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Invasive Plants – A Horticultural Perspective

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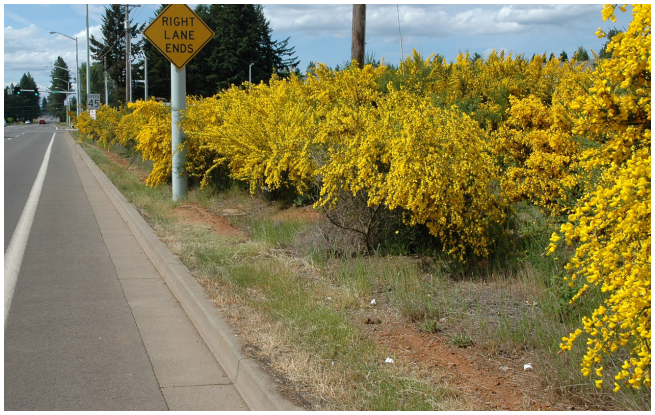
Invasive nonnative (nonindigenous) plants are the subject of a considerable amount of attention and debate. Stories about invasive plants are now common in the popular media. As purchasers of nonindigenous plants that have the potential to invade natural areas, consumers are links in the distribution chain of invasive plants. Other links are those who import, propagate, transport, and sell nonindigenous plants. Ultimately, the result is a potential impact on our natural environment.

A review of catalogs from U.S. wholesale growers shows that at least 50 percent of woody plant species are native to regions outside of North America. If one were to consider the species sold in any one area, the proportion of nonnative plants (not native to that particular ecosystem) would certainly be much higher. Most nonindigenous species have graced our landscapes with beauty and untold beneficial environmental effects. However, a significant proportion of these are invasive. Data from six nongovernmental organizations indicated that 34 percent to 83 percent of the total number of invasive taxa (species, varieties, or cultivars) in the U.S. had a horticultural origin.

One of the most lucrative areas of ornamental plant sales is the introduction of new-to-the-trade plants. These novel introductions fuel plant sales, stimulate efforts to seek out new introductions, many from outside the U.S., and yield substantial profits. A quick glance at most garden catalogs and mail order websites verifies this trend, a trend that encourages plant exploration and has the potential to exacerbate the invasive plant problem.

Environmental groups, regulatory entities, and those in the ornamental horticulture industry (including consumers) are the key stakeholders in the invasive ornamental plant arena. The different interests of key stakeholders can lead to conflicting viewpoints that may



Scotch broom (*Cytisus scoparius*) has ubiquitously invaded roadsides in the Pacific Northwest. This species has not been invasive in the Mid-Atlantic states. U.S. invasive species rank: high/medium.

constitute standoffs without an apparent or imminent compromise. The perspective of an environmentalist is that nonnative invasive species represent a threat to nature. To ornamental industry personnel, profits and jobs are potentially threatened without the import and sale of these nonnative plants. As a result, the invasive nonnative plant topic evokes emotional as well as scientific or quasi-scientific debates. The lack of a complete understanding of invasion biology terminology and concepts is a significant impediment to meaningful dialogue and the resolution of differences. Stakeholders are in need of a common lexicon and understanding of concepts to effectively communicate and resolve differences, and to develop strategies that protect our environment as well as sustain the economic health of the ornamental horticulture industry. This publication presents the information and issues of the invasive plant debate to help clarify the understanding and perceptions of stakeholders. It also suggests resources that gardeners can access for species-specific information.

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What is an invasive plant?

The legal definition of an invasive species, and the official position of the U.S. government, is "An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." (*www.invasivespeciesinfo.gov/laws/execorder.shtml*) The legal definition of alien species, also termed nonindigenous or exotic, is "… with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem." In a strict interpretation, any plant outside its native ecosystem is considered nonindigenous. For example, black locust (*Robinia pseudoacacia*) is a common tree native to the central Appalachian and Ozark Mountains but is considered an invasive species in California. Thus, plants native to one state can be invasive in another state.

The process of invasion is characterized by three phases, initial slow growth, exponential growth, and another period of slow growth (Radosevich et al. 2003). These phases represent introduction, colonization, and naturalization, respectively. Richardson et al. (2000) define the following: "**Introduction** means that the plant (or its propagule) has been transported by humans across a major geographical barrier. **Naturalization** starts when abiotic (e.g., environmental factors) and biotic (e.g., predators, disease) barriers to survival are surmounted and when various barriers to regular reproduction are overcome. **Invasion** further requires that introduced plants produce reproductive offspring in areas distant from sites of introduction (approximate scales: greater than 100 meters [328 feet] over 50 years for taxa spreading by seeds and other propagules; greater than 6 meters [20 feet] per three years for taxa spreading by roots, rhizomes, stolons, or creeping stems)." The definition of "invasive species" has been further refined. An invasive species can be placed in three stages of invasion: widespread but rare, localized but dominant, or widespread and dominant. Thus, invasion biologists are moving towards more explicit terms to accurately define an invasive species.

Although invasive species are an environmental problem, the proportion of nonindigenous species that become invasive is quite small. The term "harm," synonymous with impact, is open to interpretation. Some researchers characterize impact on the basis of range, abundance, and the per-capita or per-biomass effect of the invader. To fully understand the invasive plant issue, one must consider that invasive plant species have varying degrees of impact, ranging from relatively harmless to very environmentally disruptive.

English ivy (*Hedera helix*) will grow as a ground cover or vine. When grown as a vine (pictured), it not only poses a threat to the tree but also enters into a mature phase and will flower and produce seed. This species is especially aggressive in the Pacific Northwest, where it is regarded as a noxious weed. U.S. invasive species rank: high/medium.

In 1996 the "tens rule" was proposed by Mark Williamson and Allistair Fitter (1996). This rule states that one in ten imported plant or animal species (brought into the country) appear in the wild (introduced, feral), and one in ten of those become an established self-sustaining population. One in ten of established plants become a pest (negative economic effect). Thus, if 1,000 species were imported, then 100 species would escape into the wild, 10 species would establish in the wild, and only one species would be become a pest. The authors of the tens rule acknowledge that this is a relatively gross prediction and qualified that one in ten actually represents the range of one in five to one in 20.

In 2001, Lockwood et al. determined the proportion of naturalized (self-sustaining populations) invasive species that were classified as "the most harmful exotics" or "natural area invaders" in three U.S. states. They found that 5.8 percent, 9.7 percent, and 13.4 percent of nonnative plants in California, Florida, and Tennessee, respectively, were natural area invaders.

Thus, their findings are in general agreement with the tens rule. Despite the relatively low percentage of plants that ultimately become serious invaders, the large number of garden plants for sale makes the potential invasive nonindigenous plant list quite sizable. *Dave's Garden – Plant Files*, an Internet database of garden plants, lists 28,992 species and 79,731 cultivars. An inventory of North American seed and nursery catalogs (1988-1989) records almost 60,000 plant taxa sold. Applying the tens rule to this 60,000 number and assuming half of these were nonnative to a particular area, approximately 3,000 plants would escape, 300 species would establish in the wild, and 30 would become pests. Thirty plant taxa can be construed as a relatively small number; however, this apparently low count belies the negative ecological effects of even a single species. One only has to consider the catastrophic effects of saltcedar (*Tamarix* spp.) in the western U.S. or melaleuca (*Melaleuca quinquenervia*) in the Florida Everglades to realize that a single species can cause ecological and economic havoc. The tens rule also does not take into account the unique situation of garden plants where plants are sold year after year and planted in all parts of the country. Such repeated introductions (invasion pressure) is discussed in the next section.

Predicting invasive potential

Predicting which nonindigenous plant species will become invasive is one approach to keeping potentially invasive species out of commerce, thereby eliminating the threat to the native environments. However, predicting which species will be invasive in a particular area is a very difficult task due to the complexity of nature. There has been an abundance of work to determine the plant characteristics and ecological factors that lead to plant invasion. At present, the most reliable and powerful predictor of a species' invasiveness is its record of invasiveness in other nonnative sites. Many prediction schemes have been developed to assess the potential of plant taxa to be invasive. These approaches to understanding the invasive potential have significantly increased the ability to predict which taxa will be invasive.

Using lists of known invasive and noninvasive plants, prediction models have correctly identified 80 percent to 90 percent of invasive nonindigenous invasive species. One shortcoming of these models is that they have a relatively high rate (≥10 percent) of false positives (i.e., identifying a noninvasive species as invasive). Another shortcoming of invasive potential prediction models is that the knowledge needed for most of these schemes is plant and region specific. This type of information is difficult to obtain. The methodology for the prediction of invasive plants has not been integrated into a package that is easily used by those who are not well versed in ecology. A need also exists for prediction schemes to include, among other variables, the role humans play in overcoming the effect of random natural events on immigrant plant populations.

Prediction based on biological characteristics can reliably foretell if a plant will establish and spread. However, prediction is less reliable in forecasting the impact a species will have on an environment. Because invasiveness and ecological impact are not necessarily linked, some scientists are in favor of categorizing those invasive plant species that have a profound effect on biodiversity, about 10 percent of invasive plants, with the term "transformer species." The notorious saltcedar (*Tamarix* spp.) is an example of a species that has significantly altered many western U.S. riparian ecosystems. Transformer species, because of their impact, would receive the majority of resources for containment, eradication, and control.

Young black locust (*Robinia pseudoacacia*) and Chinese bittersweet (*Celastrus orbiculatus*) have invaded the Cape Cod National Seashore in Massachusetts. Black locust, despite being native to several U.S. states is threatening natural areas of several other states. .U.S. invasive species rank for both species: high/medium. Photo taken by Betsy Von Holle.

In addition to predictive models, there are some strategies and efforts to induce sterility into popular ornamental invasive plants. As an example, the triploid cultivar *Hibiscus syriacus* 'Diana' (rose-of-sharon) sets very little fruit, in contrast to other rose-of-sharon cultivars that set a large amount of fruit and prolifically reproduce themselves. Inducing sterility, either by breeding or molecular tools, could diminish invasion risk of a seed-dispersed species that, due to its popularity and economic impact, could not feasibly be removed from the ornamental horticulture trade. However, extensive research on the efficacy and stability of the sterility systems as well as the realized prevention of invasiveness should be conducted before sterile, noninvasive cultivars are released.

Why should we be concerned about invasive plants?

In short, nonnative invasive plants have negative effects on biodiversity (i.e., the rich genetic resource of flora, fauna, and microbes) at the ecosystem level and the community and population levels. Examples of how invasive plants threaten the health of natural areas are 1) replacement of diverse systems with single stands of nonnative species, 2) changes in soil chemistry, land form processes, fire regime, and hydrology, 3) competition with endangered species, and 4) competition with and displacement of native fauna.

In addition to the detrimental effects of invasive plants in the environment, two biological phenomena are particularly applicable to the ornamental horticulture industry's role in distributing nonnative plants: lag time and invasion pressure. Lag time is the amount of time following a species' introduction that is required to increase its population to a size that will begin to invade and increase exponentially. Lag times for woody plants can exceed 100 years. For example, amur corktree (*Phellodendron amurense*) is a landscape tree species that was introduced into the U.S. in the 1850s and has only recently (2006) been declared an invasive species by the Plant Conservation Alliance, a consortium of ten federal government member agencies and over 225 nonfederal cooperators. Lag times for herbaceous perennials are believed to be much shorter than for woody plants. The length of a lag phase depends on several factors including detection, invasion pressure, environmental forces, dispersal pathways, and introduction of new pollinators. Unless prediction models are developed to identify those species with relatively long lag times prior to widespread planting, we may be currently selling, dispersing, planting, and admiring environmental disruptors of the future.

The frequency of introduction of invasive species, known as invasion pressure, is one of the most important factors that contributes to the invasion of an area. One recent study looked at the role of the ornamental horticulture industry in invasion pressure by relating the naturalization rate of invasive plants to the number of years an invasive species was sold in the nursery trade. Results showed that the rate of naturalization increased as the period of sale increased. For example, only 1.9 percent of plants naturalized that were sold for one year, whereas 30.9 percent of plants naturalized that had been sold for ten years or more. Once sold, garden plants are cultivated. Cultivation is an important process in overcoming the destructive forces of random natural events. Ultimately, cultivation favors the invasion process. Additionally, plant characteristics that make desirable garden plants, such as a fast growth rate, abundance of fruit, and tolerance of poor growing conditions, also favor naturalization and invasiveness. The very nature of the ornamental horticulture industry (selling, transporting, and cultivating species) has the potential to foster the invasion process.

Invasive plants also impose significant costs to the economy. Introduced invasive species have resulted in an estimated $26 to $35 billion in crop losses and herbicide expenditures annually. These figures do not take into consideration the huge indirect economic

Cogon grass (*Imperata cylindrical*), an Asian native, has invaded the south and southeastern U.S. as far north as Virginia and Maryland and as far west as Texas. U.S. invasive species rank: high. Photo was taken by Betsy Von Holle at the Kennedy Space Center in Florida.

and environmental costs associated with the loss of biodiversity or aesthetic appeal, or the unintentional importation of disease organisms that piggyback on imported plants

What should landscape professionals and gardeners do?

How does one make decisions about nonindigenous plants that are invasive or potentially invasive? Information on the Internet can be overwhelming, confusing, and inconsistent. Although a variety of lay sources may describe a particular species as "invasive," what resources are available to determine if this information is science-based? Purveyors and consumers of new-to-the-trade nonindigenous taxa generally cannot know a taxon's invasive potential unless a predictive screening system is implemented. There are a few good sites that include ranking systems of invasive impacts based on scientific observation. NatureServe, a nonprofit conservation organization, has a current data-based assessment of nonindigenous plant species. On the NatureServe website (*www.natureserve.org/explorer/servlet/NatureServe?init=Species*), one can search for a species and then click on the U.S. Invasive Species Impact Rank (I-Rank). NatureServe has assessed 452 plant species. Each species is given an overall invasive ranking based on ecological impact, current distribution/abundance, trend in distribution/abundance, and management difficulty. Other sources that have developed rankings relevant to Virginia residents are the Virginia Native Plant Society in conjunction with the Virginia Department of Conservation and Recreation (*www.dcr.virginia.gov/natural_heritage/invsppdflist.shtml*) and the Southeast Exotic Pest Plant Council (*www.se-eppc.org/*). These groups have ranked species according to their perceived and observed threats to the environment.

The understory of a wooded lot in Blacksburg, Va. is dominated by Japanese honeysuckle (*Lonicera japonica*), other honeysuckle species (*Lonicera* spp.), and privet species (*Ligustrum* spp.).

The above-mentioned ranking systems assess nonindigenous plants that are already naturalized in the U.S. Determining the invasiveness of new introductions is more difficult. Another complication of the invasive plant problem is that a nonnative species may be regionally invasive. For example, a species that is a problem in the eastern part of Virginia may not be a problem in the western part of the state due to temperature or ecological constraints. Presently, the only good options for gardeners concerned about the invasive potential of nonindigenous plants is to stay aware of the invasive status of plants by accessing the aforementioned sites.

Native plants and nonindigenous landscape plants that have been proven to be noninvasive can be used in place of invasive species that negatively impact natural areas. Native plants tend to be more resistant to herbivores such as deer and native insects. Regional plant societies such as the Virginia Native Plant Society have developed lists of plants (*www.dcr.state.va.us/dnh/native.htm*) native to the state and physiographic provinces. Additionally, there are multiple books that provide instructions on how to propagate and grow plants native to specific regions (*www.mdflora.org/booklist.html#landscaping*). When selecting indigenous plants, one should remember that native plants may not necessarily be better adapted to a particular region than nonnative species. Considering how dramatically we alter the ecology of our residential habitats (e.g., soil, vegetation, sun/shade, temperature, and water regimes), a native plant may not be better suited to a garden environment than a nonnative plant. However, there are many aesthetically pleasing native plants that thrive in garden settings and provide environmental benefits such as nectar and fruit for native birds and butterflies.

Finally, if a gardener would like to use a native plant as an alternative for a specific nonnative plant, there are books and websites that have this information (e.g., Brooklyn Botanical Garden, 2006; *www.dcr.virginia.gov/natural_heritage/nativeplants.shtml* [click on "Native Plant Tables"]; *www.mdflora.org/publications/invasives.htm*). Below is a list of Internet resources. In sum, a responsible gardener will judiciously plant species native to the region or nonnative species that do not invade natural areas (e.g., daffodil, etc.), rather than nonnative plants known to invade natural areas.

Cited Literature

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Williamson, M. and A. Fitter. 1996. The varying success of invaders. Ecology 77:1661-1666.

Internet Sources for Invasive Plant Information

Avoiding, Removing Invasive Plants [EPA]
http://www.epa.gov/reg3esd1/garden/invas.htm

Invasive Alien Plant Species of Virginia
http://www.dcr.virginia.gov/natural_heritage/invspinfo.shtml

Invasive Alien Plant Species of Virginia [species list]
http://www.dcr.virginia.gov/natural_heritage/documents/invlist.pdf

Invasive and Exotic Species
http://www.invasive.org/

Invasive Plants of the Eastern United States: Identification and Control
http://www.invasive.org/eastern/

Managing Alien Invasive Plants in Natural Areas, Parks, and Small Woodlands
www.dcr.virginia.gov/natural_heritage/invspfactsheets.shtml

NatureServe Explorer
www.natureserve.org/explorer/

Plant Conservation Alliance Alien Plant Workshop
www.nps.gov/plants/alien/factmain.htm

Plant Invades of the Mid-Atlantic Natural Areas
www.nps.gov/plants/alien/pubs/midatlantic/index.htm

Species Factsheets [alien species in Virginia
www.dcr.virginia.gov/natural_heritage/invspfactsheets.shtml

Southeast Exotic Plant Pest Council
www.se-eppc.org/

The Nature Conservancy – Invasive Species
www.nature.org/initiatives/invasivespecies/

USDA – State Laws and Regulations
www.invasivespeciesinfo.gov/laws/va.shtml

Virginia Native Plant Society
www.vnps.org/invasive.html

Reviewers

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