

New England Wild Flower

Conservation Notes of the New England Wild Flower Society

invaders

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Front Cover: "Purple Loosestrife & Cattail – William Larkin

Back Cover: "Oriental Bittersweet" – John A. Lynch

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New England Wild Flower

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Conservation Notes of the New England Wild Flower Society

Featuring: "Invaders"

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—The Editors

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Editor's Note: Normally, when we have a chance to share our wonderful images and showcase the talented photographers who donate some of their best work to the New England Wild Flower Society, we try to pick the most attractive representations of each plant and scene. But in the case of invasive non-native plants, we faced a dilemma: did we really want to present these plants, these scenes in an appealing light? Wouldn't that defeat our whole purpose? We were afraid that if we used the best-looking images available, the publication would seem like a tantalizing nursery catalogue. Then we realized that was really the point; many of these invaders were originally introduced as garden plants and are beautiful and useful in themselves. Often, those are the very qualities that let them get a foothold here in the first place. In fact, a surprising number of them are still sold and planted today. So no apologies for the "beautiful beasts" you'll see on these pages. We're not trying to convince you that these plants are ugly or evil, only that their unchecked growth can have a devastating effect on our native plants and their natural habitats. Once you learn to spot them in landscapes of your own, we think it will open your eyes to the troubling tangles beneath the enticing green surface.

Scientific names for the plants mentioned in this publication follow Gleason & Cronquist's *Manual of Vascular Plants, Second Edition* (1991)

Note to New England's Policy Makers

Few conservation challenges are as critical as the problem of non-native invasive plants, yet this matter has so far received little attention from New England's regional policy makers. Non-native invasive plant species threaten to overtake native plants in many of their habitats, but New England lags behind much of the rest of the nation in addressing this serious concern.

The New England Wild Flower Society's goal in this special edition of its *Conservation Journal* is to propel the problem of invasive plants into the public policy spotlight in order to stimulate long-range conservation awareness and action. We hope that this publication will set the stage for a coordinated regional approach to the invasive non-native plant issue. We will touch on some alternatives and possible solutions, but essentially our objective is to make New England's environmental policy makers aware of the extent of the problem and the many points of view involved.

New England's policy and decision-makers face a difficult task. Choosing among competing environmental imperatives involves painful trade-offs. The issues can seem overwhelming, and effective action will require understanding, collaboration, and coordination among many government agencies, nonprofit organizations, and commercial enterprises. Considerable costs are involved in effecting the removal of invasive plant species and, in many cases, the restoration of habitats. These real dollar costs become greater with every year that we ignore the problem. How will these mitigations be paid for? Who will bear the cost? What value can we place on our New England landscapes and plant diversity?

This publication was prepared with the support of the members of the New England Wild Flower Society, and of the Ellis L. Phillips Foundation. Because of their generosity, we will be able to mail a copy of this edition of *New England Wild Flower Conservation Notes* to every state legislator in New England and key environmental administrators in each New England state. In addition, we will make this publication available to land trusts, highway departments, conservation commissions, and other concerned organizations.

— David L. DeKing, Executive Director
New England Wild Flower Society

Front Cover Notes



"Loosestrife K.O.s Cattail" — This cartoon by illustrator Gordon Morrison makes a humorous point, but the implications are far from funny. As the front cover photograph by William Larkin illustrates, native wetland species such as Cattail are in serious danger of being overwhelmed by non-native invasive plants like Purple Loosestrife, an introduction from Eurasia. For more on Purple Loosestrife, see page 29.

I have always thought that “endangered species” should be added to religion and politics on the list of topics unsuitable for dinner conversation. As we approach the millennium, I would now add “invasive exotic plants” to the list of unmentionables. Plant professionals usually have strong opinions on this subject, and the views of some gardeners about these thugs of the plant world are unprintable in this journal. It seems that almost everybody has had some personal experience with changes caused by an invasive plant, either in the garden or in the larger landscape. These experiences instill deeply held convictions, which tend to polarize our conversations.

The published statistics on the potential impact of invasive plants are indeed frightening:

- Invasive plants already cover over 100 million acres and continue to increase by 8 to 20 percent annually — an annual increase in area equal to twice the size of the state of Delaware.
- Our public natural areas are being lost at an estimated rate of 4,600 acres per day to invasive species.
- The Nature Conservancy estimates that 42% of the declines of threatened and endangered species in the U.S. are partly due to the effects of invasive species.

Yet there is little unanimity over the scope of the problem or the solutions. Perhaps this is because the exotic species controversy is really about ourselves — about humans and our role in shaping the landscape of the earth — a subject with which many of us are uncomfortable.

In this issue of *New England Wild Flower: Conservation Notes*, we have tried to present a primer on the topic of Invasive Non-Native Species, complete with the biology of invasiveness (traits that made invasive species so successful), a “Rogues’ Gallery” of important invasive species in our area, and personal anecdotes from workers in the field and senior naturalists who have watched the pace of change increase over the years. We will discuss the controversies surrounding this very divisive topic and, we hope, present some possible solutions.

Defining The Problem

“Native plants” are generally thought of as those species existing here (assuming that *here* is the U.S.) before the advent of the Europeans. “Invasive exotic species” are those non-native species that invade and alter both natural and managed areas. By these broad definitions, which are themselves disputed, there are many exotic species in this country, but only a few of them are considered invasive. For example, although one-third of the 3000 species listed in Seymour’s (1969) *Flora of New England* are not native to our region, most, even if ubiquitous in the landscape, cause little concern among biologists. On the other hand, a few species, when released from the natural controls present in their region of origin (usually Europe or Asia) threaten to overwhelm our landscape, alter our ecosystems, and change the face of New England.

Controversy In A Capsule

Here is a brief summary of some of the dialog from both sides of the issue, and, from my perspective, the fundamental reasons for trying to stem the tide of exotic invasions.

Controversy 1: Native vs. Non-native?

Native plant enthusiasts argue that native plants are better

William Brumback is Conservation Director of the New England Wild Flower Society. He has worked in the conservation field for 20 years.



New England's

adapted, more appropriate, and more ecologically suited to our area than exotics. Supporters of horticulturally useful invasive exotic species have argued that these plants were brought here by people and, like people, can be considered part of the natural evolutionary spread of a species. They also argue that some exotic species are filling gaps where native plants are not able to thrive — urban streets being a prime example. But as long as our landscape is green, most people don't care whether the plants they see are “native” or “exotic.” And what about native plants anyway? Aren't some of them invasive too?

Although some native species have invasive tendencies, few native species are considered troublesome in the long-run within their own range. Natural succession — the progress of meadow to woodland or pond to marsh — by changing conditions and fostering competition, is enough to prevent one species from dominating a habitat.

Relatively few natives from one region of the contiguous U.S. have become problems in other regions where they are not native. There are exceptions, such as Black Locust (*Robinia pseudoacacia*), a native of the southern U.S. that has escaped from cultivation and become a problem in parts of New England. Or a native New England cord grass, *Spartina alterniflora*, that was intentionally planted by the Army Corps of Engineers in California to hold sand dunes in place, but has apparently been so successful that it eliminates other species in that dune community.

But it would be difficult to name a dozen native U.S. species that are problems in other regions of the country. It's a lot easier to name exotic problem plants, especially Asian plants, which may be successful here due to the climatic similarities and biogeographic relationships of the east coasts of Asia and North America. And, to be fair, we have no idea how many U.S. plants are problems in other parts of the world, especially Japan.

Controversy 2: Personal Experience vs. The Larger Picture

When my brother-in-law first arrived in New England from Louisiana, he commented on the beauty of Purple Loosestrife in the wetlands, but by the end of his weekend trip he was saying, “You've got a problem.”

The same plant that is a devastating invasive in your region may not even be noticed in mine. When I look through lists of species purported to be invasive exotics in a New England state or the region as a whole, I almost always see one or two names that cause me to think, “That's not a problem; why is it on this

By William Brumback



list?"

Recently, when a specialist on invasive plants of the northwestern U.S. was telling me about the aggressive acts of Herb Robert (*Geranium robertianum*) in the natural areas of that region. I tried to defend the plant, which is listed in *Gray's Manual of Botany* as a native species. Countering my arguments, the northwest specialist informed me that in Gleason and Cronquist's (1991) *Manual of Vascular Plants* the plant is described as an introduced species. Even if it is introduced, I pleaded, it isn't a problem where I live. In New England it's a well-behaved denizen of rich, rocky woods, and shady ledges. I even view it as a good indicator of a rich, diverse natural habitat where rare species can also be found. It all depends on point of view.

Controversy 3: Ecology vs. Economy

Because nurseries and botanic gardens originally introduced, promoted, or currently make their living from selling many of the plants that are now considered pests, they tend to become defensive when the topic of invasiveness arises. Some even deny that any problem exists, especially when the suggestion is made that only native plants be used in modern landscaping. If you had 10,000 of a certain plant species growing in your nursery, you too might be a trifle irritated to be told that your investment was a terrible weed and shouldn't be sold. Understandably, some nursery owners demand proof that an exotic plant is a problem before ending its sale.

Either intentionally or unintentionally, humans have been moving plants all over the world for millennia, and I don't think

that our innate desire for the new, the improved, or the unusual is going to end anytime soon. Yet, it is time to take a look at the issues posed by exotic species in the horticultural trade. One source states that 50% the problem plant species invading this continent were brought here to beautify our gardens. Should we screen all plants coming into this country for invasive tendencies? Should we regulate which species can be sold in an at-risk area? [See page 11 for more about nurseries and botanical gardens.]

Controversy 4: Act Now or Wait for All the Facts?

It's a basic principle of nature that there are just so many niches in a habitat. When one species starts to dominate, something else is being lost, but hard data on both the abundance and effects of invasive exotics in natural areas is difficult to find. For this reason, some argue that conservationists are overreacting to the effect of invasive species.

Herbarium specimens, which form a permanent record of our flora collected over many years, should be the perfect resource to track the spread of invasive species to a new area, but unfortunately this record is often incomplete. Curators note that specimens of invasive exotics are greatly under-represented in proportion to their abundance on the landscape. This is probably because many botanists never think to collect these abundant invaders.

Invasive exotic plant species may cause many changes in a habitat, but we still lack full information on these changes. For example, Purple Loosestrife apparently makes poor nesting habitat for many birds, but we do not yet know what specific effects Purple Loosestrife infestation may have on individual plant or animal species. You don't need a Ph.D in Conservation Biology though, to see the Purple Loosestrife in a swamp that turns the color of Barney the Purple Dinosaur in July and August. Though more research is clearly needed, the pace of change and the potential for damage is too great to justify extended delay in beginning to take preventive measures.

The Bottom Line

Biodiversity

Although we do not know how many native species we need in order to maintain viable communities and ecosystems, it is important to maintain as much resilience and stability as possible by maintaining as much natural diversity as possible. This is essential for adaptability and a harmonious, fully functional ecology. Diversity protects whole systems from the potentially disastrous effects of disruption, both human and natural. As invasive plants take over, many of our natural communities are apparently becoming less diverse. Although documentation of these changes is lacking, and our ability to understand the effects to ecosystems is still very limited, we should not take the threat posed by invasive exotics lightly. History is full of ecological disasters caused by human neglect or hubris.

Because we understand so little of the long-term effects of invasive exotics on our ecosystems, we need to maintain natural areas that are minimally affected as reference points for native flora and for continued maintenance of basic ecosystem functions. In general, we must try to keep as many natural areas as possible free of invasive exotics. In some instances, the areas we have set aside as "conservation lands," including many state parks and town properties, are already too compromised in terms of species integrity to be included in a list of natural areas. For many of these lands, the expenditure of time, money, and effort to reclaim the property from exotic plants would be too great to warrant the attempt.

Don't get me wrong; many of these lands are certainly worth preserving as open space or for other public interests, but in terms of "natural areas," the biomass of the invasive exotic species can far outweigh the native plants. In other, relatively pristine places, however, the battle is just beginning, and it is in these areas, where the first skirmishes for the landscape are now underway, that we must be particularly vigilant. With invasive exotic plants, knowing when to fight and when to walk away is not only smart, but vital if we are to conserve the limited conservation resources we have. [See "Options for Control" on page 27.]

Landscape

What do we want our landscapes to be? What types of vegetation should surround us, in our own backyards, our towns, our states, or our regions? Does it matter if New England's vegetation looks like Japan's? To me, the varied landscapes of New England are signatures of the underlying local diversity — a source of vitality that deserves protection. Unfortunately, we are seeing more and more of the botanical equivalent of monoculture — the same kinds of trees, shrubs, and perennials, some of which are thought to be highly invasive, used over and over again in home or business landscapes throughout a region. Similarly, natural areas are being invaded by many of these same exotic species used in horticulture. The pictures introducing this article dramatically illustrate the contrast between a diverse natural woodland and a woodland dominated by an invasive, exotic plant species.

There can be little doubt that invasives are changing the face of our landscapes on a large scale. They may even be affecting our major native vegetation types, which are based on the dominant species typically found there. In New England, for example, the Oak-Hickory forest and the Beech-Maple woodland are two of the most prevalent vegetation types. If the course of these changes continues, we may have to add a couple of new types: the Oak-Hickory-Japanese Barberry forest or the Beech-Maple-Bush Honeysuckle woodland. Or how do you feel about about a Buttonbush-Purple Loosestrife swamp?

Some scientists have dubbed our current geologic epoch the "Homogocene," a humorous play on words that makes a serious point — the homogenization of the world's flora and fauna is a very real possibility. As humans have spread to occupy most of the earth, many plants used for horticulture and agriculture have spread with them, often with unintended effects on the native vegetation. It is time to examine these effects, come to grips with the real and potential threats to our ecosystems, and, if possible, develop a consensus to deal with the issue). We should learn how to identify non-native invasive plants. We must begin the documentation process that has been neglected. We must develop methods of control, and refine procedures for determining which new species may become invasive problems in the future. We must examine the effects of our horticulture programs, especially large scale planting by town, highway departments, and other governmental agencies because this is where our decisions may have the strongest impact. Although there may be no cumulative difference between 1,000 homeowners each planting a single specimen of an invasive exotic species, and one highway department planting 1,000 of the same species, it seems like a good beginning to consider using only native species (or exotics that have shown no invasive tendencies over decades of use) for any large scale public landscaping project.

As you read this publication, and others on the same topic, you will encounter differing opinions, definitions, and positions, as well as some contrasting statistics. This sort of divergence is only to be expected when a subject first enters the public spotlight. The views contained here are intended to reflect that diversity and make no claim to fully reconcile the differences. While it's too soon to draw final conclusions, now is the right time to start studying this important and costly problem and examining the alternatives. I hope as you read these pages, you will find the information you need to begin to draw your own conclusions about the problems and potential solutions surrounding invasive exotic plant species in your own "native landscape." ❁

A Living History

— Mary Walker, Concord, MA

Mary Walker is a past president of the New England Botanical Club. She was a volunteer curator of the Concord Field Station Herbarium and spent 20 years as a volunteer naturalist for the Appalachian Mountain Club.

I grew up in Connecticut, have lived in the Southeast, Midwest, and West, and spent the last thirty years in Massachusetts. Always I have been interested in the plants around me and the changing landscape. One of the greatest changes I have seen is the process of open pastures reverting to second growth woodland. This results in a loss of open space in the countryside. Another change is the increase in new housing development. One effect of this is that some landscaping and garden plants have escaped cultivation in numbers that were not seen there fifty years ago.

After the 1938 hurricane, Phragmites, formerly a coastal reed, encroached on inland wetlands. Purple Loosestrife has become increasingly visible in wetlands in mid-summer, all over New England and even into Ontario. In spring, extensive populations of Garlic Mustard grow along back country Connecticut roadsides and in Concord near the entrances to local conservation areas. According to Eaton's *A Concord Flora*, there was only one abundant patch of this in 1974. Along the paths are an abundance of Buckthorn shrubs. According to another of Eaton's notes, Buckthorn (*Rhamnus frangula*) was first noticed in New England in 1915; it was well established in Concord by 1937, and occurred so frequently by 1965 that "some colonies [were] choking out native vegetation." Late in summer many large patches of Japanese Knotweed catch the eye and in the fall the yellowing leaves make one realize that Oriental Bittersweet has invaded and climbed into many trees, turning them into shapeless mounds of vegetation.

A Legacy of Concern

By Leslie J. Mehrhoff

The problem of invasive non-indigenous plant species has been with us for a long time. As early as 1735, John Bartram, the famous Philadelphia botanist known both for his botanical reconnaissance of the Britain's American colonies and for his gardening prowess, was alarmed to see that Lilacs and Double Narcissus were "already too numerous" around Philadelphia, "as the roots brought by early settlers had spread enormously."

Over the next two centuries, not much appears to have been written about the abundance and spread of non-indigenous plants into North America's native habitats. During the 19th and early 20th centuries, the emphasis on non-native species primarily involved weeds of agricultural lands. Many non-native species, mostly introduced from Europe, were well established in New England by the middle of the 19th Century. Early floras record that many plants, introduced intentionally or by accident, were considered part of the local flora. New Englanders saw an influx of species from China and Japan that were hardy here and could be used as ornamentals during the period following the opening of that region to Western trade. Many of today's most seriously invasive non-native species were established in this country as ornamentals by the beginning of the 20th Century. Early herbarium labels often include comments such as "in garden," "naturalized by birds," or, more presciently, "garden escape."

In 1938, Harvard botanist Merritt Lyndon Fernald wrote a paper based on a talk he gave to the Franklin Institute in Philadelphia on the preservation of rare native plants. In this paper, he spoke of the threats to native vegetation, especially to localized populations of rare or endemic species, caused by invasive non-native species. Fernald, a native of Maine and author of the 8th Edition of *Gray's Manual of Botany*, was indisputably the most knowledgeable source of information about the New England flora at that time. Although the main focus of the paper was not on what he called "the ultrademocratic intruders," much of it was devoted to a discussion of "the present-day biological success of the introduced weeds." In Fernald's typically colorful prose, he discusses the introduction and spread of "the crowding and handsome but over-whelming" Flowering Rush (*Butomus umbellatus*) and the Purple Loosestrife (*Lythrum salicaria*), and the problems with Japanese Honeysuckle (*Lonicera japonica*) which had "invaded the Southeast like a horde...." He even advocated using Civilian Conservation Corps help to control the spread of the Japanese Honeysuckle. Of this aggressively invasive species, he said, "Its destruction would be a notable achievement. Its continued toleration is a menace to the native plants and animals." All of these species are considered highly invasive

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Botanist Merritt Lyndon Fernald, author of the 8th Edition of *Gray's Manual of Botany*, at his desk at the Gray Herbarium of Harvard University on June 20, 1911. Photograph by H.H. Bartlett. Courtesy of the Gray Herbarium Archives, Harvard University, Cambridge, MA 02138



today.

This was not the first time Fernald had discussed the effects non-indigenous plants had on the native flora. In 1905, he addressed the Massachusetts Horticultural Society on "Some Recently Introduced Weeds." Interestingly, in the paper that was subsequently printed in the *Transactions of the Society*, he does not mention any of the Asiatic invasive woody plants, such as Japanese Barberry, Japanese Honeysuckle or Oriental Bittersweet, that are so troublesome today. It is probably safe to speculate that these were not yet viewed as problems.

Until the mid 1980s, little official concern was shown for non-native invasive plants. By that time, the numbers of individuals of some invasive species had reached proportions that could no longer be ignored. "Invasives," "exotics," or "aliens" — new terms, or more precisely, old terms reused in a different context — were applied to certain species and became part of the conservation lexicon. By that time too, whole landscapes had become dominated by a handful of non-indigenous species. As Fernald had suggested almost five decades earlier, these species knew "no restraints and had begun to obliterate our original native flora."

Although the movement was slow to start, each year more people become concerned about the problem of invasive species. The groundswell is having a positive effect. Invasive species are being surveyed, their biology is being researched, their intentional dispersal curtailed, and their management, control, or eradication attempted. People are increasingly aware of the negative roles these invasive species play in natural plant communities. Non-invasive, native alternatives for horticultural use are being sought by both gardeners and the nursery trade. [See page 11.] ❁

The Biology of Plant Invasiveness

By Leslie J. Mehrhoff

Most people, when they look at the New England landscape, take the mixture of plants they see there for granted. If they give any thought at all to the vegetation, it usually does not go beyond admiring those species with pretty flowers or attractive autumn foliage. There is little interest in where these species come from or how they came to be part of the mosaic of species that make up a particular landscape. But when you take a closer look, there are reasons for concern: some non-native plants are altering our landscapes in unforeseen and possibly irreversible ways.

What Is Native?

Native plants are those species that are thought to be indigenous to this region. This means that they were already present at the time of European colonization or appear to have arrived in the region by virtue of a natural range extension without any obvious aid from humans. In a few cases, such as Phragmites or Common Reed (*Phragmites australis*), the distinction between native and non-native may not be clear. All other species, regardless of whether they were accidentally or intentionally introduced, are considered non-native or "exotic" species. In determining what is native or non-native to an area, the historic information gleaned from herbarium specimens is often of great importance.

What Is Invasive?

Most habitats contain a diversity of species. It is this diversity that both allows the system to function well and perhaps more important, allows it to respond to various kinds of environmental and human disturbances. When invasive species become established in a plant community, they expand both in numbers and the space they occupy until other kinds of plants are pushed out. This tends to homogenize the plant community by reducing the number of different plant species — a decrease in biological diversity. This downward spiraling effect can, in time, cause local extinctions and severely effect overall health, especially in small or highly sensitive plant communities.

Some native species are invasive, such as Poison Ivy (*Toxicodendron radicans*), Hay-scented Fern (*Dennstedtia punctilobula*), or Greenbriar (*Smilax rotundifolia* or *S. glauca*). These exhibit the same characteristics as the non-native invasives with one exception: natural succession seems to keep most of the native invasives in check over the long haul. The native

invasive species do not seem to tolerate competition as well as their non-native counterparts. For instance, Poison Ivy will grow in a closed-canopy forest but its stature appears to be much reduced there. It is not as robust in shade as it is in the full sun of an open field or on a talus slope, and its invasiveness is inhibited by competition from species favored by those conditions.

Aldo Leopold, the arch-conservation ecologist, called attention to the fact that not all non-native species are invasive in a 1943 manuscript entitled "What is a weed?" He pointed out that "good and bad are attributes of numbers, not of species." Most non-native species are an innocuous part of the flora. Many have been here for a very long time without becoming a problem beyond occasionally popping up in a lawn or a garden. Numbers of individuals within their populations never seem to get too high and they do not severely alter the natural habitat.

According to regional botanical sources, approximately 3,000 vascular plants comprise New England's flora. Vascular plants are the familiar plants we see every day, including ferns, grasses, sedges, orchids, herbs, shrubs and trees. Of these, between 65 and 70 percent are thought to be native to the region. This leaves 30 to 35 percent, or approximately 1,000 species, that are naturalized (established in the wild) but are not indigenous to New England. Maybe 200 of the 1,000 non-native species are commonly encountered in New England, and of these 200, only a few can be considered invasive. Perhaps three dozen are documented as seriously invasive and another three or four dozen either have only been recently reported in the region, or have the potential to become invasive based on their actions elsewhere. This means less than three percent of the vascular plant species in New England are both non-native and invasive. Yet these three percent have the potential to seriously damage native plant communities.

Traits Of Invasiveness

Five key biologic traits characterize invasive species: 1) each plant produces large quantities of seeds or propagules; 2) they have very effective dispersal mechanisms; 3) they are readily established; 4) they grow rapidly; and 5) they are very effective competitors. The combination of these characteristics gives these species an advantage over less aggressive types.

1. Invasive plants produce abundant fruits and seeds.

Morrow's Honeysuckle (*Lonicera morrowii*) and the hybrid Bella Honeysuckle (*Lonicera* × *bella*), Autumn Olive

The importance of natural disturbance was brought home to me in 1996 when I visited the St. John River in northern Maine with the Josselyn Botanical Society. One of the plants we hoped to see was the very rare Furbish Lousewort (*Pedicularis furbishiae*). Before then, I was not that concerned about the annoyingly invasive Japanese Knotweed (*Polygonum cuspidatum* or *Fallopia japonica*) because I

thought it was only a problem at sites of human-caused disturbance. It grew along roadsides and railroad tracks and in abandoned lots and back yards, so I didn't think of it as a threat to natural plant communities. But along the St. John, Japanese Knotweed grows on the river shores right next to the endangered Lousewort. Here the disturbance was natural, caused by ice scour in the late winter and high water

level in the spring. The encroachment of the invasive species on the rare plant is so close that one of the leaders of the Josselyn Society expedition marked a small stand of Furbish Lousewort seedlings by hanging some bright orange surveyor's flagging on the nearest convenient place — the branches of a mass of Japanese Knotweed.

— Leslie Mehrhoff

(*Eleagnus umbellata*), Multiflora Rose (*Rosa multiflora*), Purple Loosestrife (*Lythrum salicaria*), and Oriental Bittersweet (*Celastrus orbiculatus*) are notable examples of invasive plants that produce prodigious amounts of fruits and seeds.

Most plant species produce fruits that ripen at about the same time. European or Shining Buckthorn (*Frangula alnus*), however, begins flowering in late May or early June and continues to produce fruit until frost. This allows for dispersal by both the summer resident birds and the fall migrants.

Some plants, like Japanese Stilt-grass (*Microstegium vimineum*) and Garlic Mustard (*Alliaria petiolata*), may not produce as many seeds, yet populations seem to become established “almost overnight.” The success rate of seedling establishment must be very high for these plants.

2. **Invasive plants have very effective dispersal mechanisms.**

Most invasive species have the ability to disperse a large number of seeds readily over considerable area. Almost all the well-known invasive woody plants, including trees, shrubs, and vines, are dispersed by birds. Most of these have brightly colored fruits that provide nourishment for the birds, which eat the highly visible fruits, fly to another spot and defecate the seeds, all ready for sprouting.

Some non-native invasives, such as the Swallowworts (*Vincetoxicum nigrum* & *V. rossicum*), Tree-of-heaven (*Ailanthus altissima*) and Norway Maple (*Acer platanoides*) are easily dispersed by wind. Along roadsides, where they frequently appear, they may even be dispersed by the breeze of passing vehicles.

Others, such as the mustard *Cardamine impatiens* and the

touch-me-not *Impatiens glandulifera*, disperse seeds by mechanical means. When their seed pods burst open with propulsive force, their populations literally explode!

Some plants gain added advantage by having more than one dispersal method. Those growing in or near water may disperse by floating seeds or fruits. Purple Loosestrife and Yellow Iris (*Iris pseudacorus*) disperse this way. Once established along a watercourse, these species are likely to appear downstream in short order. Others may be dispersed by animals. Water Chestnut (*Trapa natans*) is a good example of a species with two different ways of dispersing — fruits and plant parts can float downstream, and large birds often carry the spiny fruits stuck to their feathers.

Some invasives can reproduce from parts of themselves (vegetative propagules), enhancing their ability to spread and rapidly establish. Most invasive aquatics are like this. Eurasian Watermilfoil (*Myriophyllum spicatum*) and Hydrilla (*Hydrilla verticillata*) produce over-wintering buds that begin to grow the following spring.

Although not technically aquatics, some terrestrial perennials that occur on floodplains or near brooks can disperse by bits of the rhizome (an underground stem) or pieces of the root that float downstream. Once deposited on land, they send out roots and quickly become established. In this way, Japanese Knotweed (*Polygonum cuspidatum*) has become well established along river shores where winter ice scour or high water in the spring has created suitable habitat for it. This species can rapidly dominate the vegetation along entire shorelines, sandbars, or low-profile islands.

Humans are often unwitting vectors of invasive species. Soils in which ornamental plants are growing can contain seeds of invasive plants and transporting potted or balled plants can disperse invasive plants over unnaturally long distances. The incidence of *Cardamine impatiens* in the Wild Gardens of Acadia in Maine is probably an example of this kind of inadvertent dispersal. Aquatics are often introduced either as escapes from water gardens or when the contents of aquaria are dumped into a local pond. This was probably the source of the *Egeria densa* in a small pond near the Connecticut River in central Connecticut. The pond is on the grounds of what was once a private school. It is not difficult to imagine that some student, told to dispose of the fish tank in a dorm room, dumped the contents into a pond, as the compassionate alternative to giving it the flush. Unlike the ill-fated tropical fish, the aquarium plants spread, until now they threaten the Connecticut River.

Some invasives were intentionally introduced and subsequently spread from the introduction site. Many of the most troublesome species, such as Japanese Barberry (*Berberis thunbergii*), Purple Loosestrife, or Oriental Bittersweet, were introduced into this country as ornamentals and have spread from cultivation. It is not inconceivable that the Water Chestnuts in a pond on the Mount Holyoke College Campus were put in there by a botanist or horticulturist. Water from this pond eventually flows into the Connecticut River. Although we can never be certain that there was only one source of introduction, it is possible that fruits from the campus pond started the population now choking a backwater of the Connecticut River near Holyoke and threatening every point downstream in Massachusetts and Connecticut.

Some species have no apparent dispersal mechanism, yet they seem to spread rapidly. One of the best examples of this is that scourge of northeastern woodlands and roadsides,

Non-native species often leave behind the predators, parasites or diseases that helped keep them in check in their natural ranges



Eurasian Watermilfoil (*Myriophyllum spicatum*) spreads efficiently from the smallest plant fragments and can quickly overwhelm waterways, interfering with recreational and industrial water use. See page 29 for more information on this aquatic invader.

Garlic Mustard. A number of agents, including white-tailed deer, have been suggested to explain this plant's swift progress; as yet, none have been proven.

3. ***Invasive plants are easily and rapidly established.***

Ground disturbance usually plays an important role in the spread of invasive plants. Disturbance can be caused by human activity, such as construction, or may have natural causes. Natural disturbance can come from fluctuations in water level that prohibit normal seed germination and growth or knock out competing native species that would normally grow at these sites. Natural disturbance can also come in the form of wind-throw — trees blown over in a forest — allowing some species such as Japanese Barberry or Garlic Mustard to get a foothold.

A number of adaptations can facilitate rapid establishment of an invasive species. Most invasive species have a high percentage of germination and seedlings with a wide range of biological tolerance. Look under a Norway Maple in the spring and you will often see hundreds of its seedlings.

4. ***Invasive plants grow rapidly.***

Annuals produce a large number of seeds in one year and biennials in two. The large number of seedlings and the one-or two-year lifecycle can make non-indigenous annuals and biennials a serious problem. Invasive perennials must grow rapidly to maturity in order to produce seeds. Invasive woody vines are usually rapid growers and quickly reach high into the canopy of the trees or overtop the surrounding vegetation. Oriental Bittersweet, Japanese Honeysuckle (*Lonicera japonica*), and Mile-A-Minute (*Polygonum perfoliatum*) are good examples, especially in open areas, of how quickly some of these species can grow.

Many of the woody shrubs and trees that are becoming invasive problems grow very rapidly once established. Privet (*Ligustrum* spp.) as an ornamental seldom gets very large, yet individuals found growing wild on a flood plain in northeastern Connecticut have main stems with less than 20 years growth and a diameter of almost 8 cm. These plants produce thousands of fruits each year that are available for birds or that could float around the floodplain or down stream during high water events.

5. ***Invasive plants are aggressive competitors.***

Non-native species often leave behind the predators, parasites or diseases that helped keep them in check in their natural ranges, one reason often given for their success in new areas. This feature is inextricably linked with those of easy establishment and rapid growth. It is also one of the factors of greatest concern to land managers and conservationist because the impact on natural communities and native species can be devastating. Once established in a plant community, the non-indigenous invasives take over and dominate the vegetation. Fields overrun by Autumn Olive or Multiflora Rose, closed-canopy woodlands colonized by Japanese Barberry or Garlic Mustard, river shores densely covered by by Japanese Knotweed or Yellow Iris, and wetlands crowded with Purple Loosestrife or Phragmites (*Phragmites australis*) are commonly seen in New England.

Lakes, ponds, or streams dominated by Eurasian Watermilfoil, Water Chestnut or Hydrilla are increasing, although this fact is often overlooked except by conservationists, and by boaters or other recreational users. The aggressive growth of many invasive aquatic plants can take

A Living History

—Richard H. Goodwin

Richard H. Goodwin, Professor Emeritus of Botany at Connecticut College, served for many years as Chairman of the Botany Department and as Director of the College Arboretum. He served as an early volunteer president of The Nature Conservancy (1956–58, and 1964–66), and now resides on the Burnham Brook Preserve.

An area which is now part of the Burnham Brook Preserve of The Nature Conservancy in East Haddam has been under observation for 42 years. In 1956, the property was relatively free from exotic woody species. By 1966, Japanese Barberry (*Berberis thunbergii*), Common Barberry (*Berberis communis*), Oriental Bittersweet (*Celastrus orbiculatis*), and Multiflora Rose (*Rosa multiflora*) were listed as being present in the pasture, which was being kept open by grazing. Since then, the Japanese Barberry population has exploded and is invading the surrounding woodlands. A concerted effort has been underway for at least a decade to eliminate it. Strangely, the Common Barberry has shown no tendency to spread there. Nearby deciduous woodlands in Lyme show what can happen if nothing is done to check the spread of Japanese Barberry. There, the understory and the herbaceous layer are completely dominated by a thick stand of this prickly shrub. The Oriental Bittersweet is showing itself to be very aggressive at the Preserve, seedlings becoming established along the fencerows and under every juniper bush in the pasture. At the edges of the adjacent forest, the vines have reached the canopy, the older stems showing about 30 annual growth rings. Multiflora Rose is somewhat shade-intolerant, but can become a serious nuisance in the pastures.

over a pond to the exclusion of native species, not only choking the waters, perhaps changing water chemistry, but also preventing sunlight from reaching the pond bottom where other submerged species are affected.

Ecological principles and common sense suggest that these “hostile take-overs” must be at the expense of other plants. Too often it is at the expense of native species that are less effective competitors. Always, it is to the detriment of the natural community.

There is much we still need to learn about invasive species. We can identify problem plants, but we need scientific research to help us understand their biology. We need effective ways to manage and control these species. Most important, we need to educate people about both the problems and the solutions. Unfortunately, we don't have the luxury of waiting until we can see the whole picture. If we wish to protect natural plant communities and native species, we must begin now. ❁

Roots of Trouble/Seeds of Change: *The role of nurseries & botanic gardens*

By Cheryl Lowe

Since the beginning of civilization, people have cultivated plants for food, medicine, ritual or decoration. In the last century, however, with enormous increases in population and the speed and distance we travel, our impact on the natural world has increased exponentially. We are changing not just the landscapes we deliberately cultivate, but also, inadvertently, the natural areas and sanctuaries we have set aside for preservation. Since an understanding of the past often gives us tools to help direct the future, we need to ask how invasive plants arrive and spread, so that we can avoid future mistakes.

This article explores two primary aspects of the relationship between horticulture and the problem of exotic invasive species: the horticultural trade as a source of plants, and the selection, evaluation and promotion of new plants.

The Horticultural Trade As A Source of Plants

Horticulture and agriculture have always played a primary role in the introduction of new species into a continent or region. Nurseries, botanical gardens, arboreta, and individuals bring plants into this country through international plant trades, seed exchanges, and plant collection expeditions. After a period of time that varies from one season to many years, some of these plants are then introduced as new, different, or easier plants for landscapers and gardeners.

Before we try to assign “blame” for the introduction of invasive species, we need a better understanding of how many horticulturally introduced plants have actually become invasive. At first, the numbers look high. Dr. Sarah Reichard, of the University of Washington, Center for Urban Horticulture, Seattle, Washington, writing in *American Nurseryman* [“Invited but Unwanted,” S. Reichard and F. Campbell, July 1, 1996], reported that “of the 235 woody plants known to invade natural areas in the U.S., 85% were introduced primarily for ornamental and landscape purposes, while another 14% were introduced for agricultural uses.” This does not really tell us, however, what percentage of the hundreds of thousands of non-native plants, — both woody and herbaceous — have actually become invasive problems after introduction by the horticultural trade.

First of all, there is no real way to count how many new plant species have been introduced over time, or even in the last few years. Joel Albizo of the American Nursery and Landscape Association’s national office explained that there is no current mechanism to track numbers of plant introductions. There are several reasons for this: 1) Seeds and plants come into the nursery trade through many different modes of entry and there is no one organization that tracks them. 2)

The key time for preventing a new introduction from becoming a problem is before wholesale promotion and production begins, before an economic commitment has been made. Preventive evaluation by all who introduce new plants into the trade can have enormous positive impact.

Commercial nursery and botanical garden introductions often include hybrids and multiple forms (cultivars) of one species. From a botanical perspective, is this one or many different introductions? 3) Is a plant considered to be “introduced” if it is grown for display in a botanical garden collection, or small private collector’s garden, or only if it is taken up and propagated by the commercial nursery trade? Bear in mind that it may be many years before a plant is propagated, promoted and accepted in large numbers.

How many of these plants are potentially invasive? Again, this is difficult to answer for several reasons. Each region of the country has a wide range of environmentally distinct sites, some better suited than others to establishment of new species. Also, as plant communities change — either due to natural events such as hurricanes or floods, or more often, because of human-caused disturbances such as highway construction, or the abandonment of fields — opportunities arise for new species to become established. How do we count a plant which may be invasive in one part of the country, but not in another, or at one time, but not at another? As indicated above, many introductions are multiple forms of the same species. How genetically different is each cultivar, and do some produce offspring with different invasive characteristics? There is also the question of hybrids. While some hybrids are sterile, other combinations of species can produce offspring with unknown characteristics. The term “hybrid vigor” indicates more vitality (and perhaps more aggressive potential) than either parent. Finally, since potentially invasive species introduced on a large scale or repeatedly have an increased probability of becoming established and invasive, the degree of acceptance of a plant by professional landscape contractors, government agencies or the general public becomes highly significant. Such common invasive species as Japanese Barberry (*Berberis thunbergii*) and Multiflora Rose (*Rosa multiflora*) were introduced not just once or twice, but time and again, by both wildlife and humans.

Because no one could give me figures, I studied an old list spanning 50 years (1872 to 1922) of Arnold Arboretum plant introductions [*Journal of Arnold Arboretum*, Vol. 3, 127–171; 1922]. Only six out of the more than 2,700 taxon in that list are considered invasive today. That translates to about 0.2% of the total.

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Selection, Evaluation & Promotion Of New Plants

The key time for preventing a new introduction from becoming a problem is before wholesale promotion and production begins, before an economic commitment has been made. Preventive evaluation by all who introduce new plants into the trade can have enormous positive impact.

Nursery growers, the staffs of botanic gardens and arboreta, and landscape contractors hold diverse views about growing and selling plants. Selection of plants for next year's sales may be based on such factors as propagation and production schedules, market niche, a personal passion for certain groups of plants, and environmental concerns. The first factor is one of the most important. If you look at the key characteristics that make for a successful invasive plant species [see page 8] you will notice how these same qualities can also make plants attractive to the nursery trade: easy and often multiple means of propagation, tolerance for a wide range of growing conditions, and rapid growth are advantages allowing plants to be produced quickly and in large numbers.

Promotion by plant associations, nurseries, botanical gardens and arboreta, and production by large-scale nursery operations, make plants more popular and more widely available. Supply and demand also plays a role. Many wholesale and retail nurseries continue to sell known invasive species because they are easy to produce and familiar to buyers. But they are not the only ones responsible. As *The Avant Gardener*, a horticultural news clipping service, reported in 1996: "It's a self-perpetuating problem: landscape architects and government agencies say they order these plants because 'they're the only ones the growers have,' and the nurseries say they grow them because 'they're the only ones our customers order.'"

Opportunities & Initiatives

According to Rena Summer, of the Massachusetts Nursery and Landscape Association (MNLA), the nursery industry acknowledges that certain plants are invasive. And although what should be done about it is being debated, progress is being made. Many state nursery groups like the MNLA offer their members educational forums, publish newsletter articles, and promote education, research, and the adoption of established selection criteria, balanced with realism and consideration of regional and local factors.

On a national level, the American Nursery and Landscape Association is working with the Weed Science Society of America, Nursery Association Executives of North America, The Nature Conservancy, U.S. National Arboretum, USDA Plant Inspection Service, and others to develop an evaluation method to screen new plant introductions and encourage voluntary self-regulation by the nursery industry. With the understanding that a combination of certain characteristics makes a species more likely to be invasive, Dr. Sarah Reichard is working with this collaboration to develop a model that will lead to recommendations for judging which plants are safe to introduce, which ones need to be monitored carefully for a period of time, and which species are very likely to become invasive.

I tried out a prototype of this model on a few plant species not yet common in the trade, and found it fairly easy to use. One book, *FPI: Flowering Plant Index*, published by the University of Minnesota Libraries and the Anderson Horticultural Library (1997) was very helpful in directing me to commonly available reference books and periodicals. Dr. Reichard suggests the Internet for those without access to a handy reference library.

In the last five to ten years, state highway and natural resource agencies have also been working together to eliminate invasive species from state nursery distribution centers and encourage

more appropriate (and native) plantings. The Connecticut Bureau of Natural Resources Wildlife Division and the Connecticut Department of Environmental Protection publish a booklet, *Enhancing Your Backyard Habitat for Wildlife*, which specifically lists "Invasive Exotic Plants Not Recommended." In Vermont, Craig Dusablon, Landscape Coordinator with the Vermont Agency of Transportation, reports that his agency is working closely with the Agency of Natural Resources to control existing invasives, avoid introducing new ones, and encourage contractors to consider using native species in their plantings.

Botanic gardens and arboreta, an important source of new introductions, are also exercising greater care. Tom Ward, Nursery Manager at the Arnold Arboretum of Harvard University, says that since about 1980 they have been monitoring new plant introductions for ten to fifteen years before releasing them into the nursery trade. New species are observed for five to seven years in the nursery before being planted out on the arboretum grounds, where they are observed for up to ten years more.

The problems and challenges presented by invasive exotic species will not be solved overnight, but there is increased commitment to research, education, and enlightened action. New information and tools for informed decision-making are becoming widely available. By rethinking how they select and evaluate plants, all those associated with the introduction of new species into North America — public gardens and arboreta, nurseries, landscape designers, government agencies for conservation of natural resources, and professional horticultural associations — share one of the greatest opportunities to influence the future. ❁

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"A well-meaning friend once brought me some Goutweed. I planted it in a perennial border not knowing its growth habit. Needless to say, the entire area is now rampant with Goutweed and is now beyond control. The lesson from this is to know the growth habit of the plant; if it has an invasive nature, it is best to leave it alone."

— Pennie Logemann
Volunteer Slide Librarian,
New England Wild Flower Society

Lifestyles Of Invasion: *Three case studies*

By Frances H. Clark & Chris Mattrick

The three plants selected for these in-depth profiles were chosen not only for their ubiquity in the landscape and their troubling effects on native plant habitats and human interests, but also because their methods of dispersal and the problems of control that they present are characteristic of many invasive, non-native plants. Garlic Mustard (*Alliaria petiolata*) is a widespread herbaceous plant that can quickly overwhelm a site; the Buckthorns (*Ramnus cathartica* and *R. frangula*) are woody shrubs that, once you learn to recognize them, can be seen lining highways and byways throughout the region; Eurasian Watermilfoil (*Myriophyllum spicatum*) is an aquatic weed already affecting industrial, and recreational water use and quality. The three are well-established here, and battles to limit their spread are already being waged in many parts of New England.

Garlic Mustard

Alliaria petiolata



Most invasive exotic species thrive on two things, sunlight and disturbance. Although they may continue to grow and become problematic in shady situations, they usually require sunlight to become established. Garlic Mustard is the maverick, one of

the few exceptions to this rule. Native to Europe, it was first reported on Long Island in 1868, where it was probably introduced by settlers as part of their herb gardens. Today it is known to occur in 30 states, stretching from New England, west to Kansas and Nebraska and as far

south as Virginia. It is also known in several eastern Canadian provinces.

Primarily an invader of disturbed forest communities, Garlic Mustard is common in the dappled shade of forest edges and roadsides. It also tolerates deep shade and it seems increasingly adapted to growth in full sun. New infestations are often found in floodplain forests. Floodwaters are among the primary means of dispersal for this species and from these lowland forests it tends to spread upland aided by wildlife, such as birds, and by human activities.

Adaptable, Prolific — & Smelly

A cool season biennial, Garlic Mustard both germinates and blooms in the spring and early summer. In the first year, seeds sprout following the first or second heavy rain of the spring and by mid-summer have developed rosettes of dark green, kidney-shaped leaves edged with rounded teeth. Flowering stalks emerge from the rosettes in early spring of the following year. The stalks can reach a height of two to three feet and by late spring are topped with clusters of white, cross-shaped flowers. Seeds borne in slender tawny pods begin developing by mid-summer. An average plant produces 800 seeds and an extremely robust, large specimen can produce as many as 6,000. A handful of plants one year can explode into a serious infestation the next year, dominating the herbaceous layer. Dense colonies have been measured at 20,000 seedlings per square meter. The prolific seed production and

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Garlic Mustard (*Alliaria petiolata*) has been in Rhode Island for a while, but has not yet spread widely. Richard Champlin says that Newport landscapers call it the "Newport weed," and the major site for it that I know is in Portsmouth. Another plant we are keeping our eyes on!

—Lisa L. Gould
Rhode Island
Natural History Survey



the density of growth allow Garlic Mustard to easily out-compete our native woodland flora for light, moisture and nutrients. The effect is especially devastating on spring blooming species such as Bloodroot, Wild Ginger, Toothwort and Hepatica, which are attempting to flower and produce seed at the same time as the invader.

The first step in controlling an outbreak of Garlic Mustard is to properly identify the species, since it resembles several native plants. The dark green first year rosettes can be identified by simply walking through an area — when crushed underfoot the stems and leaves smell strongly of garlic. If pulled out of the soil, rosettes have a distinctly curved, white taproot. During the second year, the alternate, heart-shaped and distinctly toothed stem leaves develop and blooming plants are easily spotted in forests and along roadsides. The strong smell of garlic produced by broken stems and leaves also persists in second year plants.

A Heated Resistance

Once identified, small infestations of Garlic Mustard can be easily controlled, but large colonies are difficult and time consuming to remove. As is the case in controlling most invasive species, one of the primary goals is to prevent seed production. This is especially true of Garlic Mustard because, as biennials, individual plants are not long-lived and it is the seeds that sustain infestations. Easiest, if most labor-intensive, is to simply pull the plants by hand. Hand pulling should be performed during or just prior to bloom, and may reduce populations by up to 98%. Manual control is still effective on large infestations, but is time-consuming unless a

mower or other mechanical means is used. Here again control should be performed during or prior to bloom time in order to prevent seed production. Prescribed burning has also proved useful in controlling large populations. Fires must be hot enough to burn through the leaf litter and the entire area must be scorched. Consideration should be given to a fire's potential effect on native vegetation at the site. As a source of disturbance, burning also creates an environment ripe for re-infestation of Garlic Mustard, unless repeated each year for three to five years to eliminate the seeds. The proper use of herbicides can also provide significant reductions

in populations, sometimes up to 98%. Herbicides can be applied to the basal rosettes at any time of year including winter, temperature permitting. (Most herbicides are not effective at temperatures below 50 degrees Fahrenheit.) Considerable thought should be given to the effect of herbicides on non-target species. Many herbicides are non-selective. A bio-control program has recently been started for Garlic Mustard and initial results look promising for the use of two kinds of insect larvae, one of which eats stems and seeds, while the other bores into the roots. Garlic Mustard seed lasts three to five years in the soil, so in order to achieve complete and effective control any program should be repeated for up to five years.

Garlic Mustard is widespread throughout our region and becoming an increasing problem in natural areas where it monopolizes habitats occupied by some of our most desirable native species. Fortunately, it is relatively easy to control in its early stages. If we act now, we can achieve control of this undesirable invasive species and return the upper hand in many of our woodlands to our native flora.

— Chris Mattrick

A Living History

—Richard L. Champlin, Jamestown, RI

Richard L. Champlin of Jamestown, Rhode Island, is a graduate of Mt. Hermon School, Middlebury College (with two-year hitch in the U.S. Navy between), and a career librarian, retired from the Redwood Library, Newport, Rhode Island.

Rhode Island before the arrival of Oriental Bittersweet, Japanese Honeysuckle, Autumn Olive, and other "undesirables" was, admittedly, no Garden of Eden. We had, and still have, to contend with Bullbriar. Even so, it was an Age of Innocence. The Bittersweet established a beachhead on the Island of Conanicut about 1950. When I first found it, I was enchanted. I collected twigs for decoration at home. What's more, I wouldn't tell anyone where I found it. This was my discovery. Let the others search for themselves. From that landing, the vine has overspread the island as it has the state. This happened about the time the mockingbirds and cardinals became residents. Did the birds bring the seed to us, or did they settle here because they found in those exotics a goodly supply of winter food? We may never know.

Common & Glossy Buckthorn

Rhamnus cathartica & *R. frangula* (*Frangula alnus*)



Buckthorns are insidious, inconspicuous invaders. Because they lack the showy flowers and bright fruits of many woody invasive exotics, few people notice that the shrubs invading back yards or nearby fields, forming thickets along the roadside, or growing in the woodland understories are invasive aliens. Yet their control has become one of the major challenges for natural area managers, requiring a combination of persistent efforts at pulling, hand cutting, girdling, burning, mowing, or applying herbicides. Along with other invasive exotic plants, Buckthorns are altering the structure, composition, and function of our common and special natural communities, in both uplands and wetlands, changing them so much that many birds, mammals, and wildflowers can no longer survive in the last sanctuaries left to them.

Identification of the non-native Buckthorns is relatively easy. Common Buckthorn has roundish, glossy leaves with fine teeth and more or less parallel veins that curve forward. Fruits are black and glossy. It develops into a dense, small tree somewhat similar in appearance to an old apple tree. Glossy Buckthorn has oval leaves without teeth, with relatively straight parallel veins. The fruits are first reddish and then turn purple-black. The broken twigs have an

acrid smell. Both species can reach up to 20 to 25 feet in height.

These two Buckthorns have all the characteristics of successful exotic invaders. They are adaptable to a variety of site conditions, grow quickly, produce an abundance of fruits, and form viable seeds which are readily dispersed by many birds and then germinate when conditions are favorable. They have a long growing season. The leaves of Glossy Buckthorn last well into the fall, giving it an edge over native plants in acquiring light, nutrients, and water. The plants produce berries from mid-summer into fall. Because they are exotic plants, there are few native diseases or insects here to impede their advance. Though poisonous to many animals (they have laxative properties), the fruits are attractive to common birds such as starlings, blackbirds, cedar waxwings, robins, and blue jays, which aid in their dispersal. The berries can also float for several days, allowing for dispersal by water, an easy way to infest wetlands. The plants are notorious for resprouting after they have been cut back, creating a Medusa-like tangle of new stems, which can produce flowers and fruit the same year. Even when the main stem is removed, the remaining roots send up new shoots. These are plants that know how to survive and conquer.

Introduced before the 1800s, when they were promoted for hedges, shelter-

belt plantings, and wildlife habitat, both species now range from southern Canada throughout the Northeastern U.S. They are still readily available from nurseries for these purposes.

All the Comforts of Home

Common Buckthorn grows naturally throughout most of Europe in the understory of open Oak, Oak-Beech, or Ash woods, as well as in riverine woods, exposed rocky sites, hedgerows, and pastures. This species tolerates a variety of soils, but prefers neutral or alkaline soils. Glossy Buckthorn has a broader natural range than the Common Buckthorn, including Africa and Asia as well as Europe. It typically inhabits wetter, less shaded, and more acidic soils, including Heath-Oak, Pine, and Spruce woods.

Their habitats here are similar to those where they are native. In New England these species have invaded a variety of disturbed and natural communities. Once you know how to identify them, look for Glossy and Common Buckthorn in old fields, hedgerows, powerline cuttings, and at the edges of woods.

They are less frequent in large forests where the common fruit-eating birds do not roam and dense shade prevents the few plants that do get established from forming seeds, but the plants can wait in the shade for up to 50 years until a gap in the forest canopy or a new trail provides enough light for seed to set and germinate. Glossy Buckthorn is common in wetlands including sphagnum bogs, beaver meadows, and calcareous fens — particularly important habitat types.

Observations by land managers exemplify the problem in New England. During a botanical survey for a land trust, this author inventoried an old horse paddock that was abandoned 10 years before and had become overgrown by Glossy Buckthorn 10 to 15 feet high. I literally had to crawl through the stems to see what was growing. The plants were so thick that all the typical understory species were shaded out including grasses, shrubs, tree seedlings, and, of course, wildflowers. Jim MacDougall, Stewardship Director for Essex County Greenbelt, a land trust in Massachusetts, says Buckthorn is particularly prevalent where the understory has been disturbed such as through logging operations. If the harvesting is done in early spring or summer, "the germination of [Buckthorn] seeds is extraordinary, with hundreds of plants per square meter." Disturbance by mowing along edges of trails or utility lines creates avenues for infestation as

well. Of Central Massachusetts and southern New Hampshire, Rick Van de Poll, a professor at Antioch College, says that “Perhaps the most discouraging observation has been the fact that [Buckthorn] has successfully invaded essentially undisturbed areas in pristine wetlands. Many of these sites are either adjacent to old growth forest or entail old growth and unaltered forested wetlands themselves.”

The dominance of Buckthorn can reduce the number of species, change the physical structure of a habitat, disrupt the food web, and delay the long-term process of succession.

Depriving The Woodlands Of Song?

In talking to my biologist colleagues, I learned more about the impact of these invasives. By eliminating the herbaceous layer, the Buckthorns alter the moisture, temperature, humidity and light near the ground and therefore diminish habitat for species such as grasshoppers, mice, voles, rabbits, and snakes. Furthermore, the thickets prevent Blackberries, Viburnums, Winterberries, Dogwoods, and Spicebush from growing in, so local birds do not have the diversity of food they need both in summer and winter. Migrating birds such as thrushes may not be able to obtain the energy they require to sustain their long journeys. The timely, high-quality native food is replaced by easily accessible “junk food.” MacDougall wonders whether the laxative effect of the berries in fact provides a net loss of energy for the birds. The dominance of Buckthorn prevents seedlings of other shrubs and trees from getting established and therefore retards the natural progression from field, to scrub, to forest, eliminating habitats for a variety of plants

and animals. It is unclear how long it might take for these native species to recolonize the area. Thus, the dominance of Buckthorn can reduce the number of species, change the physical structure of a habitat, disrupt the food web, and delay the long term process of succession.

Persistence Pays Off — Maybe

Given the severity of Buckthorn infestation, natural resource managers throughout New England have been experimenting with its control. In the town of Lincoln, Massachusetts, the conservation commission has conducted two small control projects. Where young Buckthorn was pulled out of a bog which harbors a rare plant, the removal of Buckthorn in a very small area seemed to enable Sundews and Pitcher Plants to come back. So far, the Buckthorn seedlings have not returned. Twice over two years, Lincoln plowed and seeded a small patch of meadow which was being overrun by Buckthorn. Three years later, the plowed area has regrown with seeded Little Blue Stem and Buckthorn is minimal.

In northeastern Massachusetts, Jim MacDougall has worked on larger scale projects. When a group of volunteers meticulously “weed-wrenched” a disturbed open site (using a special pulling tool), results were disappointing. “A year later you could not tell it had any effect,” according to MacDougall. Concluding that hand-pulling is fruitless, he has now resorted to herbicides, applying a solution to cut stems. From this, he gets good control for the first two to three years but then sees sprouts from the same stumps treated three years before. Mowing, MacDougall notes, only creates denser root systems making the plants more resistant to control. MacDougall concludes: “Don’t mow or cut it; just kill it!” Acknowledging the ecological and health hazards of herbicides, he adds “We have to weigh what’s best of a bunch of evils.”

To date, natural area managers have found no quick and easy solution to the



Pulling Together — Volunteers use a weedwrench — a special tool designed to remove an entire plant or shrub — on a woody invasive plant on land trust property in Massachusetts.

plague of Buckthorn, which is overrunning our domestic and natural communities. They employ a variety of strategies, often including herbicides, that need to be applied in a timely and persistent manner over several years. Seeds remain viable in the soil and seed sources persist in surrounding areas, ready to be dispersed by birds back into the managed site. Effective control will require the careful selection of priority sites, with strategies based on site conditions, and above all, a long-term commitment. By sharing our experiences and conducting scientific research, we are learning how to discourage, if not totally eliminate, this threat to local habitats.

—Frances H. Clark

My greatest concern in Central New England has been European Buckthorn on account of its very rapid spread in moderately well-drained to poorly drained sites. *** Its spread has been remarkable. Perhaps the mostly discouraging observation has been the fact that it has successfully invaded essentially undisturbed areas in pristine wetlands. Many of these sites...contain either adjacent old growth forests or entail old growth and unaltered forested wetlands themselves.

—Rick Van de Poll
Antioch NE Graduate School, Keene, NH

Eurasian Watermilfoil

Myriophyllum spicatum



Eurasian Watermilfoil is one of two invasive milfoils and several other alien aquatic plants overwhelming lakes and waterways throughout much of New England and elsewhere in the United States. Unlike many of the upland invasive plants, which often go unnoticed or unchallenged as they begin to invade abandoned fields and forests, aquatic invasives have been a target of control since their initial incursion into water-based recreational areas. National and state agencies have spent millions of dollars on research and management programs. Homeowners have banded together in lake and watershed associations. Some states have passed legislation to prevent transport or sale of Watermilfoil and other aquatic invasive species. Despite these measures, Eurasian Watermilfoil, along with its rogue companions, continues to infest our lakes and rivers, altering their ecology and usefulness. This is the story of Eurasian Watermilfoil, considered one of the worst of the aquatics, and the efforts of the State of Vermont and its citizens to try to limit its growth. The lessons can be applied, however, to other species and states throughout New England.

Ten species of milfoil are found in New England. According to Jody Conner, Limnology Center Director of the New Hampshire Department of Environmental Services, two of these species are “con-

sidered handfuls by scientists all over the world.” The exotic Eurasian Watermilfoil, (*Myriophyllum spicatum*) from Europe, Asia, and North Africa, was first documented in 1942 in a pond in Washington, D.C. Since then it has spread to 40 states and three Canadian provinces. In Vermont it is now found in 46 lakes larger than 20 acres in size or 16% of the total of such lakes. It covers thousands of aquatic acres, including large bays in Lake Champlain and in Lake Bomoseen. It is also found in hard water lakes of western Massachusetts and Connecticut. It was discovered at one site in New Hampshire, where thanks to quick action it has been extirpated for the time being. The other invasive milfoil, Variable Watermilfoil, *Myriophyllum heterophyllum*, is native in the southeast and central United States, but has now invaded the more acidic waters of southern Maine, Massachusetts, and New Hampshire. It has not yet been found in Vermont. Both species are beginning to spread into the same territory. Of the exotic aquatic invasive plants threatening New England, Eurasian and Variable Watermilfoils are often considered the worst of the bunch.

Eurasian Watermilfoil is a submerged perennial aquatic plant that roots in the soil of lakes, rivers, ditches, ponds, and reservoirs. The submerged, feather-like leaves grow in whorls of four that look as

if someone has blunted the ends with scissors. The stems tend to be reddish toward the tips. The inconspicuous reddish flowers are borne in the axils of tiny scale-like leaves on stems that stick out of the water. The flowers are pollinated by wind. Occasionally the plants set seed but this is not considered the main means of spread.

Watermilfoil spreads prolifically from stem fragments. The plants grow to flowering stage and then the stems break into pieces, which circulate about, sink to the bottom, and root. They overwinter as roots or low growing evergreen shoots. In spring they grow quickly to the surface of the water where they are dominant early in the season. In aquatic environments, where light is at a premium, other species don't have a chance to grow in the shadow of Eurasian Watermilfoil.

The plants spread efficiently to other lakes when the fragments hitch a ride on boats, propellers, and trailers, or are transported downstream to other parts of a watershed, quickly dominating a string of interconnected ponds and lakes. Eurasian Watermilfoil prefers nutrient rich, fine mineral sediments and alkaline waters, although it is tolerant of a variety of conditions. It can grow in shallow waters along shorelines or take root in as much as 25 feet of water depending on water clarity. Disturbance, including drought and other changes in water levels, sedimentation, and decline or removal of other species due to shoreline erosion, are conditions that seem to favor this opportunistic plant.

Watermilfoils win a place at the top of the public's hit list because the large tangled masses interfere with swimming, boating and fishing. Consequently they also have negative effects on real estate and local businesses. Fragments can clog intake pipes and interfere with water-dependent industries.

Eurasian Watermilfoil alters the ecology of lakes, reducing water quality and fish numbers and distribution. Mats of Watermilfoil may be beneficial to young fish which find concealment and food there; but the same mats may impair fish growth, particularly largemouth bass, which cannot see their smaller prey. In fall, the decomposing plants can reduce oxygen, causing fish kills. Decomposing Watermilfoil releases higher concentrations of phosphorus than other plants. The aggressive growth can crowd out beneficial aquatic plants such as pondweeds (*Potamogetons* spp.), Water Celery (*Vallisneria americana*), and Water Nymph (*Najas flexilis*), which serve as excellent

duck food.

Many Trials, Few Triumphs

Vermont has tried a variety of controls, few of which have proven effective for more than two years. The costs of control usually range from \$300 per acre to \$10,000 per acre. Bottom barriers of impenetrable mesh cost up to \$15,000 per acre and require maintenance as they can become covered by silt. Various mechanical harvesters have short-term success, but the plants usually grow back, sometimes within a month or, at best, within a couple of years. Harvesters cost up to \$100,000 and it takes a day to cut three acres at an operational cost of \$300–\$600 per acre. And cutting methods fragment the plants, thereby promoting their spread. Finally, harvester blades can harm turtles and small fish. Raking and suction methods disturb lake bottoms and affect other organisms. Herbicides can kill plants in small areas but prove ineffective for a large scale projects. Lake shore owners often use herbicides illegally, thereby threatening the lake environment and its residents. Draw-down of lake levels in winter can help freeze out the plants but can also affect other aquatic organisms and well supplies. Grass carp is a biological control promoted by some states, but the fish have not been tried in Vermont, because of potential effects on native aquatic plants. The list of attempted controls is long but, so far, of limited use due to the expense, ineffectiveness, and possibility of harm to the environment.

Hope From A Tiny Predator

One possibility for a relatively low-cost and effective biological control is a native weevil. Its discovery was fortuitous: the State of Vermont was considering the use of grass carp to control an infestation in Brownington Pond in the Northeast Kingdom. When state researchers arrived to initiate the study, the Watermilfoil had already disappeared. Further investigation indicated that a native weevil, present in high numbers, might be debilitating the plants. Since then, with the help of a five-year, \$575,000 EPA grant, the state contracted researchers at Middlebury College to determine the role of the weevil. Originally a natural predator of a native milfoil (*M. sibiricum*), the weevil has “jumped” host plants, and now apparently prefers the exotic European Watermilfoil.

It appears that the weevil may be an effective control under certain conditions. It is found naturally in 33 of the 46 Vermont lakes with Eurasian Watermilfoil. Watermilfoil density has declined in ten of these lakes but, so far, due to lack of



We have visited several Connecticut lakes nearly every year since 1993 and see some sites where the Eurasian Milfoil has not become very invasive, but others where it has increased dramatically to the point of virtually dominating the lake. In the latter case, we have observed a correlated decline in the number of native lake species.

— Donald Les,
University of Connecticut

research, the weevil has been shown to be the cause of this reduction in only one lake.

Unfortunately, Vermont has no more money to pursue scientific research into this question. It is puzzling that the weevil does not seem to affect the Variable Watermilfoil. New Hampshire officials were eager to try the weevil in their Variable Watermilfoil-infested lakes, only to find that the weevil could tell the difference between the species, and refused to bite.

The current strategy of Vermont and other states is to prevent spread of Eurasian Watermilfoil to new lakes. Vermont has had one of the most extensive public awareness campaigns, including a newsletter, fact sheets, and identification cards distributed to recreational users, lake associations, and watershed organizations. The state has also posted signs at every boat ramp to inform the public of the plant's threat and the means of its spread.

Much Enthusiasm, But Scant Funding

“Weed Watcher” campaigns include hundreds of volunteers who monitor their lakes and report any early sightings, so that the state can respond quickly to a new colony. Other states are using similar strategies, but lack of funds and staff also limit their effectiveness.

Holly Crosson, Aquatic Biologist for the State of Vermont, who has been involved

with the campaign for over a decade, had been optimistic that their comprehensive program was holding the line on Watermilfoil. “The word is getting out there, people know what it is, and call when they find it,” she said. But this past summer Eurasian Watermilfoil was reported in four new lakes. “I think we are starting to lose the battle. Despite giving annual grants to municipalities, we are not reducing the population to the extent needed. It is hard to keep up with it, especially in lakes that are heavily used by boaters,” Crosson laments. As far as the spread to new lakes, she points out, “All it takes is one plant fragment.” In a recent survey, volunteer observers were stationed at a lake access ramp on weekends, during which time, 13 boats arrived with Watermilfoil fragments. This is why Crosson places her hopes on more weevil research. So far, this tiny creature is the only environmentally compatible biological control for large, heavily infested lakes. “There is enough evidence to believe that it may work, and we don't think it does any harm.” Unfortunately Vermont at the time of this writing has no funding to study this option.

Other state agents have mixed opinions on control. Dr. Rick McVoy, Environmental Analyst with the Department of Environmental Protection in Massachusetts, feels they are unlikely to eradicate Variable Watermilfoil. Noting that many of the control efforts just spread the plants by fragmentation and disturbance, he wonders whether, if left alone, the Variable Watermilfoil might be kept in check by a natural control someday. However, he notes realistically, “Most people are not that patient.” Jody Conner, pointing out that every lake in New Hampshire where the species has been introduced still has problems with Variable Watermilfoil, sums it up: “We are looking for scientists to come up with a biological or chemical control that will be safe and productive.”

Thousands of people throughout New England have tangled with the tenacious Eurasian and Variable Watermilfoils to little avail. The hope lies in public awareness and individual action to prevent the spread of exotic Watermilfoils to new lakes, and in scientific development of solutions that can reduce the impact of existing colonies on recreational activities and ecological processes. More research is the only way to assess the long-term effect our efforts will have on the goal of sustaining the ecological integrity of our waterways.

—Frances H. Clark

Rogues Gallery: *Notable Invasive Plants of NE*

Edited by Frances H. Clark, Chris Mattrick & Sarah Shonbrun

This collection of problem plants is not intended to cover all the invasive exotic plants to be found in New England. The plants on the following pages have been chosen by our contributors because they clearly illustrate invasive plant characteristics, have qualities that make them particularly troubling, or seem likely to expand their range dramatically in the coming years. By its nature, this list will change and grow over time. The Resource List on page 31 contains other sources of invasive exotic plant information pertinent to New England, several of which contain lists of other plants that have already been identified as problems or that should be watched.

Autumn Olive *Eleagnus umbellata*

Autumn Olive (*Eleagnus umbellata*), originally from China, Korea and Japan, has a long history in North America, where it has been popular since colonial times for its good looks and hardy character. This is a small deciduous tree, growing to approximately 20 feet. Autumn Olive's oval leaves are a dark gray-green, with pale red fruits. The tree is found from Maine to Virginia, and west to Wisconsin. Flowers appear after the early leaves, and are pale yellow and small. Where the trees have escaped cultivation, they can be found along roadways and in open areas such as pastures, open woodlands and woodland edges. Their ability to fix nitrogen, similar to that of "green manure crops" makes these plants particularly versatile and opportunistic, able to thrive in poor soils. Producing many seeds and capable of very rapid growth, they also sprout energetically when cut back, making them hard to discourage. Controls include cutting trees and painting herbicide on the stump (to prevent resprouting). Small plants can be pulled, taking care to get the entire root system. Because of their enthusiastic regrowth, burning is not effective.



When Black Locust is found outside its native range, humans are usually the cause. Naturally occurring on the lower slopes of the southern Appalachian Mountains, it has been widely planted elsewhere for its ability to thrive in difficult situations and to help control erosion. The large fragrant flowers are a good source of nectar for honeybees and the hard wood is highly prized for fence posts and lumber. Black Locust generally establishes itself in early successional habitats, following some disturbance such as agriculture or logging. It can also form a single species climax community because of its ability to crowd out other vegetation. Thriving in full sun, once established on a site it outcompetes native trees and herbaceous plants with its rapid growth and the dense shade cast by mature individuals. Although large quantities of seed are produced, research has shown that they rarely germinate. The

Black Locust *Robinia pseudoacacia*



primary means of reproduction and spread is vegetative. Black Locust root suckers and stumps sprout vigorously producing large, continuously spreading colonies, connected by a single root system. A member of the pea family, Black Locust is easily identified by long paired thorns found along the trunk and branches of seedlings, sprouts, and the younger branches of older trees. Now found throughout the Midwest and Northeast along roadsides, prairies and forest edges, it is also a significant problem in some areas of Europe. In New England, it poses the

greatest ecological threat to our native sandplain grasslands and pine barrens. On Cape Cod, Black Locust occupies thousands of acres of former Scrub Oak-Pitch Pine forest, permanently altering the delicate balance of this unique ecosystem by shading out sun-loving herbaceous species, suppressing fire, and crowding



Black Swallowwort *Vincetoxicum nigrum*

“This is the nastiest thing I have come up against,” says state botanist Bob Popp in Vermont. Popp saw the vine for the first time in 1990 along the railroad tracks near one of the only sites in the world for the federally listed endangered Jesup’s Milk-Vetch. The Swallowwort was not near the Milk-Vetch then, but now it is clambering all over the rare plant’s river-bank habitat as well as over the islands in the Connecticut River. It forms a dense, knobby mass of roots that, according to Popp, is impossible to eradicate, breaking apart when you attempt to dig it up. Cutting off the flowers only delays the maturing of fruits

which cast seeds to the wind like milkweed, its close relative. There is no mechanical way to eradicate it, confirms Tom Rawinski, Botanist for the Massachusetts Audubon Society, who spent a whole summer trying to pull it out of his garden in North Carolina. Botanist Nancy McReel says the plant grows on lobster traps stored on Mohegan Island, 12 miles off the Coast of Maine. Open sites in wildlife sanctuaries, along roadsides, and railroads are soon overwhelmed by this plant, beneath which nothing else can grow. This is an incoming pest that needs to be headed off. An ounce of prevention is worth a pound of cure.

The branching structure, interesting bark, and blazing red fall foliage have made this invasive a favorite for landscape, foundation, and highway plantings. The smaller branches often have corky wings that help identify Burning Bush in any season. The cultivated landscape and highway corridors have provided a jumping off point for this species to invade forests and open spaces. Although it does not spread as rapidly as some other invasives, given time the result is equally devastating. Happy in sun or shade, Burning Bush produces copious quantities of fruit that are attractive to birds, its primary means of dispersal. More troubling than its massive seed production is the shade cast by its dense foliage. In addition, the root system forms a nearly impenetrable mat just a few inches below the soil. The combination of dense shade and dense root system makes it impossible for anything to survive beneath an established Burning Bush except its own

Burning Bush *Euonymus alatus*



seedlings. A first hand example of Burning Bush gone bad can be seen in a yard in Hopkinton, Massachusetts. When the house was built in the 1950s, three specimens of Burning Bush were planted as part of the landscape. Today they are well-established shrubs with a beautiful form and lovely fall color — a magnet for every bird in the area. From 1978–1997, the house was left vacant and essentially untended. In this time, the three shrubs parented at least 1,000 offspring spreading to the woodland border around the property, along the edge of the road, throughout the neighborhood, and into the natural area beyond. This plant is still used widely in landscape and highway plantings. Our native Highbush Blueberry is a more suitable shrub. It has wonderful fall color, great structure, grows in similar conditions and has a fruit that is not only good for wildlife but for people too.

Some confusion about this problem plant comes from its having been described variously as a forage toxic to grazing animals, particularly horses and cattle, but also as a browse for sheep. The milky juices of the cut plant are said to be a skin irritant, capable of causing a rash in sensitive individuals. That milky juice, and the pinkish buds on its wide-spread perennial roots, help to distinguish it from similiar plants. Another visible cue is the dense bunches of greenish-yellow flowers on multi-branching umbels which begin appearing in spring and continue well into fall. This perennial is capable of reproducing both by the seeds contained in three-lobed seedpods, which follow the flowers, and by those pink root buds, from which erect stems and large numbers of narrow leaves grow from a whorl of stubbier leaves. Cypress Spurge has spread from cultivation into pastures and abandoned farmland, woodlands and along roadsides. Because of its toxicity, this plant is regarded as particularly troublesome to livestock in pastures. Natural enemies from its native Europe are being studied and some results are promising.

Cypress Spurge *Euphorbia cyparissias*



Goutweed *Aegopodium podagraria*

This herbaceous perennial, with delicate clusters of flowers similar to Queen Anne's Lace, is often sold in garden centers as a durable ground cover. Indeed the plant will not die, but rather will spread and persist for years in the garden and out through the fence into the edges of natural areas. It is also found invading floodplains along the Connecticut River. A gardener who introduced some plants years ago into her garden admitted to using herbicides (not necessarily according to the label), landscape cloth under bark mulch, and persistent weeding to try to eliminate the shoots bearing three-part leaves. Small pieces of root left after weeding easily resprouted, much to her aggravation. Not only is Goutweed an ongoing nuisance in the garden, but it persists in more natural areas and can become locally abundant, remaining for years after the frustrated gardener has moved away.



Honeysuckles

Lonicera Morrowii, *L. tatarica*, *L. Maackii*, *L. x bella* & *L. japonica*

Originally from Russia, Asia, and Japan, these robust shrubs, and the related vine, were introduced as garden ornamentals for their sweet-smelling flowers, colorful orange to red berries, and attractiveness to birds. They were widely promoted by the U.S. Soil Conservation Service for erosion control and wildlife cover, and continue to be offered by nurserymen as a versatile plant. Consequently, they are now well-established in abandoned fields, edges of woods and wetlands, and along roadsides. Adaptable to a variety of soil types, moisture regimes, and light densities, the several shrubs, and the equally adaptable vine, Japanese Honeysuckle, have become dominant plants in many conservation lands and

on uncontrolled edges of home landscapes. Observations show that little grows in the dense shade of these six- to 10-foot plants. Honeysuckles shade out the ferns, grasses, and wildflowers that serve as important microhabitat for insects, small rodents, and snakes. They also suppress forest succession. The Japanese Honeysuckle vine covers the ground in a lush thicket that smothers other plants. Once established, Honeysuckles can homogenize the landscape for years to come. Despite their seductively sweet scent, homeowners are wise not to introduce them into their yards and to pull up any seedlings from seed deposited by birds before they become too much of a good thing.

A classic example of an invasive water plant, Hydrilla (shown in this picture surrounding native waterlilies) is on the federal "prohibited plant" list and is considered one of the top problem weeds in some U.S. states. Hailing from Australia, Asia and Central Africa, this plant was first identified in Florida in the 1960s, probably discarded when an aquarium was cleaned. In less than 40 years, Hydrilla has spread throughout the southern states and as far west as Washington and California, and north to New England, where it has gained a foothold in Connecticut. The branching, upright stems of this underwater plant can extend 25 feet or more to reach the surface, where it produces stalks of small white flowers. It closely resembles our native Elodea, but unlike the



Hydrilla *Hydrilla verticillata*

native, Hydrilla has half-inch tubers borne on underground stems and spreads both by these and by stem fragments. It tolerates difficult conditions, including dim light, nutrient-poor water, and a broad temperature range. Heavy concentrations of Hydrilla are known to degrade water quality and foul waterways, curtailing recreational activities. In Florida, where Hydrilla is the chief aquatic pest plant, millions of dollars have been spent on control using herbicides and harvesting equipment. Biological control attempts in the south include a fish and several different insects imported from Hydrilla's native regions. Despite some successes, this vigorous invader remains

remarkably difficult to control — a significant and costly problem. Because it is newly arrived in New England, vigilance and vigorous control may still prevent its spread here.

One of our most widespread invasive plants, this small, thorny shrub was first brought into the Boston area as seed around 1875. Widely used as an ornamental hedge because of its brilliant fall foliage and scarlet fruit, it seems to be dispersed primarily by birds, which consume its fruits. It has naturalized in many habitats but is most common on field edges, roadsides and in open forests. Easily identifiable by its small, untoothed leaves and the presence of a single spine beneath each cluster of leaves, it is also one of the first plants to leaf out in the spring, coloring the forest in a pale green haze. A related species, Common Barberry (*Berberis vulgaris*) is separated from the Japanese variety by its toothed leaves and the presence of a two

Japanese Barberry *Berberis thunbergii*



site in the Berkshires is not the exception. Many of our forested natural areas, especially in southern New England, are suffering the same fate as the lower slopes of Mt. Race.

Even Alaska, which still has few invasive exotics, has fallen victim to Japanese Knotweed. This fall-blooming, herbaceous perennial can reach a height of ten feet on hollow stems that resemble bamboo. Introduced from Japan in the late 1800s as an ornamental species, it soon escaped from gardens into the wild. Its spread was furthered by its use for erosion control along streams and rivers. Tolerant of high salinity, deep shade, and heat, it is rumored to be able to push its way through several inches of asphalt. Once established, it forms large, dense colonies that are extremely difficult to control. Japanese Knotweed spreads primarily by rhizomes (underground stems), which can travel up to 65 feet from a single plant. Initially

Japanese Knotweed *Polygonum cuspidatum* or *Fallopia Japonica*



quick growth and the dense shade cast by the large leaves of individual plants and colonies, make this species a major threat to native plant communities. River shores are especially at risk.

or three-branched spine beneath each cluster of leaves. On a recent visit to Mt. Race in Sheffield, Massachusetts, a group of NEWFS volunteers searching for an endangered species ran into an extensive stand of Japanese Barberry. Anyone familiar with the Berkshires knows the wonderful flora of these limestone regions. But as we entered the forest what lay before us, as far as the eye could see, was a floor dominated by Japanese Barberry. We had to force and hack our way through more than half a mile of these thorny shrubs. Under their dense cover, virtually nothing but Barberry seedlings was able to grow. Unfortunately this

botanists believed all the plants in North America were female, produced no viable seeds, and reproduced only vegetatively, as is the case in the United Kingdom. Recent research has shown that viable seeds are produced. Plant pieces in fill or compost can regenerate into a new colony. This species has the ability to flower the first year from seed given suitable conditions, giving it a substantial advantage over most native species. In late autumn, as the canes die off and fall to the ground, they create a thick layer of mulch through which nothing but Japanese Knotweed can sprout. This, in combination with its early emergence,

This easily overlooked, shade-tolerant annual, first seen in Tennessee in 1919, is now found from Florida to Connecticut, west to Ohio. In New York and Connecticut it can be seen along the Hudson and Connecticut Rivers. It prefers moist shady habitats such as river banks, floodplains, swamps and woodland thickets as well as roadsides. Each plant typically produces over 100 seeds, enabling rapid spread, replacing herbaceous ground vegetation within three to five years of its

arrival. Floodplains and wetlands harbor specialized herbaceous species such as native buttercups which cannot compete with this thick-growing, lime-green grass that can be 24- to 40-foot high. Also called "Chinese Packing Grass," this plant may have been introduced as protective packaging for imported porcelain. The fact that it is just arriving in New England offers an opportunity to control it before it affects the natural integrity of our valuable floodplain and wetland habitats.

Japanese Stiltgrass *Microstegium vimineum*



Mile-A-Minute *Polygonum perfoliatum*

Mile-A-Minute is an attractive annual vine with triangular, blue-green leaves. The stems, as well as the midrib of the leaves, have recurved spines, which aid it in climbing over vegetation and structures. Single plants produce huge amounts of seed, which remain viable in the soil for up to five years. The blue fruits are primarily dispersed by birds, although they also float, making use of rivers and streams for dispersal. Commonly found in open or edge situations and requiring sunlight to grow vigorously, Mile-A-Minute can survive in shaded situations with greatly reduced growth. Unlike such woody vines as Oriental Bittersweet, which strangle other vegetation,

Mile-A-Minute simply crawls over other plants, matting them down and preventing sunlight from reaching their leaves, making it a serious pest for agricultural and nursery crops, as well as native plants. A native of Asia, seed of Mile-A-Minute was accidentally introduced into a Pennsylvania nursery in 1938. Within three years it had spread into half a dozen counties in Pennsylvania and today is found in all the mid-Atlantic states. At the time of this writing, Mile-a-Minute has not been documented in New England. At last report it was in New York, just a mile from the Connecticut border and, given this vine's extremely rapid growth rate, indicated by its common name, it is surely here by now.



Multiflora Rose *Rosa multiflora*



Native to eastern Asia, this plant is now extensively naturalized in old fields, roadsides, and backyards throughout most of the northeastern and midwestern U.S. It was originally promoted as understock (or root) for grafted ornamental roses and later distributed widely as living fences for livestock, erosion control, and wildlife cover. Its large clusters of fragrant white flowers and showy rose hips are appealing. Some say that the northward expansion of wintering mockingbirds, robins, and cedar waxwings is due in part to the prevalence of this thicket-forming, berry-producing plant. The seeds are easily dispersed by birds and mammals and remain viable in the soil for 10 to 20 years. While certain songbirds have benefited, other plant and animal species have been displaced. Control measures include using the "brontosaurus"—a giant mulching machine—persistent cutting (three to six times a year for two to four years), herbicide spraying, or perhaps grazing by goats. Some hold out hope for a native virus spread by a mite; however, native roses, plums, apples and other members of the rose family are also susceptible to this biological control. Despite its attractions, introduction of Multiflora Rose seems to have been an expensive mistake.

Norway Maple *Acer platanoides*

This stately native of Europe and western Asia has long been a popular ornamental and street tree in New England. The very traits that make it attractive — easily transplanted, rapid-growing in a variety of light, soil, and moisture conditions, hardy under environmental stresses like drought and pollution, resistant to pest damage — ensure its success as an invader, giving it the potential to outcompete its valuable, indigenous relative, the Sugar Maple. The two trees are very similar in shape, size, flower and fruit, but the Norway Maple is distinguished by dark, furrowed bark, generally larger, broader leaves, and yellow autumn coloring.

When torn, the Norway's leaves and stems exude a milky sap, which is the easiest way to identify this species. Seedlings sprout readily, in urban, suburban, and natural areas, along roadsides, woodland verges, and at the margins of wetlands, forming dense, shady canopies that inhibit wildflowers as well as the seedlings of other trees. Control includes pulling saplings as soon as they can be identified, cutting larger trees, and inhibiting sprouting if necessary. Advocating the elimination of Norway Maple is complicated; it is still important in the nursery trade and, because of its hardiness in urban settings, it is a valuable street tree.



Oriental Bittersweet *Celastrus orbiculatus*

No habitat is safe from the onslaught of this twining woody vine. Native to the temperate regions of Japan, Korea and China, it was introduced into North America in the mid-1800s as an ornamental and soon spread from Louisiana to Maine. An invader of open fields, forests, wetlands, meadows, edges of salt marshes and many roadsides, its woody stems wrap around and strangle trees, shrubs and other vines. When it can find no surface to climb on, it will simply scramble around on the ground until it locates a victim it can scale. By forming an impenetrable tangle, it chokes out all other vegetation. Even in its native range it is a domineering plant, blanketing the lower slopes of mountains. Oriental Bittersweet can grow to a height of 60 feet, so even mature forest trees are not safe from its smothering grasp. Also known as Asiatic Bittersweet, it is most easily identified in autumn when the yellow fruits split open revealing the bright red seed covering

(aril). This covering is a nutritious food for a variety of wildlife, which eat the fruit and disperse the undigested seed. Humans contribute to its spread by using the vines and seeds in holiday decorations. Discarded wreaths and swags quickly sprout on the trash heap. North America has a native bittersweet, *Celastrus scandens*, which can be confused with the invasive species. American Bittersweet has flowers and fruits only at the end of each branch. Oriental Bittersweet's flower and fruit are located in between the leaf and stem. It is suspected that the two kinds of bittersweet may hybridize. Recent observations around Framingham, Massachusetts, reveal many bittersweets in the wild that may exhibit characteristics of both species, but might retain the invasive nature of Oriental Bittersweet. Control is difficult; when cut off, the vines resprout and grow quickly.



Phragmites or Common Reed *Phragmites australis*

The Common Reed, or Phragmites, is one of our most visible invasive species. Its colonies of eight- to 10-foot stems are found in wetlands and along the coast in saltmarshes, as well as in roadside ditches. Mysteriously, Phragmites, unlike most other invasive species, is believed to be a native. Soil records indicate its presence in Connecticut 3,000 years ago, while individual stands are thought to be as much as 1,000 years old. Until fairly recently Phragmites was a naturally occurring part of many tidal and non-tidal wetland habitats where it fills a small niche, providing water filtration and food and cover for several wildlife species. But increases in development and agriculture in and around wetlands have created disturbed situations that Phragmites is well-suited to exploit. Producing copious amounts of seed, dispersed by



wind, water, or wildlife, it can quickly become established at a new site, where it forms a dense stand, sending up new shoots from its root system or above-ground runners. These runners often travel great distances from the parent plant. The largest stand of Phragmites, over 7,000 acres, is found in the Hackensack Meadows in New Jersey, opposite New York City. Some scientists believe that around 1900 a new aggressive strain of *Phragmites australis* was introduced from Europe, and it is this strain that is invasive. Whether native or exotic, the ecological effects of Phragmites are obvious. Once-diverse wetland communities have been reduced to monotonous stands of *Phragmites australis*. Although Phragmites has some wildlife value, it is causing the decline of many species much more beneficial to wildlife.

"*Celastrus orbiculatus*: Another terror in my gardens. I love to see *Celastrus* growing over multiflora rose. I call it 'the battle of the invasives.' *Celastrus* almost always seems to win."

— Leslie Duthie
Norcross Wildlife Sanctuary, Monson, MA

"Oriental Bittersweet is the 'Kudzu of Rhode Island,' spreading rampantly throughout the state, but most especially in coastal areas and on many of the offshore islands."

— Lisa L. Gould
Rhode Island Natural History Survey, Kingston, RI

Porcelain Berry

Ampelopsis brevipedunculata



This delicate-looking vine with shiny bunches of berries, in shades from white, yellow, lilac or green, to a bright turquoise blue, was introduced from northeast Asia in the 1870s as an ornamental plant in estate gardens along the Atlantic seaboard. Ironically, the plant can be found in the backyard of Minna Hall, one of the founders of the Massachusetts Audubon Society, who lived in Brookline, Massachusetts, more than 100 years ago. Now a 3.5 acre sanctuary surrounded by highrises, this remnant of countryside is overwhelmed by Porcelain Berry and other invasive exotic species. Local groups and conservation commissions are working to control, if not eradicate, this plant and other exotic species, and to replant the site with native species of value to wildlife. Porcelain Berry has become locally dominant along the coast where it is spread from gardens by birds. It is still sold at garden centers and is still as appealing to the unknowing gardener as it may have been to Mrs. Hall almost 100 years ago.

Spotted Knapweed

Centaurea maculosa

This is a pervasive rangeland pest in the western U.S. where it covers thousands of acres, reducing livestock and elk forage by up to 90%. It is a short-lived perennial which overwinters as a rosette and then shoots up by late spring to produce pink flowers by mid-summer. The seeds do best in full sun and therefore the plant is less of a nuisance in the shade of our eastern forests. However, it does grow along roadsides and into grasslands. It is also found growing at a site on the

Connecticut River in Massachusetts near populations of rare asters. So far it doesn't appear to be in direct competition with them. Resource managers recommend an integrated set of control measures including using introduced weevils and flies (which affect roots and seed set), spot application of herbicides, and competition from other species. Though not yet a major presence in the east, it has great invasive potential. Care is recommended in handling this plant, as it is suspected to be carcinogenic.



First introduced in 1784 in Philadelphia as a horticultural specimen, this native of central China was well-established by the mid-1800s. Its aggressive nature and ability to spread both by seeds and root suckers was documented as early as 1850, but planting continued well into the 1900s. Resistance to disease and pests as well as a tolerance for poor soils and pollution made it valuable in urban settings. Tree of Heaven has spread into rural, agricultural, and natural communities, where today it is considered a serious problem, commonly found invading abandoned fields or open meadows where it forms island-like colonies. Individual specimens are not long lived, but the colonies can persist indefinitely. If a tree is injured, it will send up shoots from the stump which can reach 15 feet in a single season. The dense growth makes it difficult for native tree seedlings and herbaceous vegetation to compete. Growth buds located at intervals along the



Tree of Heaven

Ailanthus altissima

root system remain dormant until reaching a suitable area (often quite far from the parent) where they will grow rapidly, thereby expanding the colony. A single mature tree can produce 300,000 papery, winged seeds in one season, which are dispersed by wind and may remain dormant for several years before germinating. It does not take long for new colonies to take hold and dominate the areas, as a seedling can grow up to three feet per season! The trees also produce a chemical compound that is fatal to some other vegetation. With competition such as this, native flora stands little chance. Control of this species is difficult, but can be accomplished by

the use of some herbicides, once proper identification is made. Tree of Heaven closely resembles some of our most valuable native trees and shrubs including Walnut, Sumac, and Elderberry. It can be distinguished by its long compound leaves with smooth edged leaflets except for one to three teeth near the leaflet base, and by its winged fruits.

This aquatic plant is locally dominant in several lakes and slow-moving rivers in Massachusetts and Vermont. Rowers along the Charles River in Cambridge, paddlers on the Sudbury River west of Boston, and fishermen in Lake Champlain are among those who have tangled with this weed, which sprouts from a sharp-spined fruit capable of puncturing tractor tires and crippling horses and dogs. The plants grow quickly, with stems up to 16 feet long forming a tidy, bladder-supported rosette almost a foot across, and flowers which produce up to 15 new seeds within the growing season. The whole plant rosette can spread by floating downstream or the Darth Vader-like fruits can hook a ride on the breast of a

Water Chestnut

Trapa natans



goose or duck. Large mats of vegetation form in quiet waters, where they deplete oxygen and cause fish kills, blocking out light for native vegetation, and providing ideal habitat for another exotic invasive, the carp. The annual's biomass fills in shallow areas and speeds the eutrophication process. Volunteers in one town recently worked to eradicate the plants and seeds on a popular lake only to discover another population in a small cove across the way, making their days of work in vain. The U.S. Fish & Wildlife Service has spent hundreds of thousands of dollars in an attempt to control this species in national wildlife refuges in Massachusetts and Vermont.



Wineberry

Rubus phoenicolasius

“Absolutely delicious!” Like birds and bears, humans can be lured to spread a plant by an appeal to the tastebuds. Those who have tried it pronounce this member of the raspberry family remarkably fine, with a tangy sweetness suggested by the common name. Yet another of its remarkable characteristics, and one that makes it much less welcome, is its ability to quickly grow out of control, becoming an impenetrable tangle in a very brief time. Originally from Japan and Western China, Wineberry entered England in the late 1800s and soon after was brought to the U.S. where it escaped from cultivation. *R.*

phoenicolasius can be distinguished from other members of the populous raspberry clan by the extremely dense and visible long reddish hairs which stand out stiffly erect on the stems, giving them a furry appearance from a distance. The fruit is bright red. Birds, especially robins, seem to enjoy these, dispersing the seed over wide areas. Like most raspberries, when cut back, Wineberry tends to resprout vigorously and is equally difficult to control. The hairy white undersurface of the leaves contrasts vividly with the dark green upper surfaces. This shrub is increasingly common in southern New England.

Yellow Flag Iris

Iris pseudacorus

This showy European native was extensively planted to provide a splash of color along pond edges, stream banks, and in other places with enough moisture. Because of its deep blue-green sword-like leaves and lemony yellow flowers, etched with brown, the Yellow Flag Iris became immensely popular. Standing two to four feet high with pointed leaves and large bright flowers that can be surprising when encountered far from cultivated gardens and domestic ponds, it energetically colonizes wild wetlands and streamsides, where

it can displace native irises. It has spread relentlessly since first reports of its escape from cultivation in New York State in the late 1800s, and is now frequently spotted along eastern Massachusetts shorelines. It is also found in the far west along waterways in the San Francisco Bay area and the wine country of California. It spreads by seed and by division. To control, dig or pull the whole plant. Because of its tendency to resprout, burning can worsen the problems caused by this attractive nuisance.



What are Our Options?

Education, control efforts & what comes next

By Greg Lowenberg

As evidence pointing to the negative impact of non-native invasive plants on our regional flora and fauna accumulates, several basic questions arise: What should be our collective goals as citizens, landowners, land managers, and government officials? What strategies can we follow to limit or reverse the spread of invasive plants? What are the highest priorities we can agree upon, and what human and monetary resources can we bring to bear on the problem? Finally, should these problems be attacked in a coordinated way regionally or nationally, or will we do better with decentralized grassroots efforts at the community or individual landowner level? What role, if any, should there be for government, in the form of legislation and regulation?

These are difficult questions and answers are only now beginning to emerge. While we begin to grapple with the problem, non-indigenous weeds are already spreading rapidly, consuming over 4,600 acres of wildlife habitat per day on public land alone. The cost of *preliminary* management attempts to prevent the spread of just one species, Purple Loosestrife, is estimated at \$45 million per year. Annual costs of non-native invasive plants have been calculated in the billions of dollars nationally, and these estimates don't reflect the incalculable costs to natural ecosystems. Will we grasp the complexities of this issue soon enough to apply effective



Nature Conservancy volunteers and staff hand pull entire Water Chestnut plants from East Creek, Vermont. The annual plant's seeds remain viable in the bottom sediments for up to twelve years, so this strategy will only pay off with persistence and continuing control efforts. In Vermont, the goal is to progressively eliminate populations, starting in the north and working toward the southern tip of Lake Champlain, its point of original introduction into Vermont from the Hudson Canal.

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"The invasion of noxious alien species wreaks havoc on America's environment and economy that is matched only by damage caused by floods, earthquakes, mudslides, hurricanes, and wildfire. These aliens are quiet opportunists, spreading by a slow motion explosion."

— Secretary of the Interior Bruce Babbitt

tive controls?

The goals of this article are to discuss what is being done now to inform the public about the problems caused by invasive non-native plants, to look at the range of control options, and to suggest some potential next steps in what will probably be a long-term public effort in New England and across the country.

Public Awareness Lags

How much does the public actually know about biological invasions by plants? A recent survey by Peter Alpert of the University of Massachusetts ["Public Awareness of Biological Invasion," *Natural Areas Journal*, 18 (3):262-66, 1998] concluded that invasive plants are not generally perceived as a problem. Alpert and his colleague, Thomas Colton, discovered that, while many respondents had a good understanding of the concept of "weed," almost none (2%) realized that most weeds are non-native. Fewer than one in five of the common "weeds" that people could name were among the serious problem non-native plants of natural areas. In short, the average person does not seem to have noticed the advance of Buckthorn on our forests or the expansion of Eurasian Watermilfoil in our lakes.

In fact, about a third of Alpert and Colton's respondents thought of weedy invasive plants as attractive, helpful in controlling erosion, or useful as food for animals. Such conceptions might result in public opposition that could thwart serious attempts to protect native plant and animal communities.

Organized public information will be needed to provide the answers people will need to make informed decisions and participate in concerted efforts to address these problems at every level. Scientists are already working hard to assess the the negative effects of invasive plants and the options available for their control. This work needs more exposure if we are to arouse broad public support for proposed control strategies.

Efforts to inform the public in New England about non-native plant invaders have already begun. The Massachusetts Division of Fish and Wildlife recently published a guide to invasive plants, complete with color photos, line drawings, and background information about the most common problem species. The Connecticut and Vermont Departments of Environmental Protection, in cooperation with The Nature Conservancy's state chapters, have issued sets of fact sheets on invasive plants, including information on control methods. Several state resource agencies in New England have published similar guides to invasive aquatic plants in an

effort to help recreational users of waterways identify problem species and prevent their spread.

Garden organizations are also getting involved. The Garden Club of America has taken "Alternatives to Invasives" as one of their conservation themes. They are distributing information about garden plants that disrupt natural ecosystems, and providing gardeners with lists of alternative species. The Brooklyn Botanical Garden recently published a popular guide to invasive plants, with species profiles and practical information that is also useful to New Englanders.

The issue of invasive plants has the potential to unite many interest groups, ranging from those concerned about wetlands (duck hunters, birdwatchers, conservation commissioners, fisherman), forests (landowners, foresters, ecologists, wildlife enthusiasts, hunters), and horticulture (landscape designers, growers, nursery operators, gardeners). As a coalition of people with diverse interests forms to push for solutions to a mutually-perceived problem, the solutions, in turn, will call for close collaboration among governmental agencies, private citizens and diverse organizations.

Some Options for Invasive Plant Control

Many methods are being developed and studied in the effort to combat the spread of non-native plants. The choice of methods depends on the nature of the species to be managed, the scope of the problem, the sensitivity of the affected ecosystem to disturbance, and the human resources available. Often, two or more methods used together are most effective. But, we still do not know what works best in most cases; a much greater research effort is warranted for invasives that are severely out of control.

Prevention & Early Detection

An analogy might be made between a plant invasion and the development of cancer in a human body. At the beginning, the problem is very localized and does not immediately disrupt normal functioning of the overall system. The initial growth of the population (of plants or cancer cells) is slow and unnoticeable. Eventually, perhaps after many years, the number of invaders reaches a critical mass and results in a fairly rapid spread to other areas. Once this happens, conditions are ripe for widespread disruption of system functioning, and control becomes much more difficult. Although not a perfect analogy for every plant invasion, it does point to prevention and early detection as the best strategies in any control effort.

Almost everyone involved in the issue agrees that the most efficient, cost-effective way to stop the spread of invasive plants is to prevent them becoming established in the first place. Unfortunately, prevention is far more difficult than might be imagined.

The difficulty begins at our national borders. A federal agency, APHIS (Animal and Plant Health Inspection Service), exists to control the importation of "noxious weeds" under the Federal Noxious Weed Act. [See "Legislative Notes," page 30.] Of the 1,400 scientifically recognized pest plant species in the U.S., only about 100 are officially recognized by APHIS as noxious weeds, and only a few of those are non-agricultural weeds of natural areas. Many of the species mentioned in this issue of *New England Wild Flower Notes* are still not on the federal list. Although it is not known how many potentially invasive species have been prevented from reaching our shores, the prevention strategy has not been entirely successful. Recognition of pest status usually comes only after a species has already invaded, when control has become expensive and difficult.

The chief conundrum in prevention is how to recognize a species that may turn into an aggressive invader before it is introduced. Of approximately 4,000 exotic plant species in the U.S.,

most are quite benign or pose few problems. Only a relatively small number of species manage to proliferate into natural areas. Some of these invasions may take decades or even centuries to manifest. Oriental Bittersweet (*Celastrus orbiculatus*), introduced as an ornamental in the mid 1800s, apparently reached a "critical mass" via bird dispersal of its seeds and has virtually exploded in a variety of habitats. Many land managers report an extremely rapid spread of several non-indigenous plant species beginning only in the past 15 to 20 years on the sites they monitor, even though these species were introduced long ago.

Predicting Success

One situation in which prevention can be successful occurs as species move from state to state. Where a known invasive species has not yet entered a state, a combination of regulations and a program of monitoring has the potential to prevent its establishment. For example, Mile-A-Minute (*Polygonum perfoliatum*) is established in New York, at the northern edge of its current distribution, within a mile of the Connecticut border. Aptly named for its expansive tendencies, it will certainly arrive soon in Connecticut unless a concerted effort is mounted to prevent its invasion. Water Chestnut (*Trapa natans*) is already present in New England, but has yet to invade aquatic habitats in Rhode Island, Connecticut, and Maine. In both instances, timely cooperative action at the state and local levels, against plants already known to be problems elsewhere, can make a difference.

After an invasive species has been identified as a problem, another form of prevention is the avoidance of intentional planting. Government agencies, which were once among the worst purveyors of aggressive invaders — planting such species as Multiflora Rose and Autumn Olive — have begun to see the light and now promote native species for erosion control, wildlife habitat, and roadside cover. This change of policy has not trickled down to all agencies, however, and it is now up to citizens to monitor the practices of their local agencies and to push for the use of native alternatives.

The nursery industry is also coming to grips with the results of past practices. [See page 11.] More than half of our invasive plant species were originally introduced through horticulture and many are still being marketed at nurseries and garden centers. Although some states have banned the sale of a few species (notably, Purple Loosestrife), the nursery industry is largely unregulated with respect to invasives and relies on voluntary compliance and the enlightenment of its members, as well as pressure from the public to restrict its marketing of invasive species.

If the goal is to prevent establishment in a very localized natural area and the plant species is well known as an invasive one, then a strong monitoring effort by landowners, managers, or citizens may be able to detect the invasion at an early stage, when eradication is more feasible. This is especially true for lands that have not been significantly disturbed in the past. The Nature Conservancy has provided a good model, organizing exotic plant "swat teams" to evaluate and suppress invasions of particular species on their preserves.

Another facet is how rapidly a control effort can be mounted once an invasion is detected. A one- or two-year delay often makes the difference between effective management and an uncontrollable infestation. For example, lake associations that are able to detect and act to eliminate Eurasian Watermilfoil (*Myriophyllum spicatum*) at an early stage have a much better chance at eradication, since growth of this aquatic invader is extremely rapid.

On a small scale, decentralized efforts make good sense. But if the matrix of lands surrounding natural areas harbors large populations of invasive species, re-invasion will be a continuous problem, and early detection and local eradication may be ineffective. Many

conservation lands are already overrun with invasives. Where this is the case, coordination at a broader level is required.

Biological Controls: Considerations & Precautions

Biological control, though potentially the only effective tool to combat certain widespread invasives, may not be appropriate for all invasive plant species. Good biological control programs for plants require that the agents of control (usually insects or fungal diseases) attack that plant species alone. Such specialists are not always found in a plant's native habitat, and even when they are, may not survive being moved to a new part of the world.

When they do thrive, some imported insects can end up having unexpected effects, not unlike those of the plant they were meant to combat. They may switch plant hosts or expand their food preferences when placed in a new environment. For instance, *Rhinocyllus conicus*, a weevil imported to stem the spread of European Musk Thistle, has expanded its geographic range beyond that of the target plant and now feeds heavily on several native thistles, including at least one rare thistle. Such shifts can even impinge on other native species that feed on the same hosts.

Since the introduction of a single species can cause a cascade of repercussions to an ecosystem, rigorous research on the ecology and behavior of a proposed biocontrol agent is absolutely necessary. Great care must be exercised in protecting native species from disruption.

In the case of Purple Loosestrife, the U.S. Department of Agriculture, which gave approval to species introductions for biocontrol, was satisfied that the insects would not also feed on closely-related plants. This large-scale experiment is now underway across North America, and it remains to be seen whether there will be unforeseen side-effects.

Mechanical Control Methods

Mechanical control is most favored where the invasion is small, when other methods are environmentally risky, and when the plant can be physically yanked from the ground or water without disturbing other vegetation. Repeated defoliation of certain perennial invasives is also sometimes effective. In some cases, fire or mulching can eliminate localized invasions.

For example, where infestations of Purple Loosestrife are light, hand-pulling is appropriate when done before plants set seed in late summer. This is already being practiced on several Nature Conservancy preserves in the region, and has potential in other small wetland areas. One innovative Canadian program with a focus on smaller infestations provides an interesting model. In 1994 the Manitoba Purple Loosestrife Project and the Manitoba Weed Supervisors introduced an exchange designed to get Purple Loosestrife out of backyards. Non-invasive perennial plants were given to anyone who dug up and brought in a Purple Loosestrife. Ten thousand Loosestrife plants were redeemed in the first two years, and countless incipient invasions were thwarted.

Groups of volunteers are beginning to attack infestations of shallow-rooted shrubs like Buckthorn and Honeysuckle that invade forests and wetland edges. Using a "weed wrench" — a tool that grabs the base of a woody trunk tightly and supplies tremendous leverage to pull the whole plant from the soil — a team can make significant headway in a recently infested area.

Hand-pulling of Water Chestnut (*Trapa natans*) from canoes has been conducted annually in tributaries of Lake Champlain in Vermont. Scores of volunteers have participated in an effort that appears to have drastically reduced the populations of this aggressive aquatic invader. This program is coordinated with a mechanized harvesting program in the lake itself, conducted by

Purple Loosestrife in Michigan A Study in Biological Control



Purple Loosestrife (*Lythrum salicaria*), a European import, is now a highly aggressive invader of North American wetlands. The species was introduced over one hundred years ago. Now found in 36 states, Purple Loosestrife chokes out nearly all native vegetation where it occurs and severely degrades wildlife habitat. No bird, mammal or fish in North America is known to feed extensively on Loosestrife, although some beekeepers see it as a good late-summer nectar source. Purple Loosestrife is still extending its range within many states. Each plant can produce up to two million seeds, which remain viable in the soil for many years. Once established, populations are very difficult to eradicate.

Biological control of Purple Loosestrife by introduction of natural enemies from its native range appears to be the only practical solution where the plant is established over a large area. Chemical control is currently not considered practical or safe. Three species of insects, native to Europe where they feed on Loosestrife naturally, were tested and received USDA approval for importation and release in 1992. Data from recent releases in 27 states (including most New England states) and all the Canadian provinces are just coming in. Most effective appear to be two *Galerucella* beetles that feed on bud, leaf and stem tissue, thus preventing or inhibiting flower and seed production.

The State of Michigan provides a model that could be replicated in New England states or in the region as a whole. Beginning in 1994, the Michigan Department of Natural Resources (MDNR) received approval to release *Galerucella* beetles on several infested state game areas. Within three years the insects were established in the release areas and began to have an effect on Loosestrife populations there. Then, with the cooperation of Michigan State University where a lab produces 150,000 *Galerucella* per year, a training program was set up to involve local groups in the research. As of this writing, local stakeholder groups all over the state are releasing beetles at many sites, and setting up their own beetle-rearing facilities. These groups are committed to long-term monitoring of their areas. Conservation commissions, environmental organizations and even public school classes are involved in this hands-on science project. These releases are predicted to reduce the density of Purple Loosestrife in some areas by as much as 80% in the next ten to twenty years.

This kind of partnership approach, coordinated at the state level, but with action at the local level, may be the best way to achieve results when the problem is widespread. A great deal of education is accomplished, resulting in a public that is knowledgeable and supportive of biological control techniques. Implementation of a strategy is spread over a large area and conducted by people that will have an incentive to stay involved for years to come.

Chemical Control Methods

Integrated Pest Management (IPM) is a technique of the agricultural industry that may have the potential to help rid natural areas of invasive plants as well. Chemical control methods are combined with a variety of mechanical and biological methods, minimizing the use of chemicals by applying them in low doses at strategic times in the life cycle of the pest. There is considerable public opposition to chemical spraying, however, and it may not be easy to gain acceptance for chemical use, even when combined with other methods.

One promising way to apply chemical herbicides in the most controlled and minimized way involves cutting woody plants such as Buckthorn and Honeysuckle, followed by an application of a glyphosphate herbicide to the cut stump. Several studies have shown this to be an effective method of killing these woody shrubs, where cutting or stem girdling have only resulted in resprouting at the base of the plants. The control method can be performed in the winter when the ground and water are frozen, a major plus for dealing with species like Glossy Buckthorn, which grows in and along wetlands. In addition, since other plants are dormant, the cut-and-herbicide method is not likely to harm surrounding vegetation, comparing favorably with aerial spray methods.

Chemical controls might be effective when an invasive plant so completely dominates an area that spraying will not damage other components of the ecosystem. This is rarely the case in natural areas. Infestations of Common Reed (*Phragmites australis*) sometimes fit this category, and recently an herbicide treatment resulted in the reestablishment of a natural community in a western Massachusetts fen. Most herbicide treatments are non-selective, however, so where the invasive plant is only one component of a complex community of plants, it will be very difficult to spray chemicals and not do more harm than good.

A Glimpse of Two Possible Futures

How will our natural ecosystems look in the future with an unchecked spread of non-native plant invaders? Here are a few

projections:

1. A significant proportion of our most rare plant and animal species may become even more endangered and perhaps be driven to regional extinction or, in some cases, global extinction.
2. Natural communities will be further degraded, leading to the loss of biodiversity, as animals and other organisms that depend on native species are displaced.
3. The functions of ecosystems that are important to humans, such as water filtration, wood production, and recreation will be further diminished.
4. Economic costs will continue to mount, both due to loss of use and because of increased need for expensive control efforts.

Given what we know about them, the problems caused by invasive non-native plants are not going to go away. In New England, we have the opportunity to address this problem effectively. As communities, as states, and as a region, we can sustain and increase efforts that have already begun. Among the most important goals should be:

1. To conduct surveys to assess the extent of the problems.
2. To fund basic and applied research that will help us better understand the effects of these species on our native flora and fauna, how to protect our ecosystems from invasions, and how to safely extirpate the most aggressive species that are already present.
3. To agree on goals for control efforts for each species.
4. To further educate the public and get all stakeholders involved in management activities.
5. To take effective steps, including legislation and industry standards, to prevent further introductions of potentially damaging species.

If we're really serious about achieving these goals, let's make sure that efforts are coordinated between local, state and federal agencies. We must use the local expertise of citizens and stakeholders, as well as scientists. Finally, an effective effort to protect both our natural heritage and our economy should recognize that the two are fully compatible, and will remain so when the effort is largely carried out at an informed, motivated grass-roots level. ❁

Legislative Notes

The Animal and Plant Health Inspection Service (APHIS) is charged with implementing federal laws related to imported plants ("weeds") and imported pests of economically important plants ("plant pests"). Current federal laws, regulations, and policies that affect APHIS's authority with respect to weeds include:

The Federal Noxious Weed Act [7 U.S.C. 2801-2814] 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 of Agriculture is authorized to initiate control and eradication actions against incipient infestations of noxious weed that are introduced into this country. "Noxious weed" means any living stage... of any parasitic or other plant of a kind, or subdivision of a kind, which is of foreign origin, is new to or not widely prevalent in the United States, and can directly or indirectly injure crops... or other interests of agriculture, including irrigation, or navigation or the fish and wildlife resources of the United States or the public health."

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., Witchweed) that directly or indirectly cause injury, disease, or damage to any plant or plant product.

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. APHIS administers the foreign commerce provision of this Act; the Agricultural Marketing Service (AMS) administers the interstate commerce provisions.

Plant Protection Act (proposed): The draft Plant Protection Act is a proposal to consolidate and streamline APHIS's plant protection authority, including the Federal Noxious Weed Act. The draft proposal incorporates the term "noxious weed" into the definition of plant pest. This change would enable APHIS to conduct noxious weed activities in the same unencumbered manner in which APHIS currently conducts other plant protection programs involving plant pests. The list of regulated noxious weeds would no longer be limited to the current list of weeds. This proposal also adds another sub-classification of weeds, "weeds causing economic damage." For this group of weeds, the proposal would authorize APHIS to provide technological transfers or biocontrol.

Resources for More Information on Non-Native Invasive Plants

The following is only a sample of the resources available. Many more are being added as this topic attracts greater public interest. The internet, in particular, has become a very rich source of documents, fact sheets, and contacts for non-native invasive plant information and one that is particularly useful because it can be updated as new material becomes available.***

Books & Reference Publications:

A Guide to Invasive Plants in Massachusetts, Weatherbee, P.B., P. Somers, T. Simmons, 1998, The Massachusetts Biodiversity Initiative, Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program, Field Headquarters, Rabbit Hill Road, Westborough, MA 01581, 508/792-7270, x 200

A Guide to Invasive Non-native Aquatic Plants in Massachusetts, Hellquist, C. Barre, 1998, Mass. Dept. of Environmental Management, Lakes and Ponds Program, 100 Cambridge St., Boston, MA 02202, 617/727-3267, x 588

Alien Invasion: America's Battle with Non-native Animals & Plants, Devine, R., 1998, National Geographic Society, 1145 17th St. NW, Washington, DC 20036

America's Least Wanted, Stein, B.A., & S.R. Flack, The Nature Conservancy, 1815 N. Lynn St., Arlington, VA 22209, 703/841-5300

Biological Pollution: the Control and Impact of Invasive Exotic Species, Proceedings of a Symposium held at the University Place Conference Center, Indiana University-Purdue University at Indianapolis, Oct. 25 & 26, 1991, McKnight, W.N. (Ed.), 1993, Indiana Academy of Science, Indianapolis, MN

Books & References, continued:

Handbook for Ranking Exotic Plants for Management and Control, Hiebert, R.D., and J. Stubbendieck, National Park Service (available online in several formats):

<http://www.nature.nps.gov/pubs/ranking/>
Harmful Non-indigenous Species in the United States, U.S. Congress, Office of Technology Assessment, 1993, U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328

Invasive Plants: Changing the Landscape of America: fact book, Westbrooks, R., 1998, Federal Interagency Committee for the Management of Noxious and Exotic Weeds, Washington, DC

Invasive Plants: Weeds of the Global Garden, Randall, J.M., J. Marinelli (Eds.), 1996, Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, NY 11225

Non-native Invasive Plant Species Occurring in New England, Dept. of Ecology & Evolutionary Biol., G. Safford Torrey Herbarium (CONN), 75 N. Engleville Rd, U-42, Storrs, CT 06259-3042, 203/486-1889

Government Agencies & Organizations:

USDA Animal & Plant Health Inspection Service (APHIS) Legislative and Public Affairs Office, 301/734-7799

Dept. Environmental Protection, Geological & Natural History Survey, Natural Diversity Database, 79 Elm St., Hartford, CT 06106

Native Plant Conservation Initiative, Bureau of Land Management, Fish, Wildlife & Forests Group WO 230, 1849 C Street NW, LSB-204, Washington, DC 20240, 202/452-0392

Professional Associations:

New England Nursery Association, 8D Pleasant St., So. Natick, MA 01760, 508/653-3112, Fax (508) 653-4112, E-mail: nensyasn@aol.com

American Nursery & Landscape Assoc., 1250 I St. N.W., Suite 500, Washington, DC 20005, 202/789-2900, www.anla.org

Fact Sheet Sources:

Virginia Dept. of Conservation & Recreation, 1500 E. Main St., Suite 312, Richmond, VA 23219, 804/786-7951

The Nature Conservancy of VT, 27 State St., Montpelier, VT 05602, 802/229-4425

The Nature Conservancy, 1815 North Lynn St., Arlington, VA 22209, <http://www.tnc.org>

Internet, Interactive Media, and Audiovisual Resources

CD-ROM: *Noxious and Nuisance Plant Management Information System*, ID and control information on 34 terrestrial and aquatic weeds. Copies can be obtained by contacting Dr. Mike Grodowitz, CEWES-ER-A, 3909 Halls Ferry Road, Vicksburg, MS 39180, E-mail: grodowm@mail.wes.army.mil, 601/634-2972

Video: *Restoring the Balance: Biological Control of Purple Loosestrife*, Cornell University, Media Services Center, 7 Cornell Business & Technology Park, Ithaca, NY 14850, 607/255-2090

Web Sites:

Aquatic Nuisance Species Task Force: <http://anstalkforce.gov>

Aquatic Exotics News: <http://www.ucc.uconn.edu/~wwwsgo/aen.html>

Biological Control of Non-indigenous Plant Species, a Cornell University site: <http://www.dnr.cornell.edu/bcontrol/weeds.htm>

Brooklyn Botanic Garden site, including excerpts from *Invasive Plants: Weeds of the Global Garden*: <http://www.gardenweb.com/bbg/plant.html>

Center for Aquatic Plants and the Aquatic and Wetland Plant Information Retrieval System (APIRS): <http://aquat1.ifas.ufl.edu/aq-w96~1.html>

Federal Interagency Committee for the Management of Noxious & Exotic Weeds: <http://refuges.fws.gov/FICMNEWFiles/FICMNEWHomePage.html>

Invasive Alien Plant Cooperative Project (VA): <http://www.state.va.us/~dcr/dnh/invproj.htm>

National Biological Information Infrastructure brings together many resources about invasive species: <http://www.nbio.gov/invasive/index.html>

National PLANTS Database provides standardized plant names and other plant attribute information: <http://plants.usda.gov/plants/>

Native Plant Conservation Initiative, Exotic Plant Working Group: <http://www.nps.gov/plants/alien/>

Nonindigenous Aquatic Nuisance Species Program: <http://nas.nfrcg.gov/>

Non-native Invasive Plant Species Occurring in Connecticut: <http://darwin.eeb.uconn.edu/ccb/publications/publication-1.html>

Noxious Weeds of North America: <http://dogwood.itc.nrcs.usda.gov:90/weeds/index.html>

Pulling Together: National Strategy for Invasive Plant Management: <http://bluegoose.arw.r9.fws.gov/FICMNEWFiles/NatWeedStrategyTOC.html>

Tennessee Exotic Plant Management Manual: <http://webriver.com/tn-eppc/manual.htm>

The Nature Conservancy Wildland Weeds Management & Research Program: <http://tncweeds.ucdavis.edu/>

USDA Animal & Plant Health Inspection Service (APHIS) Noxious Weeds Home Page: <http://www.aphis.usda.gov/ppq/weeds/>

Weed Science Discipline Group (International): <http://www.agric.wa.gov.au/progserv/plants/weeds/>

***NOTE: Updates to this publication will be posted on the following website: <http://www.newfs.org/invasive/invasive.htm>



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