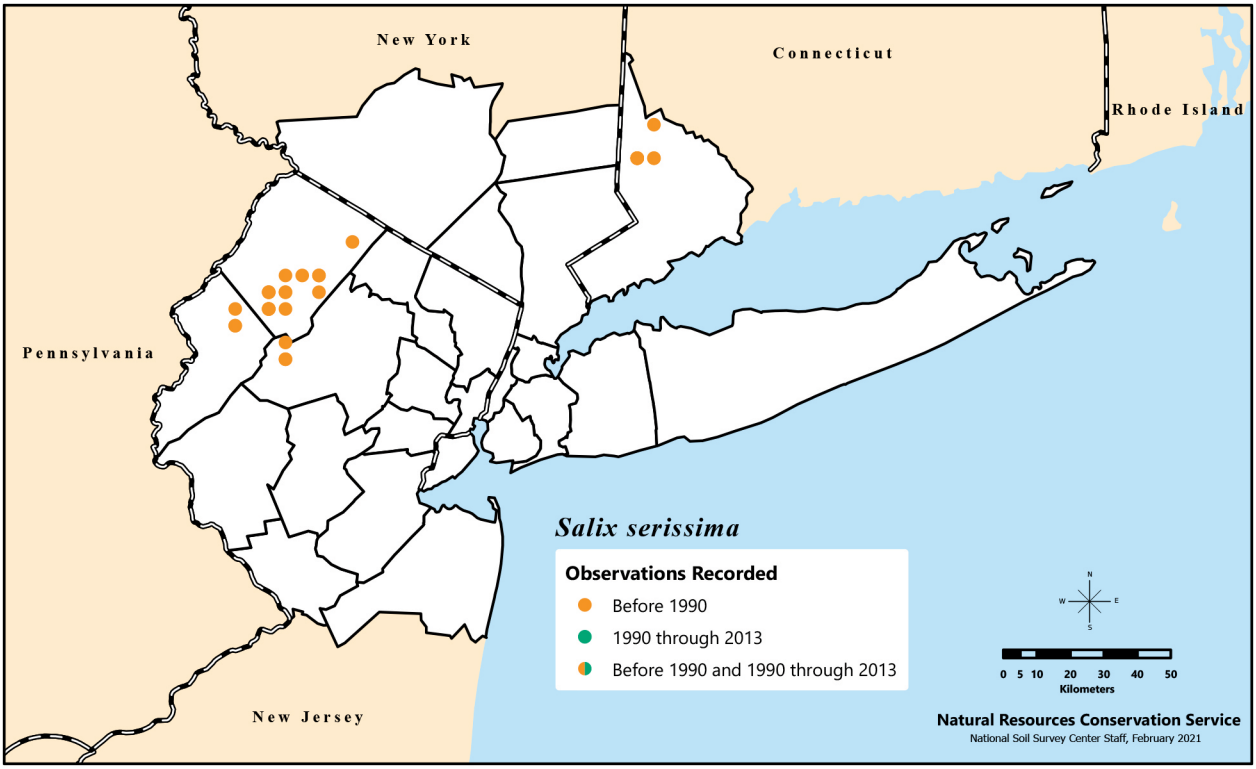
12. *Salix serissima* (L.H.Bailey) Fernald – autumn willow ↓↓↓

Salix lucida var. *serissima* L.H.Bailey

Shrub. Flowering June–July; fruiting Aug.–Sept. Swamps, bogs, fens, streambanks, and marshes,



Distribution of *Salix sericea*, or silky willow, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Salix serissima*, or autumn willow, recorded in the New York Metropolitan Region during three time categories.

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often on limestone. Epithet means “very late” in Latin and refers to the lateness of the flowering and fruiting.

Reported to hybridize with *Salix lucida* (Fernald 1950; hybridization questioned by Argus 2010). This is an unusual *Salix* sp. in that the seeds mature in late summer, remain dormant throughout the winter, and germinate in the spring (Argus 2010). Rare occurrences in the region.

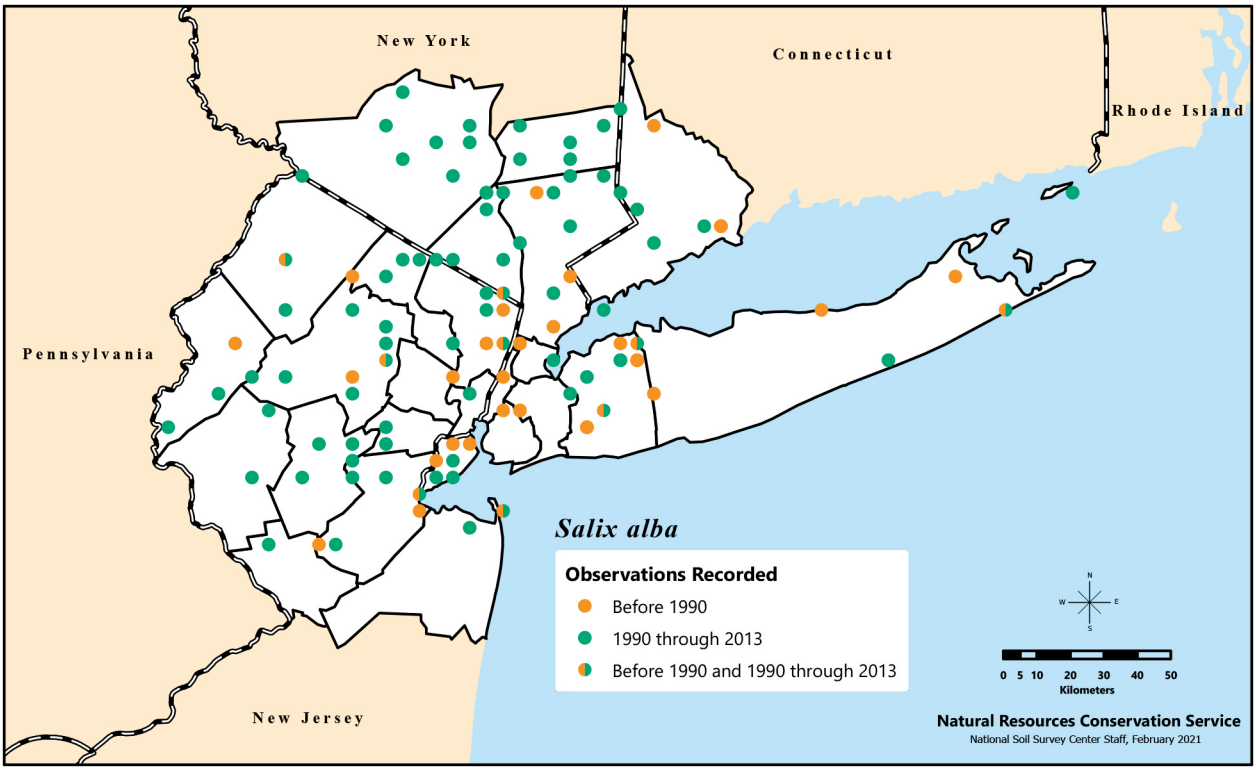
Tracked as imperiled in NJ (S2).

Nonnative Species

13. *Salix alba* L. – white willow ↑

Tree. Flowering Apr.–May; fruiting June. Mesic disturbed open wetlands, including riverbanks, swamps, and gravel pits; and uplands, including roadsides, beaches, and fields. Native to northern Africa, south-central Asia, and Europe; occasionally escaping from cultivation. Epithet from Latin refers to the white pubescence present on the twigs and leaves.

Numerous cultivars (sometimes treated as subspecies or varieties) present, including ‘Caerulea’ (twigs dark brown), ‘Chermesina’ (twigs reddish), ‘Sericea’ (twigs and leaves densely pubescent), ‘Vitellina’ (twigs yellow to yellow-brown; the most common subspecies encountered in the region). These can still be identifiable in some escaped material. Reported to hybridize with *S. nigra* (Argus 2010). Fernald (1950) reported the hybrid as *S.* ×*hankensonii* Dode (honoring its discoverer, Edward L. Hankenson, [1845–1910], the son in the clothing retailer James W. Hankenson & Son and a student of the flora of Wayne County, NY) and restricted it to a cross between *S. alba* var. *vitellina* (L.) Stokes and *S. nigra*. Also reported to hybridize with *S.* ×*fragilis* (Fernald 1950 applied the name *S.* ×*rubens* Schrank to this cross [Triest et al. 2000]; Argus 2010 questioned the application of this name), *S. lucida* (*S. jesupii* Fernald), and *S. petiolaris* (Argus 2010, Fernald 1950; hybridization with *S. petiolaris* and *S.* ×*fragilis* questioned by Argus). When *S.* ×*fragilis* is taken



Distribution of *Salix alba*, or white willow, recorded in the New York Metropolitan Region during three time categories.

as a cross between *S. alba* and *S. euxina* (as Argus (2010) did; Fernald (1950) treated *S. fragilis* as a species, not a hybrid), a cross between it and *S. alba* would represent a backcross. *Salix ×fragilis* (or *S. ×rubens*), however, is also considered an invasive willow and has become a serious problem in some parts of North America (Shafroth et al. 1994) and world-wide (Budde et al. 2011, Holland-Clift et al. 2011). For the cross between *S. alba* var. *vitellina* and *S. babylonica* (*S. ×sepulcralis*) see discussion under *S. babylonica*.

Has a prolific root suckering system and spreads easily. Mostly insect pollinated, but also wind pollinated (Dirr 1998). Can change sex in response to its environment or an insect or disease (Freeman et al. 1980). Vulnerable to numerous diseases and insects, including bacterial twig blight (*Pseudomonas syringae*), black canker (caused by the fungus *Glomerella miyabeana*), powdery mildew (*Erysiphe adunca*, *Phyllactinia guttata*), willow flea weevil (*Rhynchaenus* spp.), willow scurfy scale (*Chionaspis furfura*), and mottled willow borer (*Cryptorhynchus lapathi*). This pest problem may reduce the likelihood it will be selected above other willows in plantations for bioenergy production (Adegbidi et al. 2001), but it is still considered a viable bioenergy source (Arevalo et al. 2007, Mleczek et al. 2010), which could be problematic given its invasive tendencies. Highly invasive in Australia (Adair et al. 2006) and listed as invasive in some states in the U.S. (Widrlechner et al. 2004), including several mid-Atlantic states (University of Georgia 2018). Considered one of the best upright willows for landscaping in wet areas where little else will grow. However, its root system can dominate other vegetation and damage manmade structures (Dirr 1998). Some consider it and other willows undesirable trees that will soon break and become hazards, but adequate pruning usually prevents this for *S. alba* (van Wassenaer and Richardson 2009). Like all willows, seeds have no dormancy and germinate within 12–24 hours of hitting moist soil (Dirr 1998). This species' bark contains salicin, which is known for its fever-reducing and pain-relieving activities (Graf 2000).

14. *Salix atrocinerea* Brotero – large gray willow ↑↑↑

See discussion under *Salix cinerea*. We group these as the *S. atrocinerea–cinerea* complex. Epithet means "dark" ("atro") "gray" ("cinerea"), in reference to the pubescence.

Listed as invasive in NY (prohibited).

***Salix babylonica* L. – weeping willow**

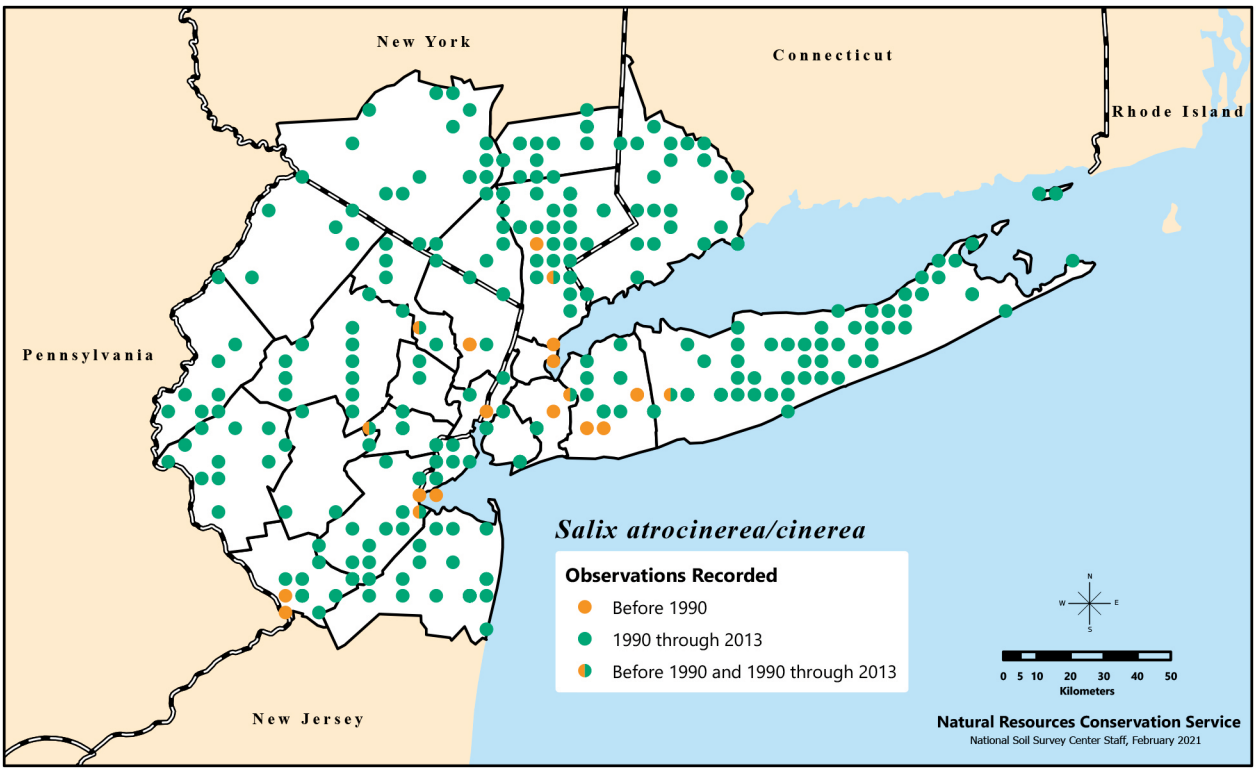
See discussion under *Salix ×pendulina*.

15. *Salix cinerea* L. – large gray willow ↑↑↑

Shrub. Flowering Apr.–early May; fruiting May–early June. Mesic disturbed open to shaded areas, including riverbanks, swamps, roadsides, fields, thickets, woodlands, and woodland edges. Native to Europe. Epithet means "gray" in Greek, a reference to the pubescence.

Closely related to and reported to hybridize with *Salix atrocinerea*, also native to Europe and found in similar habitats in the NY Metropolitan Region.

Most records of florist's, goat, or hoary willow, *Salix caprea* L., native to Asia and Europe, have proven to be *S. atrocinerea* and *S. cinerea*. Many early collections (some back to the 1890s) of *S. atrocinerea–cinerea* were misidentified as the native *S. discolor* (Glenn and Moore 2008b). *Salix caprea* (and the native *S. discolor*) can be distinguished from the *S. atrocinerea–cinerea* complex through examination of decorticated (bark peeled off) twigs; *S. caprea* and *S. discolor* have smooth decorticated twigs (or with short ridges, less than 6 mm long), and *S. atrocinerea–cinerea* has many ridges 6–60 mm long). European *S. ×smithiana* Willd. (*S. caprea* × *S. viminalis*), cultivated in Canada for basketry, is known to escape there (Argus 2010). Recent hybrids between *S. caprea* and *S. viminalis* (see discussion under *S. viminalis* in *S. candida* entry) and *S. cinerea* and *S. viminalis* also reported from North America (Argus 2010, Fernald 1950). *Salix aurita* L. (eared willow), native to Europe, reported from MA and PA (Argus 2010) but not the NY Metropolitan Region. It differs from *S. atrocinerea–cinerea* and *S. caprea* (and *S. discolor*) by its blades with strongly impressed veins.



Distribution of the *Salix atrocinerea–cinerea* (large gray willow) complex, recorded in the New York Metropolitan Region during three time categories.

Material from *Salix atrocinerea* was first collected in the U.S. from Buncombe County (NC) but was not correctly identified until the 1980s (Argus 1986a). It was documented in the region and New England in the late 1990s and early 2000s. In MA, it may be one of the most pervasive willows and highly invasive. It may have been mistaken for other nonnative willows, such as *S. cinerea*, as well as some natives including *S. bebbiana* and *S. discolor*. The European gall-making sawfly (*Euura cinerae*) has been found on *S. atrocinerea* (Zinovjev 2010). Unlike at least one other willow, *S. atrocinerea* is not affected by the allelopathic compounds of Japanese knotweed (*Fallopia japonica*), another invasive species in wet areas. The researchers (from Europe) in this study suggested using *S. atrocinerea* to restore areas where *F. japonica* has been removed (Dommanget et al. 2014). However, in the U.S., this would be the equivalent of replacing one invader with another.

Like *S. atrocinerea*, to which it is closely related, *S. cinerea* is considered an invasive species in the northeastern U.S. (Argus 2010) and New Zealand and Australia (Ward et al. 2002a). Insects (at least galling insects) show a strong preference for larger buds and rapidly growing shoots, and there may be positive feedback with rapid growth in response to the herbivory (Price 1991). Pollinated predominantly by insects, but wind pollination also occurs. As with most other willows, seeds are not long-lived (usually no longer than 8 weeks after maturity) and, thus, do not form a seed bank (Hopley and Young 2015). Based on one study in Wales, U.K., the sex ratio of *S. cinerea* is often female biased. There appears to be no site-specific spatial segregation between the sexes (Alliende and Harper 1989). However, male trees tend to suffer more from herbivory than female trees (Alliende 1989). *Salix cinerea* has also been documented to change sex (Freeman et al. 1980), despite having well-established heteromorphic sex chromosomes (Westergaard 1958, as interpreted in Freeman et al. 1980). Could potentially be used for bioremediation because it accumulates heavy metals; it will be most effective in year-round wetlands (Vandecasteel et al. 2005). Responds positively to fire and in some areas (bogs and wet heaths of Australia's alpine habitats) fire may be required to ensure its establishment (Giljohann et al. 2011).

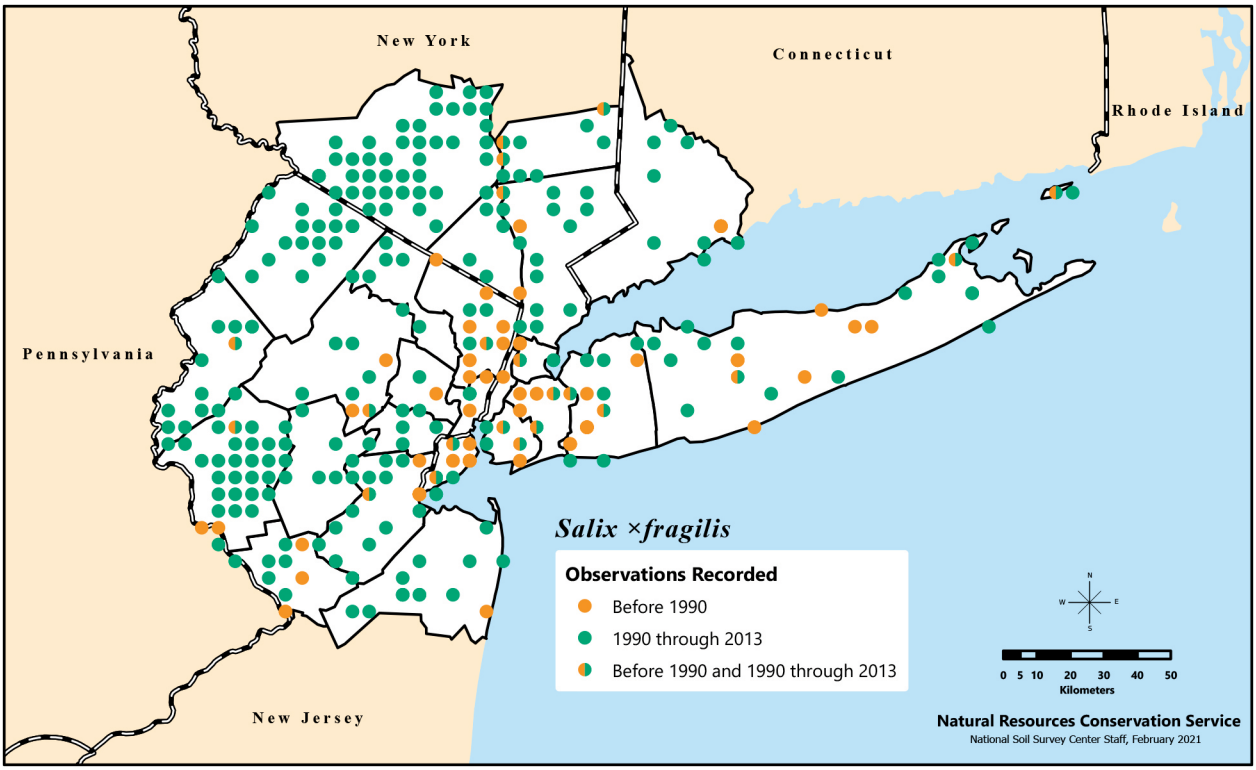
***Salix elaeagnos* Scop. – hoary willow**

Historically reported from CT. Naturalized occurrences from the 1800s and early 1900s (Argus 2010), but not currently known to be cultivated or naturalized in the region. Native to Europe, where it is commonly found along river margins and is considered a pioneer species (Francis et al. 2005). Can establish with substantial root and shoot biomass in stable, declining, and inundated hydrological conditions, but prefers stable conditions with slow water table decline (Francis et al. 2005). Very resistant to uprooting, which may explain its ability to become established in disturbed areas (Karrenberg et al. 2003). Considered a potentially good source of bioenergy, with a little genetic improvement (Smart et al. 2005). Would be identified as *Salix humilis* in both keys.

16. *Salix* ×*fragilis* L. – crack willow, hybrid white willow ↑↑

Tree. Flowering Apr.–May; fruiting May–early June. Planted and occasionally escaped in mesic disturbed open wetlands, riverbanks, swamps, uplands, roadsides, and fields. Until recently, treated as a species native to Europe and possibly western Asia. However, more recently (e.g., Argus 2010) taken as a stabilized hybrid, from the crossing of *Salix alba* (see discussion under *S. alba*) and *S. euxina* I.V.Belyaeva, a species native to Turkey and only recently described (Belyaeva 2009). Epithet from Latin refers to the brittleness of the twigs, especially at the base.

Previously, the name *S.* ×*rubens* Schrank has been applied to this material (Argus 2010). Reported to backcross with *S. alba*. *Salix* ×*fragilis* (or *S.* ×*rubens*) is intermediate in characteristics with its parents (*S. alba* and *S. euxina*), but the three species are well defined, indicating little, if any, backcrossing (Oberprieler et al. 2013). This hybrid and its two parents are considered an invasive species complex (Budde et al. 2011, Holland-Clift et al. 2011), invading riparian zones in Australia, New Zealand, South Africa, North America, and South America. Vegetative propagation is common, due to brittle, easily broken twigs (Budde et al.



Distribution of *Salix* ×*fragilis*, called crack willow or hybrid white willow, recorded in the New York Metropolitan Region during three time categories.

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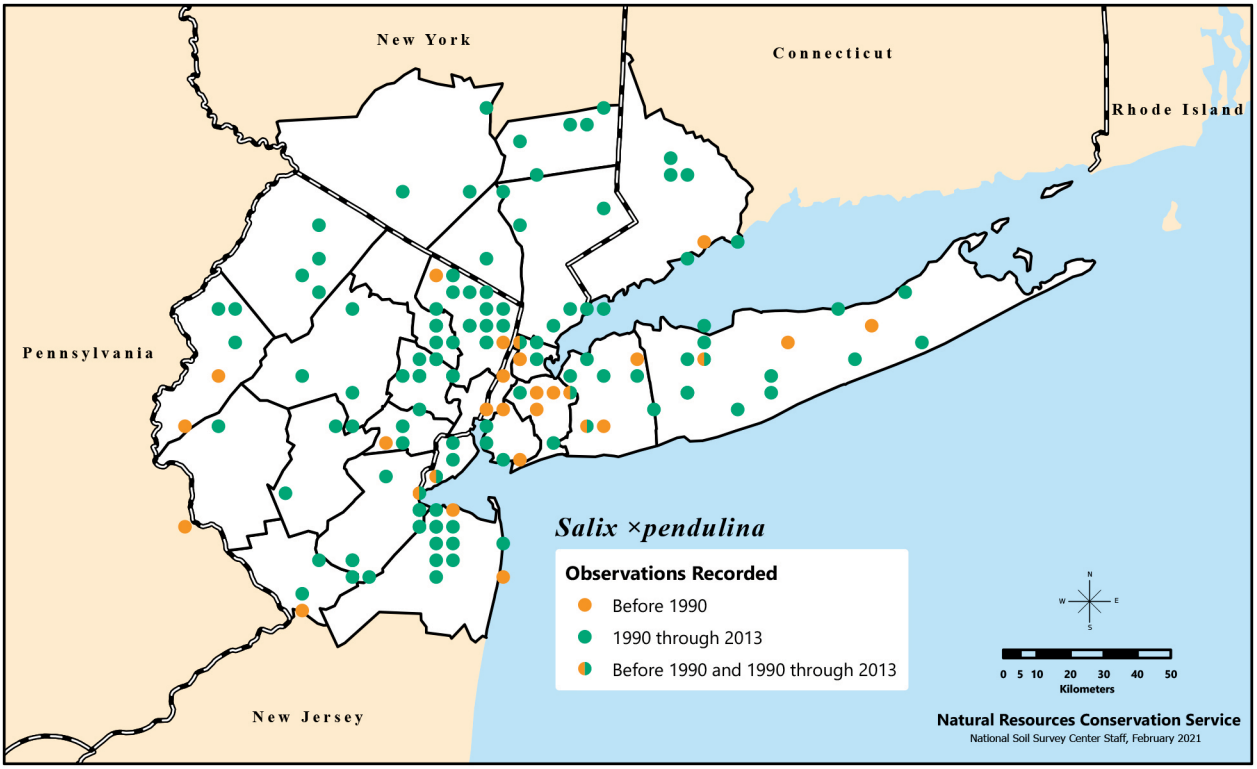
2011, Henderson 1991). Morphologically, *S. euxina* can be very difficult to distinguish from *S.* ×*fragilis* (Argus 2006, Beismann et al. 1997). *Salix triandra* L. (*S. amygdalina* L.), almond leaf willow, would key here. Native to Europe and Asia and occasionally cultivated; reported as a rare escape in eastern Canada and the U.S. Distinguished from *S.* ×*fragilis* by its flaky bark on older twigs and persistent (not deciduous) stipules.

17. *Salix* ×*pendulina* Wender. – weeping willow ↑↑

Tree. Flowering Apr.–May; fruiting May–early June. Planted and occasionally escaped in disturbed open areas. Epithet from Latin means "hanging down," a reference to the pendulous aspect of the branches.

Much "weeping" willow material from the region has been wrongly identified as *Salix babylonica*. Argus (2010) reported *S. babylonica* as not cold-hardy (though some freezing resistance has been documented (Sakai 1970) and not commonly planted or escaped in the Northeast. The "weeping" material from the region most likely represents *S.* ×*pendulina* Wender. (*S. babylonica* × *S. euxina* I.V. Belyaeva) and *S.* ×*sepulcralis* Simonk (*S. alba* var. *vitellina* × *S. babylonica*). *Salix* ×*pendulina* is not truly weeping, although the branches are somewhat pendulous. It is possible that this is instead a hybrid between *S. babylonica* and *S. pentandra*, which is a female clone.

Salix babylonica (one of the possible parents of *S.* ×*pendulina*) is an invasive tree along South African river channels and changes their stability and width (Rowntree 1991). It is the most widespread woody riverine invader in grasslands of South Africa (Henderson 1991). Also invasive in Australia, where it has invaded temperate and riparian *Eucalyptus* (eucalypt) forests and impacts the composition of aquatic invertebrates (Grice et al. 2004). Because it can spread and stabilize slopes rapidly as stem cuttings root easily and grow fast, it is suggested for riverbank restoration in China (Li et al. 2006). This willow



Distribution of *Salix* ×*pendulina*, or weeping willow, recorded in the New York Metropolitan Region during three time categories.

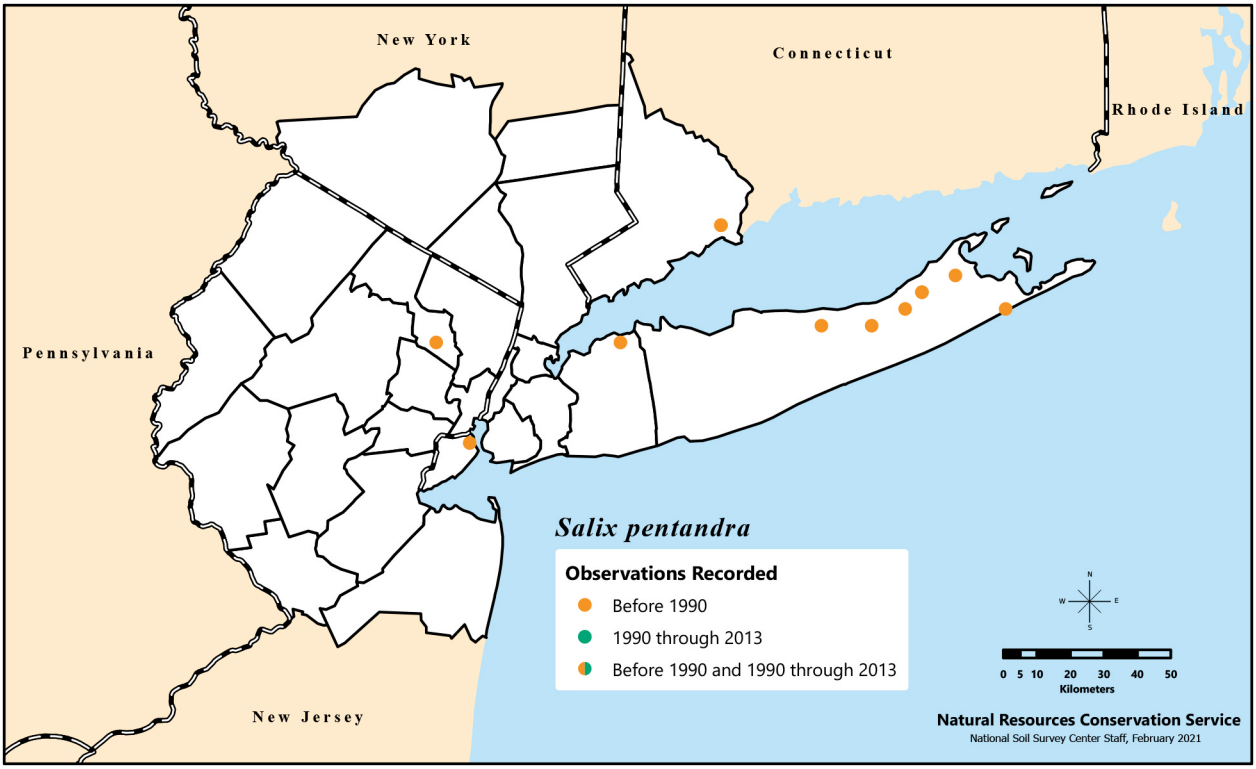
sp., unlike *S. fragilis* and *S. cinerea*, has a very high evapotranspiration rate in wetland habitats and may be a good species to funnel water back to the atmosphere (Pauliukonis and Schneider 2001). Originally described by Linnaeus (1753); application of the name *S. babylonica* has long been problematic. Fang et al. (1999) reported the plant as widespread throughout China. However, Argus (2010) stated: "It is thought to have originated in China, although it no longer occurs in the wild and its origins are uncertain." Possibly native to Japan (Sakai 1970). Further taxonomic work needed on local "weeping" willow material to determine what species it represents. The closely related "nonweeping" *S. matsudana* Koidzumi (Chinese willow) is occasionally planted, especially *S. matsudana* 'Tortuosa' (corkscrew or curly willow cultivar), but not known to escape in the region.

Salix euxina (one of the possible parents of *S.* ×*pendulina*) may be found throughout southern Canada and the U.S., but rarely escapes. It is found along banks of mountain streams near the Black Sea and in the mountains of Asia Minor and southern Georgia in its native regions (Argus 2010). *Salix euxina*, once referred to as *S. fragilis*, hybridizes easily with *S. alba*, resulting in *Salix* ×*fragilis*. Several more recent papers still use *S. fragilis* and not *S. euxina*, causing some doubt about the taxonomy.

Salix ×*sepulcralis* is considered invasive in the U.S. (Loeb 2012, Randall 2001). First made available in 1888 in Berlin, Germany; has since reportedly replaced most other weeping willows in cultivation world-wide (Royal Botanic Gardens, Kew 2015).

18. *Salix pentandra* L. – bay leaf willow ↓↓↓

Shrub. Flowering May–early June; fruiting June–July. Mesic open areas, including roadsides. Native to Asia and Europe and rarely escaped from cultivation; not recently reported. Argus (2010) reported only pistillate plants known from North America. Epithet means "five stamens."



Distribution of *Salix pentandra*, or bay leaf willow, recorded in the New York Metropolitan Region during three time categories.

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Salix pentandra contains phenolic glucosides which deter herbivory by the shoot galling sawfly (*Euura amerinae*) (Kolehmainen et al. 1994). Photoperiod, as well as temperature, triggers cold acclimation in this species (Junttila and Kaurin 1990). Considered to have the most handsome foliage of all the willows but is susceptible to leaf diseases to the point of complete defoliation (Dirr 1998).

19. *Salix purpurea* L. – purple willow, basket willow ↔

Shrub. Flowering Apr.–May; fruiting July. Disturbed open areas. Native to northern Africa, Asia, and Europe; occasionally encountered as an escape. Originally introduced for basket making. Epithet from Latin refers to the purple color of the twigs.

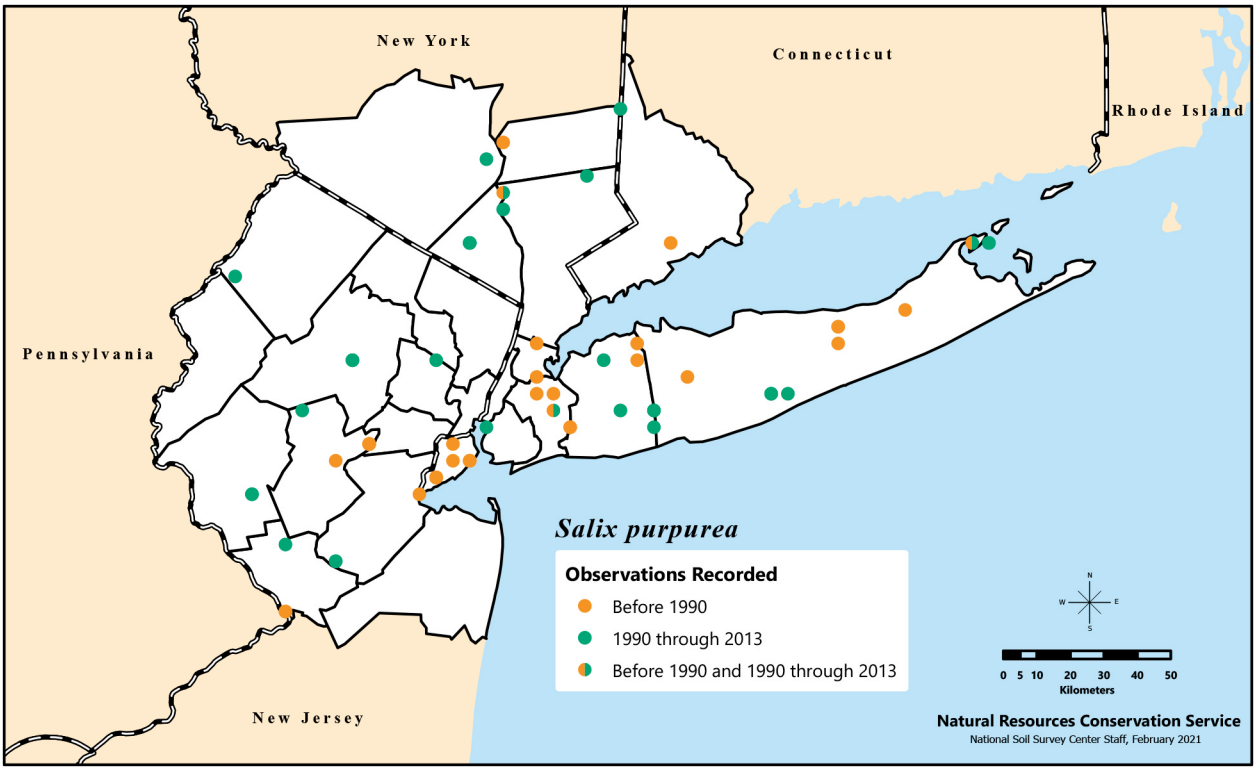
Was once and may still be considered a good landscape shrub for wet areas to stabilize banks (Dirr 1998). Was once recommended as a useful species to plant for wildlife habitat (Edminster 1950). Potentially good choice for bioenergy production (Gan et al. 2014). Leaves contain important glycosylated flavonoids and salicylates and high concentrations of tannins that may be used in herbal drug production (Julkunen-Tiitto and Sorsa 2001). However, it has been documented as an invasive in the U.S. (Loeb 2012, Mills et al. 1996, Randall 2001). At least 3 cultivars (Dirr 1998), including 'Streamco,' which NRCS uses for stabilizing banks and waterways (Clark 2014). This species' success as an invader is attributed to its propensity to grow clonally (Lin et al. 2009).

20. *Salix* ×*sepulcralis* Simonkai Ø

See discussion under *S.* ×*pendulina*.

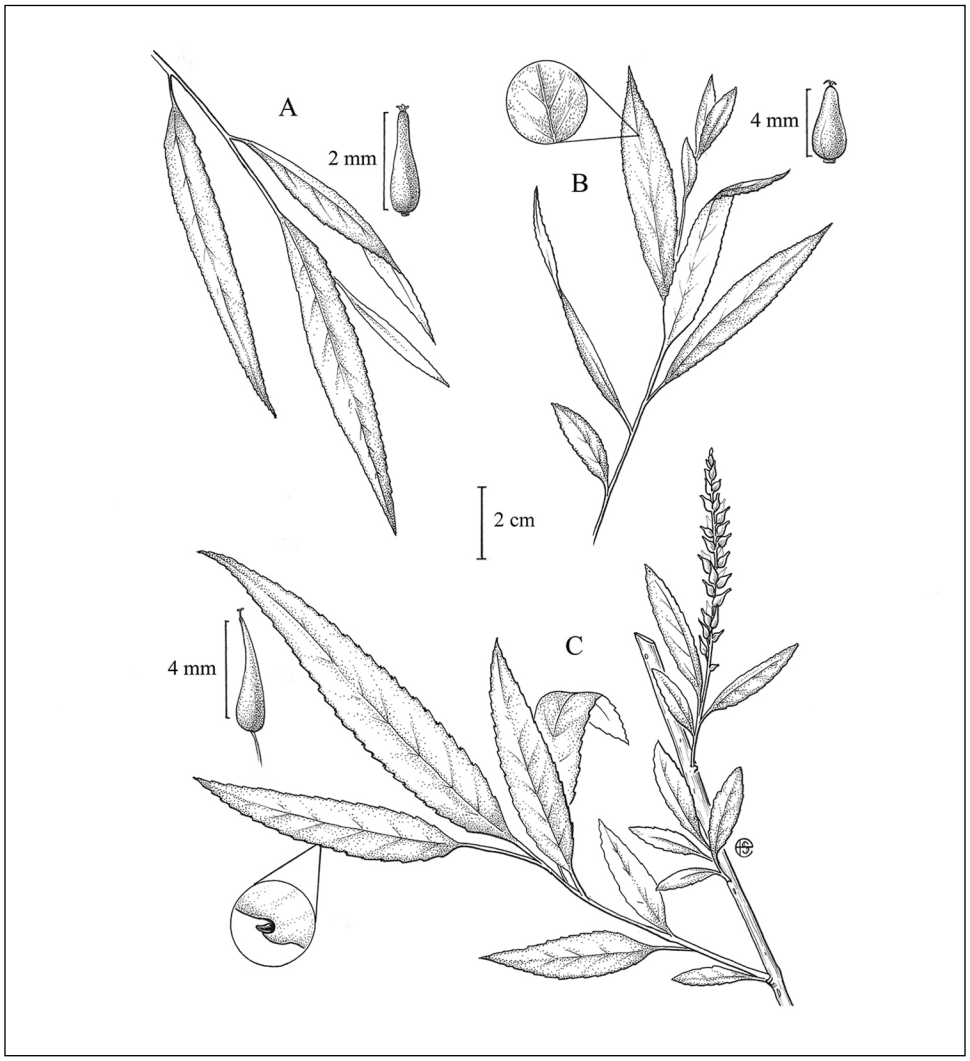
Management

Several native and nonnative willow species have the potential for commercial production for their wood, bioenergy, bioremediation, or phenolic compounds. But many of the nonnative species with the potential for economic production are also potentially invasive: *Salix alba*, *S.*

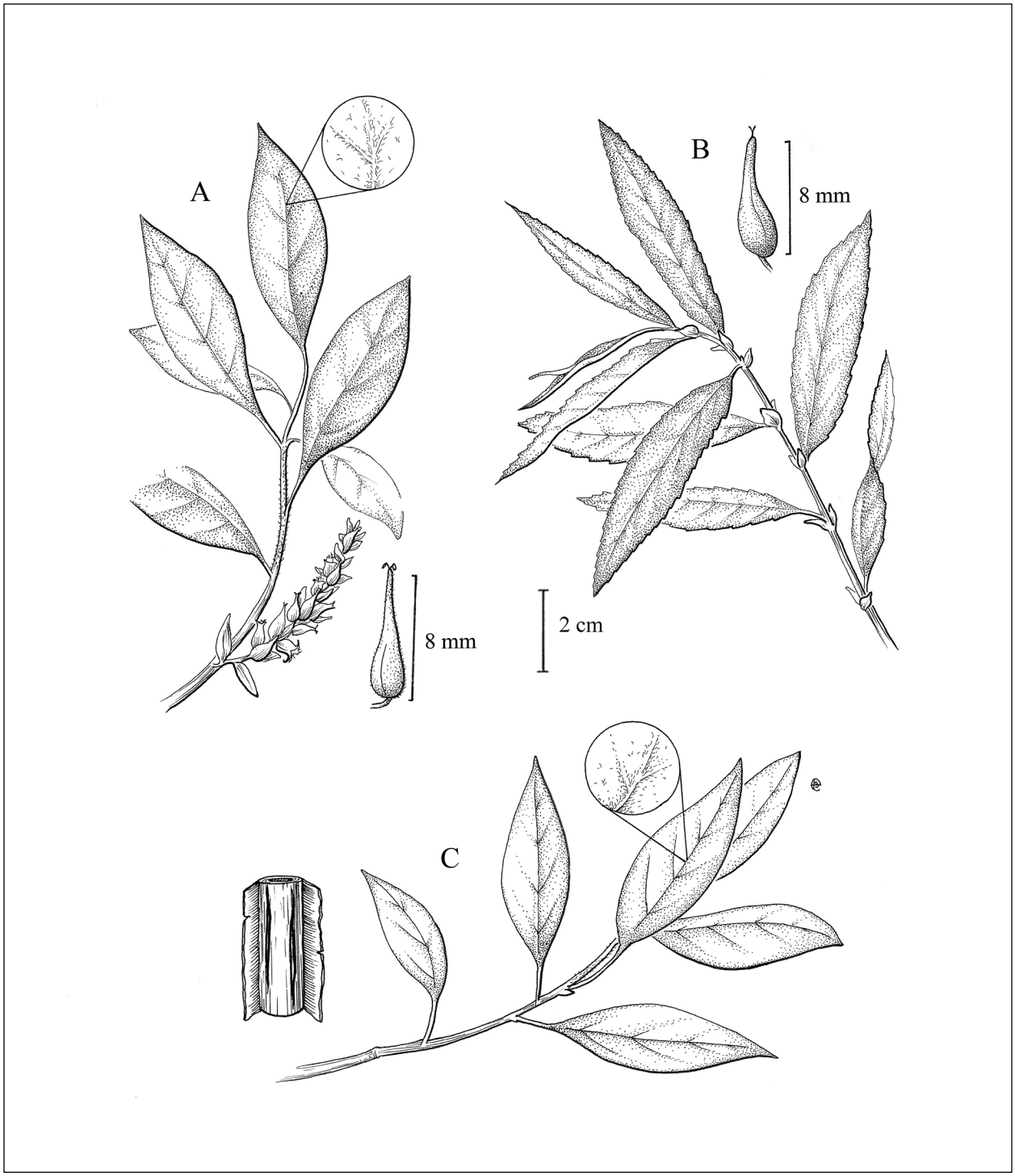


Distribution of *Salix purpurea*, called purple or basket willow, recorded in the New York Metropolitan Region during three time categories.

×*fragilis*, *S. atrocinerea*, and *S. purpurea*. *Salix nigra*, a native willow with economic potential, may also invade beyond its range or dominate habitats. Many remaining willows share the characteristics associated with biomass production, phytoremediation, or medicinal value but have not been considered for commercial production. Part of this may be due to high susceptibility to disease as with *S. pentandra*, but it may also be due to a lack of abundance of these species. It is conceivable that increasing their abundance artificially for economic reasons could also result in similar invasive tendencies. Because of the relatively high likelihood of hybridization, especially with native willows, we recommend not planting nonnative willow species and perhaps removing such species where it is feasible to do so. Great care should be taken in considering establishment of plantations of *Salix* of any species for commercial purposes. Costs associated with a species' ability to hybridize and spread may be greater than benefits associated with using it as a crop. Several native willow species (*S. candida*, *S. humilis*, and *S. lucida*) have decreased substantially in abundance in the region, which is a concern. While we do not promote extensive planting of these species, we do recommend researching further why these species have decreased in population size and perhaps attempting the restoration of some populations.



A) Leafy twig and fruit of *Salix* ×*pendulina*; B) leafy twig, with enlarged view of leaf midrib, and fruit of *Salix alba*; C) flowering leafy twig, with enlarged view of leaf margin, and fruit of *Salix* ×*fragilis*. Illustration by Emma Skurnick.



A) Flowering leafy twig, with enlarged view of leaf midrib, and fruit of *Salix bebbiana*; B) leafy twig and fruit of *Salix eriocephala*; C) winged stem and leafy twig, with enlarged view of leaf midrib, of *Salix atrocinerea*. Illustration by Emma Skurnick.

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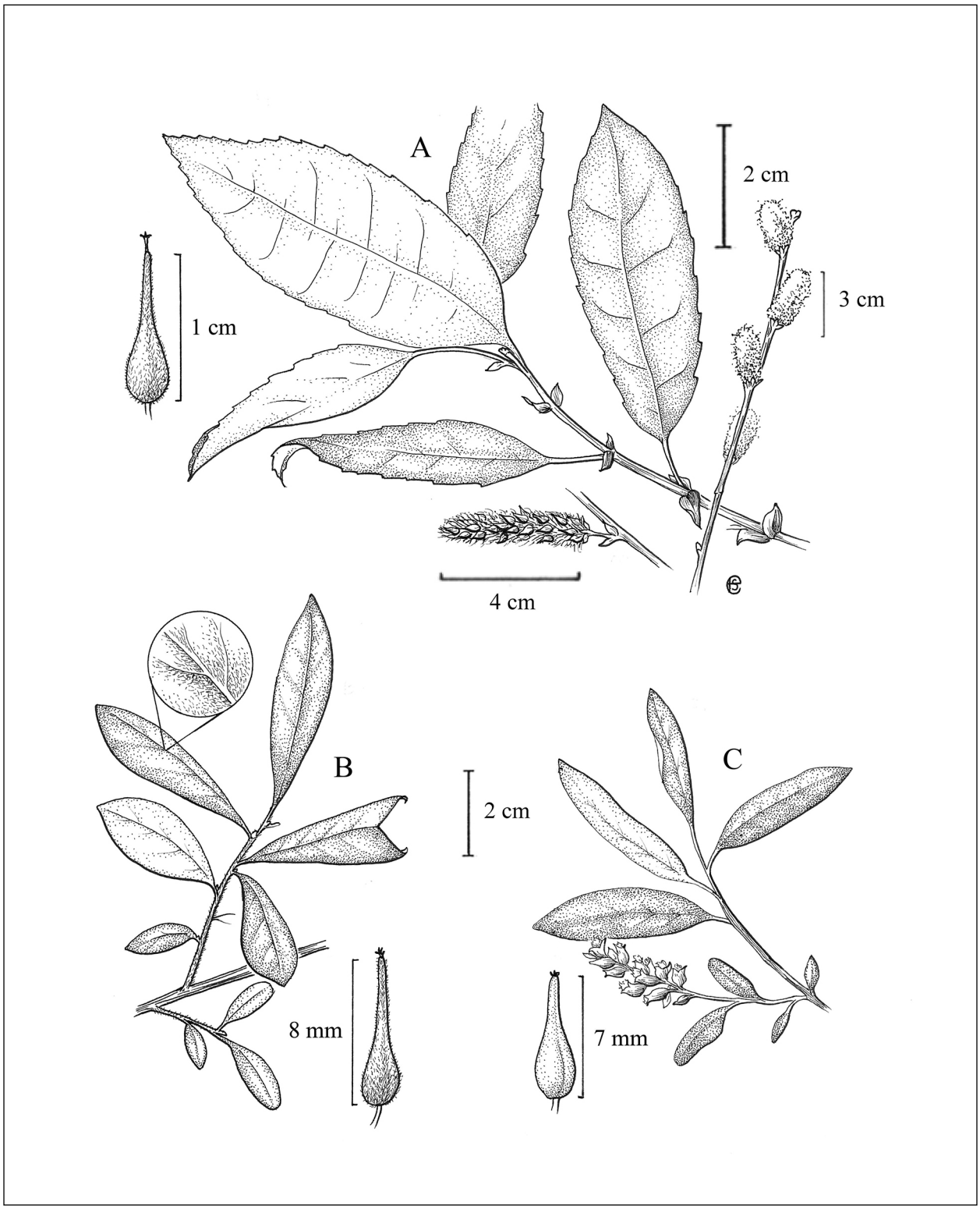
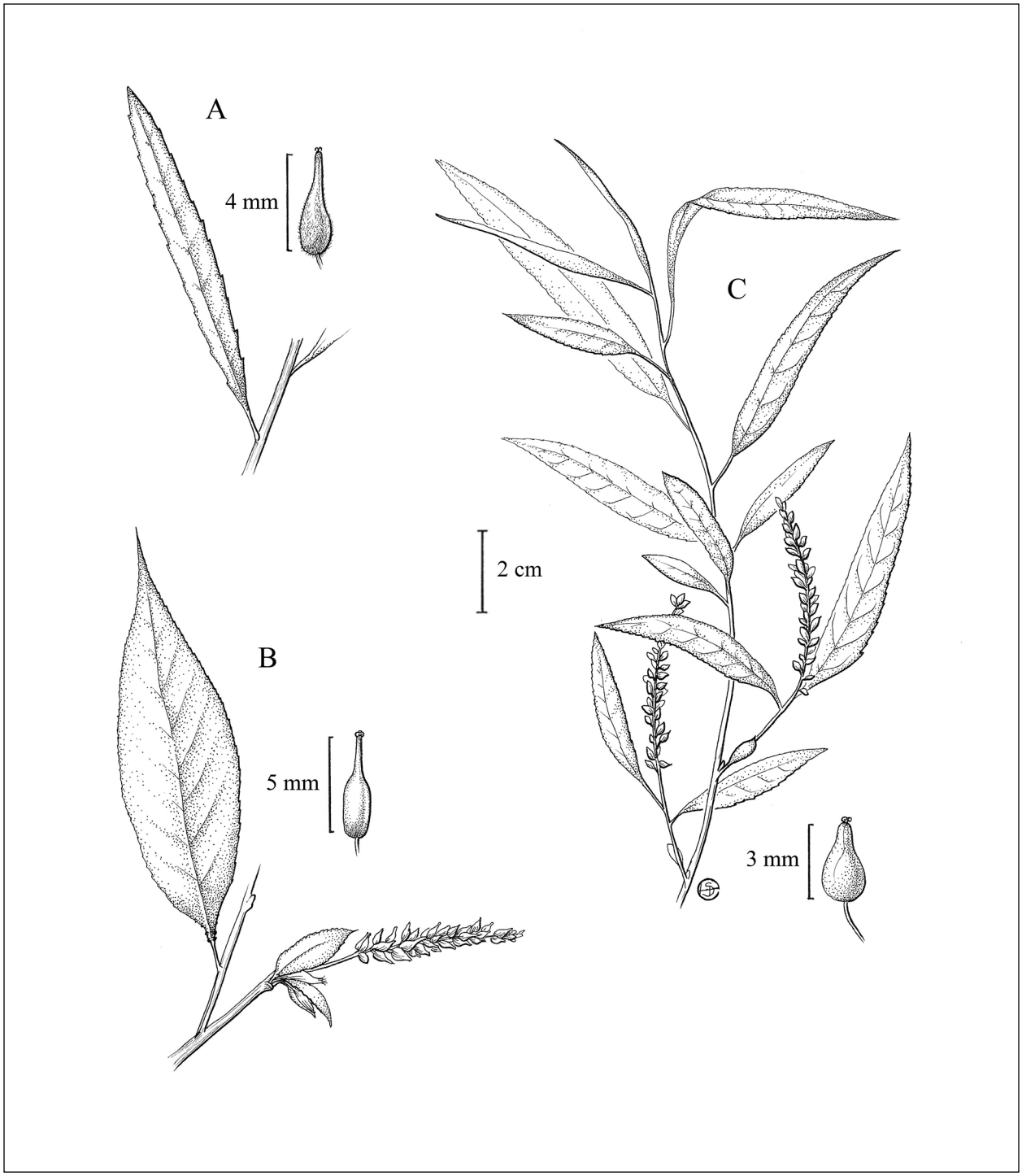


A) Fruit, leafy twig, and male and female catkins of *Salix discolor*; B) leafy twig with enlarged view of leaf midrib, and fruit of *Salix humilis*; C) flowering leafy twig, and fruit of *Salix pedicellaris*. Illustration by Emma Skurnick.



A) Twig with leaf, and fruit of *Salix interior*; flowering leafy twig and fruit of B) *Salix lucida* and C) *Salix nigra*. Illustration by Emma Skurnick.

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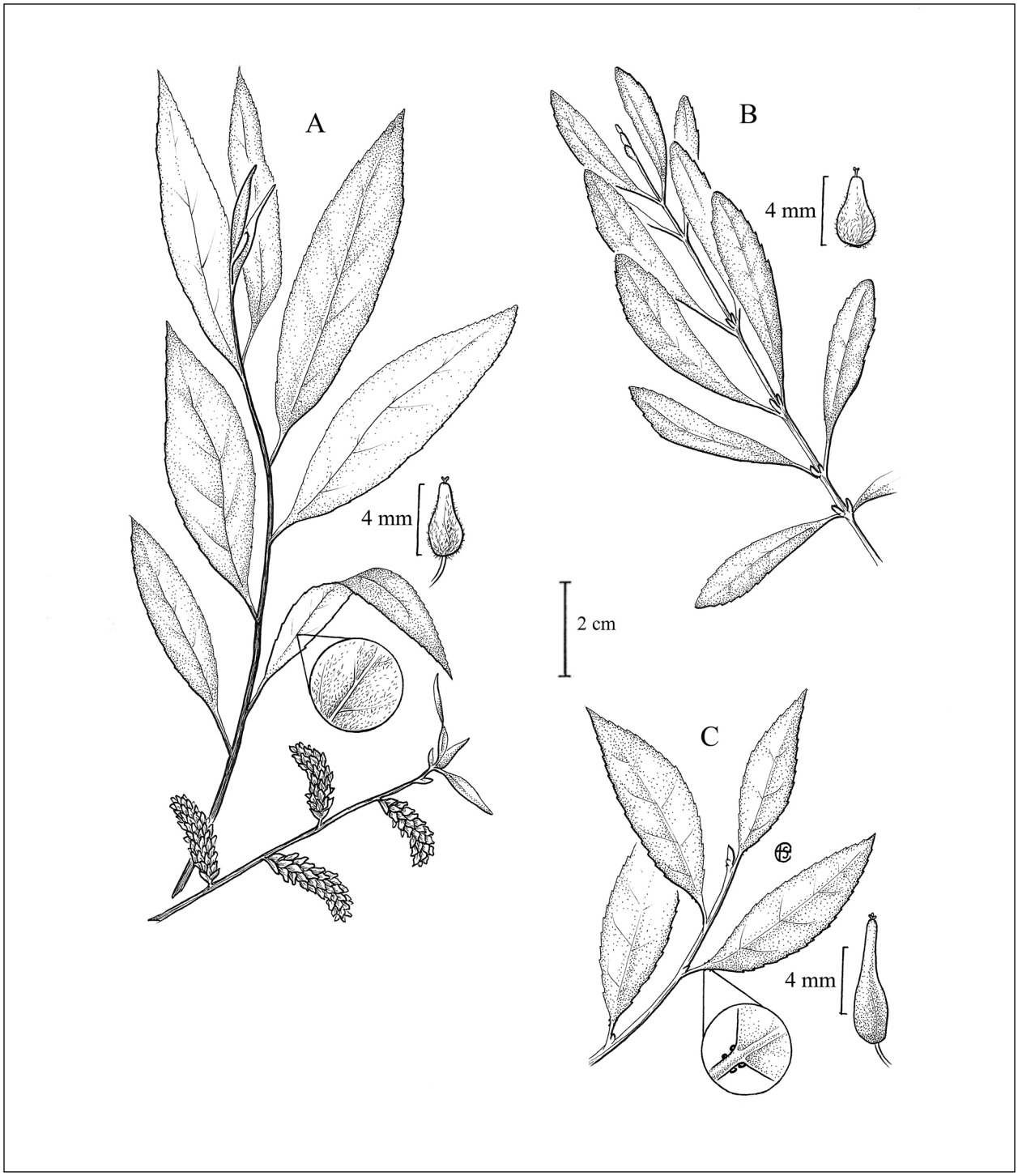

A) Leafy twig, with enlarged view of leaf midrib, and female catkins and fruit of *Salix sericea*; B) leafy twig and fruit of *Salix purpurea*; C) leafy twig, with enlarged view of petiole glands, and fruit of *Salix serissima*. Illustration by Emma Skurnick.

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Sambucus L. – elder

Adoxaceae (Caprifoliaceae; Sambucaceae). Shrubs, trees. Species 9–30 in Asia, Australia, Europe, North America, and South America. Various possible origins of the genus name. Rehder (1949) and Fernald (1950) stated it was simply the ancient name of elder. Fernald further indicated the name was possibly derived from the Greek "sambuce," an ancient musical instrument; the stems of *Sambucus* were used for flutes and whistles. Gerard (1895), however, indicated the name to be derived from an erroneous 10th-century Anglo-Saxon translation of the 4th-century "Herbarium of Apuleius." The translator misidentified a Greek word of Coptic origin as "elder," which was adopted by pre-Linnaean botanists and perpetuated to this day.

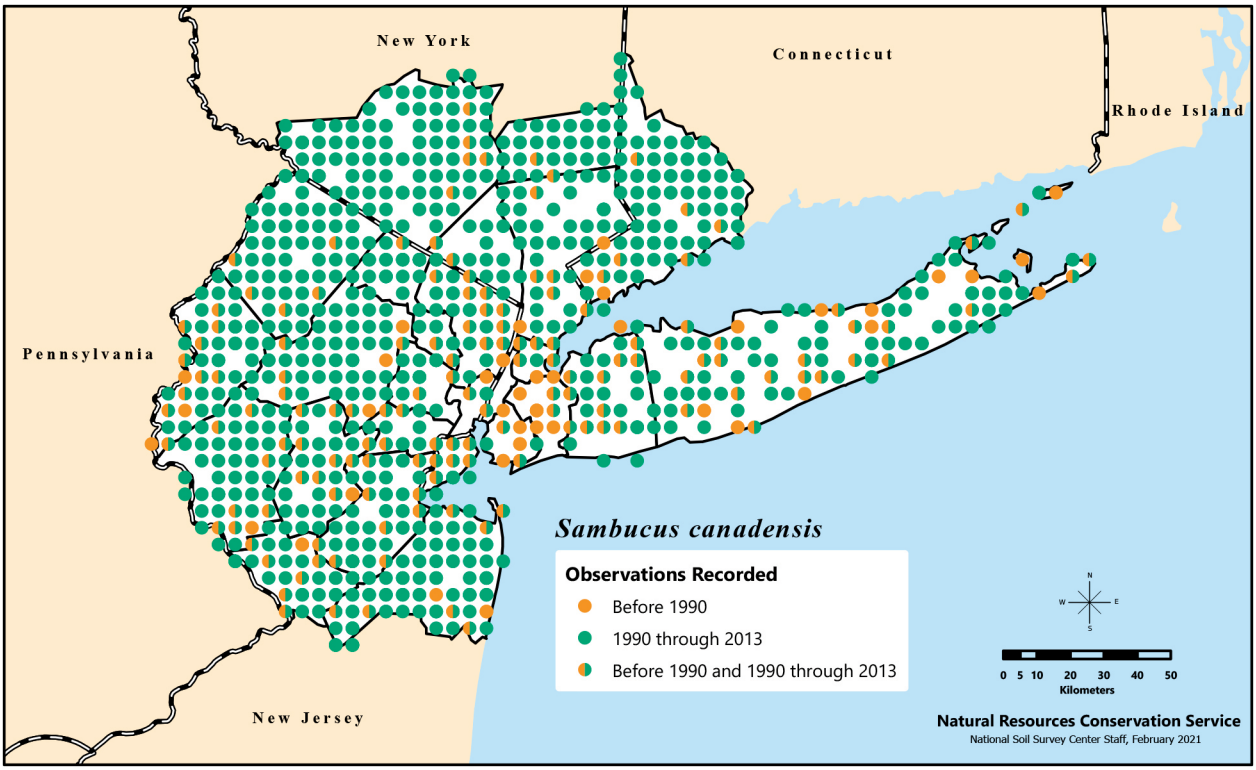
Native Species

1. *Sambucus canadensis* L. – common elderberry ↑↑

Flowering May–July; fruiting July–Sept. Swamps, marshes, wet woods, roadside ditches, lake and pond shores, river margins, streambanks, mesic thickets, and swales; rarely in drier situations, such as old fields and upland mixed woods. Sometimes

Sambucus Key

1. Pith white; inflorescences 5-rayed from the base, lacking a central axis above the lowermost branches. . . . . ***Sambucus canadensis***
1. Pith brown; inflorescences panicle-like, with the main axis extending well above the lowermost branches. . . . . ***Sambucus racemosa***



Distribution of *Sambucus canadensis*, or common elderberry, recorded in the New York Metropolitan Region during three time categories.

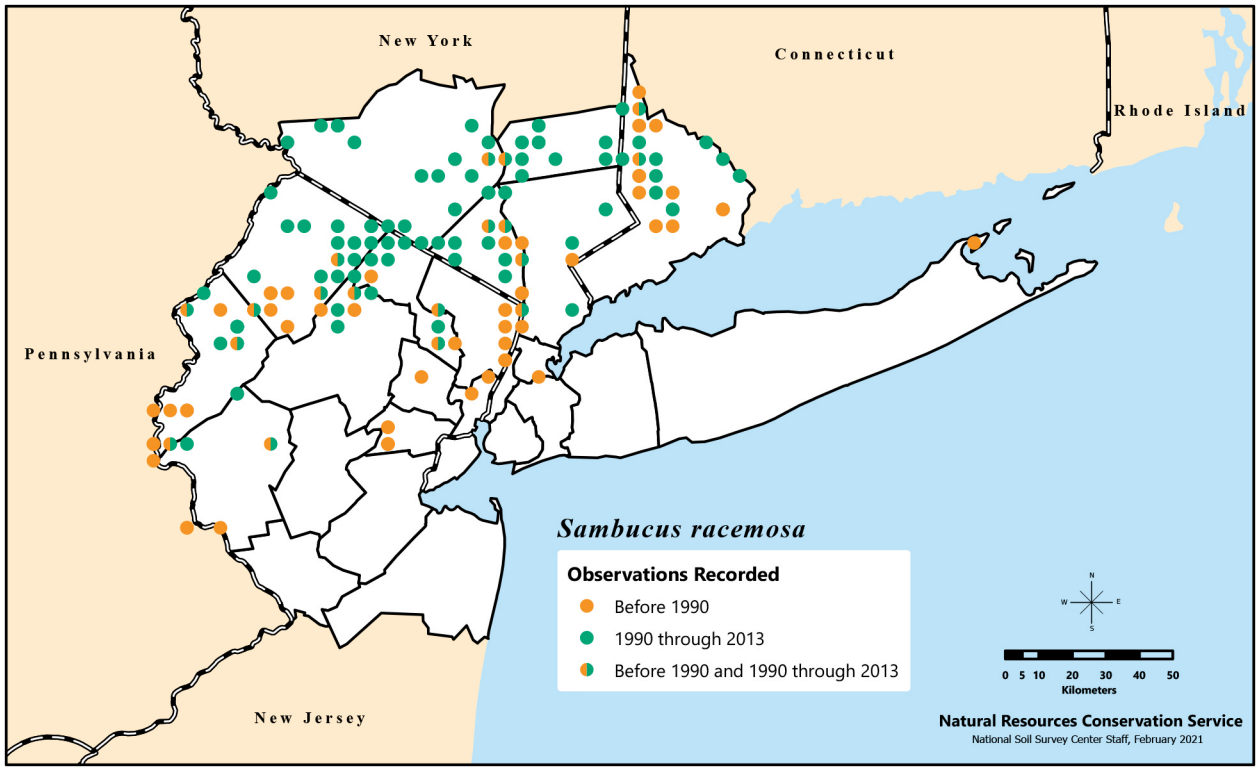
treated as a subspecies of *Sambucus nigra* L., *S. nigra* subsp. *canadensis* (L.) R.Bolli. True *S. nigra* (*S. nigra* subsp. *nigra*) is native to northern Africa, western Asia, and Europe, but has been reported as an escape or remnant from cultivation just outside the region in CT and PA. *Sambucus canadensis* differs from *S. nigra* in being a stoloniferous shrub (*S. nigra* is a small non-stoloniferous tree); leaves with 5–11 leaflets (5–7 leaflets in *S. nigra*); ovary 4-locular (3-locular in *S. nigra*); and fruit purplish, up to 6 mm in diameter (black, 6–10 mm in diameter in *S. nigra*).

Height at maturity 2.7 m (Brinkman and Johnson 2008). Cultivated since 1761, with at least 6 cultivars (Dirr 1998). Several insects visit the flowers, including *Apis*, *Ceratina*, *Halictus*, *Hemipenthes*, *Allograpta*, *Chrysogaster*, *Eristalis*, *Mesograpta*, and *Syrphus* spp. (Robertson 1892). At least 38 different bird species as well as chipmunks (subfamily Xerinae), squirrels (family Sciuridae), mice (*Mus* spp.), and deer (*Odocoileus* spp.) eat the fruit (Hidayati et al. 2000, Martin et al. 1951, Ridley 1930, Sherburne 1972, White 1965). Germination rates highest after a warm stratification followed by a cold stratification (Brinkman and Johnson 2008, Davis 1927, Hidayati et al. 2000, Rose 1919).

Native Americans used the plant for medicinal purposes and used the berries to make wine, pies, jellies, sauces, and porridges; they also ate raw berries. Blossoms were dipped in hot water to make a pleasant drink. Stems were used to make popguns, water squirt guns, blowguns, and medicine blowing tubes. The inner bark was used to make a repellant to ward off flies and other insects (Moerman 1998). Increases in the region may be related to reforestation.

2. *Sambucus racemosa* L. – red elderberry ↔

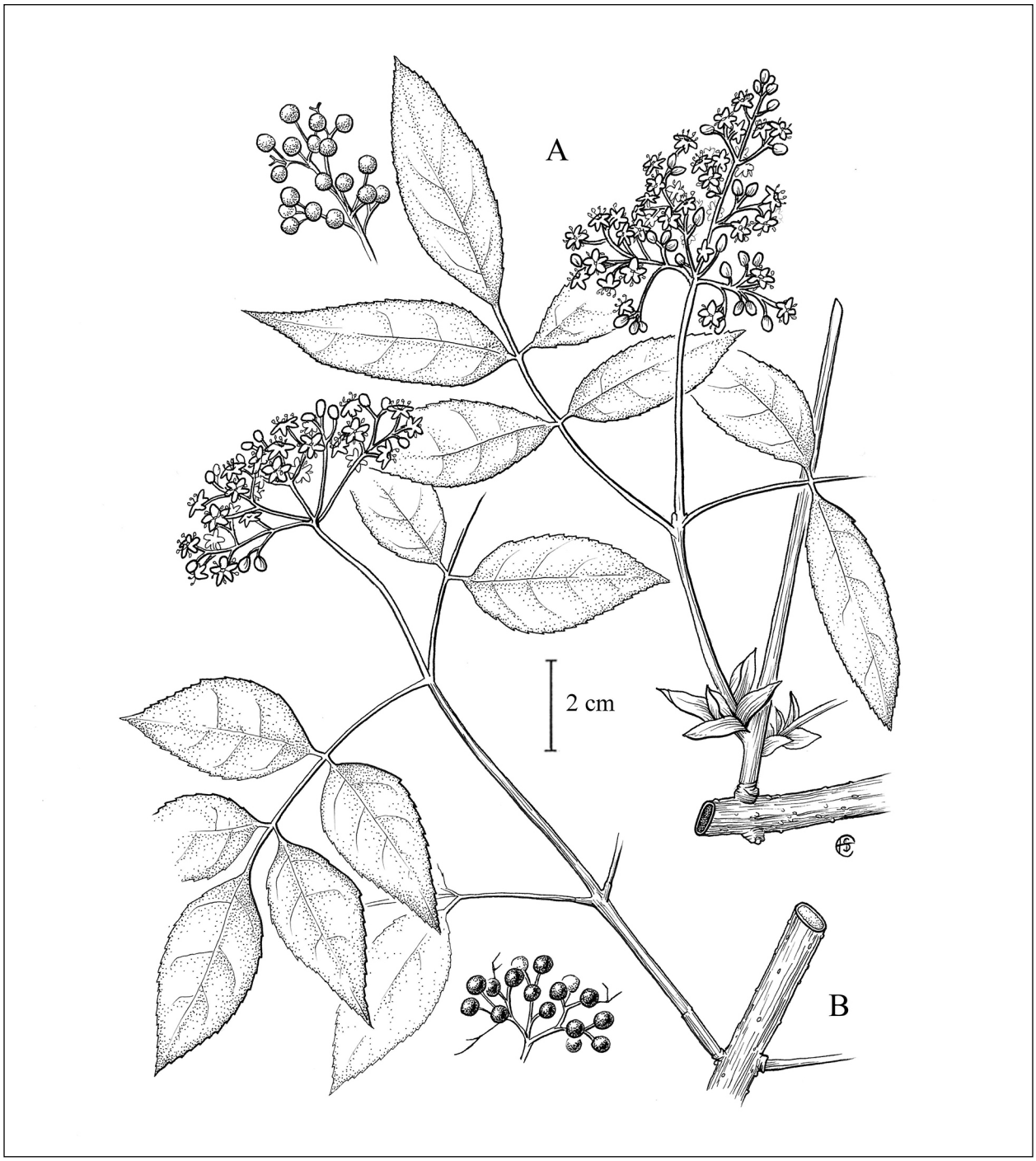
Flowering Apr.–May; fruiting June–Aug. Mesic conditions in rich soil, such as wooded ravines, rocky woods, mountain stream banks, mesic thickets, and occasionally roadsides; usually in upper elevations. Our material is referable to *Sambucus racemosa* subsp. *racemosa* var. *racemosa* (both subspecies and variety recognized).



Distribution of *Sambucus racemosa*, or red elderberry, recorded in the New York Metropolitan Region during three time categories.

STU

Height at maturity 3 m. Cultivated since 1812 (Brinkman and Johnson 2008). This name has also been used as an accepted name for European red elder (Dirr 1998, ITIS 2018), a native of Europe and western Asia that has been in cultivation since 1596. However, the European red elder may refer to *S. racemosa* var. *pubens* or var. *leucocarpa* or var. *microbotrys* (ITIS 2018).



Flowering leafy twig and infructescence of A) *Sambucus racemosa* and B) *Sambucus canadensis*. Illustration by Emma Skurnick.

STU

Sassafras J.Presl. – sassafras

Lauraceae. Trees. Species 3 in Asia and North America; 2 others, *Sassafras randaiense* (Hayata) Rehder and *S. tzumu* (Hemsl.) Hemsl., endemic to China, the latter limited to Taiwan. Aromatic; used in beverages, food, and medicinals. Limited use today; some compounds carcinogenic. According to Fernald (1950), name is an aboriginal name applied by early French settlers in FL. According to Rehder (1949), name is derived from Spanish "salsafras," the name for *Saxifraga*, a reference to its supposedly similar medicinal properties.

Native Species

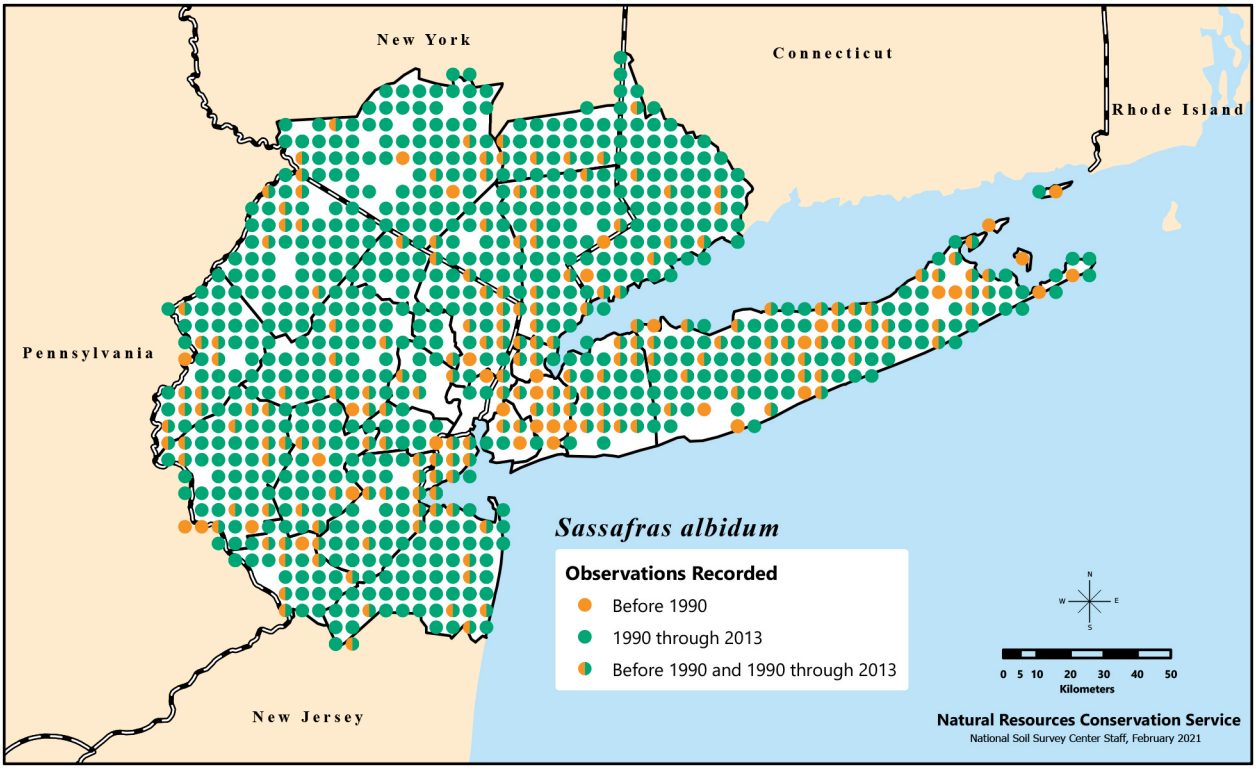
1. *Sassafras albidum* (Nutt.) Nees – sassafras ↑↑

Laurus albida Nutt.; *Laurus sassafras* L.

Flowering Apr.–May; fruiting July–Aug. Dry to mesic woodlands, including pinelands, and woodland edges on many soil types, throughout the region. Epithet means "whitish," a reference to the roots.

Dioecious. Birds are the primary dispersers of the seeds and they usually eat the fruit and seeds before they fall from the tree (Davidar and Morton 1986, Little and Delisle 1962, Shiflett and Young 2010). Earliest seed-bearing age 4 years; good crops of seed every 1–2 years (Bonner 2008o). Moist cold stratification at 2–4 ºC for 120 days required for germination. May also be propagated from root cuttings. Species sometime split into two varieties: *S. albidum* var. *albidum* (white sassafras) and *S. albidum* var. *molle* (Raf.) Fernald (red sassafras), the latter with pubescent twigs and leaf undersides.

An important wildlife and, to a lesser extent, timber tree. Wood is lightweight and durable. In more southern and fertile sites, height at maturity 30 m (Bonner 2008o). Prefers moist, loamy, well-drained, acidic soils; may suffer chlorosis in soils with high pH. Prefers full sun to light shade (Dirr 1998). Roots are used to make tea, sassafras oil, and perfume for soap (Bonner 2008o). The root extracts associated with its use in teas or root beer have been shown to be carcinogenic;



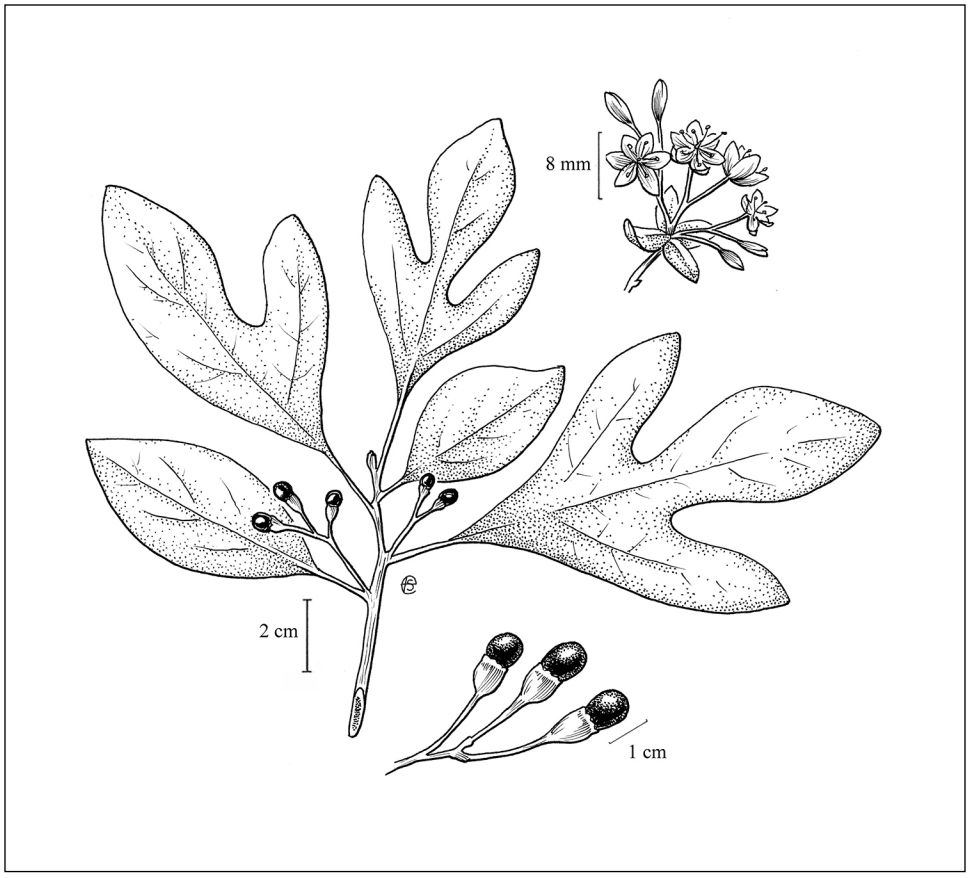
Distribution of *Sassafras albidum*, or sassafras, recorded in the New York Metropolitan Region during three time categories.

STU

many consider them unsafe (Segelman et al. 1976). Safrole, *S. albidum*'s essential oil, may have antifungal (Simic et al. 2004) and possible insecticidal properties (Bonner 2008o). However, at least one insect is dependent on it and other members of the Lauraceae. The spicebush swallowtail butterfly (*Papilio troilus*) can oviposit only on members of the Lauraceae (Carter et al. 1999). Because of its rapid growth and high oil content, *S. albidum* is ranked high as a possible hydrocarbon-producing crop (Buchanan et al. 1978). Cultivated since 1630 (Dirr 1998, Griggs 1990). Several diseases, fungi (mildew) and insects, including sassafras weevil (*Odontopus calceatus*), Japanese beetle (*Popillia japonica*), and scale (superfamily Coccoidea), impact this species in the form of cankers, root rot, leaf spots, and wilt (Dirr 1998). Some documentation of possible allelopathic effects that may allow *S. albidum* to maintain itself as an almost pure stand at different stages of early succession (Gant and Clebsch 1975). This species photosynthesizes efficiently under both old field (water stress and high light) and somewhat open forest (e.g., pine forests; relatively low light intensities) environments (Bazzaz et al. 1972). Trees growing in forests may be more reliant on sun flecks in order to achieve positive net photosynthesis. Lobing of leaves increases with increasing light availability; lobing may enhance heat loss and can differ by site as well as within a single tree (de Soyza and Kincaid 1991). Though stems of *S. albidum* become totally embolized (blocked by air bubbles) by Oct., the roots do not, possibly enabling this clonal species to root sprout and colonize more rapidly in early summer (Jaquish and Ewers 2001). Increases in the area may be due to reforestation.

Management

Because this clonal, somewhat aggressive species gives way to other more shade-tolerant canopy trees over the course of forest succession, it is not a concern. If there are allelopathic properties, they do not appear to affect many species or are short-lived. Its importance to many successional ecosystems and associated wildlife, as well as the economic possibilities associated with its oil and wood, justifies management that includes it as part of the forest system.



Fruiting leafy twig, fruit, and flowers of *Sassafras albidum*. Illustration by Emma Skurnick.

STU

Smilax L. – greenbrier

Smilaceae (Liliaceae s.l.). Climbing shrubs, woody vines, and herbs; some herbs may also climb. Species 300–350 in Africa, Asia, Australia, Europe, North America, and South America. Besides the woody species treated here, the following herbaceous species occur in the region: *Smilax herbacea* L.; *S. pseudochina* L.; *S. pulverulenta* Michx. The woody *Smilax walteri* Pursh, is reported just south of the region in southern NJ to Burlington County; distinguished from species treated here by its red fruit. Genus name is an ancient name for an evergreen oak, later applied to this genus. All species in the region are dioecious with bird-dispersed seed.

Native Species

1. *Smilax glauca* Walt. – sawbrier ↑

Flowering May–July. Dry (rarely mesic) woodlands, including pinelands, and woodland edges, especially in disturbed areas.

On Staten Island, found growing along dry, sandy bluffs; differs in morphology from plants found growing, more typically, on mesic ground (Davis 1891). Foliage and fruit are eaten by white-tailed deer (*Odocoileus virginianus*). Its habit may make good small mammal and bird cover. The roots have been used to make a drink similar to root beer as well as a sweet jelly (Kurz 1997). Epithet is from the Greek word for "grayish-blue," "blue-green," or "glimmering."

2. *Smilax laurifolia* L. – laurel greenbrier Ø

Flowering May–July. Mesic to wet pinelands and Atlantic white cedar swamps. Barely reaches the region; Monmouth County (NJ) is the northern limit of its range and only county reported in the region for this species.

Has large, knotty, tuberous rhizomes that are 7–10 cm thick, with numerous shoots arising from an extensively branched rhizome system. Shoots may grow 7 cm per day (Martin and Tucker 1985).

Listed as rare in NJ (S3).

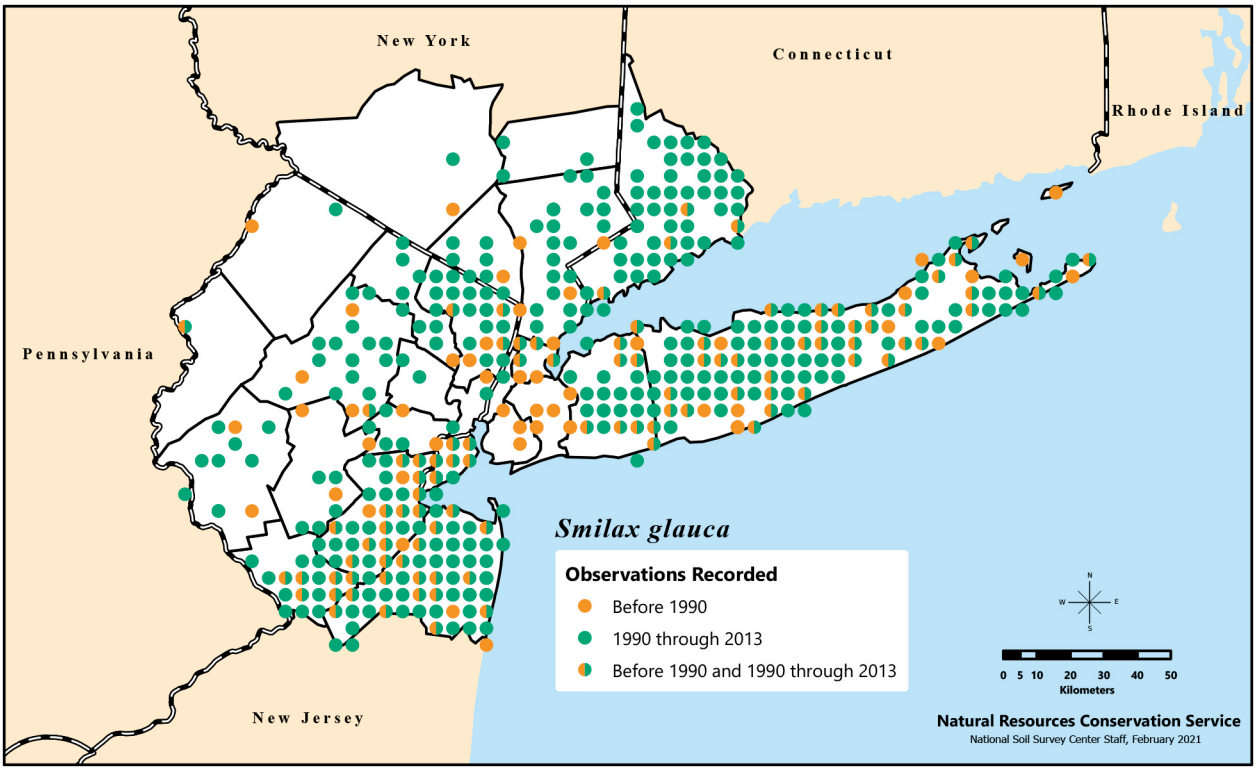
3. *Smilax rotundifolia* L. – greenbrier ↑↑

Flowering May–July. Dry to mesic woodlands, including pinelands, and woodland edges, especially in disturbed areas, where it can form nearly impenetrable thickets. The most common *Smilax* in the region.

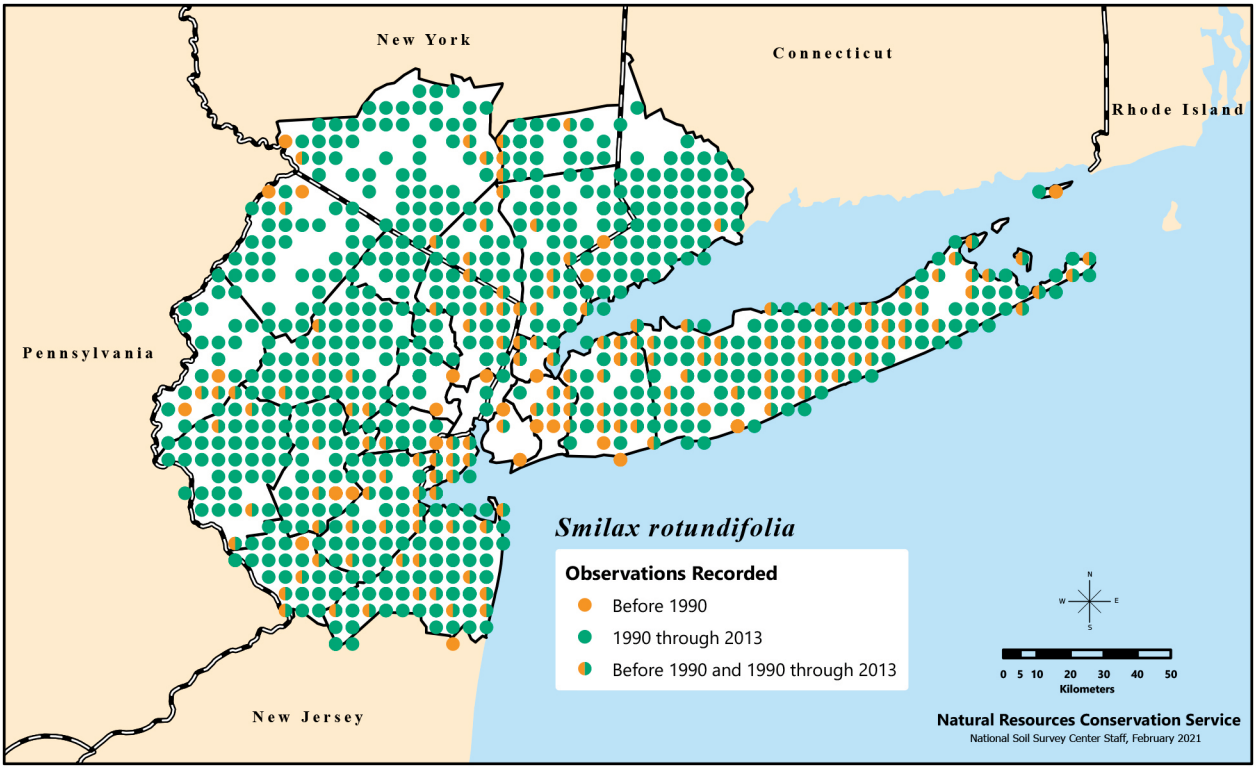
Grows well in high light and shade environments, showing physiological plasticity (Carter and Teramura 1988). Despite abundance in the NY Metropolitan Region, this species is threatened in Canada. Pollinated by insects. Pollen grains are connected to each other with sticky strands (viscin threads), which prevents wind-pollination. In areas where the population consists of only one gender, there is often no sexual reproduction. This species does not appear to make up for a lack of outcrossing with vegetative growth; for example, there was no evidence of vegetative

Smilax Key

1. Leaves glaucous beneath . . . . . ***Smilax glauca***
1. Leaves green beneath 2
2. Leaves evergreen, strongly leathery, oblong to oblong linear; many leaves without tendrils; stigma 1 . . . . . ***Smilax laurifolia***
2. Leaves deciduous, not strongly leathery, ovate to rounded; most leaves with tendrils; stigmas 2 3
3. Leaf margin minutely serrulate (visibly so at 10×); black bristles at bases of stems . . . . . ***Smilax tamnoides***
3. Leaf margin entire; bristles absent (prickles or spines present) . . . . . ***Smilax rotundifolia***



Distribution of *Smilax glauca*, or sawbrier, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Smilax rotundifolia*, or greenbrier, recorded in the New York Metropolitan Region during three time categories.

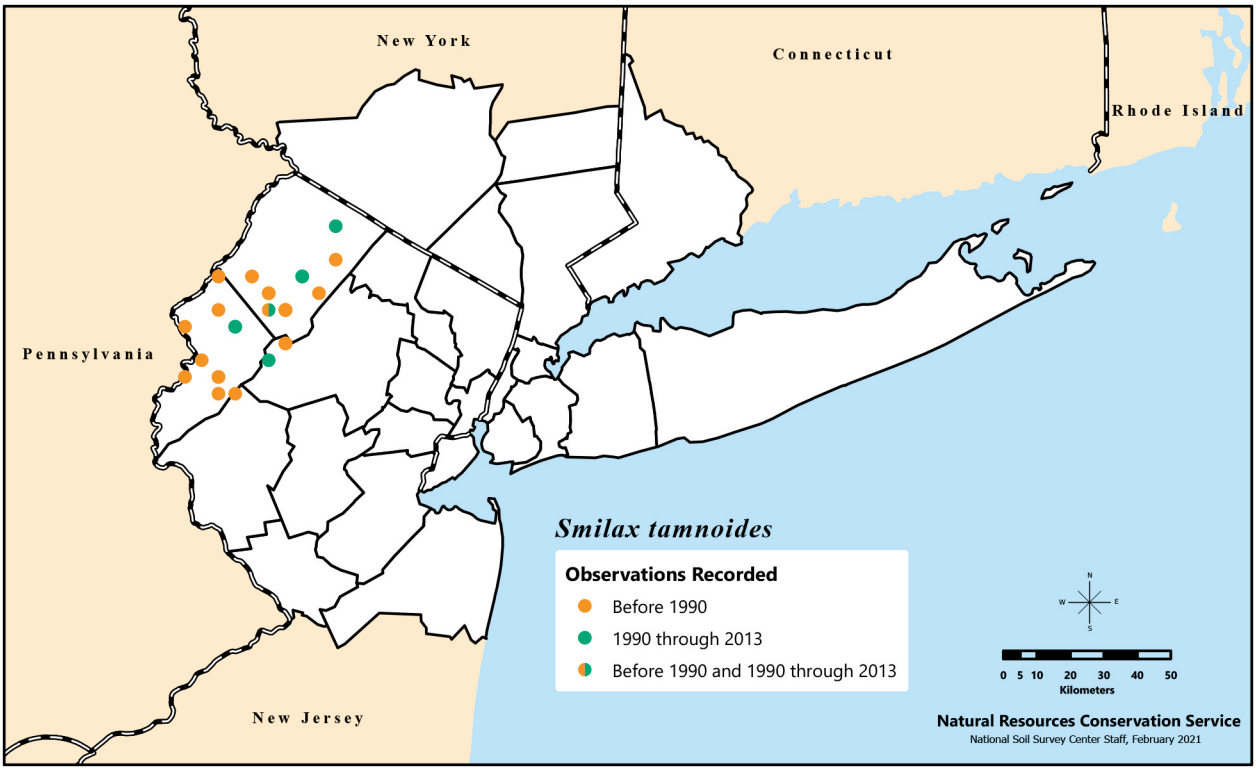
spread in the Carolinian forests of Canada (Kevan et al. 1991). A lack of vegetative growth for this species is surprising because it does produce rhizomes and can completely cover many eastern U.S. forest floors. Rhizomes differ from those of *S. laurifolia* in that there are no tubers or swollen masses, suggesting that *S. rotundifolia* may be less able to grow vegetatively (Martin and Tucker 1985). Seeds are dispersed by birds, rabbits (family Leporidae), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and deer (*Odocoileus* spp.) (Kurz 1997), though possibly not preferred over other species, including some nonnative species. Foliage and fruit are eaten by white-tailed deer (*O. virginianus*). Foliage is high in condensed tannins, but the amounts are not high enough to impact its digestibility by deer (Greenberg and Walter 2010). Its habit may make good small mammal and bird cover. Early growth (stems, leaves, and tendrils) may be eaten as fresh greens. The roots, like those of *S. glauca*, are used to make a drink similar to root beer and a sweet jelly. Sterile plants exist (Kurz 1997). This monocot may persist above-ground in the winter in temperate regions because of its strong root pressure, which maintains protoxylem full of sap throughout the year and enables the metaxylem to overcome embolism (blocking by air bubbles) early in Apr. (Cobb et al. 2007). Increases in the region may be due to reforestation.

4. *Smilax tamnoides* L. – bristly greenbrier ↓↓

Smilax hispida Muhl. ex Torrey; *Smilax tamnoides* var. *hispida* (Muhl. ex Torrey) Fernald

Flowering May–July. Mesic rich woodlands, and woodland edges; restricted in the region to northwestern NJ. Epithet refers to the species' superficial similarity to black bryony or tamus (*Dioscorea communis* (L.) Caddick & Wilkin).

Foliage and fruit are eaten by white-tailed deer. Its habit may make good small mammal and bird cover. It may be possible to train this species, with proper pruning, into a landscape hedge plant (Kurze 1997). Decreases in the region are of concern and possibly due to deer pressure.



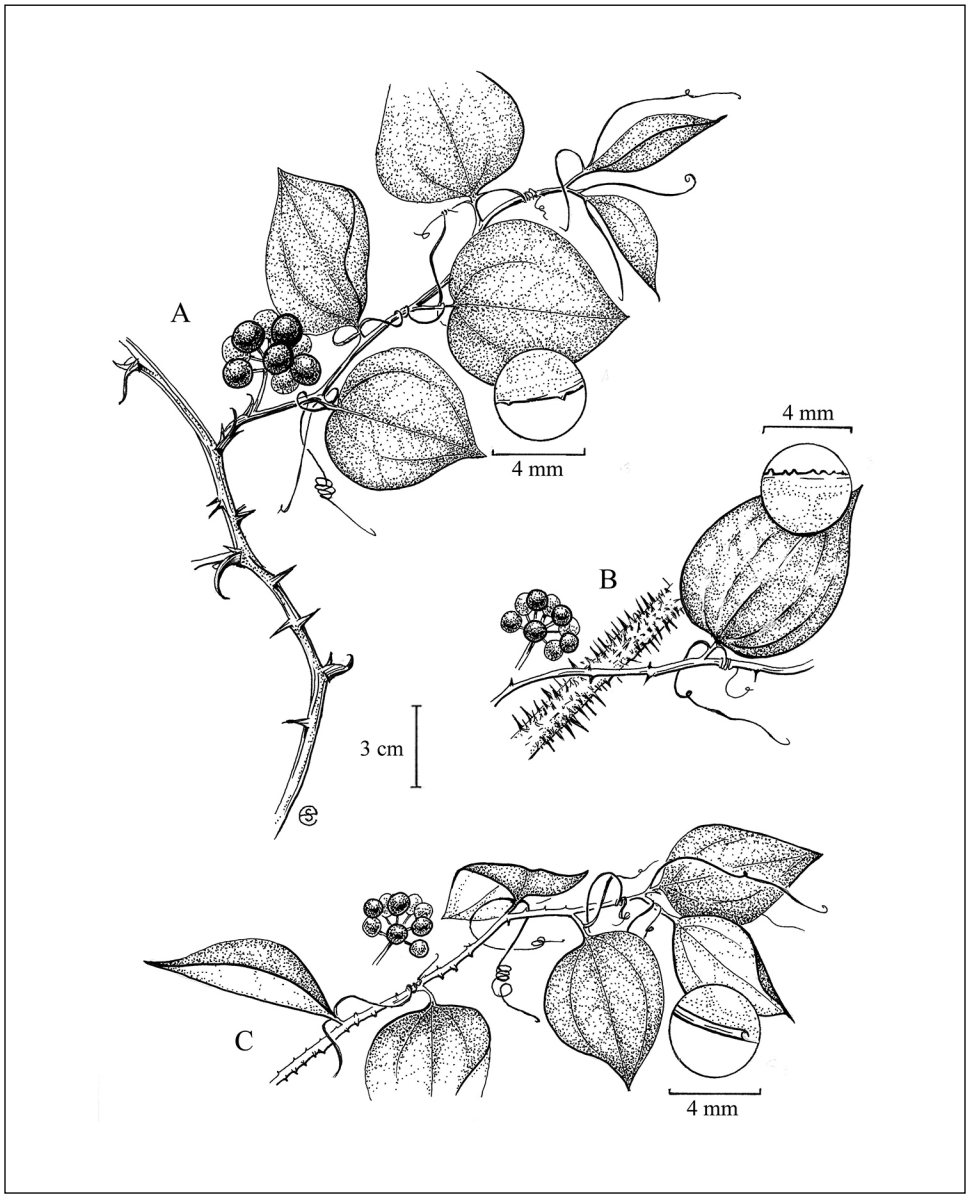
Distribution of *Smilax tamnoides*, or bristly greenbrier, recorded in the New York Metropolitan Region during three time categories.

STU

Listed as a species of special concern and believed extirpated in CT (S3) under the name *Smilax hispida*; tracked as rare in NJ (S3).

Management

Though many complain about the apparent abundance of *Smilax rotundifolia* in some forest understories, this species is kept to reasonable levels with deer browse, an apparently weak vegetative growth system, and pollinator-limited sexual reproduction. Likewise, the very efficient vegetative growth of *S. laurifolia* could make it a potentially aggressive native species, but it has limited sexual reproduction (pollinator limited and occurring only every 2 years) and is browsed by deer. All four woody *Smilax* spp. are important for wildlife in the region and are now competing with nonnative shrub species for dispersal by birds. Hence, where possible, these species should not be removed but managed as important components of the ecosystem, especially the declining *S. tamnoides*, which was once relatively abundant in the western portion of the region.



A) Fruiting leafy twig, with enlarged view of leaf margin, of *Smilax rotundifolia*; B) fruit, lower twig with bristles, and leafy twig, with enlarged view of leaf margin, of *Smilax tamnoides*; C) fruit and leafy twig, with enlarged view of leaf margin, of *Smilax glauca*. Illustration by Emma Skurnick.

STU

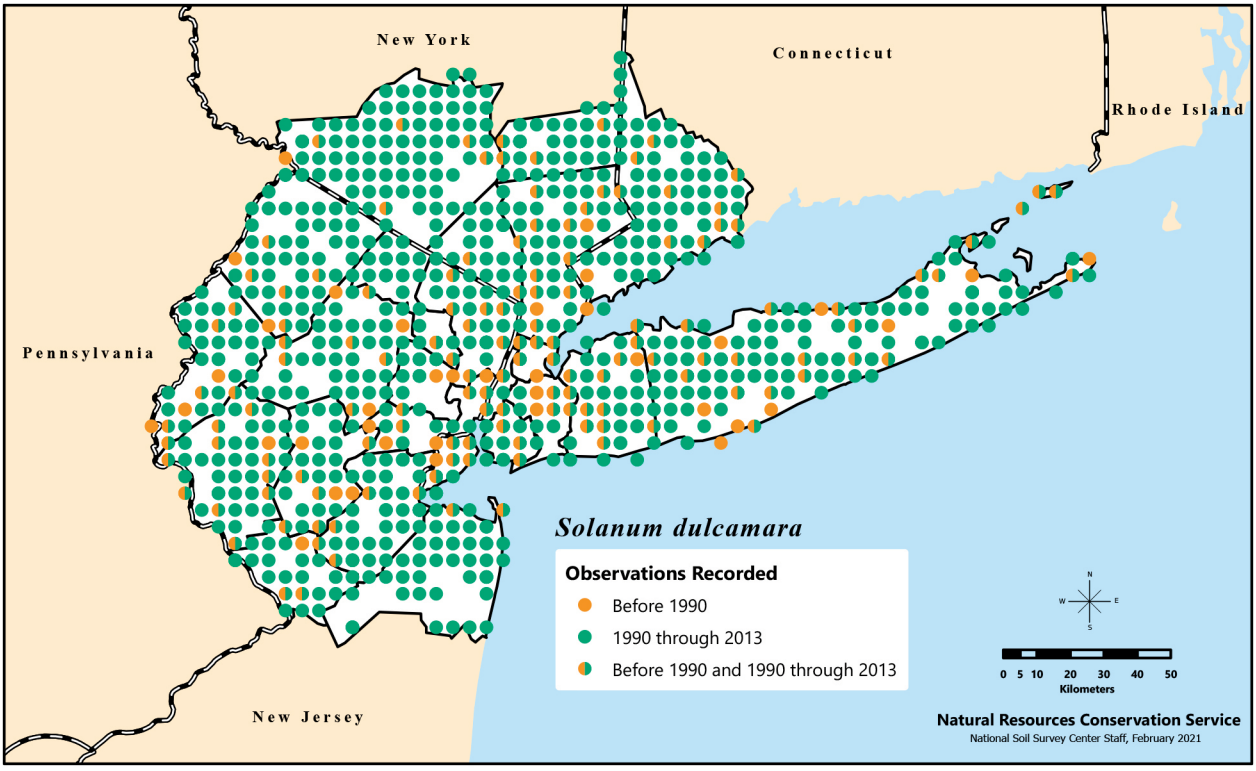
Solanum L. – nightshade

Solanaceae. Trees, shrubs, herbs. Species 1,200–2,000 in Africa, Asia, Australia, Europe, North America, and South America. Genus name is the ancient Latin name for the plant; possibly derived from "solori," meaning "to quiet," perhaps a reference to the many medicinal properties of the genus.

Nonnative Species

1. *Solanum dulcamara* L. – climbing nightshade ↑↑

Flowering May–Sept. Scrambling shrub. Disturbed mesic to upland areas. Native to northern Africa, Asia, and Europe. Epithet an "old generic name, bittersweet, early and bold experimenters stating that the chewed root first tasted bitter then sweet" (Fernald 1950: 1253). Capable of a wide range of moisture regimes (Visser et al. 2016). Freshly dispersed seeds have high germination capacity with no pretreatment required (Zasada and Crossly 2008). Long-distance dispersal by deer (*Odocoileus* spp.) (Myers et al. 2004) and birds (White and Stiles 1992). Fruit is red when ripe; is poisonous to many animals including humans, pets, and livestock, but most birds are able to consume it (Gleason and Cronquist 1993).



Distribution of *Solanum dulcamara*, or climbing nightshade, recorded in the New York Metropolitan Region during three time categories.

STU



Flowering and fruiting leafy twig of *Solanum dulcamara*. Illustration by Emma Skurnick.

STU

Sorbaria (Ser.) A.Braun – sorbaria

Spiraea sect. *Sorbaria* Ser.

Rosaceae. Shrubs, rarely trees. Species 4–9; all native to temperate Asia, including the 1 species that is found in the NY Metropolitan Region. Name refers to the related genus *Sorbus* L.

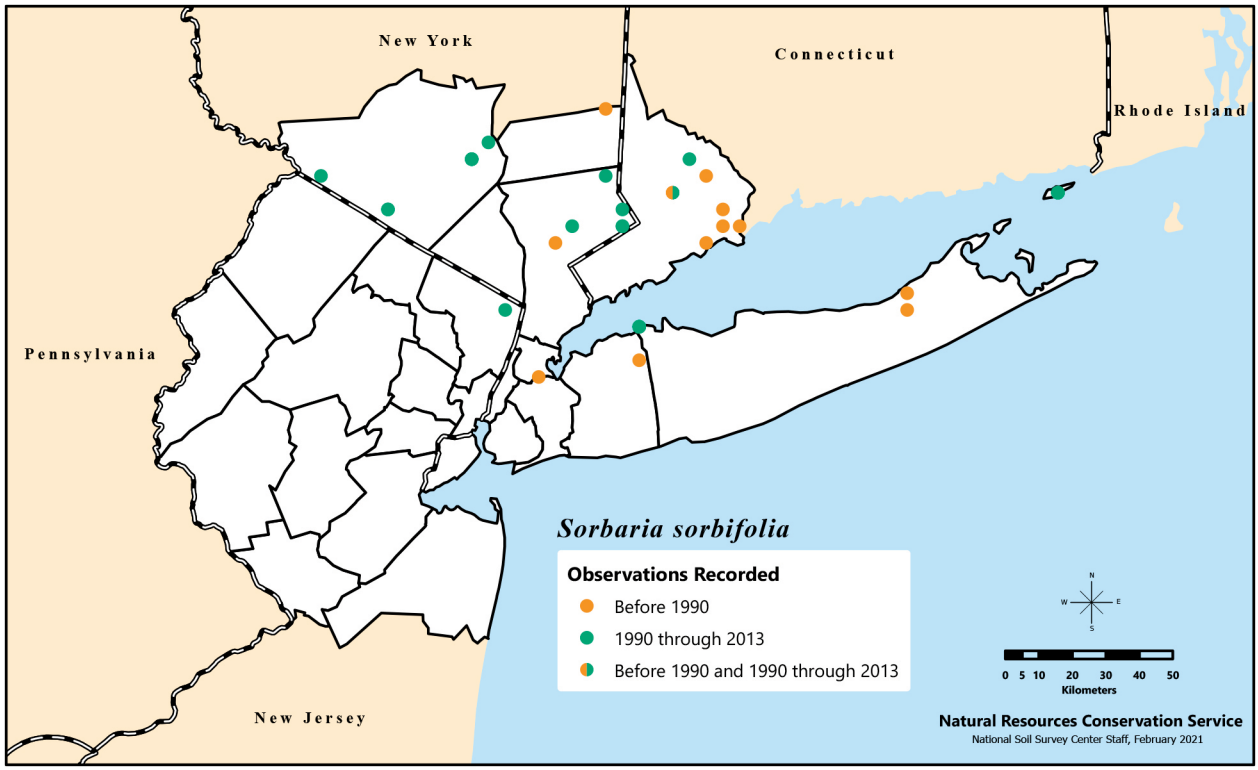
Nonnative Species

1. *Sorbaria sorbifolia* (L.) A.Braun – sorbaria, false spiraea ↔

Spiraea sorbifolia L.

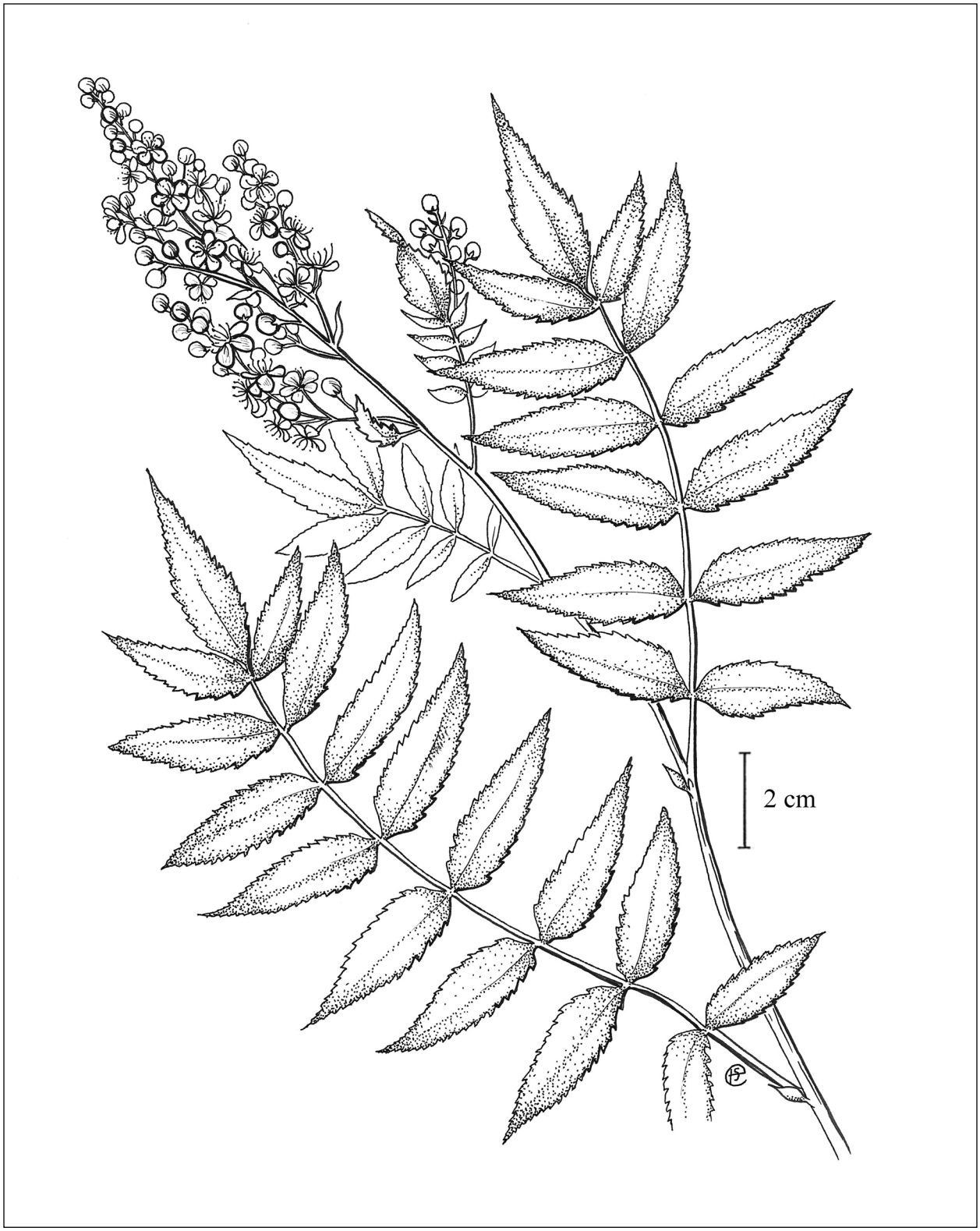
Flowering June–July. Disturbed areas and old homesteads as a remnant or escape from cultivation.

Prefers moist, well-drained organic soils. Freely suckers and spreads. Cultivated since 1759 (Dirr 1998).



Distribution of *Sorbaria sorbifolia*, called sorbaria or false spiraea, recorded in the New York Metropolitan Region during three time categories.

STU



Flowering leafy twig of *Sorbaria sorbifolia*. Illustration by Emma Skurnick.

Sorbus L. – mountain ash

Rosaceae. Trees, shrubs. Species 100–135 in northern temperate areas of Asia, Europe, and North America. Sometimes treated as a subgenus in a broadly circumscribed *Pyrus* L., *P.* subg. *Sorbaria* S.F.Gray. Name is the ancient Latin name for the genus.

Native Species

1. *Sorbus americana* Marshall – American mountain ash Ø

Flowering May. Mesic upland woods, woodland edges, and slopes.

Height at maturity 4–10 m. Cold stratification for 60 days required for germination (Stein 2008). Cultivated since 1811 (Dirr 1998). Occurs only rarely in the region. Populations reported from Sussex County (NJ) and Orange, Rockland, and Westchester Counties (NY). Also reported from outside the region in CT.

Tracked as imperiled in NJ (S2).

2. *Sorbus decora* (Sarg.) Schneid. – showy mountain ash Ø

Pyrus americana var. *decora* Sarg.; *Pyrus decora* (Sarg.) Hyland

Flowering May. Coniferous forests, hardwood forests, woodland edges, open rocky areas, slopes and summits, and talus slopes. Usually at higher elevation sites than *S. americana*. Some records from the region are are of uncertain identity, and the confirmed records most likely represent cultivated remnants or escapes from cultivation. Occurs only rarely in the region; the only documented native occurrence is from Fairfield County (CT). Reports from Orange and Rockland Counties (NY) are likely to represent material that is cultivated or persisting from cultivation.

Nonnative Species

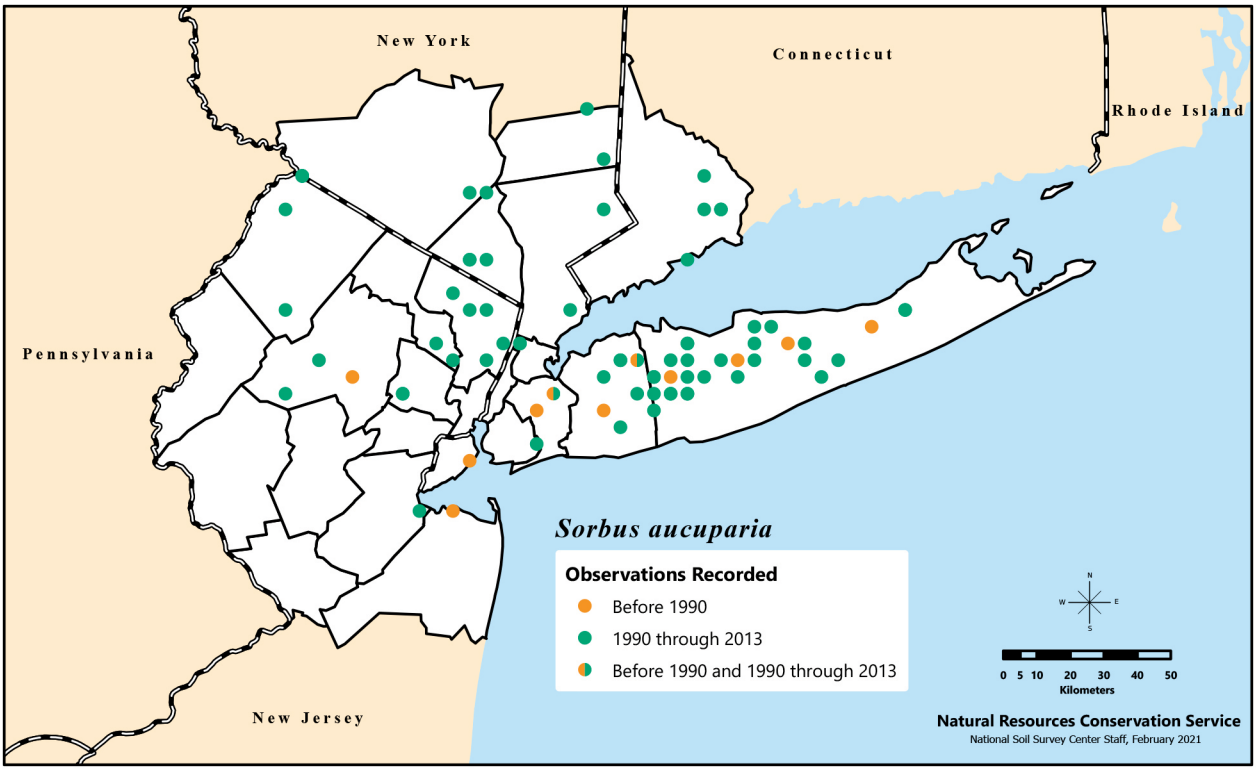
3. *Sorbus aucuparia* L. – European mountain ash ↑↑↑

Flowering May. Disturbed areas and old homesteads as a remnant or escape from cultivation. Native to Europe. Epithet from the Latin "aucupatio," meaning "fowling," a reference to the fruit being eaten by birds and thus useful in attracting them.

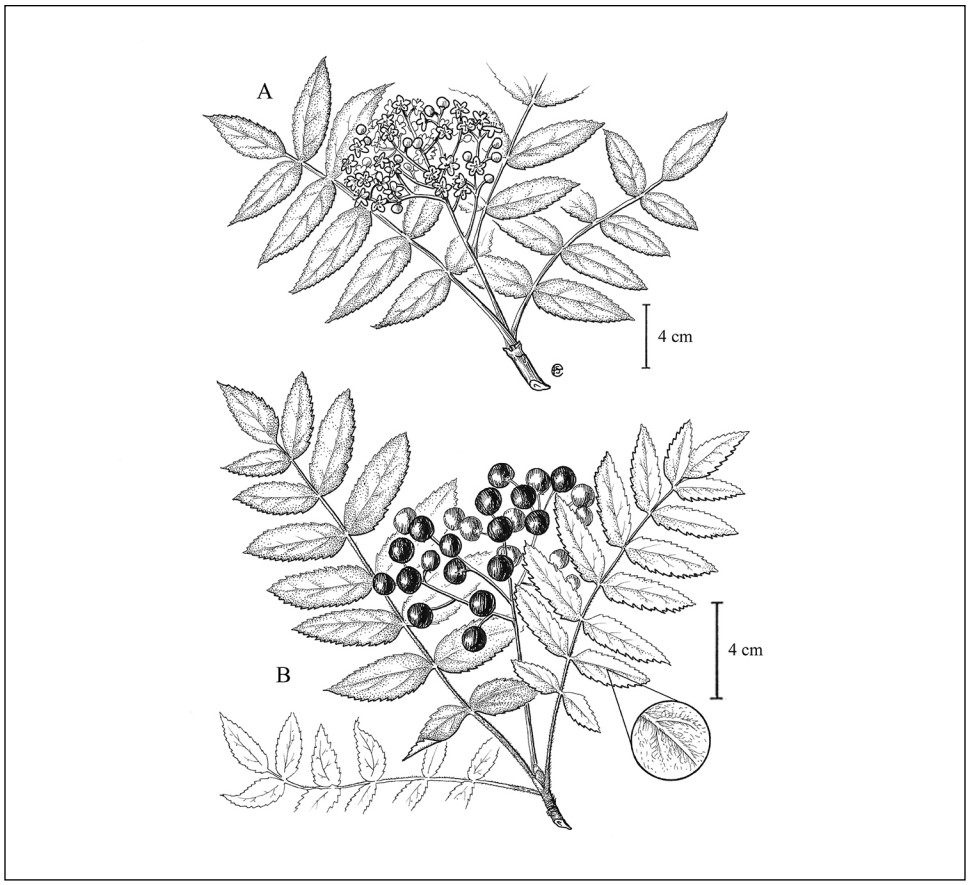
Height at maturity 5–20 m. May be weakly self-incompatible. Earliest seed-bearing age about 15 years. Good seed crop almost annually, with light crops in intervening years. Seeds dispersed by birds and mammals, enhancing germination rates after passage through gut (Paulsen and Högstedt 2002). Stratification requirements for germination may differ by tree and year, but cold stratification for 60–120 days may give good results. Long cultivated, with at least 19 cultivars. Prefers acidic soils and does not grow well in polluted areas with compacted soils, so it may not fare well as an urban tree. Susceptible to several pests (Dirr 1998). Though it has increased in the region, possibly due to landscape plantings, this species does not appear to be invasive. However, it is highly invasive as a native species in other countries, such as Finland (Hamberg et al. 2011). Given its increases in the region, its potential invasiveness should be evaluated further.

Sorbus Key

1. Twigs, lower surface of leaflets, branches of the inflorescence, and hypanthium all densely white-villous; winter buds white-villous, not glutinous . . . . . ***Sorbus aucuparia****
1. Twigs, leaflets, branches of the inflorescence, and hypanthium glabrous or glabrate 2
2. Flowers 5–6 mm across; inflorescence dense, glabrous; fruit 4–6 mm across . . . . . ***Sorbus americana***
2. Flowers 8–10 mm across; inflorescence loose, slightly pubescent; fruit 7–10 mm across . . . . . ***Sorbus decora***



Distribution of *Sorbus aucuparia*, or European mountain ash, recorded in the New York Metropolitan Region during three time categories.



A) Flowering and fruiting leafy twig of *Sorbus americana*; B) fruiting leafy twig and enlarged view of pubescence of leaf underside of *Sorbus aucuparia*. Illustration by Emma Skurnick.

STU

Spiraea L. – spiraea

Rosaceae. Shrubs. Species 80–120 in Asia, Europe, and North America. Distinguished from other genera in the Rosaceae by its leaves lacking stipules and fruit being an aggregate of follicles. Frequently cultivated for ornament. Genus name is derived from the Greek "speira," meaning "wreath"; the flexuous twigs are used in making wreaths.

Native Species

1. *Spiraea alba* Duroi. − meadowsweet Ø

Flowering June–Sept. Bogs, fens, meadows, moist to wet roadsides, and other open wetlands.

In early literature, material was treated as part of a broadly circumscribed *Spiraea salicifolia* L., which is currently treated as occurring in Asia and Europe. True *S. salicifolia*, *S.* ×*rosalba* Dippel (*S. alba* × *S. salicifolia*), *S.* ×*billardii* K.Koch (*S. alba* × *S. douglasii* Hook.) occasionally planted and possibly encountered as remnants from cultivation would key here.

Two varieties (sometimes treated as separate species) keyed here are reported from the region. Vast majority of the records from the region are *S. alba* var. *latifolia*., whereas *S. alba* var. *alba* is critically imperiled or imperiled in NJ (S1S2), with records from Middlesex, Mercer, and Sussex Counties. Further work is needed to precisely map the distribution of both varieties.

***Spiraea corymbosa* Raf. – dwarf spiraea, shinyleaf meadow-sweet**

Spiraea betulifolia var. *corymbosa* (Raf.) S.Watson

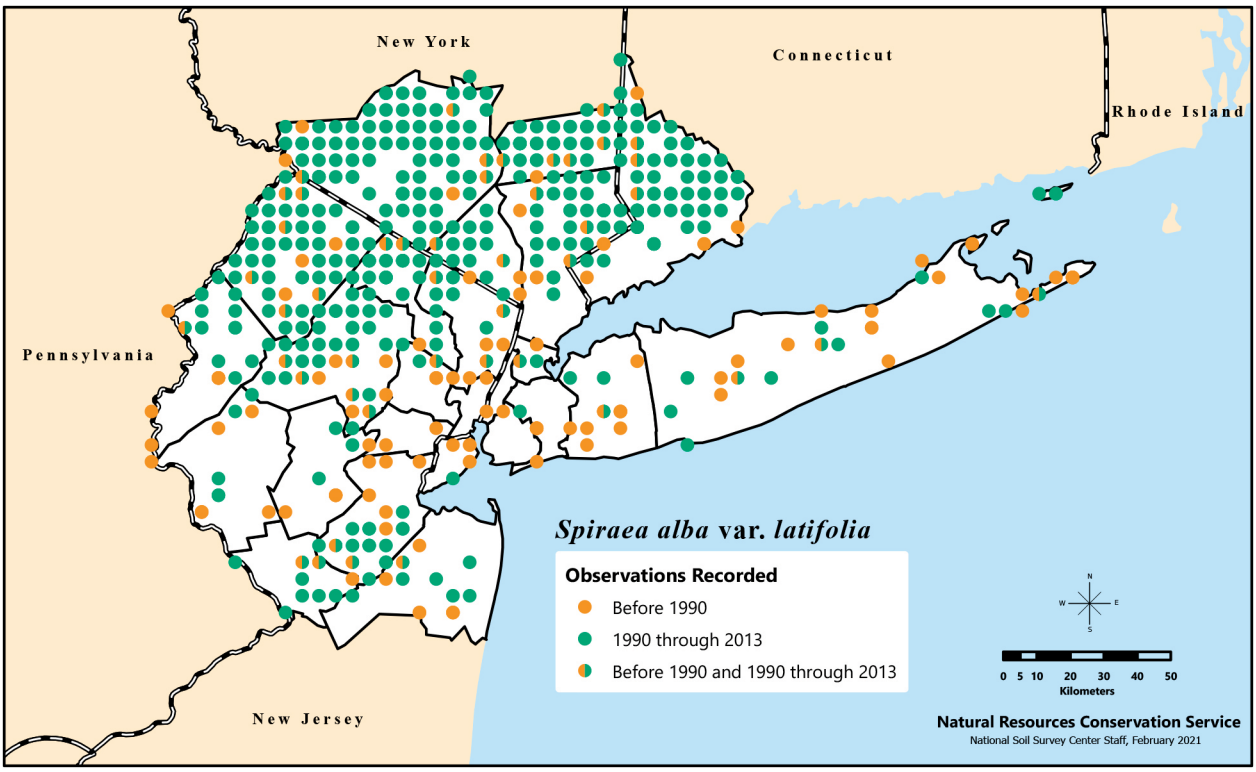
Reported from NJ in early literature (1889) but without confirmation. Species has a more southern and western distribution, reaching the northern limit of its range in south-central PA. Sometimes treated as belonging to *Spiraea betulifolia* Pall.; true *S. betulifolia* native to eastern Asia.

Spiraea Key

1. Inflorescences simple, unbranched umbels or umbel-like racemes 2
1. Inflorescences compound, branched panicles or corymbs 3
2. Leaves ovate to oblong-lanceolate . . . . . ***Spiraea prunifolia****
2. Leaves linear-lanceolate . . . . . ***Spiraea thunbergii****
3. Inflorescences corymbs, the floriferous part wider than long 4
3. Inflorescences panicles, longer than broad 5
4. Leaves acute, obtuse, or rounded; flowers usually white . . . . . ***Spiraea corymbosa***
4. Leaves long-acuminate; flowers usually pink . . . . . ***Spiraea japonica****
5. Leaves and inflorescences nearly or quite glabrous . . . . . ***Spiraea alba***
5. Leaves beneath and inflorescences densely tomentose . . . . . ***Spiraea tomentosa***

Spiraea alba Key

1. Leaf blade margins serrulate; inflorescence conical, branches pubescent . . . . . ***Spiraea alba* var. *alba* Ø**
1. Leaf blade margins coarsely serrate; inflorescence pyriform, branches glabrous . . . . . ***Spiraea alba* var. *latifolia* (Ait.) Dippel ↑**
(*Spiraea latifolia* Ait.; *S. latifolia* var. *septentrionalis* Fernald represents polyploid material)



Distribution of *Spiraea alba* var. *latifolia*, or meadowsweet, recorded in the New York Metropolitan Region during three time categories.

2. *Spiraea tomentosa* L. – hardhack, steeplebush ↔

Flowering June–July. Swamps, meadows, moist to wet roadsides, and other open wetlands. Flowers usually pink, rarely white.

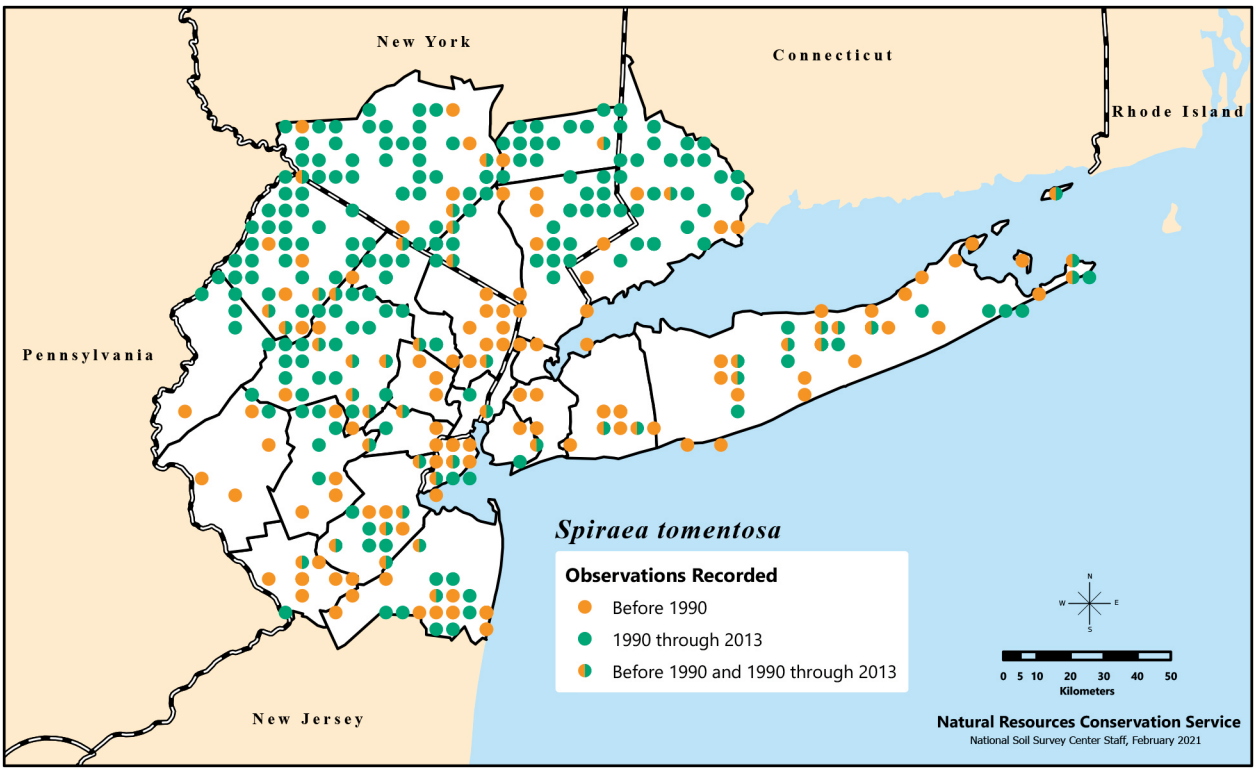
Two varieties keyed here reported from the region (Salamun 1951) but not currently in the records. Further work is needed to precisely map the distribution of both varieties.

Nonnative Species

The following species (keyed previously) native to Asia are frequently planted and can occasionally persist as remnants from cultivation or as casual escapes. Escapes of *Spiraea prunifolia*, *S. thunbergii*, and other cultivated species (which could also be encountered) of *Spiraea* sect. *Chamaedryon* Ser. show little floral resemblance to the native species (or the nonnative *S. japonica*) in that they possess double flowers, the corolla consisting of multiple whorls of white petals.

Spiraea tomentosa Key

1. Pedicels less than 0.5 mm; flowers densely clustered on branches, usually greater than 12 per cm; follicles finely tomentose . . . . . ***Spiraea tomentosa* var. *tomentosa***
1. Pedicels greater than 0.5 mm; flowers loosely clustered on branches; usually less than 11 per cm; follicles glabrate . . . . . ***Spiraea tomentosa* var. *rosea* (Raf.) Fernald** (*Spiraea rosea* Raf.)



Distribution of *Spiraea tomentosa*, called hardhack or steeplebush, recorded in the New York Metropolitan Region during three time categories.

3. *Spiraea japonica* L.f. – Japanese spiraea Ø

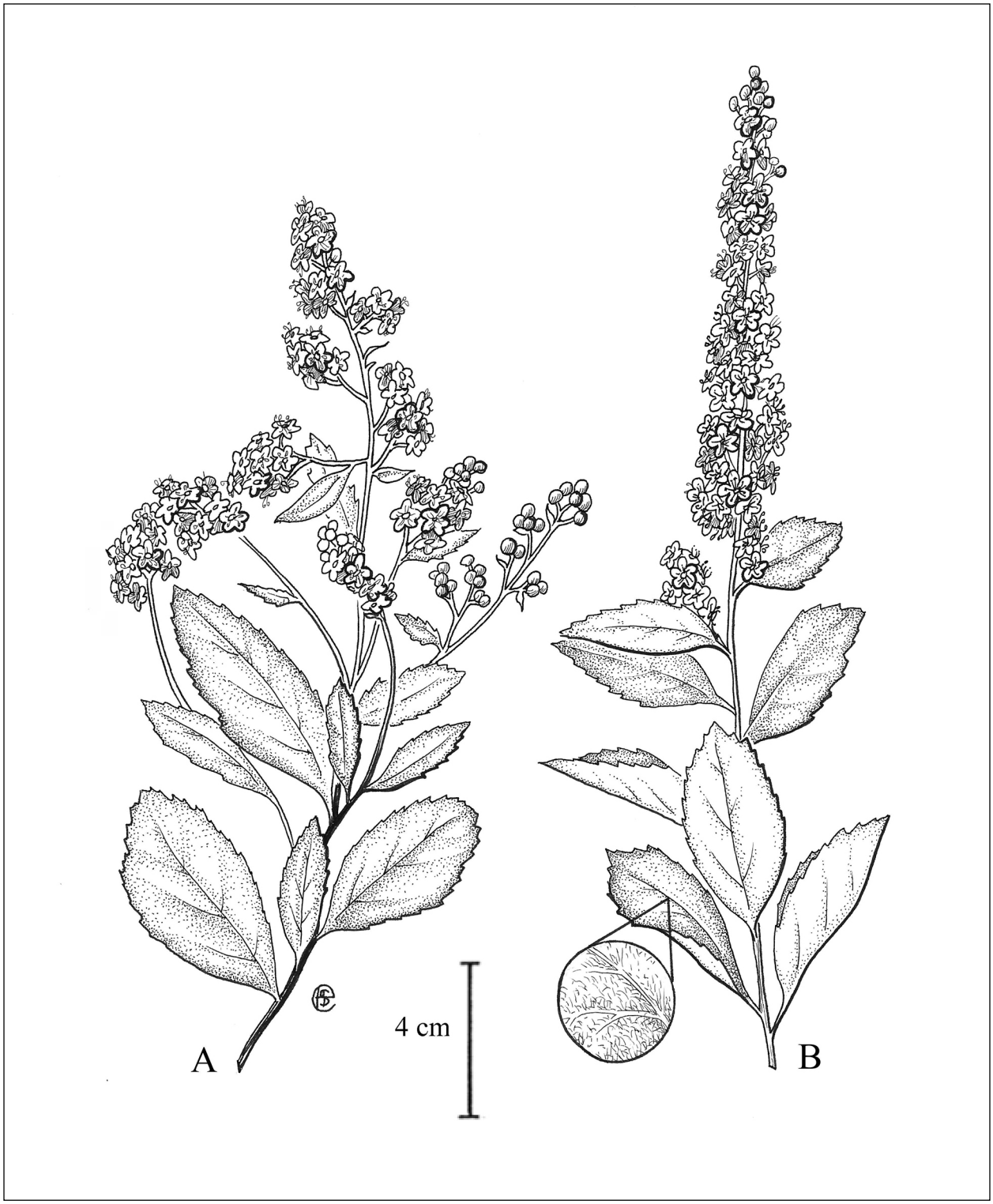
Has shown the potential to become invasive and is listed in some states as an invasive plant (Bowen et al. 2002, University of Georgia 2018). May be in the initial stages of establishment or lag phase of invasion (Herron et al. 2007, Wilson and Hoch 2009). Of 20 cultivars tested, 3 ('Crispa,' 'Dart's Red,' and 'Neon Flash') may be less likely to be invasive due to observed sterility that was not related to polyploidy (Wilson and Hoch 2009). Though there is a chance that the sterile conditions could change with hybridization or other genetic changes, planting these cultivars could reduce any impacts of *S. japonica*, which has nearly doubled in the region, though with fewer than 10 total occurrences. Possible or likely naturalized populations reported from Fairfield County (CT), Monmouth and Morris Counties (NJ), and Orange and Westchester Counties (NY).

Spiraea prunifolia Siebold & Zucc. – bridal-wreath spiraea

Planted in part because of its tolerance to urban environments (Flint 1985).

Spiraea thunbergii Siebold – Thunberg's spiraea

Though known to be a landscape plant, it is not documented in the region. However, it is noted to have allelopathic potential (Hiradate et al. 2010) and could be of concern if horticultural popularity were to increase in the region.



A) Flowering leafy twig of *Spiraea alba* var. *latifolia*; B) flowering leafy twig and enlarged view of upper leaf surface pubescence of *Spiraea tomentosa*. Illustration by Emma Skurnick.

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Staphylea L. – bladdernut

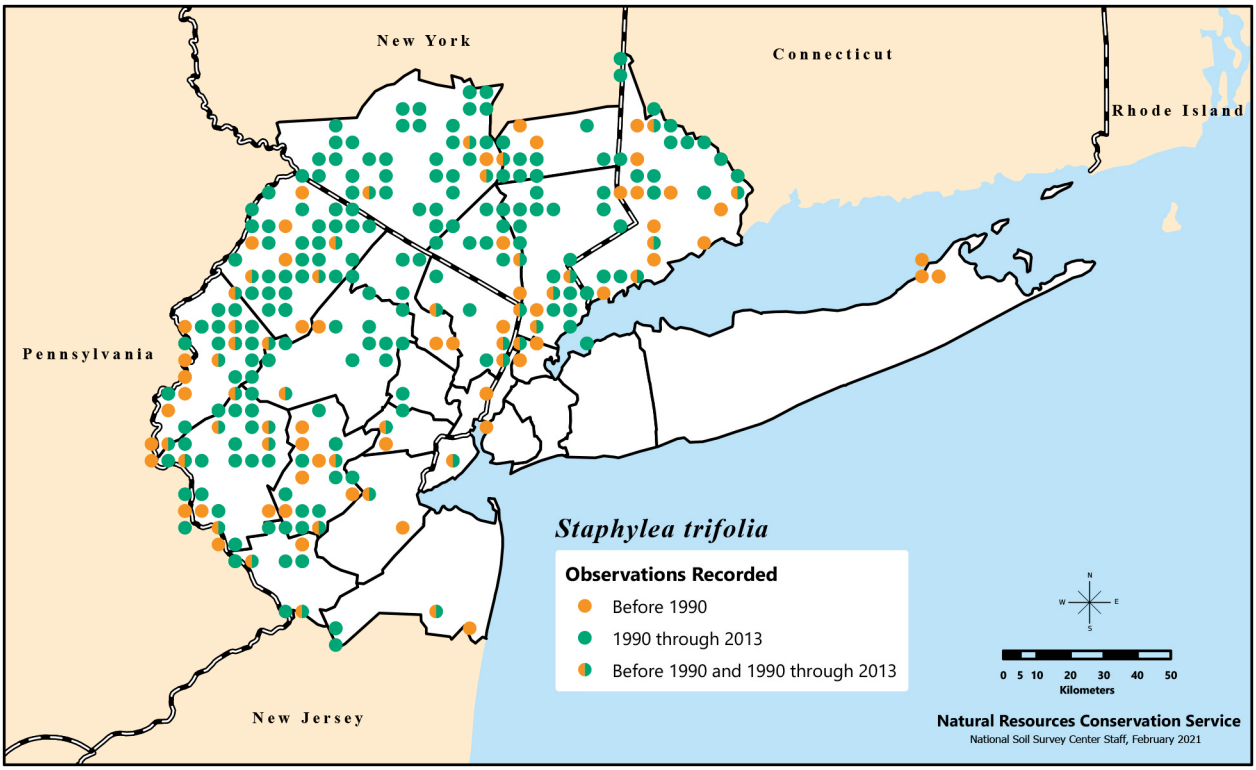
Staphyleaceae. Shrubs, trees. Species 11–13 in northern temperate Asia, Europe, and North America. Genus name is derived from the Greek "staphyle," meaning "a bunch of grapes," a reference to the fruit.

Native Species

1. *Staphylea trifolia* L. – bladdernut ↑

Flowering May. Rich, mesic woodlands and woodland edges, often on rocky soils, usually off the Coastal Plain.

Height at maturity 3–5 m. Cultivated since 1640. Flowers somewhat self-incompatible although later-flowering individuals may produce more fruit (Garwood and Horvitz 1985). Flowers receive many insect visitors, including *Apis* and *Bombus* spp. (Robertson 1889). Seeds have a double dormancy. Warm stratification for 3 months, followed by 3 months of cold stratification, required for optimal germination; seeds should not dry out before stratification (Dirr 1998). Increases in the region may be due to reforestation.



Distribution of *Staphylea trifolia*, or bladdernut, recorded in the New York Metropolitan Region during three time categories.

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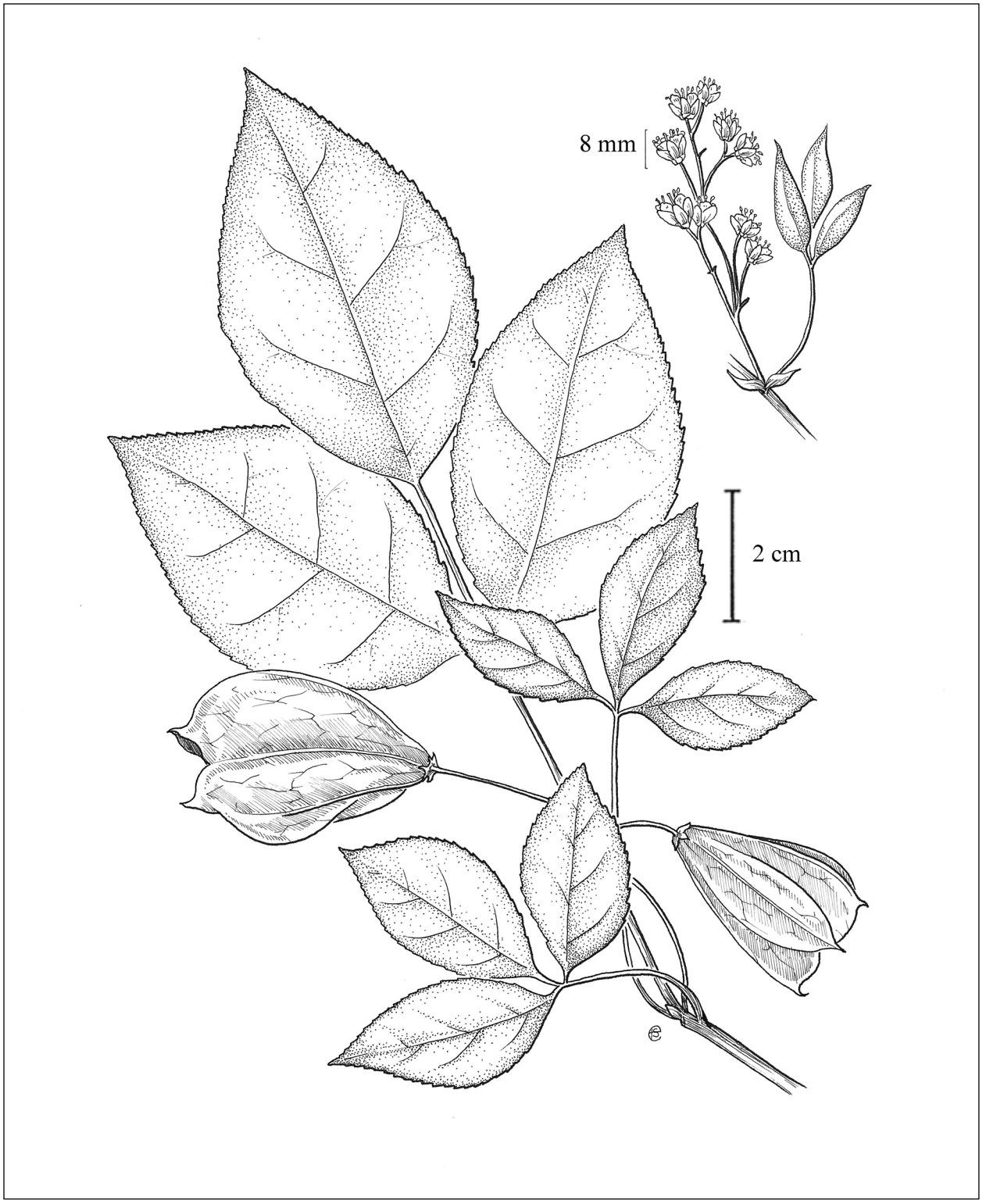


Fruiting leafy twig and flowering leafy twig of *Staphylea trifolia*. Illustration by Emma Skurnick.

Styphnolobium Schott – pagoda tree

Fabaceae. Trees, shrubs. Species 4–9: Asia (1), Central America, and North America. Distinguished from *Sophora* L. (within which it has sometimes been included) by its paniculate inflorescence (racemose in *Sophora*), flowers subtended by bracteoles (ebracteolate in *Sophora*), and indehiscent fruit (dehiscent in *Sophora*). Species in *Styphnolobium*, unlike *Sophora*, are unable to form root associations with nitrogen-fixing bacteria. Genus name means "astringent pod" in Greek, a reference to the taste of the pulp in the fruit.

Nonnative Species

Styphnolobium japonicum (L.) Schott – Japanese pagoda tree

Sophora japonica L.

Flowering Aug.–Sept.; fruiting Oct. Commonly planted as a street tree (though not documented in the region yet); can persist from cultivation, but not currently known to escape. The epithet is misleading, the species being native to China and Korea and introduced in Japan.

Height at maturity 17–25 m. Tolerant of urban conditions. Susceptible to twig blight, cankers, powdery mildew, leaf hoppers, and damping off of seedlings. Introduced in 1747, with at least 5 cultivars. A yellow dye is made from its petals (Dirr 1998).

Styrax L. – styrax, storax

Styraceae. Trees, shrubs. Species approximately 130 in Asia, Europe, North America, and South America. Readily distinguished from other shrubs by its pendulous clusters of bell-shaped, 5(–8)-lobed, waxy white flowers. Genus name is the ancient Greek name for *Styrax officinalis* L.

Nonnative Species

Styrax japonicus Siebold & Zucc. – Japanese snowbell

Flowering May. Native to Asia; cultivated and rarely encountered as a remnant from cultivation or casual escape.

Symphoricarpos Duhamel – snowberry, coralberry

Caprifoliaceae. Shrubs. Species 15: North America (14) and Asia (1). Readily distinguished by its berry fruits, which are in compact clusters, the fruit appearing to be fused together. Pollinated by bees (order Hymenoptera); cleistogamy reported in cultivated material. Genus name is derived from Greek "symphorein" ("bear together") and "carpos" ("fruit"), in reference to the clustered berries.

Native Species

1. _Symphoricarpos albus_ (L.) S.F.Blake – common snowberry ↓↓↓

Vaccinium album L.

Reported from the region but is most likely to be the nonnative variety. Shows a decreasing trend similar to *Symphoricarpos albus* var. *laevigatus*.

Symphoricarpos albus var. *albus* has leaves pubescent on lower surface; is native to the eastern U.S. and is reported north and west of the region, but not reported from the region.

Nonnative Species

2. _Symphoricarpos albus_ var. _laevigatus_ (Fernald) S.F.Blake – western snowberry ↓↓↓

Symphoricarpos racemosus var. *laevigatus* Fernald

Flowering mid-June–Aug.; fruiting July–Oct. Native to the Pacific Slope (region west of the

Symphoricarpos Key

1. Current year's twigs finely hairy or glabrous; corollas 5–8 mm; fruit white. . . . . ***Symphoricarpos albus***
1. Current year's twigs minutely villous; corollas 2–4 mm; fruit red . . . . . ***Symphoricarpos orbiculatus****

Symphoricarpos albus Key

1. Plants up to 1 m tall; leaves mostly hairy underneath; fruits 0.6–1 cm . . . . . ***Symphoricarpos albus* var. *albus***
1. Plants 1–2 m tall; leaves mostly glabrous underneath; fruits 1–1.5 cm . . . . . ***Symphoricarpos albus* var. *laevigatus****

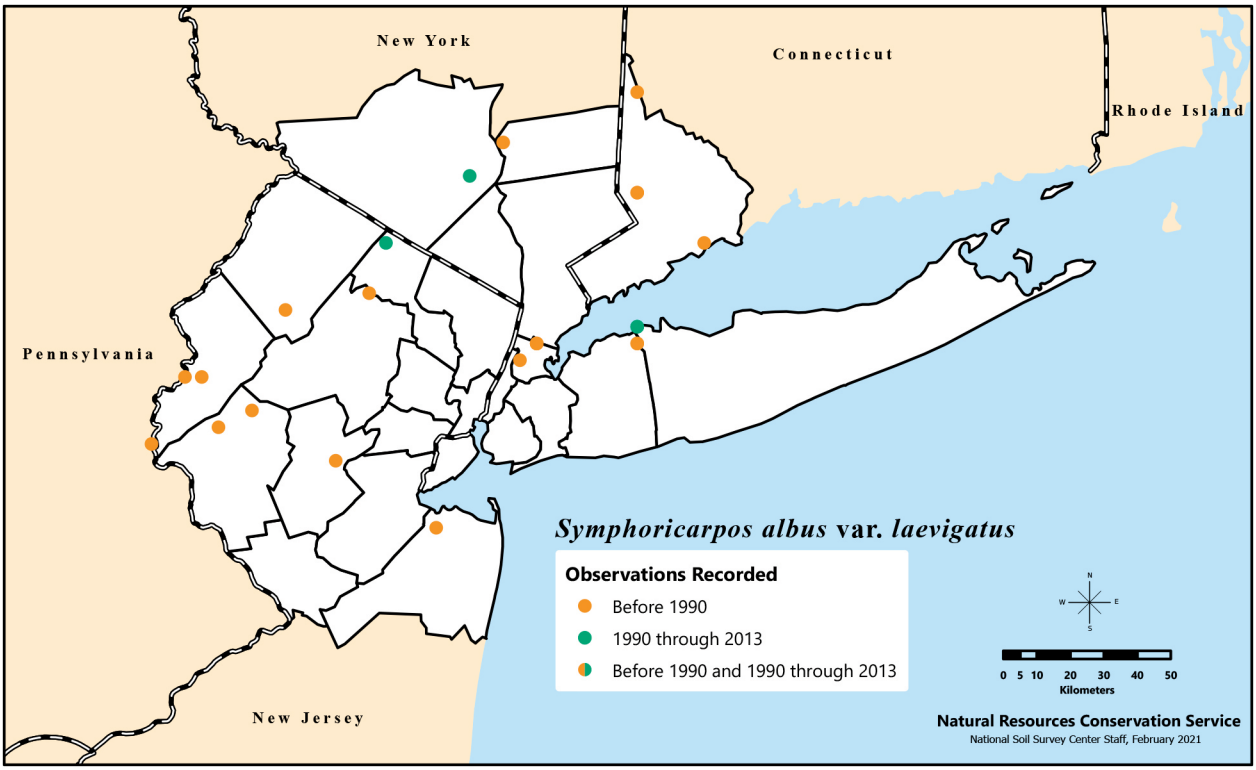
Continental Divide and Rocky Mountains); cultivated and sometimes escapes in dry to mesic roadsides, thickets, and woods. Varietal epithet means "smooth" in Latin, a reference to the leaves with glabrous undersides. The apparent decrease could represent a switch from this species to *S. orbiculatus* (see next entry) in horticultural marketing focus or popularity.

Tracked as potentially invasive in NJ (category 2).

3. *Symphoricarpos orbiculatus* Moench. – coralberry ↑↑

Flowering late July–late Aug.; fruiting Sept.–Oct. Somewhat dry to mesic woods, roadsides, thickets, fencerows, and old homesteads. Species is native to west of the region, including PA. However, all populations in the northeastern U.S. are taken as nonnative, based on early floristic accounts of the region (Britton 1889, Taylor 1915). Thus, its presence is considered to be the result of escape from cultivation. Though it is native farther west, its increasing abundance is a concern and should be further evaluated.

Tracked as potentially invasive in NJ (category 2).



Distribution of *Symphoricarpos albus* var. *laevigatus*, or western snowberry, recorded in the New York Metropolitan Region during three time categories.

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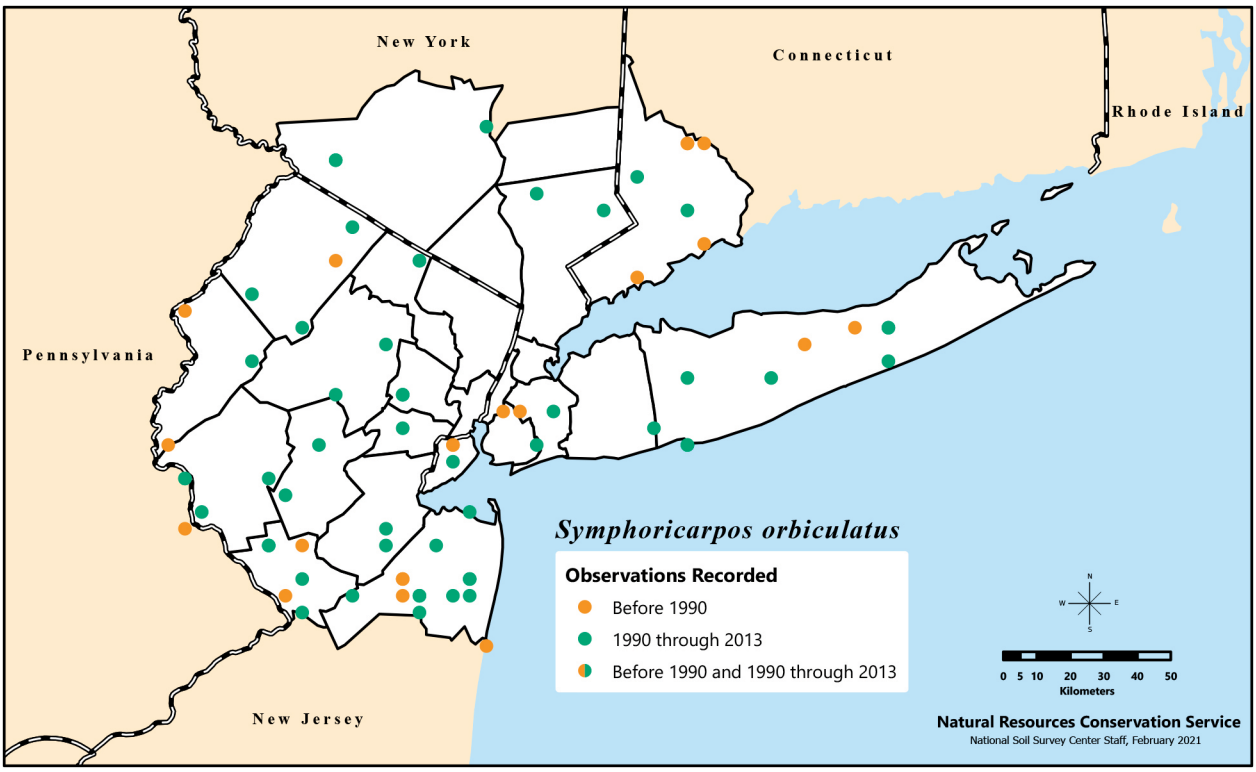
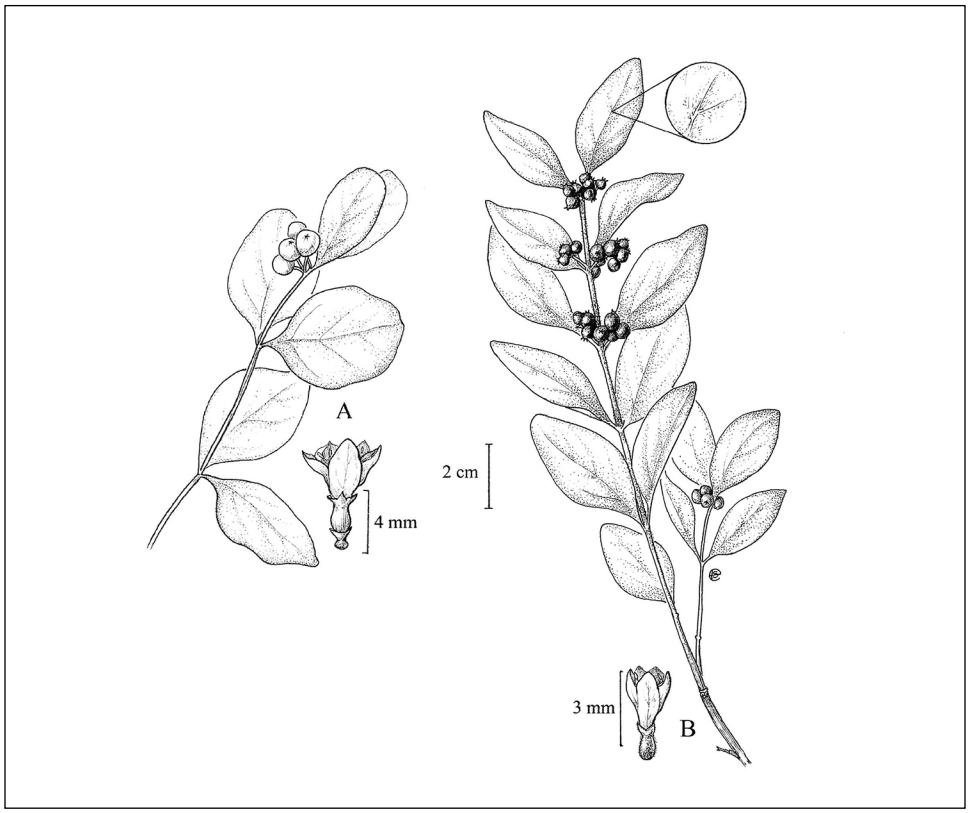


Distribution of *Symphoricarpos orbiculatus*, or coralberry, recorded in the New York Metropolitan Region during three time categories.



A) Fruiting leafy twig, and flower of *Symphoricarpos albus* var. *laevigatus*; B) fruiting leafy twig, with enlarged view of leaf underside, and flower of *Symphoricarpos orbiculatus*. Illustration by Emma Skurnick.

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Symplocos Key

1. Leaves sharply serrate; flowers in panicles . . . . . ***Symplocos paniculata****
1. Leaves obscurely toothed; flowers in axillary clusters . . . . . ***Symplocos tinctoria****

Symplocos Jacq. – sweetleaf

Symplocaceae. Shrubs, small trees. Species 260–300 in Asia, North America, and South America. Distinguished from other shrubs by its fruit, a blue drupe. Genus name means "together" in Greek, a reference to the stamens being united at the base.

Nonnative Species

1. *Symplocos paniculata* Miq. – Asiatic sweetleaf Ø

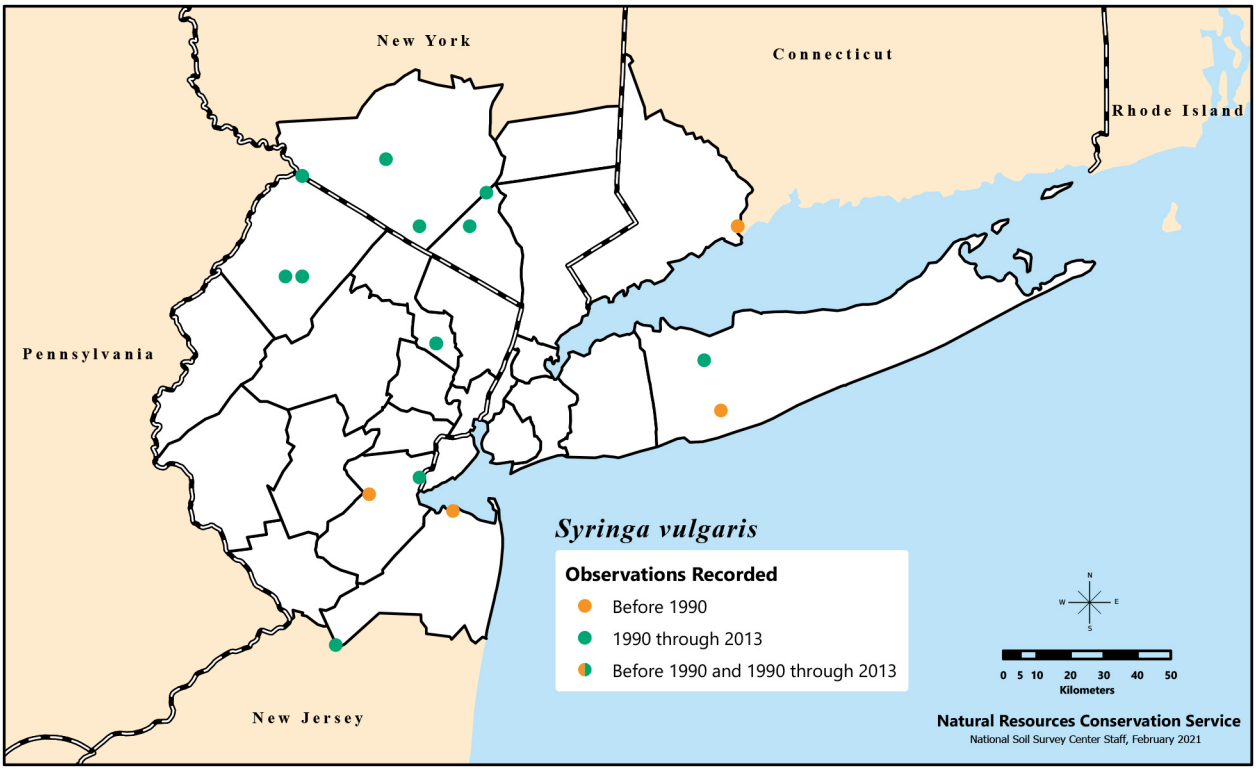
Flowering May–June; fruiting Aug.–Sept. Native to Asia; rarely encountered as a remnant from cultivation or casual escape. Naturalized population known from Nassau County (NY).

Symplocos tinctoria L'Her. – sweetleaf

Flowering early May–June; fruiting Aug.–Sept. This shrub is native to the southeastern U.S. with DE at the northern limit of the range; the one occurrence documented in the region is thought to be the result of accidental introduction with other southeastern species used in landscaping.

Syringa L. – lilac

Oleaceae. Shrubs, occasionally small trees. Species 20 in Asia and Europe. Closely related to privets (*Ligustrum* L.). Widely cultivated for ornament (showy, fragrant flowers). Genus name derived from the Greek "syrinx," meaning "pipe";



Distribution of *Syringa vulgaris*, or common lilac, recorded in the New York Metropolitan Region during three time categories.

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in pre-Linnean times the genus name *Syringa* was applied to the genus now known as *Philadelphus* L., the branchlets of which were used for making pipes. However, Linnaeus applied the name to this genus (Moore 2016).

Nonnative Species

1. *Syringa vulgaris* L. – common lilac ↑↑

Flowering May–June. Native to southeastern Europe; rarely encountered as a remnant from cultivation or casual escape.

Height at maturity 3–7 m. Pollinated by insects. Seeds dispersed by wind. Best germination may occur with daytime temperatures of 30 ºC and nighttime temperatures of 20 ºC, but there is much variation. First cultivated in the U.S. in 1563 (Rudolf et al. 2008), with over 400 cultivars (Dirr 1998). Listed on several invasive plant lists as a species that is invading natural areas, but not currently viewed by most States or invasive species councils as an invasive species of concern. Most often encountered in the region as persisting from cultivation, spreading locally most likely by vegetative sprouts. In 2002, however, Steve Glenn found a seedling far from any cultivated specimens along a forest margin in Sussex County (NJ). Evidently lilac can occasionally exhibit long-distance naturalization, which is cause for concern and indicative of the need for more information about this species.

Syringa reticulata (Blume) H.Hara, originating from northern Japan and introduced in 1876, is increasing in landscape use in the U.S. (though no documented records in the NY Metropolitan Region). Similar to *S. vulgaris* in many respects, but may be the most trouble-free landscape lilac; has a less strong flower fragrance than *S. vulgaris* (Dirr 1998). Reported to have naturalized in VT (Springer and Parfitt 2007).



Flowering leafy twig, flower, and fruit of *Syringa vulgaris*. Illustration by Emma Skurnick.

Taxodium Rich. – cypress

Cupressaceae (Taxodiaceae). Trees. Species 1–3 in North America. Readily distinguished by their deciduous needles and "knees" (pneumatophores). Genus name is derived from the Greek "taxos," meaning "yew" and "eidos," meaning "resembling," in reference to the superficial similarity of the needles to those of *Taxus*.

Nonnative Species

1. *Taxodium distichum* (L.) Rich. – bald cypress Ø

Native to the southeastern U.S. north to DE; rarely encountered in the region and only as a casual escape. Naturalized populations known from Orange, Rockland, and Suffolk Counties (NY). Sometimes planted as a street tree. Monoecious. Cones maturing Oct.–Dec., at which point the entire cone or cone scales containing two seeds each may fall. Seeds are produced annually; abundant seed crops are expected every 3–5 years (Wilhite and Toliver 1990). Epithet means "two-ranked," a reference to the arrangement of the needles on the stems.

Taxus Rich. – yew

Taxaceae. Trees, shrubs. Species 6–10 in mostly northern temperate Asia, Europe, and North America (including Mexico), and the Philippines. Genus name is derived from "taxos," the Greek name for yew.

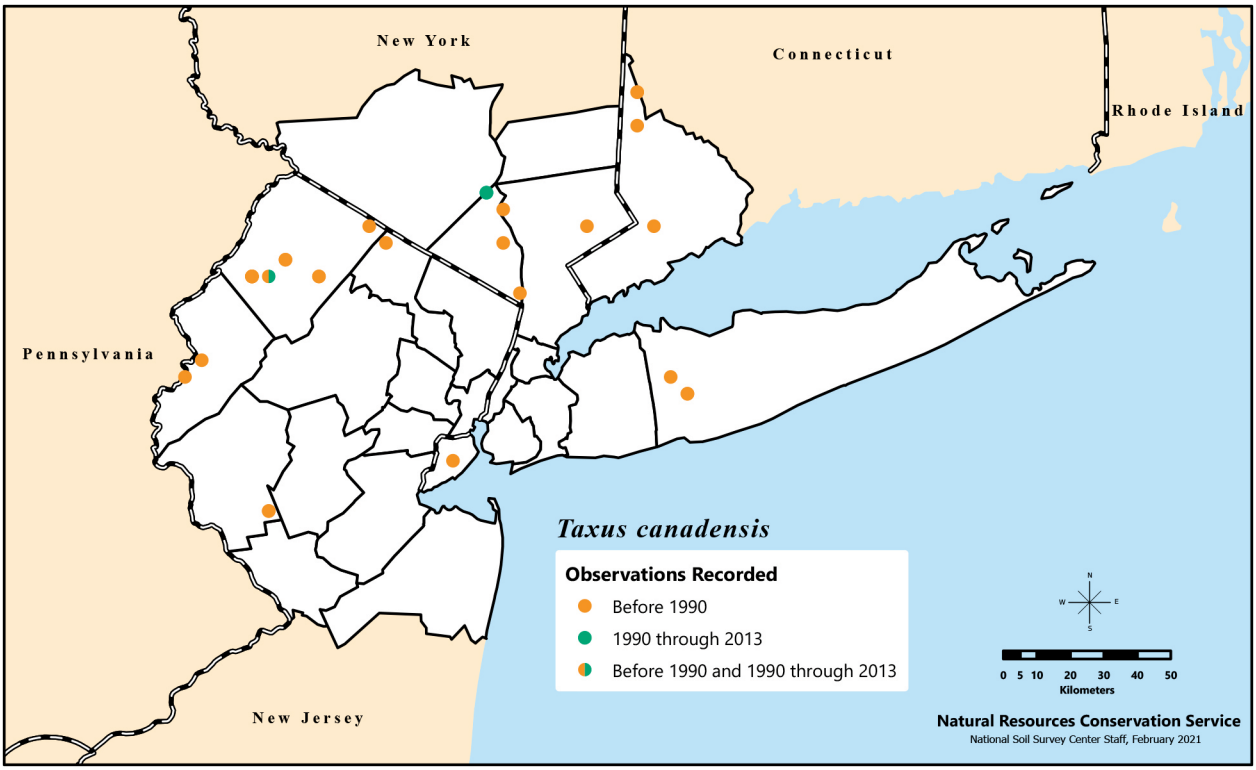
Native Species

1. *Taxus canadensis* Marshall – American yew ↓↓↓

Shrub. Pollen Apr.–May. Boreal, northern species (Welch 1935) found in mesic woodlands and woodland edges and slopes, often growing under *Tsuga* spp. (hemlocks). Epithet refers not to the modern Canada, but rather to a region encompassing the northeastern U.S. and Canada.

Prefers moist sandy loam soils; does not tolerate heat or drought and requires winter shade. Its natural habitat is in mesic deciduous or mixed conifer-deciduous forests in northeastern forest understories (Martell 1974). Pollinated by wind. Self-compatible (Wilson et al. 1996). Gender ratio adjustments are most pronounced in smaller individuals, with the smaller shrubs more likely to devote more energy to female strobili (Allison 1991). Unlike other gymnosperms, seeds are not borne in cones, but instead are found singly on short axillary shoots and in an aril-like fleshy structure (Gleason and Cronquist 1993). Like other yews, breaking dormancy of the seed of the species requires warm plus cold stratification (Dirr 1998, Vance and Rudolf 2008). Seeds and foliage are poisonous to livestock. Propagation by seed is slow; most propagation from stems removed in Oct.–Jan. and treated with hormones. However, rooting still may take 2–3 months (Dirr 1998). Species spreads clonally on its own by rooting from prostrate branches (Wilson et al. 1996). Cultivated since 1800, with 1 cultivar. Not affected by any serious diseases.

Compared to the nonnative yews, this species tends to be more prostrate and stragglier and, thus, less appealing as a landscape plant. Like other yews, it has a slow growth rate (Dirr 1998). Of all the yews, *T. canadensis* is the only monoecious species, though shrubs that are one sex or the other are also found. Selection for monoecy may have occurred because, compared to other yews, removal and destruction of seed by rodents (order Rodentia) is thorough and occurs quickly. Monoecy as well as ripening gradually (some but not all fruit ripening Jul.–Oct.) helps reduce seed predation by making the fruit less conspicuous compared with the fruiting displays of its dioecious relatives. Browsed *T. canadensis* shrubs produce fewer strobili of both sexes than shrubs that are not browsed (Allison 1990a, 1990b). There tend to be more male shrubs and fewer monoecious plants in populations experiencing deer (*Odocoileus* spp.) browse. With protection from deer, the proportion of monoecious plants increases with time. Small individual yews tend to be completely male, and small monoecious shrubs tend to have female-biased strobilus ratios. However, large yews tend to be monoecious and have male-biased ratios (Allison 1992). Thus, the decline of *T. canadensis* may differ depending on degree of herbivory and length of time since



Distribution of *Taxus canadensis*, or American yew, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Bergen and Morris Counties (NJ) and New York and Orange Counties (NY).

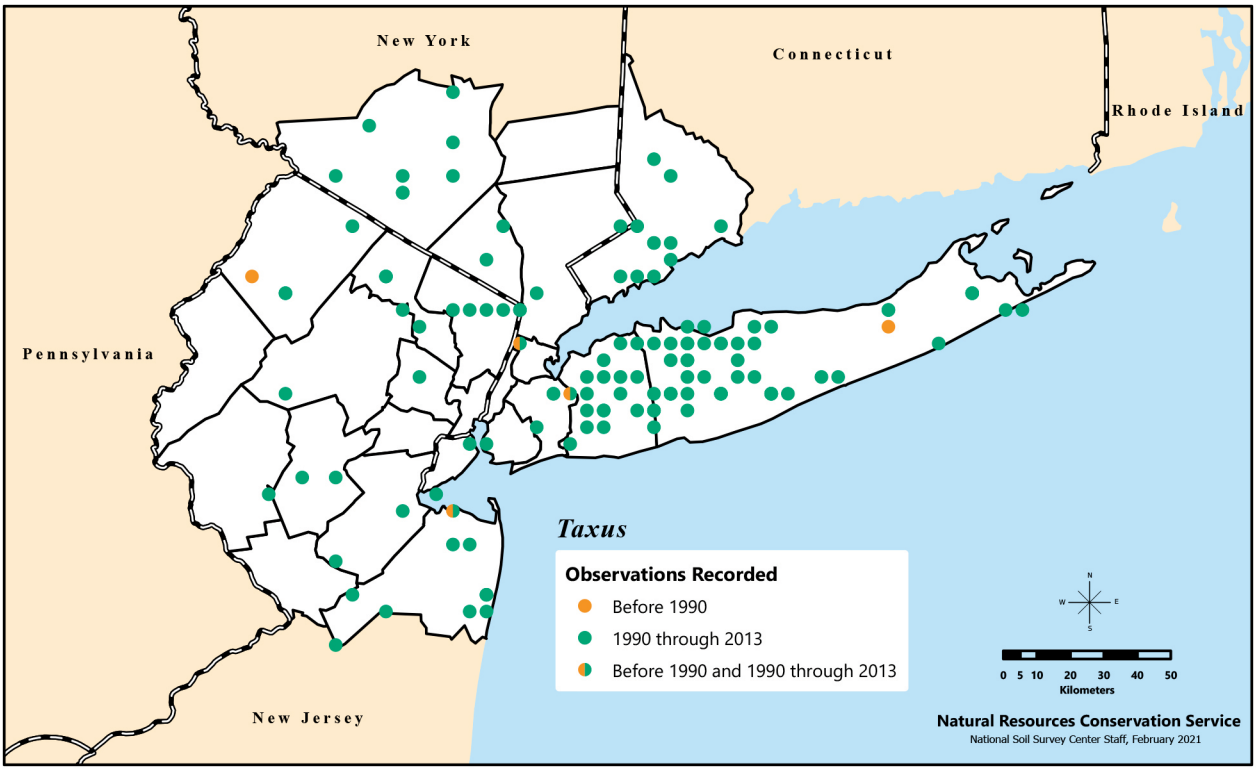
herbivory began. Species suffers from even low levels of herbivory, and reproductive recovery from the effects of browsing may take some time after protection from browsing is initiated.

In substantial decline due to anthropogenic disturbances (i.e., habitat loss, forest management, harvesting for pharmaceutical purposes) and deer herbivory (Windels and Flaspohler 2011). Even at relatively low levels of deer density and despite abundant resource availability, this species cannot cope with the effects of deer (Côté et al. 2004, De Grandpré et al. 1993). Its global status was last ranked in 1983 as globally secure (G5). Currently, it is still ranked as a G5 and as nationally secure (N5) in the U.S. and Canada. Species is considered critically imperiled (S1), imperiled (S2), or vulnerable (S3) in the 12 states in the southern portion of the species' range: IA (S3), IL (S2), IN (S1), KY (S2), MD (S2), NC (S1), NJ (S2), OH (S3), PA, (S3), TN (S1), VA (S3), and WV (S2) (NatureServe 2019a).

Nonnative Species

***2. Taxus* spp. ↑↑↑**

Besides the native *Taxus canadensis*, many immature specimens of yews are encountered in the region. They are located far from the populations of *T. canadensis* and most likely represent escapes of planted material, such as *Taxus baccata* L., *T. cuspidata* Sieb. & Zucc., and the hybrid between them, *T.* ×*media* Rehd.; seeds probably dispersed by birds. They differ in having typically erect stems (sprawling stems in *T. canadensis*) and are probably currently unidentifiable to species (Hils 1993). This material is accounted for in the following distribution map.

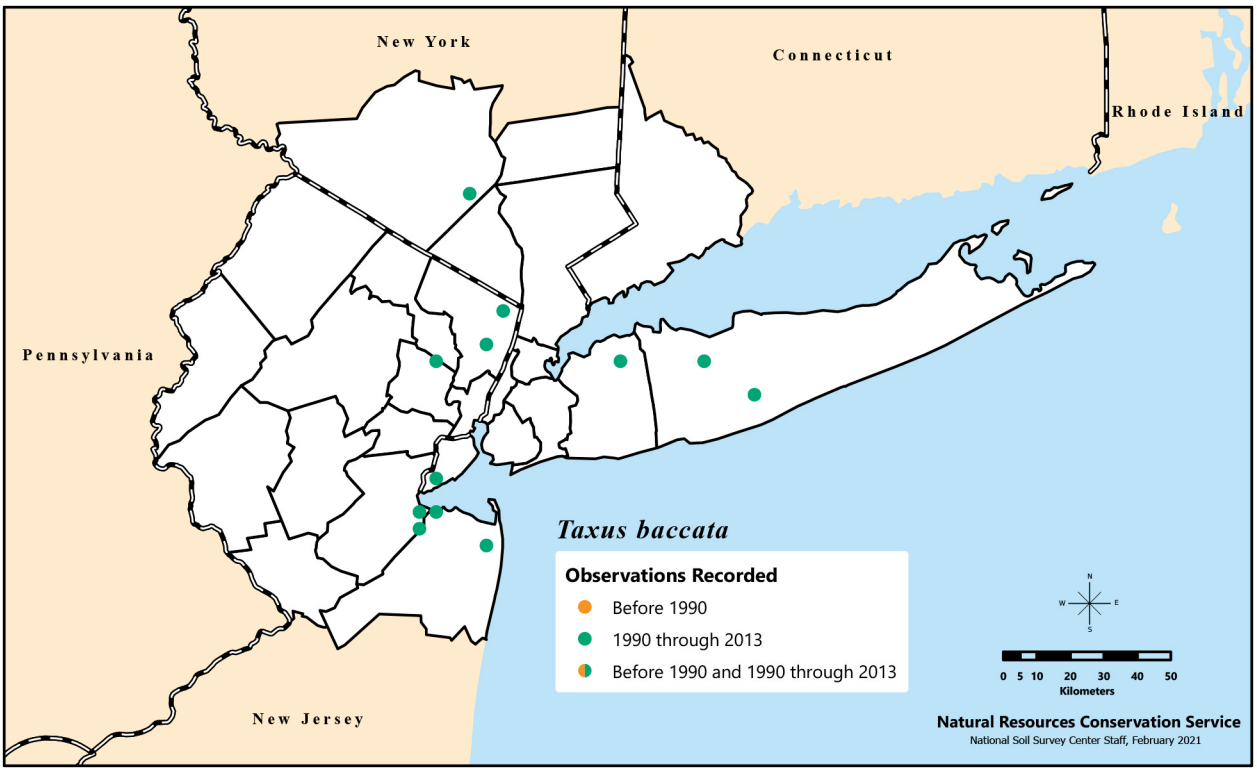


Distribution of *Taxus*, or yew, recorded in the New York Metropolitan Region during three time categories. Map represents records of *T. baccata*, *T. cuspidata*, and their hybrid.

3. *Taxus baccata* L. – English yew ↑↑↑

Pollen Mar.–May. Native to northern Africa, western Europe, and western Asia. Prefers moist, well-drained, sandy loam soils (Dirr 1998). Epithet means "berry-like," a reference to the fleshy cup-like aril that surrounds the seed.

Individuals may live for thousands of years. Earliest seed-bearing age about 30–35 years. Primarily dioecious with sex ratios ranging from 44 to 70 percent female; the sexes are known to change (Thomas and Polwart 2003). Seeds do not germinate readily; storage at 16–18 ºC for 60–120 days and then 2–5 ºC for another 60–120 days recommended. Natural germination of seeds in the seed bank usually takes place the second spring after seeds have fallen (Vance and Rudolf 2008). Found primarily on calcareous soils and very shade-tolerant, but regeneration within a mature yew woodland is rare in its native range of England. Tends to regenerate along woodland edges or in gaps. In more open areas, it is more likely to regenerate with nurse trees, typically *Juniperus* spp. (junipers) or *Crataegus* spp. (hawthorns) in England (Thomas and Polwart 2003), possibly because such trees provide some protection from herbivores (Garcia and Obeso 2003, Garcia et al. 2000). Drought-tolerant and, though shade-tolerant, it is better adapted to grow in full sun (Thomas and Polwart 2003). Due to slow propagation from seeds and relatively slow growth, it is typically propagated from cuttings, which root easily (Dirr 1998). Birds like the arils of the fruit, some rodents (order Rodentia) eat the seeds though they are toxic to most birds, and the foliage is eaten by rabbits (family Leporidae) and deer (*Odocoileus* spp.) though it is toxic to other animals, such as some cattle (*Bos taurus*) (Vance and Rudolf 2008). Some cattle and sheep (*Ovis aries*) browse it without any apparent negative response (Thomas and Polwart 2003). Cultivated for over 1,000 years, with over 100 cultivars (Dirr 1998). Though *T. baccata* appears to be fairly resistant to insects in its home range (Daniewski et al. 1998), it is not resistant in North America, where 42 insects and mites (family Tetranychidae) have been documented on *Taxus* spp. in general, 27 of which are in the western



Distribution of *Taxus baccata*, or English yew, recorded in the New York Metropolitan Region during three time categories.

U.S. Chemical compounds associated with *Taxus* spp. appear to deter chewing insects but favor fluid-feeding arthropods. Many of these insects and mites are not native (Lattin 1998). Susceptible to mealybug (family Pseudococcidae), black vine weevil (*Otiorhychus sulcatus*), scale (superfamily Coccoidea), and yew gall midge (*Taxomyia taxi*) (Dirr 1998). *Phytophthora ramorum* (the fungus that causes the disease sudden oak death) has been documented to cause dieback on this species in England (Lane et al. 2004).

Historically used for making bows and drum frames. Currently, it is used as a landscape plant and its wood is used to make some musical instruments. More importantly, it is a source of taxol (derived from its taxanes), which is used as a chemotherapeutic drug against cancer (Cragg and Newman 2005, Vance and Rudolf 2008). This species has become locally extinct in many parts of Europe and is categorized as rare and endangered in parts of Spain, Poland, Transcaucasus (Georgia, Armenia, and Azerbaijan), and Norway. Reasons for this decline include herbivory by deer (Mysterud and Østbye 2004, Thomas and Polwart 2003), overharvesting (especially in Ireland, England, and mainland Europe; Thomas and Polwart 2003), and a lack of appropriate habitat or microsites for young seedlings (Hulme 1996).

4. *Taxus cuspidata* Sieb. & Zucc. – Japanese yew ↑

Pollen Apr.–June (Vance and Rudolf 2008). Native to northern China, Japan, and Korea. Introduced into the U.S. in 1853. Prefers moist, well-drained, sandy loam soils; can grow well in shade or sun.

Dioecious with similar seed stratification requirements as *Taxus baccata* (Vance and Rudolf 2008). At least 15 cultivars. Serious diseases not a concern. Propagates readily from cuttings; like other yews, it is slow-growing and hard to propagate from seed. Intolerant of poorly drained or wet soils. Too much sun and wind could cause leaves to turn brown. Tolerant of pollution;

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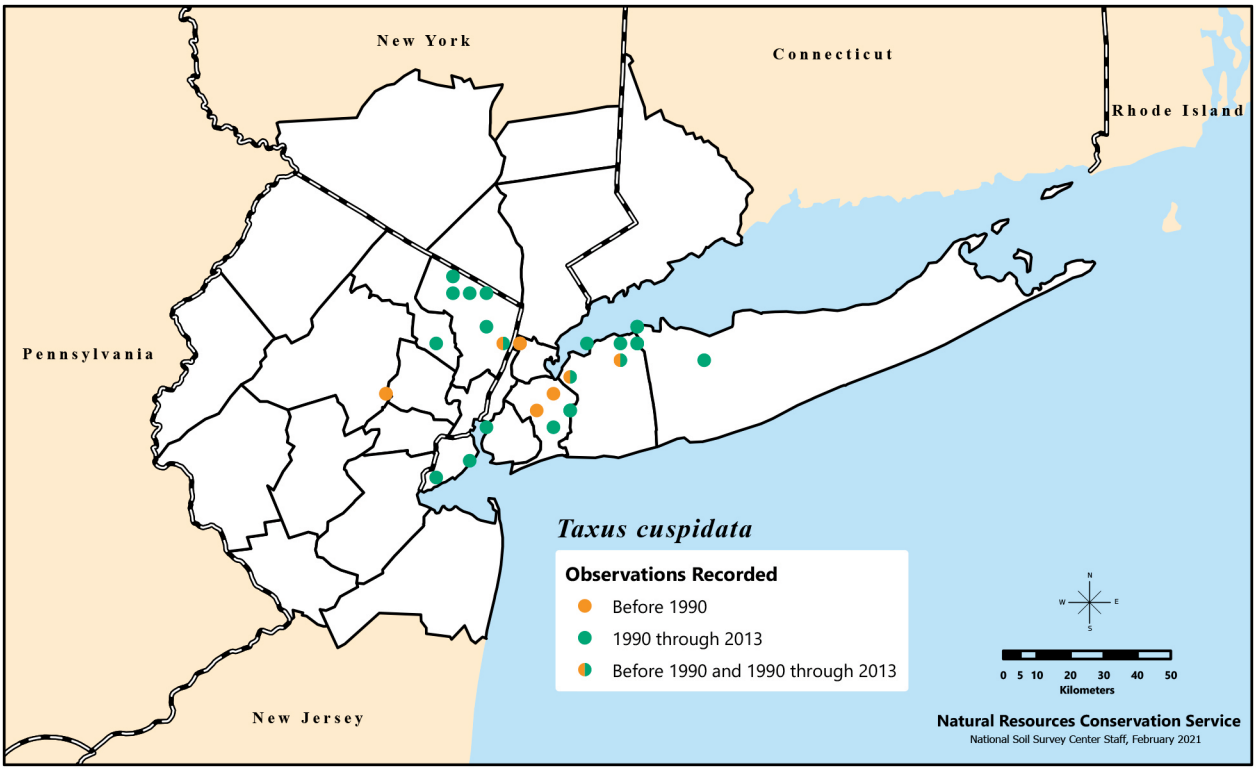


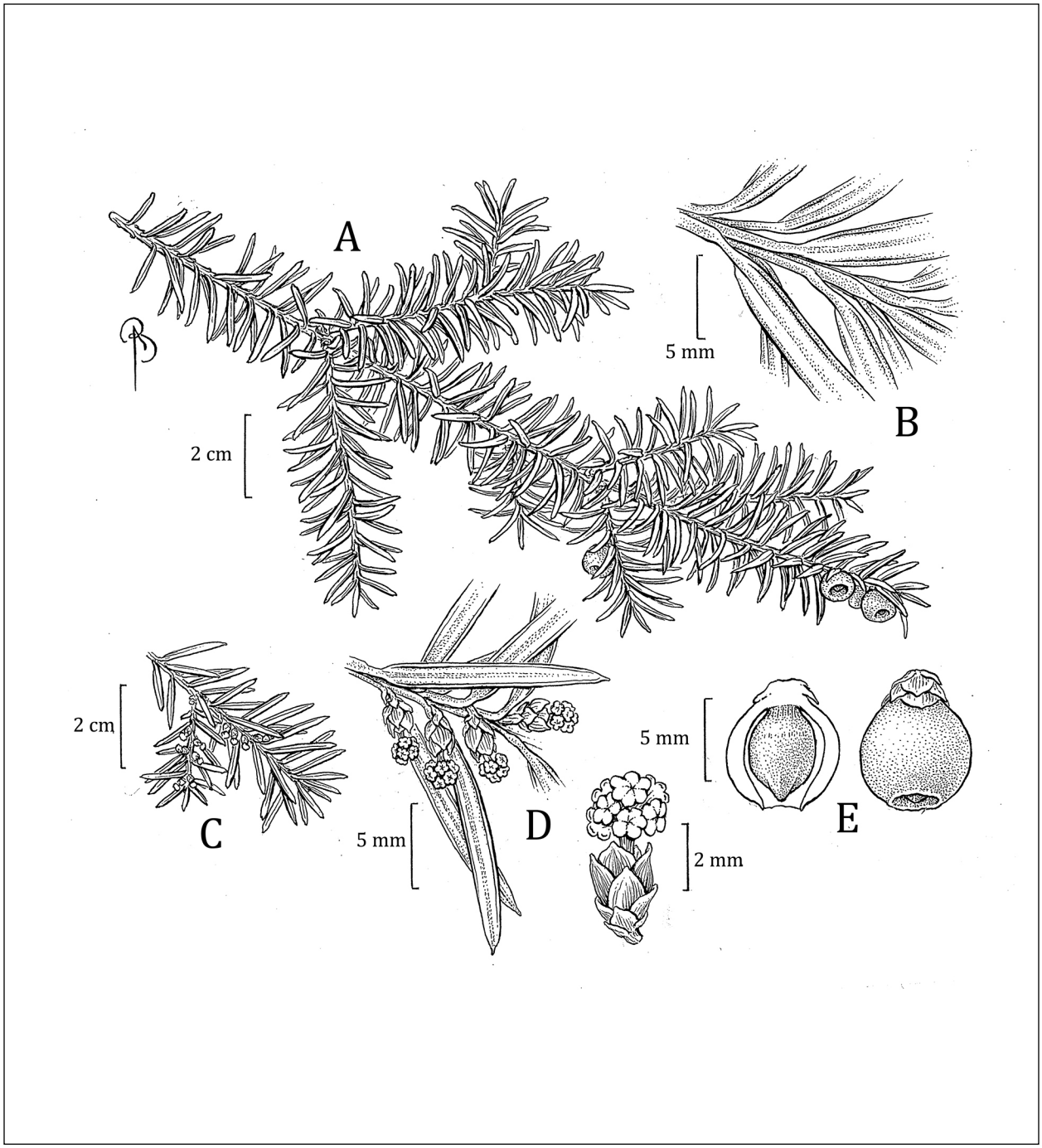
Distribution of *Taxus cuspidata*, or Japanese yew, recorded in the New York Metropolitan Region during three time categories.

withstands high levels of pruning (Dirr 1998), which suggests it may suffer less from deer herbivory, but this is not confirmed. The red arils are most likely consumed by birds and the seeds predated upon by rodents.

Taxus ×*media* Rehder.

This hybrid between *T. baccata* and *T. cuspidata*, which was first cultivated in about 1900, may resemble *T. cuspidata* most in terms of foliage and its preferred growth habits, but all three can be difficult to distinguish with certainty. At least 32 known cultivars (Dirr 1998).

STU



A) Seeding twig; B) view of leaf nodes and flat leaf shape; C) twig with male cones; D) twig with male cones, and male cone; E) seed with part of fleshy structure removed and fleshy-covered seed of *Taxus canadensis*. Illustration by Bobbi Angell.

STU

Thuja L. – arborvitae

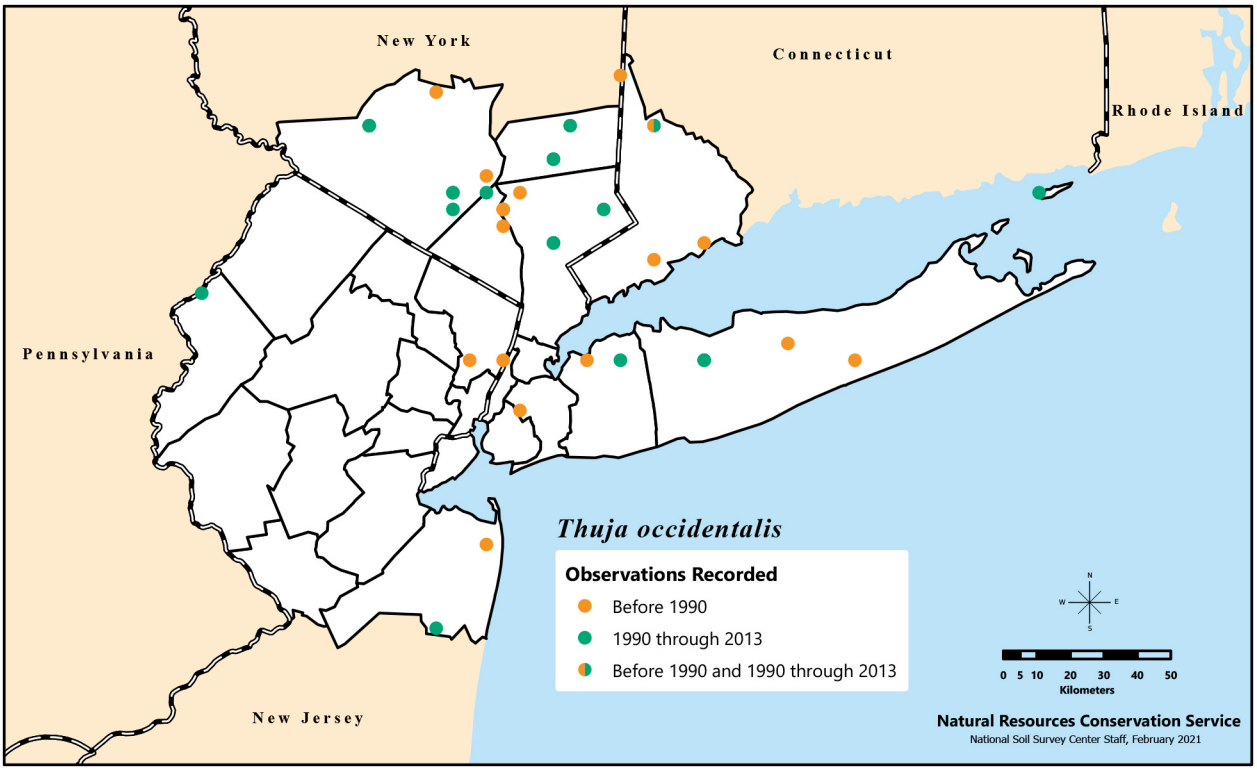
Cupressaceae. Trees. Species 5 in Asia and North America. Readily distinguished from other conifers by its opposite 4-ranked scale-like leaves and woody seed cones with 4 to 6 pairs of scales. However, can be difficult to separate from some *Chamaecyparis* spp. if no cones are present. The lateral leaves in *Thuja* are spread apart with no seam visible; in most cases, *Chamaecyparis* lateral leaves meet on a visible seam (Cope 1986). Cultivated for ornament, windbreaks, and timber. Genus name is an ancient Greek name for "evergreen tree."

Native Species

1. *Thuja occidentalis* L. – American or eastern arborvitae, northern white cedar ↔

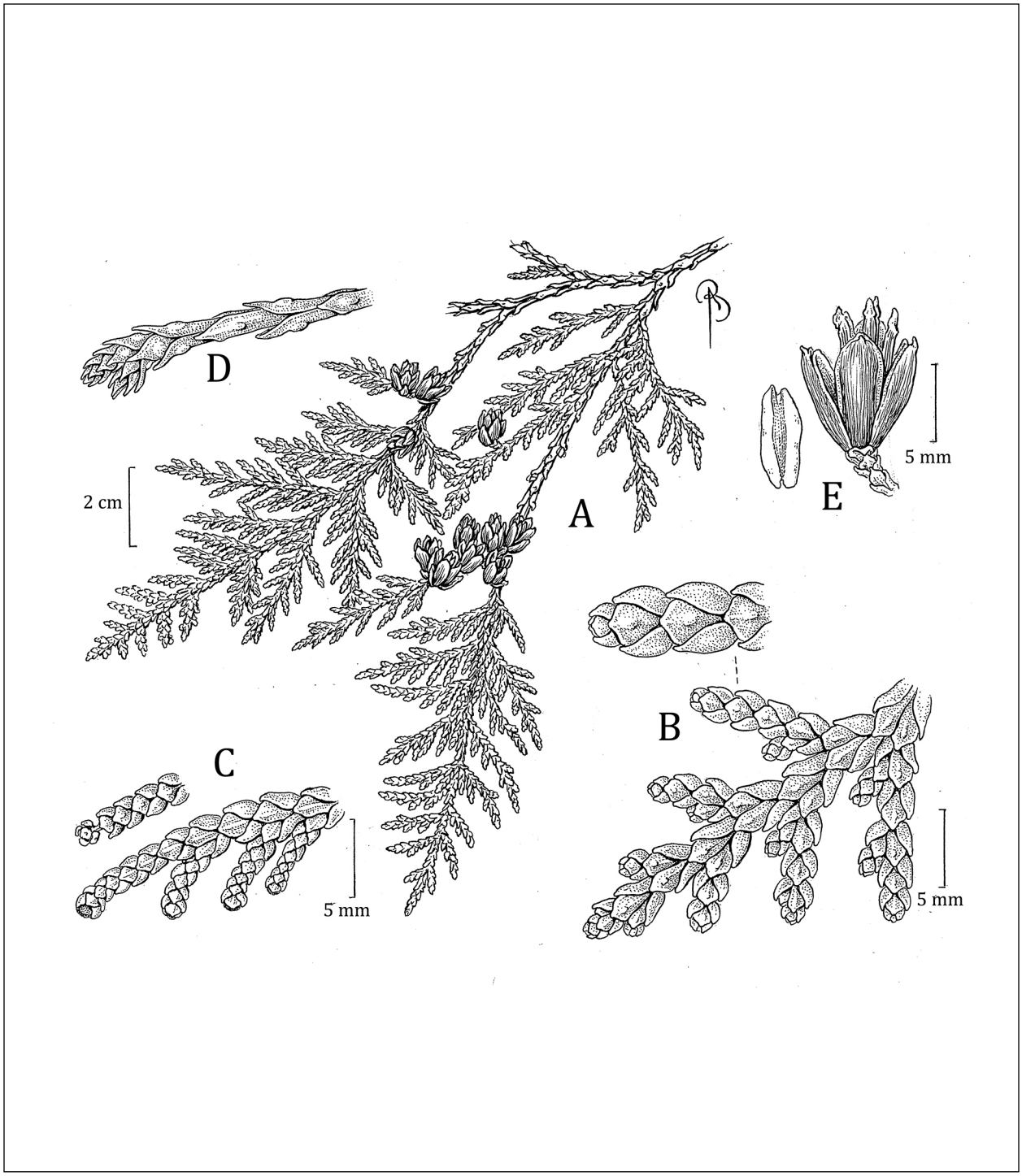
Pollen maturing May–June. Boreal, northern species (Bergeron and Dubue 1988, Welch 1935) found in swamps and watersides; usually on rocky calcareous soils. Epithet means "western" in Latin, a reference to the New World in contrast to the *Thuja* spp. from Asia. Some records may represent escapes or remnants from cultivation, especially those on the Coastal Plain; Taylor (1915) did not report native populations from Long Island. The similarities between this species and *Taxus canadensis* regarding its rarity in a large portion of its southern range is striking; it is considered critically imperiled (S1), imperiled (S2), or vulnerable (S3) in the 8 states in the southern part of its range: IL (S1), IN (S1), KY (S2), MD (S1), NJ (S1), OH (S3), TN (S3), and WV (S2) (NatureServe 2019b).

Native material is listed as threatened in CT (S2) and endangered in NJ (S1).



Distribution of *Thuja occidentalis*, variously called American or eastern arborvitae, or northern white cedar, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Sussex County (NJ) and Bronx County (NY).

STU



A) Twig with female cones; B) twig, with enlarged section showing scale-like leaves; C) twig with male cone and enlarged section with male cone; D) terminal twig; and E) female cone and side view of seed of *Thuja occidentalis*. Illustration by Bobbi Angell.

STU

Tilia L. – basswood, linden

Malvaceae s.l. (Tiliaceae). Trees. Species 23–40 in primarily temperate and subtropical Asia and Europe. Distinguished by palmately veined leaves often truncate and oblique at base and cream-colored fragrant flowers in pendant clusters subtended by a large leaf-like bract. Cultivated for ornament, flowers for honey production, and timber; wood soft, white, used for piano keys, carvings, and excelsior. Pollinated by bees; sugar content in flowers so high it can result in the death of bees. *Tilia* is the ancient Latin name for the genus.

Besides the keyed species, the European linden, *T.* ×*europaea* L. (a stable hybrid originating from a cross between *T. cordata* L. and *T. platyphyllos* Scop.) is planted and may be encountered as a remnant from cultivation. It differs from *T. cordata* in that its leaf undersides are not glaucous.

Native Species

1. *Tilia americana* L. – American basswood ↑↑↑

Flowering late June–July; fruiting Aug.–Sept. Woodlands, bottomlands, and streambanks in rich soils; also cultivated.

The vast majority of the material is referable to *Tilia americana* var. *americana*. However, there are scattered historical reports (e.g., Britton 1889) of *T. americana* var. *heterophylla* (Vent.) Loudon, a primarily Appalachian taxon found west of the region. *Tilia americana* var. *heterophylla* differs from the typical variety in having the leaves permanently pubescent beneath with white or brown stellate hairs. Shade-tolerant and somewhat fast growing. Grows best on mesic sites with sufficient nitrogen in soils ranging in pH from 4.5 to 7.5 but occurs more often in the less acidic part of this range. Seed-bearing age ranges from 15–100 years. Fruit dispersed by wind, gravity, and animals (Crow 1990). Seeds exhibit double dormancy and require scarification and moist cold stratification to improve germination rates. Seeds stored in a sealed container at 1 to 4 °C have retained their viability for 5 to 6 years (Rowe and Blazich 2008b). Increases in *T. americana* var. *americana* may be due to reforestation.

Tilia americana var. *heterophylla* is listed as endangered and tracked as historical (SH) in NY, although all confirmed historical records of native populations were outside the region (Young 2019).

Nonnative Species

2. *Tilia cordata* Mill. – little-leaf linden ↑↑↑

Flowering late June–July; fruiting Aug.–Sept. Native to Europe; cultivated and encountered as a remnant from cultivation or true escape. It remains a popular landscape small-leaved shade tree, despite susceptibility to bark splitting and trunk decay (Iles and Vold 2003). Its increase is of concern and needs further evaluation.

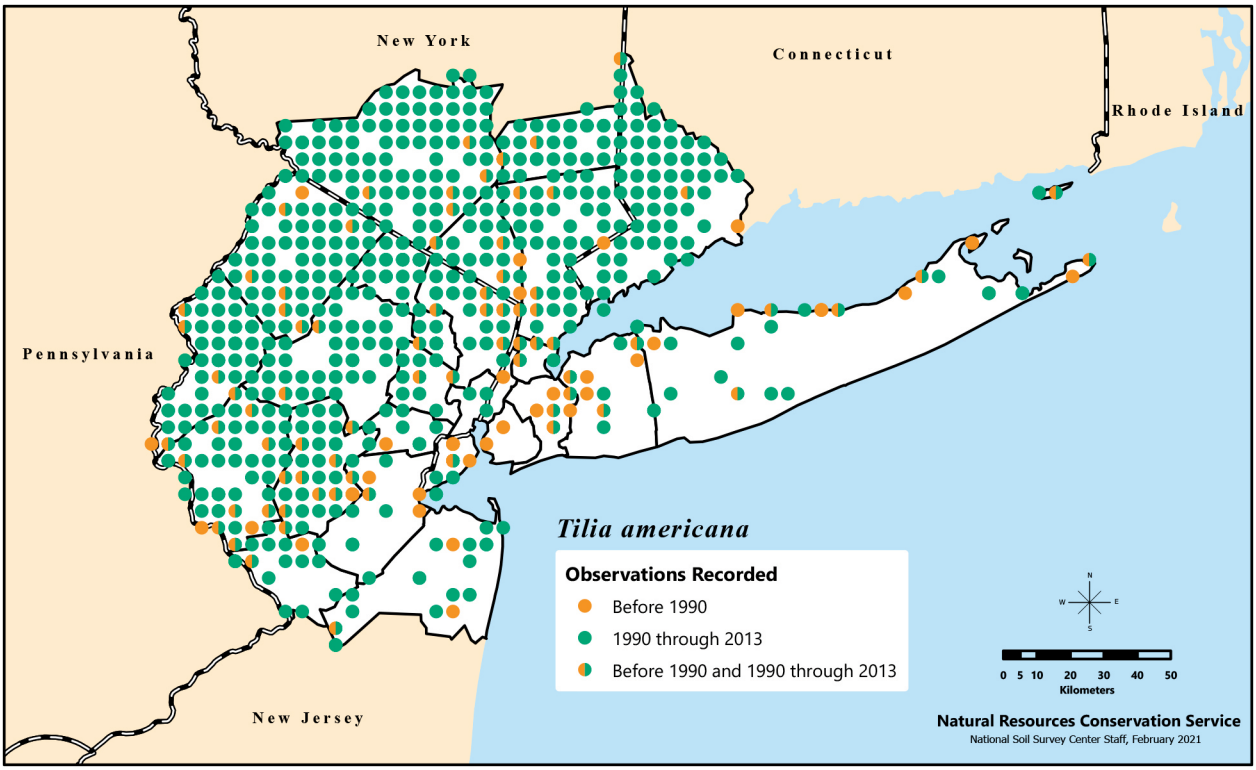
***Tilia tomentosa* Moench. − silver linden**

Flowering July; fruiting Aug.–Sept. Native to Asia and Europe. One unconfirmed report as an escape in Somerset County (NJ).

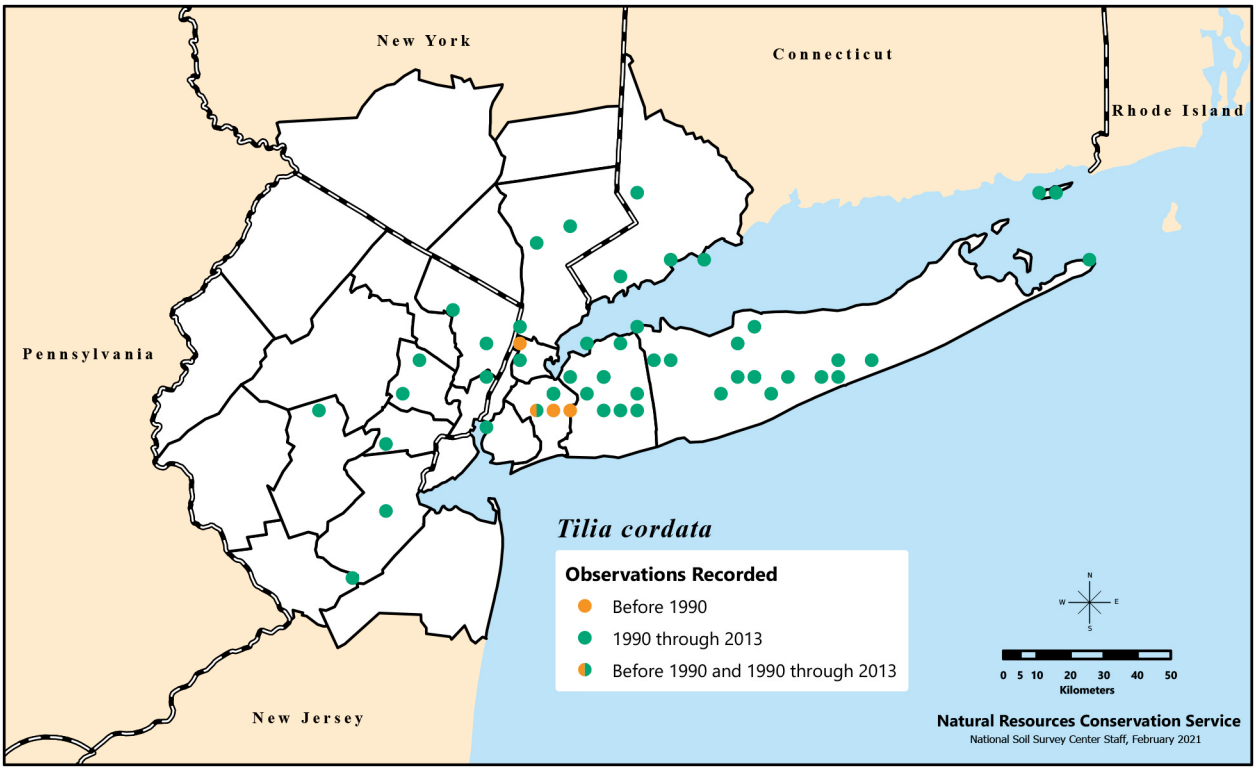
S T U

Tilia Key

1. Leaves tomentose throughout beneath (commonly cultivated) . . . . . ***Tilia tomentosa****
1. Leaves glabrous beneath or with hairs only in the vein axils 2
2. Flowers with staminodes; fruits smooth to slightly verrucose; leaves 10 cm or longer and lacking tufts of brown hairs in the vein axils beneath . . . . . ***Tilia americana***
2. Flowers without staminodes; fruits ribbed (commonly cultivated); leaves less than 10 cm long with tufts of brown hairs in the vein axils beneath . . . . . ***Tilia cordata****

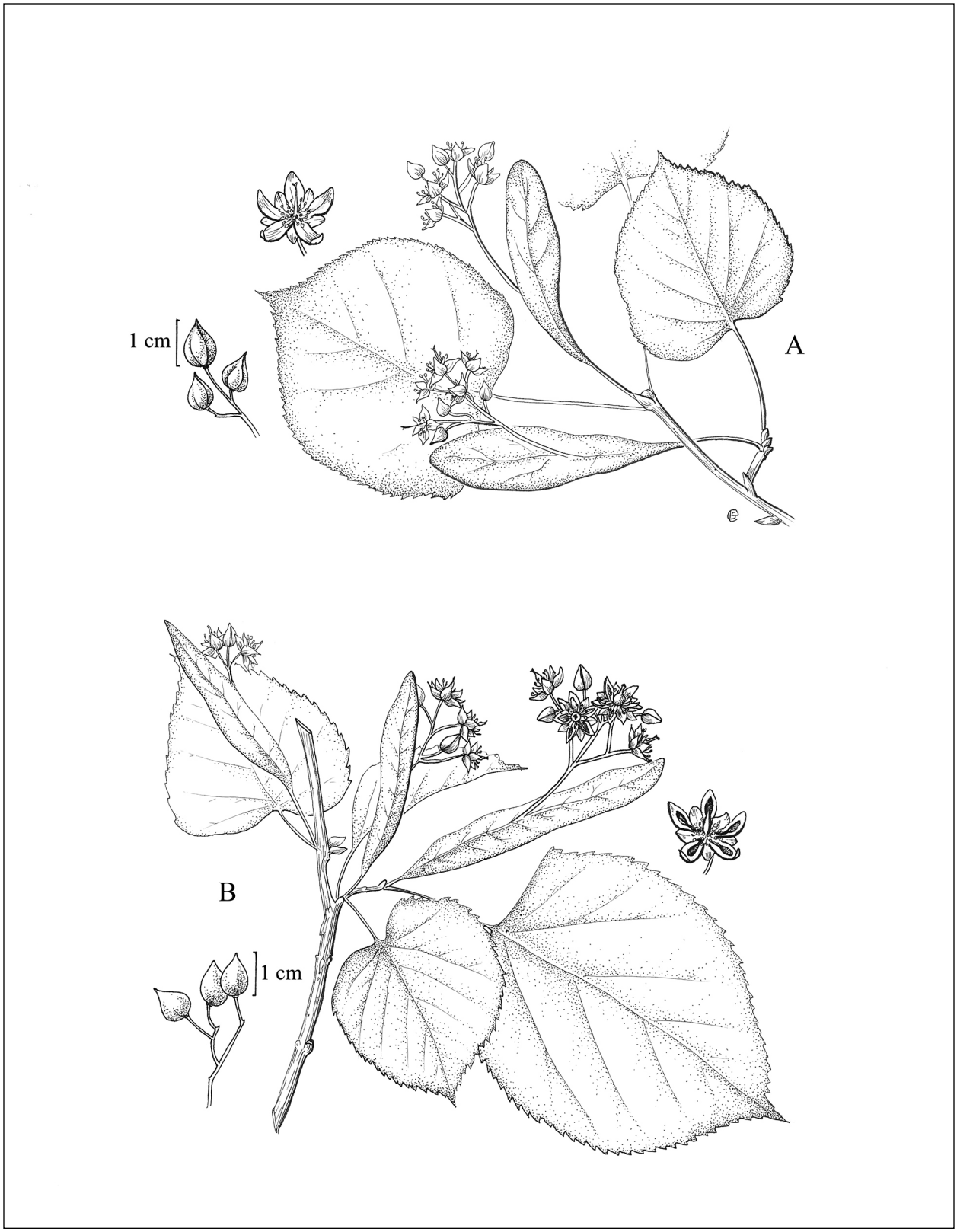


Distribution of *Tilia americana*, or American basswood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Tilia cordata*, or little-leaf linden, recorded in the New York Metropolitan Region during three time categories.

STU



Flowering leafy twig, fruits, and flower of A) *Tilia cordata* and B) *Tilia americana*. Illustration by Emma Skurnick.

Toxicodendron Mill. – poison ivy, poison sumac

Anacardiaceae. Trees, shrubs, woody vines. Species about 20 in eastern Asia and North America. All reports of *Toxicodendron pubescens* (eastern poison oak) are misidentification of *T. radicans*. Northern limit of *T. pubescens*' range is south of the region in southern NJ. Genus name is a compound meaning "poison tree," in reference to the skin allergy that many have when coming into contact with the plant. Dioecious; fruits, which are drupes, are borne in panicles. Male flowers are more fragrant than female flowers; pollinated by bees. Fruit may remain on the female plants throughout the winter, but usually disappear by spring during bird migrations (Gain and Beaman 1986).

Native Species

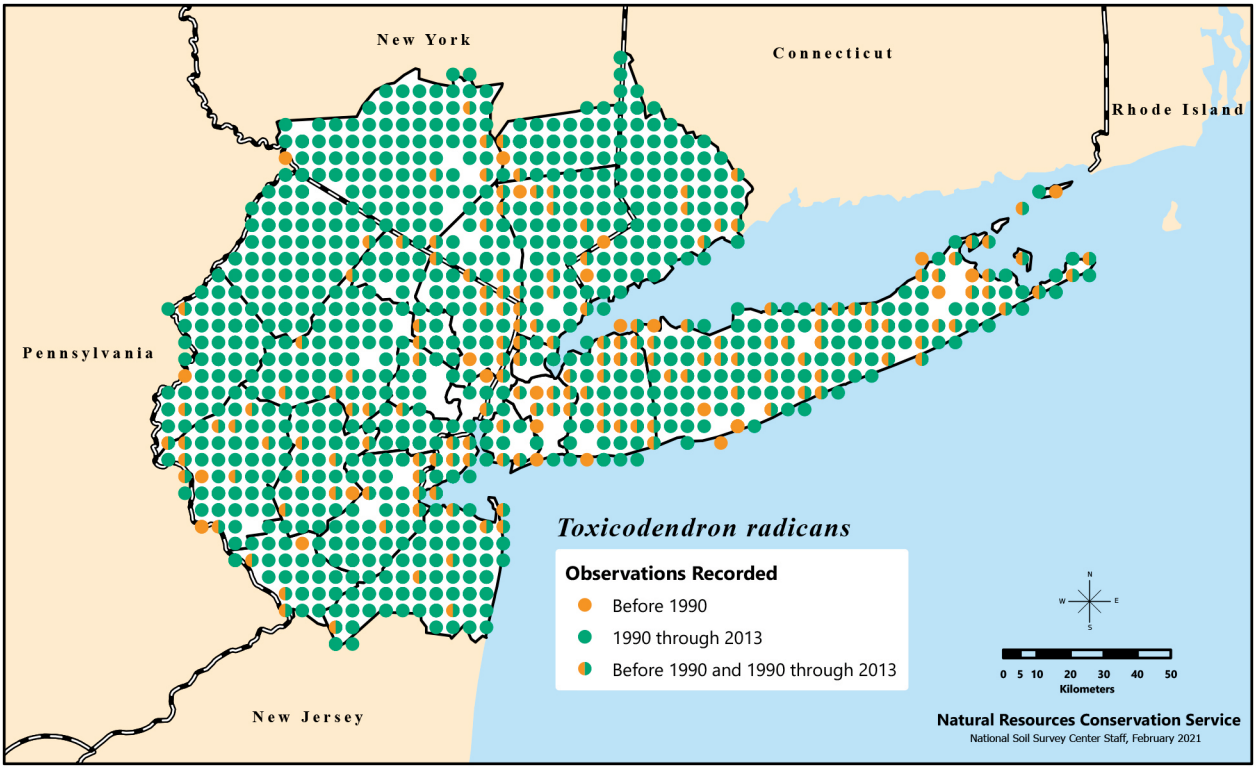
1. *Toxicodendron radicans* L. – poison ivy ↑↑

Climbing or trailing vine, rarely shrubby. Flowering May–July. Woodlands, woodland edges, fields, marshes, and swamps, on a wide range of soil types; most abundant in disturbed areas. Epithet from Latin refers to the aerial roots.

Toxicodendron pubescens (poison oak) is known just outside the region from southern NJ. It differs from *T. radicans* in that it is always an erect shrub and has larger (up to 5 mm), more pubescent fruit.

Toxicodendron Key

1. Leaflets 3 . . . . . ***Toxicodendron radicans***
1. Leaflets 7–13 . . . . . ***Toxicodendron vernix***



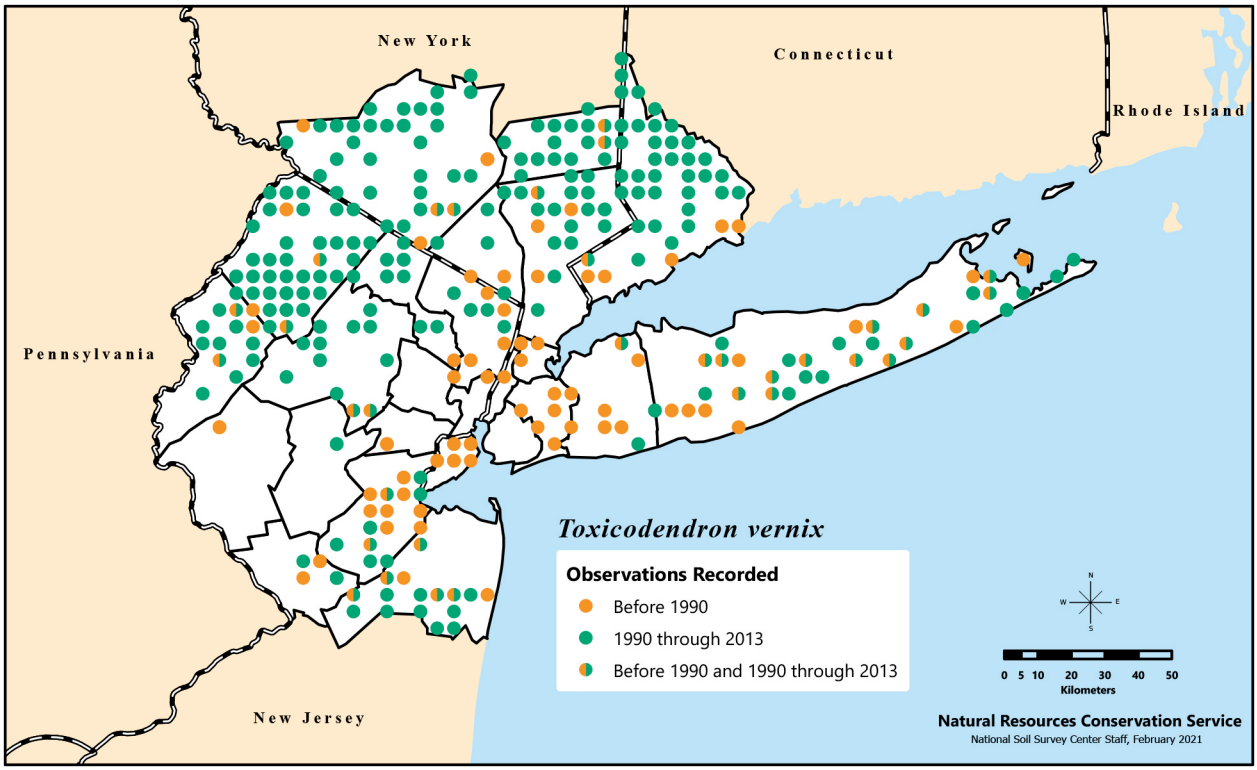
Distribution of *Toxicodendron radicans*, or poison ivy, recorded in the New York Metropolitan Region during three time categories.

STU

Flowering is not likely to start until after 3 or more years of growth (Gain and Beaman 1986). The etiologic allergens in *T. radicans* that cause dermatitis are known as catechols (1,2-dihydroxybenzenes) and are found in the plant's sap (anywhere sap may be exuded, i.e., leaves, stems, and roots). Uninjured leaves do not cause dermatitis. Closely related mixtures of catechols of *Toxicodendron* spp. are commonly known as urushiol, which is stable and readily binds to skin, but dissolves in water easily if exposed to water within 5–30 minutes (Resnick 1986). Young leaves tend to contain higher concentrations of urushiol (Baer et al. 1980). This poisonous sap will usually turn white paper purple. Seeds digested by birds generally fall within 21 m of the fruit source (Hoppes 1988). Increases in carbon dioxide (CO_2) may result in significant increases in overall biomass of this species (Ziska et al. 2007), and may also increase the concentration levels of urushiol (Mohan et al. 2006, Ziska et al. 2007). Foliage is a favorite forage of deer (*Odocoileus* spp.) and rabbits (family Leporidae) (Hoppes 1988, Mohan et al. 2008); plants exposed to higher levels of CO_2 were impacted more by deer herbivory than plants grown at normal CO_2 levels (Mohan et al. 2008). Light availability is a much stronger driver of overall performance than nutrient availability (Jelesko et al. 2017). Long-term observational field studies in WI show that *T. radicans* (and other woody vines) has not increased in abundance over the last 45 years within forests but has increased sharply in abundance along forest edges (Londré and Schnitzer 2006). Increases are noted in the region, perhaps due to reforestation or increases in fragmented forests and moderately disturbed areas.

2. *Toxicodendron vernix* L. – poison sumac ↑

Shrub, rarely small tree. Flowering May–July. Low-lying areas, woodlands, marshes, and swamps, including Atlantic white cedar swamps. Epithet means "varnish" in Latin; Linnaeus incorrectly believed the species to be a source of varnish.

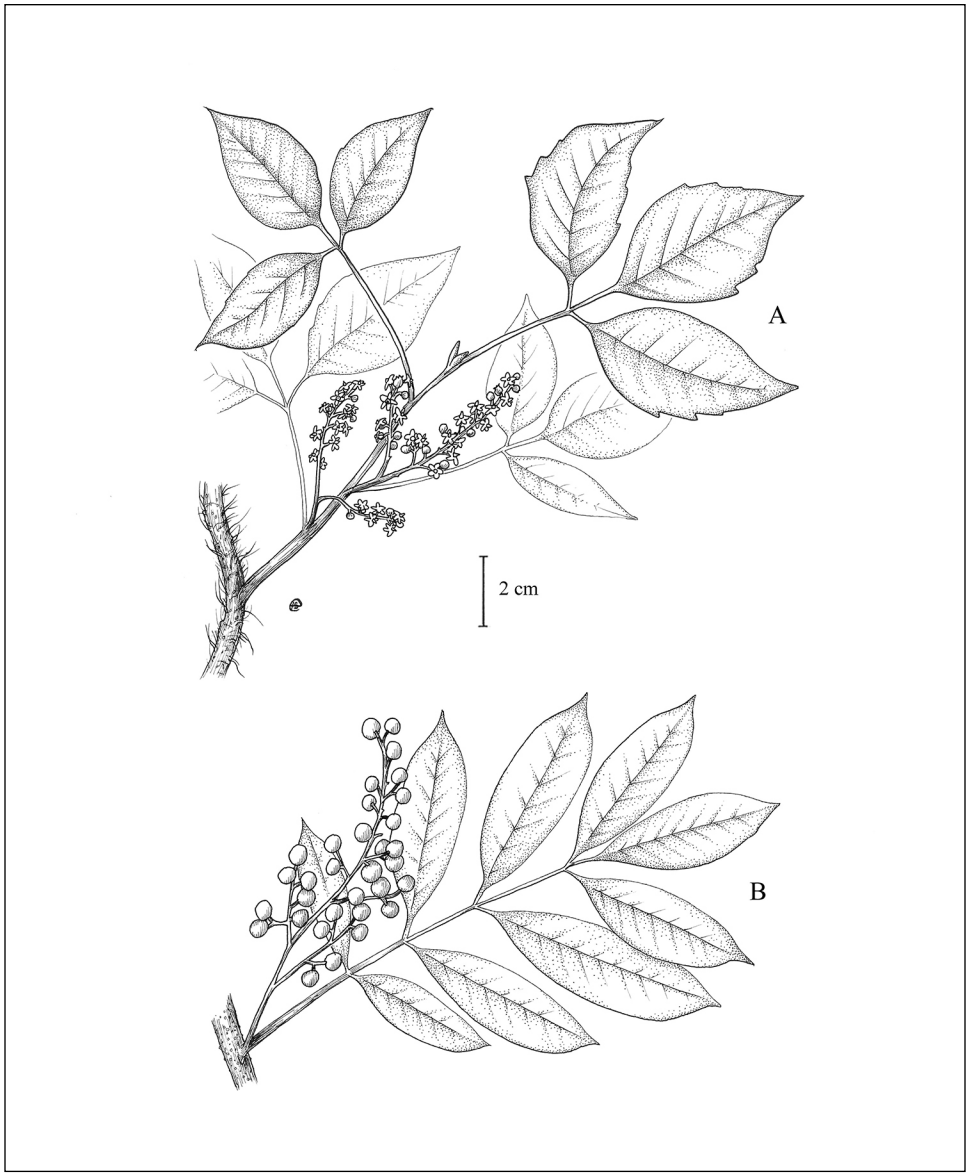


Distribution of *Toxicodendron vernix*, or poison sumac, recorded in the New York Metropolitan Region during three time categories.

Toxicodendron vernix forms arbuscular mycorrhizal associations, probably due to the limited phosphorus availability in fen habitats (Cornwell et al. 2001). Bird ingestion of the fruit and passing the seed through, appear to improve seed germination likelihood (Krefting and Roe 1949).

Management

Succession, deer herbivory, and landowners' careful removal of *Toxicodendron* plants are likely to continue to keep these species in check despite potential increases due to climate change or habitat improvement. These species remain a food source for birds and several mammals and thus should be considered important components of many ecosystems.



A) Flowering leafy twig of *Toxicodendron radicans*; B) fruiting leafy twig of *Toxicodendron vernix*. Illustration by Emma Skurnick.

Tsuga (Endl.) Carrière – hemlock

Pinus sect. *Tsuga* Endl.

Pinaceae. Trees. Species 9–10 in Asia and North America. Readily distinguished from other conifers by twigs with peg-like projection and needles that narrow to a petiole-like base. Cultivated for timber and pulp. Genus name is the Japanese name for "group."

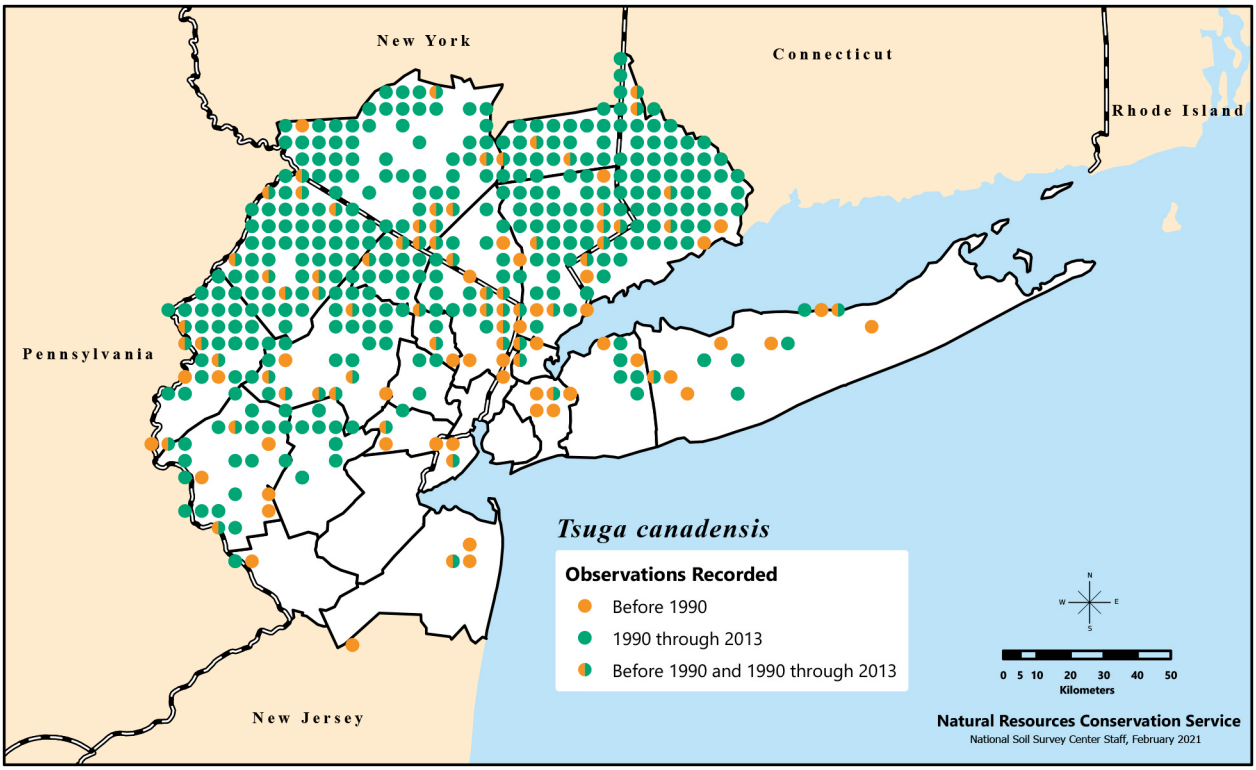
Native Species

1. *Tsuga canadensis* (L.) Carr. – eastern hemlock ↑↑

Tsuga canadensis L.

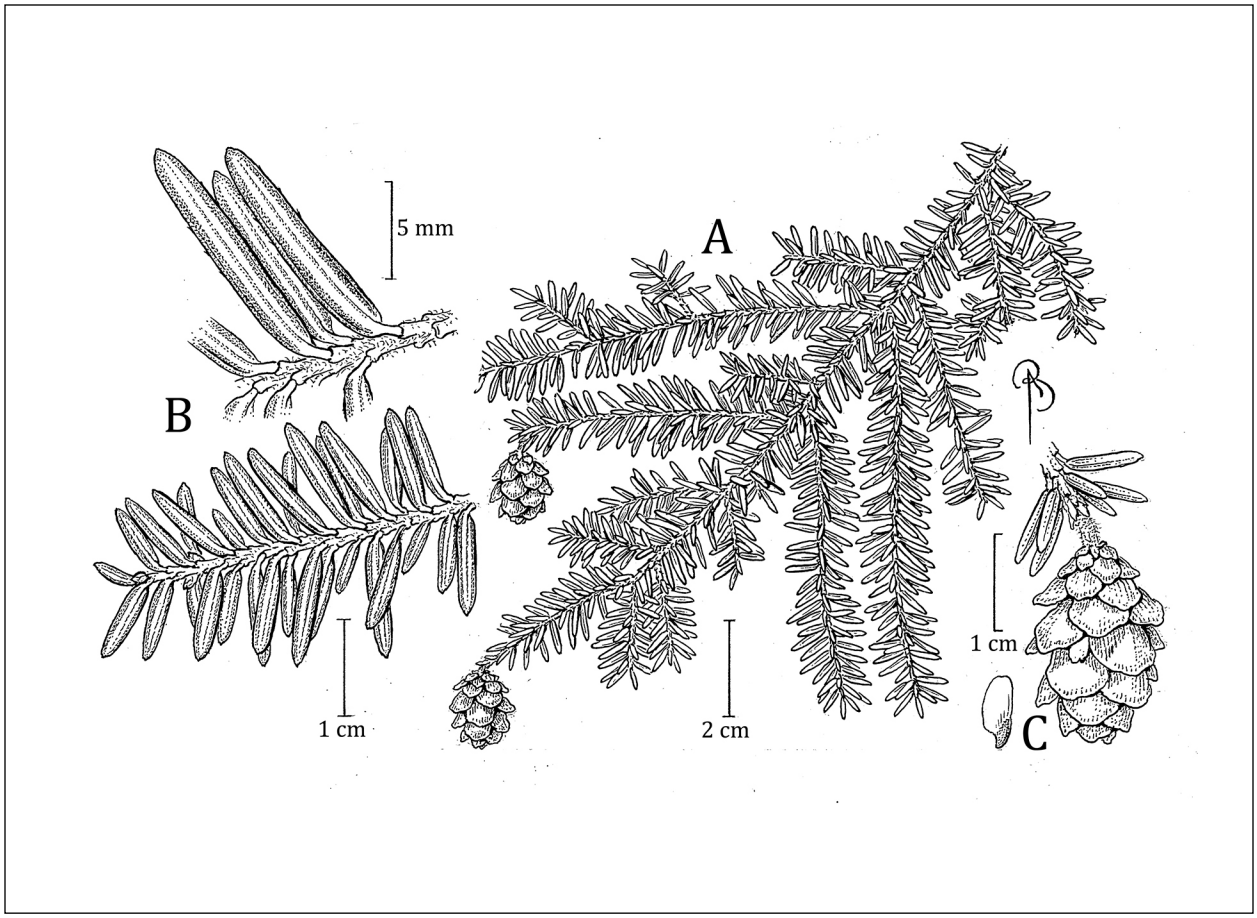
Pollen maturing Apr.–May; seeds maturing Sept.–Oct. Dry to mesic woodlands, shaded slopes, and hummocks in swamps, often on rocky soils; much less common on the Coastal Plain. Twigs and bark used by Native Americans to make a tea.

Hemlock woolly adelgid (*Adelges tsugae*) first became a problem in the region in the early 1980s. Our data show an increase in *T. canadensis*, which is evidence of increased plantings and the fact that a species can still be present at a location albeit less abundant. Ideally these trees could be resistant. More likely, they are younger trees attempting to regenerate or remnant patches of trees that were missed by the adelgid and free from infestation, at least temporarily, because the distance to an infested tree is too great. The adelgid can move long distances only through passive vectors (birds, people, wind) and is set back by cold winters (Fitzpatrick et al. 2012). The adelgid is a small insect that feeds on the sap at the base of the needle, depleting the trees of nutrients and possibly injecting a phytotoxin. Infestations often result in evident mortality within 9 years (Eschtruth et al. 2006, Krapfl et al. 2011). This tree species is considered a foundation species because it creates acidic soils and dark and cool microhabitats that are populated by unique communities of species of herbs and shrubs (D'Amato et al. 2009), and wildlife (Rohr et al. 2009). Hemlock forests also moderate stream flow and temperature in riparian areas (Ellison et al. 2005, Hadley et al. 2008, Orwig et al. 2012).



Distribution of *Tsuga canadensis*, or eastern hemlock, recorded in the New York Metropolitan Region during three time categories.

STU



A) Twig with female cones, B) twig sections, and C) seed and cone of *Tsuga canadensis*. Illustration by Bobbi Angell.

Ulex L. – gorse

Fabaceae. Shrubs. Species 10–20 in northern Africa and western Europe. Readily distinguished from other leguminaceous shrubs by its extreme thorniness; the leaves in adult plants (seedlings and young plants have trifoliate leaves) are largely replaced by thorns (modified shoots). Closely related to *Cytisus*, which also escapes in the region. Genus name is an ancient name possibly applied to this genus.

Nonnative Species

***Ulex europaeus* L. – gorse**

Flowering May–June. Native to northern Africa and Europe; one historical record of its escape on Staten Island. Sometimes planted in sandy areas for soil stabilization. Although this species can be highly invasive (Leary et al. 2006), its presence in the region is rare.

Ulmus L. – elm

Ulmaceae. Deciduous or evergreen trees, shrubs. Species 20–40 in Asia, Europe, and North America. Distinguished by its toothed leaves often with oblique bases, bisexual flowers, and samaras. Pollinated by wind. Planted for ornament, shade, and timber. *Ulmus* is the classical Latin name for the genus.

Native Species

1. *Ulmus americana* L. – American elm, white elm ↑↑↑

Flowering late Feb.–early Apr. (before the leaves appear); fruiting Apr.–May. Mesic woodlands, usually on rich soil; also cultivated (once a common street tree) and some material may represent escapes from cultivation.

Prefers rich, moist soils, but can tolerate a variety of conditions, including standing water, salt, and variable soil pH. First cultivated in the U.S. in 1752 (Dirr 1998). Earliest seed-bearing age 15 years (Barbour and Brinkman 2008b). Cold stratification for 60–90 days usually required to break seed dormancy (Barbour and Brinkman 2008b, Dirr 1998). This species is highly susceptible to Dutch elm disease and many other diseases and insects, including phloem necrosis, wetwood (caused by the bacterium *Erwinia mimipressuralis*), cankers, bacterial leaf spot, powdery mildews, spongy moth (*Lymantria dispar*), elm leaf miner (*Fenusa ulmi*), and white

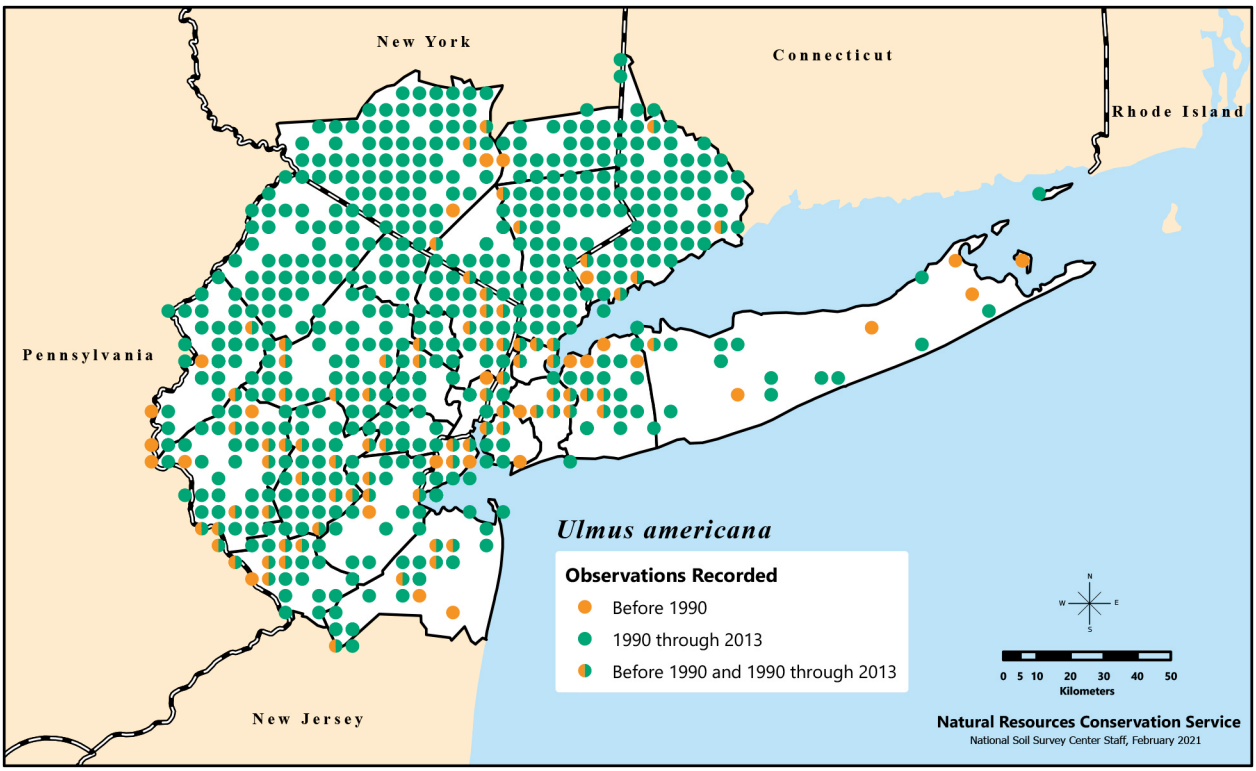
Ulmus Key

1. Leaf blades shorter than 7 cm 2
1. Leaf blades longer than 7 cm 3
2. Leaf blades shorter than 5 cm; flowering in fall . . . . . ***Ulmus parviflora****
2. Leaf blades 5–7 cm long; flowering in spring . . . . . ***Ulmus pumila****
3. Upper surfaces of leaves rough, sandpapery 4
3. Upper surfaces of leaves smooth 5
4. Older twigs with corky wings . . . . . ***Ulmus procera****
4. Older twigs lacking corky wings 6
5. Older branches with cork-ridges; flowers in racemes; samaras pubescent on the sides. . . . . ***Ulmus thomasii***
5. Older branches without cork-ridges; flowers in fascicles; samaras glabrous on the sides. . . . . ***Ulmus americana***
6. Leaves ciliate; buds covered with russet hairs; fruit pubescent. . . . . ***Ulmus rubra***
6. Leaves not ciliate; buds pale-pubescent or glabrous; fruit glabrous 6
6. Young branches pubescent; fruit with the seed in the middle . . . . . ***Ulmus glabra****
6. Young branches glabrous; fruit with the seed above the middle (commonly cultivated) . . . . . ***Ulmus ×hollandica****

marked tussock moth (*Orgyia leucostigma*) (Dirr 1998). Phloem necrosis is caused by a mycoplasma-like organism and is spread by the whitebanded elm leafhopper, *Scaphoideus luteolus* (Barbour and Brinkman 2008b).

Dutch elm disease was first discovered in OH in 1930 and is caused by the fungi *Ophiostoma ulmi* (Barbour and Brinkman 2008b) and *O. novo-ulmi* (Brasier 1991), which are transmitted by the European elm beetle, *Scolytus mutistriatus*, and the native elm bark beetle, *Hylurgopinus rufipes*, both of which also feed on the tree (Barbour and Brinkman 2008b). Despite the decimation of many individuals of *U. americana* in the mid-20th century, this species has increased in the region, possibly the result of planting the more resistant cultivars. Similar increases in *U. americana* were noted between 1926 and 1976 but were limited to small-diameter individuals (Parker and Leopold 1983). The American elms present in the region may also be limited to small-diameter individuals. Approximately 6 cultivars that show some resistance to Dutch elm disease exist; 'Valley Forge' may be the most tolerant (Dirr 1998).

Commonly used in urban landscaping due to its tolerance to drought and pollution and shade-producing canopy that can overhang streets much like an arch. Mostly tetraploid, which makes breeding it with resistant elm species difficult (Newhouse et al. 2007). A major source of genes for resistance to Dutch elm disease are the Asiatic elms, especially *U. parvifolia* and *U. pumila* (Smalley and Guries 1993). Genetically engineering (using an agrobacterium-mediated transformation) resistant *U. americana* has been tried with some success (Newhouse et al. 2007). Some individuals of *U. americana* (about 21 percent of sampled wild species) are diploid. Most diploids may be located in the Atlantic Coastal Plain. Though diploids and tetraploids are found near each other, there are no reported triploids yet (Whittemore and Olsen 2011). Use of any diploids that show resistance may make breeding for resistance easier. Susceptibility to Dutch elm disease is seasonal and may vary with temperature and available soil moisture. Environmentally induced resistance has been noted in drier years (Smalley and Guries 1993). It may be possible to



Distribution of *Ulmus americana*, called American or white elm, recorded in the New York Metropolitan Region during three time categories.

STU

induce resistance by inoculating trees with less aggressive strains of the fungi (Hubbes and Jeng 1981, Jeng et al. 1983).

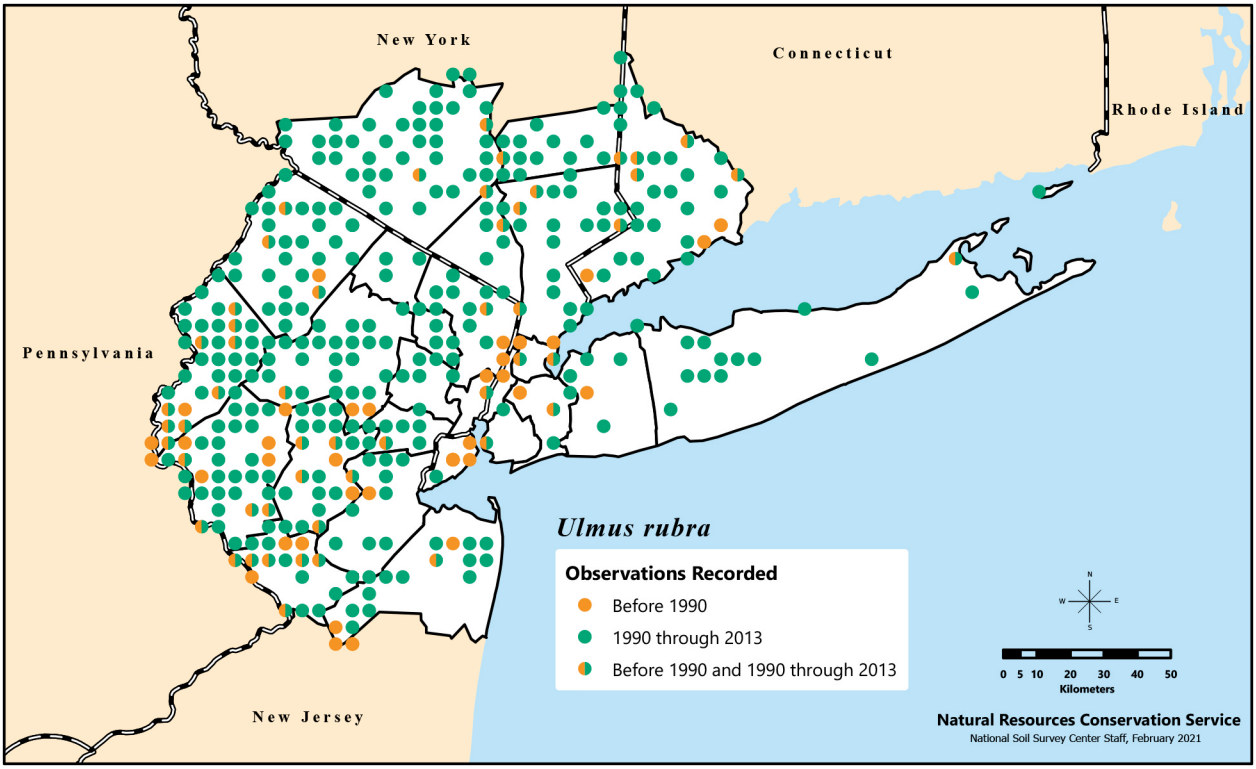
In some sites, shrub density may increase in a forest understory if dead elm density is greater than 5 stems per hectare (Dunn 1986), and resulting dense patches of shrubs could reduce tree regeneration (Huenneke 1983), though other forested sites with canopy gaps caused by increased *U. americana* mortality may be colonized by other deciduous trees, such as *Acer saccharum* and *Celtis occidentalis* (Parker and Leopold 1983). Despite an apparent increase, *U. americana* is ranked a species in need of conservation because specific gene conservation measures are needed to protect the integrity of the native gene pool due to its susceptibility to Dutch elm disease (Beardmore et al. 2006). *Ulmus americana* is genetically most closely related to *U. laevis* (European white elm), *U. mexicana* (native to Mexico and Central America), and *U. alata* (winged elm, native to the southeastern and south-central U.S.) and more closely related to *U. thomasii* (see following) than to *U. rubra* (Wiegrefe et al. 1994).

2. *Ulmus rubra* Muhl. – red elm, slippery elm ↑↑

Ulmus fulva Michx.

Flowering late Feb.–early Apr. (before the leaves appear); fruiting Apr.–May. Dry to mesic woodlands and floodplains, often on limestone soils.

Like *Ulmus americana*, *U. rubra* also increased in the region, but probably only as small-diameter trees. Earliest seed-bearing age 15 years (Barbour and Brinkman 2008b). Moist cold stratification for 2 months most likely needed to break dormancy and improve germination of stored seeds; fresh seeds may not require pretreatment to germinate (Barbour and Brinkman 2008b). Cultivated since 1830, though its ornamental value is limited because it can become a weed, colonizing any idle ground (Dirr 1998). Can also persist in flooded conditions, though it is not likely to reproduce if the flooding is prolonged (Cooley



Distribution of *Ulmus rubra*, called red or slippery elm, recorded in the New York Metropolitan Region during three time categories.

and Van Sambeek 1990). Also susceptible to Dutch elm disease but not to the degree of *U. americana* (Dirr 1998). This species shares many of the same disease and insect problems of *U. americana*. Although the wood, which is harder than *U. americana*, is considered inferior to *U. americana* wood, it is used for many of the same products, including furniture and paneling. The seeds are eaten by birds and small mammals (Cooley and Van Sambeek 1990). This species is genetically distinct among all other members of the genus (Wiegrefe et al. 1994). A diploid with 28 chromosomes. It is commonly crossed with *U. pumila*, the hybrid of which grows faster than *U. pumila*. A triploid thought to be the product of a *U. pumila* × *U. rubra* cross has been reported. Natural hybrids between *U. thomasii* and *U. rubra* have been found in WI and MO (Cooley and Van Sambeek 1990). The mucilaginous inner bark distinctive to this species was chewed by pioneers to quench thirst (Dirr 1998). This inner bark has also been used to treat edema and inflammation of the upper airway (i.e., throat irritations and laryngitis) (Watts and Rousseau 2012). Despite an apparent increase, *U. rubra* is ranked as a species in need of conservation, because specific gene conservation measures are needed to protect the integrity of the native gene pool due to its susceptibility to Dutch elm disease (Beardmore et al. 2006).

3. *Ulmus thomasii* Sarg. – rock elm Ø♥

Ulmus racemosa D.Thomas non Borkh. (illegitimate later homonym)

Flowering Mar.–early Apr. (before the leaves appear); fruiting Apr.–May. Dry ridges, rock outcrops, woodlands, and bottomlands, often on thin soils over calcareous bedrock. Epithet honors David Thomas (1776–1859), an American civil engineer who discovered the tree and first named it *Ulmus racemosa*, a later homonym.

Earliest seed-bearing age 20 years (Barbour and Brinkman 2008b). The wood of this species is heavy, hard, and tough and is used in construction (Crow 1990b) and to make furniture, agricultural implements, hockey sticks, and ax handles. Cultivated since 1903 (Dirr 1998). Susceptible to Dutch elm disease. Unlike *Ulmus americana* and *U. rubra*, *U. thomasii* can self-fertilize, but it is protandrous, making self-fertilization less likely. May hybridize with *U. pumila* and *U. laevis* (Crow 1990). Closely related to *U. serotina* (September elm; native to the southern U.S.) and *U. crassifolia* (cedar elm; native to the south-central U.S.) (Wiegrefe et al. 1994).

Ranked as a species in need of conservation because specific gene conservation measures are needed to protect the integrity of the native gene pool due to its susceptibility to Dutch elm disease (Beardmore et al. 2006). Historically uncommon in the region.

Listed as extirpated in NJ (SX) and threatened in NY (S2S3). The only records known from the region were from Sussex County (NJ).

Nonnative Species

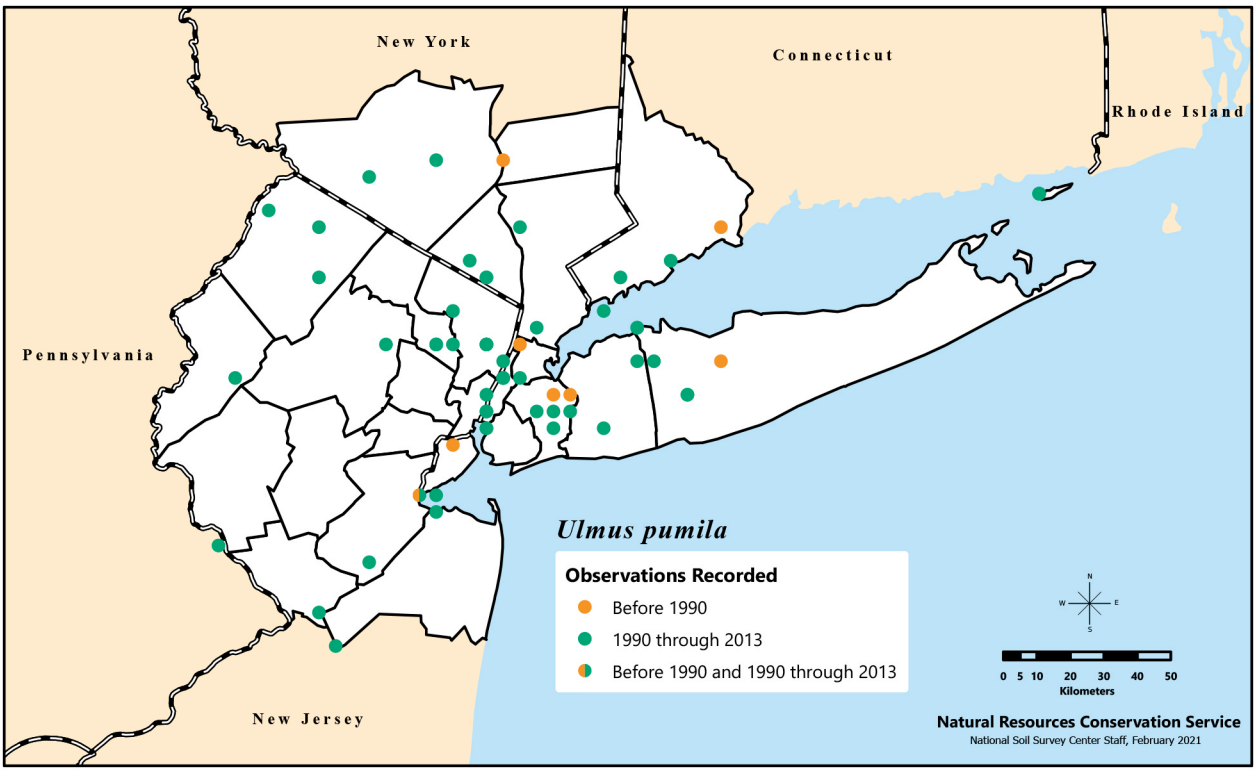
***Ulmus parvifolia* Jacq. – Chinese elm**

Native to Asia; cultivated and reported to be escaping in PA (Rhoads and Block 2007). Thus, it may be found in the region. Differs from all the elms treated here in flowering and fruiting in late summer (Aug.–Sept.) and early fall (Sept.–Oct.). Documented occurrences are lacking in the region.

4. *Ulmus pumila* L. – Siberian elm, dwarf elm ↑↑↑

Flowering Mar.–early Apr. (before the leaves appear); fruiting Apr.–May. Native to Asia; cultivated and occasionally escaping.

Earliest seed-bearing age 8 years, with 45 years between large seed crops (Barbour and Brinkman 2008b). Cultivated since 1860, with at least 8 cultivars in the U.S. A fast-growing species with little ornamental appeal, though it has been planted frequently. The wood is brittle. It is, however, resistant to Dutch elm disease as well as phloem necrosis, though elm leaf beetles (*Xanthogaleruca luteola*) can damage the foliage (Dirr 1998). Its resistance to Dutch elm disease may be due to its narrow and scattered xylem vessels, but vessel size can be seasonal (Solla et al. 2005). Unlike many nonnative species (such as *Ailanthus altissima*), the leaf litter of *Ulmus pumila* is not high in nitrogen and this species' presence in an ecosystem has little impact on the nitrogen cycle (González-



Distribution of *Ulmus pumila*, called Siberian or dwarf elm, recorded in the New York Metropolitan Region during three time categories.

Muñoz et al. 2013). However, its leaf litter may have allelopathic properties, possibly due to high concentrations of phenolic compounds, which have been shown to inhibit growth of *Trifolium repens* and *Dactylis glomerata* (Perez-Corona et al. 2013).

Hybridizes naturally with *U. minor*, producing Dutch elm disease-resistant individuals (Brunet et al. 2013), as well as with *U. rubra*. *Ulmus pumila* is an invasive tree in 41 U.S. states. A genetic analysis indicates widespread hybridization of *U. pumila* with *U. rubra*. Such hybridization increased the genetic diversity of *U. pumila* populations, which may increase the success of *U. pumila* as an invader in the U.S. This hybridization is biased toward *U. pumila* and thus threatens the genetic integrity of *U. rubra* (Zalapa et al. 2009, 2010).

The following three species are cultivated and may be encountered as cultivated escapes; it has yet to be determined that they are firmly established in the region.

Ulmus glabra Huds. – Scotch elm

Flowering Mar.–Apr.; fruiting May–June. Native to Asia and Europe.

Moderately shade-tolerant; requires deep, rich, moist soils (Edlin 1949). Intolerant of flooding and drought, but relatively tolerant of urban pollution (Thomas et al. 2018). Not commonly found in the region, but there may be a slight increase in its abundance.

Long cultivated, with at least 5 cultivars found in the U.S. (Dirr 1998) and at least 40 cultivars world-wide (Green 1964). It is highly susceptible to Dutch elm disease, but it is less favored as a host by elm bark beetles, which are vectors of the disease. The presence of alnulin (a triterpene) deters the beetles (Martín-Benito et al. 2005). *Ulmus glabra* hybridizes naturally with *U. minor* Mill., producing *U.* ×*hollandica* (and a number of new cultivars) (Green 1964). Regeneration, at least in its native region, can be very limited due to high deer (*Odocoileus* spp.) browse (Beckett and Beckett 1979).

***Ulmus* ×*hollandica* (*U. carpinifolia* × *U. glabra*) – Holland elm**

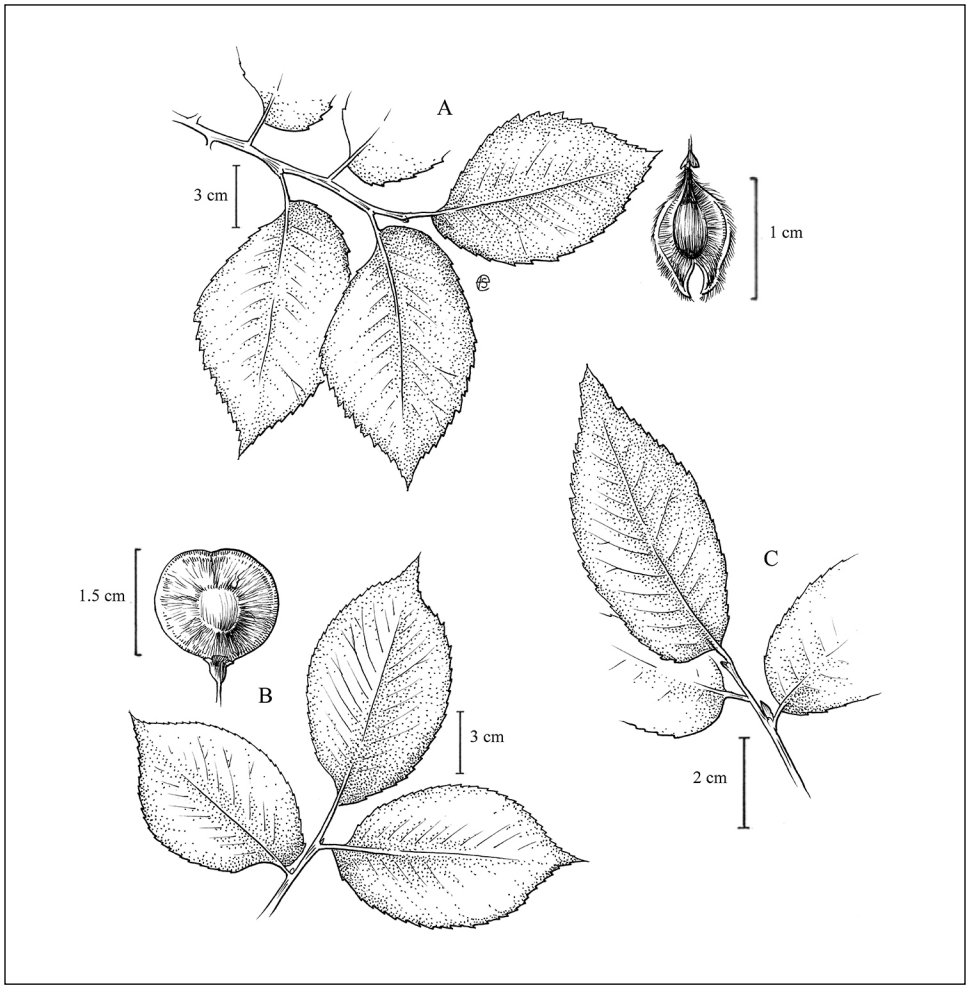
Parents native to Asia and Europe.

***Ulmus procera* Salisb. – English elm**

Native to northern Africa and western Europe. It has intermediate resistance to Dutch elm disease, with some cultivars, of which there are at least 25 used in the U.S., showing high resistance to the disease (Dirr 1998). Resistance to Dutch elm disease may be due to its smaller-diameter xylem vessels, which are less likely to undergo cavitation in response to the disease (Solla and Gil 2002).

Management

Planting of potentially resistant *Ulmus americana* and *U. rubra* is encouraged, if such resistant individual trees can be found in the region. We strongly discourage use of *U. pumila*, not only because it is highly invasive and hybridizes with *U. rubra*, but also because it makes a poor ornamental tree. Though smaller-diameter (younger) trees of *U. americana* and *U. rubra* (more so the latter due to a lower susceptibility to Dutch elm disease) may be somewhat abundant now, there is a significant risk of losing *U. rubra* to the *U. pumila* gene pool.



Fruit and leaves of A) *Ulmus americana* and B) *Ulmus rubra*; C) leaves of *Ulmus pumila*. Illustration by Emma Skurnick.

Vaccinium L. – blueberry, cranberry, deerberry

Ericaceae. Shrubs, some creeping, and trees. Species 450–500 in Africa, Asia, Europe, Madagascar, North America, South America, and the West Indies. The three subgenera here, cranberries, deerberries, and blueberries, sometimes recognized as separate genera: *Oxycoccus* Hill, *Polycodium* Raf., and *Vaccinium* L. s.s. (see Vander Kloet 1988 for treatment of *Vaccinium* s.s.) Genus name is New Latin, from Latin for "blueberry" or "whortleberry," probably not of Indo-European origin, but see Vander Kloet (1992). Blueberries are of interest for their potential health benefits (antioxidant activity) due to certain compounds they contain, such as anthocyanins, flavonoids, and polyphenols, but not all blueberries are the same (Sinelli et al. 2008). These compounds and their antioxidant activity decrease with ripening (Castrejón et al. 2008).

Native Species

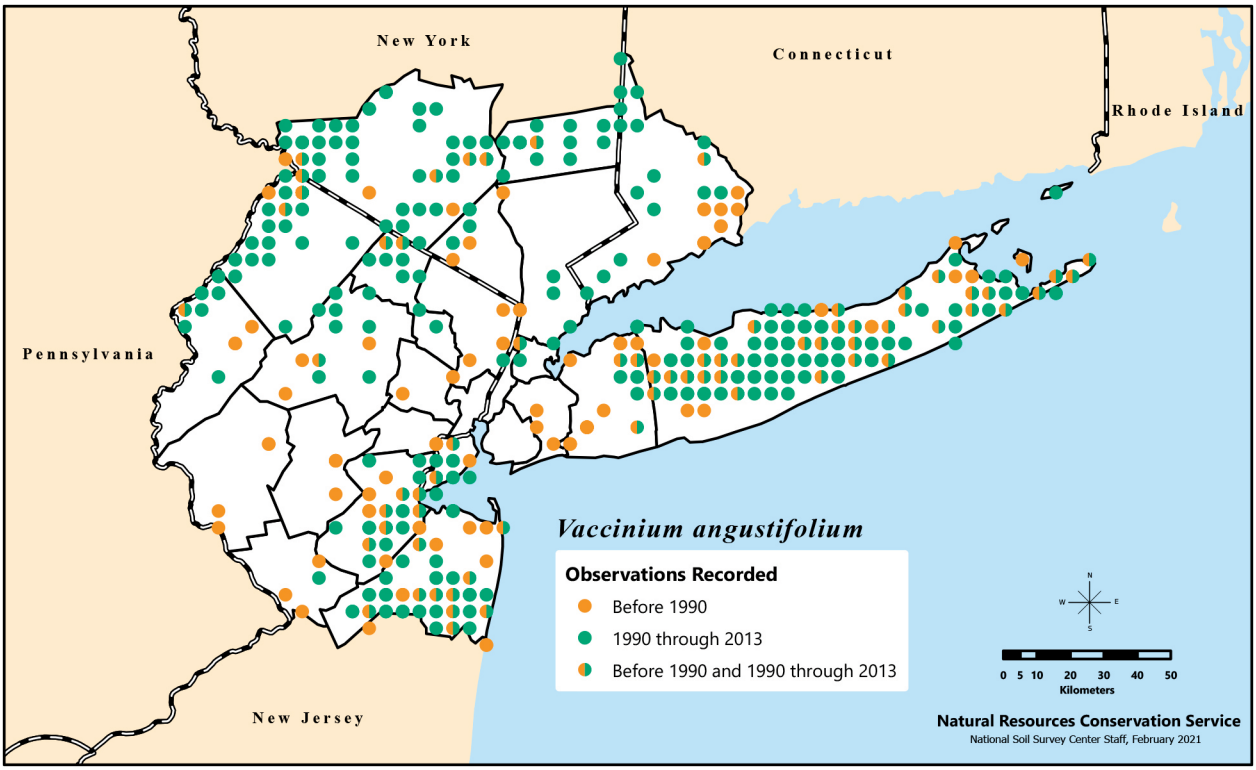
1. *Vaccinium angustifolium* Aiton – lowbush blueberry ↔

Flowering Apr.–May; fruiting June–Aug. Dry areas: sandy and rocky woods, pine clearings, dry fields, dry scrub oak woods, pine barrens, beech-hemlock-oak woods, and mixed mesic woods. Fire stimulates asexual reproduction and affects flower initiation. All plants are sterile the year following a burn but flower profusely during the second year. Important species for the assessment of pollutant impacts in boreal areas (Sheppard 1991). Epithet is Latin for "narrow leaf."

Cold stratification required for germination later in a heated greenhouse (Baskin and Baskin 2001). Rarely grows taller than 0.6 m. Prefers dry, acidic, and relatively infertile soils. An example of a managed wild crop because few, if any, commercial cultivars have been selected. Annual value of wild crops in ME at least $40 million. Six cultivars are used for ornamental purposes and not for fruit production. Cultivated since 1772 (Dirr 1998). Though irrigated wild crops produce a 43 percent higher yield, the quality of the berry is lower, apparently because rain-fed crops produce firmer berries with higher Brix solids (sugar content of an aqueous solution) and lower moisture content than berries of irrigated crops (Seymour et al. 2004). Similarly, adding fertilizer multiple times increases yield and nitrogen content of the leaf tissue of wild-grown *V. angustifolium* in NS and PE (Percival et al. 2003). However, the effect of adding fertilizer on

Vaccinium Key

1. Stems trailing; flowers 4-merous, divided to below the middle with reflexed lobes; fruit red (cranberries; *V.* subg. *Oxycoccus* (Hill) A.Gray) 2
1. Stems erect; flowers 4- to 5-merous, not deeply divided; fruit blue 3
2. Leaves ovate-oblong, ovate, or triangular, strongly whitened beneath; bracteoles scale-like, attached below the middle of the pedicel . . . . . ***Vaccinium oxycoccus***
2. Leaves oblong-elliptic, only slightly paler beneath; bracteoles leaf-like, attached above the middle of the pedicel . . . . . ***Vaccinium macrocarpon***
3. Twigs smooth and pubescent; anthers spurred (deerberries; *V.* subg. *Polycodium* (Raf.) Sleumer) . . . . . ***Vaccinium stamineum***
3. Twigs verrucose; anthers not spurred (blueberries; *V.* subg. *Vaccinium*) 4
4. Plants usually more than 1.5 m tall . . . . . ***Vaccinium corymbosum***
4. Plants less than 0.8 m tall. 5
5. Leaves sharply and uniformly serrate . . . . . ***Vaccinium angustifolium***
5. Leaves entire or irregularly serrate 6
6. Leaves glaucous, usually glabrous; twigs pubescent in lines . . . . . ***Vaccinium pallidum***
6. Leaves not glaucous, densely pubescent; twigs pilose . . . . . ***Vaccinium myrtilloides***



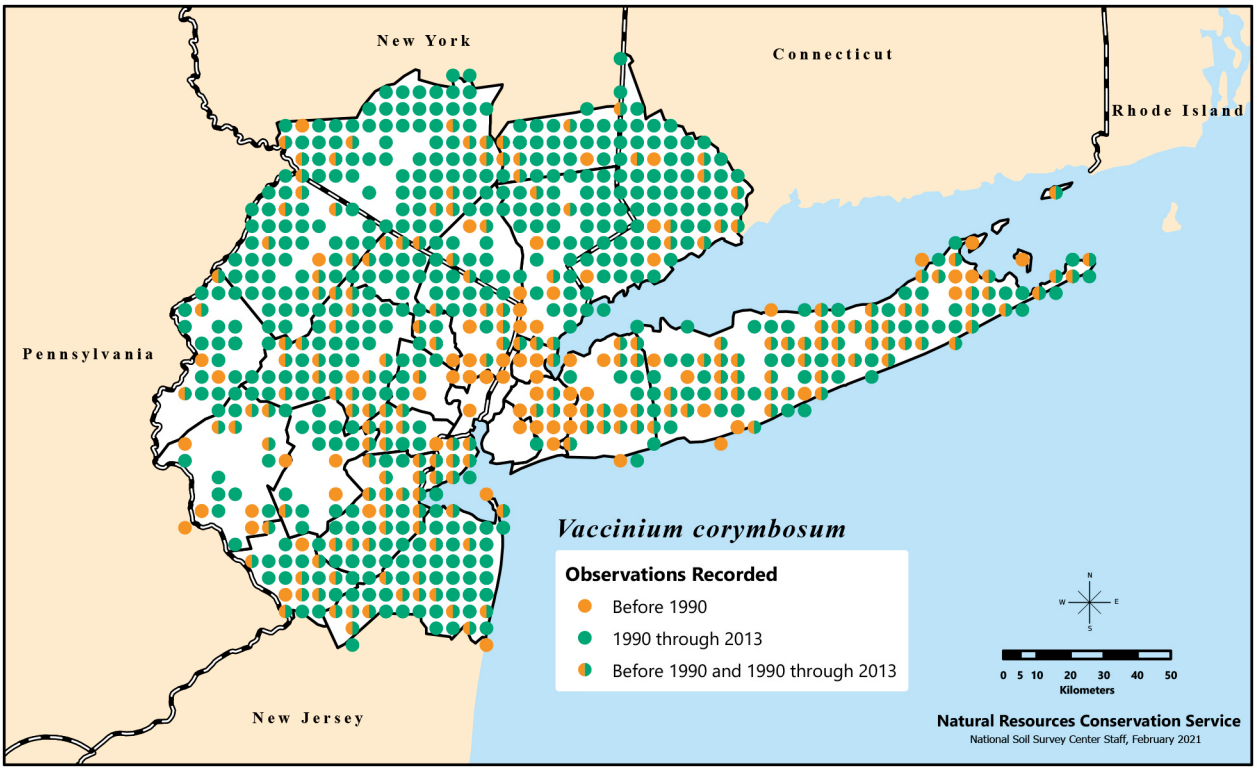
Distribution of *Vaccinium angustifolium*, or lowbush blueberry, recorded in the New York Metropolitan Region during three time categories.

fruit quality has not yet been evaluated. Shade may reduce flower and fruit production compared to plants grown in full sunlight (Hall and Ludwig 1961). This species' anthocyanins may alleviate hyperglycemia associated with diabetes (Grace et al. 2009). Species sprouts after a top-kill from fire and may also increase in cover, flower, and fruit production after a fire (Foster 1985). Increases in the region follow a triband pattern and may be due to reforestation at higher elevations.

2. *Vaccinium corymbosum* L. – highbush blueberry ↑

Flowering late Apr.–June; fruiting late June–Aug. Woodlands, woodland edges, swamps, and marshes; generally not in exceptionally dry areas. Common highbush blueberry of the region; species used in cultivation. Variable and sometimes split into three (or more species): *V. atrococcum* (A.Gray) Heller, flowering earlier (Apr.) before leaves appear, fruit black without a glaucous bloom; *V. caesariense* Mack., with leaf undersides glaucous and corollas 4–6 mm; *V. corymbosum* s.s., with leaf undersides not glaucous and corollas 6–12 mm. Epithet is from the Latin "corymbus," meaning "cluster of fruit or flowers."

Flowers just before the leaves completely open (Dirr 1998, Griffin and Blazich 2008). Prefers sandy, acidic soils in full sun or partial shade (Dirr 1998). Light levels below 60 percent full sunlight should be avoided for optimal photosynthesis and growth of the 'Bluecrop' cultivar (Kim et al. 2011). Can reach heights to 4 m. Cultivated since 1765, with at least 24 cultivars and an additional 4 southern varieties (Dirr 1998). Usually pollinated by insects, especially bees; honey bees (*Apis* spp.) may be more common in cultivated sites than wild blueberry sites, where beehives are often placed (Mackenzie and Eickwort 1996). Because the fruits are not sweet without the addition of sugar, *V. corymbosum* is primarily used as an ornamental and secondarily for fruit (Dirr 1998). Fruits on individual shrubs tend to be asynchronous with some ripening ahead of others. This asynchronous ripening may be due to seed number per fruit;



Distribution of *Vaccinium corymbosum*, or highbush blueberry, recorded in the New York Metropolitan Region during three time categories.

fruits with more seeds develop faster (Gorchov 1985). Fruits with more seeds tend to be larger and plants with abundant pollinators tend to produce fruits with more seeds (Brewer and Dobson 1969, Vander Kloet 1984). However, there is an optimal amount of pollen beyond which gains in fruit mass or fruit set do not occur; this optimal number of outcrossed pollen tetrads is about 125, which give better results than 300 pollen tetrads as well as 10 or 25 pollen tetrads (Dogterom et al. 2000). Maternal investment in fruit production appears to be regulated with a varying environment (Pritts and Hancock 1985). Though not completely self-incompatible, many cultivars of this species produce many more fruits when cross-pollinated than when self-pollinated. Self-pollination may occur only late in the season (Bieniasz 2007, MacKenzie 1997, Vander Kloet and Lyrene 1987). Self-fertilization may also lead to early-acting inbreeding depression, demonstrated by increases in seed abortions (Krebs and Hancock 1990). The seeds do not require any pretreatment; softwood cuttings collected in June propagate well.

Blueberry species are generally impacted by several insects and diseases, but only commercially grown blueberries are likely to warrant the cost of an extensive control program (Dirr 1998). *Vaccinium corymbosum* produces volatile compounds in response to herbivore damage; these compounds signal adjacent undamaged leaves and branches, which respond by producing more jasmonic acid to deter further feeding (Rodriguez-Soana et al. 2009). Increases in the region may be due to reforestation.

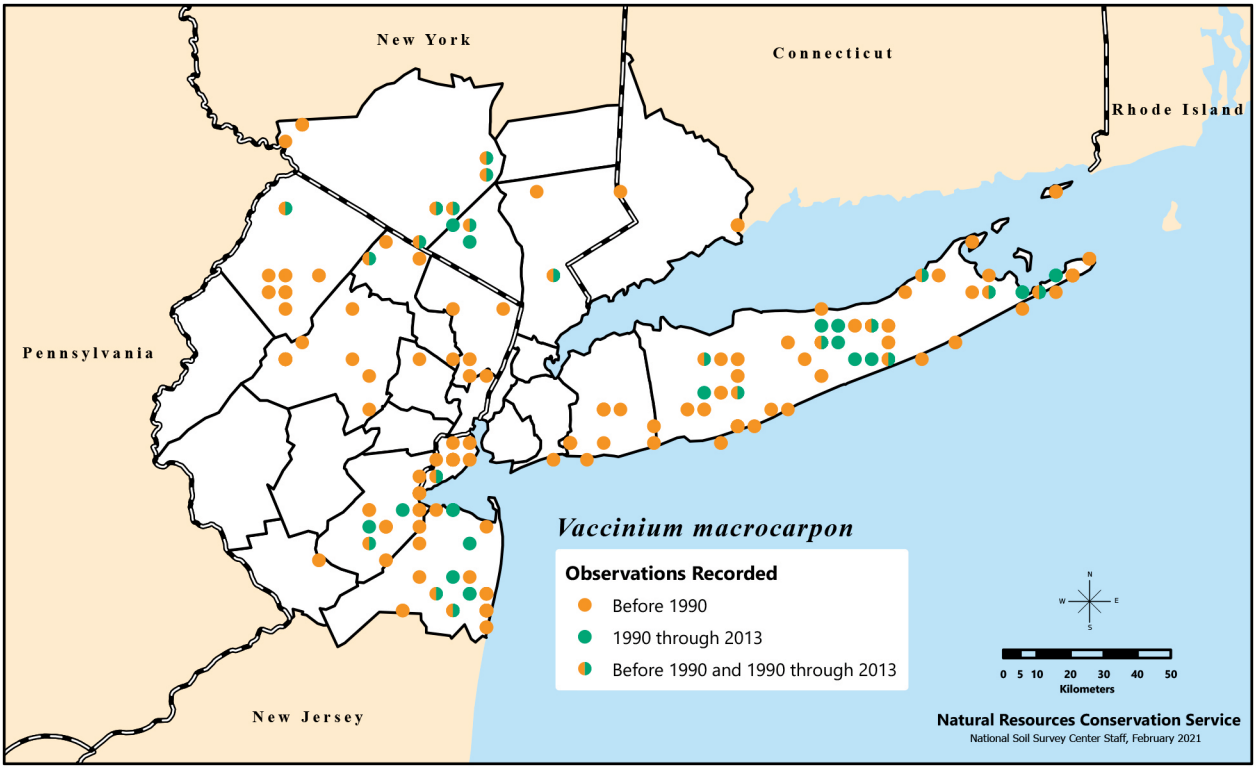
3. *Vaccinium macrocarpon* Aiton – large cranberry ↓

Flowering late June–July; fruiting late Aug.–Oct. Bogs, open swamps, and watersides. The commercial cranberry. Epithet refers to its large fruit, especially in comparison to *Vaccinium oxycoccos*.

Height at maturity about 15 cm, but horizontal spread is indefinite. Honey bees visit cranberry flowers for nectar and to a lesser extent pollen.

Those that visit for pollen tend to be pollen-hoarders, a specific honeybee genotype. Cranberry flowers visited by pollen-hoarders receive four times as much pollen than those visited by nectar-foragers; more pollen loading per stigma increases the likelihood of fruit set. Hence, using honey bees with the pollen-hoarding genotype could result in greater cranberry production (Cane and Schiffhauer 2001). This species can self-fertilize, but more fruit set is achieved with cross-pollination because the self-fertilized seeds are more likely to abort. Later flowers are less likely to set fruit (Cane and Schiffhauer 2003). The upper flowers do not produce fruit, even if pollinated, when the lower flowers produce fruit, which suggests that growth inhibitors may be controlling whether energy is put into fruit production of the later, upper flowers (Brown and McNeil 2006). Cold stratification for 3 months required for germination. *Vaccinium macrocarpon* can also be propagated from softwood cuttings. Prefers full sun, possibly light shade; roots must be kept cool and moist. Cultivated since 1760, with 2 cultivars. Greater fruit production with mycorrhizal infections (Stribley and Read 1976, Stribley et al. 1975). Weed competition from plants such as *Cuscuta gronovii* (swamp dodder) (Bewick et al. 1988) can reduce the yield of cranberry, and has prompted research on transgenic cranberry that can tolerate herbicides with broad spectrum activity, low toxicity to animals, and short soil half-lives (Zeldin et al. 2002). This species is the cranberry from which most of the commercial cranberry juice, gelatins, sauces, and other products are made. Diseases and insects are a problem for commercial growers (Dirr 1998).

This species, which is a diploid, is probably closely related to *V. oxycoccos*, and is considered the more primitive of the two species (Jacquemart 1997). Despite the lower success of self-fertilized seed, *V. macrocarpon* populations have surprisingly low levels of genetic diversity (comparing 10 populations ranging from WI to DE). This could be of concern because of possible large losses if there were a disease outbreak. If this lack of genetic variation is due to a genetic bottleneck that occurred during the Pleistocene



Distribution of *Vaccinium macrocarpon*, or large cranberry, recorded in the New York Metropolitan Region during three time categories.

(i.e., during glaciation), then unglaciated areas where this species also occurs (relict populations in the Appalachian Mountains) but were not sampled, could be a source of greater genetic diversity (Bruederle et al. 1996). Another source of genetic diversity may be Canadian clones and cultivars, which were genetically distinguishable in a more recent study using RAPD-PCR (random amplification of polymorphic DNA by the polymerase chain reaction). This study detected no geographical pattern despite a great deal of genetic diversity among the clones, a result that was also attributed to a glacial bottleneck (Debnath 2007). Cranberries have several medicinal and other economic uses beyond a food source, including treatment or prevention of urinary tract infections (Pérez-López et al. 2009), a food preservative (Wu et al. 2009a), and use of the polyphenols to fight cardiovascular disease (McKay and Blumberg 2007) and some cancers (Yan et al. 2002). Decreases in the region have not been attributed to a particular cause.

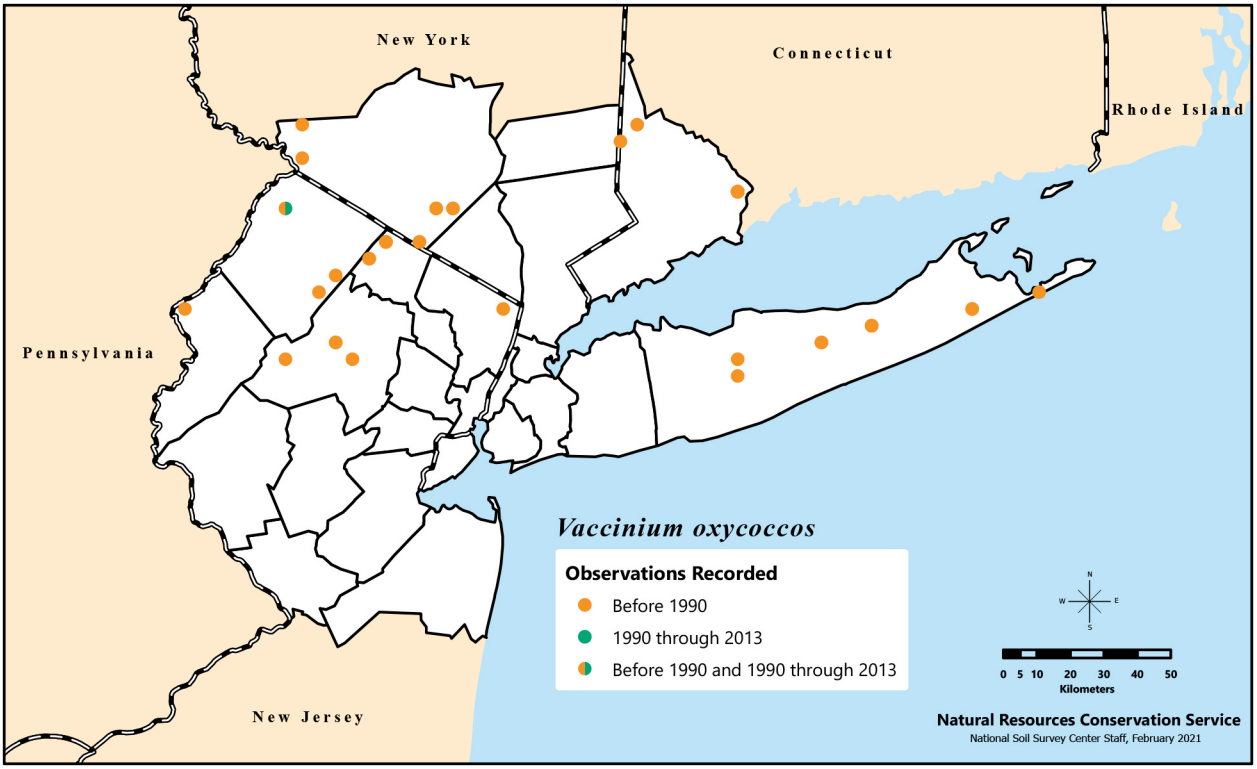
4. *Vaccinium myrtilloides* Michx. – sourtop Ø

Flowering May–June; fruiting July–Sept. Bogs, open swamps, and watersides. More common in upstate NY; has been reported from unspecified localities in Orange County (NY), but no specimens have been seen. There are also records just adjacent to the region in Litchfield County (CT) and Ulster and Dutchess Counties (NY). Epithet refers to the similarity of this species to the European bilberry, *Vaccinium myrtillus* L.

Listed as endangered in CT (S1).

5. *Vaccinium oxycoccos* L. – small cranberry ↓↓↓

Flowering late May–July; fruiting late Aug.–Oct. Bogs and watersides. Prefers acidic soils with humus-type peat, and prefers hollows over hummocks (Jacquemart 1997). Epithet is the Greek generic name for the cranberry, meaning "sour fruit."



Distribution of *Vaccinium oxycoccos*, or small cranberry, recorded in the New York Metropolitan Region during three time categories.

A circumboreal species (Fröborg 1996), occurring in Asia, Europe, and North America (Mahy et al. 2000). Thought to be extirpated from the Pyrenees, Spain, Italy, Croatia, and Romania (Jacquemart 1997). Evergreen shrub (Dirr 1998). Berries remain on the plant over winter and are dispersed by water, birds, and mammals in early spring. Seeds collected in early spring germinate easily without any stratification requirements. Seeds collected in Oct. may or may not require a cold stratification. Does not appear to form a seed bank. Its shallow root system makes it reliant on sphagnum for water (Jacquemart 1997). A diploid, tetraploid (more common in the NY Metropolitan Region), and a hexaploid (only in Europe) (Mahy et al. 2000). Cultivated since 1789 (Dirr 1998). Though fruit set is less abundant in flowers that have been self-fertilized, there was no significant difference in overall fruit set between self-pollinated and cross-pollinated plants in one study, suggesting that this species is not as strongly self-incompatible as other *Vaccinium* spp. (Fröborg 1996). Protandrous and insect pollinated, but self-pollination is common in its native regions (Jacquemart 1997). Forms mycorrhizal infections (Jacquemart 1997). In Europe, *V. oxycoccos* does not appear to compete well with other insect-pollinated shrubs (Van Rossum et al. 2013). Distribution of this species in England and Ireland has substantially decreased, most likely due to drainage operations that make the land too dry (Jacquemart 1997). A loss of habitat for similar reasons or a lack of pollinators (or a combination thereof) may explain its decline in the region.

Tracked as imperiled in NJ (S2).

6. *Vaccinium pallidum* Aiton – lowbush blueberry, hillside blueberry ↑

Vaccinium vacillans Torr.

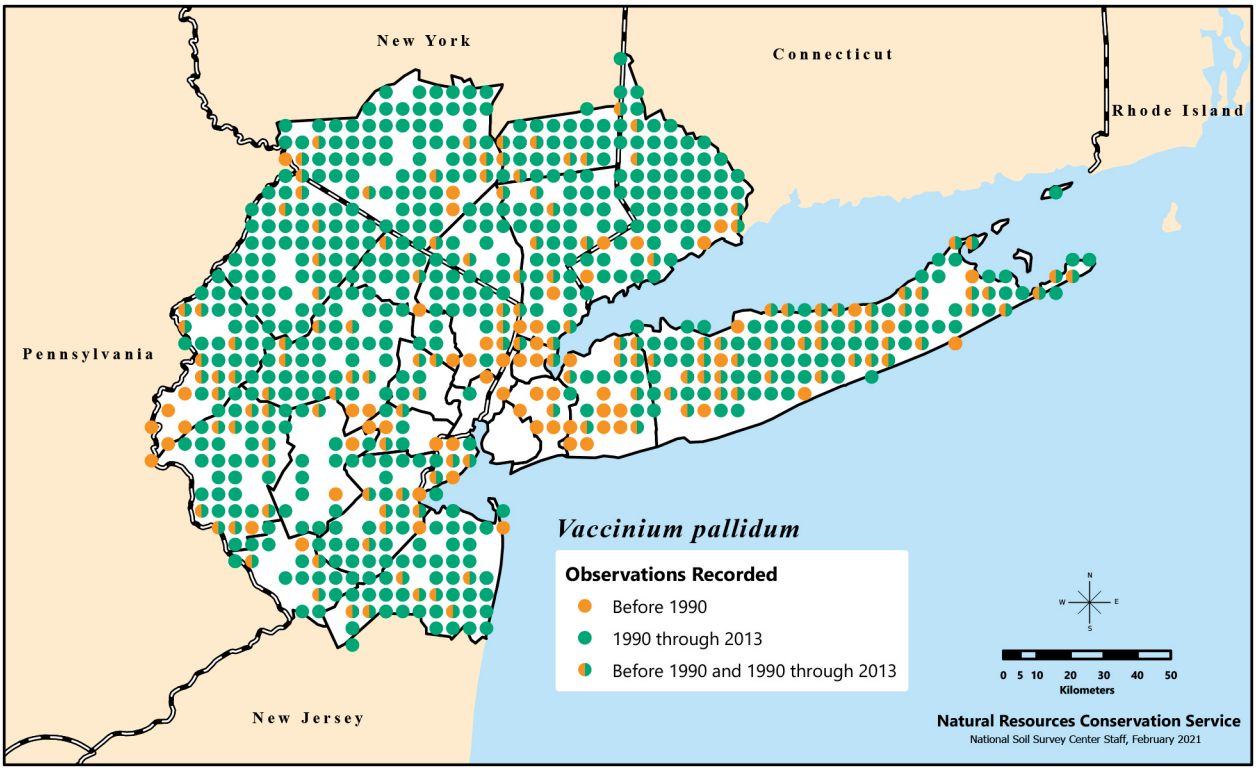
Flowering late Apr.–May; fruiting late Aug.–Oct. Dry upland woods and woodland edges, bluffs, glades, ridges, and slopes with acidic soils (Kurz 1997). Most common lowbush blueberry of the region. Epithet from the Latin for "pale," possibly a reference to the lower leaves.

The fruits are eaten by rabbits (family Leporidae), foxes (*Vulpes* spp.), white-tailed deer (*Odocoileus virginianus*), and birds. White-tailed deer also eat the foliage (Kurz 1997). The taxonomic status of this species is in question possibly due to hybridizations between it and other *Vaccinium* spp. Nonetheless, currently, this species is recognized as separate from *V. angustifolium* by leaf width and margin (*V. pallidum* leaves are wider and entire or irregularly serrate). It is differentiated from *V. corymbosum* by plant height (shorter than *V. corymbosum*) (Vander Kloet 1978). *Vaccinium pallidum* is considered synonymous with *V. vacillans* (Uttal 1986, 1987). Increases the first growing season after a prescribed fire via stem sprouts but is likely to return to prefire abundance by the next growing season (Matlack et al. 1993). More resistant to intensive fires than *Gaylussacia baccata* (Brayton and Woodwell 1966). However, burns that occur more often than every 3 years will reduce the cover of this species by as much as 50 percent compared to *V. pallidum* cover found on less frequently burned sites (Buell and Cantlon 1953). Seed banks, though uncommon, have been documented for this species (Matlack and Good 1990, Schiffman and Johnson 1992). Increases in the region may be due to reforestation.

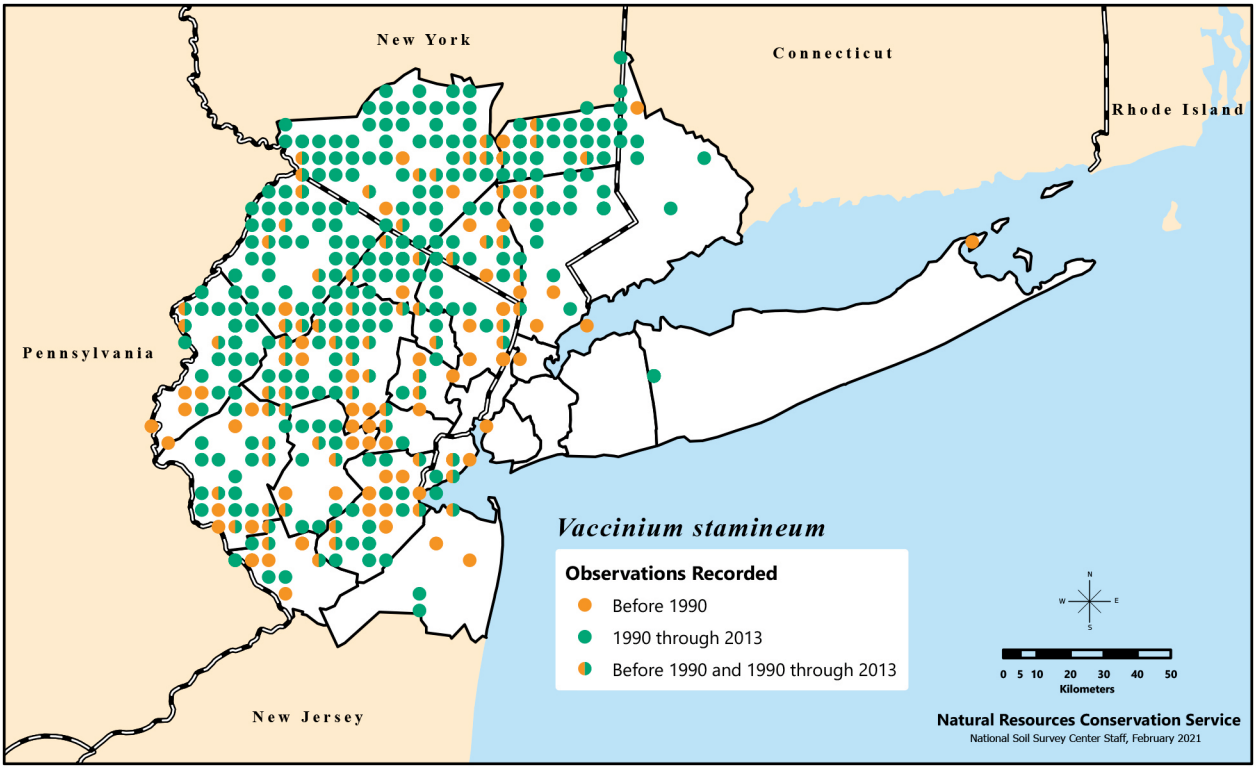
7. *Vaccinium stamineum* L. – deerberry ↑

Flowering late Apr.–June; fruiting late July–Oct. Dry upland woods and woodland edges. Flowers open prior to anthesis (no bud); fruits generally not as edible, having a tough skin and dropping quickly. Epithet from Latin refers to the flowers' prominent stamens.

Prefers well-drained, sandy soils. Height at maturity 3 m (Dirr 1998), but most found in the wild do not reach much above 1–1.3 m (Gleason and Cronquist 1993). Habit may vary from stoloniferous to having a single stem (Ballington 1995). Flowers appear with the leaves (Dirr 1998). Pollinated by insects (Ballington 1995). Successful fruit set requires pollination by sonication of anthers (or buzz pollination), which only a few pollinators accomplish, one of the most important of which is *Melitta americana*, a solitary, oligolectic bee (one with specialized pollen preferences, often limited to one plant species or genus). This bee sonicates the anthers while it forages for nectar. Other frequent visitors



Distribution of *Vaccinium pallidum*, called lowbush or hillside blueberry, recorded in the New York Metropolitan Region during three time categories.

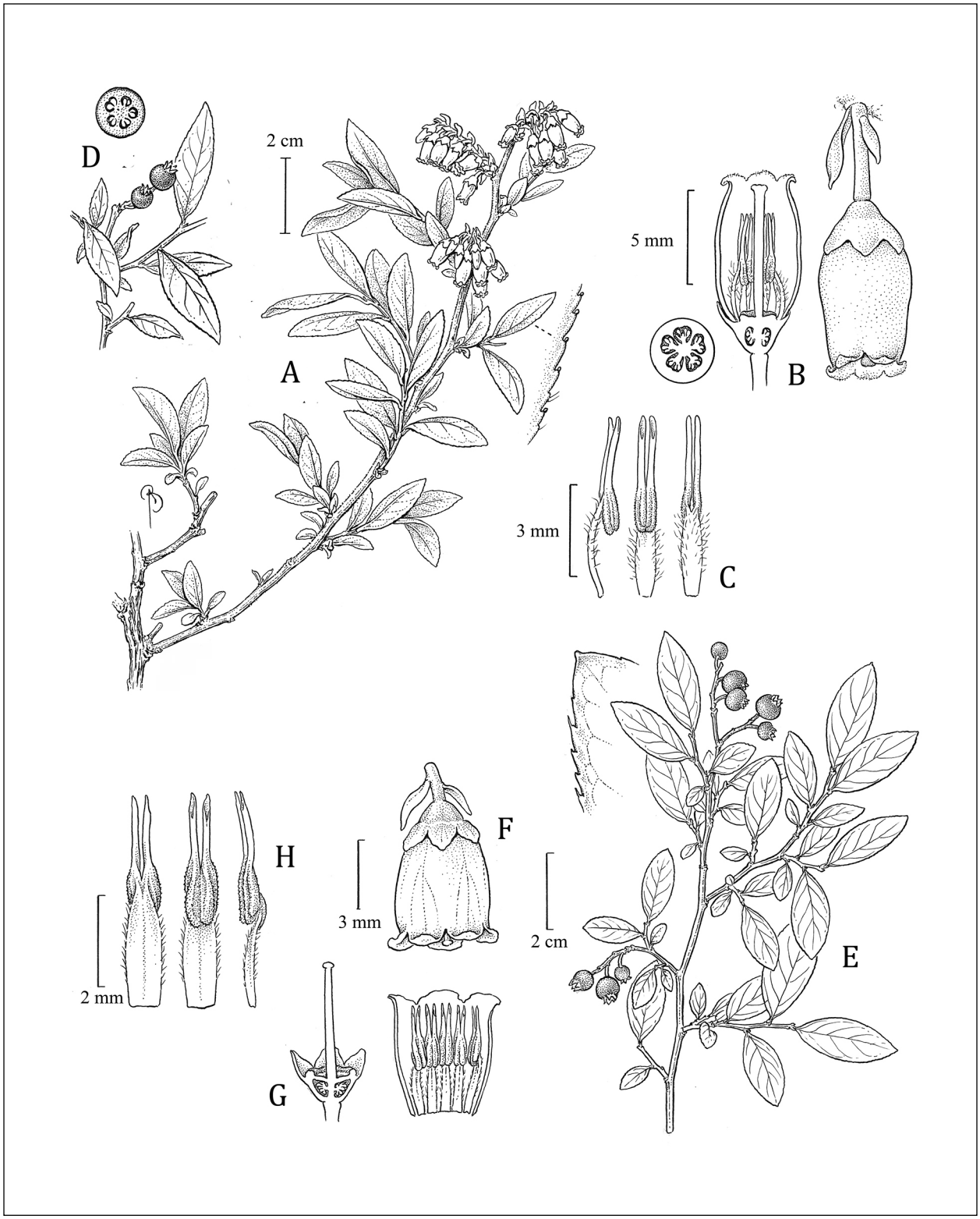


Distribution of *Vaccinium stamineum*, or deerberry, recorded in the New York Metropolitan Region during three time categories.

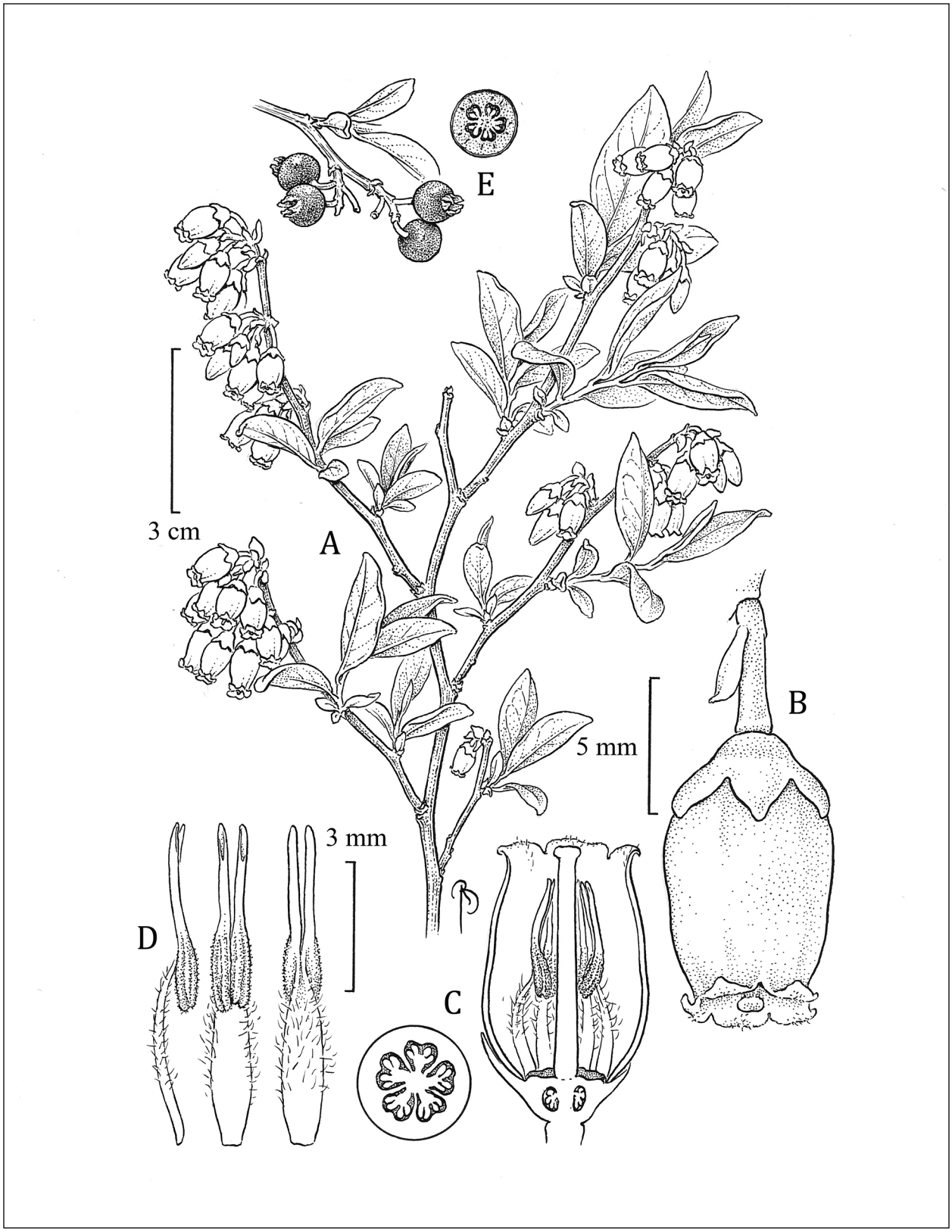
to *V. stamineum* flowers do not provide this same service. Thus, the types of pollinators that are available can be critical for this species (Cane et al. 1985). Fruits are eaten by foxes, white-tailed deer, and birds. White-tailed deer also eat the foliage (Kurz 1997). *Vaccinium stamineum* is a polymorphic diploid species (Ballington 1995). Though highly clonal, clonal populations may still contain high genetic diversity, probably due to seedling recruitment (Kreher et al. 2000). Its fruit flavor and the presence of anthocyanins and flavonols are similar to cranberry, but soluble solids content can be high, unlike cranberry. Genotypes that provide large fruit, high palatability, and resistance to shattering have been identified (Ballington 1995, Wang and Ballington 2007). This species has been used historically in the southern U.S. for jams, pies, and jellies, and has been considered for use as a commercial small fruit crop (Ballington 1995). Increases in the region may be due to reforestation.

Management

Blueberries and cranberries are of tremendous economic importance. There is concern about a lack of genetic diversity in some species, especially the cranberries. Given the potential for a devastating population crash due to disease or insects, efforts should be made to describe the genetic integrity of these species. Development and use of transgenic herbicide-resistant crops to allow for greater control of weeds should be evaluated for all the risks involved. Managing wild populations of each species that shows signs of successful outcrossing should be a first step to help maintain and possibly increase genetic diversity. Fire may be a tool that could temporarily increase abundance and flowering of several blueberry species.



A) Flowering leafy twig, with enlarged view of leaf margin; B) ovary cross-section, flower cross-section, and flower, C) stamens; and D) fruiting leafy twig and cross-section of fruit of *Vaccinium angustifolium*; and E) fruiting leafy twig with enlarged view of leaf margin, F) flower, G) cross-sections of pistil and flower with part of the corolla removed, and H) stamens of *Vaccinium pallidum*. Illustration by Bobbi Angell.



A) Flowering leafy twig, B) flower, C) cross-sections of ovary and flower, D) stamens, and E) fruiting leafy twig and cross-section of fruit of *Vaccinium corymbosum*. Illustration by Bobbi Angell.

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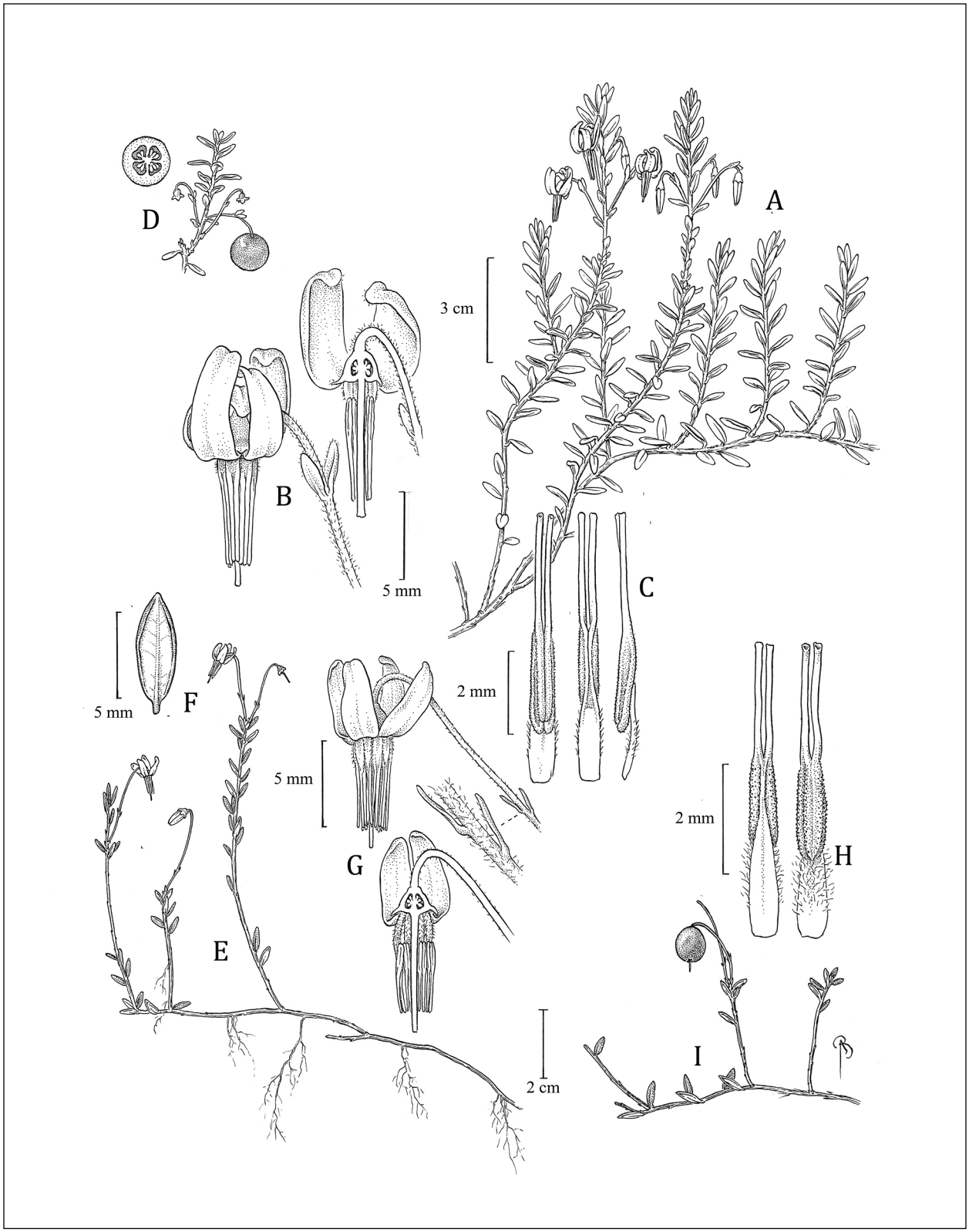

A) Flowering leafy twig, B) flower and its cross-section, C) stamens, and D) fruiting leafy twig and cross-section of fruit of *Vaccinium macrocarpon*; E) flowering leafy twig; F) leaf; G) flower, with enlarged view of bracteoles, and flower cross-section; H) stamens; and I) fruiting leafy twig of *Vaccinium oxycoccos*. Illustration by Bobbi Angell.

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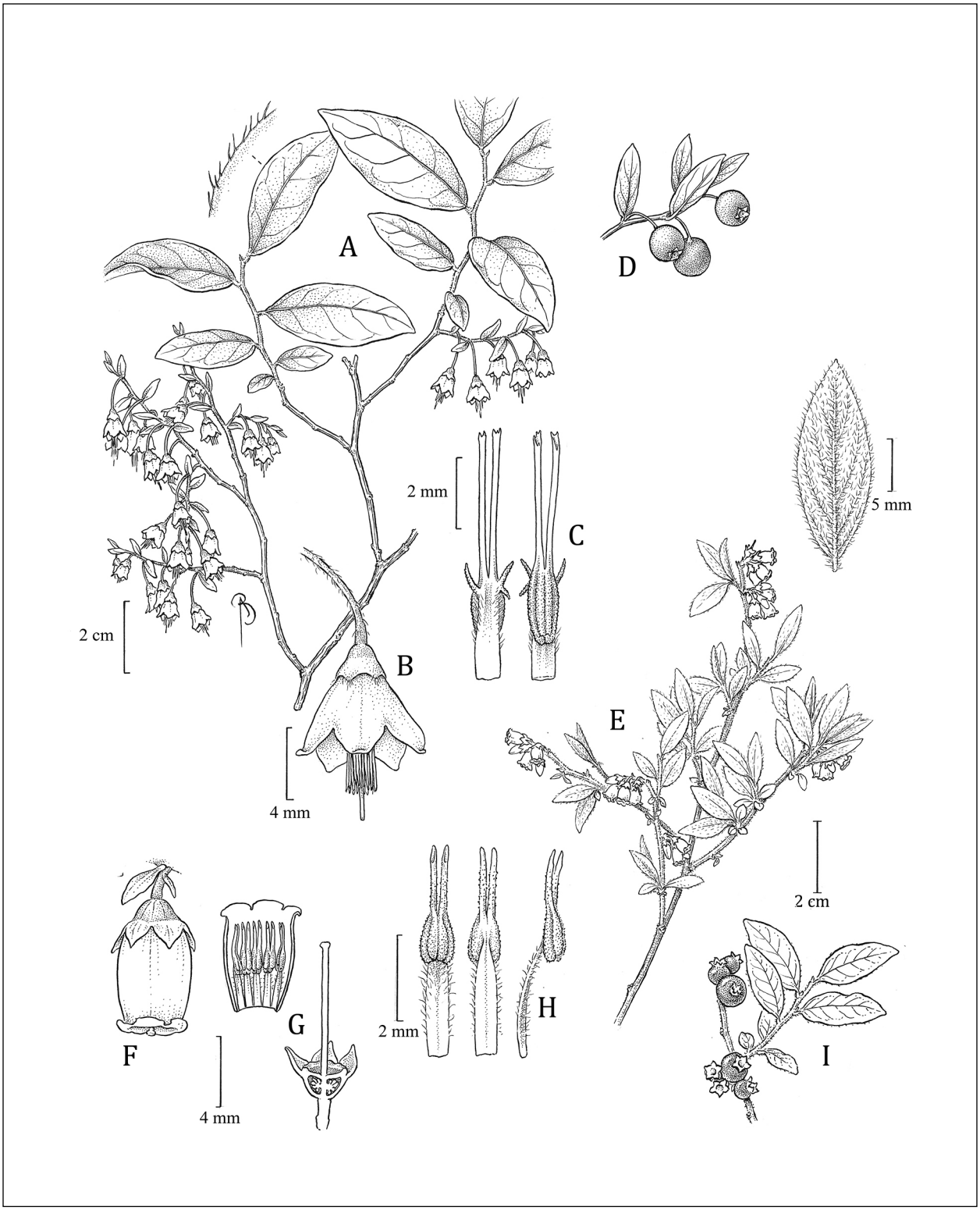


A) Flowering leafy twig with enlarged view of leaf margin, B) flower, C) stamens, and D) fruiting twig of *Vaccinium stamineum*; E) flowering leafy twig and leaf showing dense pubescence, F) flower, G) cross-sections of flower and ovary, H) stamens, and I) fruiting leafy twig of *Vaccinium myrtilloides*. Illustration by Bobbi Angell.

V W
X Y Z

Viburnum L. – arrow-wood, wild raisin

Adoxaceae (Caprifoliaceae s.l.). Small trees, shrubs. Species 120+ in northern Africa, Asia, Central America, Europe, and North America. *Viburnum* is the ancient Latin name for *V. lantana*; its origins possibly Etruscan. Bees (e.g., *Andrena*, *Augochlorella*, *Augochloropsis*, *Dialictus*, *Lasioglossum*, *Osmia*, *Xylocopa*) and dipterans, such as mosquitoes (e.g., *Aedes*) and hover flies (e.g., *Temnostoma*) are the main pollinators (Cane et al. 1985, Magnarelli 1983, Waldbauer 1984). The seeds are dispersed by many birds and small mammals that eat the fruits (Martin et al. 1951, Ridley 1930, Stol et al. 1980). The viburnum leaf beetle (*Pyrrhalta virburni*) was introduced into the U.S. from Europe as early as 1996 in NY (Majka and LaSage 2007); the most susceptible viburnums are the natives *V. dentatum*, *V. opulus* var. *americanum*, and *V. rafinesquianum*, and the nonnatives *V. opulus* var. *opulus*, and *V. lantana* (Desurmont et al. 2012, Weston et al. 2007). Plants in the shade suffer greater feeding damage than plants in the sun. Repeated defoliations by this beetle kill the shrub. Defoliations occur twice in a growing season, first by the larvae and then by the adults; mature shrubs may die within 3 years of initial defoliation (Weston et al. 2007, 2008). Viburnum seeds are slow to germinate, and most species have embryo dormancy as well as seedling (epicotyl) dormancy and hard seed coats (Fedec and Knowles 1973). Seedling dormancy may be overcome by removal of the cotyledons or by a treatment of gibberellic acid. Stratification for 180+ days at daytime temperatures of 30 °C and nighttime temperatures of 20 °C followed by 60–120 days at 5 °C in moist soil or peat has given good results (Giersbach 1937b). Seeds stored in the pulp in a sealed container at 5 °C showed no loss of viability after 2 years. Dried seeds can be stored at low temperature for several years (Young and Young 1992). The native species are preferentially browsed by deer (*Odocoileus* spp.). Species in the region are generally placed in the following sections: *Lentago* (*V. lentago*, *V. nudum*, *V. prunifolium*); *Odontotinus* Rehd. (*V. acerifolium*, *V. dentatum*, *V. dilatatum*, *V. rafinesquianum*, *V. setigerum*); *Opulus* DC (*V. opulus*); *Pseudopulus* Dipp. (=*Tomentosa*; *V. plicatum*); *Pseudotinus* Clarke (*V. lantanoides*); *Thyrsosma* (Raf.) Rehder (=*Solenotinus*; *V. seiboldii*); *Viburnum* (=*Lantana*; *V. lantana*). Results from recent molecular phylogenetic studies (e.g., Winkworth and Donoghue 2005) question the traditional circumscriptions of some of these sections. The bark of viburnums has been used to treat urinary tract infections and malaria. Some Native Americans make a tea from the bark of viburnums to increase urine flow (Kurz 1997).

Native Species

1. *Viburnum acerifolium* L. − maple-leaf viburnum ↑

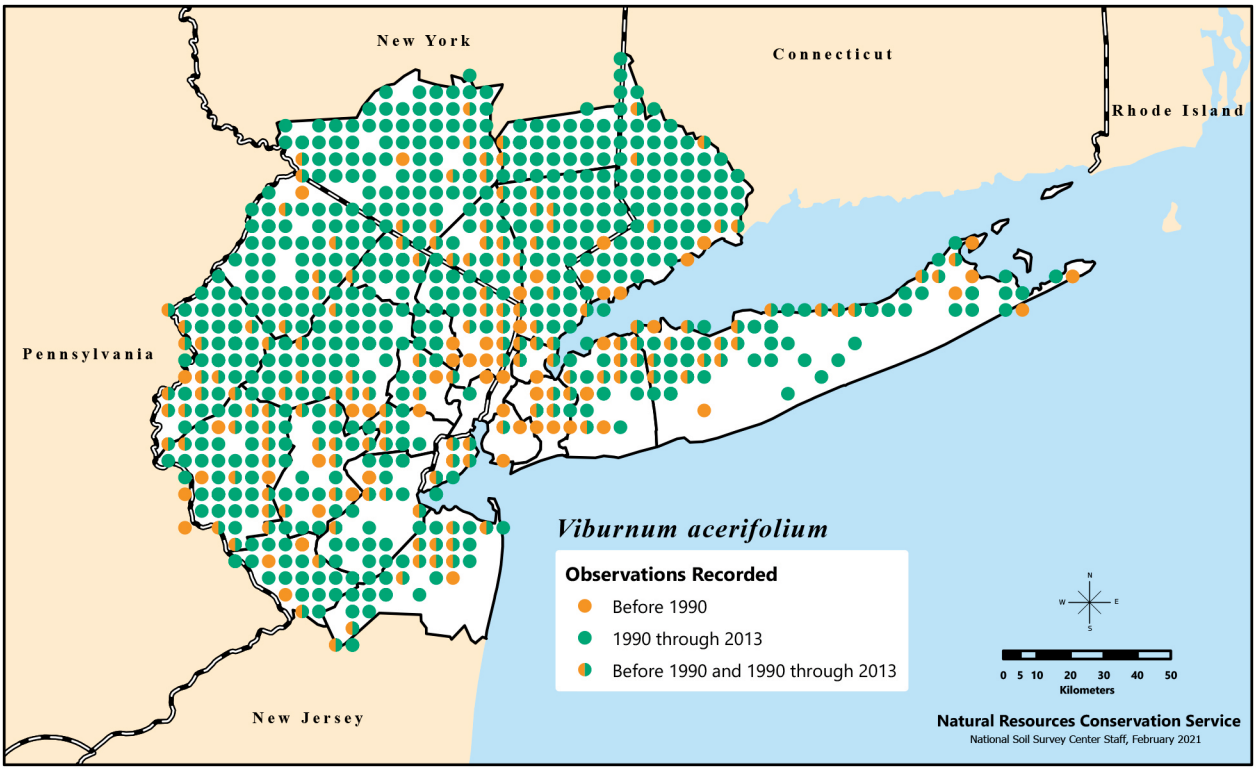
Shrub. Flowering early May–late June. Dry to mesic woodlands. Epithet from Latin is in reference to the trilobed leaves of the species, which superficially resemble those of *Acer* (maple). Exceptionally shade-tolerant and adapted to dry soils (Dirr 1998), but found in a wide range of both soil moisture and nutrient conditions. Retains higher concentrations of nutrients in its foliage under stressful drought conditions than under more mesic conditions (Minoletti and Boerner 1994).

Earliest seed-bearing age about 2–3 years. Larger seed crops occur every other year. Stratification treatments include a warm stage for 180–510 days followed by a cold treatment for 60–120 days (Bonner et al. 2008). The seeds of *V. acerifolium* have epicotyl dormancy, also known as morphophysiological dormancy. The warm treatment is required for radicle elongation; the cold treatment is required for the epicotyls to elongate. The radicle generally emerges in Oct., and the epicotyl begins to emerge in Nov.–Jan. Though only one cold treatment and one warm treatment are necessary, seeds generally go through two cold treatments because seeds are dispersed in winter (Hidayati et al. 2005). Height at maturity 2 m. (Bonner et al. 2008).

Based on both chloroplast and nuclear loci, *V. acerifolium* (a purple-fruited New World viburnum) appears to be more closely related to red-fruited Old World *Viburnum* spp., including *V. dilatum* (eastern Asia) and *V. kansuense* (a

Viburnum Key

1. Leaves lobed 2
1. Leaves without lobes (margins entire or dentate) 3
2. Young branchlets pubescent; abaxial leaf surface with stellate pubescence and red-brown glands; mature fruit blue-black (immature fruit scarlet) . . . . . ***Viburnum acerifolium***
2. Branchlets glabrous; abaxial leaf surface with a few straight hairs or glabrous and without glands; mature fruit scarlet . . . . . ***Viburnum opulus****
3. Winter buds naked or scaly; leaf teeth outer margins 1.5 mm or less in length or margins entire; mature fruit red, purplish, or blue-black (immature green, white, pink, red) 4
3. Winter buds scaly; leaf teeth outer margins 2 mm or more in length; mature fruit blue-black (immature green, pink, or red) 5
4. Leaf margins entire . . . . . ***Viburnum nudum***
4. Leaf margins with teeth or wavy 6
5. Petiole and abaxial leaf surface glabrous (or with a few straight hairs). . . . . ***Viburnum dentatum* (var. *lucidum*)**
5. Petiole and abaxial leaf surface with stellate hairs 7
6. Leaf teeth widely spaced, 2 or fewer per cm; mature fruit red . . . . . ***Viburnum setigerum****
6. Leaf teeth closely spaced, 3 or more per cm; mature fruit red, purplish, or blue-black (immature white, pink or red) 8
7. Leaf bases long-cuneate; leaf margins lacking teeth on lower 1/4 to 1/3 of blade; crushed leaf with disagreeable odor (petroleum, pepper); cymes paniculate . . . . . ***Viburnum sieboldii****
7. Leaf bases rounded-acute; teeth extending to base of blade; crushed leaves lacking strong odor; cymes umbelliform 9
8. Petioles and abaxial leaf surface glabrous 10
8. Petioles and abaxial leaf surface with stellate hairs. 11
9. Petioles 8 mm or less in length; linear stipules persistent . . . . . ***Viburnum rafinesquianum***
9. Petioles 9 mm or more in length; stipules absent 12
10. Leaf teeth with rounded apices . . . . . ***Viburnum nudum***
10. Leaf teeth with sharp, pointed apices. 13
11. Winter buds scaly; abaxial leaf surfaces with clear (sometimes red-brown), shiny glands; mature fruit red . . . . . ***Viburnum dilatatum****
11. Winter buds naked; abaxial leaf surfaces without glands; mature fruit purplish to black 14
12. Stellate hairs on abaxial leaf surface limited to primary veins . . ***Viburnum dentatum* (var. *dentatum*)**
12. Stellate hairs on abaxial leaf surface throughout 15
13. Petioles with bumpy, wavy margins; leaf apices acuminate; leaves light green . . . . ***Viburnum lentago***
13. Petioles without bumpy, wavy margins; leaf apices acute; leaves dark green. . . ***Viburnum prunifolium***
14. Leaves mostly more than 7 cm wide; marginal flowers of cyme sterile and enlarged . . . . . ***Viburnum lantanoides***
14. Leaves mostly less than 7 cm wide; marginal flowers of cyme fertile and not enlarged . . . . . ***Viburnum lantana****
15. Stellate hairs stout, red-brown; leaf apices usually acute; marginal flowers of cyme fertile and not enlarged . . . . . ***Viburnum dentatum* (var. *venosum*)**
15. Stellate hairs thin, clear; leaf apices usually abruptly acuminate; marginal flowers of cyme often sterile and enlarged . . . . . ***Viburnum plicatum****



Distribution of *Viburnum acerifolium*, or maple-leaf viburnum, recorded in the New York Metropolitan Region during three time categories.

Chinese species) than to other purple-fruited New World species (Winkworth and Donoghue 2005). Fruit of *V. acerifolium* considered fall, low-quality fruit. Fruit contains relatively low percentage dry weight of lipids and remains on the plants well into winter with slow dissemination by birds. Other species with higher quality fruits, such as *Lindera benzoin* and *Rubus allegheniensis*, are rapidly dispersed by Oct. (Stiles 1980). *Viburnum acerifolium* can form a seed bank, at least for 1 year (Schiffman and Johnson 1992). Although a common native understory species of eastern deciduous forests, *V. acerifolium* has also been cultivated since 1736 (Bonner et al. 2008), but with no notable culivars (Dirr 1998). It forms colonies with root sucker sprouts and rooting of decumbent aerial shoots. This species may dominate some forest understories due to this clonal growth (Pickett and Kempf 1980). Unlike tree species with lobed leaves that benefit from increased photosynthetic activity in young leaf lobe tips and marginal teeth, *V. acerifolium* and several other shrub species with lobed leaves do not show similar increases in photosynthetic activity (Baker-Brosh and Peet 1997). Increased presence in the region may be related to reforestation.

2. *Viburnum dentatum* L. – arrow-wood ↑↑

Shrub. Flowering late May–July. Dry to mesic woodlands, woodland edges, thickets, and old fields, in a wide variety of soil types. Epithet from Latin refers to the dentate leaf margins of the species. Though not as common as *V. acerifolium*, especially in forest understories, *V. dentatum* is commonly found in the northeastern U.S. (Meiners and Stiles 1997). Prefers open areas or areas with moderate shade, but it can tolerate areas of high shade as well as soils that are high in salt (Dirr 1998, Kurz 1997). Apparently prefers moist soil conditions with ample light (Kurz 1997) and is often found in early successional habitats, such as old fields (Meiners and Stiles 1997).

Viburnum dentatum as circumscribed here exhibits significant morphological and phenological variation. Numerous varieties (or sometimes separate species) have been recognized. In the

Viburnum dentatum Key

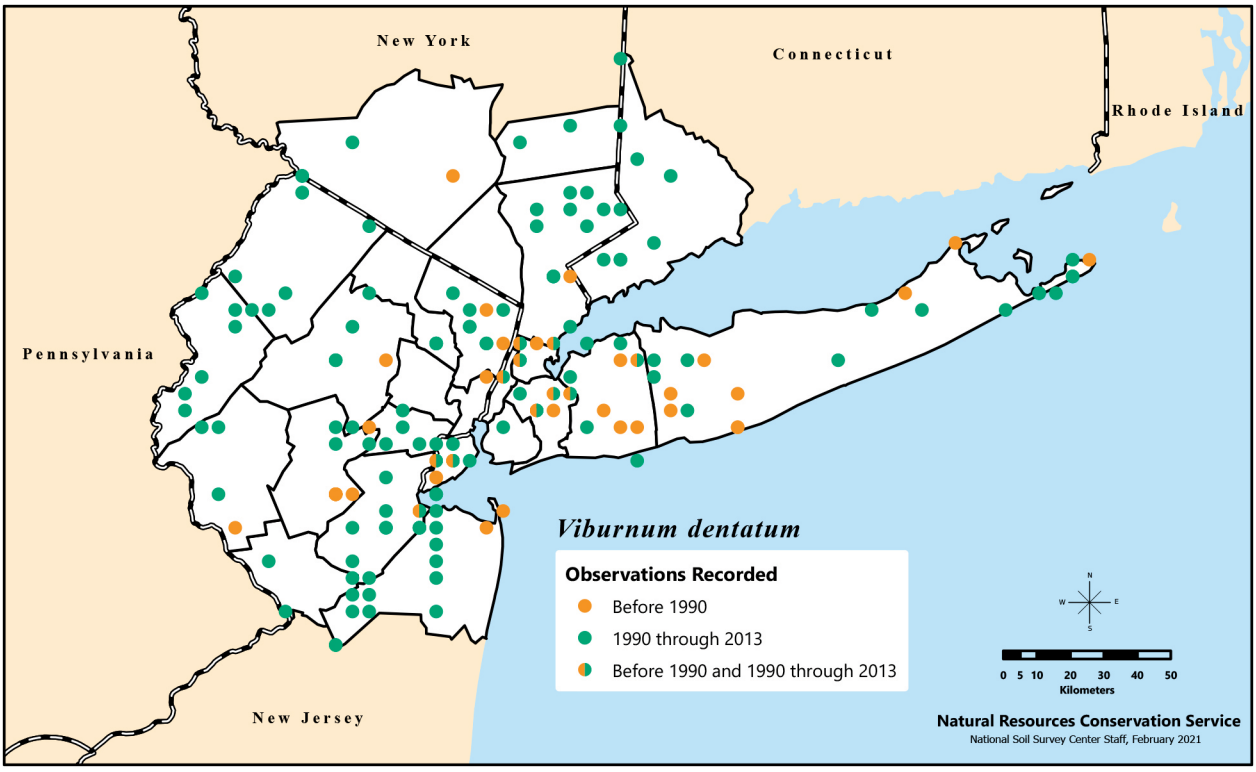
1. Petiole and abaxial leaf surface glabrous (or with a few straight hairs, especially along the veins) . . . . . ***Viburnum dentatum* var. *lucidum*** ↑↑
1. Petiole and abaxial leaf surface with stellate hairs 2
2. Leaves thin, lacking strongly raised veins, stellate hairs on abaxial surface limited to primary veins. . . . . ***Viburnum dentatum* var. *dentatum*** ↑
2. Leaves somewhat thick, veins strongly raised, stellate hairs throughout abaxial surface. . . . . ***Viburnum dentatum* var. *venosum*** ↑

region, 3 varieties are commonly recognized (see key above): *Viburnum dentatum* L. var. *dentatum* (=*Viburnum pubescens* (Aiton) Pursh), *V. dentatum* var. *lucidum* Aiton (=*Viburnum recognitum* Fernald), *V. dentatum* var. *venosum* (Britton) Gleason (=*Viburnum venosum* Britton). *Viburnum dentatum* var. *dentatum* and *V. dentatum* var. *venosum* are chiefly limited to the Coastal Plain, with *V. dentatum* var. *dentatum* being more frequent, but neither is common in the region. *Viburnum dentatum* var. *lucidum* is the most common variety and is found throughout the region. In earlier treatments (e.g., Rehder 1949), typical *V. dentatum* was applied to material now known as *V. dentatum* var. *lucidum*.

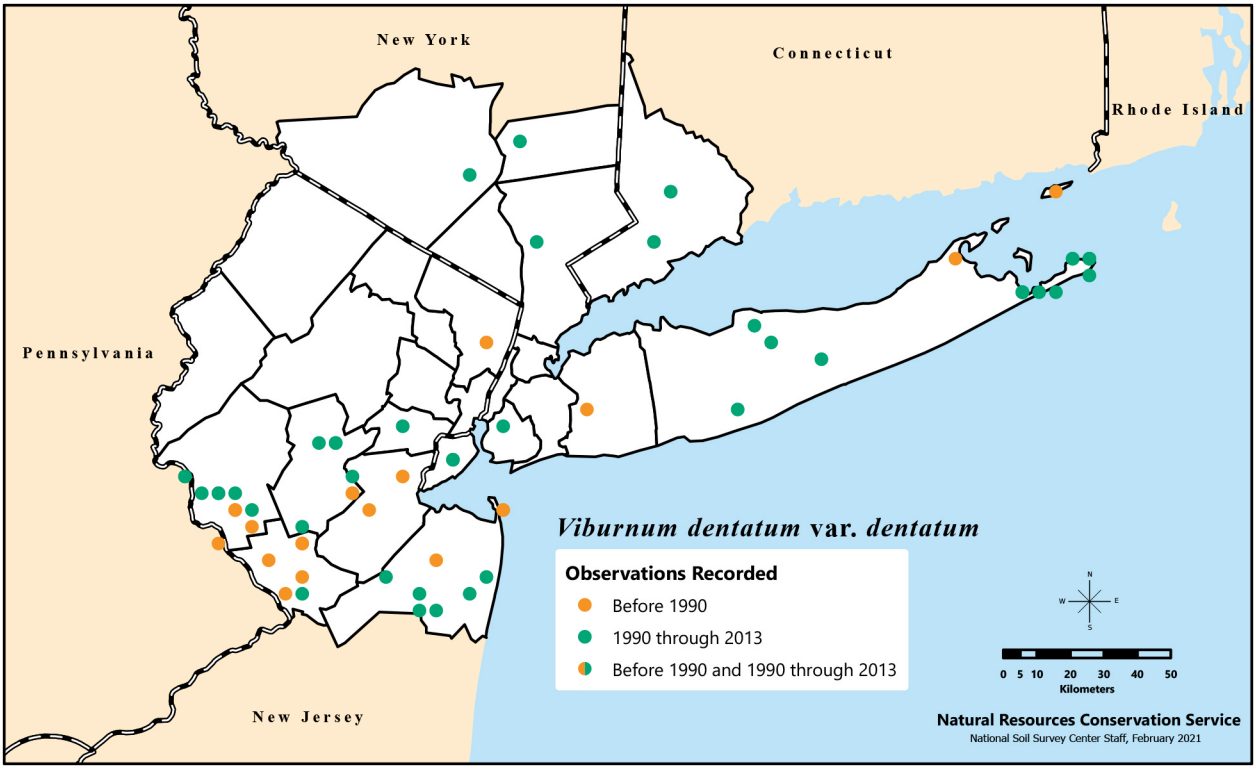
Reaches maturity at about 5 m. Earliest fruit-producing age 3–4 years. Like *V. acerifolium*, it has morphophysiological dormancy (Baskin and Baskin 2001); cold stratification for 180–510 days followed by warm stratification for 60–120 days required for germination (Dirr 1998). However, these may depend on where the seeds are collected; seeds from plants grown in TX did not require any kind of stratification for germination (Bonner et al. 2008). Unlike *V. acerifolium*, the fruit is a preferred food for birds (Meiners and Stiles 1997) and is high in lipids. Other wildlife also consume the fruit, including rabbits (family Leporidae), wild turkeys (*Meleagris gallipavo*), ruffed grouse (*Bonasa umbellus*), chipmunks (subfamily Xerinae), and squirrels (family Sciuridae) as well as deer (*Odocoileus* spp.) (Kurz 1997). Some birds, such as house finches (*Carpodacus mexicanus*), consume only the seeds (Meiners and Stiles 1997) or destroy the seeds when consuming the fruit, and, thus, are seed predators (Sargent 1990). At least 24 bird species (both resident and migrant) feed on the fruit of *V. dentatum*. The fruit does not persist on the plant through winter but instead falls off if not consumed by late fall. More fruit removal occurs on an individual shrub if the shrub is surrounded by other *V. dentatum* shrubs also with fruit (Sargent 1990). Unlike *V. acerifolium*, *V. dentatum* is more closely related to other New World viburnums (Winkworth and Donoghue 2005).

Cultivated since 1736 (Bonner et al. 2008), with at least 8 cultivars (Dirr 1998). Easily propagated from softwood cuttings as well as by seed (Dirr 1990). Gleason and Cronquist (1993) describe *V. dentatum* var. *dentatum* as the most southern variety found mainly on the Coastal Plain as far south as FL and TX and as far north as NJ (and in parts of the NY Metropolitan Region); *V. dentatum* var. *lucidum* as the most northern variety, found as far north as ME; and *V. dentatum* var. *venosum* found mostly on sandy soil of the Coastal Plain from MA to NJ. Deer browse the stems and leaves (Kurz 1997). Foliage is among the most digestible of the woody species of the northeastern U.S. (Robbins and Moen 1975). Fruit consumed by deer can be a significant loss of seed to a habitat (Sargent 1990). This species, especially *V. dentatum* var. *lucidum*, is susceptible to the newly introduced viburnum leaf beetle (Weston and Desurmont 2002). Native Americans made arrows from the straight stems of *V. dentatum* and used the inner bark as tobacco (Kurz 1997). More research is needed concerning the increases in this variety, which could be attributed to reforestation.

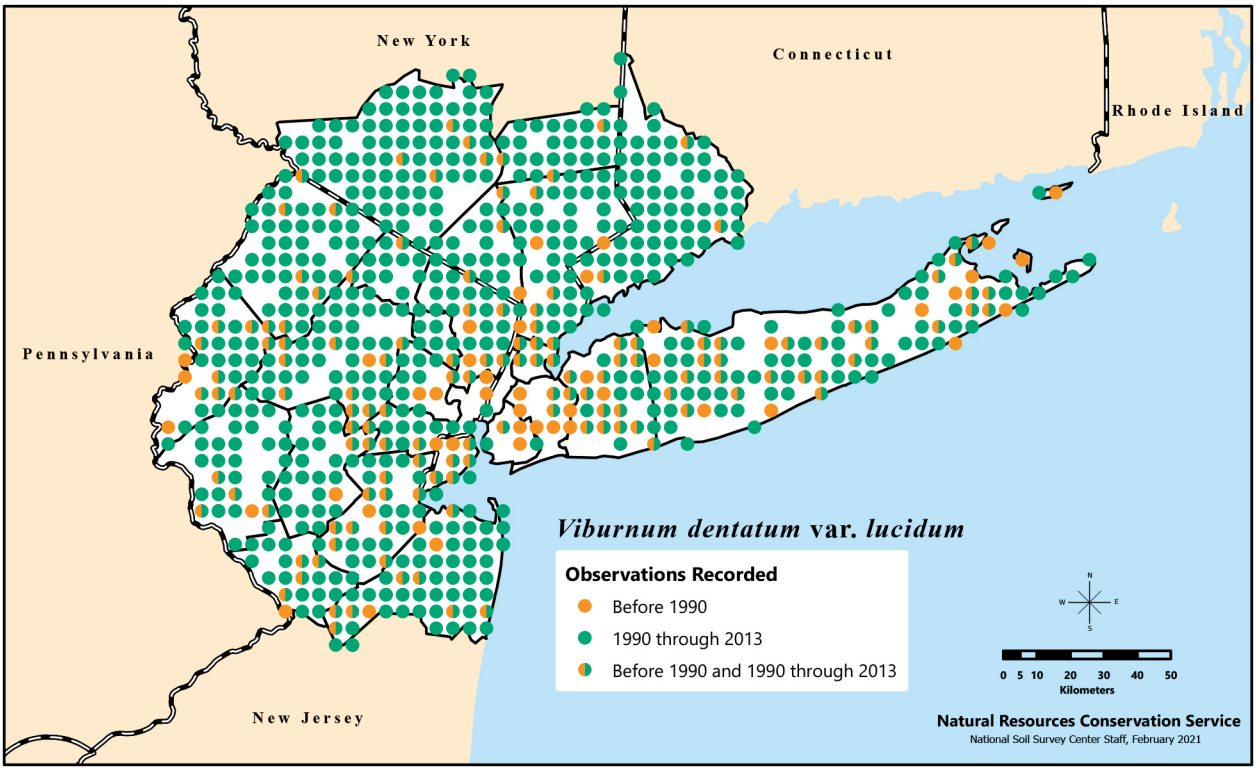
Viburnum dentatum var. *venosum* is tracked as imperiled in NJ (S2) and threatened in NY (S2).



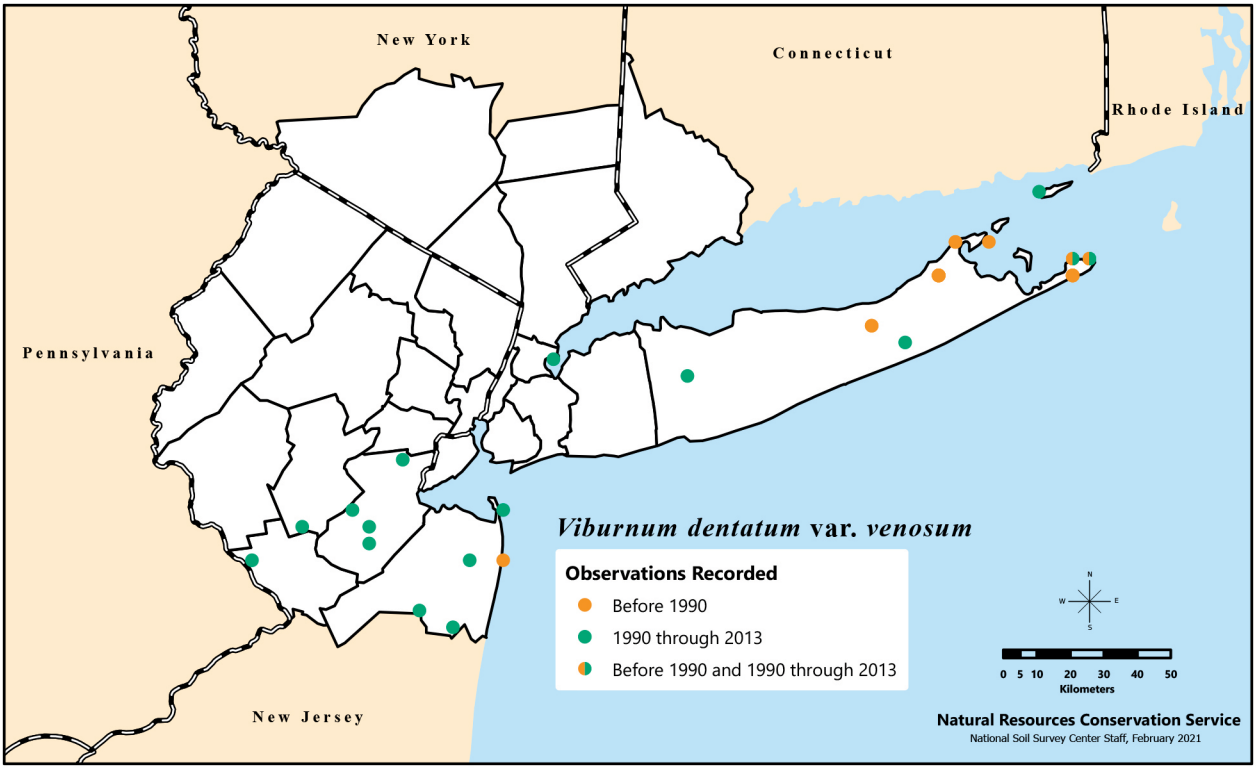
Distribution of *Viburnum dentatum*, or arrow-wood, recorded in the New York Metropolitan Region during three time categories. Map represents all records of the species (records differentiated to the variety level and those not separated by variety).



Distribution of *Viburnum dentatum* var. *dentatum*, a variety of arrow-wood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum dentatum* var. *lucidum*, another variety of arrow-wood, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum dentatum* var. *venosum*, another variety of arrow-wood, recorded in the New York Metropolitan Region during three time categories.

3. *Viburnum lantanoides* Michx. – hobblebush ↓↓

Viburnum alnifolium auct. non Marshall

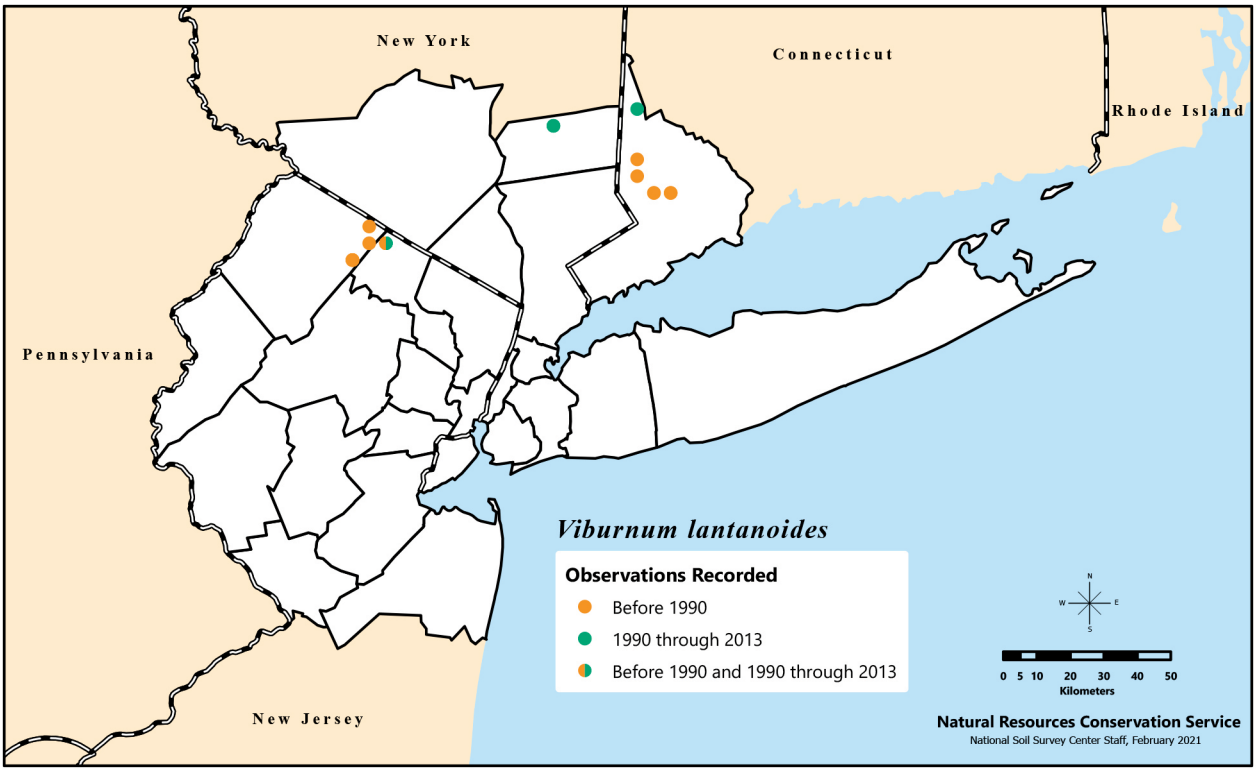
Flowering May. Mesic rich woods. Epithet is in reference to its similarity to *V. lantana*. This species is a boreal or high-elevation species (Park and Donoghue 2019) that is rare in the region. Prefers mesic, shady conditions (Nyland et al. 2006b). Unlike other boreal and high-elevation species, *Viburnum lantanoides*' historical and current local ranges are not markedly different. The earlier name *V. alnifolium* Marshall has been misapplied to this species; *V. alnifolium* is synonymous with *Hydrangea arborescens* L.

Can produce large seed crops every 3–4 years (Bonner et al. 2008). As with other *Viburnum* spp., warm stratification for 150 days followed by cold stratification for 75 days required for germination (Bonner et al. 2008). Height at maturity 3 m.

Reproduces primarily by vegetative means, using rhizomes that can form dense thickets of new shoots. Dense thickets are most likely to form after a ground or overstory disturbance that results in a canopy opening. These thickets can be so problematic that *V. lantanoides* may be considered an interfering species, because it can produce thickets that cast very heavy shade (Nyland et al. 2006a).

Browsed heavily by deer, but degree of browse varies from site to site. For instance, in western PA, *V. lantanoides* browsing was so heavy that this species can no longer be found in most forest stands. However, when other species that are more desirable for browse are present, *V. lantanoides* can still be found in the northeastern U.S. (Nyland et al. 2006b). Cultivated since 1820 (Bonner et al. 2008), with at least 1 known cultivar (Dirr 1998).

Listed as endangered in NJ (S1).



Distribution of *Viburnum lantanoides*, or hobblebush, recorded in the New York Metropolitan Region during three time categories. There are also unmapped historical (pre-1990) records from Bronx, New York, Orange, and Westchester Counties (NY).

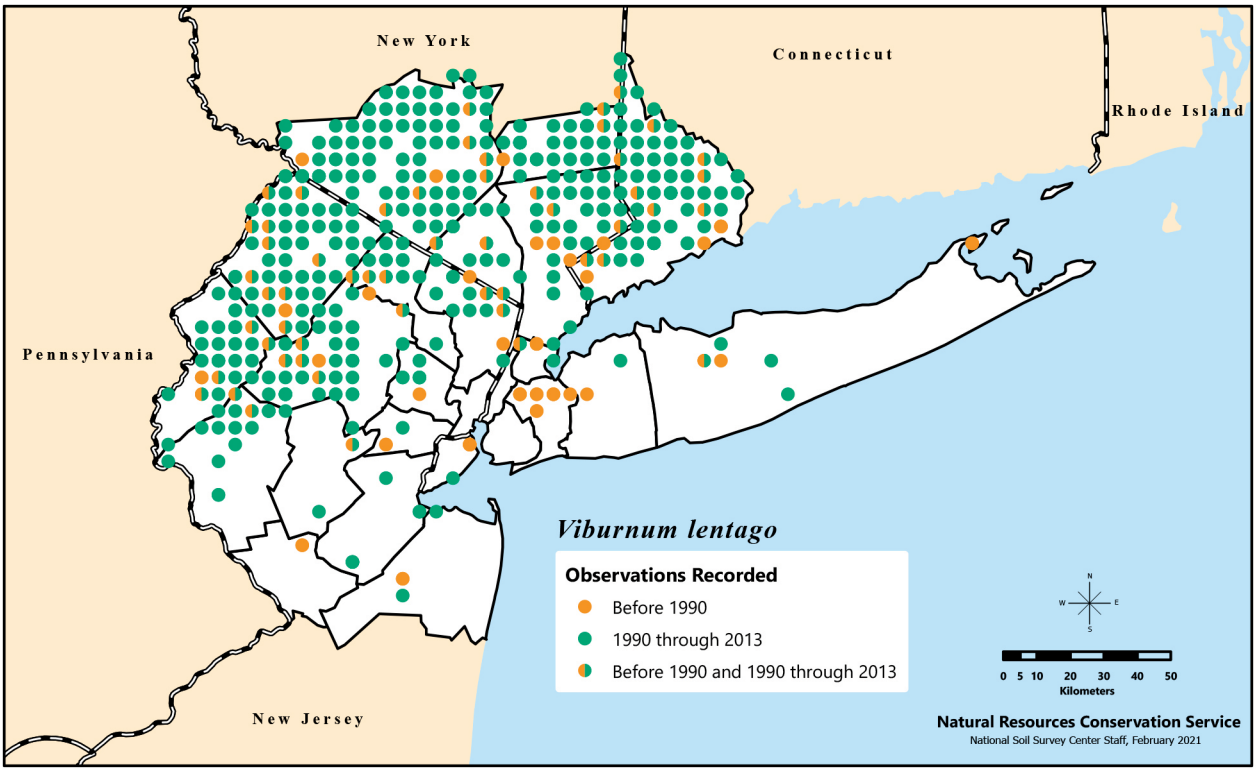
4. *Viburnum lentago* L. – nannyberry ↑↑

Shrub, rarely small tree. Flowering mid-May–mid-June. Mesic rich woods, woodland edges, and thickets. Prefers open areas (Niering and Egler 1955, Niering et al. 1986), and is prone to mildew under shady conditions. Can grow in both moist and dry soils (Dirr 1998). Epithet from Latin means "flexible," a reference to the species' flexuous branches.

Earliest fruit-producing age 8 years. Produces large seed crops every other year. Like other *Viburnum* spp., warm stratification for 150–270 days followed by cold stratification for 60–120 days required for germination (Bonner et al. 2008). Sprouts prolifically (Niering and Egler 1955) and is easily propagated from softwood cuttings (Dirr 1990). Height at maturity 8 m.

Cultivated since 1761 (Bonner et al. 2008), with at least 3 cultivars (Dirr 1990). Hybridizes with *V. prunifolium* (*Viburnum* ×*jackii*) (Dirr 1998). The hybrid's rarity is hypothesized to be due to the different flowering times of the species in zones of sympatry, with *V. prunifolium* usually flowering approximately 2 weeks before *V. lentago* (Dirr 1998, Donoghue 1980, Rader 1976).

Niering and Egler (1955) suggested this species as a good native alternative to forest edge species, in part due to its height (at least 10 m) and wildlife value (fruit eaten by several species), but also because of its relative impenetrability as long as it remains in full sun (Niering et al. 1986). Such a border may help keep unwanted invasive species from colonizing forests from roadsides and forest edges.



Distribution of *Viburnum lentago*, or nannyberry, recorded in the New York Metropolitan Region during three time categories.

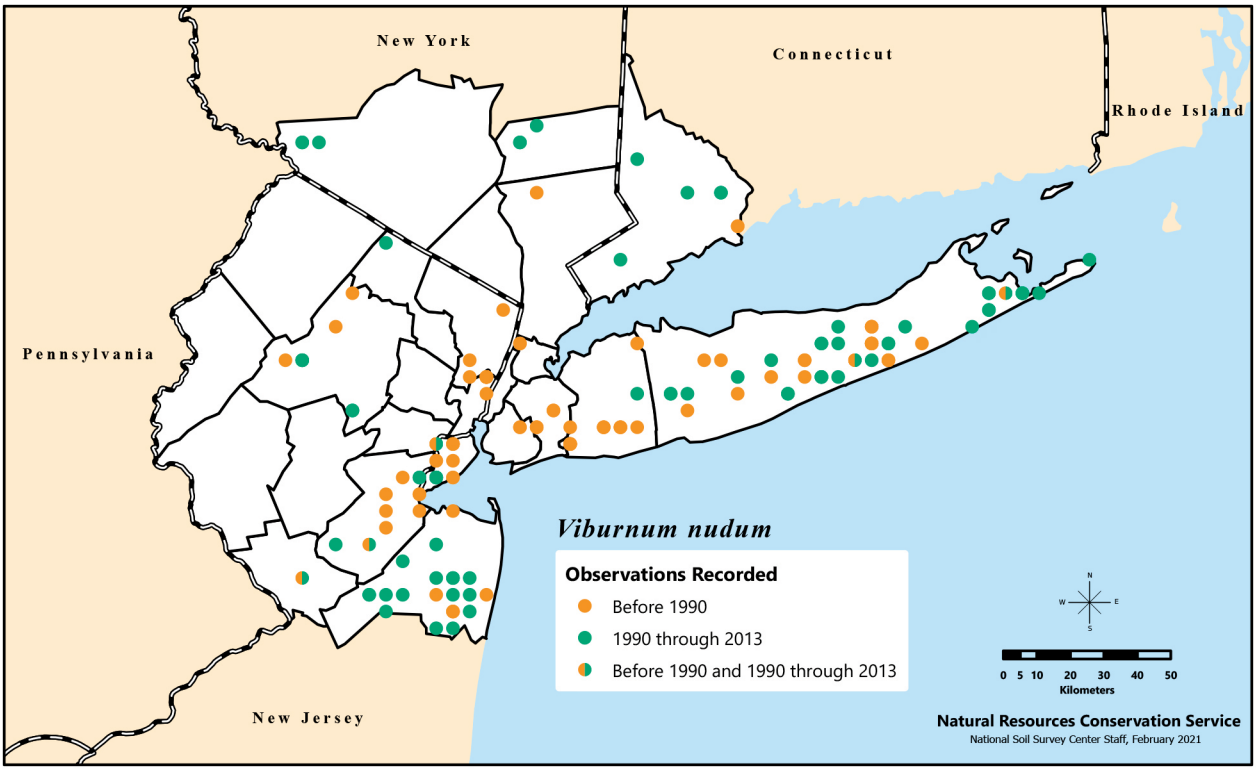
5. *Viburnum nudum* L. – possum-haw ↔

Shrub. Flowering mid-May–mid-July. Nutrient-poor bogs, fens, and other wetlands; rarely in drier situations, such as hardwood forests (Johnson and Leopold 1994, Pittillo 1994). Most common on the Coastal Plain. Epithet is in reference to *Viburnum nudum* var. *nudum*'s long pedunculate cyme (relative to *V. nudum* var. *cassinoides*, which Linnaeus regarded as specifically distinct), appearing "nude" as it is not subtended by leaves. The possum-haws show great morphological variability and are often divided into 2 separate varieties or species (see following key) (Bonner et al. 2008, Dirr 1990): *Viburnum nudum* var. *nudum* and *V. nudum* var. *cassinoides* (L.) Torrey & A.Gray (=*V. cassinoides* L., the epithet from Latin referring to the similarity of the leaves to those of *Ilex cassine*) based on differences in height, buds, leaf blades, anther position at anthesis, and stone shape (see following key). Leaves of *V. nudum* var. *cassinoides* are bronze to chocolate-colored when young, but otherwise green; leaves of *V. nudum* var. *nudum* turn from green to a reddish to reddish-purple in the fall (Dirr 1998). Intermediate material between the two taxa can be found. *Viburnum nudum* var. *nudum* is more common in the region, and the 2 varieties are not geographically or phenologically isolated; they can be found growing together in similar habitats. The two taxa have similar ranges, but *V. nudum* var. *cassinoides* extends much farther north into Canada whereas *V. nudum* var. *nudum* reaches its northern limit in NY.

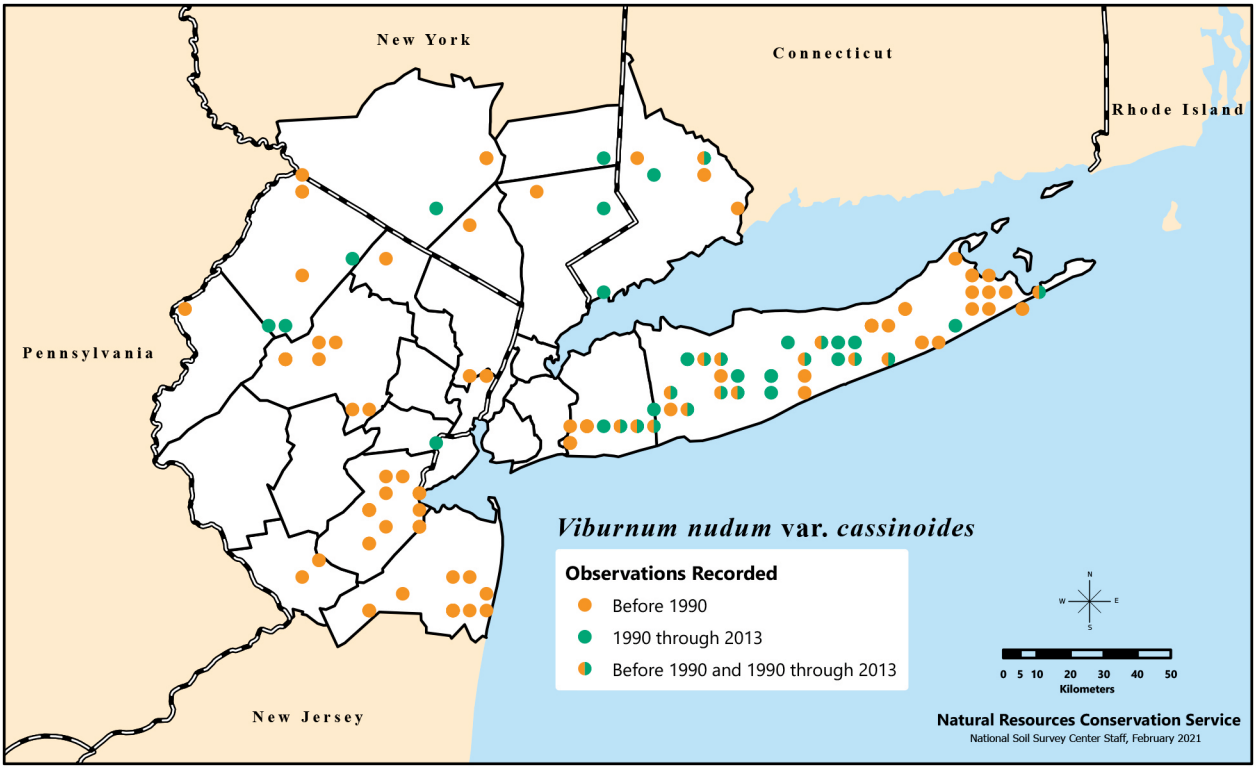
Seeds of both varieties require warm stratification for 60 days followed by cool stratification for 90 days for germination. Both varieties are self-incompatible and pollinated primarily by beetles (family Coleoptera), with bees (order Hymenoptera) as rare visitors (Rathcke 1988). Both twigs (spring, summer, and fall) and fruit (primarily in summer and fall) are eaten by deer (Skinner and Telfer 1974) and ruffed grouse, primarily in the fall (Brown 1946). Indeed, consumption by deer may be one cause of *V. nudum*'s decline in eastern U.S. forest understories. Only *V. nudum* var. *cassinoides* has been cultivated (since 1761; Bonner et al. 2008). Despite their beauty, both varieties are underutilized as landscape shrubs (Dirr 1998).

Viburnum nudum Key

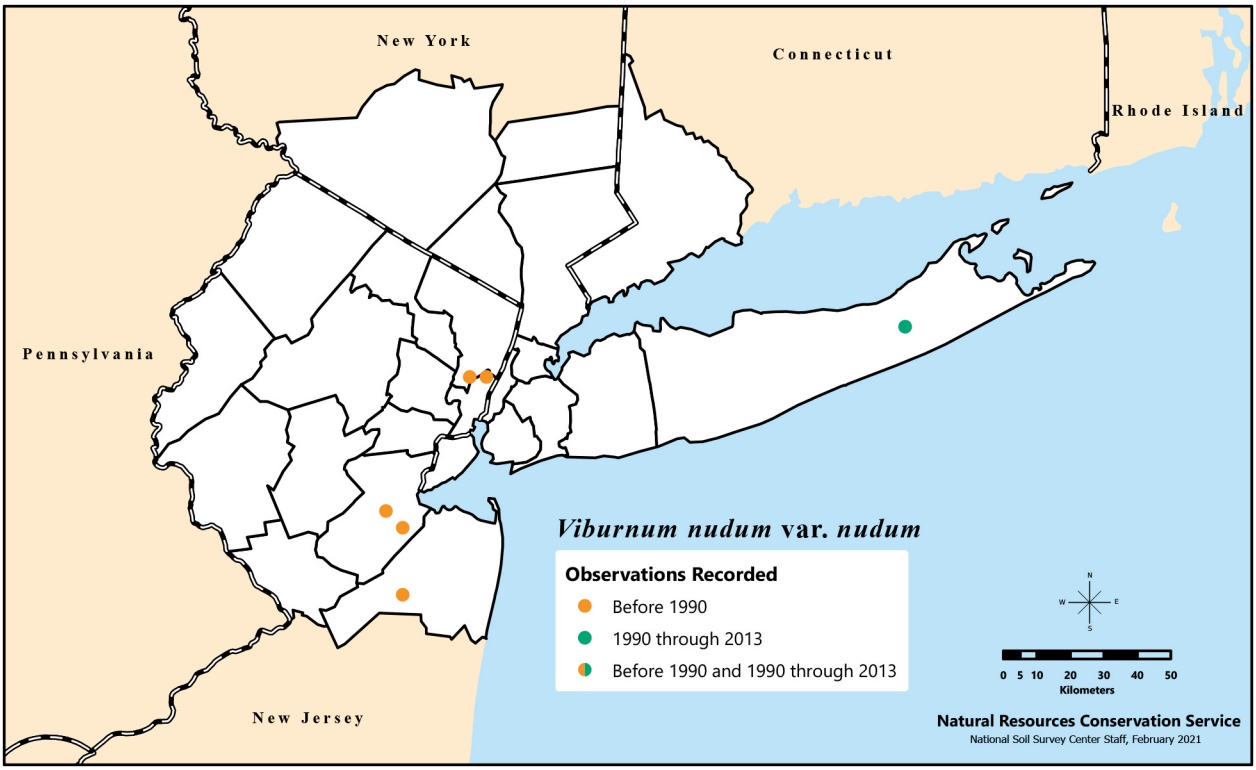
1. Shrub to 1.8 m; axillary buds scarcely developed at flowering time;
   bud scales brown; blade margins entire to crenulate, apex acute to rounded,
   adaxial surface shining; peduncles less than 2 cm long;
   anthers at anthesis 4.0–5.0 mm above throat of corolla;
   stone obovate . . . . . ***Viburnum nudum* var. *nudum* ↔**
2. Shrub to 3 m or more; axillary buds well developed at flowering time;
   bud scales golden yellow; blade margins crenulate to crenate,
   apex abruptly acuminate; adaxial surface dull; peduncles 2–5 cm long,
   anthers at anthesis 1.0–2.0 mm above throat of corolla;
   stone elliptic to oblong . . . . . ***Viburnum nudum* var. *cassinoides* ↓**



Distribution of *Viburnum nudum*, or possum-haw, recorded in the New York Metropolitan Region during three time categories. Map represents all records of the species (records differentiated to the variety level and those not separated by variety).



Distribution of *Viburnum nudum* var. *cassinoides*, a variety of possum-haw, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum nudum* var. *nudum*, another variety of possum-haw, recorded in the New York Metropolitan Region during three time categories.

6. *Viburnum prunifolium* L. – black-haw ↑

Shrub, rarely small tree. Flowering late Apr.–early June. Mesic woodlands, thickets, and roadsides. Reaches the northern limit of its range in NY and CT. Common in the region, although it occurs only rarely on the Coastal Plain. Epithet from Latin refers to the similarity of the leaves to those of plums; "prunus" is the ancient name for plum (this name now used for the genus *Prunus*, which includes plums, cherries, and peaches). Rarely hybridizes with *Viburnum lentago* (see discussion under *V. lentago*). Tolerant of many soil types and moisture and light conditions (Dirr 1998).

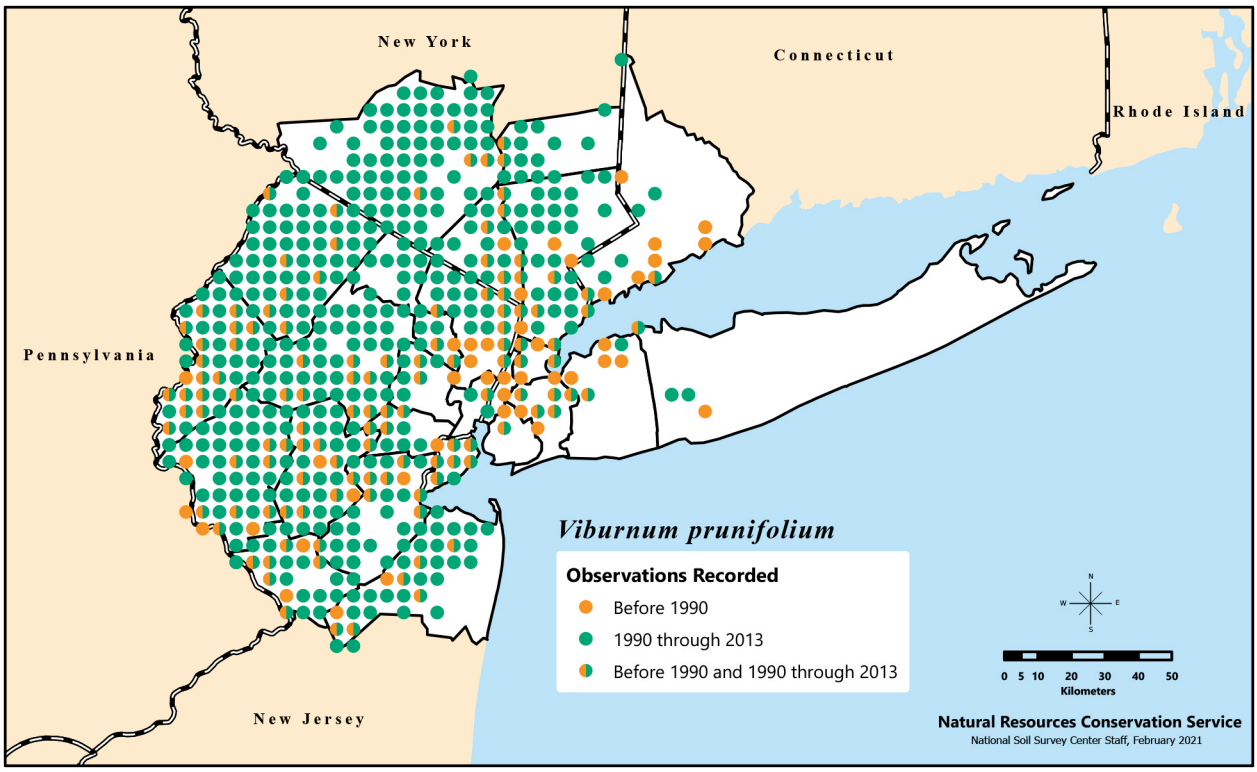
Height at maturity 5 m. Earliest fruit-producing age 8–10 years (Bonner et al. 2008). Germination requires a warm period followed by a cold period (Baskin and Baskin 2001). Though seed propagation is possible, it is most easily cultivated by transplanting it. Fruit is palatable (Dirr 1998). This native species may prove to be one of the least susceptible to the viburnum leaf beetle (Weston and Desurmont 2002). Increases in the region may be attributed to reforestation.

Listed as threatened in CT (S2).

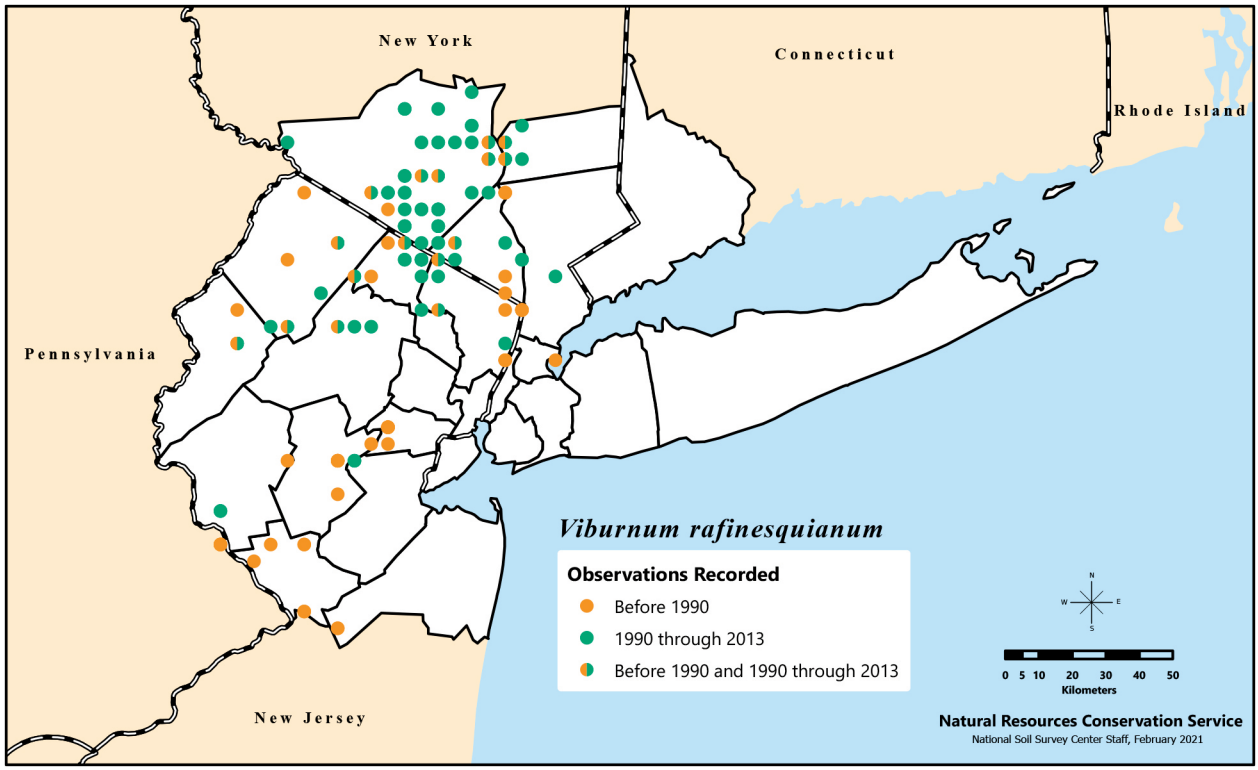
7. *Viburnum rafinesquianum* Schult. – downy arrow-wood ↔

Flowering late May–mid-June. Dry to mesic woodlands, often in calcareous areas. Grows on steep wooded bluffs, in rocky open woods, and in thickets bordering rocky stream beds (Kurz 1997), which may describe the preferred habitat of *V. rafinesquianum* var. *affine*, which is found more in the Midwest. *Viburnum rafinesquianum* var. *rafinesquianum* prefers dry, calcareous woods but is found farther east and in the NY Metropolitan Region (Gleason and Cronquist 1993). However, it is also considered a characteristic shale barren plant in MD (Morse 1983). Species is named for its discoverer, Constantine Samuel Rafinesque-Schmaltz (1783–1840), noted European researcher who made important contributions in archaeology, botany, linguistics, and zoology.

Height at maturity 2 m. Cultivated since 1830 (Bonner et al. 2008).



Distribution of *Viburnum prunifolium*, or black-haw, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum rafinesquianum*, or downy arrow-wood, recorded in the New York Metropolitan Region during three time categories.

Our material is referable to *Viburnum rafinesquianum* Schult. var. *rafinesquianum*. In the region, *V. rafinesquianum* is primarily restricted to the Ridge and Valley and Highlands provinces, although it occasionally occurs in the Piedmont province.

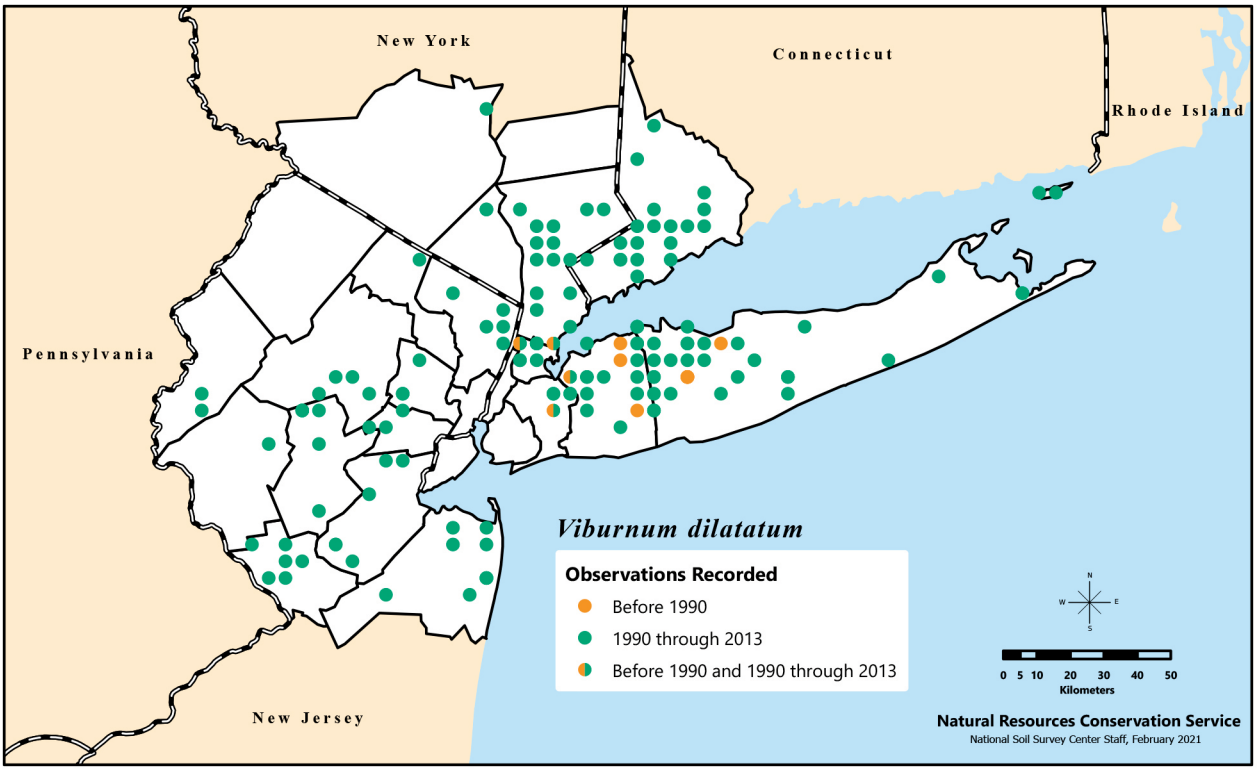
Nonnative Species

8. *Viburnum dilatatum* Thunb. – linden arrow-wood ↑↑↑

Shrub. Flowering late May–mid-June. Dry to mesic woodlands, woodland edges, and thickets, in a variety of soil types. Not suitable for more extreme cold or warm weather (Dirr 1998). Like most viburnums, prefers moist well-drained soils with no critical soil texture or pH requirements (Bonner et al. 2008). Epithet means "dilated" in Latin, a reference to the species' broad leaf blades.

Native to eastern Asia. First introduced into the U.S. in the mid-1800s (Dirr 1998). Apparently, however, it has only recently become firmly established in the wild. Previous floristic manuals (e.g., Fernald 1950, Gleason and Cronquist 1993) for the region do not treat this species.

Fruit dispersed primarily by ingestion and subsequent defecation by animals, such as birds. In its native habitat, *Viburnum dilatatum* reproduces vegetatively and sexually equally well, even in response to a disturbance such as fire (Goto et al. 1996). Also in its native range, the amount of seed dispersed by birds is significantly correlated with the fruit crop size, which is about 1,100 fruits per plant. Birds remove approximately 560 fruits per plant (Takahashi and Kamitani 2004). Browsed heavily by deer in its native Japan (Kumar et al. 2006). Seeds have deep simple epicotyl morphophysiological dormancy, meaning the radicle emerges first in fall and the epicotyl emerges later in spring. The radicle emergence depends on warm stratification and epicotyl emergence depends on cold stratification. At the time of epicotyl emergence some plants with this type of dormancy may already have a well-established main root with several laterals (Baskin and Baskin 2001). The anthocyanins in the fruit



Distribution of *Viburnum dilatatum*, or linden arrow-wood, recorded in the New York Metropolitan Region during three time categories.

of this species have documented antioxidant properties that have successfully treated gastric ulcers in rats (*Rattus* spp.) (Iwai et al. 2004a) and oxidative stress induced by diabetes (Iwai et al. 2004b). These phenolic compounds have general radical scavenging properties (Kim et al. 2005).

At least 9 cultivars (Dirr 1998). This species is ranked as an environmental weed (a plant that invades natural areas) by several organizations, including USDA Forest Service Eastern Region (AgWest and Hawaiian Ecosystems at Risk Project [HEAR]) 2010).

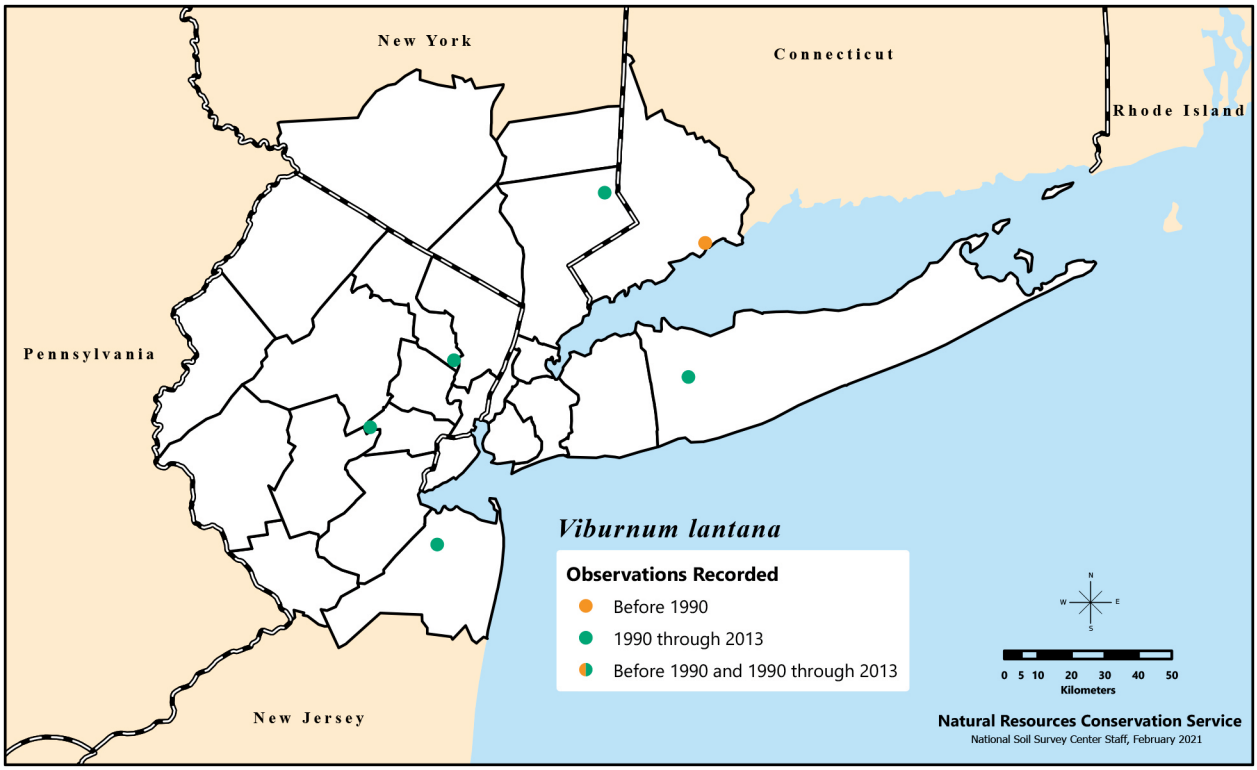
Tracked as potentially invasive in NJ (category 2).

9. *Viburnum lantana* L. – wayfaring-tree Ø♥

Shrub. Flowering May. Mesic woodlands and edges of woodlands. Recent naturalized populations known from Fairfield County (CT); Monmouth, Passaic, and Union Counties (NJ); and Suffolk and Westchester Counties (NY). Native to Europe and western Asia. The Latin epithet "lantana," like "lentago," refers to the flexible nature of the twigs.

May prefer moist well-drained soils with no particular soil texture or pH requirements (Bonner et al. 2008). In central and northern Europe, *V. lantana* is found in drier sites (Sack and Grubb 2002). In England it appears to prefer well-drained chalk or limestone soils with pH values greater than 7 though it can tolerate soil pH as low as 5 (Kollmann and Grubb 2002). Does not handle extreme heat well (Dirr 1998). Shade-tolerant, especially as a seedling (Grubb et al. 1996, Sack 2004).

Frequently cultivated and occasionally persists from cultivation. Distinguished from other *Viburnum* spp. in the region by its naked winter buds, unlobed leaves with serrulate margins and stellate pubescence on the petioles and abaxial leaf surfaces, fertile marginal flowers, and blue-black fruit (red when immature). This species is the only European representative of the *Viburnum* sect. *Viburnum* (there may be 14 sections; Donoghue et al. 2004). A diploid (2n=18). At least 6 known cultivars (Dirr 1998).



Distribution of *Viburnum lantana*, or wayfaring tree, recorded in the New York Metropolitan Region during three time categories.

Viburnum lantana is deciduous as an adult but tends to be evergreen as a juvenile, in which case the first leaves may last up to 2 years. Earliest flowering at about 5–6 years (Kollmann and Grubb 2002). All flowers are fertile and similar in size but with an unpleasant odor. Both self-pollination and insect pollination are possible. Because very little nectar is produced, most pollinators are pollen-gathering insects. Anthers are located directly above the stigma (Kollmann and Grubb 2002). Frugivorous birds are the primary dispersal agents (Kollmann and Grubb 2002); fruit also consumed and dispersed by mammals such as deer (Bonner et al. 2008). Between 1 and 120 fruits per infructescence produced each year, with the lower numbers found in shaded environments (Kollman and Grubb 2002). However, the leaves and stems are unpalatable to deer, at least in England. Seeds are consumed by rodents (order Rodentia) (Kollmann et al. 1998). Seed predation by rodents tends to be heavier along forest edges than within forests (Kollmann and Buschor 2002). Despite a relatively thick seed coat, seeds germinate typically within the first year (Lee et al. 1991). Even when present and relatively abundant in the existing vegetation, this species does not appear to form seed banks in those communities (Dutoit and Alard 1995). Germination rates of *V. lantana* are high (80–90 percent; Kollmann and Grubb 2002).

The shade leaves of this species are dimorphic, some much smaller in area than the typical sun leaves and some being larger than the sun leaves (Kollmann and Grubb 2002). Responds positively to an increase in nutrients but only under higher light conditions (63 percent of full sunlight; Grubb et al. 1996). Because this species is capable of inhabiting dry habitats, it may have low carbohydrate requirements that enable it to keep its stomates closed for long periods (Hinckley et al. 1983). Though it may wilt in response to drought, it is capable of recovery without any notable twig or branch death (Kollmann and Grubb 2002). Very susceptible to ozone injury (Orendovici et al. 2003). Somewhat tolerant of salt in soils (Thompson and Rutter 1986). Salt tolerance may suggest that this species could spread along roads without having a growth reduction in response to road salts. *Viburnum lantana*, like *V. dilatatum*, is listed as an environmental weed (a plant that invades natural areas) in the U.S. (AgWest and HEAR 2010).

Fruit of this species is traditionally consumed as a jam by rural communities in the Campoo region of northern Spain (Pardo-de-Santayana et al. 2005). Many humans find the fruits unpleasant tasting, possibly due to the presence of calcium oxalate crystals (Kollmann and Grubb 2002). Extracts of *V. lantana*'s bark have been used as a pain reliever and show some anti-inflammatory activity, but the leaves can be toxic to mice (*Mus* spp.) (Yilmaz et al. 2007). The young twigs have been used for binding of sheaves and wicker-work (Kollmann and Grubb 2002).

Tracked as a moderate invasive in NY (not prohibited or regulated).

10. *Viburnum opulus* L. s.l. – cranberry bush ↑↑

Flowering mid-May–June. Mesic woodlands, woodland edges, and thickets. Epithet from Latin is an old genus name formerly applied to this group of viburnums.

Can withstand colder temperatures and shadier habitats than *Viburnum lantana*. Like *V. lantana*, prefers more alkaline soils, with soil pH generally above 7 and rarely below 5 (Kollmann and Grubb 2002). May tolerate heat a little better than *V. lantana*. As a planted nonnative, this species can grow in sun and shade, but fruit production is best in full sunlight (Dirr 1998).

Circumpolar, with *V. opulus* var. *americanum* indigenous to northern North America and *V. opulus* var. *opulus* indigenous to northern Asia and Europe. Almost all material from the NY Metropolitan Region is the nonnative *V. opulus* var. *opulus*. Historical records for the native *V. opulus* var. *americanum* (=*V. trilobum* Marshall) exist from the northern portions of the region. The following key can be used to distinguish the 2 varieties, although intermediate material with respect to the large petiole glands is often noted. The snowball tree cultivar, *V. opulus* var. *opulus* 'Roseum,' with rounded cymes and all or most of the flowers enlarged and sterile is planted and also occasionally escapes.

Viburnum opulus Key

1. Stipules filiform attenuate, with slender tips,
petioles with depressed, mostly sessile, concave glands;
blades (especially abaxial surface) pubescent,
lobes acuminate, prolonged; fruit bitter . . . . . ***Viburnum opulus* var. *opulus** ↑↑**

1. Stipules filiform clavate, often with broad, somewhat thick tips,
petioles with stalked, dome-shaped clavate glands;
blades usually glabrous, lobes rounded, less prolonged;
fruit acidic but often palatable . . . . . ***Viburnum opulus* var. *americanum* ↓**

Earliest flowering at about 3–5 years. Self-fertilization appears possible but rare. Outcrossing is more common, and the key pollinators include hover flies (family Syrphidae) and beetles (order Coleoptera) (Kollmann and Grubb 2002). Formation of a seed bank is unlikely (Kollmann and Grubb 2002, van der Valk and Verhoeven 1988). Has relatively thin seed coats (Lee et al. 1991). Seeds have deep simple epicotyl morphophysiological dormancy, meaning the radicle emerges first in fall and the epicotyl emerges later in spring. The radicle emergence depends on warm stratification (60–90 days) and epicotyl emergence depends on cold stratification (30–60 days) (Baskin and Baskin 2001, Bonner et al. 2008).

Fruit can remain on the plants through fall and winter, sometimes until May (Englund 1993, Jones and Wheelwright 1987, Witmer 2001); may not be a preferred food, at least not by avian seed predators. The ripe pulp of the fruit has a disagreeable scent and taste to humans (more so for *V. opulus* var. *opulus*). Bullfinches (*Pyrrula pyrrula*) and rodents typically eat around the pulp, consuming only the seeds; cedar waxwings (*Bombycilla cedrorum*) eat the entire fruit and defecate the seeds. Deer also eat the whole fruit, but the seed appears to be destroyed during digestion. In NY, the primary consumers of *V. opulus* fruit are cedar waxwings. Cedar waxwings' diet in Apr. and May can be primarily *V. opulus* fruit and catkins (a source of protein and thus nitrogen) from tree species, such as *Populus deltoides*. *Viburnum opulus* fruits are exceptionally acidic, which aids in fruit longevity, and consumption requires a protein source to alleviate the effects of the acid (amino acids like glutamine can form bicarbonates and ammonium that can then serve as buffering agents against the acid). *Viburnum opulus* depends on the cedar waxwing for much of its seed dispersal, and the cedar waxwing depends on *V. opulus* for an early spring food source as long as a protein source is nearby. *Viburnum opulus* may have replaced the native *V. opulus* var. *americanum* (*V. trilobum*) in this mutualistic function (Witmer 2001).

The nonnative variety has been cultivated for centuries, with at least 10 cultivars (Dirr 1998). A diploid (2n=18) (Kollmann and Grubb 2002) with no known ability to hybridize with other *Viburnum* spp. (except perhaps within the 2 varieties). Often forms adventitious roots and new vertical shoots from low-growing branches (Kollmann and Grubb 2002); vegetative and seed propagation are both successful (Dirr 1998).

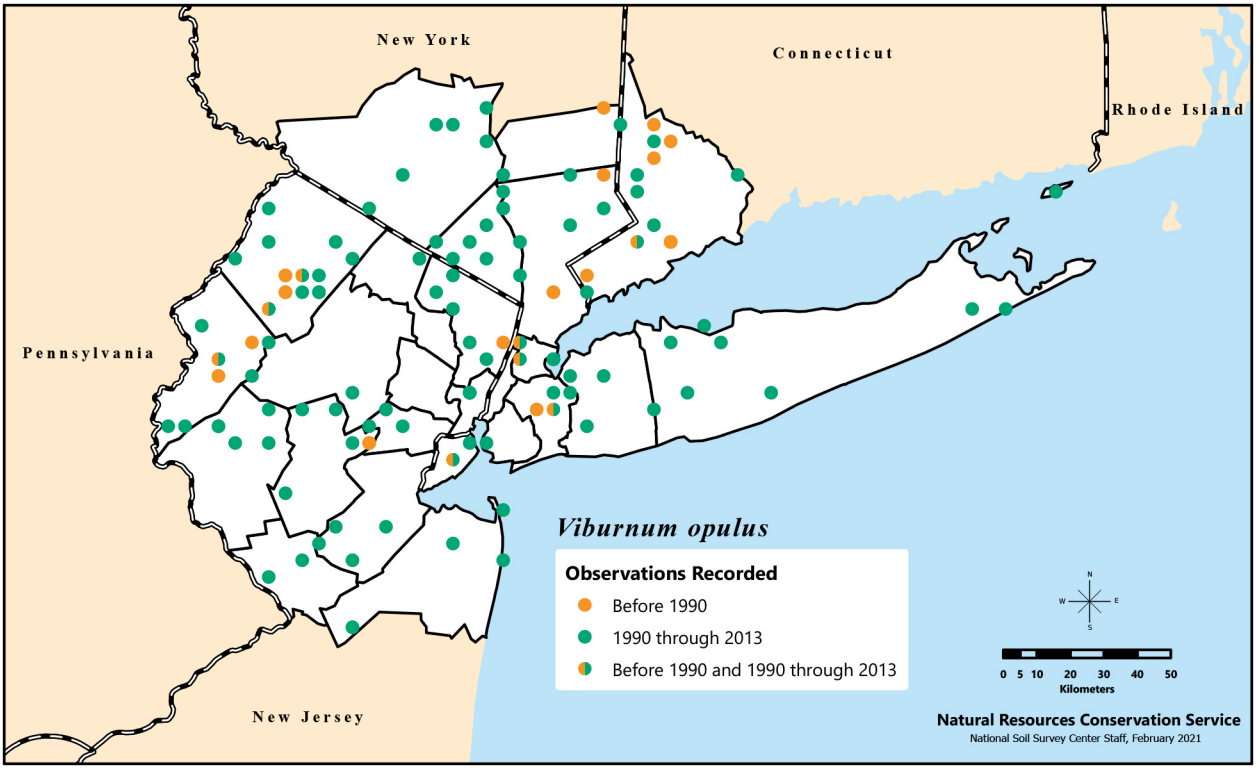
Maximum lifespan of this species may be 50 years. Is negatively impacted by drought, and its response is independent of irradiance conditions (Sack and Grubb 2002). Susceptible to the newly introduced viburnum leaf beetle (Weston and Desurmont 2002).

In Scandinavia, it is popular to cook *V. opulus* fruit into preserves; in Canada the fruit may be substituted for cranberries. The fruit may also be fermented into an alcoholic drink. In Russia, the

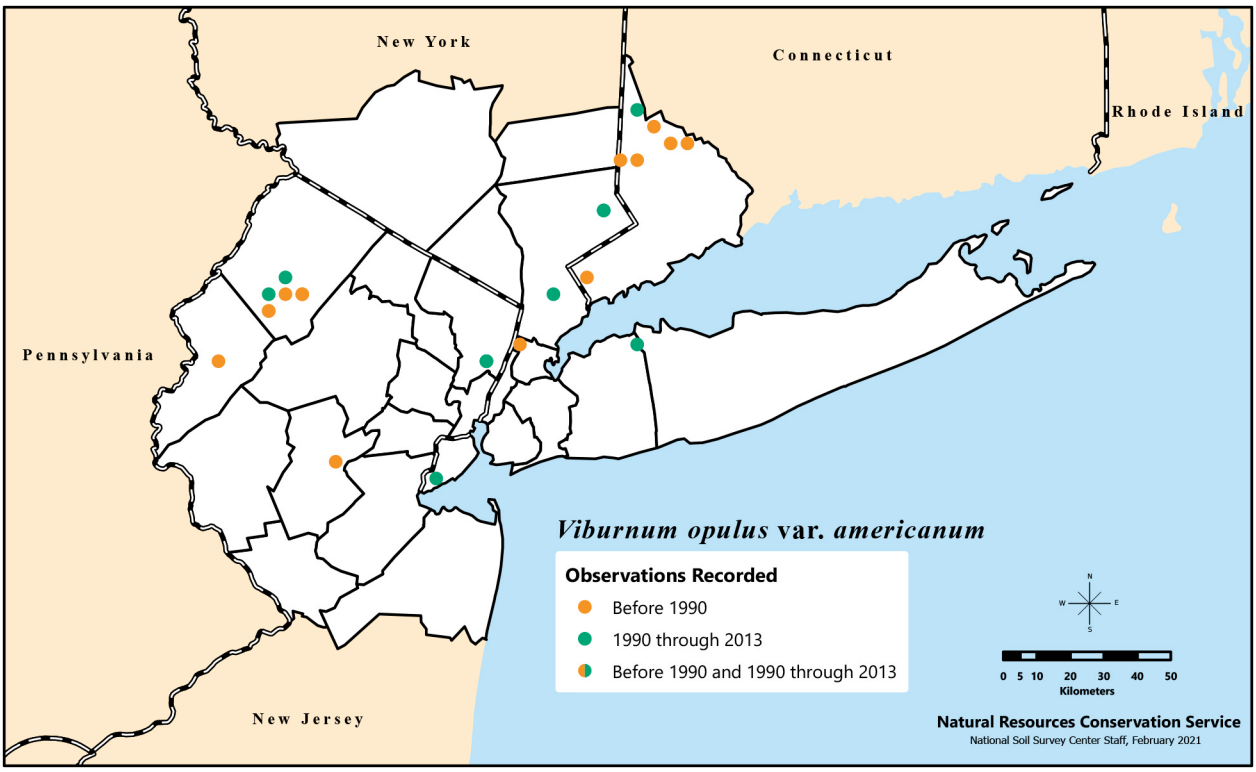
fruit is used to treat high blood pressure, heart ailments, coughs, colds, tuberculosis, kidney and bladder problems, stomach pain, shortness of breath, and ulcers (Velioglu et al. 2006). Despite all these uses, *V. opulus* fruit may actually be mildly poisonous to humans (Kollmann and Grubb 2002).

Viburnum opulus var. *americanum* may be considered to be more beautiful in terms of flowers, leaf color, and fruit than the nonnative *V. opulus* var. *opulus*, but is more difficult to find in nurseries. It is much less susceptible to aphids (superfamily Aphidoidea) than *V. opulus* var. *opulus*, but it may be affected by stem blight *Pseudomonas syringae* pv. *Viburnum* under warm, humid conditions. It is likely to be more adaptable to a wider range of conditions than *V. opulus* var. *opulus* (Dirr 1998). However, it does not tolerate water stress well (Dirr 1997). *Viburnum opulus* var. *americanum* has been cultivated since 1812, with at least 6 cultivars (Dirr 1998). *Viburnum opulus* var. *opulus* is classified as an environmental weed (a plant that invades natural areas) in the U.S. (AgWest and HEAR 2010).

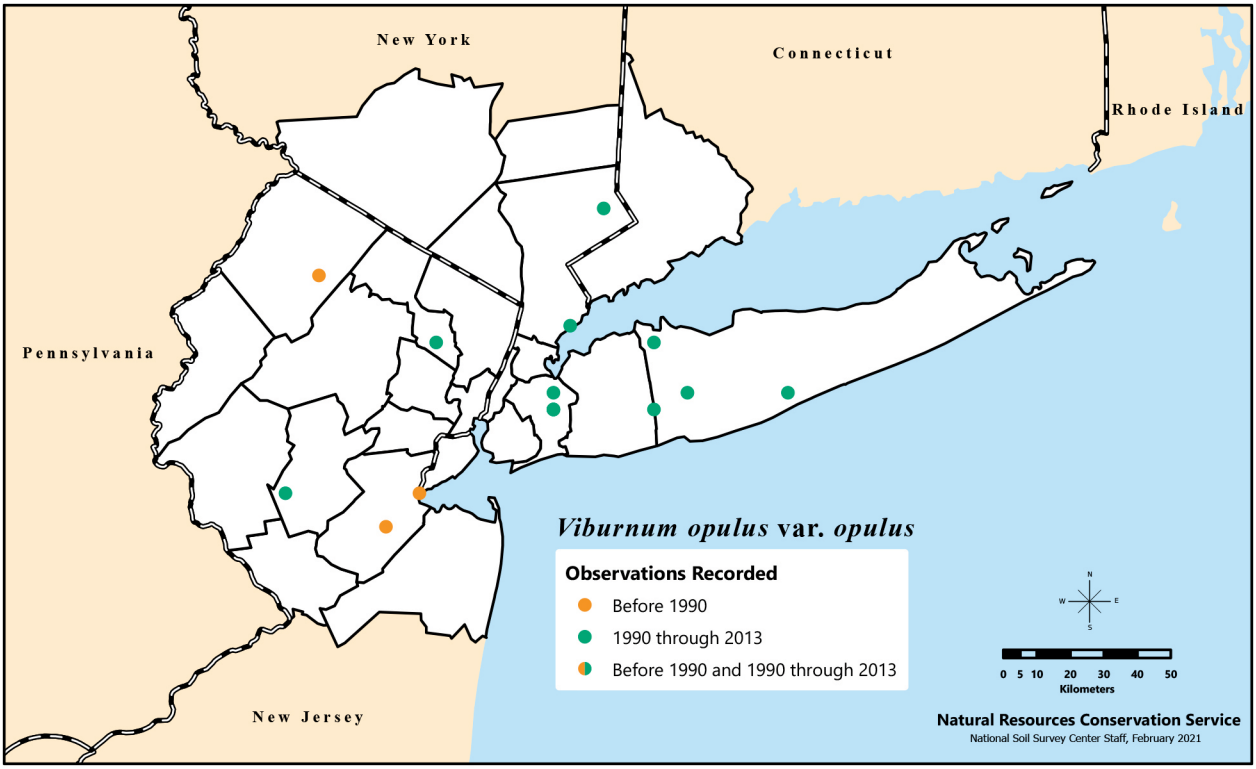
Viburnum opulus var. *americanum* is tracked as vulnerable (S3) in NJ. *Viburnum opulus* var. *opulus* is tracked as potentially invasive in NJ.



Distribution of *Viburnum opulus*, or cranberry bush, recorded in the New York Metropolitan Region during three time categories. Map represents all records of the species (records differentiated to the variety level and those not separated by variety; probably mostly *V. opulus* var. *opulus* due to uncertainty of some identifications, which would need further confirmation).



Distribution of *Viburnum opulus* var. *americanum*, a variety of cranberry bush, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum opulus* var. *opulus*, another variety of cranberry bush, recorded in the New York Metropolitan Region during three time categories.

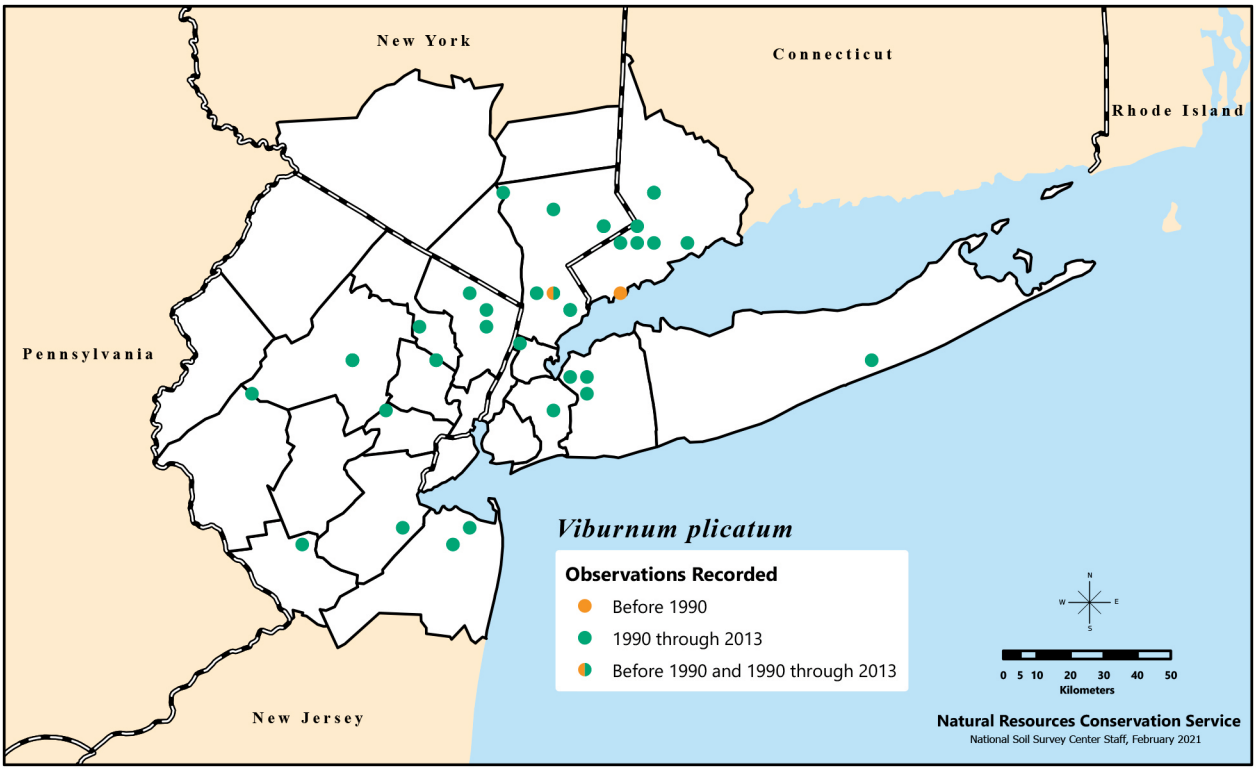
11. *Viburnum plicatum* Thunb. – doublefile viburnum, Japanese snowball ↑↑↑

Shrub. Flowering May. Mesic woodlands and woodland edges. Native to Asia. Epithet from Latin refers to the pleated or plicate appearance of the leaf blades. The earlier name *Viburnum tomentosum* Thunb. (1794) is sometimes applied to this plant. However, this name is an illegitimate later homonym of *V. tomentosum* Lam. (1779) and is not available for use.

Introduced into the U.S. in the mid-1800s (Dirr 1998); often cultivated. Frequently persists after cultivation; occasionally escapes from cultivation. There are at least 12 cultivars of *V. plicatum* and at least 18 cultivars of *V. plicatum* var. *tomentosa*. *Viburnum plicatum* var. *tomentosa*, also from China and Japan, was first introduced into North America in 1865. The best way to propagate this species is by cuttings (Dirr 1998).

Flowers about 2 weeks later than *V. plicatum* var. *tomentosa*, which flowers in mid-Apr.–May. *Viburnum plicatum* is sterile; it flowers but never produces any fruit. Unlike the snowball inflorescences of *V. plicatum*, the inflorescences of *V. plicatum* var *tomentosa* are not showy, and only the outer flowers are sterile. Fruit of *V. plicatum* var. *tomentosa* usually devoured by birds before it is ripe (Dirr 1998). It is unclear whether the birds that consume the seeds just eat the pulp and defecate the seeds (for possible dispersal) or consume the seeds. *Viburnum plicatum* is a diploid but differs from *V. lantana* and *V. opulus* in that it has 16 chromosomes instead of 18 (Yiming 1997). It is not known whether the variety shares the same number of chromosomes. Gleason and Cronquist (1993) do not recognize *V. plicatum* and *V. plicatum* var. *tomentosa* as separate entities.

Viburnum plicatum var. *tomentosa* flowers as well in the shade as in the sun. It does not tolerate poorly drained clay soils (Dirr 1998). *Viburnum plicatum* var. *tomentosa* may be among the least cold-hardy of the *Viburnum* spp. (Dirr 1998, Robinson and Hamilton 1980). *Viburnum plicatum* var. *tomentosa* is among the most susceptible viburnums to *Phytophthora ramorum* (Grunwald



Distribution of *Viburnum plicatum*, called doublefile viburnum or Japanese snowball, recorded in the New York Metropolitan Region during three time categories.

et al. 2005), making it a potential carrier of the disease like several other viburnums originating from nurseries. This species has been shown to be resistant to the newly introduced viburnum leaf beetle (Weston and Desurmont 2002). *Viburnum plicatum* (and most likely the variety) is considered an environmental weed (a plant that invades natural areas) in the U.S. (AgWest and HEAR 2010).

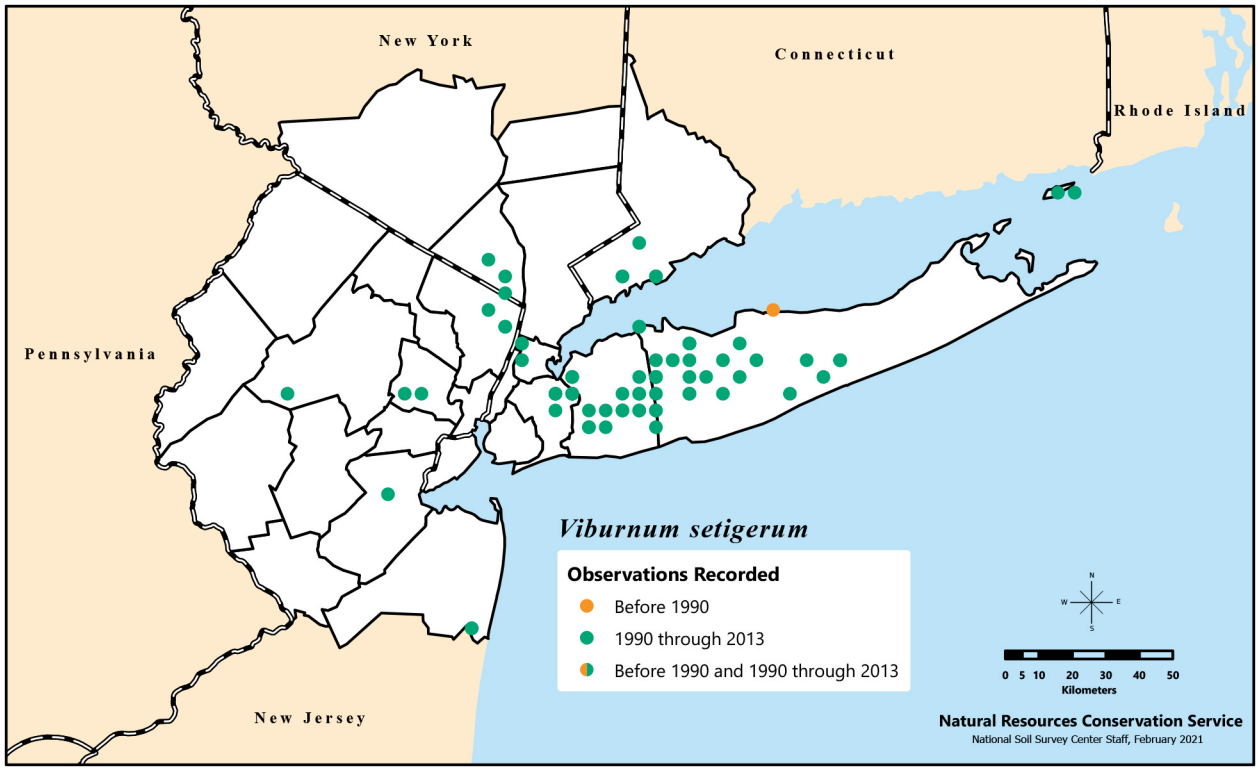
12. *Viburnum setigerum* Hance – tea viburnum ↑↑↑

Shrub. Flowering mid-May–June. Mesic woodlands and woodland edges; not cold-tolerant (Dirr 1998). Native to central and western China. Epithet from Latin refers to the long hairs that can be present, especially on the peduncle, rays, and abaxial surface of the leaf blades.

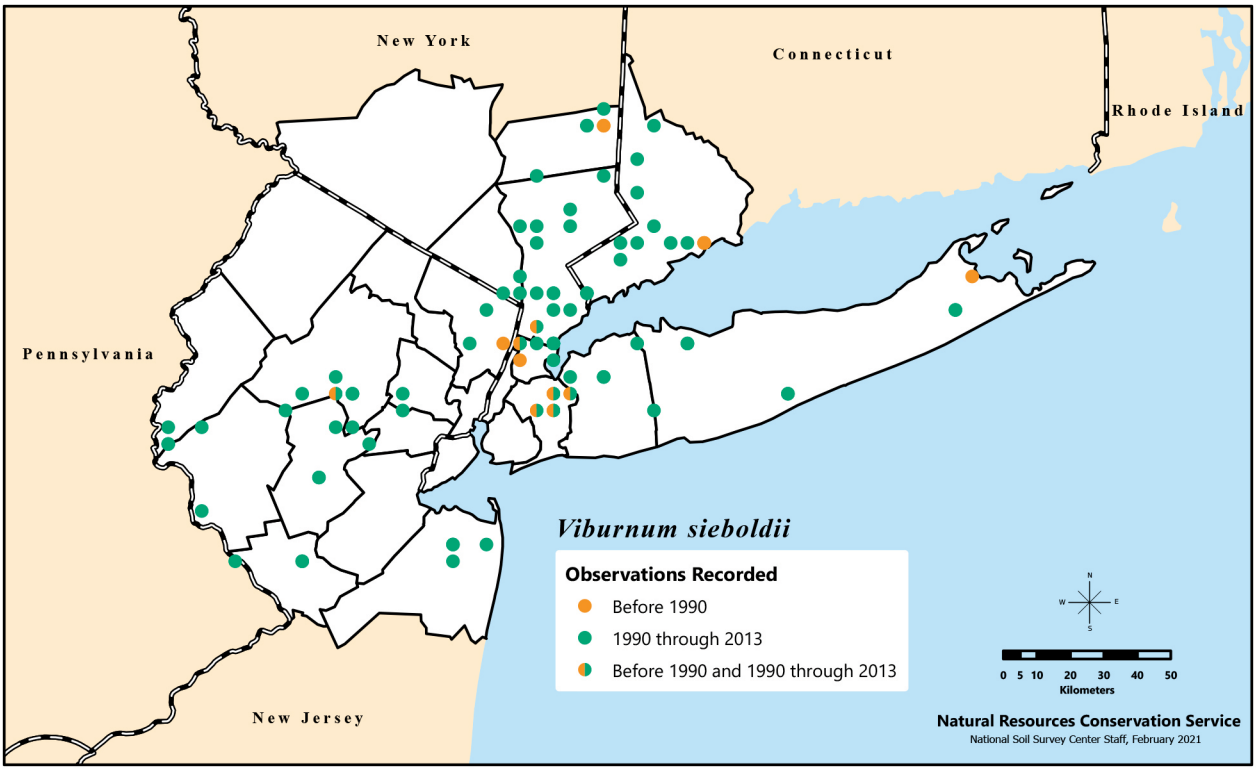
Introduced into the U.S. in the early 1900s. This species is becoming more common in the wild, especially on the Coastal Plain. At least 1 known cultivar (Dirr 1998). Propagation is best from cuttings. Drupes are bright red, and most likely dispersed or consumed by birds (Dirr 1998). Fruit may persist on the plant into late fall. Though this plant sets fruit best in full sun, a reasonable fruit set can be found in shade (Dirr 1997). Utilized for its pigments (Zhida and Yong 1996). Though it may become an invader and has escaped from cultivation, this species is not listed as an invasive species (AgWest and HEAR 2010). Nonetheless, its large increase in the region warrants further evaluation.

13. *Viburnum sieboldii* Miq. – Siebold's viburnum ↑↑↑

Shrub. Flowering mid-May–June. Mesic woodlands and woodland edges. Native to Japan. Prefers moist, well-drained soils, but is pH-adaptable and can tolerate shade (Dirr 1998). Native habitat is thick woods along streams (Künstler 1993). Named in honor of Philipp Franz von Siebold (1796–1866), German physician and noted researcher of the endemic flora and fauna of Japan. The earlier name *Viburnum tomentosum* Thunb. (1794) is sometimes applied to this



Distribution of *Viburnum setigerum*, or tea viburnum, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Viburnum sieboldii*, or Siebold's viburnum, recorded in the New York Metropolitan Region during three time categories.

plant. However, this name is an illegitimate later homonym of *V. tomentosum* Lam. (1779) and is not available for use.

Introduced for cultivation into the U.S. in 1880, with at least 3 cultivars (Dirr 1998). Among the largest of the viburnums; height at maturity 6–7 m. Crushed leaves emit a fetid or green pepper odor, and the leaves tend to remain on the plant late (Dirr 1997), sometimes into Nov. Birds consume the fruit (Dirr 1998), and possibly disperse the seeds via defecation. Infructescence stems remain rose-red, almost fluorescent, even after removal of fruit (Dirr 1997, 1998). A diploid (2n=16, like *V. plicatum*; Gleason and Cronquist 1993, Yiming 1997). Best propagated from cuttings (Dirr 1998); can reproduce vegetatively (Künstler 1993). This species is resistant to the newly introduced viburnum leaf beetle (Weston and Desurmont 2002).

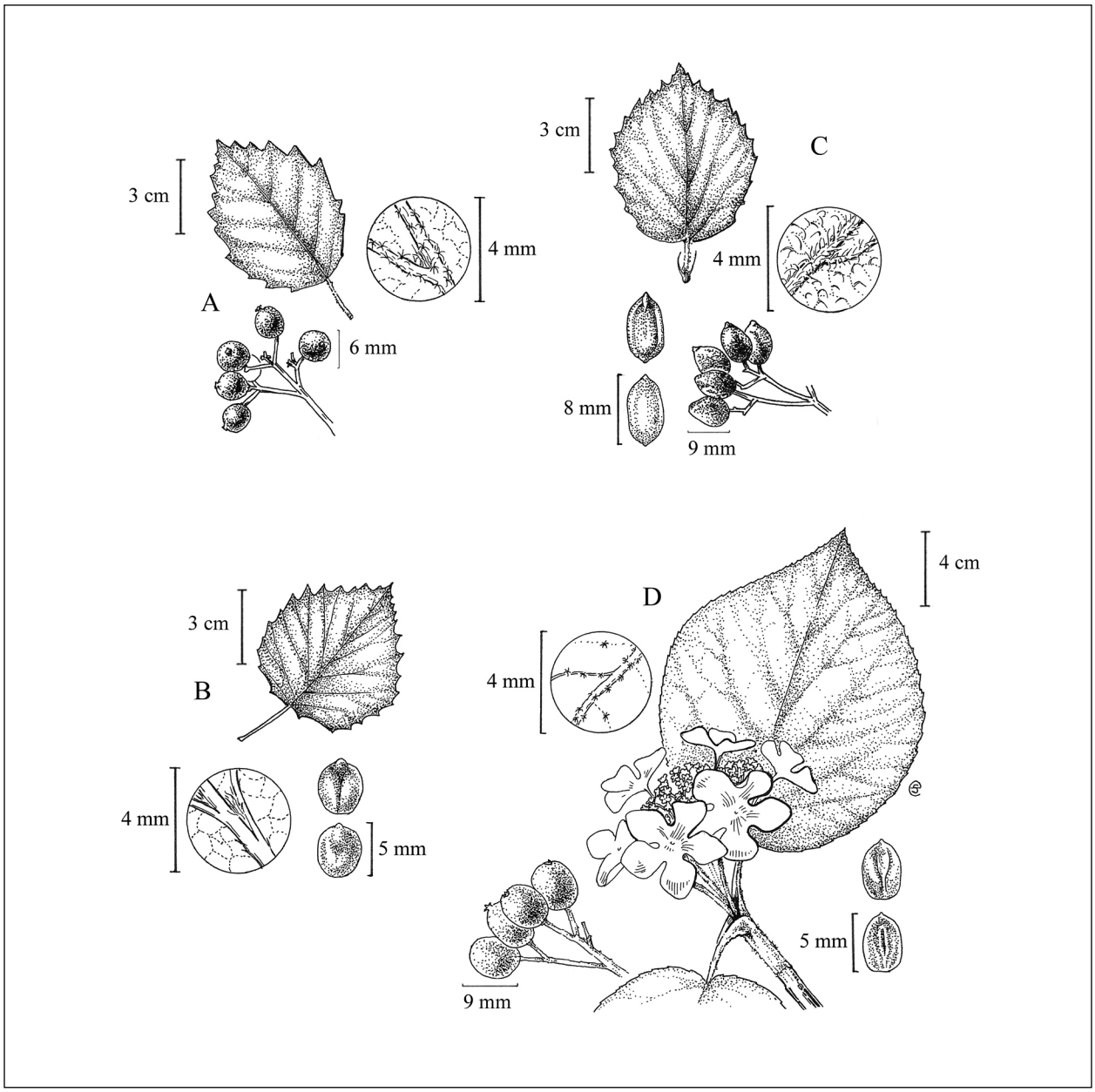
Six novel neovibsanin compounds have been isolated from *V. sieboldii*. These compounds may be used to develop drugs for the treatment of neurodegenerative diseases such as Alzheimer's disease (Kubo et al. 2010). Documented invading natural areas (AgWest and HEAR 2010); according to Künstler (1993), its invasive potential is underestimated.

Tracked as potentially invasive in NJ.

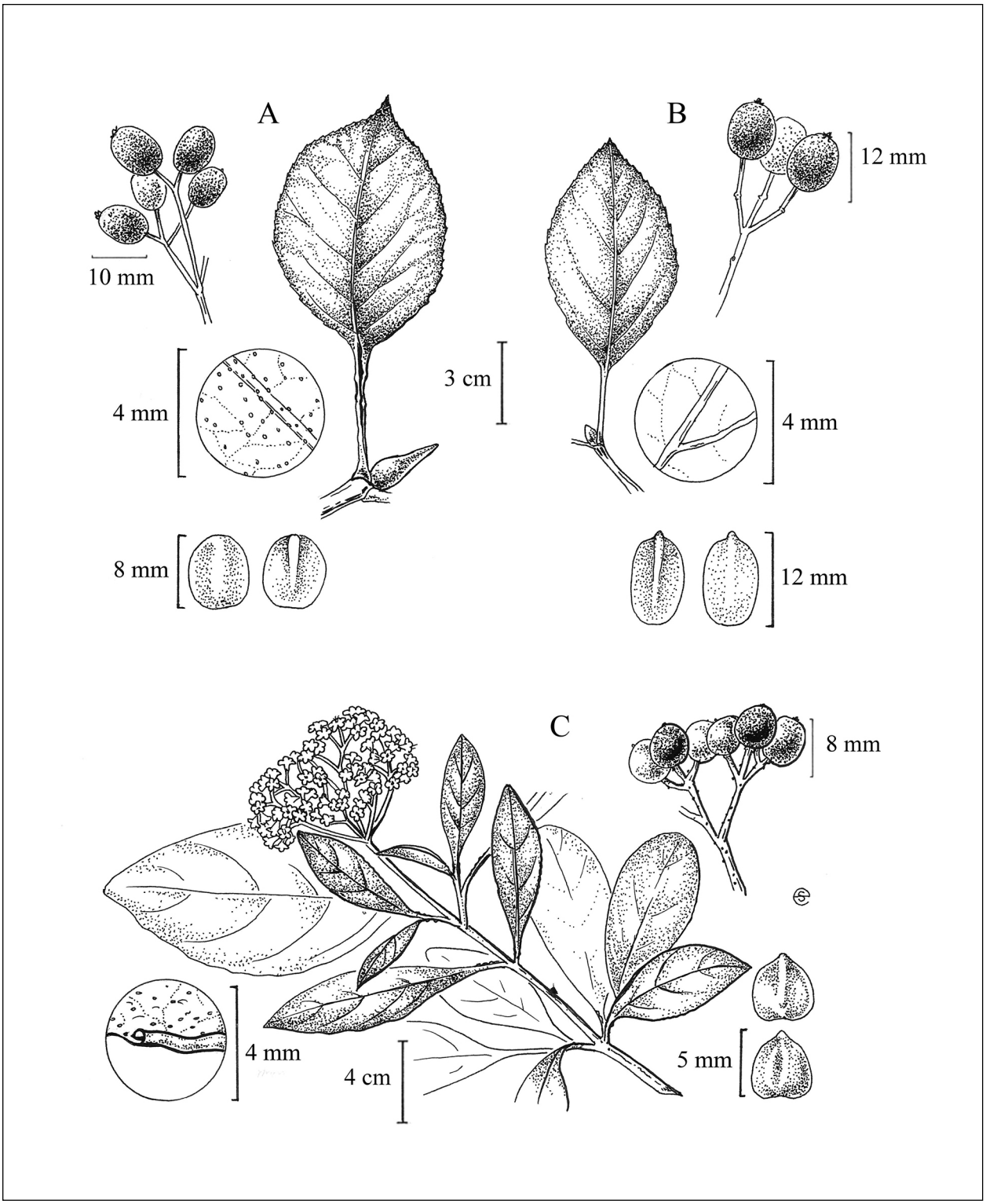
Management

Because of the range of possible environmental conditions that the native viburnums tolerate, there is a native *Viburnum* sp. that potentially could thrive in place of every nonnative *Viburnum* sp. in the preceding descriptions. Further, all the viburnums described here are dispersed by birds and small mammals, as well as large mammals, with some of the seeds being lost to predation. This pattern suggests a relatively sustainable means of maintaining populations as well as increasing the range of populations. Viburnums suffer from both a newly arrived insect pest (native to Europe), the viburnum leaf beetle, and overbrowsing by deer; the native viburnums

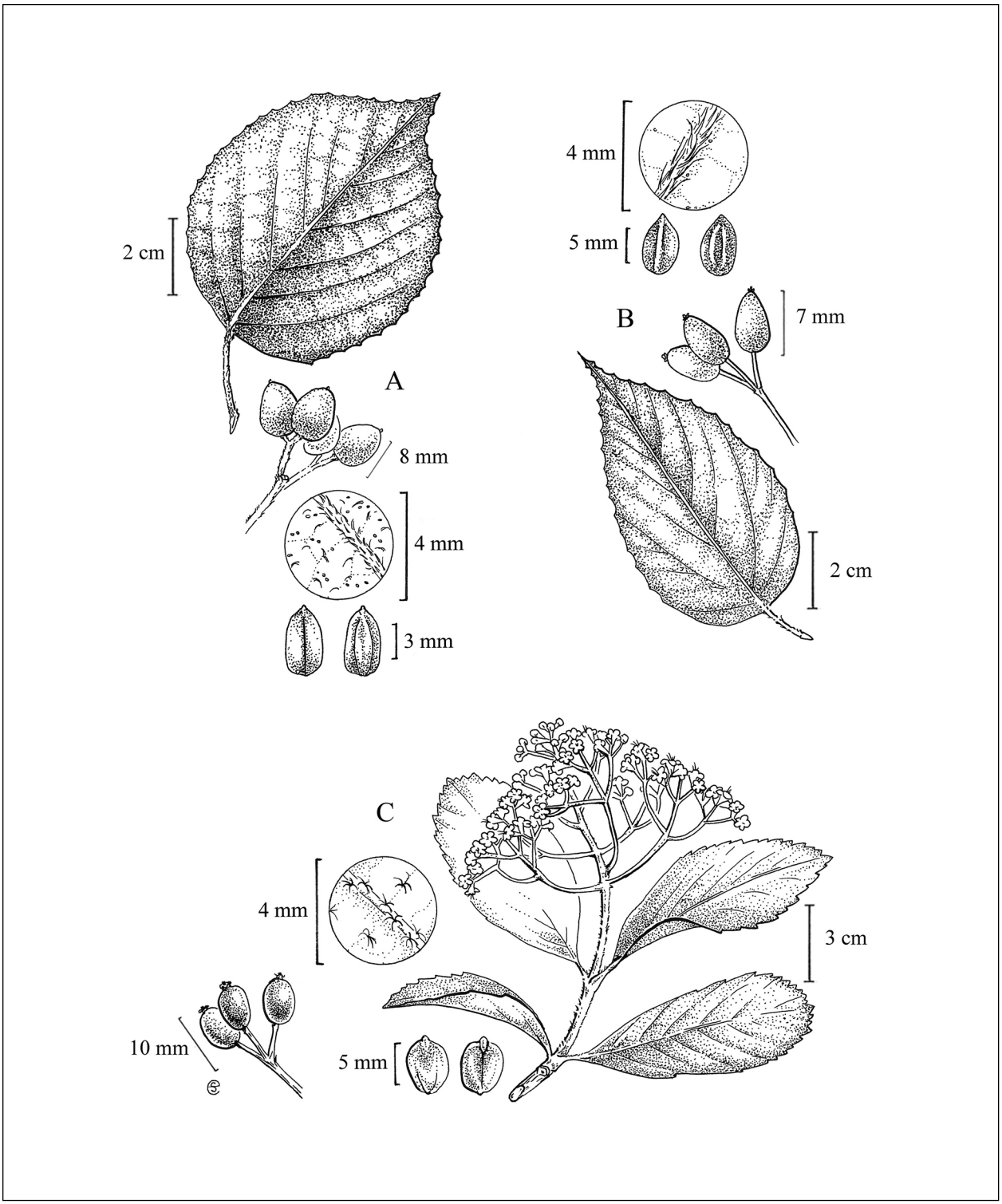
are potentially more susceptible to both. The leaf beetle was first detected in central NY in 1996. It has since been found in PA, OH, and VT (Weston and Hoebeke 2003). There is a lack of information about the resistance of some native viburnums, including *V. acerifolium*, to this beetle. Based on the limited information that appears to come from a single research group at this time, it may be best to use *V. prunifolium* as a substitute for most nonnative viburnums, especially in drier conditions. Protection from the leaf beetle and a reduction in deer herbivory may ensure restoration of a natural viburnum shrub layer even if nonnative species continue to be planted as landscape species. However, without such protection from the beetle or reduction in deer herbivory, we may find that our forests are invaded further by nonnative, shade-tolerant species that are resistant to the leaf beetle, such as *V. sieboldii* and *V. plicatum* (Weston 2004).



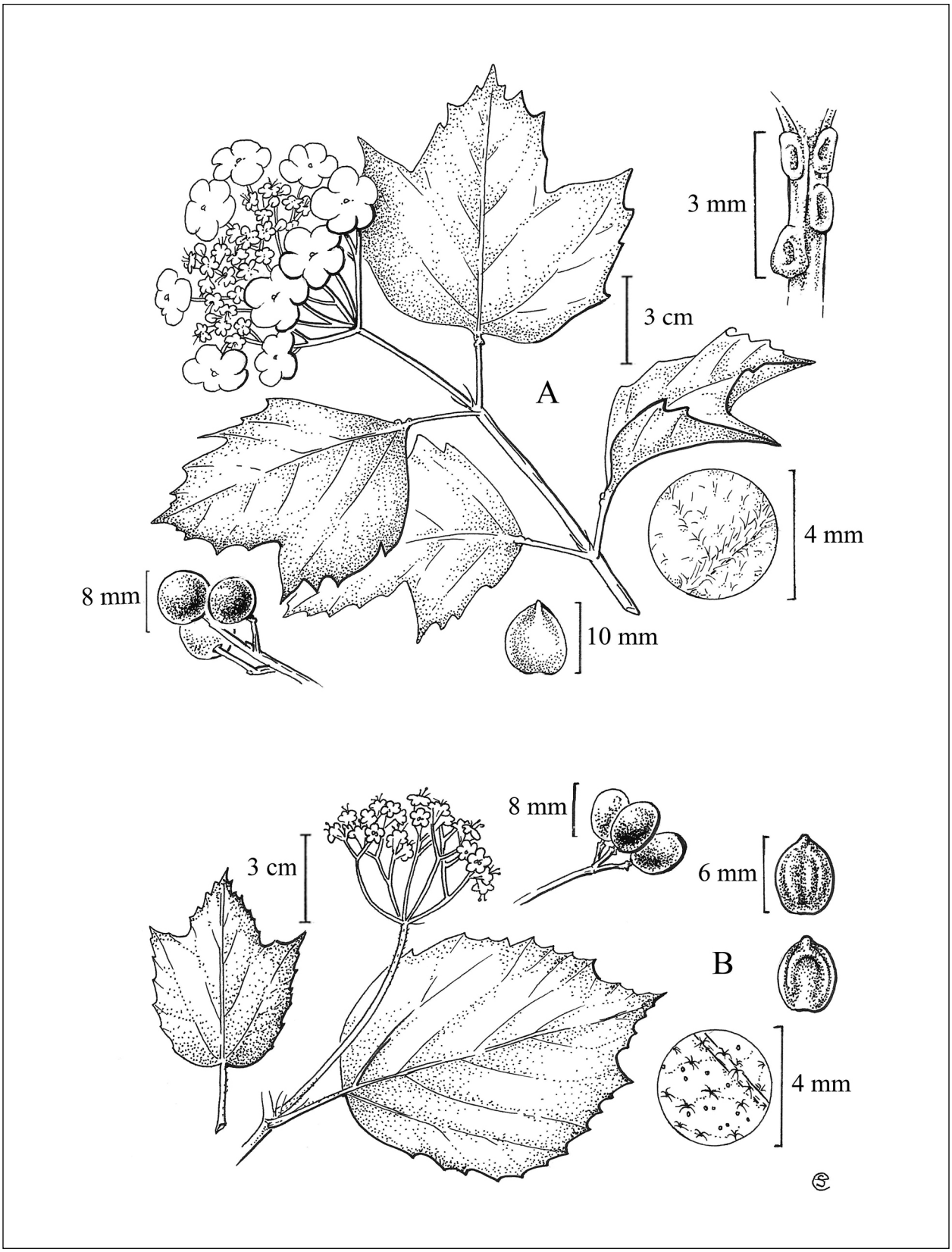
A) Leaf, with enlarged view of underside pubescence, and fruiting twig of *Viburnum dentatum* var. *dentatum*; B) leaf, with enlarged view of underside pubescence, and seeds of *Viburnum dentatum* var. *lucidum*; C) leaf, with enlarged view of underside pubescence, and seeds and fruiting twig of *Viburnum rafinesquianum*; D) fruiting twig, flowering twig with leaves and enlarged view of leaf underside pubescence, and seeds of *Viburnum lantanoides*. Illustration by Emma Skurnick.



Fruiting twig, leaf and bud with enlarged view of leaf underside, and seeds of A) *Viburnum lentago* and B) *Viburnum prunifolium*; C) flowering leafy twig, with enlarged view of leaf underside and margin, and fruit and seeds of *Viburnum nudum*. Illustration by Emma Skurnick.



Leaf, fruiting twig, enlarged view of leaf underside, and seeds of A) *Viburnum dilatatum* and B) *Viburnum setigerum*; C) fruiting twig, flowering twig with leaves and enlarged view of leaf underside, and seeds of *Viburnum sieboldii.* Illustration by Emma Skurnick.



A) Flowering leafy twig and enlarged views of leaf underside pubescence and petiole glands, and fruiting twig and seed of *Viburnum opulus* var. *opulus*; B) leaf, flowering leafy twig with enlarged view of underside pubescence, and fruiting twig and seed of *Viburnum acerifolium*. Illustration by Emma Skurnick.

Vitis L. – grape

Vitaceae. Woody vines, usually dioecious (exception *V. vinifera*). Grown world-wide with 60–65 species in Asia, Europe, and North America. Distinguished from other vitaceous genera by its shredding bark (lacking lenticels), simple leaves, and flowers with petals united at apex, the united portion shed as a cap (calyptra). Seeds dispersed by birds, box turtles (*Terrapene carolina*), and many small mammals that consume the fruit. Widely cultivated for the fruit, which is eaten fresh and dried (raisins) as well as processed as juice and wine. *Vitis vinifera*, most likely native to southwestern Asia and southeastern Europe, is the primary species used in fruit production for wine-making. After an outbreak of aphid rootlouse or phylloxera (*Daktuolosphaira vitifolia*) in 1867, the cause of the Great French Wine Blight, American *Vitis* spp. that were resistant to the rootlouse were used as grafting stock with *V. vinifera*. These American species include the hybrids *V. berlandieri* × *V. riparia* and *V. riparia* × *V. cinerea*; the former hybrid is only partially resistant (Zhang et al. 2009).

All *Vitis* spp. described here have generally similar phenology: flowering late May–July; fruiting mid-Aug.–Oct.

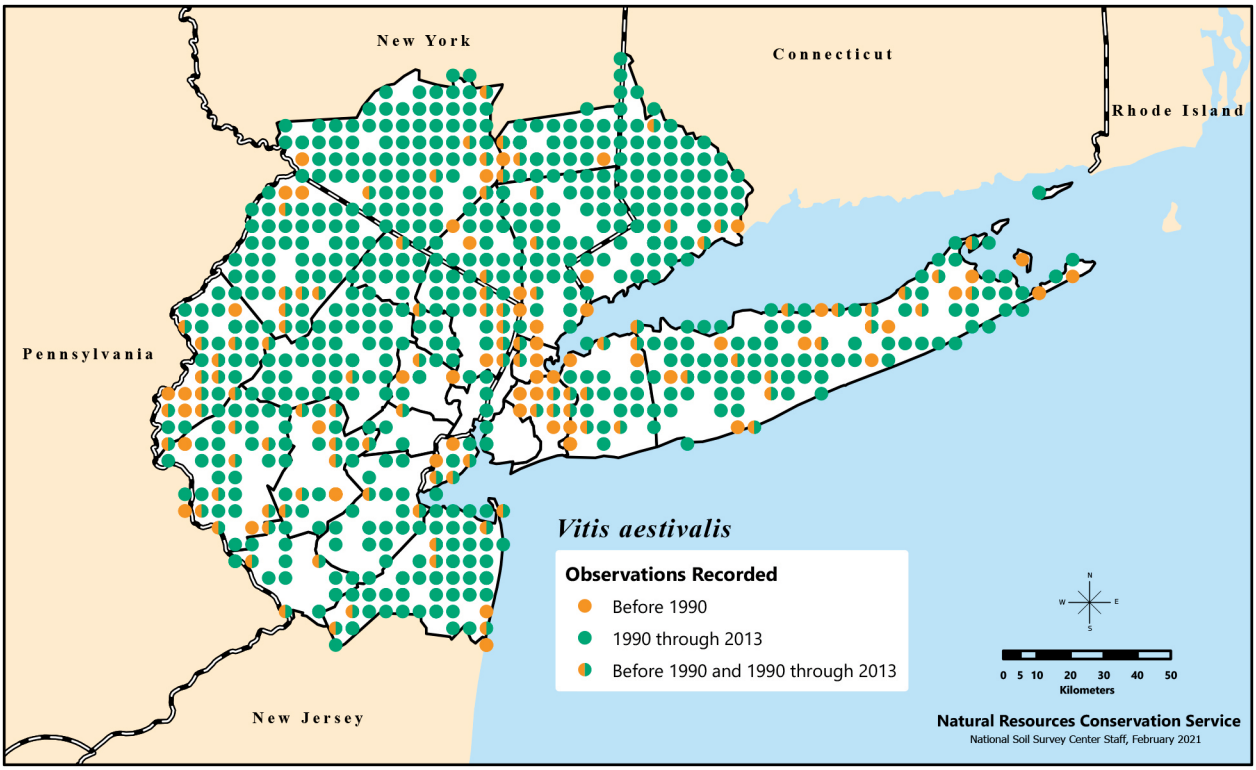
Native Species

1. *Vitis aestivalis* Michx. – summer grape, pigeon grape ↑↑

Dry to mesic woodlands, woodland edges, thickets, and roadsides. Epithet from Latin refers to summer, possibly a reference to the fruit, which can mature in late summer. Reforestation may explain its increase in the region.

Vitis Key

1. Flowers usually hermaphroditic; skin and pulp of fruit closely adhering, skin not readily separated from pulp; cultivated species, rarely escaping . . . . . ***Vitis vinifera****
1. Flowers unisexual, plants dioecious; skin and pulp of fruit readily separating, allowing the grape to be "pulped"; native species 2
2. Leaves pubescent beneath with long cobwebby hairs (at least when young), simple straight hairs possibly occurring along the veins 3
2. Leaves pubescent beneath when young, especially along the veins, with short, rather straight and somewhat spreading hairs, glabrous at maturity except in vein axils 4
3. Tendrils or panicles (or both) not produced at more than 2 successive nodes; leaves at maturity usually densely white-tomentose beneath . . . . . ***Vitis aestivalis***
3. Tendrils or panicles (or both) occasionally or regularly produced from 3 or more successive nodes; leaves at maturity either densely reddish-tomentose or merely pubescent or floccose on the veins beneath 5
4. Growing tips enveloped by enlarging, unfolding leaves; nodal diaphragms less than 1 mm wide, usually less than 0.5 mm wide; leaves cuneiform . . . . . ***Vitis riparia***
4. Growing tips not enveloped by enlarging, unfolding leaves; nodal diaphragms more than 1 mm wide; leaves cordate 6
5. Leaves permanently densely tomentose beneath, the surface concealed by the reddish pubescence . . . . . ***Vitis labrusca***
5. Leaves at maturity merely pubescent or floccose along the veins beneath . . . . . ***Vitis ×novae-angliae***
6. Nodal diaphragms more than 2.5 mm wide; leaf apices usually long-acuminate; current year's branches red . . . . . ***Vitis palmata****
6. Nodal diaphragms less than 2.5 mm wide; leaf apices acute or short-acuminate; current year's branches not red . . . . . ***Vitis vulpina***



Distribution of *Vitis aestivalis*, called summer grape or pigeon grape, recorded in the New York Metropolitan Region during three time categories.

2. *Vitis labrusca* L. – fox grape ↑↑

Mesic to wet woodlands, woodland edges, thickets, streambanks, and roadsides; usually in rich soil. Epithet is the Latin name of the wild vine. Reforestation may explain its increase in the region.

3. *Vitis* ×*novae-angliae* Fernald (*V. labrusca* × *V. riparia*) Fern. – New England grape Ø

Hybrid found in areas where the two species overlap. Epithet is Latin for New England. Has invaded Europe and is now prohibited in Europe. This species apparently was responsible for the introduction of two North American pests, phylloxera and downy mildew (*Plasmopara viticola*), to Europe (Ardenghi et al. 2015).

4. *Vitis riparia* Michx. – riverbank grape, frost grape ↑↑↑

Mesic woodlands, edges of woodlands, river islands, and streambanks; usually in rich soil. Reforestation may explain its increase in the area.

5. *Vitis vulpina* L. – winter grape, frost grape ↔

Mesic woodlands, edges of woodlands, thickets, and streambanks; in rich soil.

Listed as endangered in NY (S1), where it approaches the northern limit of its range.

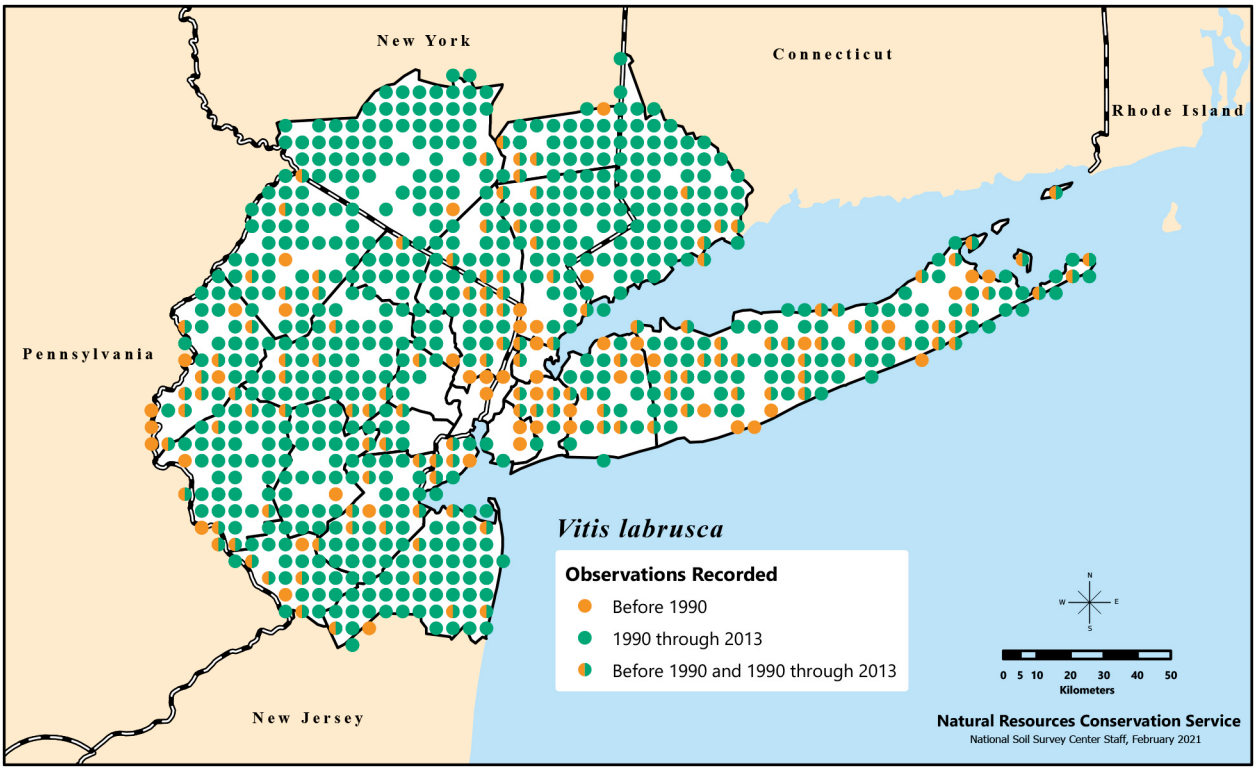
Nonnative Species

***Vitis palmata* Vahl. – red grape**

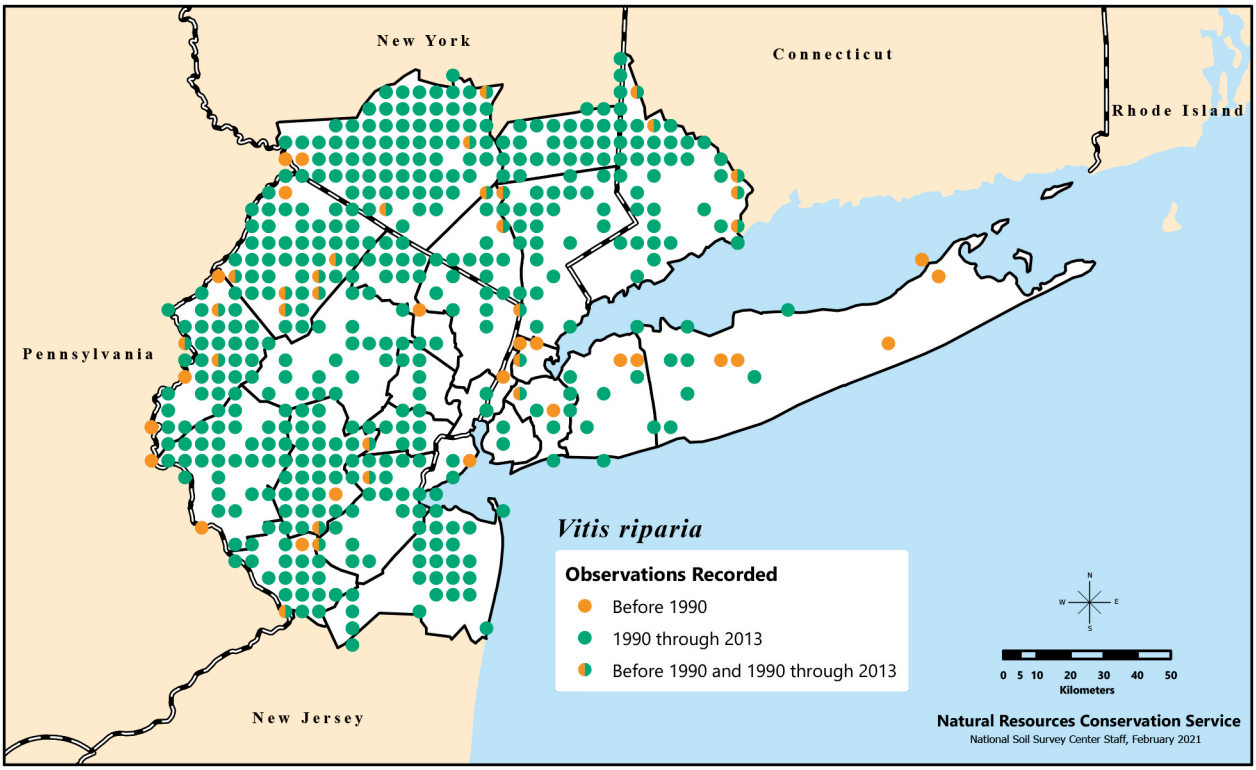
Cultivated; may be encountered as a remnant from cultivation or casual escape.

6. *Vitis vinifera* L. – wine grape Ø

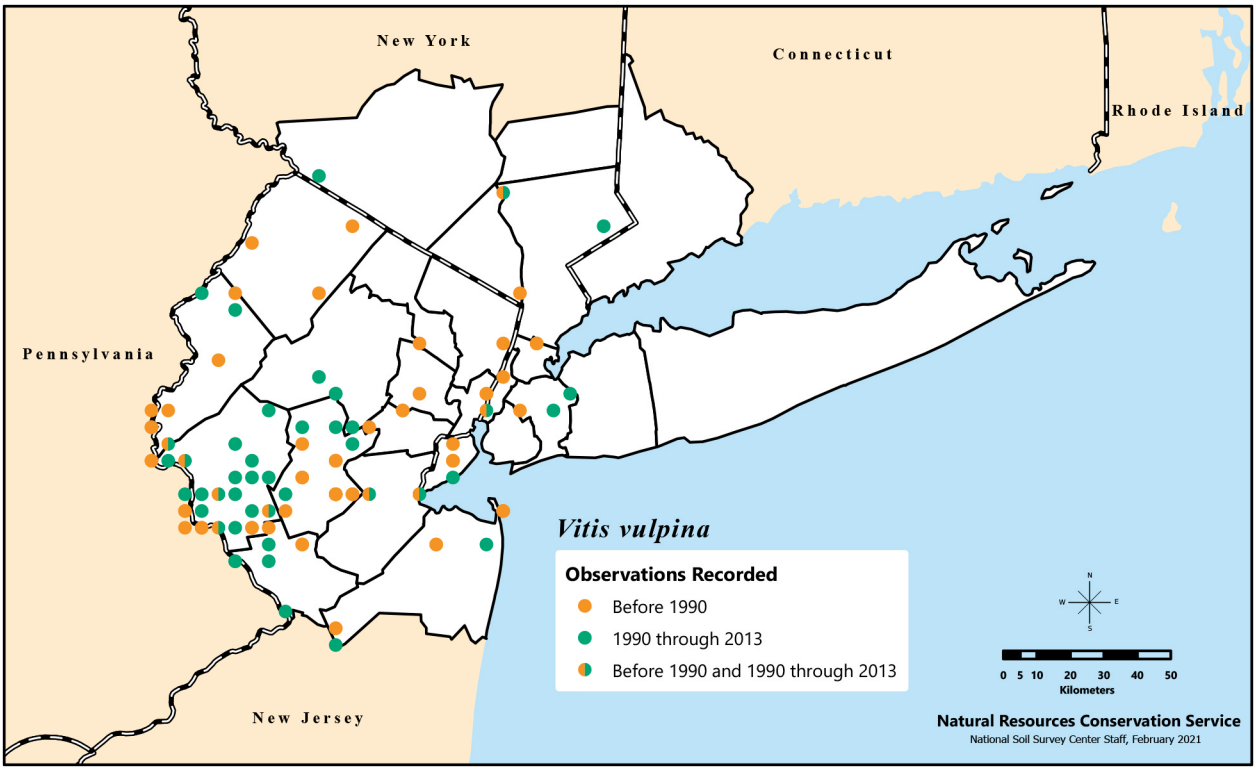
Cultivated; encountered as a remnant from cultivation or escape. Escaped populations have been observed in vacant lots and other urban areas in Kings and Queens Counties (NY). Epithet is Latin, meaning “wine-producing.”



Distribution of *Vitis labrusca*, or fox grape, recorded in the New York Metropolitan Region during three time categories.



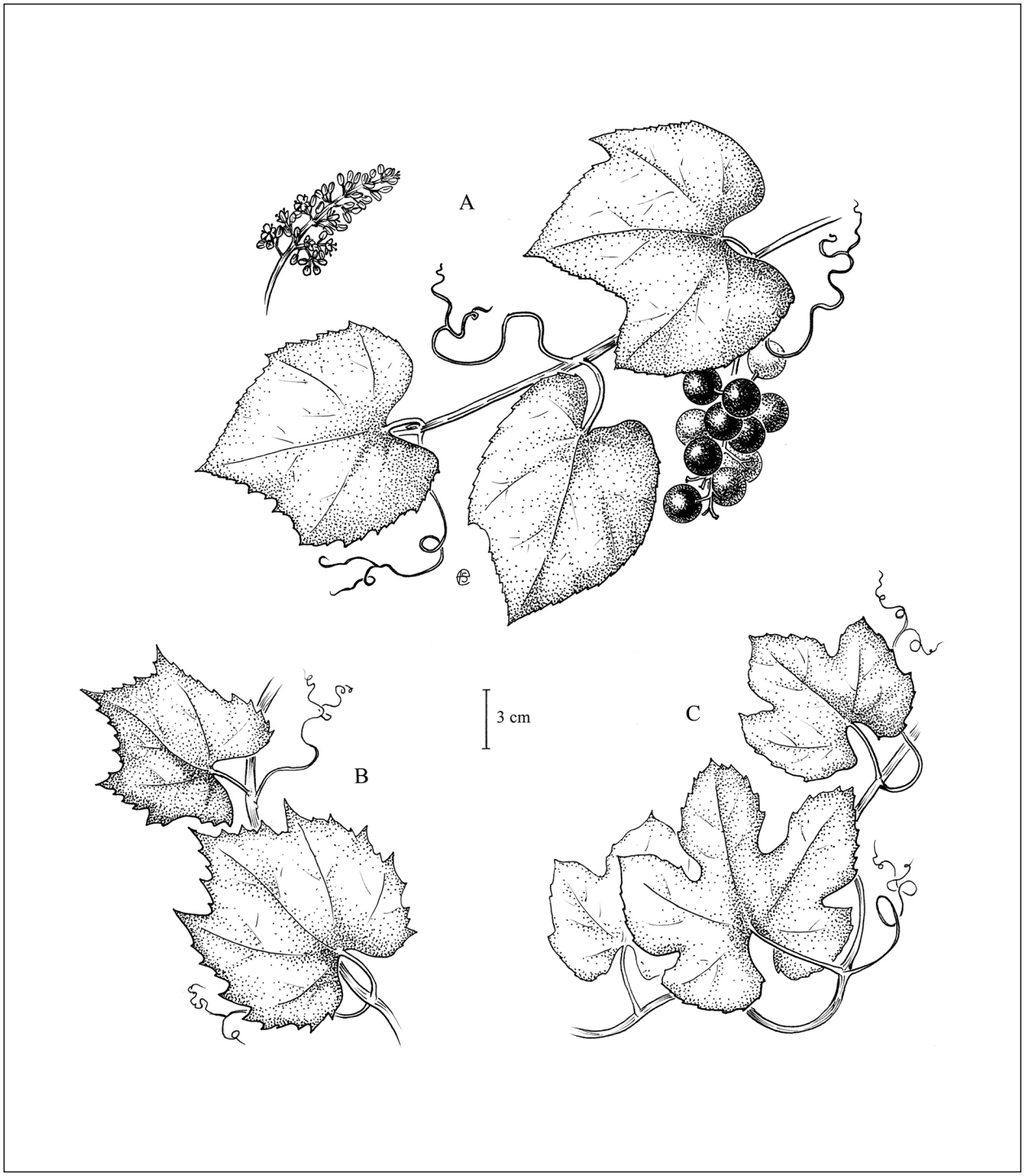
Distribution of *Vitis riparia*, called riverbank grape or frost grape, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Vitis vulpina*, called winter grape or frost grape, recorded in the New York Metropolitan Region during three time categories.

Management

Both native and nonnative grapes can become a problem in recently cut forests, by taking advantage of the increase in light and growing on new tree growth or on any residual trees. Those trees often cannot grow, or fall from the weight of the vines. Management of grape vines is commonly done by cutting and applying herbicides. Cutting alone results in sprouting and more growth of the vine, unless done in heavy shade (Smith 1984). An increase in *Vitis* spp. may indicate an increase in forested area as well as forest harvesting or other disturbances to the forest canopy (e.g., wind storms) in certain parts of the region.



A) Flowers and fruiting twigs with leaves and tendrils of *Vitis labrusca*; twigs with leaves and tendrils of B) *Vitis vulpina* and C) *Vitis aestivalis.* Illustration by Emma Skurnick.

Wisteria Nutt. – wisteria

Fabaceae. Woody climbing vines, shrubs. Species 6 in eastern Asia and North America. Primarily flower in spring; rarely a second bloom later in the season, with the racemes fewer in number and smaller. Honors Caspar Wistar (1761–1818), anatomy professor at the University of PA and a president of the American Philosophical Society (Nuttall 1818). Some have changed the spelling to *Wistaria* (e.g., Bigelow 1917, Halsted 1897, Smith 1895, Sumner 1909), while others, such as Nicolson (1984), have argued against changing the original spelling. The original spelling is now conserved (Wiersema 2015).

Nonnative Species

1. *Wisteria floribunda* (Willd.) DC. – Japanese wisteria ↑↑

Glycine floribunda Willd.

Flowering May–June. Open woods, old homesteads, and disturbed areas; a rare escape or remnant from cultivation. Native to eastern Asia. Epithet from Latin meaning "abundant flowers."

Introduced into the U.S. in 1830 with at least 25 cultivars. Flowers open first at the base of the raceme. Fruit may persist into winter. May be difficult to transplant (Dirr 1998). Can be propagated both by seed and vegetatively, with which it expands horizontally using stolons (Sakai et al. 2002). Prefers deep, moist, well-drained loamy soils at higher pH and full sun. Can grow 3 m per year. Several different insects such as crown gall (*Rhizobium radiobacter*), Japanese mealybug (*Pseudococcus comstocki*), and fall webworm (*Hyphantria cunea*) and diseases such as stem canker (caused by *Fusarium* spp.), powdery mildew (causal agent *Erysiphe necator*), and tobacco mosaic virus (*Tobamovirus* spp.) affect this species. Adequate support is needed because it produces heavy vines that can crush many structures (Dirr 1998). Few young twining shoots can use tree stems greater than 5 cm in diameter as support. Thus, while *Wisteria* spp. are found along forest edges and in forest gaps, they are not as likely to invade a closed canopy forest with larger trees (Sakai and Suzuki 1999, Sakai et al. 2002). Germination does not require any pretreatment. *Wisteria floribunda* is difficult to differentiate from *W. sinensis* (described subsequently), which flowers about 2 weeks later than *W. floribunda*. Twining of *W. floribunda* is clockwise while *W. sinensis* twines in a counterclockwise direction (Dirr 1998). The difficulty in telling these species apart is more likely because most of what is called either species is actually a hybrid of the two from hybridization events that occurred in the U.S. or in New Zealand (Trusty et al. 2007, 2008) and not Japan or China (from which *W. sinensis* originates). In the Trusty et al. (2008) study, they found no true *W. sinensis* cultivars available in the horticultural trade. There were true *W. floribunda* cultivars in the horticultural trade, but 60 percent of those sampled were hybrids with *W. sinensis* (Trusty et al. 2008).

Tracked as invasive in NJ (category 1).

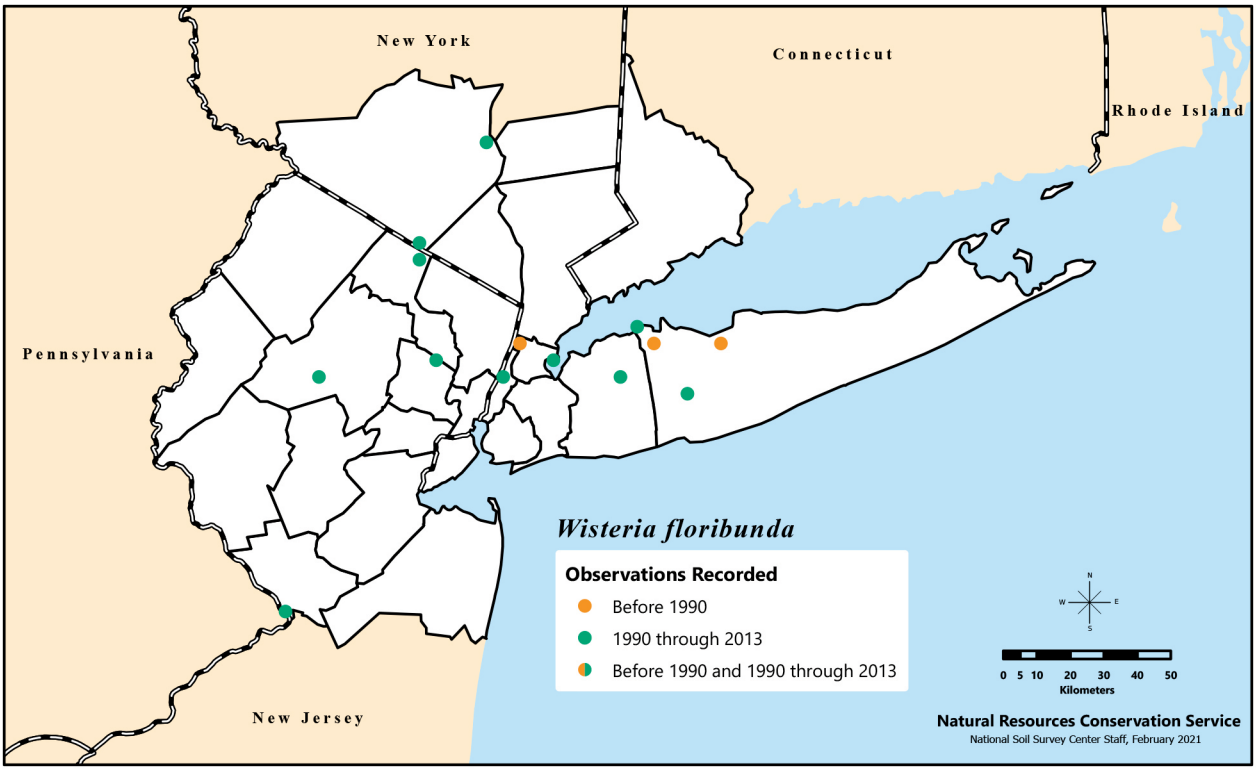
2. *Wisteria frutescens* (L.) Poiret – Atlantic wisteria ↑↑↑

Glycine frutescens L.; *Wisteria macrostachya* Nutt.

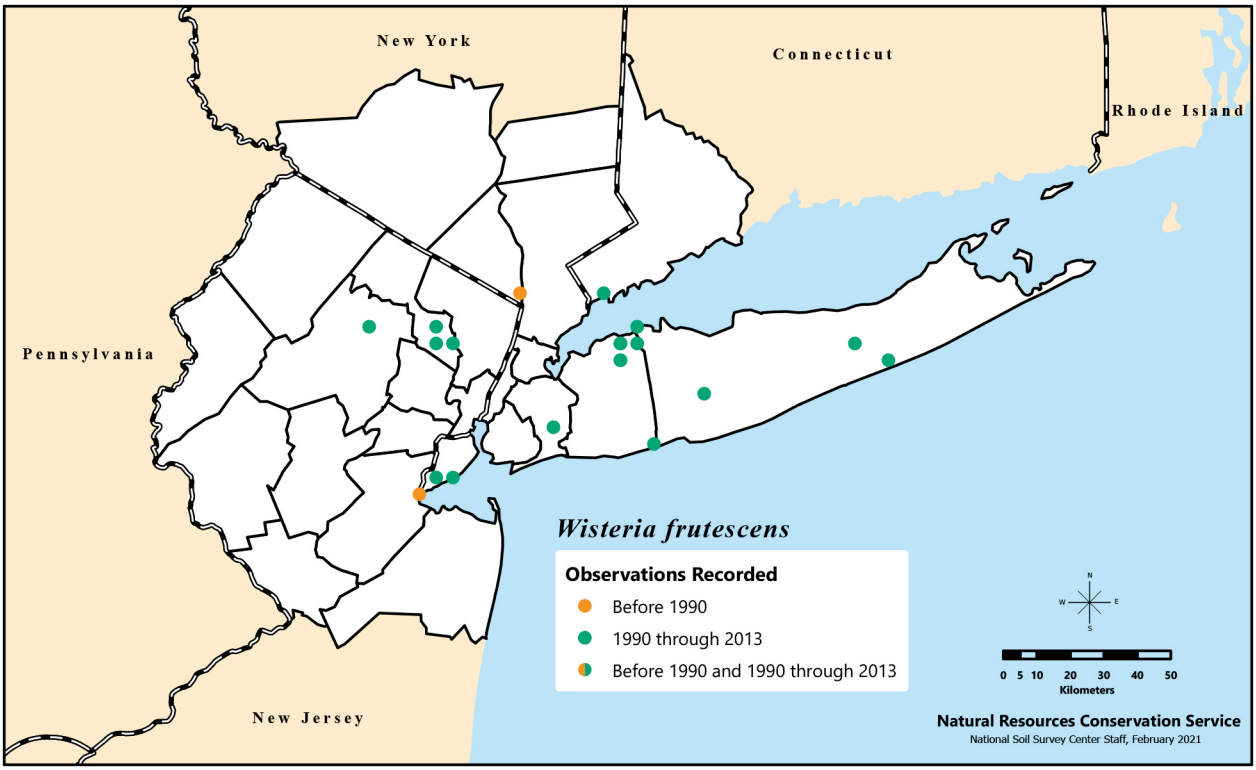
Flowering late Apr.–May. Open woods, old homesteads, and alluvial disturbed areas; often in moist soils. A rare escape or remnant from

Wisteria Key

1. Ovary and legume glabrous; pedicels 5–10 mm long . . . . . ***Wisteria frutescens****
1. Ovary and legume pubescent; pedicels 10–25 mm long 2
2. Leaflets 13–19; racemes narrow, 20–60 cm long, flowers expanding from base to apex . . . . . ***Wisteria floribunda****
2. Leaflets 7–13; racemes thick, cylindric, 10–20 cm long, flowers more or less opening simultaneously . . . . . ***Wisteria sinensis****



Distribution of *Wisteria floribunda*, or Japanese wisteria, recorded in the New York Metropolitan Region during three time categories.



Distribution of *Wisteria frutescens*, or Atlantic wisteria, recorded in the New York Metropolitan Region during three time categories.

cultivation. Native to the southeastern U.S.; the northern limit of its native range most likely VA. *Wisteria macrostachya*, if held distinct, has longer racemes, 15–32 cm (4–12 cm in *W. frutescens* s.s.), and pedicels and calyx with numerous club-shaped glands (absent or few glands in *W. frutescens* s.s.). Epithet means "shrubby" in Latin.

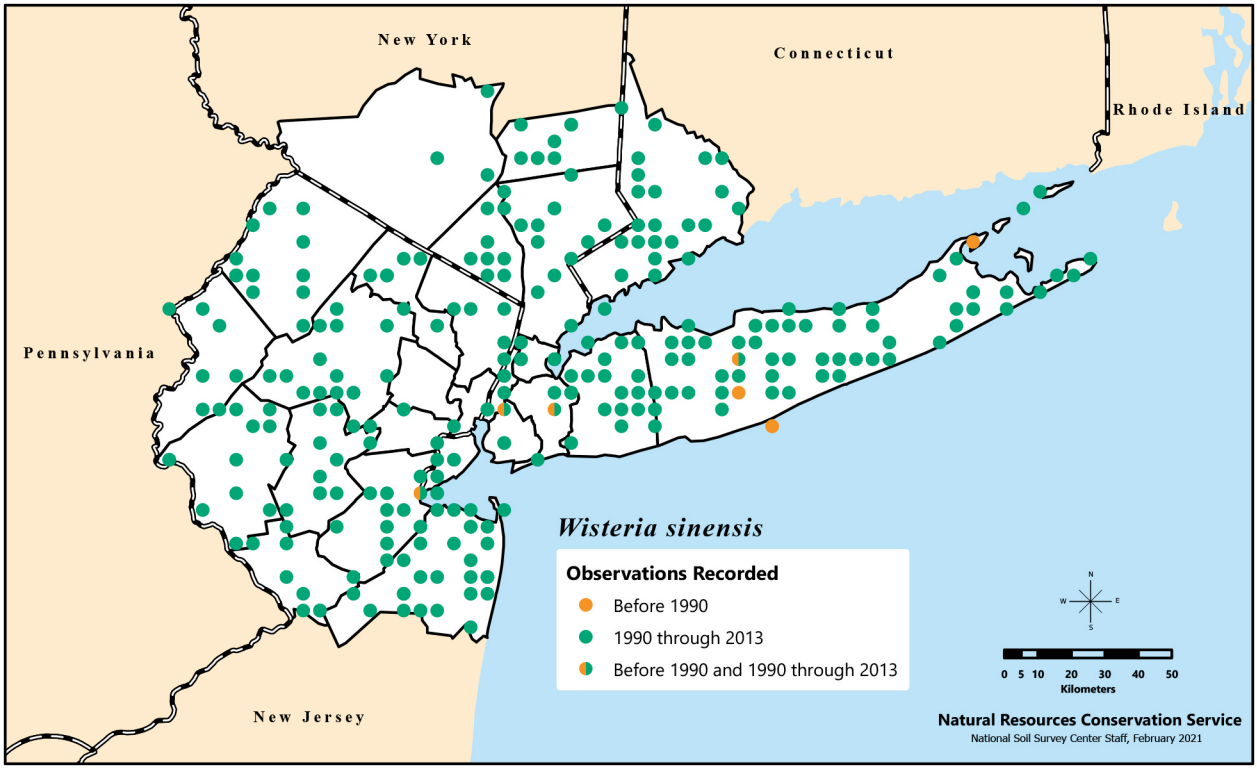
May have recurrent flowering throughout the summer. *Wisteria frutescens*, or American wisteria, has a native range from FL to TX, north to VA, and west to IL, MO, and OK (Dirr 1998, Kurz 1997), and is not native to the NY Metropolitan Region. Cultivated since 1724, with at least 3 cultivars (Dirr 1998). Like *W. sinensis*, it twines counterclockwise (Trusty et al. 2007). The bark, pods, and seeds of all *Wisteria* are toxic (Liu et al. 2005), though the flowers of *W. frutescens* have been used in salads and batters for fritters (Kurz 1997). *Wisteria frutescens* has racemes that are half as long as those of *W. floribunda* and *W. sinensis* (Kurz 1997). There is no documentation yet of *W. frutescens* forming hybrids with either *W. floribunda* or *W. sinensis*. Its increase in the region may be due to range expansion or plantings, or both.

3. *Wisteria sinensis* (Sims) Sweet – Chinese wisteria ↑↑↑

Glycine sinensis Sims

Flowering May–June. Open woods, old homesteads, and disturbed areas; a rather frequent escape or remnant from cultivation. Native to eastern Asia. Epithet is from the Latin "Sina," meaning "China."

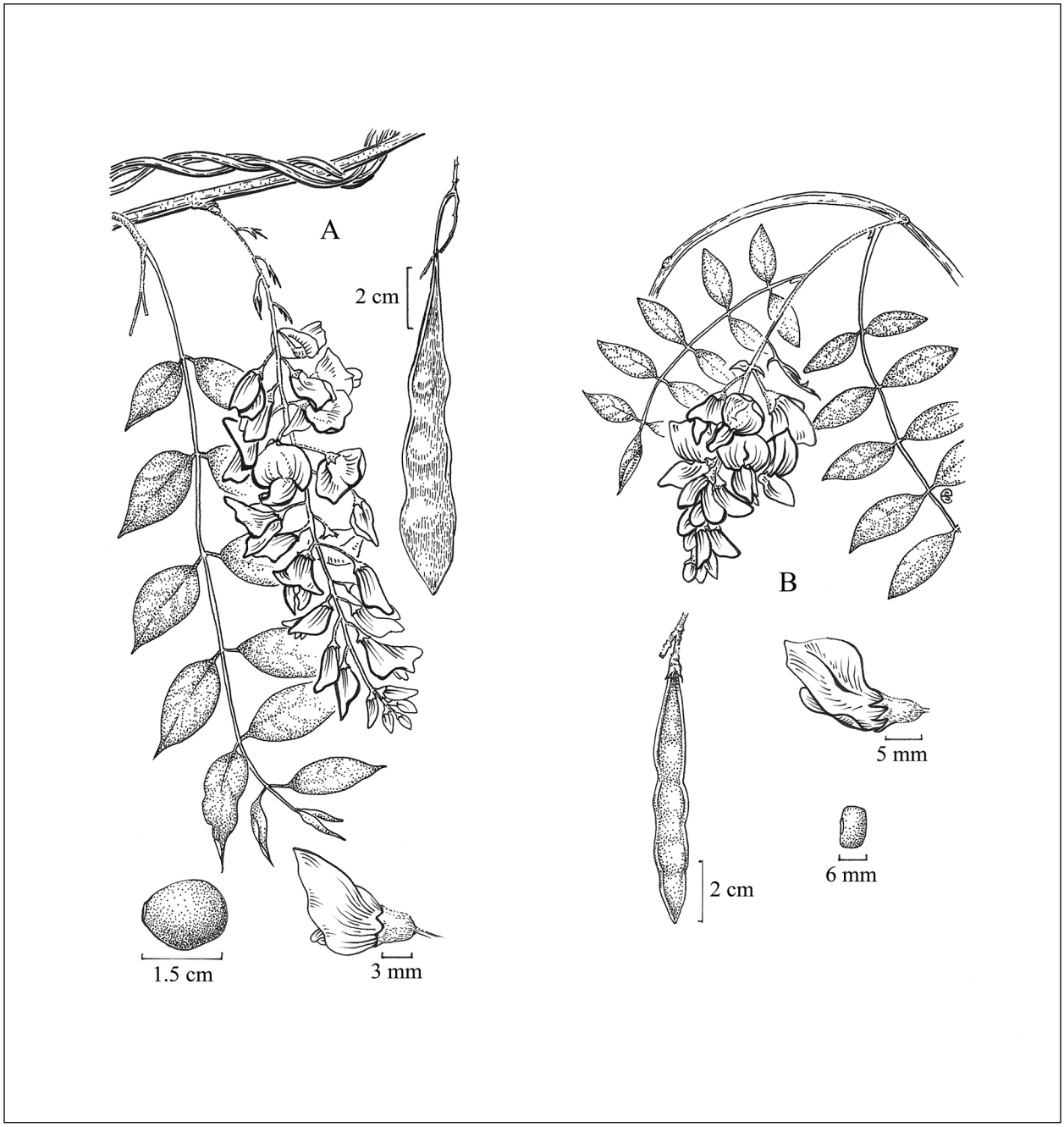
Introduced into the U.S. in 1916; at least 17 cultivars. This species may suffer from bacterial stem galls and leaf spot (Dirr 1998). There is some indication of shade tolerance in *Wisteria sinensis* (Wang and Ma 2004), as well as some potential drought tolerance (Zhang et al. 2007b).



Distribution of *Wisteria sinensis*, or Chinese wisteria, recorded in the New York Metropolitan Region during three time categories.

Management

Foliar herbicide sprays are an effective control strategy for *Wisteria* spp., though multiple applications may be needed (Miller 2006, Thomas 1993). Most of the species invading urban and natural areas are probably the *W. floribunda* × *W. sinensis* hybrid, though *W. frutescens* has increased in the region as well. Given the lack of information concerning hybridization of these three species and their potential to increase, planting them is not advised.



Flowering leafy twig, fruit (legume), seeds, and flowers of A) *Wisteria sinensis* and B) *Wisteria frutescens*. Illustration by Emma Skurnick.

Xanthorhiza Marshall – yellowroot

Ranunculaceae. Shrub. Species 1 in eastern North America. Distinguished by its yellow bark and roots, pinnate leaves, and purple-brown flowers in terminal pendulous racemes. Genus name from the Greek "xanthos," meaning "yellow" and "rhizos," meaning "root."

Nonnative Species

1. *Xanthorhiza simplicissima* Marshall – yellowroot Ø

Native to the southeastern U.S. north to OH, VA, and WV; occasionally planted as a groundcover and persisting or escaping from these plantings. Possible naturalized populations reported from Fairfield County (CT), Mercer County (NJ), and Bronx, Kings, Suffolk, and Westchester Counties (NY). Not clearly established in the flora. Epithet from Latin means "most simple," a reference to the unbranched or sparingly branched main stem.

Yucca L. – yucca

Asparagaceae. Shrubs. Species about 50 in Central America, North America, and the West Indies. Genus name is derived from "yucca," the Caribbean name for the cassava (*Manihot esculenta* Crantz) that was misapplied to this genus.

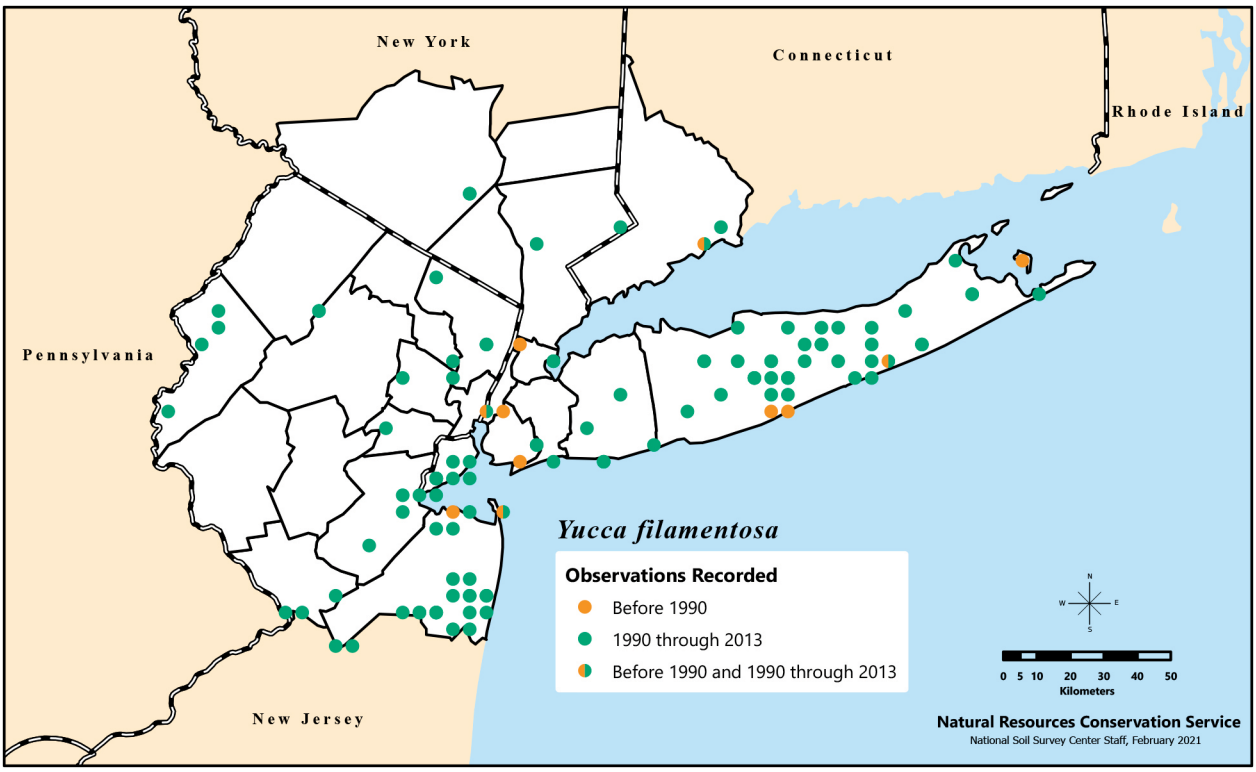
Nonnative Species

1. *Yucca filamentosa* L. – Adam's-needle, yucca ↑↑↑

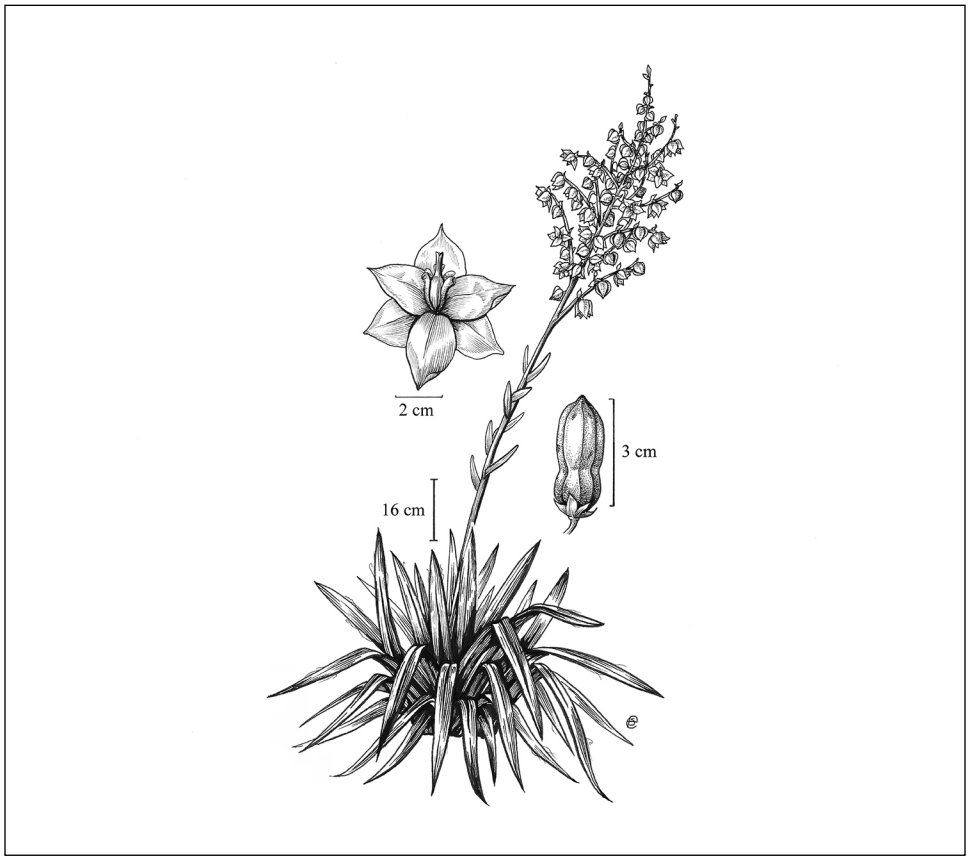
Flowering late June–early Aug. Open, dry sandy areas, especially on the Coastal Plain. Native to the Coastal Plain in the southeastern U.S.; generally not taken as native to the NY Metropolitan Region (Graves 1910, Taylor 1915, Weldy et al. 2020), although Fernald (1950) did regard it as native to southern NJ. Epithet from Latin refers to the slender fibrous threads that are present on the leaf margins.

Evergreen. Can be grown as far north as MN. A true shrub though its stem never rises above ground level. Cultivated since 1675, with at least 2 cultivars. Often confused with *Y. smalliana* Fern. (also native to the southeastern U.S.), which has thinner and narrower leaves with a long tapered apex and a pubescent central axis on the panicle. It is also often confused with *Y. filifera* Chabaud. (from Mexico), which has shorter and narrower leaves that bend downward above the middle (Dirr 1998). Self-compatible, but mutualism with the yucca moth (*Tegeticula yuccasella*) helps ensure that most offspring are products of outcrossing (Massey and Hamrick 1999). Yucca moths pollinate only yucca flowers and collect pollen from one or several yucca plants. They oviposit in a locule of a yucca flower's ovary and then deposit the collection of pollen on the stigmatic surface of the style. The larvae consume only a small fraction of the seeds (Engelmann 1872, Riley 1872). *Yucca filamentosa* forms large clones that may make it difficult to ensure the pollen comes from a different clone. The evident outcrossing (very high genetic diversity) associated with this species (Massey and Hamrick 1998) suggests that this species may be selecting against self-fertilization; large clones tend to have higher abortion rates (Marr et al. 2000). Estimates of pollen flow rates also indicate that yucca moths can travel at least 300 m and probably much farther (Massey and Hamrick 1999). Its increase in abundance outside its range suggests that the yucca moth also survives outside its native range (as noted by Pellmyr 1999), or that more northern populations are less genetically diverse and potentially composed of a few large clones. No research, to our knowledge, has addressed the genetic structure of *Y. filamentosa* populations outside its native range. The presence of *Y. filamentosa* in the region is primarily the product of abandoned farmsteads where it was planted and from which it has since spread (Pándi et al. 2014). The yucca moth has also been intentionally brought to the northeastern U.S. (Pellmyr 1999).

Some of our material may be referable to *Yucca flaccida* Haworth, which is sometimes recognized as distinct from *Yucca filamentosa* and is also native south and west of the region (see Hess and Robbins 2002). *Yucca flaccida* can be distinguished from *Y. filamentosa* based on its often pubescent inflorescence axes (glabrous in *Y. filamentosa*) and shorter (3–5 cm) sepals (5–7 cm in *Y. filamentosa*).



Distribution of *Yucca filamentosa*, called Adam's-needle or yucca, recorded in the New York Metropolitan Region during three time categories.



Flower, plant with leaves and flowers, and fruit of *Yucca filamentosa*. Illustration by Emma Skurnick.

V W
X Y Z

Zanthoxylum L. – prickly ash, Hercules' club

Rutaceae. Trees, shrubs. Species about 200 in Africa, Asia, Australia, North America, and South America; chiefly tropical. Genus name is derived from the Greek "xanthos," meaning "yellow" and "xylon," meaning "wood." Original spelling sometimes changed to *Xanthoxylum*; original spelling is correct.

Native Species

1. *Zanthoxylum americanum* Mill. – prickly ash ↔

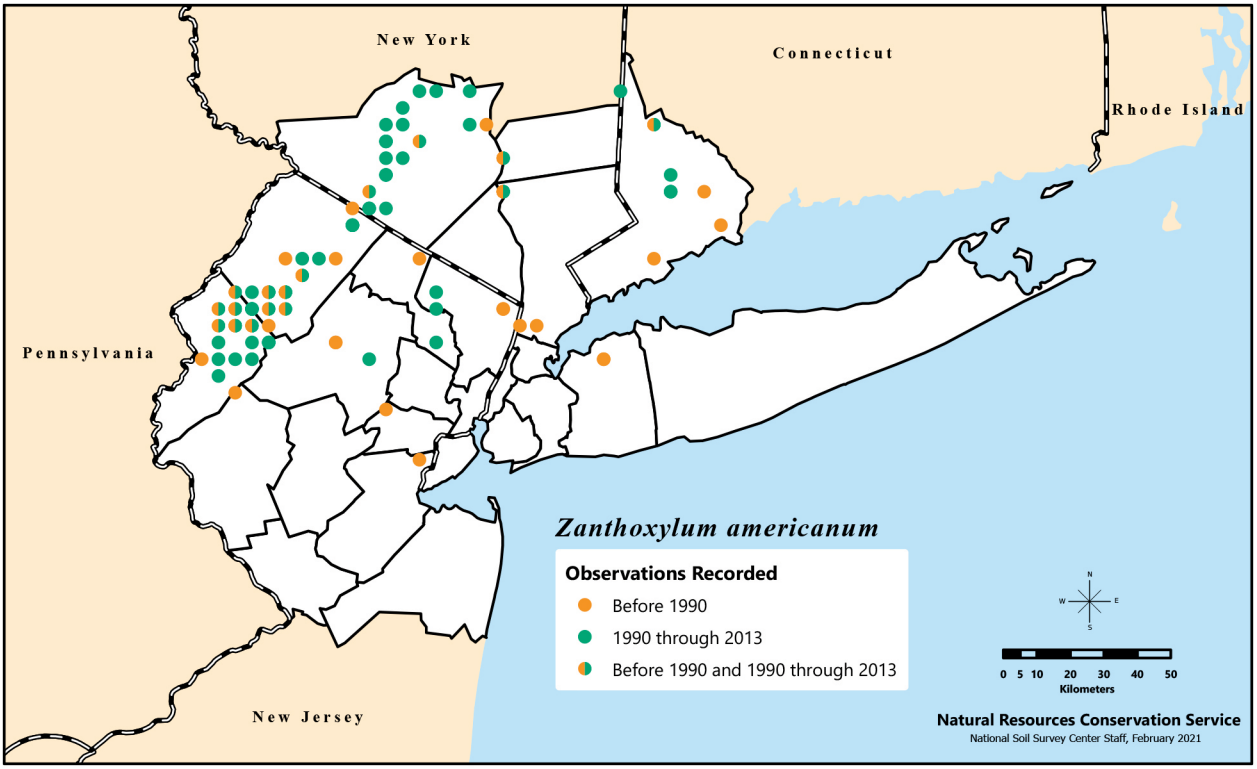
Flowering Apr.–May (before leaves appear). Open rich woodlands, woodland edges, and streambanks; often on limestone.

Height at maturity 8 m. Primarily dioecious; however, two additional reproductive strategies have been identified: 1) plants with functional protandrous flowers with rudimentary pistils and 2) hermaphroditic flowers with fully functional pistils (protogynous) and anthers. One study found 10 to 30 percent of the male plants bore at least one fruit each year. Sex ratios (female:male plants) within populations may differ (Munter et al. 2018). Scarification required for germination (Bonner 2008p). Cultivated since 1740, though considered an undesirable landscape tree. Stem and bark may have been chewed by Native Americans to alleviate toothaches. The bark's acrid juice has a numbing effect (Dirr 1998).

Nonnative Species

***Zanthoxylum simulans* Hance – Chinese-pepper**

Native to China. Occasionally planted; may be encountered as a remnant from cultivation. Differs from *Z. americanum* by glabrous (or nearly so) leaflets (pubescent in *Z. americanum*), flowers appearing later (June–July) after leaves have appeared.



Distribution of *Zanthoxylum americanum*, or prickly ash, recorded in the New York Metropolitan Region during three time categories.



Male flower, male flowering twig with thorns, and female fruiting leafy twig with thorns of *Zanthoxylum americanum*. Illustration by Emma Skurnick.

Zelkova Spach – zelkova

Ulmaceae. Trees, shrubs. Species 5 in Asia and southeastern Europe. Genus name is derived from the Georgian "dzelkva," common name for *Zelkova carpinifolia* (Pall.) K.Koch.

Nonnative Species

***Zelkova serrata* (Thunb.) Mak. – Japanese zelkova**

Corcorus serrata Thunb.

Flowering Apr.–May. Woodland edges and disturbed areas; remnant from cultivation and also a rare escape. Used in street tree plantings. Occurs only rarely in the region.

Glossary

abaxial: on the side away from the axis.

abscission: shedding of parts, such as leaves.

accrescent: increasing in size with age.

achene: the most generalized type of dry, indehiscent (not opening) fruit, usually one-seeded, lacking specialized features of a nut, caryopsis (fruit of the grass [Poaceae] family), or samara.

acrodromous: with veins curving toward the apex.

actinodromous venation: a leaf vein pattern with three or more primary veins diverging radially from a single point.

acuminate: gradually tapering to a narrow tip.

acute: sharp-pointed, with straight distal (far from the point of attachment) margins.

adaxial: on the side toward the axis.

adnate: having unlike or different parts that have grown together or are attached.

adventitious roots: roots arising from stem tissue.

adventive: introduced but not established or naturalized.

aerial roots: roots growing in the air.

aggregate (fruit): fruit derived from two or more pistils from a single flower.

alkaloid: a large group of nitrogenous, often pharmacologically active, ring compounds.

allelopathic: pertaining to the chemical inhibition of one organism by another.

allopolyploidy: genomes derived from two or more distinct species.

allotetraploid: having four sets of chromosomes derived from different species.

alternate (leaves): one leaf per node.

alternate (stamens): stamens alternating with the petals.

amphidiploid: having a diploid set of chromosomes derived from each parent.

annual: a plant that completes its life cycle within a single year.

antepetalous: having stamens opposite the petals.

antesepalous: having stamens opposite the sepals.

anther: the pollen-bearing portion of the stamen.

anthesis: the period of blooming when a flower is capable of shedding or receiving pollen.

apex: the tip; highest point.

apical: at the tip.

apomixis: the setting of seed without fertilization. Adjectival form (pertaining to species): **apomictic** (able to produce seed without fertilization).

apophysis: irregular swelling; enlargement of the base.

appressed: pressed close and flat against the surface.

aril: fleshy thickening surrounding the seed coat.

attenuate: gradually tapering to a point.

autogamous: self-pollinating, pollination occurring within a closed flower.

autonomous: having no vector pollinator.

autotetraploid: having four sets of chromosomes derived from the same species.

autotrophic: having the ability to produce its own nourishment.

awned: with an apical projection.

axil: position between an axis and a lateral organ, usually in reference to the angle between the stem and a leaf.

axillary buds: buds occurring at nodes along the twig.

backcross: the crossing of a hybrid with one of its parents.

basionym: in botany, an earlier valid name of a taxon that has since been renamed and from which the new name is partially derived.

biennial: a plant that completes its life cycle in 2 years.

bifid: cleft at the tip into two equal parts.

bilabiate: two-lipped.

bipinnate: twice-pinnate, the primary pinnae again pinnate.

bisexual: having both male and female parts and functions for either a flower or a plant.

boreal: denoting or native to habitat in the northern part of the Northern Hemisphere with a climate of snowy winters and short summers.

bract: structure found at the base of a pedicel or peduncle; any reduced or modified leaf associated with a flower or inflorescence, but not part of the flower or inflorescence. Adjectival form: **bracteate**.

bracteoles: the structures that subtend (occur below) a single flower in an inflorescence.

bud scales: specialized leaves that protect the bud.

bulb: underground stem surrounded by fleshy, overlapping leaf bases.

callus: a firm thickening.

calyx: all the sepals of a flower. Plural form: **calyces**.

campanulate: bell-shaped.

canker: area of dead tissue in response to a pathogen.

capsule: a dry, dehiscent (opened) fruit composed of more than one carpel.

carotenoids: plant pigments, chiefly carotenes and xanthophylls, responsible for red, yellow, and orange colors.

carpel: the fertile female structure of flowers which contains the ovules; a pistil (ovary plus style and stigmas) contains one or more carpels.

catkin: a dense, bracteate spike or raceme bearing many flowers without petals; also called ament.

caudice: woody, overwintering stem base found in some herbaceous perennials.

cauliferous: on the stem (e.g., cauliferous flowers).

chamaephyte: woody or herbaceous evergreen perennial from 25 to 50 cm tall, or whose shoots die back periodically.

chambered pith: compartmentalized pith.

chlorosis: yellowing due to nutrient deficiency (especially nitrogen deficiency).

chromosome: a threadlike structure of nucleic acids and protein found in the nucleus of most living cells, and containing genetic information in the form of genes.

ciliate: with a fringe of marginal hairs.

circumboreal: occurring all the way around the North Pole, in both Eurasia and NorthAmerica.

circumscribe: to define a taxon.

clavate: shaped like a club or baseball bat.

cleft: divided for a portion of its length.

cleistogamy: reproductive system with closed, self-fertilizing flowers.

clustered buds: buds without readily discernible internodes between buds.

commensalist: an organism in an association with another organism in which one benefits from the other and the other neither benefits nor experiences a cost.

conduplicate: folded together lengthwise, usually in two equal halves.

congener: within the same genus.

conical: shaped like a cone.

coniferous (forests): containing conifers (trees or shrubs consisting mostly of evergreen and cone-bearing species).

coniferous (seed plants): cone-bearing.

connate: united or joined.

connivent: coming together or converging but not united.

continuous pith: pith without walls or compartments.

convolute: arranged so one edge of each petal is covered while the other edge is exposed.

copal: tree resin, generally those in the polymerization process between gums and amber.

cordate: shaped like a stylized heart, with the notch at the base.

coriaceous: thick and leathery.

corm: an underground stem covered with thin, dry leaves.

corolla: all the petals of a flower.

corymb: a simple racemose inflorescence that is flat or round topped because the outer pedicels are longer than the inner.

cotyledon: a leaf of the embryonic plant within a seed.

crateriform: bowl shaped.

crenate: toothed at the margin, the teeth rounded.

crenulate: having smaller crenate teeth.

cultivar: a plant variety that has been produced in cultivation.

cuneate: having a shape with a length-to-width ratio between 6:1 and 3:1, widest at the apex, and with straight margins.

cuneiform: wedge-shaped.

cyanogenic glucoside: a precursor compound of cyanide.

cyme: a broad class of inflorescences with the terminal flowers blooming first. Adjectival form: **cymose**.

cytoplasmic: pertaining to material of the living cell that excludes the nucleus.

deciduous: usually losing its leaves with the approach of winter.

decompound: repeatedly and often irregulary compound into numerous leaflets.

decorticated: having bark peeled off or with short ridges (stems), or both.

decumbent: flat on the ground, but with upturned tips.

decurrent: with an adnate wing or margin extending down the stem or axis.

decussate: positioned opposite on the stem but with nodes in two planes alternating at right angles to one another along the stem.

dehiscent: opening at maturity, releasing or exposing seed. Verb form: **dehisce**.

deltate: having a shape with a length-to-width ratio of 1:1, widest at the base, and with straight margins.

deltoid: shaped more or less like an equilateral triangle with one side as the base.

dentate: having margins with spreading and pointed teeth.

denticulate: having margins with small spreading and pointed teeth.

depressed obovate: having a shape with a length to width ratio between 1:1.5 and 1:2, widest above the middle, and with symmetrically curved margins.

depressed ovate: having a shape with a length to width ratio between 1:1.5 and 1:2; symmetrically curved margins, and widest below middle.

diadelphous: having stamens with filaments in two connate groups.

diaphragm: transverse membrane in a plant stem; chambered pith.

dichotomous: dividing into two, for example, dichotomous venation (venation in which the veins regularly split into two veins of more or less equal size).

didynamous: having two long and two short stamens.

dilated: expanded.

dimorphic: of two forms.

dioecious: producing male and female flowers on different individuals. Noun form: **dioecy**.

diploid: having two full complements of chromosomes per cell.

diplostemonous: having stamens in two whorls: the outer whorl of stamens alternate with the petals, the inner whorl of stamens opposite the petals.

disarticulate: to separate at a joint.

distichous: having leaves alternate, but with nodes occurring in one plane on the stem.

dormant: being in a state when a plant's growth slows or ceases but its parts are protected from the environment. Noun form: **dormancy**.

dorsal: pertaining to or located on the back.

drupe: a fleshy fruit with a firm endocarp that encloses the solitary seed.

drupelet: a diminutive of drupe, usually applied to smaller and often aggregate fruit.

ebracteate: without bracts.

eglandular: without glands.

elliptic: having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest at the middle, and with symmetrically curved margins.

emarginate: notched at the tip.

endemic: confined to a particular geographic area.

endocarp: inner part of the pericarp.

epicotyl: the region of shoot above the cotyledons.

epidermis: outermost layer of cells covering the stem, root, leaf, flower, fruit, and seeds.

epigeal: related to germination where the cotyledons (seed leaves) arise above the ground.

epipetalous: having stamens arising from the petals.

epiphyte: a plant that germinates and roots on other plants.

epithet: the name used to label a group; here, the epithet is the second name of the binomial (the combination of genus and species names).

eponymic: pertaining to a person from which something takes its name.

equitant: with leaves overlapping, but in two ranks.

erect: more or less perpendicular to the ground.

erose: having an irregular notched or toothed margin.

estipulate: without stipules.

evergreen: retaining leaves throughout the winter.

exfoliating: peeling irregularly.

exserted: projecting beyond other nearby parts or structures, such as stamens protruding from the perianth or bracts extending beyond cone scales.

extirpated: destroyed completely; extinct.

extrafloral: referring to structures close to but not part of the flower (e.g., extrafloral bracts).

extrorse: having stamens facing outward.

falcate: hooked or curved.

fascicle: a cluster of flowers or leaves.

fecund: fertile; capable of producing offspring.

fibrous roots: threadlike and frequently numerous roots.

filament: the stalk of a stamen (supporting the anther).

filiform: exceptionally slender, thread-like.

flexuous: flexible.

floricane: the second year of growth, with flowers and fruits (*Rubus* spp.).

foliaceous: leaf-like in flatness, color, and texture.

follicle: a fruit derived from a single carpel; dehisces along the seed-bearing suture (furrow or line) at maturity.

floccose: covered with very long, soft, fine, loosely spreading and tangled hairs; like tomentose but looser and more open.

frugivorous: fruit-eating.

funnelform: trumpet-shaped.

furrowed: with longitudinal grooves.

gamo-: united; for example, gamopetalous (with petals united).

geitonogamy: fertilization from pollen from a different flower on the same plant.

genome: the whole hereditary information encoded in an organism's DNA.

girdling: cutting through the phloem tissue and cambium (a formative layer between phloem and xylem) around the stem to kill a tree.

glabrate: nearly glabrous or becoming glabrous.

glabrescent: becoming glabrous with age.

glabrous: having no hairs.

gland: a protuberance or depression on the surface of an organism; it usually secretes a substance.

glaucous: covered with a fine, waxy, removable powder that imparts a whitish or bluish cast to the surface.

globose: more or less spherical.

glutinous: with a firm, somewhat sticky covering or component.

glycoside: compound formed from a simple sugar and another compound through the replacement of a hydroxyl group in the sugar molecule. Many drugs and poisons derived from plants are glycosides.

grit cell: a stone (sclereid) cell with thick lignified cell walls (e.g., in pears [*Pyrus* spp.]).

gymnosperm: a member of the group of plants that have ovules not enclosed in an ovary and produce no flowers.

gynodioecious: producing female flowers on one plant and perfect flowers on another.

haplostemonous: having stamens in one whorl.

head: a spicate or racemose inflorescence of sessile or subsessile flowers crowded at the tip of a peduncle.

herbivory: feeding on plants.

hemi-epiphyte: a plant that germinates on other plants and then establishes soil contact, or a plant that germinates on the ground and later terminates soil contact.

hermaphrodite: a perfect flower (containing male and female parts that are also functional). Adjectival form: **hermaphroditic**.

heterodichogamous: exhibiting temporal separation of male and female function in flowers.

heteromorphic: occurring in multiple forms.

heterotrophic: depending on other organisms for nourishment.

hip: accessory fruit of a rose (*Rosa* spp.) that consists of a usually fleshy receptacle enclosing numerous achenes.

hirtellous: pubescent with short, relatively stiff hairs.

hispid: pubescent with coarse and firm, often pungent, hairs.

homologous: pertaining to organs or structures that are similar in position and evolutionary origin but not necessarily in function.

homonym: a name of a taxon identical in spelling to the name for another taxon.

hybridization: interbreeding between two different species or genetically divergent individuals of the same species.

hypanthium: a ring or cup around the ovary.

hypocotyl: the germinating stem below the cotyledons but above the root.

hypostomatous: having stomates on the underside of a leaf.

imbricate: overlapping.

imparipinnate: having compound leaves with a single terminal leaflet.

included: having stamens that do not project beyond the perianth.

indehiscent: remaining closed at maturity.

indumentum: a covering of hairs. Plural form: **indumenta**.

indurated: hardened.

inferior (ovaries): perianth attached at the top of the ovary, the ovary thus appearing inferior relative to the perianth.

inflorescence: a flower cluster; the arrangement of flowers on an axis.

infraspecific: taxonomic level below species (subspecies, variety).

infrastipular: hooked, broad-based, in reference to prickles.

infructescence: the aggregate of fruits derived from the ovaries of an inflorescence.

infundibuliform: funnel-shaped.

internodal: between nodes (the points where leaves are attached). Noun form: **internode**.

introgressive: pertaining to the transfer of information from one species to another as a result of hybridization and repeated backcrossing.

introrse: having stamens facing inward.

inundation: flooding.

involucre: the set of bracts beneath an inflorescence.

involute: rolled inward such that the lower side of a plant organ is exposed and the upper side is concealed.

keel: a sharp or conspicuous longitudinal ridge. Adjectival form: **keeled**. Also the partly united lower petals of flowers in the bean (Fabaceae) family.

laciniate: cut into narrow and usually unequal segments.

lamellate: composed of thin layers.

lanceolate: lance-shaped (sword-shaped), having a shape with a length-to-width ratio between 6:1 and 3:1, widest toward the base, and with symmetrically curved margins.

leachate: water that has percolated through a solid and filtered out some of the solid's constituents.

lectotypification: the selection of a type specimen (lectotype) from the material consulted in the original description of the species .

legume: the fruit of the bean (Fabaceae) family, typically dry, flattened, and several seeded.

lenticel: a small pore with loosely arranged cells involved in gas exchange.

lenticellate: with lenticels.

linear: having a shape with a length-to-width ratio of 12:1 and parallel margins.

linear obtriangular: having a shape with a length-to-width ratio of 12:1, widest at the apex, and with straight margins.

linear triangular: having a shape with a length-to-width ratio of 12:1, widest at the base, and with straight margins.

locule: a cavity in a fruit or anther containing either seeds or pollen.

loculicidal: dehiscing along the medial line of the locule.

margin: edge.

mast: to intermittently produce large amounts of seed synchronously by a plant population. Mast can also refer to the fruit itself (which often serves as an important food source for wildlife).

medial: in the middle.

membranaceous: thin and flexible.

-merous: consisting of the specified number of members in a set, usually in reference to the whorls of the perianth.

mesic: relatively moist; wet.

micropyle: the opening in the integument (outermost layer of the ovule) leading into the ovule's nucellus (central part of the ovule containing the embryo sac).

microsatellite (genetics): any number of short segments of DNA that are distributed throughout the genome, consist of repeated sequences usually of two to five nucleotides, and tend to vary from one individual to the next.

microsporangium: the plant structure in which microspores (e.g., pollen) are found. Plural form: **microsporangia**.

midrib: prominent middle nerve or vein of leaf or other structure.

midvein: the central vein of a leaf from petiole to apex. It usually divides the leaf in half, and other veins radiate from it. May be used interchangeably with "**midrib**."

monadelphous: having stamens with filaments connate most of their lengths, forming a tube around the style.

monoclinous: with both male and female structures in the same flower.

monoecious: with unisexual flowers but having both sexes on the same individual plant.

morph: a specific form.

morphological: relating to the different forms of organisms and the relationship between their structures.

mucronate: tipped with a sharp, short, slender point.

multiseriate: consisting of or arranged in many series.

mycorrhizae: a symbiotic association of a fungus and the roots of a vascular plant.

myocarditis: inflammation of the heart muscle.

naturalized: thoroughly established, but originally coming from another area.

nectary: a structure that produces nectar, usually but not always in association with a flower.

node: the point on a stem where a leaf or leaves are attached. Adjectival form: **nodal**.

nodulation: the process of forming nodules, such as root nodules containing symbiotic bacteria.

nomen dubium: a scientific name of unknown or doubtful usage. Plural form: **nomina dubia**.

nomen nudum: a name published without a description or diagnosis. Plural form: **nomina nuda**.

nothogenus: a hybrid between two or more genera.

novirame: first year of growth that has flowers and fruit (*Rubus* spp.).

nutlet: diminutive of nut.

ob-: inversely.

obdeltate: having a shape with a length-to-width ratio of 1:1, widest at the apex, and with straight margins.

obdiplostemonous: having stamens in two whorls: the outer whorl of stamens opposite the petals, the inner whorl of stamens alternate with the petals.

oblanceolate: having a shape with a length-to-width ratio between 6:1 and 3:1, widest toward the apex, and with symmetrically curved margins.

oblate: having a shape with a length-to-width ratio of 1:1.2, widest at the middle, and with symmetrically curved margins.

oblique: slanting, neither parallel nor perpendicular.

oblong: having a shape with a length-to-width ratio between 2:1 and 1.5:1, and with parallel margins.

obovate: having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest above the middle, and with symmetrically curved margins.

obtriangular: having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest at the apex, and with straight margins.

obtuse: blunt, both sides coming together at more than 90 degrees.

ochlospecies: a species that exhibits complex variation among its members but that cannot be separated into subspecific groups.

opposite (leaves): with two leaves at the same node.

opposite (stamens): with stamens opposite the petals.

orbicular: circular in outline.

orifice: a mouth or other opening.

outcrossing: pollination and fertilization involving different individuals. Highly outcrossed species often have greater genetic diversity than self-fertilized species.

oval: broadly elliptic.

ovary: the structure that encloses the ovules in flowering plants; lower portion of the pistil.

ovate: egg-shaped in outline and having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest below the middle, and with symmetrically curved margins.

oviposit: to lay an egg (insects).

ovoid: shaped like a chicken egg (i.e., broader at the basal end).

ovule: structure in the ovary which upon fertilization becomes the seed.

palmate: with three or more lobes, nerves, leaflets, or branches arising from a common point.

panicle: a compound, branching, indeterminate (blooming from base upward) inflorescence, usually broadest near the base and tapering upward. Adjectival form: **paniculate**.

papillose: having small epidermal outgrowths.

pappus: in composites (family Asteraceae), the modified calyx crowning the ovary (and later achene) consisting of hairs, scales, or bristles.

parasitoids: insect larvae which live as parasites that eventually kill their hosts.

parcifrond: the second year of growth with no flowers or fruit (*Rubus* spp.).

parenchymatous: composed of parenchyma tissue (tissue composed of relatively unspecialized, thin-walled cells).

paripinnate: having compound leaves with all leaflets more or less paired; therefore, leaves lack a single terminal leaflet.

pectinate: comb-like, with a single row of narrow spreading appendages (or hairs) of uniform size, like the teeth on a comb.

pedicel: the stalk of a single flower in an inflorescence. Adjectival form: **pedicillate**.

peduncle: a "stalk" supporting either a single flower or an inflorescence.

pellucid: transparent or transluscent.

peltate: attached to the lower surface (e.g., of a leaf), instead of to the base or margin.

peltate scales: shield-shaped structures attached to the surface by a stalk.

pendent: supported from above; suspended.

pendulous: hanging or drooping.

perennial: a plant that lives several to many years.

perfect flower: a flower which contains male and female parts that are also functional; also called a hermaphrodite.

perianth: all the sepals and petals of a flower.

pericarp: the matured ovary wall of a fruit.

perigon: the term used for petals collectively.

petal: a member of the inner set of floral leaves, usually colored or white; serves to attract pollinators.

petaloid: petal-like.

petiole: a leaf stalk.

phanerantherous: having stamens with anthers that project beyond the perianth.

phanerophyte: a woody or herbaceous evergreen perennial, taller than 50 cm, or whose shoots do not die back.

phenological: having cyclic and seasonal patterns.

phytotoxicity: the toxic effect of a chemical on plants.

pilose: sparsely beset with straight spreading hairs.

pinna: primary lateral division of a pinnately divided leaf. Plural form: **pinnae**.

pinnate: having two rows of lateral branches, parts, or veins along an axis, like barbs on a feather.

pinnatifid: pinnately divided.

pistil: the organ of a seed plant that consists of the ovary, style, and stigmas.

pistillate: having one or more pistils.

pith: a central, parenchymatous tissue in a stem or root surrounded by the central cylinder of vascular tissue.

placenta: the tissue of the ovary to which the ovules are attached.

plane: having no elevations or depressions; flat.

plated: with shallow, circular depressions.

plicate: folded like a fan.

plumose: having fine, elongate hairs, giving a feathery appearance.

pneumatophore: a specialized aerial root that sticks up out of the soil.

polyadelphous: having stamens with filaments in several, connate groups.

polygamous: with both perfect and unisexual flowers.

polymorphic: having or occurring in various forms. Noun form: **polymorphism**.

polyploidy: having three or more chromosome complements in each cell.

pome: a fruit with a core, such as an apple (*Malus* spp.).

pomological: of the development, cultivation, or enhancement of fruits.

prickles: epidermal extensions not associated with nodes (i.e., not spines or thorns).

primocane: the first year of growth, which usually is sterile (no flowering) in *Rubus* spp.

procumbent: flat, but loosely on the ground.

prostrate: flat on and close to the ground.

protandrous: liberating pollen before the stigmas that are in the same flower or that are in flowers of the same plant are receptive.

protogynous: having a stigma that is receptive before pollen is liberated.

pruinose: strongly glaucous like a prune.

puberulent: minutely pubescent, usually with soft, curled hairs.

pubescent: having hairs of any sort. Noun form: **pubescence**.

punctate: dotted usually with small pits that may be translucent or glandular.

pyrene: a small bony unit derived from the endocarp of a drupe or pome and containing a seed.

pyriform: pear-shaped.

quadrate rhombic: having a shape with a length-to-width ratio of 1:1, widest at the middle, and with straight margins.

raceme: a more or less elongate inflorescence with pedicillate flowers arising from the bottom up from an unbranched central axis. Adjectival form: **racemose**.

rachis: an extension of the peduncle serving as the axis of an inflorescence.

radicle: a root.

recalcitrant: pertaining to a seed type with high moisture content upon being shed from the plant and consequent sensitivity to dessication (drying out).

receptacle: the axis (usually basal) upon which the parts of a flower are attached or, in composites (family Asteraceae), the portion of the inflorescence head, to which the flowers are attached (synonymous with torus).

recurrent: pertaining to interbreeding to keep certain traits.

recurved: curved or bent backward.

reflexed: curved or bent abruptly backward.

reniform: kidney-shaped.

resin: a usually sticky, volatile substance. Adjectival form: **resinous**.

reticulate: resembling or forming a network pattern; criss-crossed; interlaced.

retrorse: directed backward or downward.

revolute: inrolled halfway to the midrib or more.

rhizome: an underground stem with reduced leaves and internodes. Adjectival form: **rhizomatous**.

rhombic: having a shape with a length-to-width ratio of between 2:1 and 1.5:1, widest at the middle, and with straight margins.

ridged: with "prominent" longitudinal ribs.

riparian: pertaining to or growing along streambanks.

rosulate: basal and appearing as a rosette.

rotate: circular, wheel-shaped, or saucer-shaped.

rugose: wrinkled.

russet: reddish brown.

salverform: with slender tube and abruptly spreading limb, as the corolla of a phlox (*Phlox* spp.).

samara: an indehiscent, winged fruit.

scarification: weakening or altering of a seed's coat to promote germination.

sclereid cell: see grit cell.

seed bank: natural storage of seeds, some dormant, in the soil.

seed rain: natural deposition of seeds from mother plants.

segregate: a species within an aggregate species (a species complex treated as a single species for practical purposes, but that some taxonomists split further into varieties or subspecies) often distinguished on the basis of minute or subtle characters.

sepal: a member of the outmost set of floral leaves, typically green and leafy.

septicidal: splitting through the partitions (septae) and between the locules.

sericeous: silky; covered with long, fine, soft, appressed hairs.

serotinous: late, flowers developing after the leaves have fully expanded.

serrate: toothed along the margin with sharp, forward-pointing teeth.

serrulate: having smaller sharp, forward-pointing teeth along a margin.

sessile: attached directly by the base, not having a stalk.

sessile scales: usually flat structures directly against the surface.

setose: beset with bristles.

shrub: a low plant branching near the base and therefore with several to many trunks near the base.

sinus: the cleft or recess between two lobes or segments of a leaf.

soboliferous: having shoots arising from the ground in clumps; usually applied to shrubs or small trees.

somatic: referring to cells that are not reproductive.

sonication: the application of sound energy to agitate particles in a sample, often used to extract compounds from plants.

spike: an inflorescence in which the flowers are sessile on a more or less elongated axis. Adjectival form: **spicate** or **spiciform**.

spines: sharp projections developed from modified leaves.

spinulose: stipules modified into spines.

spurred: with any basal or dorsal projections.

square: having a shape with a length-to-width ratio of 1:1, and with parallel margins.

stamen: the male organ of a flower, consisting of a filament and anther, which contain the pollen.

staminate: containing stamens (and no pistil).

staminode: a modified stamen that does not produce pollen.

stellate hair: a hair split into several strands at the free end, the strands radially arranged, thus superficially resembling a star.

stigma: the part of the pistil that is receptive to pollen.

stipe: the stalk of a structure; term used when more precise terms such as petiole, pedicel, or peduncle cannot be used.

stipitate: borne on a stipe.

stipule: one of a pair of basal appendages found in association with the leaves and found at the base of the petiole. Adjectival form: **stipulate**.

stolon: an aboveground stem rooting at nodes.

stoloniferous: producing stolons.

stratification: simulating conditions to break seed dormancy and trigger germination; it may be a required cold or warm period, or both, and with or without moisture.

striate: with "fine" longitudinal ribs.

style: the slender stalk that typically connects the stigma(s) to the ovary.

sub-: somewhat or slightly; for example, subglobose (somewhat globose) and subopposite (pertaining to two leaves almost opposite one another at the same node).

subspecies: ranks taxonomically below species, often geographically isolated.

subtend: to occur below.

subulate: linear and tapering to a fine point.

sunflecks: brief increases in solar irradiance occurring in forest understories.

superior (ovaries): the perianth and stamens attached directly to the receptacle, the ovary thus appearing superior.

sylleptic: produced throughout the year.

sylleptic shoots: shoots produced by the axillary meristem without a period of dormancy and while the parent shoot is still growing.

sympatric: sharing the same geographical region; overlapping in distribution.

syncarpous: with carpels united. Noun form: **syncarp**.

syngenesious: having stamens with connate anthers.

tap root: primary root that more or less enlarges and grows downward.

tautonym: scientific name in which the same word is used for both genus name and species epithet. Such names are not permitted in botanical nomenclature.

taxon: a taxonomic group of any rank. Plural form: **taxa**.

tendril: a slender, coiling, twining modified stem or leaf that a climbing plant may use for support.

terete: round and usually solid in cross section.

terminal bud: the bud at the end of a twig.

tetradynamous: having six stamens: four long and two short.

tetraploid: containing four homologous sets of chromosomes.

thorns: twigs modified into spinelike structures which may support leaves.

thyrse: an inflorescence having a racemose central axis and cymose branches.

tomentose: covered with tangled, matted, woolly hairs.

tomentum: a covering (indumentum) of crooked, matted, or tangled hairs.

torus: the receptacle of a flower.

tree: a perennial woody plant with a single or few trunks near the base.

triangular: having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest at the base, and with straight margins.

trichome: any hair-like outgrowth from the plant epidermis.

triploid: containing three homologous chromosome sets.

tristylous: having three styles.

trullate: having a shape with a length-to-width ratio between 2:1 and 1.5:1, widest toward the base, and with straight margins.

truncate: with the apex or base transversely straight or nearly so, as if it were cut off.

tuber: underground stem tip which is enlarged and fleshy.

tuberculate: forming a small rounded protruberance on a surface.

tuberous root: a root, or portion of a root, enlarged for storage.

tubular: cylindrical.

turbinate: shaped like a spinning top or cone.

turgid: swollen, inflated.

umbel: a racemose inflorescence with greatly abbreviated axis and elongate pedicels. Pedicels are nearly equal in length and originate from a common center, forming a flat or curved surface of flowers.

umbelliform: with the form of an umbel but not necessarily the structure; having condensed cymes.

umbo: a blunt or rounded protuberance on the end or side of a plant organ, such as on the scales of pine cones.

undulate: wavy-margined.

unicellular hairs: single-celled hairs.

unisexual: having a single gender (male or female).

urceolate: urn-shaped.

valvate: adjacent to but not overlapping one another.

variegated: exhibiting different colors, especially as irregular patches or streaks.

variety: a taxonomic category that ranks below subspecies (where present) or species, differing in minor but permanent traits.

vascular: pertaining to conduction. Vascular plants have tissue (xylem, phloem) for conduction.

vascular bundle scar: the scar formed by the vascular tissue when a leaf falls off the twig.

vascular parasite: a parasite that grows on living plants.

vascular saprophyte: a plant growing on dead organic matter.

vascular semi-parasite: a green plant growing attached to another living, autotrophic plant (a plant having the ability to produce its own nourishment from simple compounds by using an energy source).

venation: how the veins in a leaf are arranged.

veneer: a thin layer of wood, often of superior value or excellent grain, that may be glued to a lower valued wood.

ventricose: inflated.

verrucose: warty, covered with wart-like projections.

villous: pubescent with long, soft, often bent or curved but never matted hairs. Noun form: **villousness**.

vine: a herbaceous or woody plant with a flexible stem and having the potential to climb other plants or structures, often via twisting stems (e.g., *Lonicera japonica*) or accessory structures such as tendrils and adhesive disks (e.g., *Parthenocissus quinquefolia*).

viscid: sticky or greasy.

warty: with "knobby" lumps on the twig surface.

whorled: with three or more leaves at the same node.

winged: with an extension emanating from the stem.

xeric: containing little moisture; dry.

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