Snyder & Kaufman 2004.

An Overview of Nonindigenous Plant Species in New Jersey

State of New Jersey
Department of Environmental Protection
James E. McGreevey, Governor
Bradley M. Campbell, Commissioner

CHZ SNYDER + KAUFMAN 2004

http://www.state.nj.us/dep/parks and forests/natural/heritage/Invasive Report.pdf
9-16-05

February 2004

Dear Friend of the Environment,

New Jersey has a rich native flora which includes hundreds of showy wild flowers like violets and orchids, as well as trees, shrubs, grasses and ferns. The state has more than 2,100 kinds of native plants, a number that is comparable to states that are three to four times greater in size. New Jersey's remarkably diverse flora has attracted scientists and citizens from around the world for some 150 years. People still marvel at the numbers and kinds of rare plants that continue to flourish in New Jersey's forests and fens, swamps and savannas, riversides and roadsides. These habitats support some of our nation's rarest plant species, some of which are found nowhere else on the planet. New Jersey and its rich floral diversity should be a source of pride to all its citizens.

However, the Garden State's natural habitats are now suffering from an onslaught of nonindigenous plant species introduced from all parts of the globe. More than one thousand nonindigenous plant species have become established in New Jersey. Some of these species cause harm by crowding out native species, contributing to species extinctions, altering the structure of natural plant communities, disrupting ecosystem functions, and degrading recreational opportunities. Harmful invasive plants are despoiling many of our open spaces including preserves such as Island Beach State Park, Rancocas State Park, and the Black River Natural Area. Invasive species are now recognized as a threat to the health of biodiversity throughout the nation and the resulting ecological damage is costing millions of dollars in economic losses.

This report provides background on the numbers and origins of nonindigenous species in New Jersey, discusses problems caused by harmful invasive species, describes current state and federal programs, and examines methods of control and prevention. Fact sheets on 27 of the most problematic invasive species have been developed to help guide management and control initiatives.

New Jersey is beginning to take action to address invasive nonindigenous species. Degradation and fragmentation of natural habitats caused by unrestricted sprawl often facilitate the spread of these species. In Governor McGreevey's Smart Growth Plan, sustainable development is designed to protect New Jersey's natural habitats and the benefits they provide including flora, fauna, clean water and air, and scenic beauty. Pilot programs to develop control techniques for invasive plant species have been initiated at several State Natural Areas. Additionally, the New Jersey Department of Agriculture has introduced beetle species as biocontrol agents for purple loosestrife at many locations across the state. It is anticipated that this report will create interest in more control projects.

It is important for us to recognize this issue. It has been building as a quiet crisis for many years. The better we understand this problem, the better prepared we will be to properly maintain our open spaces and preserve our rich natural heritage.

Sincerely,

Bradley M. Campbell

Bradley M. Campbell
Commissioner

AN OVERVIEW OF NONINDIGENOUS PLANT SPECIES IN NEW JERSEY

By

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February 2004

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This report is dedicated to the memory of Thomas F. Breden,
Administrator of the Office of Natural Lands Management,
who was instrumental in its creation.

This report may be cited as follows:
Snyder, David and Sylvan R. Kaufman. 2004. An overview of nonindigenous plant species in New Jersey. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, Trenton, NJ. 107 pages.

Cover photos clockwise from bottom left: Asian bittersweet (*Celastrus orbiculatus*) by Andrea Stevens, The Nature Conservancy; purple loosestrife (*Lythrum salicaria*) by Mark A. Mayer, NJ Department of Agriculture; tree-of-heaven (*Ailanthus altissima*) and background screen - Japanese honeysuckle (*Lonicera japonica*) by Robert J. Cartica, Office of Natural Lands Management.

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AN OVERVIEW OF NONINDIGENOUS PLANT SPECIES IN NEW JERSEY

Preface

Initial research on this report began in 1998. A working draft, written primarily by the junior author was completed in June 1999 and had some limited circulation. The scope of the report was expanded, and the senior author made substantial revisions. These revisions included an expanded section on definitions of terms and working concepts, a historical context of nonindigenous plant invasions in the state, and additional literature citations. A draft final report was completed in November 2000 and was circulated for internal review. Minor revisions and updates were incorporated in June 2001, August 2002, August 2003, and January 2004. Some sources of information used in this report that were obtained through the Internet may no longer be available online.

Introduction

Invasive nonindigenous plant species are a major threat to natural biodiversity in the United States (Clout 1996; U.S. Dept. of Interior 1991). They cause significant and sometimes irreversible ecological damage and cost millions of dollars in economic losses. Recognizing the threats posed by nonindigenous species, President Carter signed Executive Order 11987 (Federal Register 1977) which directed executive agencies to "restrict the introduction of exotic species into natural ecosystems on lands and waters which they own" and to "encourage the States, local governments, and private citizens to prevent the introduction of exotic species into the United States." The Office of Technological Assessment of the United States Congress (OTA 1993) reported that Executive Order 11987 was never fully implemented and did little to stop the introduction of nonindigenous species into the United States. Its failure was attributed to a lack of funding, gaps in legislation, and perhaps more importantly, the absence of a clear national policy (OTA 1993). OTA (1993) concluded "the total number of harmful [nonindigenous species] and their cumulative impacts are creating a growing economic and environmental burden for the country" and recognized the need for "a more stringent and comprehensive national policy." In 1999, President Clinton signed Executive Order 13112 (Appendix 1) to "prevent the introduction of invasive species and to provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause..." The Executive Order established the National Invasive Species Council and charged it with providing national leadership on invasive species.

At the state level, the response to invasive species has been varied. Some states, like Florida and Hawaii, have been especially hard hit by nonindigenous species (OTA 1993; Wilson 2002), and as a result have established aggressive programs to deal with the problems created by these species. These programs are long standing and involve the coordination of several state and federal agencies. Many other states are just beginning to assess the damage and seek solutions to the problems caused by invasive species. New Jersey is one of these states.

In 2003, the Department of Environmental Protection released the Final Report of the New Jersey Comparative Risk Project. The report presents the results of the relative risks of

environmental problems to the people and ecosystems of New Jersey (NJDEP-DSRT 2003). Eighty-eight chemical, physical, and biological factors were analyzed by 73 experts. Of the four major findings of the report, invasive species (including plants, insects, and other organisms) were identified as one of New Jersey's top environmental problems.

This present report is confined to the problems caused by nonindigenous plant species. The report defines the working concepts and terminology used to determine which plant species are indigenous to New Jersey, provides background information on the numbers and origins of nonindigenous plant species occurring in New Jersey, and discusses other key topics, including current state and federal programs addressing nonindigenous plant species, control, prevention and public awareness. Appendix 2 of this report includes 27 fact sheets on 29 invasive nonindigenous plant species documented to aggressively invade and establish in natural plant communities in New Jersey.

New Jersey does not have an official list of invasive nonindigenous plant species nor does it have a comprehensive, specimen based checklist of its vascular flora. Existing checklists are based on out-dated taxonomy and nomenclature. They contain errors of omission and commission because they are not specimen based. The identification of nonindigenous species in these lists is uneven, often conflicting, and based on imprecise or impractical definitions. Snyder (1990) reports the following terms and categories have all been used to describe New Jersey's nonindigenous plant species: adventive, alien, escaped, established, foreign weeds, fugitive, introduced, naturalized, nonnative, and waif. The inconsistency in terminology, and the absence of a definitive list of nonindigenous plant species, impedes the ability of land managers to accurately assess the numbers of nonindigenous plant species occurring in natural plant communities. As a result, nonindigenous plant species may go unrecognized as a threat until they become so abundant that their impacts on indigenous plant species and natural plant communities are obvious (Snyder and Breden 1998); by which point, much ecological damage has been sustained, and the economic cost of control and containment have escalated. Since it is the indigenous species that are typically the objective of conservation and land acquisition, it is important to be able to accurately evaluate potential long-term threats caused by harmful nonindigenous plant species and assess all associated economic costs required to maintain healthy and viable ecosystems.

Definitions and Working Concepts

Some of the following definitions of terms and concepts have been adopted or modified from Snyder (1990), OTA (1993), Williams and Meffe (1998), and Morse, et al. (1999).

Indigenous plants are those taxa (including full species, subspecies, varieties or natural hybrids) that occur naturally within a specific geographic area. Indigenous plants are composed of endemic species and species that have migrated to new geographic areas without significant human assistance. *Endemic plants* are those that have evolved within a specific geographic area through biological selection resulting from the interplay of biotic and abiotic aspects of the environment. Their evolutionary origin may be ancient, such as when speciation is achieved through geographic isolation, or relatively recent, such as speciation achieved through mutations

or genetic recombination. Depending on the geographic context being considered, a species may be endemic to a continent or to a single population.

With few exceptions, plants have the ability to migrate and to colonize previously unoccupied geographic areas. *Plant migration* is achieved through the dispersal and successful establishment of reproductive propagules; primarily seeds and spores. The rate at which plant species migrate is determined by the interplay of the adaptive traits of its propagule and environmental selection. Plant migration may occur gradually, almost imperceptibly, or abruptly as when a seed is blown hundreds of miles by the wind. The area occupied by an individual plant species is called its *geographical range*, or more simply, its *range*. Ranges of plant species are dynamic and may contract or expand in response to natural or human caused changes in environmental conditions. Some plant species have broad ranges and occupy hundreds of contiguous miles, while other species have disjunct or discontinuous ranges. The *natural range* of plant species is the geographical area they historically or currently occupy, or have the potential to occupy in the absence of significant human influence. The *geographic origin* is the portion of the geographic range from which a plant species is believed to have evolved or originally occupied prior to widespread migration. Depending on the context used, the geographic origin of a species may be described in very broad terms, such the North American continent, or more narrowly, such as the southeastern Coastal Plain of the United States.

Nonindigenous plants are those species that have been introduced outside their natural geographic range as a result of human assistance or influence. The methods of introduction may be achieved through intentional actions, such as ornamental plantings, or through unintentional actions, such as contaminants in ballast soils. For the purpose of this study, nonindigenous plants include species that have been introduced from geographic areas other than the North American continent and species whose natural range includes portions of North America, but have been deliberately or accidentally introduced by humans into other regions that they did not previously occupy, and likely were unable to migrate into without human assistance. Also included in this definition of nonindigenous plant species are all artificial hybrids and cultivars of plant species created through human selection; these are human engineered products and therefore lack natural ranges.

Whether a species is indigenous to a specific geographic area depends on the scale being considered. A species may be indigenous to North America but introduced, and therefore nonindigenous, in the United States. A species may be indigenous to the western United States but not indigenous east of the Mississippi. It may be indigenous to one state in the Northeast, but nonindigenous in an adjacent state. It is possible for a species to be indigenous only to certain specific physiographic provinces, counties, or habitats within a state. In such situations, a plant species may have both indigenous and nonindigenous populations within a state. For example, the state listed endangered *Cercis canadensis* (redbud) is indigenous to the Delaware Valley and parts of the Watchung Mountains. It has long been planted as an ornamental tree in New Jersey and it is sometimes found escaping from cultivation (Snyder 1994).

When a nonindigenous plant species successfully grows outside of cultivation and

produces a self-sustaining or potentially self-sustaining population, it is considered *established.*[1] Regardless of how long nonindigenous plant species have been established within a continent, nation, or state, they are never considered part of the indigenous flora.

Invasive nonindigenous plants are species that rapidly and aggressively migrate into natural or human altered plant communities. *Harmful nonindigenous plants* are invasive species that are capable of invading natural plant communities where they displace indigenous species, contribute to species extinctions, alter the community structure, and may ultimately disrupt the function of ecosystem processes. Invasive nonindigenous plant species share some or all of these generalized characteristics (modified from Rhodes 1999; Williams and Meffe 1998): self-fertility, high rate of reproduction, high dispersal rate, effective dispersal mechanisms, small seed size, short generation time, pioneer species, long-lived, vegetative or clonal reproduction, lack of highly specialized pollination mechanisms, high genetic variability, phenotypic plasticity, broad native range, abundant in native range, habitat generalists, shade tolerance, and climatic preadaption. Although some indigenous plant species, such as poison ivy (*Toxicodendron radicans*), common reed (*Phragmites australis*), and greenbrier (*Smilax ssp.*) display invasive characteristics, they are here termed *successful competitors*, rather than invasive or harmful species. These species respond to habitat and soil disturbances and thrive in edge conditions, an adaptation that allows them to outcompete other species that are poor competitors. Indigenous plant species that are successful competitors sometimes become undesirable in the natural landscape and the size and spread of their populations may need to be controlled. This is especially true for populations that threaten to displace rare species of plants and animals or significantly alter the structure of natural plant communities.

Harmful nonindigenous plant species differ significantly from indigenous species in that the indigenous species "have generally evolved with the competing species, predators, and diseases of an area over many thousands of years. [Indigenous] species are therefore generally in reasonable ecological balance with their associates and competitors, and have pests, predators, or diseases that limit their abundance. Many [nonindigenous species], on the other hand, lack these checks, and can quickly spread and dominate areas they invade..." (Morse, et al. 1999). Although *Phragmites australis* (common reed) is often included in lists of invasive nonindigenous plant species, it is clearly indigenous to North America. Niering and Warren (1977) found remains of *Phragmites* in 3,000-year-old peat cores collected from tidal marshes in Connecticut. Some researchers believe that a more invasive genotype of *Phragmites* has been introduced into North America from the Old World during the early 20th century (Marks, et al. 1993; Virginia Natural Heritage Program 2000)[2]. While it is possible that a nonindigenous

[1] Some authors make a distinction between "established nonindigenous plants" and "naturalized nonindigenous plants." They reserve the term "naturalized" for only those species that are abundant and widespread, while "established" is used to denote the marginally persistent species or species with rare or limited distributions. No such distinction is made in this report. The two terms are considered synonymous and are viewed as defining a process rather than a category of nonindigenous plant species.

[2] Recent genetic research by Saltonstall (2002) has identified the presence of 26 distinct lineages of *Phragmites australis*. In this study 11 lineages are considered indigenous to North America, some of which are believed to be of restricted distribution. This research also identified the presence in North America of nonindigenous lineages, which are believed by the author to have been introduced into North America sometime in the late 19th and early 20th centuries. One of these nonindigenous lineages is considered to be highly competitive and invasive, and appears to be aggressively expanding its range in North America. Preliminary research by Blossey (2002) also suggests that there are morphological differences between indigenous and nonindigenous populations of *Phragmites* that can be

genotype of *Phragmites* may have been introduced into New Jersey in the early 1800s, the early floristic literature of the state (e.g., Britton 1889; Stone 1912; Taylor 1915) clearly shows that *Phragmites* was already abundant and widespread throughout New Jersey by the close of the 19th and early 20th centuries. Much of the rapid spread in New Jersey of *Phragmites* during the 20th century may be attributed to widespread habitat alterations that favor its growth: dredging or filling of wetland habitats, increases of soil nutrient concentrations from runoff, restriction of tidal inundation of marshes, and increases in soil salinity through de-icing of roads (Marks, et al. 1993). Although *Phragmites* is indigenous to New Jersey, it is probable that many populations are unnatural, and are the result of human perturbation of wetland habitats.

Phragmites australis is an example of the difficulties sometimes encountered in determining whether a species is indigenous or nonindigenous to a specific geographic area. This determination is, for the most part, more easily made at larger geographic scales. For example, the flora of the North American continent is well studied and well documented, and its indigenous species can be determined by consulting numerous regional floristic manuals or, when completed, the Flora of North America. There are relatively few disagreements as to which plant species are or are not indigenous to North America; those that are disputed mostly involve circumboreal or pantropical species. It is at finer geographic scales, especially at the state level or county level, that most of the difficulty is encountered in sorting the indigenous species from the nonindigenous species. Almost invariably, the problem involves species that are indigenous to North America and nearby or adjacent states, but are suspected to have been deliberately or accidentally introduced into another state. Many of these cases can be resolved by examining herbarium specimens, visiting the original collection locality, and a thorough review of pertinent literature. In the absence of conclusive data, the best that can be hoped for is that by the comparison of evidence suggesting an indigenous occurrence to the evidence suggesting human-assisted introduction, a reasonable fact pattern can be established that tips the balance one way or the other (Morse, et al. 1999; Snyder 1990; Snyder 1994).

Most nonindigenous plant species intentionally introduced do not become invasive; many will not establish outside of cultivation. About 4,000 species of plants have been introduced to the United States, but only 400 plants species are considered invasive in natural plant communities by the National Plant Conservation Initiative (NPCI-APWG 1999). Many of the intentionally introduced nonindigenous plant species are considered beneficial and have been selected for desirable traits (OTA 1993; Williams and Meffe 1998). Nonindigenous plant species comprise a large part of the foundation of United States agriculture, and are economically important to many industries and commercial enterprises such as pharmaceutical research, soil conservation, horticulture, and aquaculture (OTA 1993). Some nonindigenous plant species can have both beneficial and harmful effects.

The primary focus of this report is harmful invasive nonindigenous plant species that invade natural plant communities.

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used to identify them in the field. These genetic and morphological data are preliminary and require more thorough sampling before final conclusions can be reached on the geographical origins and distribution of *Phragmites australis*.

Problems Caused by Invasive Nonindigenous Plants

More than half of the nonindigenous species currently documented in the United States are plants (Williams and Meffe 1998). Invasive nonindigenous plants cause substantial ecological and economic problems. They threaten biodiversity (here defined as including only the sum total of species and ecosystems indigenous to the geographical area considered) when they replace or cause the decline of indigenous species, or when they fundamentally alter the structure and composition of plant communities and ecosystems. Nonindigenous plant species frequently have greater competitive advantages because of the absence of predators, diseases, and competitors that they evolved with in other ecosystems or because of more efficient mechanisms of reproduction, dispersal, or use of resources (NJDEP-DSRT 2003). These competitive advantages allow nonindigenous plant species to capture soil nutrients, light, or water more effectively than the indigenous plants. Root systems of nonindigenous invasive plants can change erosion patterns, and patterns of biomass production can alter fire regimes (Vitousek 1986; Gordon 1998). Sometimes they produce allelochemicals, chemicals that leach into the soil and prevent the establishment of other plants.

Using these mechanisms, they prevent the persistence and establishment of many indigenous plants and can threaten the survival of small populations. Especially vulnerable are species that are already rare or declining. For example, a very rare species of blackberry (*Rubus ostryifolius*) known for certain from only two Northeastern states was collected and first described from Highlands, Monmouth County, New Jersey, at what is now Twin Lights Historic Site. In the early part of last century, the habitat for this species had been so altered by four nonindigenous plant species (field garlic (*Allium vineale*), tree-of-heaven (*Ailanthus altissima*), Japanese honysuckle (*Lonicera japonica*), wineberry (*Rubus phoenicolasius*)) that L.H. Bailey (1932), the world authority on North American blackberries, thought the species likely doomed at its only documented New Jersey location: "It was a strange place, overgrown under the trees with honeysuckle (*Lonicera japonica*) that weighted the plants, bending them down and nearly smothering them. In the shade and tangle the berry bushes were anything but normal in development....In my last visit I realized that there would be no call to go again....under the trees the honeysuckle had practically conquered the low and weaker vegetation....the original manifestation of the Rubus was practically obliterated....*Rubus phoenicolasius* had run riot; *Allium vineale* was established, and....there were trees of ailanthus....Inside it had come to be a hopeless subjugated tangle and the call of the bob-white led me for the last time into the open and away." Johnson, et al. (1998) reported that the second most significant threat to the continued survival of several New Jersey populations of the globally rare swamp pink (*Helonias bullata* - federally listed threatened, state listed endangered), was invasive nonindigenous plant species. Of the 33 swamp pink populations studied by Johnson, et al. (1998) the habitat of nine populations had already been invaded by nonindigenous plant species, but more alarming was that a total of 29 populations had been documented as having invasive nonindigenous plant species in adjacent wetlands and uplands. Snyder (2000) reported that the habitat for the state listed endangered beaked cornsalad (*Valerianella radiata*) had been overrun by the nonindigenous invasive Japanese honeysuckle at its only confirmed extant population at Higbee Beach Wildlife Management Area in Cape May County. Williams and Meffe (1998) report that nonindigenous species (including both plant and animal species) have contributed to the decline of approximately 35 percent of the nation's endangered and threatened species.

The effects of invasive nonindigenous plant species on endemic, rare, or declining species exceed the political boundaries of our state and nation as noted by Clout, et al. (1996): "The mixing of faunas and floras caused by people carrying species across biogeographical boundaries has, along with habitat destruction, been a major cause of extinctions throughout the world in the past few hundred years. Many of these extinctions have gone unrecorded, but there is an increasing realisation of the ecological costs of biological invasions in the irretrievable loss of native biodiversity....They have invaded and affected native biota in virtually every ecosystem type on earth and in most cases these biological invasions have proved irreversible once they have occurred."

Nonindigenous plants can fundamentally alter the structure of plant communities, as when invasive nonindigenous vines topple trees, or dense invasive nonindigenous grasses prevent the establishment of trees and shrubs (OTA 1993). When a plant community is altered, it changes the resources available for both wildlife and human communities. Monocultures tend to support a lower diversity of animal species (Begon, et al. 1986). For example, many songbirds depend on the abundance and diversity of indigenous fruiting shrubs, and when a single nonindigenous shrub species replaces indigenous species, birds may not be able to obtain the nutrition needed for migration and reproduction (Johnson 1996). Eventually invasive nonindigenous plants can alter ecosystem properties (Vitousek 1986). Patterns of water flow and erosion can change as wetlands, stream banks, and dunes are invaded by species like purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cupidatum*), and Japanese sedge (*Carex kobomugi*). Nitrogen-fixing plants like black locust (*Robinia pseudoacacia*) and autumn olive (*Elaeagnus umbellata*) can alter soil chemistry. The timing and severity of fires can be drastically changed by a single nonindigenous plant species as has happened in several western states. Cheat grass (*Bromus tectorum* L.) was accidentally introduced from Europe as a contaminant in grain shipments and now infests an estimated 100 million acres of American rangeland throughout the West (Robichaux 2000). This annual species grows densely and spreads rapidly, but dies back in the early summer, sooner than the indigenous perennial grass species die back. Once dry, the papery and highly flammable cheat grass ignites easier and burns more frequently than do the indigenous perennial grass species which it has replaced (Robichaux 2000). As a result, rangelands that typically burned once every 100 years or so, now burn as frequently as every three to five years (Pimentel, et al. 1999; Robichaux 2000). Yellow star thistle (*Centaurea solstitalis*) has overrun nearly nine million acres of northern California grassland, greatly altering the use of these grasslands (Pimentel, et al. 1999). These kinds of changes caused by nonindigenous species at the ecosystem level directly affect human society and threaten human health (Williams and Meffe 1998).

A significant, but little discussed consequence of nonindigenous plant species is the effect they have on the study of plant biogeography. The distribution of fossils of an extinct seedfern was used as evidence supporting the hypothesis of continental drift many years prior to the development of the modern theory of seafloor spread (Sauer 1988). The study of the past and present distribution and geographic range of plants has been used to determine the climate of earlier geological epochs. In recent decades, the continued retreat of northern plant species and the advance of southern species have been used to support the theory of global warming. The widespread introduction of nonindigenous plants species obscures these patterns, as observed by Snyder (b, in prep.):

...with the ascension of humans as a principal agent of dispersal...the comparatively orderly ebb and flow of natural plant migration is disrupted on a global scale by the direct and consequential actions of humankind. Range contractions are now commonly measured in terms of human caused species extinctions and extirpations, while range expansions and long distance dispersal of species are frequently the result of, or, perhaps what is more alarming, are simply attributed to human introductions....Humans ...are extremely effective agents of dispersal....

A direct result of all this human activity has been to render long distance dispersals commonplace, and to obscure the patterns of natural plant migration, or at the very least, to significantly undermine our abilities to perceive these patterns. It has fundamentally altered our biogeographical thought process by shifting the burden of proof. We now find that in the Northeast, as in other major centers of human population, newly discovered plant taxa, especially those exhibiting disjunct or discontinuous distribution, are frequently presumed introduced until proven indigenous. To paraphrase Sauer (1988), if a plant were to arrive in New Jersey by water, wind, or bird dispersal in the present day, as they obviously did in the past, could it be reasonably proven to be a result of natural migration?

A more directly quantifiable effect of the ecological problems caused by nonindigenous invasive plants is the many economic repercussions. Over $30 billion dollars per year are lost to lower crop yields and control of invasive nonindigenous plants on agricultural and pasturelands in the United States (Pimentel, et al. 1999). As the popularity of outdoor recreation increases, land managers spend more time and money on controlling invasions in parks and natural areas. Boating and swimming require the removal of invasive nonindigenous aquatic plants that choke waterways. The state of Florida spends an estimated $14.5 million annually on the control of hydrilla (*Hydrilla verticillata*), an invasive nonindigenous aquatic plant species. It is estimated that the loss of recreational revenue resulting from hydrilla infestation in just two Florida lakes is $10 million annually (Pimentel, et al. 1999). Our national parks have reached the point where land managers can no longer keep pace with the control and containment of the ever increasing numbers of nonindigenous species (Williams and Meffe 1998). The Federal Government estimates that just 15 invasive plants (not including agricultural weeds) have caused economic losses exceeding $600 million dollars over the last century (OTA 1993).

Enormousness of the Problem in New Jersey

New Jersey possesses a rich and diverse vascular flora. Preliminary data indicates that there are between 2,188 and 2,223 indigenous species, subspecies, varieties, and hybrids documented from New Jersey (Snyder a, in prep.). In the northeastern United States, New Jersey's indigenous vascular flora is comparable in number to those of New York and Pennsylvania, states which are three or four times larger than New Jersey (Stein, et al. 2000). The are about 335 indigenous taxa of trees and shrubs in New Jersey and about 1,157 different taxa of herbaceous plants. The state's grass and grass-like flora is extensive, with about 535 indigenous taxa documented. There are about 123 indigenous taxa of ferns and fern allies in the

state. New Jersey possesses nearly 20 times the number of indigenous taxa of orchids than does the State of Hawaii. Nine plant taxa have been documented only in New Jersey and are not known to occur anywhere else on the planet, while three additional taxa, that once had populations outside of New Jersey, are now only known from extant populations within New Jersey. Nineteen globally rare or regionally rare plant taxa have their largest or most viable populations in New Jersey. New Jersey's floristic diversity is due in large part to its topographic diversity, which includes five physiographic provinces with elevations ranging from about 1,800 feet to sea level. Two unique ecosystems, the Kittatinny limestone valley, located within the Ridge and Valley Province of northwestern New Jersey, and the Pine Barrens, located within the Outer Coastal Plain Province, contain a remarkably high percentage of the state's endemic, near endemic, disjunct, unusual, or rare plant taxa.

New Jersey's floristic diversity, representing the culmination of millions of years of evolution, geological processes, and complex biological interactions, is increasingly imperiled by the effects associated with intensive development and nonindigenous species. The effect of development on species diversity is obvious, especially in a state as small and urbanized as New Jersey. Populations of plant species are destroyed outright when their habitats are lost by the filling or draining of wetlands, cleared for development, or quarried, mined or lumbered to supply the raw materials needed to drive development. The effects of nonindigenous species, especially of invasive species, are less obvious and typically occur slowly over a long period of time and consequently receive little public attention. The ultimate consequence is that "the spread and establishment of introduced invasive species has broken down the genetic isolation of communities of co-evolving species of plants and animals. Such isolation has been essential for the evolution and maintenance of the diversity which comprises the biological wealth of our planet" (Clout, et al. 1996).

Based on preliminary data, there are between 1,288 and 1,363 species of nonindigenous plant species documented in New Jersey or as much as 62 percent of the state's total vascular flora (Snyder a, in prep.). Approximately 1,065 to 1,118 of these nonindigenous species have been introduced into New Jersey from continents other than North America, mostly from Europe and Asia (Snyder a, in prep.). This is comparable to the number of nonindigenous species reported from New York (1,122), California (1,113), Florida (1,017), Massachusetts (1,019), and Pennsylvania (988)--the five states having the highest number of nonindigenous species in the nation as determined by the Department of the Interior[3] (Williams and Meffe 1998).

The high number of nonindigenous plant species documented from New Jersey is directly attributable to the state's long history of colonial occupation and its subsequent rise to one of the East Coast's major commercial and transportation centers; a rise propelled by its geographically strategic location between the great seaports of New York and Philadelphia. The first nonindigenous species introduced into New Jersey were likely familiar food, fiber, and medicinal plants of Europe brought by the Dutch and Swedish colonists in the early 1600s. As population

[3] These numbers are cited for comparative purposes only. It is likely that the state totals presented in the Department of Interior's report are subject to change as more states initiate specimen based analyses of the numbers of nonindigenous plant species occurring within their jurisdictions. For example, the report cites New Jersey as having 819 nonindigenous species, about 200 fewer species that have been documented from the state.

centers swelled and spread, and transportation corridors expanded, so did the dissemination of nonindigenous plant species. While most of these early plant introductions were made intentionally, many species were introduced and spread unintentionally, such as through contaminants in imported grains or as seeds stuck in animal fleece. By far, the single most significant effective dispersal mechanism of nonindigenous plant species in New Jersey has been the dumping of foreign ballast soil at the seaports of Camden and Jersey City in the late 18th and early 19th centuries. Hundreds of plant species new to the North American continent were first recorded from the ballast dumps of New Jersey, New York, and Philadelphia (e.g., see Martindale 1876; Brown 1879). Many of these species persisted for only a few seasons, while others were destroyed by land use changes before they had the chance to become established and migrate further (Brown 1880). In New Jersey, at least 260 nonindigenous plant species are only known from collections made from ballast grounds (Snyder a, in prep.). Hundreds of other nonindigenous plants, including many of the state's most familiar weeds, were first collected in New Jersey from these ballast grounds, but have subsequently migrated throughout the state. Their spread was greatly facilitated by the railroad terminals built to service the seaports in the 1800s. In the modern era, water has replaced the use of soil for ballast in commercial shipping, and New Jersey's ballast grounds have been largely built over by commercial and industrial complexes, transportation facilities, and other types of developments.

Although the rate of new introductions has dramatically decreased from the high numbers of nonindigenous plant species that were introduced during the 19th century, new species continue to be introduced into New Jersey. Over the last 25 years, an estimated one to three nonindigenous species per year have been introduced into the state (Snyder, unpublished data). As observed by Snyder (b, in prep.) "The numbers and kinds, both realized and potential, of dispersal vectors arising through human transportation, industry, commerce, agriculture, landscape design, military transport, recreation, etc., are staggering."

Nonindigenous plant species occur in every broad habitat type that occurs in New Jersey. They can be found in disturbed habitats of old fields, fallow agricultural lands, roadsides, and railroad rights-of-way. They grow in deep shade of evergreen and deciduous forests and in the full sun of beaches, dunes, and meadows. They occur as aquatics in lakes, ponds, and streams. Drought tolerant species occupy the highest cliffs and ridgetops. Fire tolerant species occur in grasslands and pine barrens. They grow in relatively common habitats like flood plains and salt marshes, as well as rare habitats like limestone fens, trap rock glades, and sinkhole ponds. They occur in every state park, natural area, and wildlife management area. They are found in every county, municipality, and community in New Jersey.

Not all nonindigenous plant species occurring in New Jersey have harmful or invasive qualities. Many of the nonindigenous plant species used for agricultural, ornamental, or medicinal purposes either do not escape from cultivation or are incapable of persisting or reproducing outside of cultivation. The largest percentage of economically important crops grown in the United States are not indigenous to North America (OTA 1993). The difference between beneficial nonindigenous plants species and those having invasive or harmful qualities is that beneficial species are typically selected for their desirable traits and lack of significant harmful attributes. The majority of New Jersey's nonindigenous plant species are unintentional introductions, having been set loose in the state without any evaluation given to any known or

potential harmful effects. Frequently, plants are selected for certain desirable ornamental or utilitarian traits, such as having showy fruits, being cold hardy, or having value as a soil stabilizer, but then receive little or no evaluation for any potential invasive or harmful qualities. Many of New Jersey's most invasive nonindigenous plants species fit into this category.

One of the most difficult aspects in evaluating the potential invasive or harmful qualities of nonindigenous plant species is the time lag associated with the initial establishment of the species in the state until the occurrence of the species is discovered or before the harmful effects are manifested. The introduction of nonindigenous species has been described as being equivalent to an "ecological surprise attack" in which the "invaded [plant] community does not recognize the nonindigenous species that arrived in its midst and often has few or no natural controls to prevent the establishment of the invader" (Williams and Meffe 1998). Once established, some nonindigenous species spread aggressively and rapidly, and their invasive traits are soon realized. Japanese honeysuckle, Eurasian water-milfoil, and Japanese stiltgrass are examples of species that spread rapidly once established in New Jersey and all were recognized as invasive species of natural plant communities within 20 to 30 years after their initial introduction (see fact sheets in Appendix 2 for further discussion). But for many nonindigenous plant species, extended periods of time may elapse before they are detected or their invasive qualities are recognized. For example, Japanese barberry, Norway maple, lesser celandine, and garlic mustard are nonindigenous species that were documented in New Jersey for 70 or more years before they were recognized as highly invasive species occurring in natural plant communities (see Appendix 2). Why some nonindigenous plant species rapidly establish, spread, and aggressively invade natural plant communities and others do so only after many years after initial establishment, is not fully understood. Some suggested reasons include difficulty of detection, exponential growth, time required for local adaptation, and delays in introductions of pollinators or other mutualists (Rhoads 1999).

Habitats Threatened by Invasive Nonindigenous Plants in New Jersey

It is difficult to summarize how much is lost to invasive nonindigenous plants in New Jersey. There are few estimates of the impact invasive species have on New Jersey's natural plant communities or on ecosystem properties. Determining the effects of a single species can require several years of field experiments. Most of the money spent on control of invasives is included in general vegetation management budgets of state and county parks systems. The best way to describe the environmental and economic costs associated with invasive nonindigenous plants in New Jersey is to illustrate the impacts with several examples.

Wetlands: New Jersey's wetlands are especially vulnerable to invasion by nonindigenous plants, and the economic costs of invasion are high. Effects of nonindigenous species in freshwater wetlands have been magnified because of the historically widespread alteration and disturbances of these ecosystems (Williams and Meffe 1998). One of the major threats to wetlands in New Jersey is purple loosestrife (*Lythrum salicaria.*). It severely threatens the biodiversity of wetlands by forming dense monocultures that exclude indigenous plants and alter wildlife habitat. Nationally, purple loosestrife covers about 400,000 acres and costs nearly $45 million a year in control costs and lost forage for wildlife (USFWS 1998). In New Jersey, it occupies wetlands in nearly every county, but is particularly invasive in western and northern New Jersey (D. Snyder, personal observation). One hundred thousand dollars per year is spent

on biological control of purple loosestrife in New Jersey, mostly funded by the State (B. Chianese, pers. comm.). Some money also comes from the United States Department of Agriculture (USDA), Natural Resource Conservation Program's Wildlife Habitat Incentive Program (WHIP), for preservation of bog-turtle habitat threatened by purple loosestrife. Two species of beetles have been introduced as biological control agents at eight sites in New Jersey on state lands (B. Chianese, pers. comm.). Among them are the Black River Natural Area in Morris County and Whittingham Natural Area in Sussex County. Eleven additional introductions are planned on State and private lands. Biological control is also being used at Great Swamp and Wallkill National Wildlife Refuges in Morris and Sussex counties. (B. Chianese, pers. comm.).

Uplands: Upland habitats, frequently covered by diverse hardwood and coniferous forests, are invaded by many nonindigenous species. Three of the most invasive species are autumn olive (*Eleagnus umbellata*), multiflora rose (*Rosa multiflora*), and Japanese barberry (*Berberis thunbergii*). All three species were introduced as ornamental plants, and autumn olive and Japanese barberry are often still used in ornamental, highway, and wildlife plantings. Autumn olive and Japanese barberry may directly or indirectly cause changes in soil chemistry in invaded areas because they are nitrogen-fixers (Sather and Eckardt 1987; Kourtev, et al. 1998). Multiflora rose forms dense, impenetrable thickets, and can lower crop yields in adjacent fields (Eckardt 1987). Funding from the Federal government through the Wildlife Habitat Incentive Program (WHIP) is being used in three projects in New Jersey for controlling multiflora rose and barberry. WHIP has also provided Monmouth County with $10,000 for removal of multiflora rose on eight acres of county-owned land. At this time, there are no state or federally funded projects in New Jersey focusing on removal of autumn olive.

Lakes and Rivers: Nonindigenous aquatic plants that grow in New Jersey's lakes and rivers restrict swimming, boating, fishing, and other activities that depend on open waterways. They reduce the diversity of indigenous aquatic plants and are of less value as a food source for waterfowl. Oxygen levels in the water are depleted as the thick vegetation of nonindigenous aquatic plant species senesce. Two of the most invasive aquatic plants in New Jersey are Eurasian water-milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Both occur in most of the major watersheds in New Jersey. Control of aquatic plants is difficult. Herbicides are dangerous to nontargeted indigenous aquatic plants and other organisms. Mechanical weed harvesters are also used, but they must be used repeatedly to control the plants and they also can have negative effects on nontargeted species. Snyder (2000) has speculated that three state listed endangered plant species (*Armoracia lacustris*, *Megalodonta beckii*, *Myriophyllum sibiricum*) may have been inadvertently extirpated from Swartswood Lake State Park as a result of efforts to eradicate an infestation of Eurasian water-milfoil. Swartswood State Park is currently testing a biological control agent, a weevil, on Eurasian water-milfoil, in addition to harvesting. The 1996 New Jersey Bond Act provided $5 million dollars for lake management, including funding for aquatic plant control programs in several lakes.

Federal and State Programs Related to Invasive Plants

The Executive Order on Invasive Species, signed on Feb. 3, 1999, established an Invasive Species Council responsible for developing an Invasive Species Management Plan coordinating the efforts of Federal agencies that have projects on invasive species (Appendix 1). The

Council's members include the Secretaries of State, Treasury, Defense, Interior, Agriculture, Commerce, Transportation, and the Administrator of the Environmental Protection Agency (FICMNEW 1999). The main federal laws that apply to invasive species are (from APHIS 1999):

Organic Act [7 U.S.C. 147a]: This Act authorizes the Secretary of Agriculture to detect, eradicate, suppress, control, prevent, or retard the spread of plant pests in the United States. "Plant pests" are defined such that they could include weeds if the weeds are parasitic plants (e.g., species of *Cuscuta*) that directly or indirectly cause injury, disease, or damage to any plant or plant product.

Federal Plant Pest Act [7 U.S.C. 150aa-150jj]: This Act prohibits the movement of plant pests (same definition as in the Organic Act above) from a foreign country into or through the United States or interstate unless such movement is authorized by the Secretary of Agriculture. The Act provides for inspections, seizures, and emergency measures such as quarantines to protect American agriculture.

Federal Seed Act [7 U.S.C. 1551-1611]: This Act regulates interstate and foreign commerce in seeds, and addresses "noxious weed seeds" that may be present in agricultural (e.g., lawn, pasture) or vegetable seed. The Animal and Plant Health Inspection Service (APHIS) administers the foreign commerce provision of this Act; the Agricultural Marketing Service (AMS) administers the interstate commerce provisions.

Federal Noxious Weed Act [7 U.S.C. 2801-2814]: This Act provides authority for a regulatory system designed to prevent the introduction into or through the United States of noxious weeds from foreign countries. The Secretary is authorized to initiate control and eradication actions against incipient infestations of noxious weed that are introduced into this country.

The Federal Noxious Weeds List includes 88 species and five genera of plant species, most of which are agricultural weeds. Three listed species (*Avena sterilis*, *Emex spinosa*, and *Paspalum scrobiculatum*) occur in New Jersey; none of which are presently known to invade natural plant communities in the state (two of the three species have been documented only from ballast dumps in New Jersey and have not been collected in the state since the late 1800s). The application of these laws falls to many Federal agencies, but the USDA and Department of the Interior are primarily responsible. Within the USDA, APHIS is responsible for regulating the introduction of new organisms and for inspecting introduced organisms. The Agricultural Research Service (ARS) does much of the scientific research on prevention, control, and eradication of invasives. The Department of the Interior's National Park Service, Bureau of Land Management, Bureau of Indian Affairs, and Department of Defense are responsible for managing invasions on federal lands.

Several federal programs fund projects on state-owned lands in New Jersey. The Natural Resource Conservation Service provides funds through WHIP that support biocontrol projects on purple loosestrife at eight sites on state lands. Several projects incorporating control of multiflora rose at Washington Crossing and Readington state natural areas, Japanese stiltgrass

(*Microstegium vimineum*) at Rancocas Natural Area, Japanese knotweed (*Polygonum cuspidatum*) at Cheesequake State Park, Japanese barberry (*Berberis thunbergii*) at Allamuchy Natural Area, and Japanese sedge (*Carex kobomugi*) at Island Beach Northern and Southern natural areas are also funded by WHIP. The Federal Executive Order on Invasive Species (Appendix A) is likely to influence projects in New Jersey by withholding federal funding from projects that use federally listed invasive species. For example, the Department of Transportation's Federal Highway Administration is developing planting guidelines that will withhold funding from DOT projects that use invasive plants in revegetation projects (B. Harper-Lore, pers. comm.).

It is likely that stronger programs at the federal and state level would filter down to the county level as well. Few counties in New Jersey have comprehensive management plans for invasive nonindigenous plant species. Monmouth County is instituting a program for assessment of forest health and field plant community cover and condition (K. Thoman, pers. comm.). In the process they will be assessing the extent of invasions and identifying areas where invasive species are causing the most serious problems. The state could assist efforts such as that by Monmouth County if it provided information on identification of invasive plant species, management recommendations, and opportunities for funding programs related to invasive plants. The same information could be provided to the public for management of invasive plants on private lands.

Control and Management Techniques

Controlling established populations of invasive nonindigenous plant species is frequently labor intensive and expensive. Physical control often necessitates removing plant roots and all other parts of the plant from a site to reduce resprouting and seed germination. It is most effective when populations of invasive species are small. Physical control of larger stands can cause soil disturbances that increase the chance of invasion by the same or other nonindigenous plants. Disturbances in, and adjacent to, natural areas increase the likelihood that a habitat will be invaded by nonindigenous plant species. Areas where soil has been disturbed, such as along roadsides and trails, are frequently the first areas that nonindigenous species establish. Urban parks and natural lands are especially vulnerable to invasions by nonindigenous plant species. This is a direct result of a higher degree of disturbance caused by more intensive recreational pressures and by the higher degree of habitat fragmentation occurring in the urban and suburban landscape.

For some species, fire, mowing, or harvesting techniques can be useful control measures. Herbicides can be effective, but they must be used very cautiously to avoid injuring indigenous flora and fauna. Aquatic weeds often cannot be safely controlled with herbicides, due to the potential of contaminating water sources. Biological control methods are another means of control. These methods are often still experimental and, because they frequently involve the introduction of yet another nonindigenous species, adequate research and long-term monitoring are essential to minimize the potential adverse impacts to indigenous species. One of the more widely publicized incidents involving the negative consequences associated with biological control resulted when the Eurasian flowerhead weevil (*Rhinocyllus conicus*) was introduced by Canadian, United States, and state agencies in an effort to control several nonindigenous species of thistles that were aggressively invading acres of rangeland (Stolzenburg 1999). Subsequently,

the weevil migrated from the targeted nonindigenous thistles to several species of indigenous thistles, including the federally listed endangered Suisun thistle (*Cirsium hydrophilum*). Seed production was reduced by as much as 86 percent in some indigenous thistle species. Daniel Simberloff, a leading population biologist, has stated that, "Biocontrol should now be viewed as a method of last resort (Stolzenburg 1999)."

The key to controlling most invasive nonindigenous species is to find small populations before they become too large to manage effectively. The larger a population gets, the more damage it will cause to natural plant communities, and the more difficult it will be to restore indigenous native plant species. When invasive plant populations are still small, they can be removed manually, without having to use herbicides that could harm adjacent plants and without creating too much disturbance of the habitat. Once an invasion is under control, restoring natural plant communities minimizes the chances that an area will be reinvaded. Because eradication of invasives is nearly impossible once they are established, and because preventing established populations from migrating further requires long-term monitoring and management, preventing invasions from occurring in the first place is obviously the best option.

Establishing an annual survey of nonindigenous plants is one method to detect problems early. This could be done on public lands by land managers, or could involve public participation similar to the breeding bird survey (Sauer, et al. 1997) or the New York Metropolitan Flora project (Clemants and Glenn 1994). Botanical clubs and hiking clubs could also be solicited to gather data on geographic distribution of nonindigenous species across New Jersey (see Ehrenfeld 1997).

Prevention and Public Awareness

Preventing establishment of nonindigenous species is the simplest and most cost-effective way of controlling invasions. Introduced ornamental plants are a major source of nonindigenous species that aggressively invade natural plant communities in New Jersey; Japanese barberry, Japanese honeysuckle, and Norway maple being three conspicuous examples. Using indigenous species in plantings will significantly reduce future invasions. Many native plants can provide equally beautiful, hardy alternatives to nonindigenous plants. The City of New York Parks and Recreation's *Native Species Planting Guide* (Luttenberg, et al. 1993) offers excellent suggestions for native species that will grow in the New York Metropolitan Area. Native plant nurseries can also provide planting information.

The issue of invasive nonindigenous plant species must be better publicized in New Jersey. Public support, involvement, and education about the seriousness of the problems associated with nonindigenous plants are essential to prevent further spread and future invasions. Early recognition of the establishment of new populations of invasive nonindigenous plant species is key to successful control and containment. Once invasive plants become established they are very difficult to eradicate and restoration of natural plant communities can take many years. Research, initial control, and long term management of nonindigenous plant species on public and private land is expensive, and will require public support of funding initiatives.

Research

There is no sustained, systematic research currently being conducted on nonindigenous plant species in New Jersey. Although certain groups of nonindigenous invasives, such as aquatic plants, and several high profile invasive species, like purple loosestrife and Japanese barberry, have been the focus of much recent research by academics, state agencies and conservation groups, there remain substantial information gaps. Such basic data as current distribution of nonindigenous species within New Jersey, estimated abundance, rate of migration, habitat and natural plant communities most vulnerable to invasion, etc., have not been compiled in an organized, accessible method. For most of the state's nonindigenous plant species, this information simply does not exist in any form. It is an irony that, on balance, more data has been compiled on New Jersey's rarest plant species than has been compiled on the state's nonindigenous species, many of which are among the most common, most pervasive, plant species occurring in the state. Nonindigenous plant species are vastly under collected, and observations of new invasions remain largely unreported (Snyder 1987; D. Snyder, personal observation). For example, there is a single New Jersey specimen of winged spindletree (*Euonymus alata*) represented in the collections of the Academy of Natural Sciences, Philadelphia and the Chrysler Herbarium, Rutgers University, despite that this nonindigenous species has aggressively invaded natural plant communities throughout the northern and central counties and has been observed from over 100 locations (Clemants and Glenn 1999; D. Snyder, personal observation). In New Jersey, very little research has been conducted on more complex issues such as the effect that nonindigenous invasive species have on population dynamics of rare and declining plant species, alteration of plant community structures, disruption of ecosystem processes, and biologically and environmentally safe control techniques. The conclusion reached by Williams and Meffe (1998) cautions that to be sound, unbiased, and effective any policy promulgated to control, manage, or restrict the introduction of nonindigenous plant species must be based on, and preceded by, rigorous scientific research: "Our knowledge of biology, physiology, ecology, and behavior of most nonindigenous species is rudimentary at best. Compilation and analysis of information on chronology of introductions, their pathways, and their rates and modes of dispersal are essential to the development of policy for nonindigenous species. Research in these areas is critical to understanding the nature of biological invasions and how to prevent or limit their effects."

Acknowledgments

We thank the curators of the Academy of Natural Sciences of Philadelphia and the Chrysler Herbarium, Rutgers University for access to their collections. Also thanked are Robert Cartica (Office of Natural Lands Management), Bob Chianese (New Jersey Department of Agriculture), Joan Ehrenfeld and Jean Marie Hartman (Rutgers University), Bonnie Harper-Lore (Federal Highway Administration), John Kartesz (North Carolina Botanical Garden), Nancy Benton and John Randall (Wildland Weeds Management and Research Program, The Nature Conservancy), and Ken Thoman (Monmouth County Parks) for their information and helpful comments. Thanks also to the people at all the Natural Heritage Programs who provided information on invasive nonindigenous plant species found in their states. Thomas Breden is thanked for recognizing the importance of the issue of nonindigenous species in New Jersey, making it a priority, and securing the funding and his many helpful comments. Thanks also to Marjorie Kaplan (Division of Science Research and Technology) for continued support and

patience throughout this project. Initial funding of this project was provided by the Division of Science Research and Technology, and is gratefully acknowledged.

Sources for More Information

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Bureau of Land Management, http://www.blm.gov/weeds and http://www.blm.gov/education/weed/weed.html.

Ecological Society of America, 2010 Massachusetts Avenue, NW, Suite 400, Washington, DC 20036. 202-833-8773. http://www.esa.org.

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The Nature Conservancy, 1815 North Lynn Street, Arlington, VA 22209. 703-841-5300. http://www.tnc.org.

U.S. Department of the Interior, National Invasive Species Council, 1849 C Street, NW, Washington, D.C. 20240. 202-513-7243. http://www.invasivespecies.gov/.

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Appendix 1. Federal Executive Order 13112 on Invasive Species

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.), Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 U.S.C. 4701 et seq.), Lacey Act, as amended (18 U.S.C. 42), Federal Plant Pest Act (7 U.S.C. 150aa et seq.), Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801 et seq.), Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), and other pertinent statutes, to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause, it is ordered as follows:

Section 1. Definitions.

(a) "Alien species" means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.

(b) "Control" means, as appropriate, eradicating, suppressing, reducing, or managing invasive species populations, preventing spread of invasive species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of invasive species and to prevent further invasions.

(c) "Ecosystem" means the complex of a community of organisms and its environment.

(d) "Federal agency" means an executive department or agency, but does not include independent establishments as defined by 5 U.S.C. 104.

(e) "Introduction" means the intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity.

(f) "Invasive species" means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

(g) "Native species" means, with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

(h) "Species" means a group of organisms all of which have a high degree of physical and genetic similarity, generally interbreed only among themselves, and show persistent differences from members of allied groups of organisms.

(i) "Stakeholders" means, but is not limited to, State, tribal, and local government agencies, academic institutions, the scientific community, nongovernmental entities including

environmental, agricultural, and conservation organizations, trade groups, commercial interests, and private landowners.

(j) "United States" means the 50 States, the District of Columbia, Puerto Rico, Guam, and all possessions, territories, and the territorial sea of the United States.

Sec. 2. Federal Agency Duties. (a) Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law,

(1) identify such actions;

(2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

(3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(b) Federal agencies shall pursue the duties set forth in this section in consultation with the Invasive Species Council, consistent with the Invasive Species Management Plan and in cooperation with stakeholders, as appropriate, and, as approved by the Department of State, when Federal agencies are working with international organizations and foreign nations.

Sec. 3. Invasive Species Council. (a) An Invasive Species Council (Council) is hereby established whose members shall include the Secretary of State, the Secretary of the Treasury, the Secretary of Defense, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce, the Secretary of Transportation, and the Administrator of the Environmental Protection Agency. The Council shall be Co-Chaired by the Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Commerce. The Council may invite additional Federal agency representatives to be members, including representatives from subcabinet bureaus or offices with significant responsibilities concerning invasive species, and may prescribe special procedures for their participation. The Secretary of the Interior shall, with concurrence of the Co-Chairs, appoint an Executive Director of the Council and shall provide the staff and administrative support for the Council.

(b) The Secretary of the Interior shall establish an advisory committee under the Federal Advisory Committee Act, 5 U.S.C. App., to provide information and advice for consideration by the Council, and shall, after consultation with other members of the Council, appoint members of the advisory committee representing stakeholders. Among other things, the advisory committee shall recommend plans and actions at local, tribal, State, regional, and ecosystem-based levels to achieve the goals and objectives of the Management Plan in section 5 of this order. The advisory committee shall act in cooperation with stakeholders and existing organizations addressing invasive species. The Department of the Interior shall provide the administrative and financial support for the advisory committee.

Sec. 4. Duties of the Invasive Species Council. The Invasive Species Council shall provide national leadership regarding invasive species, and shall:

(a) oversee the implementation of this order and see that the Federal agency activities concerning invasive species are coordinated, complementary, cost-efficient, and effective, relying to the extent feasible and appropriate on existing organizations addressing invasive species, such as the Aquatic Nuisance Species Task Force, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds, and the Committee on Environment and Natural Resources;

(b) encourage planning and action at local, tribal, State, regional, and ecosystem-based levels to achieve the goals and objectives of the Management Plan in section 5 of this order, in cooperation with stakeholders and existing organizations addressing invasive species;

(c) develop recommendations for international cooperation in addressing invasive species;

(d) develop, in consultation with the Council on Environmental Quality, guidance to Federal agencies pursuant to the National Environmental Policy Act on prevention and control of invasive species, including the procurement, use, and maintenance of native species as they affect invasive species;

(e) facilitate development of a coordinated network among Federal agencies to document, evaluate, and monitor impacts from invasive species on the economy, the environment, and human health;

(f) facilitate establishment of a coordinated, up-to-date information-sharing system that utilizes, to the greatest extent practicable, the Internet; this system shall facilitate access to and exchange of information concerning invasive species, including, but not limited to, information on distribution and abundance of invasive species; life histories of such species and invasive characteristics; economic, environmental, and human health impacts; management techniques, and laws and programs for management, research, and public education; and

(g) prepare and issue a national Invasive Species Management Plan as set forth in section 5 of this order.

Sec. 5. Invasive Species Management Plan. (a) Within 18 months after issuance of this order, the Council shall prepare and issue the first edition of a National Invasive Species Management Plan (Management Plan), which shall detail and recommend performance-oriented goals and objectives and specific measures of success for Federal agency efforts concerning invasive species. The Management Plan shall recommend specific objectives and measures for carrying out each of the Federal agency duties established in section 2(a) of this order and shall set forth steps to be taken by the Council to carry out the duties assigned to it under section 4 of this order. The Management Plan shall be developed through a public process and in consultation with Federal agencies and stakeholders.

(b) The first edition of the Management Plan shall include a review of existing and prospective approaches and authorities for preventing the introduction and spread of invasive species, including those for identifying pathways by which invasive species are introduced and for minimizing the risk of introductions via those pathways, and shall identify research needs and recommend measures to minimize the risk that introductions will occur. Such recommended measures shall provide for a science-based process to evaluate risks associated with introduction and spread of invasive species and a coordinated and systematic risk-based process to identify, monitor, and interdict pathways that may be involved in the introduction of invasive species. If recommended measures are not authorized by current law, the Council shall develop and recommend to the President through its Co-Chairs legislative proposals for necessary changes in authority.

(c) The Council shall update the Management Plan biennially and shall concurrently evaluate and report on success in achieving the goals and objectives set forth in the Management Plan. The Management Plan shall identify the personnel, other resources, and additional levels of coordination needed to achieve the Management Plan's identified goals and objectives, and the Council shall provide each edition of the Management Plan and each report on it to the Office of Management and Budget. Within 18 months after measures have been recommended by the Council in any edition of the Management Plan, each Federal agency whose action is required to implement such measures shall either take the action recommended or shall provide the Council with an explanation of why the action is not feasible. The Council shall assess the effectiveness of this order no less than once each 5 years after the order is issued and shall report to the Office of Management and Budget on whether the order should be revised.

Sec. 6. Judicial Review and Administration. (a) This order is intended only to improve the internal management of the executive branch and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any other person.

(b) Executive Order 11987 of May 24, 1977, is hereby revoked.

(c) The requirements of this order do not affect the obligations of Federal agencies under 16 U.S.C. 4713 with respect to ballast water programs.

(d) The requirements of section 2(a)(3) of this order shall not apply to any action of the Department of State or Department of Defense if the Secretary of State or the Secretary of Defense finds that exemption from such requirements is necessary for foreign policy or national security reasons.

WILLIAM J. CLINTON

THE WHITE HOUSE,
February 3, 1999.

Appendix 2. Invasive Nonindigenous Plant Species Fact Sheets

Twenty-seven fact sheets have been prepared for 29 nonindigenous plant species that aggressively invade natural plant communities in New Jersey. These are invasive plant species that have many invasive biological traits, are generally widespread in New Jersey and are known to invade natural plant species. Most of these plant species are considered to be invasive throughout much of their range in the United States and all are considered to be invasive in two or more adjacent states (i.e., CT, NY, PA, DE, MD, VA).

The information presented in these fact sheets was primarily compiled from literature review, consultation with botanists from the network of state natural heritage programs, and an examination of herbarium specimens. Herbarium specimens cited are those contained in the collection of the Philadelphia Academy of Natural Sciences (abbreviated PH). Specimens contained in the Chrysler Herbarium, Rutgers University were unavailable for study due to the temporary closing of the collection. A study of herbarium specimens provides data on when and where a plant species was first collected in the state, the type of habitat it grows in, and its relative abundance throughout the state. This information is most useful for the years prior to 1960; after this date, the number of botanical collectors active in New Jersey decline significantly. As a result, many of the most widespread nonindigenous plant species occurring in New Jersey are underrepresented in herbaria.

Although no field surveys were conducted specifically for this project, information on habitat, distribution, and threats was augmented by data collected by the principal investigator over the course of 30 years of fieldwork in New Jersey. The county distributions presented in these fact sheets are by no means comprehensive. A thorough understanding of the distribution, abundance, habitats, and the ecological and economic threats caused by nonindigenous plant species will require many years of additional field surveys and data collection.

The State of New Jersey does not officially recognize the species described in these fact sheets as invasive nonindigenous plant species. No legislation currently exists mandating the creation of an official list of invasive nonindigenous plant species. In addition to enabling legislation, the creation on an official list of invasive nonindigenous plant species will require additional research, more documentation, and a thorough review by the public and governmental agencies.

Acer platanoides L.
(Norway maple)

Description

Norway maple is a deciduous tree that averages 90 feet tall. The leaves have five sharply pointed lobes, similar to sugar maple leaves (Univ. of DE 1998). Norway maple can be distinguished from all native species of maples occurring in New Jersey by the milky sap present when the leaf petiole is broken off from a branch. The leaves are 4-7 inches long and are arranged opposite along the stem. The tree produces small greenish yellow flowers in April, and the seeds are held in wind-dispersed samaras that are 1½ - 2 inches long (Univ. of DE 1998). Leaves turn yellow in late autumn (Webb 1996).

Habitat

Norway maple readily establishes on disturbed sites, such as road and railroad embankments, vacant lots, and fallow fields. It also invades and establishes in natural plant communities. It is particularly successful on alluvial soils in floodplain forests and along riverbanks (see specimen records cited). It also occurs in woodlands and forests where it invades through cleared edges or blow-downs within the interior. Tolerant of air pollution, drought and salt spray, it is commonly used as a street tree in cities and coastal communities (Nowak and Rowntree 1990).

Distribution

Indigenous to Europe and western Asia, Norway maple currently occurs from eastern Canada south to North Carolina, and west to Nebraska (USDA 1998). Scattered occurrences are reported from Idaho, Montana, Washington, and British Columbia (Kartesz 1999). Delaware, Maryland, Massachusetts, New York, Pennsylvania, Vermont, and Virginia list Norway maple as invasive. In New Jersey, the collected range (based on specimens at PH) of Norway maple is Burlington, Camden, Cape May, Cumberland, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Ocean, and Warren counties. Clemants and Glenn (1999) map more than 150 occurrences for the northern part of the State (i.e., Monmouth County north to Sussex County). It occurs in all physiogeographic provinces, but most collections are from the Piedmont and Inner Coastal Plain.

Threats

Norway maple is an aggressive colonizer able to survive under a range of habitat conditions. The dense shade produced by the canopy decreases understory plant diversity, but does not affect establishment of its own seedlings (Wyckoff and Webb 1996).

Control

Norway maple can be controlled mechanically or with herbicides. In some situations, the use of herbicides could harm native plants. Seedlings and saplings can be hand-pulled or dug out. They will resprout if all the roots are not removed (Webb 1996).

Literature Cited and Other Sources of Information

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Representative New Jersey Specimens Examined

Burlington Co.: Rich wooded slope, fork of Black's Creek, 1.5 mi NW of Jacobstown, 2 October 1949, *B. Long 70229*, PH; Moist wooded alluvial bank along Delaware River, Delanco, 29 April 1915, *B. Long 11607*, PH. **Camden Co.:** Road embankment, Hay's Mill Bridge, Atco, 19 July 1923, *G.W. Bassett s.n.*, PH. **Cape May Co.:** Dump near Crooked Creek, 11 September 1938, *B. Long 53077*, PH. **Cumberland Co.:** Wooded bank along Union Lake, W of Millville, 2 May 1937, *B. Long 49742*, PH; Dump, old dam on mill pond, Cohansey Creek, Seeley, 29 September 1935, *B. Long 47769*, PH. **Gloucester Co.:** Rubbish dump in old sand pit, N of Clayton, 18 October 1902, *B. Long 70402*, PH; Border of woods near old farm, Mullica Hill, 21 April 1935, *B. Long 45693*, PH. **Hunterdon Co.:** Wooded slope along Delaware River, 1.5 mi S of Lambertville, 23 June 1940, *B. Long 54549*, PH; Alluvial bank of Delaware River, below Stockton, 20 April 1950, *B. Long 70993*, PH. **Mercer Co.:** Fills and rubbish dumps, 1 mi SW of Mercerville, 30 October 1947, *B. Long 66732*, PH. **Middlesex Co.:** Alluvial woods along Raritan River, 2 mi NW of Fieldville, 3 June 1951, *B. Long 73256*, PH. **Monmouth Co.:**

Alluvium, 3/8 mi S of Allentown, 29 July 1945, *S.D. Wickoff 542*, PH. **Ocean Co.**: Roadside ditch bordering woods, Manahawkin, 23 July 1923, *B. Long 27989*, PH. **Warren Co.:** Alluvium, 1 mi SE of Columbia, 16 July 1948, *R.L. Schaeffer, Jr. 28502*, PH; Alluvium, 1.5 mi E of Belvidere, 7 August 1950, *R.L. Schaeffer, Jr. 33806*, PH.

Ailanthus altissima (P. Mill.) Swingle
(tree-of-heaven)

Description

Tree-of-heaven is a deciduous tree that can reach 90 feet tall (Hunter 1996). The bark is gray and relatively smooth. Leaves are alternate and compound with 11-30 lance-shaped leaflets (Hunter 1996; Virginia NHP1998). Most leaflets have 1-3 coarse teeth at the base of the leaflet (Virginia NHP1998). Leaves can be distinguished from sumac (*Rhus hirta*) by 1-4 small round glands on the leaflet's underside (Hunter 1996). When the leaves are crushed, they give off a distinctive ill scent of burnt peanut butter. Trees bloom in late spring, forming small green flowers at the ends of new shoots (Hoshovsky 1998; Hunter 1996). Flowers develop into clusters of samaras, papery winged fruits with a flattened seed in the center. The seeds are wind-dispersed (Virginia NHP 1998). While seedlings are highly shade intolerant, saplings appear to be more tolerant of varying light conditions (Knapp and Canham 2000). Tree-of-heaven can also reproduce asexually by sprouting from stumps or roots (Hoshovsky 1998).

Habitat

Tree-of-heaven readily establishes on disturbed sites including vacant lots, roadsides, and railroad embankments (Virginia NHP1998). It can tolerate poor soils, drought and rocky conditions (TN EPPC 1998). Early New Jersey collections largely have been made from roadsides, thickets along creeks, and old house sites (see specimens cited). It can establish in old growth forests when disturbances caused by storms or insect outbreaks create gaps in the canopy (Knapp and Canham 2000). In New Jersey, it is frequent in floodplain forests and in woods occurring on trap rock or diabase, especially on the northeastern portions of the Watchung Mountains and the Palisades.

Distribution

Tree-of-heaven is indigenous to central China. It reached the East Coast in the late 1700s as an ornamental plant (Hoshovsky 1998), and was widely planted in urban areas because of its tolerance to pollution and drought. It is now present throughout the United States, with the exception of the northernmost midwestern states (USDA 1998). It is reported for British Columbia and Ontario, Canada (Kartesz 1999). It is considered invasive in at least eight other eastern states. The collected range (based on specimens at PH) in New Jersey is Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Hudson, Hunterdon, Mercer, Monmouth, Ocean, and Warren counties. It occurs throughout New Jersey's physiographic provinces. Clemants and Glenn (1999) map it as common throughout northern New Jersey.

Threats

Tree-of-heaven can disperse rapidly due to its prolific seed production. A single tree can produce 325,000 seeds in a year (Hoshovsky 1998). It can outcompete indigenous plants for underground resources with its long taproot. Trees keep native vegetation from establishing by

producing a toxin that accumulates in the soil. Because of its rapid growth (Knapp and Canham 2000), it quickly and significantly alters plant community structure and disrupts the process of natural plant succession.

Control

Seedlings can be hand-pulled before the taproot becomes established (Hoshovsky 1998). Once trees are established, they are very difficult to remove. Cutting trees repeatedly over several years will stress the trees and prevent seed production. Herbicides are especially effective when applied late in the growing season because the herbicide is then taken into the root system (Virginia NHP1998; Hoshovsky 1998). Herbicides could harm nontargeted native vegetation, so careful application is necessary.

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Virginia Natural Heritage Program. 1998. Fact Sheet – Tree-of-heaven. Available online: http://www.state.va.us/~dcr/dnh/invalian.htm.

Representative New Jersey Specimens Examined

Atlantic Co.: Naturalized about old house site in clearing, N of Egg Harbor City, 15 December 1940, *B. Long 55757*, PH; May's Landing, 16 September 1887, *J.E. Peters s.n.*, PH; roadside, mill at Weymouth, 24 August 1935, *O.H. Brown s.n.*, PH. **Burlington Co.:** Bordentown, 14 May 1891, [no collector's name or number], PH; margin of thickets, SSW of Fostertown, 29 February 1948, *B. Long 66893*, PH. **Camden Co:** Low open thickets on tributary to Cooper Creek, E of Haddonfield, 15 December 1940, *B. Long 55771*, PH. **Cape May Co.:** Roadside woods, [Cape May]1902, *O.H. Brown s.n.*, PH; roadside thicket along Sunset Blvd., West Cape May, 20 August 1943, *W.M. Benner 9866*, PH. **Cumberland Co.:** Abundant about wooded knoll, East Point, 2 mi SW of Heislerville, 10 September 1933, *B. Long 41999*, PH; dry sandy open thicket, Maurice River, 2 mi S of Millville, 30 May 1934, *B. Long 43271*, PH. **Gloucester Co.:** Swedesboro, 31 July 1892, *C.D. Lippencott s.n.*, PH. **Hudson Co.:** roadside, Secaucus, 21 July 1970, *W. Sipple 1542*, PH. **Hunterdon Co:** Alluvial bank along Pleasant Run, 1 mi NW of Pleasant Run, 6 July 1939, *W.M. Benner s.n.*, PH. **Mercer Co.:** Open thicket, W side PRR, S of Laylor St., S of Trenton, 13 August 1950, *B. Long 71979*, PH. **Monmouth Co.:** Roadside, 0.5 mi N of Glendola, 21 June 1954, *V.L. Frazee s.n.*, PH; abundantly naturalized on wooded hillslope, 1.5 mi SSW of Marlboro, 16 March 1941, *B. Long 56057*, PH. **Ocean Co.:** Naturalized about old house site near Manasquan River, NW of Point Pleasant, 26 January 1941, *B. Long 55913*, PH; Atsion, August 1881, *C.D. Fretz s.n.*, PH; dry sandy soil, SE of Fox Island Knoll, Manahawkin, 3 June 1914, *B. Long 9969*, PH. **Warren Co.:** Fence row, 0.5 mi W of Port Murray, 2 September 1954, *R.L. Schaeffer, Jr. 47558*, PH; alluvium, 2.5 mi SE of Columbia, 29 June 1948, *R.L. Schaeffer, Jr. 27749*, PH.

Alliaria petiolata (Bieb.) Cavara & Grande (garlic mustard)

Description

Garlic mustard is a herbaceous biennial that ranges in height from 0.05 to 1.5 meters (Nuzzo 2000). Seedlings emerge in spring and form rosettes of kidney-shaped leaves by mid-summer. During the second year of growth, plants form one or more stems with alternate, sharply-toothed, triangular to heart-shaped leaves. The plants smell like garlic when crushed, especially the young leaves. A cluster of white, four-petaled flowers form at the end of the stems and branches in spring. Garlic mustard is pollinated by a number of small bees and flies but can self-pollinate in the absence of insects (Cruden, et al.1996). The small oblong black seeds are held in siliques (long narrow capsules) at the ends of the stems (Nuzzo 2000). The seeds begin to mature in May and can remain viable through the summer (Rowe and Swearingen 1998). Garlic mustard has the ability to form seed banks but as demonstrated by Baskin and Baskin (1992), these seed reserves are viable for only about four years. People readily disperse the seeds when they get stuck on their boots or clothing and by automobiles and mowers. Seeds may also be dispersed by floodwaters, or indirectly by rodents, birds, and deer (Nuzzo 2000).

Habitat

Garlic mustard is primarily a woodland herb which grows in rich moist forests, floodplains, and along trails and forest edges (see specimens cited). It is especially abundant in soils occurring over limestone, trap rock, or diabase (D. Snyder, personal observation). It frequently establishes on disturbed areas such as a treefalls or trail edges, and then spreads into undisturbed habitats (Nuzzo 2000).

Distribution

Garlic mustard is indigenous to Europe and has been introduced to North Africa, India, Sri Lanka, New Zealand, and North America (Nuzzo 2000). In North America it was first recorded on Long Island, NY in 1868 and now occupies more than 30 states across New England, west to Oregon, and south to Georgia (USDA 1998; Kartesz 1999). At least nine other eastern states list it as invasive. In New Jersey, garlic mustard was collected as early as 1891 from the bank of the Raritan River near New Brunswick, Middlesex County, where it was described as, "liberally distributed over an area of several square miles...and in some places was so abundant as to be considered a weed by the farmers" (Stevens 1893). The collected range (based on specimens at PH) of garlic mustard in New Jersey is Hunterdon, Mercer, Middlesex, Monmouth, and Warren counties. It is also reported as occurring in Bergen, Burlington, Hudson and Union counties (Hough 1983). The species' current distribution is statewide and it occurs in all physiographic provinces (D. Snyder, personal observation). It is least abundant on acid soils of the Inner Coastal Plain.

Threats

Alliaria petiolata can dominate forested understories, resulting in a decline in indigenous herb diversity (Nuzzo 2000). In turn, the decline of indigenous species alters habitat suitability for birds and other animals. Spring flowering plants and the animals dependent on them are particularly affected (Rowe and Swearingen 1998). Garlic mustard may have allelopathic effects as well, preventing plants from growing near it (Nuzzo 2000).

Control

Alliaria petiolata spreads rapidly once established. Baskin and Baskin (1992) reported that if small populations are not eradicated promptly, within a few generations, a few plants can rapidly spread and form dense populations throughout the forest. It is essential, therefore, to begin removal as soon as plants are first observed. Hand-pulling plants can control small infestations. This is most easily done when plants are small and the soil is moist (Rowe and Swearingen 1998). Plants should be pulled before seeds have matured, to prevent inadvertent dispersal. Hand-pulling should continue for at least five consecutive years in order to exhaust the seed bank. However, as Baskin and Baskin (1992) observe, it is likely that seeds will be brought in from other contaminated sites and control methods may be required indefinitely. Flower stalks can be cut in small populations to prevent seeds from maturing, and fire or herbicides can be used to control larger populations (Nuzzo 2000). Late fall is the preferred season for fire or herbicide control, because most indigenous plant species are dormant. Fire is only effective if there is a critical increase in rootcrown temperature. Rootcrowns covered by 1-2 cm of leaf litter will be protected. Removal of the leaf litter will increase seedling survival after the fire, necessitating a second burn the following year. Regardless of the control method used, sites must be monitored for at least five years to ensure that the seed bank has been exhausted (Rowe and Swearingen 1998).

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Hunterdon Co.: Alluvial woods along river, Lambertville, 28 May 1921, *K.K. Mackenzie s.n.,* PH; Light woods, near Tumble Falls, 24 April 1958, *W.L. Dix s.n.,* PH. **Mercer Co.:** Alluvial thicket, Washington Crossing, 7 November 1936, *W.M. Benner 7514,* PH; Alluvial soil between PA canal and Delaware River, 2 mi NW of Titusville, 16 November 1957, *W.L. Dix s.n.*, PH. **Middlesex Co.:** Raritan River bluffs, New Brunswick, 20 July 1890, *A.M. Vail s.n.,* PH; Wooded bluffs of Raritan River, very common, New Brunswick, 18 June 1916, *K.K. Mackenzie s.n.,* PH; Flood plain of Raritan River, Weston's Mills, New Brunswick, 16 May 1931, *G.A. Loughridge s.n.,* PH; near Raritan River, 2 mi above Highland Park, 10 May 1951, *B. Long 73000,* PH. **Monmouth Co.:** Rich open woods, 1.5 mi S of Middletown, 10 May 1952, *V.L. Frazee s.n.,* PH. **Warren Co.:** Alluvium, 1 mi N of Musconetcong, 15 July 1948, *R.L. Schaeffer, Jr. 28435,* PH; alluvium, 1 mi SE of Springtown, 20 June 1957, *R.L. Schaeffer, Jr. 54052,* PH.

Ampelopsis brevipedunculata (Maxim.) Trautv. (porcelain berry)

Description

Porcelain berry is a deciduous climbing vine in the grape family. It can climb to a height of 16 feet with support. The leaves are often deeply lobed, with 3-5 lobes per leaf, and are slightly hairy on the underside (Virginia NHP1998). Young twigs are also hairy. Small, inconspicuous, yellow flowers bloom in mid-summer (Antenen 1996). Fruits form in late summer, and mature in the fall. The fruits are hard and change color from white to pastel shades of yellow, lilac, and green, and finally to a sky blue color (Virginia NHP1998). Seeds are primarily bird dispersed, but the plant also can reproduce vegetatively from stem or root segments (Antenen 1996).

Habitat

Porcelain berry is tolerant of a wide range of environmental conditions (Virginia NHP1998). It is frequently found in old fields and along roadsides, railroads, and powerline right-of-ways. It tends to initially colonize disturbed open areas, such as forest edges, forest gaps, shorelines, and river banks. It is especially abundant in open thickets and sand dunes along coastal portions of New Jersey (D. Snyder, personal observation).

Distribution

Porcelain berry is indigenous to northeastern Asia, and was introduced to the United States as an ornamental landscape plant in the late 1800s (Antenen 1996). It is now abundant in the coastal zone from New England south to Georgia, and west to Wisconsin (Kartesz 1999). In New Jersey, its collected range (based on specimens at PH) is Cape May and Gloucester counties (see specimens cited), and it is reported from Camden and Middlesex counties (Hough 1983). Clemants and Glenn (1999) map nearly 40 occurrences in northern New Jersey. It occurs primarily in the Piedmont, Inner and Outer Coastal Plain physiographic provinces.

Threats

Porcelain berry forms thick mats, blanketing the ground and trees and shrubs on forest edges. It reduces the ability of indigenous plant species to establish, and makes the trees that it covers more vulnerable to wind (Antenen 1996) and ice damage.

Control

Porcelain berry is very difficult to remove once it has become established. Small plants can be hand-pulled, preferably before the plant is in fruit to avoid scattering seeds (Virginia NHP1998). Repeated cutting or mowing will control vines, but not kill them (Antenen 1996). Plants can be shaded out gradually by planting trees or cutting vines off existing trees until they mature. Herbicide application can be effective when applied in early autumn, but may damage

surrounding native plants. Treated sites need to be monitored for several years to remove new sprouts.

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Virginia Natural Heritage Program. 1998. Fact Sheet – Porcelain-berry. Available online: http://www.state.va.us/~dcr/dnh/invamp.htm.

Representative New Jersey Specimens Examined

Cape May Co.: Thicket on vacant lot, West Cape May, 5 September 1942, *W.M. Benner 9838*, PH. **Gloucester Co.:** Rubbish dump, North of Clayton, 18 October 1949, *B. Long 70445*, PH.

Berberis thunbergii BC.
(Japanese barberry)

Description

Japanese barberry is a woody deciduous shrub with dense spiny branches. It usually grows 2-3 feet high. The simple rounded leaves form rosettes along the branches in an alternate pattern. It produces solitary or small clusters of yellow flowers along the stem in spring, and the fruit ripens to a bright red oblong berry in late summer. Fruits are bird dispersed and are also eaten by small mammals (Wisconsin Dept. Natural Resources 1998). It is commonly planted as an ornamental shrub and for wildlife enhancement.

Habitat

Barberry often invades alluvial woods and open forests. It also grows along forest edges and in disturbed areas. Many collected specimens grew along creek banks and river banks (see specimens cited). It occasionally grows in saturated soil in wooded calcareous swamps (D. Snyder, personal observation).

Distribution

Indigenous to Asia, Japanese barberry was introduced to the United States as an ornamental shrub in the late 1800s. It now ranges from Maine to Georgia, and west to Wyoming and Colorado (Kartesz 1999; USDA 1998), and is considered invasive in at least nine other eastern states. In New Jersey, barberry has been collected (based on specimens at PH) from Burlington, Camden, Cape May, Gloucester, Hunterdon, Mercer, Monmouth, and Warren counties. It is also reported in Bergen, Essex, Middlesex, Morris, Passaic, and Somerset, Sussex, and Union counties (Clemants & Glenn 1999; Hough 1983; Ehrenfeld 1997). It occurs in all the physiographic regions of New Jersey, but is most abundant in the Piedmont, Highland, and Ridge & Valley provinces.

Threats

Barberry can grow in sun or shade and in many soil types (Johnson 1996). Branches touching the ground can root, and new shoots can develop from underground roots (Wisconsin Dept. Natural Resources 1998). Barberry can grow so thick in the understory of open forests that it shades out indigenous understory plants and decreases biological diversity. This could adversely affect birds and other animals dependent on the native plants (Johnson 1996). Barberry also affects soil properties, particularly pH, which can affect plant establishment (Kourtev, et al. 1998). Severe infestations of barberry can form nearly impenetrable thorny thickets that impact the recreational value of natural lands.

Control

Mechanical removal by hoe or weed wrench is effective if most of the root system can be removed (Vermont IEPFSS1998). Regular mowing can prevent reinfestation in successional fields. Herbicide treatment can be used to treat shoots that resprout (Johnson 1996). Small patches can be pulled or dug out early in the season, before seed set (Johnson 1996).

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Representative New Jersey Specimens Examined

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Carex kobomugi Ohwi
(Japanese sedge)

Description

Japanese sedge is a perennial sedge with leaves reaching a height of about 30 cm (Virginia NHP1998). Young leaves are yellow-green and stiff with rough edges. The older leaves are wider, darker green, and leathery to the touch. Flowers are held in dense clusters at the tops of stems. Bases of stems are triangular and covered with brown scales. The root system is extensive and can extend nearly a meter into the soil. Flowering heads are either male or female, with the male flower clusters being shorter and more cylindrical than the female flower clusters. Seeds are held in triangular cases called achenes. Plants spread rapidly by underground stems (Virginia NHP1998).

Habitat

In New Jersey, Japanese sedge is restricted to sea beaches and primary and secondary sand dunes (see NJ specimens cited). It was used in New Jersey for erosion control and sand stabilization.

Distribution

Japanese sedge is indigenous to eastern Asia. It grows along the coast of the eastern United States from Massachusetts south to North Carolina (Kartesz 1999; USDA 1998). It also has been reported from Oregon (Kartesz 1999). Virginia and New York both list Japanese sedge sedge as invasive, and it appears to be spreading northward along the coast. In New Jersey, Japanese sedge is restricted to the Coastal Plain and reaches its greatest abundance on Sandy Hook, Monmouth County, and Island Beach, Ocean County (D. Snyder, personal observation). It also has been collected from small colonies at Sea Bright and near Long Branch, Monmouth County (D. Snyder, personal collection).

Threats

The stems of Japanese sedge form dense mats that crowd out indigenous dune species such as American beach grass. Because the sedge is lower growing than the native dune grasses, it leaves dunes vulnerable to shifting sands and blowouts, changing the dune profile dramatically (Virginia NHP1998). In areas of Sandy Hook National Recreation Area and Island Beach State Park, Japanese sedge forms dense monocultures 10 to 20 meters across effectively excluding most native species (D. Snyder, personal observation).

Control

Small populations can be removed by hand digging plants. Large populations can be treated with biodegradable glyphosate herbicide towards the end of the growing season. Follow up treatments will be needed with either method to eliminate new seedlings (Virginia NHP1998).

Several test plots have been sprayed with herbicide at Island Beach State Park. Initial results are promising; especially in plots that were replanted with American beach grass (G. McLaughlin, pers. comm.).

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Representative New Jersey Specimens Examined

Ocean Co.: Frontal dunes, 1 mi S of Island Beach Life Saving Station, Seaside Park, 1 February 1931, *B. Long 34974,* PH; on sand dunes, large deep rooted colony, Island Beach, 23 August 1947, *H.N. Moldenke 19146,* PH.

Celastrus orbiculatus Thunb.
(Asian bittersweet)

Description

Asian bittersweet is a deciduous, woody, perennial vine that can also grow into a trailing shrub (Bergmann and Swearingen 1999). It climbs by twining around a support. The leaves are alternate, with a rounded glossy appearance, and finely toothed edges. The stems are brown with noticeable lenticels (Dreyer 1994). Asian bittersweet flowers in spring, producing clusters of small greenish flowers in the leaf axils. Fruits mature in late summer to early fall. The green to yellow mature fruits split open to reveal bright red arils that surround the seeds. Asian bittersweet is sometimes confused with the similar indigenous American bittersweet (*Celastrus scandens*), especially in the nursery trade (Dreyer, et al. 1987). American bittersweet can be reliably distinguished from Asian bittersweet by having terminal, rather than axillary, clusters of female flowers and fruits, and, less reliably, by its more elliptical shaped leaves and more orange-colored fruits (Dreyer 1994). The fruits are primarily dispersed by birds and small mammals (Bergmann and Swearingen 1999). People are often dispersers as well, harvesting the branches for ornamental use and later discarding them. The vine also reproduces asexually by stolons (above-ground stems), rhizomes, and root suckering (Bergmann and Swearingen 1999).

Habitat

Asian bittersweet occupies a wide range of habitats including forest edges and gaps, floodplains, fields, hedgerows, beaches and salt marsh edges (see specimens cited and Bergmann and Swearingen 1999). It is shade tolerant, and can establish under a closed forest canopy (Dreyer, et al. 1987; TN-EPPC 1999).

Distribution

Asian bittersweet is indigenous to eastern Asia, including Japan, Korea, and parts of China. It was introduced to the United States in the late 1800s, and was planted as an ornamental and used for wildlife food and cover and erosion control (Dreyer 1994). In the United States it occurs from Maine to Georgia, and west to Iowa and Arkansas (Kartesz 1999; Virginia NHP1999). It is also present in Quebec and Ontario, Canada (Kartesz 1999). Several states consider it invasive, including Connecticut, Delaware, Maryland, Massachusetts, New York, Pennsylvania, Tennessee, Virginia, and Vermont. In New Jersey it has been collected from Burlington, Mercer, Middlesex and Monmouth counties (based on specimens at PH; Patterson 1973). Clemants and Glenn (1999) map it as widespread throughout northern New Jersey with records in all counties from Monmouth north to Sussex. It occurs in all physiographic provinces, but most collections are from the Piedmont and Inner Coastal Plain.

Threats

Trees and shrubs can be severely damaged by Asian bittersweet, as its twining branches eventually constrict their trunks and branches, and the vegetative growth can over-top and

outshade them. This makes the trees more susceptible to damage by wind, snow and ice storms (Dreyer 1994). It can form pure stands over some areas. It threatens dune areas as well, possibly altering erosion patterns and outcompeting native dune vegetation. The alteration of natural vegetation structure caused by Asian bittersweet can make recovery of an area very difficult. Preliminary investigations indicate that Asian bittersweet has a much higher percentage of pollen and seed viability than does American bittersweet and may therefore be able to outcompete American bittersweet (Dreyer, et al. 1987). There is also evidence that Asian bittersweet may be hybridizing with American bittersweet, threatening the genetic identity of American bittersweet (Dreyer, et al. 1987; Dreyer 1994).

Control

Control of Asian bittersweet can be difficult, as seed germination rates are high, and seeds are persistent in the soil bank (Dreyer 1994). Small populations can be cut repeatedly until the root stores are exhausted. Juvenile plants can be hand-pulled, but any root portions not removed can resprout (TN-EPPC 1999). All plant parts should be removed from the site to prevent reestablishment. A combination of cutting and herbicide treatment of stumps can be effective (Dreyer 1994), but herbicides could adversely affect surrounding native vegetation.

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Representative New Jersey Specimens Examined

Mercer Co.: Sunny roadside, near pumping station on Stony Brook, western edge of Princeton, 16 May 1953, *I.K. Longman s.n.*, PH. **Middlesex Co.:** Sandy thickets at Sand Hills, 1.5 mi W of Deans, 2 November 1953, *W.L. Dix s n.*, PH. **Monmouth Co.:** Rich floodplain of Manasquan River, 1 mi W of Allenwood, 27 May 1958, *V.L. Frazee s.n.*, PH.

Centaurea biebersteinii DC.
[*Centaurea maculosa* auct. non Lam.]
(spotted knapweed)

Description

Spotted knapweed is a biennial to short-lived perennial herb that forms between 1-20 stems from a basal rosette (Mauer, et al. 1987). Seedling rosette leaves are pinnately to bipinnately dissected and grow 4-8 inches long. The stems can grow 1-3 feet tall, and lower stem leaves are pinnate, becoming linear on the upper stem (Mauer, et al. 1987). In summer, pink to white tubular flowers bloom, held in a thistle-like inflorescence at the ends of branches (Virginia NHP1998). Seeds are released from late summer through fall. Seeds disperse short distances passively, but long-distance dispersal can occur via rodents, livestock, vehicles, or commercial seed (Mauer, et al. 1987).

Habitat

Spotted knapweed primarily establishes in disturbed areas, but can spread into undisturbed areas once established (Mauer, et al. 1987). Western states are heavily invaded in overgrazed areas. It can grow under very dry, low nutrient conditions, and is often found on gravelly or sandy openings in old fields and roadsides (Virginia NHP1998). In New Jersey spotted knapweed occurs abundantly in dry to moist soils along roads, powerline right-of-ways, railroad embankments, old fields, and vacant lots. It also successfully invades many natural plant communities including sand plains, trap rock and limestone glades, shale bluffs, and limestone fens (D. Snyder, personal observation).

Distribution

Spotted knapweed was introduced accidentally to the United States during the late 1800s in ballast and imported seed (Mauer, et al., 1987). It is indigenous to Europe. It has been reported from all states except Georgia, Mississippi, Oklahoma, Texas, and Alaska (Kartesz 1999). It also occurs in Nova Scotia, New Brunswick, Quebec, Ontario, British Columbia, and Yukon, Canada (Kartesz 1999). Over 1.5 million acres of pasture and rangeland are invaded by spotted knapweed in the northwestern United States. In New Jersey, spotted knapweed is reported in Atlantic, Camden, Cumberland, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, and Warren counties (Hough 1983). It is also present in Sussex, Passaic, Essex, Union, Somerset, and Burlington counties (D. Snyder, personal observation).

Threats

Spotted knapweed is an excellent competitor, and is resistant to herbivores (Mauer, et al. 1987). It has been documented that spotted knapweed outcompetes and replaces indigenous plant species (Harris and Cranston 1979). High concentrations of leachates of spotted knapweed have been reported to inhibit the germination of grass and conifer seedlings (Kelsey and Bedunah 1989). Lesica and Shelly (1996) have shown that spotted knapweed reduces

recruitment and population growth of *Arabis fecunda* Rollins, a threatened plant species endemic to southwestern Montana. Spotted knapweed can increase erosion by displacing native root systems with its taproot (Mauer, et al. 1987). The Nature Conservancy's Wildland Invasive Species Program (1997) is investigating a report that spotted knapweed may contain a carcinogen that causes tumors in humans. In New Jersey, spotted knapweed invades rare natural plant communities where it replaces native plant species and significantly alters plant community structure.

Control

Most control methods have been developed for large infestations of knapweed in the western United States. It may be possible to plant indigenous grasses or other species that could outcompete spotted knapweed, but most tests of this technique have been done in western states (Mauer, et al. 1987). Removing flowering heads after plants have bolted can reduce resprouting and seed dispersal. Hand-pulling or grubbing can be used to control small populations (Virginia NHP1998). Because of the knapweed's reported, but as yet unverified, carcinogen contained in the sap, appropriate gloves should be worn when handling this species. Herbicides can be used, but they do not prevent germination from the seed bank. Four biological control agents have been introduced to the western United States, and are effective at reducing seed production (Mauer, et al. 1987).

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Representative New Jersey Specimens Examined

No herbarium specimens were examined for this species.

Cirsium arvense (L.) Scop.
(Canadian thistle)

Description

Canadian thistle is a herbaceous perennial, growing from 0.5-1 meter tall (Nuzzo 1998). The stems are branched and ridged, and sometimes slightly hairy. The alternate, lance-shaped leaves have lobed spiny margins (Thunhorst and Swearingen 1998). It can be distinguished from other thistles by creeping horizontal roots, dense clonal growth, and small (1–1.5 cm diameter) dioecious flowerheads (male and female flowers on separate plants) (Nuzzo 1998). Some plants may produce self-fertile hermaphrodite flowers. The color of the insect-pollinated flowers ranges from lavender to pink, or white. Seed production is prolific, and one plant can produce an estimated 40,000 seeds, each capable of remaining viable in the soil for up to 20 years (Cheater 1992). Seeds are dispersed by wind and possibly by water, and also as contaminants in agricultural seeds, in farm animal droppings, and on farm machinery. Plants spread primarily by vegetative growth, despite high seed production. Horizontal roots can expand by 4-5 meters per year. Plants also propagate from stem and root fragments (Nuzzo 1998). Root fragments as small as an inch can resprout (Cheater 1992).

Habitat

Canadian thistle is shade intolerant, but grows along forest edges (Nuzzo 1998). It has been collected most often from disturbed areas and fields (see specimens cited) but also occurs in meadows and limestone fens.

Distribution

Canadian thistle is indigenous to Europe (Nuzzo 1998). It was introduced to North America in the early 17th century, and is now present in 41 states (USDA 1998). It is considered a noxious weed in 35 states as well as six Canadian provinces (Nuzzo 1998). In New Jersey, the collected range (based on specimens at PH) of Canadian thistle is Burlington, Camden, Hunterdon, Mercer, Middlesex, Monmouth, Salem, Somerset, and Warren counties. It is also reported to occur in Bergen, Cape May, Morris, and Sussex counties (Hough 1983). It occupies all physiographic provinces in New Jersey.

Threats

Canadian thistle is listed as a Federal Noxious Weed, primarily because of its economic impact on agriculture (Thunhorst and Swearingen 1998). Canadian thistle competes with and displaces native vegetation, changing the structure and composition of some habitats (Nuzzo 1998). It primarily threatens nonforested plant communities, such as savannas, glades, sand dunes, fields, and meadows (Thunhorst and Swearingen 1998).

Control

Because Canadian thistle expands primarily by vegetative means, killing established clones is most effective for management (Nuzzo 1998). However, seedlings are the most susceptible growth stage. Burning can increase the competitiveness of indigenous species, but does not eliminate thistle. Mowing can be effective if done during the summer, and again in early fall, leaving enough stem and leaves to avoid stimulating the rootbuds. Herbicides may be used with effectiveness in the fall, but populations differ in their susceptibility to herbicides, and herbicides could adversely affect indigenous plants. Control may be most effective when the plant is under stress, such as during drought, flood, or after a severe winter. Repeated treatments are necessary to eliminate the seed bank (Thunhorst and Swearingen 1998).

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Representative New Jersey Specimens Examined

Burlington Co.: Near railroad bridge, 0.75 mi W of Chatsworth, 23 June 1934, *W.H. Witte s.n.,* PH; roadside gravel, SE of Duke's Bridge, 6 July 1938, *B. Long 52512,* PH. **Camden Co.:** Waste ground, Kaighn's Point, 21 June 1872, H.B. Meredith *s.n.*, PH; waste field, Berlin, 18 August 1923, *M.H. Williams s.n.,* PH. **Mercer Co.:** Rocky Hill, 20 August 1885, *J.E. Peters s.n.,* PH. **Hunterdon Co.:** Swale by roadside, E of Woodglen, 18 July 1935, *B. Long 46814,* PH. **Middlesex Co.:** South Amboy, 20 July 1868, *C.A. Boice s.n.,* PH. **Monmouth Co.:** Grassy roadside, 1 mi W of Manasquan, 6 July 1956, *V.L. Frazee s.n.,* PH. **Salem Co.:** Rare in pasture-meadow, NW of Woodstown, 19 June 1924, *B. Long 30847,* PH. **Somerset Co.:** Dry soil along roadside, Watchung, 8 July 1930, *H.N. Moldenke 1331,* PH; Waste ground, Watchung, 29 July 1946, *H.N. Moldenke 18364,* PH. **Warren Co.:** Fallow field, 3 mi SW of Belvidere, 20 July

1948, *R.L. Schaeffer, Jr. 28787,* PH; Field, 1.5 mi NW of Hope, 10 August 1948, *R.L. Schaeffer, Jr. 29614*, PH.

Dipsacus fullonum L. ssp. sylvestris (Huds.) Clapham
(wild teasel)

Dipsacus laciniatus L.
(cut-leaf teasel)

Description

Teasels grow as prickly biennial or perennial herbs, up to 2 meters tall (Auld and Medd 1987; Lorenzi and Jeffery 1987). They form a rosette of lanceolate, prickly leaves in spring, and overwinter as rosettes. In the second year of growth they form angular stems with large, simple opposite leaves. The lower stem leaves may have scalloped edges. Cut-leaf teasel tends to have broader leaves than common teasel, with deeply incised lobes (Wisconsin Dept. Natural Resources 1998). Flowers bloom in summer, arranged in a 4-10 centimeter long cylindrical head. The flowers of wild teasel are purple to pink, and those of cut-leaf teasel are white (Lorenzi and Jeffery 1987; Wisconsin Dept. Natural Resources 1998). At the base of the flower heads are long, curved spiny bracts. The flower heads dry and may remain on the stem through the winter. Seeds are ribbed, hairy and 4-5 mm long (Lorenzi and Jeffery 1987).

Habitat

Teasels are commonly found in pastures, along roadsides, and in waste places, but they also invade natural plant communities, such as limestone fens, meadows and stream corridors (see specimens cited).

Distribution

Wild teasel and cut-leaf teasel are indigenous to Europe, but were introduced to North America and Australia (Auld and Medd 1987; Lorenzi and Jeffery 1987). Cut-leaf teasel ranges across at least 18 states from New York west to Colorado, and as far south as North Carolina (USDA 1998). Wild teasel is widespread throughout most of the United States (Kartesz 1999; USDA 1998). Both species are considered invasive in Delaware, New York, and Virginia, while Tennessee only considers wild teasel to be invasive. In New Jersey, wild teasel has been collected (based on specimens at PH) from Atlantic, Burlington, Camden, Cumberland, Hunterdon, Mercer, Middlesex, Ocean, Salem, and Warren counties. It is also reported from Bergen, Cape May, Morris, and Somerset counties (Hough 1983). It is especially abundant in the limestone region of Sussex and Warren counties (D. Snyder, personal observation). It occurs in all of New Jersey's physiographic provinces. Cut-leaf teasel's range is more restricted in New Jersey; it is reported in Sussex and Warren counties (Hough 1983).

Threats

Teasel plants produce large numbers of seeds with a mature plant capable of producing over 2000 seeds (Glass 1990). The seeds can remain viable in the soil for up to two years (Glass

1990). Immature seeds are also viable (Solecki 1993). Although seeds do not disperse far, they can effectively produce a monoculture of teasel lobes (Wisconsin Dept. Natural Resources 1998). Highway mowing equipment and discarded dried teasel heads from flower arrangements can lead to the establishment of new colonies. The large rosette leaves may prevent native species from persisting, or establishing. Teasels significantly alter the structure of rare natural plant communities and reduce plant diversity. In one limestone fen in Warren County, the growth of teasel is so dense that it has eliminated the habitat for several state listed endangered plant species (D. Snyder, personal observation) including spreading globe flower (*Trollius laxus*) and sessile water speedwell (*Veronica catenata*).

Control

Small rosettes can be hand-pulled in fall or early spring (Lorenzi and Jeffery 1987). The rosettes have a large taproot that must be dug up to prevent resprouting lobes (Wisconsin Dept. Natural Resources 1998). Flowering stalks can be cut once the flowers have started to bloom, but the stalks should be removed from the site since seeds can mature after the stems are cut. Stems may need to be cut for several consecutive years. (Wisconsin Dept. Natural Resources 1998). Herbicides are also used to treat infestations of teasel, but herbicides can kill untargeted indigenous plants. Application of herbicides can be done late in fall after most other plant species have become dormant lobes (Wisconsin Dept. Natural Resources 1998).

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Representative New Jersey Specimens Examined

Dipsacus sylvestris

Atlantic Co.: Dumping ground, Atlantic City, 22 July 1923, *M.H. Williams s.n.* PH. **Burlington Co.:** Marlton, 16 July 1882, *J. Stokes s.n.*, PH; Wet meadow along South West Branch Rancocas Creek, 1.75 mi E of Marlton, 9 May 1936, *J.M. Fogg, Jr. 10254*, PH. **Camden Co.:** Ship's ballast, Kaighn's Point, 7 August 1897, *B. Heritage s.n.*, PH; Ballast, Kaighn's Point, September 1889, *B. Heritage s.n.*, PH. **Cumberland Co.:** Open sand, Mt. Pleasant Cemetery, Millville, 2 May 1937, *B. Long 49743,* PH. **Hunterdon Co.:** Along Delaware River between Bull's Island and Pt. Pleasant, July 1883, *G.N. Best s.n.*, PH; Fallow field, 1 mi. NW of Milford, 31 November 1959, *R.L. Schaeffer, Jr. s.n.*, PH. **Mercer Co.:** Princeton, July 1883, *J. E. Peters s.n.,* PH; Trenton, 30 June 1886, *A.C. Apgar s.n.*, PH. **Middlesex Co.:** New Brunswick, August 1891, *Halsted's American Weeds 28,* PH. **Ocean Co.:** Roadside Long Swamp, 2 mi S of New Egypt, 31 July 1906, *J.H. Grove 626,* PH; Roadside in Barnegat, 1 September 1914, *B. Long 10782,* PH. **Salem Co.:** Open pastured woods, along Alloway Creek, SE of Penton, 26 July 1922, *B. Long 26248*, PH. **Warren Co.:** Alluvium, 2 mi NW of Delaware, 9 August 1948, *R.L. Schaeffer, Jr. 29391,* PH; Fallow field, 1 mi E of Pequest, 13 August 1959, *R.L. Schaeffer, Jr. 59626,* PH.

Elaeagnus umbellata Thun. var. *parvifolia* (Royle) Schneid. (autumn olive)

Description

Autumn olive grows as deciduous shrubs or small trees. Autumn olive has small simple alternate leaves that are oval to lance-shaped (Virginia NHP1998). The underside of the leaf is covered with silver-white scales. In early spring the plant produces small, light yellow flowers along the twigs, just after leaves have appeared. Small juicy fruits ripen to pink or red, dotted with silver-white scales, in late summer. Birds eat and disperse the fruits.

Russian olive is closely related to autumn olive, and can be distinguished by its narrower lance-shaped leaves, silvery on both sides, thorny branches, and yellow, dry, mealy fruits (Virginia NHP1998). Russian olive also flowers later in the spring, well after the leaves have appeared. It commonly confused with autumn olive.

Habitat

Autumn olive has nitrogen-fixing root nodules that allow it to thrive in poor soils (Sather and Eckardt 1987; Muzika and Swearingen 1998). Typical habitats for autumn olive include disturbed areas, roadsides, pastures, fields, forest edges, and open woodlands (see specimens cited). The species invades a number of uncommon or rare plant communities including limestone and trap rock woodlands, shale bluffs, glades, limestone fens and meadows, and dune thickets. It also has been found growing in saturated soils of wooded calcareous swamps (D. Snyder, personal observation).

Distribution

Autumn olive is indigenous to Asia (Sather and Eckardt 1987). It was widely planted in the United States as an ornamental shrub, wildlife cover, and for revegetation of disturbed areas. Autumn olive is considered invasive in nearly all of the eastern states. Autumn olive occurs throughout New Jersey, occurring in all physiographical provinces. The collected range (based on specimens at PH) of autumn olive is Cumberland, Mercer, Ocean, and Somerset counties. It is also reported in Hunterdon, Sussex, and Warren counties (Hough 1983). Clemants & Glenn (1999) map it as widespread throughout all of northern New Jersey

Threats

Autumn olive could adversely affect the nitrogen cycle of native communities on poor soils (Muzika and Swearingen 1998; Sather and Eckardt 1987). It grows rapidly, resprouts when cut, and is a strong competitor. The dense shade it produces suppresses plants that require sunlight (Virginia NHP1998). At some locations, it forms dense monocultures that alter the structure of natural plant communities and reduces plant diversity.

Control

Burning and cutting stimulate resprouting. Seedlings can be dug out when the soil is moist to ensure removal of the root system. Herbicides are effective when applied in fall (Sather and Eckardt 1987), but herbicides can also harm indigenous plants. Public and governmental education is essential to controlling the further spread of this species. As recently as 1992, autumn olive was still being recommended for "habitat improvement projects designed to attract wildlife, provide barriers, beautify existing landscapes, and reclaim disturbed sites" (Dittberner, et al., 1992) with little or no warnings on its invasive nature. The species is still widely planted in New Jersey, especially along highway corridors.

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Representative New Jersey Specimens Examined

Eleagnus umbellata

Cumberland Co.: Roadside thicket, NW of Fordville, 10 November 1935, *B. Long 47968*, PH; Edge of woods by old clearing along Mill Creek, Fairton, 12 May 1935, *B. Long 45798*, PH; Abundant in open woods and thickets west of Carmel, 1.5 mi NE of Gouldtown, 15 August 1935, *B. Long 47367*, PH; Edge of dry pine woods, 2 mi SE of Woodruff, 2 December 1934, *B. Long, 45364*, PH. **Mercer Co.:** Bank of Delaware River, 0.5 mi SSE of Scudder's Falls, 30 May 1947, *W.L. Dix s.n.,* PH; Bank of Delaware River, 0.5 mi SSE of Scudder's Falls, 9 November 1947, *W. Perry s.n.*, PH. **Ocean Co.:** Old house site near Manasquan River, NW of Pt. Pleasant, 26 January 1941, *B. Long 55923*, PH. **Somerset Co.:** Thicket, extensively naturalized, Watchung, 21 May 1930, *H.N. Moldenke 1266,* PH.

Euonymus alata (Thunb.) Sieb.
(winged spindletree)

Description

Winged spindletree grows as a deciduous shrub or small tree to around 12 feet tall (Ebinger 1996). It has inconspicuous yellow-green flowers in the spring. Corky ridges form along the green twigs, giving the branches a winged appearance. The leaves are opposite and are elliptical in shape with toothed margins. It is also called burning bush because its leaves turn bright red to purplish red in the fall, and the seeds are contained in red or purple fruits (Ebinger 1996). The fruits are dispersed by birds.

Habitat

Winged spindletree is frequent in rich woodlands over trap rock, shale, and limestone. It also grows in alluvial soils in flood plain forests and along stream banks.

Distribution

Winged spindletree is indigenous to northeastern Asia, and was introduced to the United States in the mid 1800s as an ornamental plant (Ebinger 1996). It now occurs primarily in the northeastern states, but there are occurrences south to Louisiana and west to Arkansas and Montana (Kartesz 1999; USDA 1998). It is considered invasive in at least six other eastern states. It is documented throughout northern New Jersey (Clemants and Glenn 1999) and occurs south to at least Gloucester County (D. Snyder, personal observation). Although widespread in New Jersey, the species is poorly documented by specimen collections. By the middle 1970s, the species already was well established on the Watchung Mountains in Somerset and Union counties (D. Snyder, personal observation).

Threats

Winged spindletree replaces native shrubs in some woodland habitats (Ebinger 1996) and alters the structure of natural plant communities. Open woodlands and flood plain forests are particularly vulnerable, but upland forests are also invaded.

Control

Plants can be cut and the stumps painted with herbicide, or foliar spray can be applied in early summer for large populations (Ebinger 1996).

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Lespedeza cuneata (Dum.-Cours.) G. Don
(Chinese bush-clover)

Description

Lespedeza cuneata is a perennial legume, with somewhat woody, straight stems (Smith 1998; Remaley 1998). It grows in height from 1.5 to 5 feet, producing alternate leaves along the stem. The leaves are divided into three narrowly oblong, pointed leaflets, that are covered with flattened hairs. The hairs give the leaves a grayish-green or silvery appearance (Remaley 1998). The flowers are small and grow in the leaf axils from the middle and upper parts of the branches. They bloom in late summer and early fall, and are cream-colored with purple markings (Smith 1998). Natural seed dispersal is primarily by animals.

Habitat

Lespedeza cuneata tolerates a wide range of soil conditions including very sterile soils. It can invade open woodlands, forest and wetland edges, fields and prairies (Remaley 1998). In New Jersey it reaches its greatest abundance on the Coastal Plain where it grows along the edge of pine and oak woodlands and in dry, sandy soils in natural successional plant communities within the Pine Barrens. The species aggressively exploits roadside habitats where its rapid linear spread is facilitated by maintenance activities such as mowing and roadside scraping.

Distribution

Lespedeza cuneata was introduced to the United States from eastern Asia and was widely planted for bank stabilization, soil improvement, and wildlife forage and cover (Remaley 1998). It now occurs from New York and Massachusetts south to Florida, and west to Nebraska and Texas (USDA 1998; Kartesz 1999). It is considered invasive along the East Coast in Maryland, New York, North Carolina, Tennessee, and Virginia. In New Jersey, its collected range (based on specimens at PH) is Burlington, Cape May, Monmouth and Ocean counties in the Coastal Plain. It is also reported from Atlantic, Bergen, Burlington, Camden, Cumberland, Hunterdon, Mercer, Sussex, and Warren counties, which cover all of the physiographic regions of New Jersey (Hough 1983; Monachino 1962).

Threats

This plant is primarily a threat to open areas including meadows, open woodlands, and wetland borders (Smith 1998; Remaley 1998). It can form dense stands that prevent establishment of indigenous species, and it develops an extensive seed bank in the soil that allows it to persist for many years. It disrupts patterns of natural succession and displaces shade intolerant early successional species. The high tannin content in the leaves makes it unpalatable to native wildlife (Remaley 1998).

Control

Mowing plants in the flower bud stage for 2-3 years can reduce stand vigor and prevent further spread of a stand. Plants should be cut as low to the ground as possible. Herbicide treatments are most effective in early to mid summer (Remaley 1998), but many other indigenous plants will be growing during this season that could be killed by the herbicides.

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Representative New Jersey Specimens Examined

Burlington Co.: Dry bare sand along roadside, 1 mi N of Ewansville, 16 October 1947, *B. Long 66666*, PH. **Cape May Co.:** Fields and roadsides, Cape May, 18 August 1946, *O.H. Brown s.n.*, PH. **Monmouth Co.:** Abandoned sandy field, 1 mi SE of Farmingdale, 20 August 1955, *V.L. Frazee s.n.*, PH. **Ocean Co.:** Dike of old cranberry bog on Shannoc Brook, 1 mi ENE of Archers Corner, 17 September 1948, *B. Long 68102*, PH; Disturbed soil along Bordens Mill Branch just below dam, Colliers Mills, 2 November 1947, *B. Long 66740*, PH.

Lonicera japonica Thunb.
(Japanese honeysuckle)

Description

Lonicera japonica grows as a perennial trailing or climbing woody vine. Its leaves are 4-8 cm long, opposite, ovate and entire (Nuzzo 1998). The leaves are semi-evergreen, falling off in midwinter. Leaves are all separate, which distinguishes them from the indigenous vine honeysuckles, which have leaves joined at the base. Young stems are reddish-brown to light brown, and older stems are hollow with a brownish bark that peels in long strips. Flowers are produced from spring through summer. The tubular flowers are typically white (fading to yellow) with long curved stamens projecting from the corolla. *Lonicera japonica* var. *chinensis* has red flowers and is rarely found in New Jersey. Flowers are very fragrant and are borne in pairs on axillary peduncles (Nuzzo 1998). Black globose berries, 5-6 mm in diameter, mature in the late summer and early fall (TN EPPC 1998). The fruits are bird dispersed. Japanese honeysuckle creates dense thickets by stem branching, rooting at the nodes, and vegetative spread from rhizomes (Nuzzo 1998).

Habitat

Japanese honeysuckle frequently establishes in disturbed habitats, including successional fields, roadsides, forest edges and gaps, and fencerows (Nuzzo 1998). In New Jersey, the species grows in similarly disturbed or successional habitats but also occurs in limestone woods, trap rock glades, flood plain forests, sand dunes, beaches, salt marsh borders, Coastal Plain marl ravines, borders and thickets of Coastal Plain ponds, oak and pine woodlands, and shale bluffs (D. Snyder, personal observation; also see specimens cited). It grows most vigorously in full sun and on rich soil, but it is shade and drought tolerant.

Distribution

Japanese honeysuckle is indigenous to eastern Asia and was introduced to New York in 1806 as an ornamental plant (Nuzzo 1996). It has been reported from 38 states from Maine, south to Florida and the Commonwealth of Puerto Rico, west to Wisconsin, California, and Hawaii (Kartesz 1999). It also occurs in Ontario, Canada. It appears to be limited by severe winter temperatures to the northern latitudes, and by prolonged droughts to the west. It is considered invasive in all eastern states south of Massachusetts. Japanese honeysuckle has been recognized as an unwanted weed in New Jersey as early as 1892 (Harshberger 1916). The species is widespread and abundant throughout New Jersey where it occurs in all of the State's physiographic provinces. The collected range (based on specimens at PH) is Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Ocean, Salem, and Warren counties. It is also reported in Bergen, Essex, Hudson, Morris, Passaic, Somerset, and Sussex counties (Clemants and Glenn 1999; Hough 1983).

Threats

Japanese honeysuckle spreads rapidly and is a strong competitor, for both above and below-ground resources (Nuzzo 1998). Below-ground root competition can decrease the growth of native trees and vines. Above-ground it can change forest structure by engulfing small trees and shrubs, causing them to collapse under the weight of the vines. On the ground it can form a cover so dense that native trees, shrubs, and herbs are unable to re-establish. In New Jersey, it has been reported to occupy habitats of rare plants and is attributed as a cause of their decline (Bailey 1932; Fables 1962; Snyder 2000). Honeysuckle also leafs out very early in spring, which could inhibit flowering by spring ephemerals (Nuzzo 1998). Fernald (1950) described *Lonicera japonica* as a "most pernicious and dangerous weed, overwhelming and strangling the native flora and most difficult to eradicate; extensively planted and encouraged by those who do not value the rapidly destroyed indigenous vegetation."

Control

Removing only above-ground vegetation, either by cutting or mowing, is ineffective because of resprouting (Nuzzo 1998). Hand-pulling can be effective if most of the roots and runners can be removed, but is probably only practical for small patches of seedlings and young plants. All parts of the plant should be removed from the site to prevent re-establishment. Some herbicides are effective, and they can be applied when native plants are dormant due to the semi-evergreen nature of Japanese honeysuckle. The best time to apply herbicides is after the first killing frost, but before the first hard frost. A combination of burning and herbicide treatment has also proved effective (Nuzzo 1998).

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Representative New Jersey Specimens Examined

Atlantic Co: Pine and oak woods about ruins of old Etna furnace, 0.5 mi E Head of River, 5 January 1941, *B. Long 55863*, PH; thickets bordering brackish marsh, back of Abescon Bay, NE of Pleasantville, 29 October 1939, *B. Long 54062*, PH. **Burlington Co.:** Crest of steep wooded slope along Delaware River, Florence, 4 February 1914, *B. Long 9464*, PH; damp waste ground, 1 mi W of Green Bank, Herman, 13 June 1917, *H. Koster E7-12-2*, PH. **Camden Co.:** Roadside thicket, S of Palmyra, 16 June 1917, *B. Long 16269*, PH; abundant on roadside bank, SW of Osage, 10 June 1919, *B. Long 21077*, PH. **Cape May Co.:** North Wildwood, 10 September 1907, *J.M. MacFarlane s.n.*, PH; borders of Cape Island Creek salt marshes, NE of Cape May City, *W. Stone s.n.*, PH; woods behind sand dunes, S of Peermont, 22 October 1935, *F.S. Fender 1157*, PH. **Cumberland Co.:** Fortescue Glades Wildlife Reserve edge of old field, [near] Newport, 13 October 1981, *S. Heckscher s.n.*, PH; thicket bordering salt marsh, N of railroad, Bay Side, 5 November 1933, *B. Long 42521*, PH. **Gloucester Co.:** roadside thicket by Still Run, 1 mi SW of Mickleton, 6 February 1938, *B. Long 51711*, PH; abundant in thickets along Mantua Creek, Wenonah, 28 October 1917, *B. Long 18318*, PH. **Hunterdon Co.:** Ringoes, 10 July 1898, *H.L. Fisher s.n.*, PH; crest of wooded slope along Delaware River, 1 mi above Lambertville, 23 June 1940, *B. Long 54525*, PH. **Mercer Co.:** Open thickets Mt. Canoe, 1 mi S of Harbourton, 13 June 1936, *B. Long 48723*, PH; weedy field, 1 mi NW of Ewingville, 23 October 1954, *W.L. Dix s.n.*, PH. **Middlesex Co.:** Roadside thickets, 1 mi S of Cranbury, 27 November 1941, *B. Long 57636*, PH; rubbish dump, 1 mi NE of Cranbury, 29 July 1951, *B. Long 73786*, PH. **Monmouth Co.:** Overrunning apple orchard, 6/8 mi SW of Church and Main

Streets, Allentown, 8 June 1939, *S.D. Wikoff 1,* PH; damp woods, Wickatunk, 17 June 1956, *V.L. Frazee s.n.*, PH. **Ocean Co:** Thicket, 1.5 mi SE of Barnegat, 1 October 1937, *H. Koster C7-12-1*, PH. **Salem Co.:** Sandy beach along Delaware River, near Elsinboro Pt., 3 mi SW of Salem, 31 October 1933, *B. Long 42478*, PH; abundant on roadside bank by Cool Run, Aldine, 27 February 1938, *B. Long 51782*, PH. **Warren Co.:** Fence row, 1 mi N of Springtown, 7 August 1956, *R.L. Schaeffer, Jr. 52402*, PH; woods, 2 mi SE of Broadway, 23 August 1951, *R.L. Schaeffer, Jr. 37728*, PH.

Lonicera morrowii Gray
(Morrow's bush honeysuckle)

Lonicera tatarica L.
(twinsisters, Tartarian honeysuckle)

Description

These honeysuckles grow as upright deciduous shrubs that range from 6 to 15 feet in height (Williams 1998). Unlike most indigenous honeysuckles, the nonindigenous bush honeysuckles have hollow stems (Williams 1998). The simple, entire, opposite leaves are oblong to ovate in shape, ranging in length from 1 to 2.5 inches (Vermont IEPFSS 1998). *Lonicera morrowii* has downy leaves, whereas *L. tatarica* has smooth hairless leaves. Pairs of tubular fragrant flowers are borne in the leaf axils along the stems in spring. *Lonicera morrowii* has white flowers that turn pale yellow with age. *Lonicera tatarica* has pink to white flowers that do not turn yellow with age. The showy fruits range in color from red to orange or yellow, and each fruit contains many seeds. The fruits are dispersed by birds (Converse 1998).

Habitat

Nonindigenous honeysuckles are frequent in disturbed areas and at the edges of forests and wetlands, but they can also be found in forested areas (Vermont IEPFSS 1998; Williams 1998). Morrow's honeysuckle tends to be more widespread than Tartarian honeysuckle, and it occupies wetter sites (Converse 1998). In New Jersey, both species have been collected from disturbed or successional habitats such as old fields, roadsides, thickets, and fencerows, but also occur in calcareous woods and bluffs, rich rocky woods, traprock glades, floodplain forests, calcareous fens, and damp woods.

Distribution

Lonicera morrowii is indigenous to Japan, and *L. tatarica* is indigenous to Eurasia. *Lonicera morrowii* is reported from Maine south to South Carolina and west to Wyoming and Colorado, as well several provinces of Canada (Kartesz 1999). *Lonicera tatarica* occurs south only to Virginia but extends west to Alaska and California (Kartesz 1999). Scattered throughout northeastern North America is *Lonicera* x *bella* Zabel, a hybrid between *L. morrowii* and *L. tatarica*. This hybrid is also highly invasive, especially in parts of the Midwest. They are considered invasive in at least eight other eastern states. *Lonicera morrowii* has been collected (based on specimens at PH) from Camden, Cumberland, Hunterdon, Mercer, Monmouth, and Warren counties, and is reported from Sussex, Passaic, Bergen, Morris, Essex, Somerset, Union, and Middlesex counties. (Clemants and Glenn 1999; Hough 1983). *Lonicera tatarica* has been collected (based on specimens at PH) from Warren County and has been reported from Sussex, Passaic, Bergen, Morris, Hunterdon, Somerset, and Camden counties (Clemants and Glenn 1999; Hough 1983). *Lonicera tatarica* is more frequent in the Piedmont, Highlands, and Ridge and

Valley physiographic regions of New Jersey, whereas *Lonicera morrowii* occurs in all physiographic regions.

Threats

The bush honeysuckles can rapidly form a dense shrub layer that can alter light availability to understory plants and deplete soil moisture and nutrients. There may also be allelopathic effects of the fruit and vegetative parts of the honeysuckles (Converse 1998). Nonindigenous bush honeysuckles may also compete with indigenous plants for pollinators; reducing seed set of indigenous plants (Williams 1998). Additionally, the fruits of the bush honeysuckles are not high in the fats and nutrients migrating birds acquire feeding on native fruits. Fruits of *Lonicera morrowii* honeysuckle have been shown to change the plumage color of cedar waxwings when the birds feed primarily on the fruits (Witmer 1996).

Control

Seedlings can be pulled by hand, using care to ensure that the roots are removed. However, the disturbed soil may be easily re-invaded (Converse 1998). Repeated clipping of adult plants can be successful in shaded forest habitats (Williams 1998). Well-established older stands can be cut and the stumps treated with herbicide. Seedlings can also be treated with herbicides (Converse 1998). Herbicides can damage co-existing indigenous plants, and should be used with caution.

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Representative New Jersey Specimens Examined

Lonicera morrowii

Camden Co: Filled in area, 0.5 mi NW of Clementon, 17 May 1947, *R.L. Schaeffer, Jr. 25454*, PH; bushy field near Mt. Ephrain Park, Fairview, 27 June 1926, *G.M. Bassett s.n.*, PH. **Cumberland Co.:** Roadside thicket – escaped from nearby hedge planting, 1 mi SE of Pleasantville, 25 July 1937, *B. Long 50840*, PH. **Hunterdon Co.:** Open-bushy slope along Delaware River, 1 mi WNW of Stockton, 27 October 1940, *B. Long 55480*, PH. **Mercer Co.:** Thicket along Shabakunk Creek, 1 mi W of Prospect Heights, 14 April 1954, *W.L. Dix s.n.*, PH. **Monmouth Co.:** Gravelly hill, Brielle, 10 May 1954, *V.L. Frazee s.n.*, PH; damp woods, 0.5 mi E of Wickatunk, 28 May 1956, *V.L. Frazee s.n.*, PH. **Warren Co.:** Wooded slope, 2 mi NE of Phillipsburg, 18 June 1956, *R.L. Schaeffer, Jr. 50930*, PH; fence row, 1 mi SE of Belvidere, 25 August 1950, *R. L. Schaeffer, Jr. 34829*, PH.

Lonicera tatarica

Warren Co.: Old field, 2 mi E of Still Valley, 13 August 1956, *R.L. Schaeffer, Jr. 52781*, PH; on Delaware River on limestone bluff, below Phillipsburg, May 1883, *T. C. Porter s.n.*, PH.

Lythrum salicaria L.
(purple loosestrife)

Description

Purple loosestrife is a perennial herb, with square woody stems, that typically grows up to three or four feet in height, but under favorable conditions may grow up to 10 feet tall (Bender 1987; Swearingen 1998). The leaves are lance-shaped, and either heart-shaped or rounded at the base. They are arranged opposite or whorled in groups of three or four along the stem. In summer, plants produce large showy spikes of magenta or occasionally white or light pink flowers. Each flower has 5-7 petals. The fruit is a capsule containing minute (0.06 mg) seeds. A single mature plant may produce up to 2.7 million seeds (Gutin 1999). The seeds are mostly wind dispersed, but they can be transported on the feet of waterfowl or by other wetland animals. Seeds float and are also dispersed by water. Plants have strongly developed taproots (Bender 1987). Plants can spread by underground roots and shoots as well as by seed (Vermont IEPFSS 1998).

Habitat

Purple loosestrife occurs in wetland areas including cattail marshes, sedge meadows, and open bogs (Bender 1987). It often occurs along river and stream banks, and in disturbed wet areas. It can tolerate a wide range of soil conditions and up to 50 percent shade (Bender 1987). In New Jersey it occurs abundantly along the Delaware River and other river edges, lake and pond shores, salt and freshwater marsh edges, meadows, limestone fens, floodplain forests, and from disturbed areas such as ditches and filled wetlands (see specimens cited).

Distribution

Indigenous to Eurasia, purple loosestrife was introduced to the United States in the early 1800s (Bender 1987). It occurs in nearly every state, but is particularly concentrated in northeastern wetlands (Bender 1987). The U.S. Fish and Wildlife Service estimates that it covers more than 400,000 acres (USFWS 1998). It is one of the most widespread invasive plants occurring in New Jersey. It occurs abundantly in wetlands throughout the state, with the exception of the central Pine Barrens where it occurs only rarely in ditches and recently disturbed wetlands. The collected range (based on specimens at PH) of purple loosestrife is Bergen, Burlington, Camden, Cape May, Gloucester, Hunterdon, Mercer, Monmouth, Ocean, Salem, and Warren counties. It is also reported in Hudson, Morris, Passaic, and Somerset counties (Hough 1983). Purple loosestrife occurs in all of New Jersey's physiographic provinces.

Threats

Once it becomes established, purple loosestrife displaces native vegetation through rapid growth and heavy seed production (Bender 1987). Uncontrolled, purple loosestrife eventually forms a near monoculture that alters the structure of natural plant communities and reduces

biological diversity. Dense stands can change drainage patterns by restricting the flow of water (Colorado Division of Plant Industry 2000). Wildlife can be affected by the displacement of indigenous food items such as cattails and pondweed. Waterfowl are threatened by the loss of favorable habitat to purple loosestrife (Swearingen 1998). In 1995, the National Park Service determined that purple loosestrife was a potential threat to state listed endangered plant species, special concern plant species, and two globally rare calcareous riverside plant communities documented from the Delaware Water Gap National Recreation Area (Shank and Shreiner 1999). This lead to a joint effort between the New Jersey Department of Environmental Protection through its Office of Natural Lands Management and the National Park Service to qualify these threats. This was done by establishing baseline data on population dynamics and community composition which will allow future statistical comparisons to be made to assess the effectiveness of biological control agents introduced to control the further spread of purple loosestrife (Shank and Shreiner 1999). Several limestone fens, another globally rare plant community, are threatened by the invasion of purple loosestrife. These fens support a remarkably diverse assemblage of state and globally rare plant, animal, and insect species. In New Jersey, several populations of the federally listed bog turtle (*Clemmys muhlenbergii*) are threatened by loss of habitat through the invasion of purple loosestrife (J. Teasuro, pers. comm.). A population of the state listed endangered wiry panic grass (*Panicum flexile*) was lost when its open fen habitat was succeeded by a dense stand of purple loosestrife (D. Snyder, personal observation). The Nature Conservancy is attempting to control the spread of purple loosestrife in a limestone fen at their Johnsonburg Preserve, Warren County (A. Heasly, pers. comm.). The Fish and Wildlife service estimates that purple loosestrife costs about $45 million dollars a year in control costs and lost forage (USFWS 1998). Many cultivars of purple loosestrife have been developed and are sold as landscape plants. It is currently illegal in 13 states to purchase and plant purple loosestrife (Vermont IEPFSS 1998).

Control

Large populations are almost impossible to eradicate, and the best management strategy may be to contain the populations and try to limit seed production (Bender 1987). Herbicides should be used with caution given that loosestrife is restricted to wetlands, often covering extensive acreage. Hand-pulling before plants have set seed can be effective for small populations and isolated stems, as long as root fragments are completely removed. Uprooted plants and broken stems should be removed since stems can resprout. Biological control of purple loosestrife is being tested with six insect species, and three of these insects have been approved by the U. S. Department of Agriculture (Swearingen 1998). In New Jersey, biological control of purple loosestrife is currently underway in several state natural areas and wildlife management areas, federal wildlife management areas, and Nature Conservancy preserves.

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Representative New Jersey Specimens Examined

Bergen Co.: Ditch edge, off Moonachie Rd., Moonachie, 22 July 1970, *W. Sipple s.n.*, PH. **Burlington Co.:** Moist sandy tidal shore along Delaware River, SW of Fieldsboro, 1 September 1923, *B. Long 29158*, PH; alluvial marshes along Delaware River, 1 mi NE of Delanco, 4 July 1944, *B. Long 61267*, PH. **Camden Co.:** Sandy shore of Delaware River at Cooper's Bridge, first noted 1864, Camden, 25 June 1865, *I. Burk s.n.*, PH; Rubbish dump, Collins Ave., Collingswood, 22 July 1957, *B. Long 73650*, PH. **Cape May Co.:** Edge of sandy parking lot, Avalon, 28 August 1960, *N. Erisman s.n.*, PH; old garden site, Cold Spring, 20

August 1900, *O.H. Brown s.n.*, PH; along salt marsh, Cape May, 31 July 1919, *O.H. Brown s.n.*, PH. **Gloucester Co.:** Marshes along Delaware River, 1.5 mi NW of Bridgeport, 13 February 1949, *B. Long 68710*, PH; peaty swale bordering swampy woods along Crown Pt. Rd., SW of Westville, 29 July 1923, *B. Long 28164*, PH. **Hunterdon Co.:** Tumble Station, August 1884, *G.N. Best s.n.*, PH; wet, gravelly and muddy, alluvial shore along Delaware River, Treasure Island, 28 August 1932, *B. Long 38334*, PH. **Mercer Co.:** Mud flats, Lambertville reservoir, 24 August 1972, *M.L. Roberts 3061*, PH; sandy alluvial shore along Delaware River, NW of Trenton, 7 November 1936, *B. Long 49307*, PH. **Monmouth Co.:** Deal Beach, August 1894, *C. S. Williamson s.n.*, PH. **Ocean Co.:** Moist meadow and wood margins, dense showy colony, 23 August 1947, *H.N. Moldenke 19160*, PH. **Salem Co.:** Tidal shore along Delaware River, 2 mi SW of Harrisonville, 29 October 1934, *J.M. Fogg, Jr. 7868*, PH; wet ground, 1 mi NE of Penns Grove, 18 June 1892, *H.B. Meredith s.n.*, PH. **Warren Co.:** River bank above Foul Rift, 31 August 1907, *S.S. VanPelt s.n.*, PH; alluvial swamp, 1 mi E of Pequest, 13 August 1959, *R.L. Schaeffer, Jr. 59692*, PH.

Melilotus officinalis (L.) Pallas
(including *Melilotus alba* Desr. ex Lam.)
(yellow sweetclover)

Description

Yellow sweetclover is a biennial herbaceous plant. It has sweet-scented leaves divided into three leaflets with serrated edges. The yellow or white flowers bloom in summer, and are held in small spike-like racemes. The seeds form in small leathery pods, and are mostly dispersed by water. A long taproot makes the plants drought tolerant and winter-hardy (Eckardt 1987). Although traditionally recognized as two distinct species, Kartesz (1999) synonymizes *M. alba* under *M. officinalis*.

Habitat

Yellow sweetclover generally establishes in disturbed areas, such as roadsides and fallow fields. It also grows in open habitats maintained by natural disturbances such as fire, flooding, or ice scouring. Once established, it can invade any moist open area, often out competing native vegetation by its rapid growth and heavy seed production. Yellow sweetclover occurs abundantly on calcareous riverside seepage communities along the Delaware River in northwestern New Jersey. It has been collected from moist to dry soils in open habitats such as successional fields, limestone fens, floodplains, and sand dunes (see specimen citations).

Distribution

Yellow sweetclover is indigenous to the Mediterranean, Central Europe, and parts of Asia. It occurs across much of the United States. It has been used as a forage crop and soil builder since the early 1900s (Eckardt 1987) which has facilitated its rapid spread. In New Jersey its collected range (based on specimens at PH) is Burlington, Camden, Cape May, Cumberland, Gloucester, Hudson, Hunterdon, Mercer, Monmouth, Ocean, Salem, Somerset, Sussex and Warren counties. It is also reported in Atlantic, Bergen, and Middlesex counties (Hough 1983). It occurs in all of New Jersey's physiographic provinces.

Threats

Yellow sweetclover primarily threatens plants species that depend on open areas such as stream edges (Cole 1991), fens, floodplains, and dunes. It is one of the three most invasive species that have invaded globally rare plant communities along the Delaware River in the Delaware Water Gap National Recreation Area (Shank and Shreiner 1999). Once established it forms dense stands that prevents or reduces the establishment of indigenous species. It significantly alters the structure of natural plant communities and disrupts the process of natural plant succession. The species produces a large number of seeds that remain viable in the seed bank for several years.

Control

A series of burns, or combination of mowing and burning, can be used to control yellow sweetclover in grassland communities or fens (Eckardt 1987). Herbicides can also be used in combination with burning, but herbicides can harm indigenous plant populations. Hand-pulling first year plants in late summer or early fall can be effective on small sites. Mowing is only effective if plants are cut very close to the ground (Eckardt 1987). Because seeds remain viable in the soil for several years, treatments may need to be repeated (Lorenzi and Jeffery 1987).

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Representative New Jersey Specimens Examined

Burlington Co.: Railroad ballast, freight siding, Atsion, 22 June 1922, *B. Long 9148*, PH; sunny roadside, Camp Ockanickon, 1.5 mi SE of Medford Lakes, 7 June 1952, *I.K. Langman 4054*, PH. **Camden Co.:** Rubbish dump, Gloucester City, 22 July 1951, *B. Long 73673*, PH; Brooklawn, 15 October 1934, *F.R. Spiers s.n.*, PH; Camden, 8 August 1881, *F. Ball s.n.*, PH. **Cape May Co.:** Lighthouse Ave. near Sunset Blvd., Cape May Point, 2 July 1953, *R.C. Alexander s.n.*, PH; Waste ground, Cape May City, 8 July 1917, *W. Stone s.n.*, PH. **Cumberland Co.:** Roadside, S of Haleysville, 24 June 1934, *B. Long 1934*, PH; Old field near Burnt Mill Branch, 1 mi E of Pleasantville, 30 May 1938, *B. Long 52267*, PH. **Gloucester Co.:** Rubbish dump in old sand pits, N of Clayton, 18 October 1949, *B. Long 70407*, PH. **Hudson Co.:** Field over fill, near Little Snake Hill, 21 July 1970, *W. Sipple 1552*, PH. **Hunterdon Co.:** Along Musconetcong River, 1 mi E of Bloomsbury, 17 July 1927, *J.R. Bebler s.n.*, PH; Califon,

25 June 1904, *H.L. Fisher s.n.*, PH; Open ground by old road along Musconetcong River, above Warren Glen, 4 September 1939, *B. Long 53851*, PH. **Mercer Co.:** Roadside head of Shabkunk Creek, 0.5 mi SE of Pennington, 19 June 1937, *B. Long 50112*, PH; Trenton, 20 June 1884, *A.C. Apgar s.n.*, PH. **Monmouth Co.:** Waste places, Allenwood, 24 June 1954, *V.L. Frazee s.n.*, PH. **Ocean Co.:** Forked River "C.G.S.", Island Beach, 18 July 1950, *J. A. Small s.n.*, PH; Fallow field, Bogans (Osborne) Island, 5 August 1913, *B. Long 9148*, PH. **Salem Co.:** Roadside along Nihomus Run, 1 mi SW of Woodstown, 8 June 1934, *J.M. Fogg, Jr. 6802*, PH. **Somerset Co.:** Dry soil along roadside, Watchung, 26 July 1930, *H.N. Moldenke 1340*, PH. **Sussex Co.:** Dry shale outcrop, 2 mi SW of Fredon, 8 July 1934, *A.G. Lisi s.n.*, PH. **Warren Co.:** Roadside, 0.5 mi NE of Uniontown, 27 July 1953, *R.L. Schaeffer, Jr. 44338*, PH; Alluvium, 1 mi NW of Columbia, 3 September 1948, *R.L. Schaeffer, Jr. 30705*, PH; Fallow field, 1 mi W of Brass Castle, 18 August 1950, *R.L. Schaeffer, Jr. 34413*, PH.

Microstegium vimineum (Trin.) A. Camus
(Japanese stiltgrass)

Description

Japanese stiltgrass grows as an annual grass (Mehrhoff 2000) with a sprawling habit, and can reach heights of up to 3 feet (Swearingen 1998; TN EPPC 1998). It has thin, pale green, lance-shaped leaves, about 3 inches in length, that grow alternately along a branched stalk. The leaves have a silvery stripe of reflective hairs down the center of the upper leaf surface (Swearingen 1998). The stalk is distinctly divided by nodes, with the segments between the nodes flattened and widening toward the upper end (Smith 1998). The flowers bloom along a delicate spike that emerges from the stalk tips in late summer and early fall (Swearingen 1998). The seeds mature in mid to late fall, and can remain viable for more than five years in the soil (TN EPPC 1998). Plants spread locally by rooting at the nodes. Seed dispersal is by animals, water, or deposition with fill dirt (TN EPPC 1998). The report that there is a rhizomatous perennial form occurring in eastern North America (Ehrenfeld 1999), has been challenged by Mehrhoff (2000), who believes the report is based on misidentification of the indigenous grass, *Leersia virginica* L. The two species are vegetatively similar and grow in similar habitats, often growing in mixed populations (Mehrhoff 2000). Vegetative plants can be distinguished by the silvery stripe running along the middle of the leaves of Japanese stiltgrass, a character lacking in *Leersia virginica.* The two species are easily distinguished when in flower or fruit.

Habitat

In New Jersey, Japanese stiltgrass is found in a range of habitats, from wetlands to early successional fields and forested uplands (Hunt and Zaremba 1992). It reaches its greatest abundance in floodplain forests and moist soils over shale, diabase, and glauconite (D. Snyder, personal observation). Although it is a shade adapted species (Winter, et al. 1982), it also grows in full sunlight, especially in disturbed habitats such as roadsides, powerline right-of--ways, ditches, agricultural lands, lawns and gardens. It appears to favor soils that are moist, acidic to neutral, and high in nitrogen (Swearingen 1998).

Distribution

Indigenous to Asia, Japanese stiltgrass was introduced to the United States in the early 1900s (Fairbrothers and Gray 1972). It has spread to 23 eastern states, from New York and Connecticut south to Florida, west to Missouri and Texas and also the District of Columbia and the Commonwealth of Puerto Rico (Kartesz 1999). It is considered invasive in at least eight eastern states. It was first collected in New Jersey in 1950, and has subsequently and rapidly spread statewide (Hunt and Zaremba 1992; D. Snyder personal observation). The species is poorly represented by herbarium collections (Fairbrothers and Gray 1972; Kourtev, et, al. 1998; Hunt and Zaremba 1992; D. Snyder, personal observation). By the early 1980s, Japanese stiltgrass was already common throughout much of the Piedmont, Inner Coastal Plain, and parts of the Highlands and Ridge and Valley provinces (D. Snyder, personal observation). There are collections from Burlington, Mercer, Middlesex, Morris, Somerset, and Warren counties (see

specimens cited; Hunt and Zaremba 1992). It is also reported to occur in Hunterdon and Passaic counties (Hunt and Zaremba 1992; Hough 1983). Most collections are from the Piedmont.

Threats

Japanese stiltgrass alters the structure of natural plant communities and reduces biodiversity by displacing indigenous herbaceous vegetation through its dense growth, which rapidly forms monocultures that are sometimes acres in extent. Because of its rapid and dense growth, it alters light and moisture regimes and likely affects seed germination. Kourtev, et al. (1998) speculated that Japanese stiltgrass in association with Japanese barrberry (*Berberis thunbergii*) raises pH and reduces the organic horizons in soils.

Control

Prevent introduction of Japanese stiltgrass from invaded sites to adjacent natural areas by avoiding disturbance to vegetation and soil in the natural areas (Swearingen 1998). Small infestations can be hand-pulled, but pulling will have to be repeated until the seed bank is exhausted. Plants can be mowed when flowers are blooming, but before seed set. Herbicides can be effective, and should be applied before plants set seed (TN EPPC 1998). Herbicides should be used with caution, as they could harm indigenous co-occurring plants.

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Representative New Jersey Specimens Examined

Burlington Co.: Open thicket, shore of Delaware River, Fieldsboro, 28 September 1950, *B. Long 72292*, PH. **Mercer Co.:** Canal bank, River Rd. and Yardley Bridge, Wiburtha, 15 September 1950, *B. Long 72238*, PH; alluvial woods along Delaware River, Somerset, 1 September 1950, *B. Long 72240*, PH. **Middlesex Co.:** Dried meadow off Tices Lane, East Brunswick, 1 September 1983, *D.E. Fairbrothers, F.P. Peterson, P. Manos s.n.,* PH. **Warren Co.:** Wooded bank along Delaware River, N of Riegelsville, 2 November 1950, *B. Long 72613*, PH; alluvium, 0.5 mi SE of Columbia, 27 August 1953, *R.L. Schaeffer, Jr. 45180*, PH.

Myriophyllum spicatum L.
(Eurasian water-milfoil)

Description

Eurasian water-milfoil is a submersed, rooted, perennial herb that can form large mats of floating vegetation (Remaley 1998; Jacono1998). It has long underwater stems that branch and produce leaves near the surface. The leaves are grayish-green in color and occur in whorls of 3-4 along the stem. The leaves divide finely into 12-16 pairs of threadlike leaflets about 1.5 inches long, giving the plant a feathery appearance. The yellow flowers are 4-parted and held on a spike, projecting 2-4 inches above the surface of the water. They bloom in late summer. Hard segmented capsules contain the seeds (Remaley 1998). Most regeneration and dispersal is from fragmented stems and rhizomes rather than from seeds (TN EPPC 1998). Preliminary data suggests that while the rate of successful seed germination is low among natural populations, laboratory studies indicate that the seeds are highly viable, and likely contribute to the long-term survival of the species through seed banking (Madsen and Boylen 1989). Patten (1956) discusses the biology of this species in great detail.

Habitat

Eurasian water-milfoil grows in lakes, low-energy areas of rivers, and other bodies of fresh to brackish water (Remaley 1998). It is tolerant of pollutants and establishes readily in disturbed habitats and habitats where indigenous plants are growing poorly.

Distribution

Water-milfoil is indigenous to Eurasia and northern Africa, and was introduced into the United States in the 1940s (Jacono 1998; Pullman 1992). Earlier reports of this species in the United States are based on misidentifications (Pullman 1992). It now occurs throughout most of the United States (Kartesz 1999). Schuyler (1989) reported that the first New Jersey collection of water-milfoil was from Lake Musconetcong, Sussex County in 1952. It now occurs in all of the major watersheds in New Jersey (Jacono 1998). Its collected range (based on specimens at PH) is Camden, Hunterdon, Mercer, Ocean, and Warren counties. It is also reported from Cape May, Monmouth, Middlesex, Passaic, and Sussex counties (Hough 1983; D. Snyder, personal observation). It is especially abundant in northwestern New Jersey and the Delaware River drainage.

Threats

Eurasian water-milfoil begins growing earlier in spring than most indigenous aquatic plants. It quickly forms a dense canopy that overtops, outshades, and outcompetes surrounding vegetation (Jacono 1998). Indigenous plant diversity and abundance decline once water-milfoil establishes. A study conducted at Lake George, New York State, documented quantitatively that the number of indigenous aquatic plants species present in a 3 meter^2 grid decreased by more than half--from 20 species to nine--within three years (Madsen, et al. 1991). Vegetative

fragments do not need an organic substrate to continue to grow (Madsen, et al., 1988) and are a major mechanism of dispersal between aquatic systems. Recreational activities, such as swimming and boating, contribute significantly to the spread of this species. Waterfowl are affected because it has lower food value than native plants, and fish are affected because the plants support a lower abundance and diversity of invertebrates. The dense cover does allow for higher survival of young fish, but larger fish and predatory fish lose foraging space. Water quality and dissolved oxygen levels decline with the decay of the thick vegetation. The amount of light reaching lower growing aquatic plant species is reduced. Dense beds of Eurasian water-milfoil also impair recreational activities such as boating, swimming and fishing (Jacono 1998).

Control

In small areas Eurasian water-milfoil can be removed mechanically with a rake. In large areas, hydro-raking, dredging, and diver operated suction harvesting can be employed (Vermont IEPFSS 1998). The best time for mechanical removal is in early summer just before peak biomass, but multiple harvests are most effective (Remaley 1998). If water levels can be manipulated, plants can be "drowned" by not having access to enough light, and by lowering the water level plants can be dehydrated or frozen, depending on the time of year. Water level manipulation is most effective when used with shade barriers and herbicides (Remaley 1998). Most of these control methods can have drastic impacts on indigenous aquatic plant species, especially rare or declining species. Snyder (2000) speculated that methods used to control Eurasian water-milfoil at a lake in northwestern New Jersey may have contributed to the decline or loss of state-listed endangered or special concern aquatic plant species. Barriers can also be used to prevent the movement or spread of plants. There is a milfoil specific herbicide available that should be applied when the plants are actively growing (Remaley 1998). Several insects are currently being tested as possible biocontrol agents (Univ. Florida 1998). One of these biocontrol agents being tested is an aquatic weevil (*Euhrychiopsis lecontei*). Studies have shown that the weevil can have "rapid and substantial effects" to both plant stems and roots (Newman, et al., 1996). According to Sheldon and Creed (1995) this weevil is known to feed on Eurasian milfoil and the North American indigenous species *Myriophyllum sibiricum*, which is listed as a state endangered plant in New Jersey. Although these authors stress that the weevil "did not appear to have a significant negative impact on [*M. sibiricum*] in the field," this may not be true when populations of *M. sibiricum* are at critically low numbers. The possible negative effect that biological control methods could have on indigenous plants and other aquatic organisms should always be considered before use. In the summer of 1999, Ohio-grown weevils (*Euhrychiopsis lecontei*) were introduced into two lakes at Swartswood Lake Park in an effort to control Eurasian water-milfoil at a cost of more than 72,000 dollars (Brown 1999). Three to five years are needed to evaluate whether the program has been successful. At recreational areas infested by Eurasian water-milfoil, a method should be made available to allow the operators of boats to hose-down their vehicles and trailers to remove fragments of Eurasian water-milfoil in order to reduce the possibility of further spread.

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Camden Co.: Back channel of Delaware River between Petty Island and Camden, wet depression exposed at low tide, Pyne Point Park, 12 September 1991, *M.E. Garback & A.E. Schuyler 7549*, PH. **Hunterdon Co.:** Delaware River at lower end of Upper Black Eddy, abundant in riffle, 2 km SE of Milford, 12 July 1988, *M.E. Garback, K. Larsen, & A.E. Schuyler 7055*, PH; Round Valley reservoir, S end of lake, 5 mi E of Allerton, 27 June 1972, *M.L. Roberts 2426*, PH. **Mercer Co.:** Delaware River near mouth of Duck Creek, SE of Trenton, 15 October 1981, *R.W. Hastings s.n.*, PH; Delaware River, uncommon in 1 foot water with sandy bottom, 29 August 1972, *M.L. Roberts 3086*, PH. **Ocean Co:** Abundant in Old Sam's Pond, Point Pleasant Beach, 7 September 1980, *A.E. Schuyler 5572*, PH. **Warren Co.:** Musconetcong River, Allamuchy Township, 17 August 1977, *E.A. Laport s.n.*, PH.

Polygonum cuspidatum Sieb. & Zucc.
(Japanese knotweed)

Description

Japanese knotweed is a herbaceous perennial that forms large clumps up to 13 feet tall (Seiger 1996). The smooth stems are stout and hollow like bamboo, and they show little branching (Seiger 1992). The leaves are broadly ovate, 2-6 inches long and taper to a point. The plants are dioecious (male and female flowers on separate plants), and bloom in late summer and early fall. The greenish-white flowers are very small, and are arranged in branched sprays from the leaf axils (Remaley 1998). When in full bloom, the plant has masses of flowers all along the stem. The seeds are held in winged, triangular, shiny black-brown achenes that are generally wind dispersed, but can also be dispersed by water and by transportation of fill dirt. The plant also produces long rhizomes (up to 20 m in length) that allow the plant to spread quickly locally, and when rhizome fragments are transported to new sites they can initiate a new population (Seiger 1992).

Habitat

Japanese knotweed tolerates a wide range of soil types, pH levels, and nutrient levels (Seiger 1992). It prefers open areas, but can tolerate shade (Vermont IEPFSS 1998; TN EPPC 1998). It has become a characteristic species of floodplain forests throughout northern New Jersey and the Inner Coastal Plain. It typically forms dense monocultures along the banks of rivers and streams. It also grows on the margins of ponds and lakes, open woods and thickets, meadows and successional fields. It invades disturbed areas, such as ditches, roadsides, dredge spoils, and recently cleared or filled areas. Once established, it quickly spreads into moist or damp soils in adjacent undisturbed natural plant communities.

Distribution

Japanese knotweed is indigenous to eastern Asia, and was introduced to the United States as an ornamental before 1890 (Seiger 1992; TN EPPC 1998). It is now widespread across the United States, and is considered invasive in at least nine eastern states. It is also invasive in the United Kingdom, where it is prohibited to introduce the plant into the wild (Seiger 1992). In New Jersey, Japanese knotweed has been collected (based on specimens at PH) from Atlantic, Bergen, Burlington, Camden, Cape May, Gloucester, Mercer, Monmouth, Ocean, Somerset, and Warren counties. It is also reported in Essex, Hudson, Hunterdon, Middlesex, Salem, Sussex, and Union counties (Hough 1983; Snyder personal observation). It occurs throughout New Jersey's physiographic provinces, but is especially abundant in the Delaware River drainage.

Threats

The early spring emergence of Japanese knotweed, and its dense growth, prevent indigenous species from establishing, in turn reducing species diversity and wildlife habitat (Vermont IEPFSS 1998). Because Japanese knotweed favors damp areas and areas that have

been disturbed, riparian corridors are particularly at risk (Vermont IEPFSS 1998). It can cause flooding by decreasing water flow through stream channels (Seiger 1996). Once established, it is extremely persistent (Remaley 1998).

Control

Natural areas should be monitored to prevent establishment of Japanese knotweed. Small stands can be controlled by repeatedly cutting the stems during the growing season, and by revegetating once knotweed growth is reduced (Seiger 1992). All plant parts should be removed from the site (TN EPPC 1998). Digging out rhizomes creates soil disturbance and may spread rhizome fragments (Seiger 1992). Shading with black plastic or shade cloth may also reduce growth. Large stands can be treated effectively with herbicides, but many of the most effective herbicides are nonselective and may persist in the soil. Chemical control is currently being tested at the Cheesequake Natural Area, in Middlesex County (R. Cartica, pers. comm.). Biological control agents are being investigated in Europe, but research is still in the early stages (Seiger 1992).

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Representative New Jersey Specimens Examined

Atlantic Co.: Small colony, sandy woods, 1 mi E of Devonshire, 4 October 1958, *J.W. and M.T. Adams 8786*, PH. **Bergen Co.:** Field, E of Schuyler Ave., North Arlington, 18 June 1970, *W. Sipple s.n.*, PH. **Burlington Co.:** Rubbish dump along Assicunk Creek, Burlington, 15 June 1950, *B. Long 71311*, PH; edge of woods, bank of Delaware River, Riverton, 10 September 1932, *F.J. Hermann 3800*, PH. **Camden Co.:** Open sandy shore of Delaware River, N of Delair, 22 October 1950, *B. Long 72551*, PH; Kaighn's Point, 10 September 1914, *C.D. Fretz s.n.*, PH. **Cape May Co.:** Waste places, Cape May, 5 September 1899, *O.H. Brown s.n.*, PH; abundantly naturalized on vacant lot, Cape May City, 6 August 1933, *B. Long 34966*, PH. **Gloucester Co.:**

Large colonies in old field, NW of Dilkesboro, 4 September 1937, *B. Long 51442*, PH; disturbed soil of embankment, road over Still Run, SW of Mickleton, 6 May 1919, *B. Long 20487*, PH; rubbish heap, woods along still Run, 1 mi SW of Mickleton, 22 September 1949, *B. Long 70173*, PH. **Mercer Co.:** Waste ground and rubbish heap along PRR., S of Laylor St., S of Trenton, 3 November 1949, *B. Long 70521*, PH. **Monmouth Co.:** Roadside thicket by head of Shoppen Run, 1 mi NNW of Cream Ridge, 13 September 1942, *B. Long 58649*, PH; sterile soil, 2 mi NE of Wickatunk, 27 August 1958, *V.L. Frazee s.n.*, PH. **Ocean Co.:** Naturalized about old ruined house, toward Cedar Creek, SW of Barnegat Park, 10 September 1919, *B. Long 22101*, PH; naturalized about old house site near Manasquan River, NW of Point Pleasant, 26 January 1941, *B. Long 55921*, PH. **Somerset Co.:** Moist soil along ditch, Watchung, 26 August 1930, *H.N. Moldenke 1369*, PH; hedgerow, Watchung, 10 September 1935, *H.N. Moldenke 8255*, PH. **Warren Co.:** Alluvium, 1 mi NW of Carpentersville, 24 August 1948, *R.L. Schaeffer, Jr. 30073*, PH.

Polygonum perfoliatum L.
(mile-a-minute)

Description

Mile-a-minute grows as an annual vine, climbing up to 20 feet in height (Mountain 1989). Its rapid growth--up to a half a foot per day-- accounts for its common name. The leaves are bright green and triangular, from 1-3 inches wide. Both the leaves and stems have short spines and prickles. The pea-size fruits are blue in color, and mature in late summer. The seeds are dispersed by birds, rodents, and water. It can be distinguished from other species of *Polygonum* by its triangle-shaped leaves and the flaring, saucer-shaped sheath at the base of each leaf (Virginia NHP 1998).

Habitat

In New Jersey, mile-a-minute has been collected from dredge spoil (see specimen citation below) and from damp soil at the edge of wooded thickets, old fields, meadows, forest edges, and railroad and highway right-of-ways (D. Snyder, private herbarium). The species can climb to heights of 15 feet or more (D. Snyder, personal observation. Typical habitats in adjacent Pennsylvania also include nurseries, reforestation clear-cuts, utility right-of-ways, meadows and stream banks (Mountain 1989). Mile-a-minute establishes quickly on damp disturbed ground where there is plenty of sun, but it also grows in shadier habitats where the leaf litter keeps the ground damp. In Gloucester County, New Jersey, the species has been observed flowering and fruiting in full shade of a closed canopy red maple-black gum forest (D. Snyder, personal observation).

Distribution

Indigenous to Japan, mile-a-minute was introduced accidentally into Pennsylvania in the 1940's, apparently as a contaminant in imported holly seeds and its subsequent spread may be, at least in part, as a soil contaminant in nursery grown rhododendrons (Hickman and Hickman 1978; Rhoads 1999). It has spread north into New York State, west to Ohio, and south to North Carolina (Kartesz 1999). There are apparently disjunct occurrences reported from Mississippi, Oregon, and British Columbia, Canada (Kartesz 1999; USDA 1998). It is considered invasive in Delaware, Maryland, New York, North Carolina, Ohio, Pennsylvania, and Virginia. In New Jersey, the only collections seen were from Salem (see specimen cited below) and Gloucester, Mercer, and Monmouth counties (D. Snyder, private herbarium). It has recently been reported from Union County (Misseck 2000) and there are unvouchered reports from Burlington County (Wycoff 1998), Bergen County (K. Anderson, pers. comm.), and from several locations in central New Jersey (F. Yoder, pers. comm.). At present, the species reaches its greatest abundance in the Delaware River valley in Gloucester and Salem counties where some infestations occupy an acre or more of old field habitat.

Threats

The rapid and dense growth of mile-a-minute allows it to overtake native vegetation, smothering seedlings and outcompeting mature plants (Virginia NHP 1998; USDA 1992). Large infestations significantly alter the structure of natural plant communities and ultimately reduce biodiversity. Within the last decade, mile-a-minute has rapidly become a significant pest in several locations along the Delaware River in Gloucester and Salem counties (D. Snyder, personal observation) and in the Watchung Reservation, Union County (Misseck 2000). It is of particular concern in wet meadows that may harbor rare wetland plants (Virginia NHP 1998). A Gloucester County population of the state listed endangered Lancaster sedge (*Cyperus lancastriensis*) was destroyed within the span of a decade when its habitat was overrun and smothered by mile-a-minute (D. Snyder, personal observation). It is also weed of gardens and landscaped yards. It has the potential to become a serious pest in agricultural lands (D. Snyder, personal observation).

Control

Mile-a-minute can be hand-pulled (wearing gloves) from small areas before they set seed, and before they grow so much as to overtake other vegetation (Virginia NHP 1998). The plants lack deep-seated roots and are fairly easy to pull. Mowing or weed whacking is effective as long as it is done prior to fruiting (Mountain 1989). Removing thick litter layers may also help to control the spread of the plant. Heavily infested areas can be treated with herbicides before the plants go to seed. Herbicides should be used with caution as they can harm co-occurring indigenous plants. Research on a biological control agent (a beetle, *Rhinoncomimus latipes*) is underway at the University of Delaware (L. Morse, pers. comm.). Because mile-a-minute is apparently not yet widespread in New Jersey, successful control may be relatively easily achieved if aggressively pursued.

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Representative New Jersey Specimens Examined

Salem Co.: Along access road to spoil banks, W of Rt. 130 and S of Rt. 602, Oldman's Twp., 27 September 1991, *J. Courtney s.n.,* PH.

Potamogeton crispus L.
(curly leaf pondweed)

Description

Curly leaf pondweed grows as a submersed, perennial aquatic plant (Vermont IPEFSS 1998; Lorenzi and Jeffery 1987). The reddish-green, alternate leaves are wavy, with finely toothed margins (Vermont IPEFSS 1998). Leaves grow to be 2-3 inches long and 1.5 inches wide. The stems are smooth and somewhat flattened. Flowers are small and inconspicuous, arranged on dense spikes attached to the stems. Plants produce seeds in midsummer, but they do not play a big role in the dispersal of the plant. Dispersal is mostly by burr-like winter buds called turions that drop to the sediment and germinate the following year (Vermont IPEFSS 1998).

Habitat

Curly leaf pondweed can occupy a range of aquatic habitats (Vermont IPEFSS 1998). It grows best in alkaline or nutrient-rich water. It occurs in freshwater lakes, ponds, rivers and streams, and in slightly brackish water, in both shallow and deep water (12 feet deep or more). Pondweed is tolerant of low light and low water temperatures. In New Jersey it has been collected from rivers, creeks, lakes, ponds, and marl pits (see specimens cited).

Distribution

Curly leaf pondweed is indigenous to Eurasia, Africa and Australia (Vermont IEPFSS 1998). In the United States it was probably first introduced to the East Coast; the earliest dated specimen having been collected from Philadelphia, Pennsylvania in 1841 or 1842 (Tehon 1929). The species now occurs in almost every state (USDA 1998). It is considered invasive in the eastern United States in CT, MA, NY, PA, TN, and VT. In New Jersey, the collected range (based on specimens at PH) is Burlington, Camden, Hunterdon, Mercer, Salem, and Warren counties. It is also reported from Middlesex, Morris, Sussex, and Union counties (Hough 1983). It occurs in most of the major watersheds of New Jersey. In 1880, it was noted that *Potamogeton crispus* was so abundant at one locality in Union County "as to choke up the stream" (Tweedy 1880).

Threats

Curly leaf pondweed begins to grow earlier in spring than most other aquatic species, and forms dense beds that can outshade and outcompete native aquatics (Vermont IPEFSS 1998). The dense mats of pondweed also disrupt boating, swimming, and fishing.

Control

Mechanical removal and herbicides have been used with varying degrees of success (Vermont IPEFSS 1998). Herbicides should be used cautiously as they could harm indigenous aquatic plants and other aquatic organisms.

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Representative New Jersey Specimens Examined

Burlington Co.: SW branch of Rancocas Creek, 0.75 miles NE of Marlton, 2 July 1937, *J.M. Fogg, Jr. 12254*, PH. **Camden Co.:** Camden, June 1870, *I.C. Martindale s.n.*, PH; S branch of Pensauken Creek, deep water in channel, Pensauken, 10 July 1926, *J.W. Adams & H.W. Trudell 377*, PH. **Hunterdon Co.:** Delaware River, shallow backwater among rocks, 0.9 km NW of Titusville, 17 June 1988, *M.E. Garback, K. Larsen, & A.E. Schuyler 7045*, PH; Raven Rock, 1886, *G.N. Best s.n.*, PH; Raritan River, shallow pool protected from current, 5 mi E of Clinton, 27 June 1972, *M.L. Roberts 2431*, PH; Spruce Run Reservoir, sand-silt in shallow water along W shore, near Clinton, 27 June 1972, *M.L. Roberts 2437*, PH. **Mercer Co.:** Trenton, 24 May 1887, *A.C. Apgar s.n.*, PH; Delaware River near mouth of Duck Creek, 15 October 1981, *R.W. Hastings s.n.*, PH; Assunpink Creek near US 1, below Bakersville, 31 October 1958, *G. Claus s.n.*, PH. **Salem Co.:** Marl pits, Woodstown, 20 May 1893, *B.J. Heritage s.n.*, PH; small pond on tributary to Fenwick Creek, 0.75 mi SW of Acton, 29 April 1936, *J.M. Fogg, Jr. 10224*, PH. **Warren Co.:** Millpond N of Green Pond, 22 May 1910, *H.W. Pretz 2470*, PH; Delaware River below Sandts Eddy and upstream from Marble Hill, 28 July 1988, *K. Larsen, T. Remaley & A.E. Schuyler 7066*, PH; Delaware River above Foul Rift, 31 August 1907, *S.S. Van Pelt s.n.*, PH.

Ranunculus ficaria L.
(lesser celandine)

Description

Lesser celandine is an annual herbaceous plant that grows in early spring (Swearingen 1999). It has glossy, dark green, rounded leaves arranged in a low-growing rosette with both fibrous and tuberously thickened roots. The leaves appear in late winter and die back by early June. Bright yellow buttercup-like flowers bloom in March and April, held above the leaves. Seeds mature by May, but reportedly are rarely formed (Rhoads 1999). Vegetative reproduction is by small underground tubers and by axillary bulblets formed on the stems. Both tubers and bulblets are readily dispersed during flooding events (Swearingen 1999).

Habitat

Lesser celandine is characteristic of moist alluvial soils in forested floodplains. It also invades grassy meadows, roadsides, lawns, and less frequently drier soils of embankments and open woodlands (D. Snyder, personal observation). The earliest New Jersey collection was collected from ship ballast (see specimen citations).

Distribution

Lesser celandine was introduced from Europe both deliberately as a garden plant (Rhoads 1999) and accidentally as contaminant in ship ballast (see specimens cited). In the eastern United States, lesser celandine occurs from New England west to Wisconsin and Missouri, then south to Tennessee and Virginia (Kartesz 1999). In the western United States it has been reported from Washington and Oregon (Kartesz 1999). It is also reported from Newfoundland, Quebec, Ontario, and British Columbia, Canada (Kartesz 1999). In New Jersey, lesser celandine has been either undercollected, or its current widespread distribution has been achieved in the later part of the 20th century. It was first collected in New Jersey in 1898. Starting in 1932, and continuing through the 1970s, lesser celandine was collected at least once a decade (Snyder 1987). In a survey conducted by Snyder 1987) in 1982, lesser celandine was found to be rampant throughout the Raritan River drainage and other locations in central New Jersey. Its collected range in New Jersey is Burlington, Camden, Hunterdon, Middlesex, Somerset, Union, and Warren counties (Snyder 1987). It is also reported for Mercer and Salem counties by Snyder (1987), Monmouth County by Hough (1983), and Essex County (Glenn and Dutton 1996). It occurs mostly in the Piedmont and Inner Coastal Plain physiographic provinces.

Threats

The invasive nature of lesser celandine was first reported by Snyder (1987) who noted that it was "aggressive and spreads rapidly once established" and that it has "already become a serious pest in some areas of New Jersey." Lesser celandine forms near monocultures of extensive acreage (Rhoads 1999; Snyder 1987) in the early spring. Because of its early emergence and aggressive nature, lesser celandine poses a serious threat to indigenous spring

ephemerals (Rhoads 1999; Swearingen 1999). It has significantly altered the structure of natural plant communities.

Control

Small infestations can be dug up, taking care to remove all the tubers and bulblets, but for larger populations, digging may create too much soil disturbance (Swearingen 1999). Herbicides can be used as soon as the leaves appear, but before when indigenous plants begin to grow. Herbicides should be used very cautiously to avoid harming indigenous plant and amphibian populations.

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Representative New Jersey Specimens Examined

Burlington Co.: Moorestown, 16 April 1932, *J. Stokes s.n.*, PH; **Camden Co:** Ballast, Kaighn's Point, 23 April 1898, *C.F. Saunders, s.n.,* PH.

Rhamnus cathartica L.
(common buckthorn)

Description

Common buckthorn is a deciduous shrub or small tree that can grow up to 20 feet high (Converse 1998; Vermont IEPFSS 1998). The leaves (1-2.5 inches long) are dull green, smooth, and oblong in shape with very finely toothed edges (Converse 1998). The leaves are arranged nearly opposite along the stem (Vermont IEPFSS 1998). First year seedlings have two heart-shaped leaves (Samuels 1996). Gray-black bark and twigs have prominent raised patches (lenticels) and the twigs can be tipped with sharp thorns (Converse 1998; Vermont IEPFSS 1998). Buckthorn bears fragrant greenish-yellow flowers in spring. The four-petaled flowers are borne in umbrella shaped clusters (umbels) along the stem, from the leaf axils (Converse 1998). The black fruits ripen in fall, and are small and round, each containing 3-4 seeds (Converse 1998; Vermont IEPFSS 1998). The fruits persist on the plants throughout much of the winter (Vermont IEPFSS 1998). Birds are the primary dispersers of the seeds. Dry fruits and seeds can also float for several days, and water dispersal may be important in areas with extensive fall and winter flooding (Converse 1998).

Habitat

Buckthorn occurs in a variety of habitats including woodlands, fields, and roadsides (Vermont IEPFSS 1998; Samuels 1996). It prefers alkaline soils, but is not limited to them (Converse 1998). Although widely in scattered in northern New Jersey, the species has been undercollected and habitat information is poorly known. In New Jersey, it has been observed or collected from roadside thickets, fence rows, waste ground, and in upland woods and thickets over traprock. It occurs in floodplain forests and margins of sinkhole ponds. It appears to be most frequent along the edges of calcareous fens and in open woods adjacent to the fens (D. Snyder, personal observation).

Distribution

Common buckthorn is indigenous to Eurasia, and was brought to the United States primarily to use in shelter belt plantings (Samuels 1996). It is now widespread in North America from Nova Scotia to Saskatchewan, south to Missouri, and east to Virginia (Converse 1998). The collected range in New Jersey includes Sussex County (see specimen cited), but Hough (1983) also reports it from Camden, Hunterdon, Mercer, Middlesex, and Somerset counties. It inhabits a range of physiographic provinces including the Ridge and Valley, Piedmont, and Inner Coastal Plain provinces. It is especially abundant in the Wallkill River valley in Sussex County and other areas in Sussex and Warren counties that are underlain by dolomites and limestones (D. Snyder, personal observation). This species appears to be undergoing a rapid population explosion in the northern part of the state.

Threats

Because of its long growing season and rapid growth rate, common buckthorn poses a serious threat to indigenous vegetation (Converse1998). It can rapidly form dense thickets that outcompete indigenous plants for light and other resources. All parts of the plant are poisonous to humans if ingested, and the plants are an alternate host for the fungus that causes oat rust (Samuels 1996).

Control

Seedlings are easily pulled by hand (Samuels 1996). Mature shrubs or trees can be cut repeatedly, or treated with herbicide after cutting (Converse 1998; Vermont IEPFSS 1998). Herbicides could harm indigenous co-occurring plants. In open areas, mowing can keep seedlings from establishing.

Literature Cited and Other Sources of Information

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Hough, M. Y. 1983. New Jersey Wild Plants. Harmony Press, Harmony.

Samuels, A. 1996. *Rhamnus cathartica*. *In* J.M. Randall and J. Marinelli (eds.), Invasive Plants, Weeds of the Global Garden. Brooklyn Botanic Garden, Inc., Brooklyn.

Vermont Invasive Exotic Plant Fact Sheet Series. 1998. Department of Environmental Conservation and Department of Fish and Wildlife, Vermont Agency of Natural Resources and The Nature Conservancy of Vermont.

Representative New Jersey Specimens Examined

Sussex Co.: Fence row, Montague, 16 June 1884, *H.H. Rusby & N. L. Britton s.n.*, PH.

Robinia pseudoacacia L.
(black locust)

Description

Black locust is a fast growing deciduous tree, growing up to 80 feet tall (Sargent 1922; Converse 1998; Hunter 1996). Older trees have dark brown deeply furrowed bark, and the branches usually have stout spines. The compound leaves are alternately arranged, with 7-21 elliptical leaflets. The fragrant white flowers, which are blotched with yellow at the base, are borne in drooping clusters in late May and early June. Red-brown 3-4 inch long pods develop during the summer. The seeds are reported to be viable in the soil for a minimum of 88 years (Haynes 1956). Seedlings grow rapidly and are easily identified by the presence of long paired thorns (Wieseler 1998). Trees reproduce vegetatively through extensively spreading underground runners.

Habitat

In the southern and central Appalachian Mountains, where black locust is indigenous, trees grow singly or in small groups in forests and woodlands at altitudes up to 3,500 feet (Sargent 1922; Weakley 2000). In New Jersey, black locust is abundant in successional or disturbed habitats such as old fields, roadsides, hedge-rows, railroad and utility right-of ways, waste ground, fallow agricultural fields, and dredge spoils. It also invades and readily establishes in natural plant communities such as floodplain forests and rivershores, greensand marl ravines, grasslands, and pine and oak woods (see specimen citations; D. Snyder, personal observation).

Distribution

The indigenous historic range of black locust was primarily along the Appalachian Mountains and the Ozarks. The species is now so widespread in the northeastern states, it is sometimes mistakenly considered as indigenous. Darlington (1853) in his flora of Chester County, Pennsylvania, noted, "This tree—so common in our mountains, and so valuable for its durable timber—is naturalized in many places, --and often cultivated; but it has never appeared to me as truly indigenous, in this County." Britton and Brown (1913) report the indigenous range as: "Monroe Co., Pa, south, especially along the western slopes of the mountains, to Georgia, west to Iowa, Missouri and Oklahoma. Extensively naturalized elsewhere in the United States and eastern Canada and in Europe." Valued for it durable wood, black locust was planted widely across the United States, and now occurs in all states except Alaska and Hawaii (Kartesz 1999; USDA 1998). On the East Coast it is considered invasive in MA, NY, and VT. The collected range (based on specimens at PH) in New Jersey is Burlington, Camden, Cape May, Gloucester, Hunterdon, Mercer, Monmouth, Ocean, Salem, and Warren counties. It is also reported as occurring in Bergen, Essex, Middlesex, Morris, Passaic, Somerset, Union, and Sussex counties (Hough 1983; Clemants and Glenn 1999). It occurs in all physiographic provinces.

Threats

The New Jersey Forest Service describes black locust as, "one of the most aggressive successional species in New Jersey" (Martine 1998). Black locust creates dense stands in open habitats such as old fields and grasslands, where it alters the process of natural succession and displaces indigenous plant species (Hunter 1996; D. Snyder, personal observation). In riparian habitats, especially floodplain forests, it can become dominant in the overstory. Because black locust is a nitrogen fixing plant, it may change the available soil nutrients in plant communities (Converse 1998). The seeds, leaves and bark are toxic to humans and livestock (Hunter 1996).

Control

Mowing and burning are not effective because they tend to increase suckering and root sprouting (Converse 1998). Freshly cut stumps can be painted with a systemic herbicide that will enter the root system (Converse 1998; Wieseler 1998), but herbicides leaching out of the root system could harm indigenous plants. Treated stumps should be monitored for several years (Wieseler 1998).

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Representative New Jersey Specimens Examined

Burlington Co.: Naturalized about old clearings, Calico, 28 July 1937, *B. Long 50913*, PH; N side Mt. Holly, 27 June 1922, *H.B. Meredith s.n.*, PH. **Camden Co:** Thickets, along Cooper Creek, N of Haddonfield, 17 April 1914, *B. Long 9516*, PH; Kresson Rd., 3 mi E of Haddonfield, 15 May 1938, *L.P. Hynes s.n.*, PH. **Cape May Co.:** Cape May Court House, 12 Ausgust 1918, *O.H. Brown s.n.*, PH; abundant along field margin, 1 mi N of Fishing Creek, 31 July 1941, *W.M. Benner 9678*, PH. **Gloucester Co.:** Mantua Twp., 29 May 1870, *C.P. Burrough s.n.*, PH; Swedesboro, 30 May 1892, *C.D. Lippencott s.n.*, PH; abundant in dry, sandy old field, N of Jefferson, 26 March 1937, *B. Long 49692*, PH. **Hunterdon Co.:** Margin of gravelly thicket, shore of Delaware River, Treasure Island, 21 May 1933, *B. Long 39977*, PH. **Mercer Co.:** Princeton Junction, 29 May 1906, *E.B. Bartram s.n.*, PH; Rocky Hill, 3 June 1885, *J.E. Peters s.n.*, PH. **Monmouth Co.:** Naturalized in pine and oak woods from old house site, 0.5 mi E of Charleston Springs, 29 May 1938, *B. Long 52217*, PH; roadside and hedge rows, Allenwood, 20 May 1953, *V.L. Frazee s.n.*, PH. **Ocean Co.:** New Egypt, 28 May 1908, *J.H. Grove 644*, PH; abundant on roadside, fields and woods, SW of Prospertown, 7 June 1924, *B. Long 30594*, PH. **Salem Co.:** Sandy thickets, N end artificial island, 4 mi W of Hancocks Bridge, 23 October 1934, *J.M. Fogg, Jr. 7785*, PH. **Warren Co.:** Alluvium, 1-2 mi S of Carpentersville, 12 July 1948, *R.L. Schaeffer, Jr. 27963*, PH.

Rosa multiflora Thunb.
(multiflora rose)

Description

Multiflora rose grows as a thorny perennial shrub with arched canes (Eckardt 1987) but can also sprawl or climb in trees 10 feet or more (Gleason and Cronquist 1991; D. Snyder, personal observation). The compound leaves are divided into 4-11 oval leaflets with toothed margins. The leaves are arranged alternately along the stems. Multiflora rose flowers in spring and early summer with clusters of white to pinkish-white flowers. The fruits, or rose hips, mature in fall, turning bright red. A single bush is capable of producing up to a million seeds in one season (TN EPPC 1998). The seeds are dispersed by many species of birds and by other animals. The seeds are reported to remain viable for many years, perhaps as long as 10-20 years (Eckardt 1987; TN EPPC 1998). Multiflora rose also reproduces vegetatively from root sprouts and from the rooting of the tips of the canes (Eckardt 1987).

Habitat

Multiflora rose occurs abundantly in disturbed or successional habitats like fields, roadsides, railroad and utility rights-of-way, old home sites, thickets, and agricultural lands. It also invades natural plant communities like floodplain forests, calcareous fens, grasslands, and forest gaps. Most early collections have come from woods, roadsides, and other disturbed areas.

Distribution

Multiflora rose was introduced from Asia in the late 1800s as an understock for ornamental roses (Eckardt 1987). It has been widely planted as living fences to contain livestock, as wildlife cover, and used in soil conservation and highway projects (Eckardt 1987). It occurs throughout the eastern and central United States and Canada, and also in Washington, Oregon, and California (Kartesz 1999). Virginia and North Carolina both designate multiflora rose as a noxious weed, and most eastern states consider it invasive. The collected range (based on specimens at PH) in New Jersey is Cumberland, Gloucester, Mercer, Middlesex, Monmouth, Ocean, Passaic, and Warren counties. It is also reported in Cape May, Hunterdon, and Somerset counties (Hough 1983). The species, like most widespread nonindigenous plants species occurring in New Jersey, is poorly represented in herbaria (D. Snyder, personal observation). A more accurate depiction of its distribution in the state is presented in Clements and Glenn (1999), where more than 150 locations are mapped in northern and central New Jersey. It occurs in all of New Jersey's physiographic provinces.

Threats

Multiflora rose can produce dense, impenetrable monocultures that exclude indigenous plants and restrict the movement of some animals (Eckardt 1987). It is a strong competitor for below-ground resources, inhibiting the growth of indigenous plant species and also commercial crops in adjacent agricultural fields (Eckardt 1987). It is tolerant of some shade, and of a range

of moisture conditions, enabling it to invade a variety of natural plant communities. It significantly alters natural plant community structures and reduces overall biological diversity.

Control

Repeated mowing or cutting can be used to control the spread of small populations, but will not eradicate them (Eckardt 1987) since multiflora rose can resprout from stumps. Small plants can be dug out, provided the entire root is removed (Virginia NHP 1998). Plant growth regulators have been used effectively to prevent plantings from spreading, and herbicides can be used to kill plants (Eckardt 1987). Herbicides should be used with caution, as they could harm indigenous plants. Several potential biological control agents are under investigation (Eckardt 1987).

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Representative New Jersey Specimens Examined

Cumberland Co.: Edge of dirt road, Fostescue Glades Wildlife Refuge, 2.5 km [near] Newport, 7 June 1983, *S. Heckscher s.n.*, PH; along old earth road through woods, Shiloh, 30 May 1933, *B. Long 40140, PH.* **Gloucester Co.:** Open ground, dry bushy field, S of Sewell, 6 June 1920, *B. Long 23088*, PH. **Mercer Co.:** Thicket, 1 mi S of Ewingville, 1 November 1954, *W.L. Dix s.n.*, PH. **Middlesex Co.:** Thicket near rubbish dump, 1 mi NE of Cranbury, 29 July 1951, *B. Long 73797*, PH; open thicket along NJ Rt. 20, SW of New Brunswick, 3 June 1951, *B. Long 73250*, PH. **Monmouth Co.:** Ravine by Crosswicks Creek, rich wooded slope, 2 mi SW of Hornerstown, 14 April 1949, *B. Long 68879*, PH; naturalized on roadside bank, 1 mi W of Cream Ridge, 25 May 1941, *B. Long 56678*, PH. **Ocean Co.:** About old house site, E of Manahawkin, 21 August 1923, *B. Long 28842*, PH. **Passaic Co.:** Old quarry, just W of Patterson, 10 July 1949, *R.L. Schaeffer, Jr. 31089*, PH. **Warren Co.:** Fallow slope, 1 mi N of Sarepta, 23 July 1959, *R.L. Schaeffer, Jr. 59299*, PH; woods, 1 mi W of Oxford furnace, 15 August 1950, *R.L. Schaeffer, Jr. 34225*, PH.

Rubus phoenicolasius Maxim
(wineberry)

Description

Wineberry grows from biennial arching canes, which reach up to 2 m long. The leaves are divided into three leaflets whose undersides are covered in small, dense white hairs. The stems and buds are covered by dense 3-5 mm long purple hairs, which give the stems a shaggy appearance (Gleason and Cronquist 1991). The five-petaled flowers are white and bloom in late spring to early summer. The fruits mature in mid to late summer (Hough 1983). Fruits are red, juicy berries dispersed by birds and other animals.

Habitat

Wineberry is frequent in open or disturbed habitats such as thickets, fields, and forest edges, railroad and utility rights-of-way, and old homesites. It also successfully invades wooded ravines, floodplain forests, calcareous forests, shale bluffs, and traprock and diabase forests.

Distribution

Wineberry was introduced into the eastern United States from Asia (Fernald 1950). Originally grown in cultivation, wineberry is now widespread throughout the Eastern United States were it occurs from Vermont south to Georgia, and west to Arkansas (Kartesz 1999; USDA 1998). The collected range (based on specimens at PH) in New Jersey is Burlington, Camden, Cape May, Cumberland, Hunterdon, Mercer, Sussex, and Warren counties. It is also reported from Bergen, Essex, Hudson, Middlesex, Monmouth, Passaic, Somerset and Union counties (Hough 1983; Clemants and Glenn 1999). It occurs throughout New Jersey's physiographic provinces, but reaches its greatest abundance in the Piedmont, Highlands, and Ridge and Valley provinces (D. Snyder, personal observation).

Threats

Wineberry forms an extensive, nearly impenetrable understory layer in favorable locations such as moist soils in forests over dolomite, marble, shale, diabase, and traprock (D. Snyder, personal observation). These substrates are known to support several rare plant communities and unique plant assemblages. Thickets of wineberry alter the structure of natural plant communities, outcompete rare or declining plant species, and contribute to the loss of biological diversity. In the Piedmont and the Kittatinny limestone valley of the Ridge and Valley Province, wineberry frequently occurs with the invasive nonindigenous species Japanese barberry (*Berberis thunburgii*), Japanese honeysuckle (*Lonicera japonica*), and Japanese stiltgrass (*Microstegium vimineum*) (D. Snyder, personal observation). Such wholly unnatural plant associations can dominate an acre or more of woodland, with an obvious reduction in the diversity of indigenous understory and herbaceous species. Bailey (1932) reported that wineberry, in association with Japanese honeysuckle and the nonindigenous invasive tree-of-heaven, had completely altered the habitat at the type locality of a rare indigenous species of

blackberry in Monmouth County, New Jersey, and was directly contributing to the species decline.

Control

There is currently no control information specific to wineberry, but other *Rubus* species are controlled mechanically and with herbicides (Hoshovsky 1998). Small plants can be hand-pulled, and larger plants can be dug out. It is important to remove the root crown, as plants will resprout from the crown. Root crowns and stumps can also be treated with herbicides if left in the ground, but herbicides can harm adjacent indigenous plants.

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United States Department of Agriculture. 1998. *Rubus phoenicolasius*. Natural Resources Conservation Service. Available online: http://plants.usda.gov/plantproj/plants/plntmenu.html.

Representative New Jersey Specimens Examined

Burlington Co.: Ravine along Delaware River, Florence, 22 June 1924, *R.R. Dreisbach 2197*, PH; moist wooded slope back of PRR Station along brook tributary to Delaware River, Kinkora, 27 April 1917, *B. Long 15724*, PH. **Camden Co.:** Loamy wooded slope along streamlet tributary to S. Branch Timber Creek, NW of Blackwood, 13 October 1915, *B. Long 13866,* PH. **Cape May Co.:** Fence rows, Cold Spring, 27 September 1905, *O.H. Brown s.n.*, PH; waste ground, Cape May City, 15 July 1917, *W. Stone s.n.*, PH. **Cumberland Co.:** Bramble thicket edge of woods, W of Deerfield, 29 March 1934, *B. Long 42784*, PH; roadside below mill,

Seeley, 10 July 1941, *B. Long 56977*, PH. **Hunterdon Co.:** Abundant on Laport farm, Mountain Rd., East Amwell Twp., 14 June 1973, *E.A. Laport s.n.,* PH; High Bridge, 25 June 1902; *H.L. Fisher s.n.*, PH. **Mercer Co.:** Margin of open woods, 1 mi NW of Pennington, 30 June 1937, *W.M. Benner 7876*, PH; 2 mi SW of Princeton, 19 June 1938, *L.P. Hynes s.n.*, PH. **Sussex Co.:** Newton, 7 July 1907, *C. S. Williamson s.n.,* PH. **Warren Co.:** Alluvial woods, 1 mi SW Belvidere, 30 July 1948, *R.L. Schaeffer, Jr. 35515*, PH; woods, 1 mi SE of Hazen, 22 June 1951, *R.L. Schaeffer, Jr. 35515*, PH.