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**An estimate of the commercial value of potentially invasive nursery crops  
grown in North Carolina**

**ABSTRACT**

Considering the large economic value of nursery crops, invasive plant assessment systems should ideally consider economic benefits along with environmental risks of selling potentially invasive ornamental plant species. Since state-level and species-specific economic data was unavailable for North Carolina, an online grower survey was developed to capture information on plant production and general sales of eighteen potentially invasive nursery crops. Thirty individuals completed the survey representing 4.3% (\$37,927,250) of the wholesale value of the entire North Carolina nursery industry (\$890 million) in 2007. The eighteen potentially invasive nursery crops examined in this study contributed an estimated \$206 million annually, or 23.1% of state-wide wholesale sales. However, the economic value of specific crops varied considerably. *Celastrus orbiculatus* Thunb. (Oriental bittersweet) had an estimated state wide annual wholesale value of less than \$6,000 state wide, while *Miscanthus sinensis* Andersson (Chinese silvergrass) exceeded \$39,000,000. The results of this survey will be incorporated in species assessments using the North Carolina Invasive Species Assessment System.

**INTRODUCTION**

The impacts, both positive and negative, of growing non-native horticultural crops can be varied and complex. As presented in the Invasive Species Definition and Clarification and Guidance White Paper (NISC 2006), an invasive species is a non-native species whose

introduction causes or is likely to cause economic or environmental harm or harm to human health that outweighs any benefits. Adopting this concept requires a cost benefit analysis to adequately assess the impacts that potentially invasive plants may have.

The North Carolina Invasive Species Assessment System (Trueblood 2009) was developed to evaluate potentially invasive ornamental plant species that are currently found in natural areas within the state. In addition to environmental impacts, the North Carolina assessment considers the commercial value of potentially invasive ornamental plant species and the ecosystem services, wildlife habitat, and cultural benefits provided by some potentially invasive species. The Benefits and Value section of the North Carolina protocol allows the assessment to weigh the commercial value and benefits of a species against the ecological risk of potential invasiveness. Other state assessments, including Florida (Fox et al. 2005) and Michigan (Schutzki et al. 2004) also identify species with substantial economic value. Since species-level production and sales information were largely unavailable for the state, the Florida (Fox et al. 2005) model estimated economic value based on sales from chain retail stores. The sale of high income species at retail stores was suspected to translate to grower sales within the state. The Economic Value section of the Florida (Fox et al. 2005) model identifies whether a species has Low or High Economic Value, and numerical scores are not assigned to Economic Value criteria. In addition to economic value, the Michigan model (Schutzki et al. 2004) considered the aesthetic, erosion control, and wildlife habitat value. The economic impact and value-added section of the North Carolina model was inspired by the Florida (Fox et al. 2005) and Michigan models (Schutzki et al. 2004) that estimated the state-wide value of potentially invasive species. In the Benefits and Value section of the North Carolina assessment, species that provide economic value and other benefits are assigned negative point values that subtract from the

overall invasiveness rating and may reduce the likelihood that those plants are recommend limited or non-use.

According to the USDA Economic Research Service (2007), floriculture and nursery crops have been among the fastest growing components of the US agricultural economy, and North Carolina consistently ranks among the top 4 producers by state. The North Carolina Green Industry Council (2005) conducted an economic impact study of the green industry, which is composed of growers, producers, contractors, and retail centers in North Carolina, and determined that the green industry contributes \$8.6 billion and 151, 982 jobs to the state economy. Among agricultural sectors in North Carolina, the nursery and floriculture industry captured the majority (29 percent) of total crop sales in 2007 with an estimated wholesale value of \$890 million (North Carolina Agricultural Statistics 2008).

Wirth et al. (2004) recently conducted an impact study to evaluate the economic value of potentially invasive ornamental plant species on a state-wide level in Florida. These researchers assessed the economic impact of 14 potentially invasive landscape plant species designated as invasive by the Florida Exotic Pest Plant Council, but which have significant economic value according to the Florida Nurserymen and Growers Association (Wirth et al. 2004). The survey design and data analysis developed by Wirth et al. (2004) provided a template for the North Carolina economic impact survey.

Considering the large economic contribution of the nursery industry (North Carolina Agricultural Statistics 2005), an invasive assessment system for North Carolina should ideally consider the economic impact of selling potentially invasive ornamental plant species. The objective of this project was to assess the commercial value of potentially invasive nursery crops grown in North Carolina.

## METHODS

A brief survey comprised of 24 questions was developed and posted online through the North Carolina State University College of Agriculture and Life Sciences. The link to the online survey was distributed to 881 North Carolina Nursery and Landscape Association (NCNLA) members via e-mail in March 2009. A reminder/thank you e-mail was sent to each NCNLA member in April 2009. The survey was publicized through a presentation to growers at a NCNLA trade show in January 2009 and an article in the November/December 2008 edition of the NCNLA trade publication, Nursery Notes.

Survey questions included multiple choice responses regarding estimated total annual sales attributed to 21 species (Appendix A1). The survey addressed sales at the species level and cultivars were not considered separately. In addition, the survey asked growers to classify their business as a wholesale and/or retail nursery and provide some general information, including the total gross value in sales for nursery crops from 2008. All responses were strictly anonymous and used for this NCSU research project only.

Twenty-one taxa were included in the survey. Of the 21 taxa, 18 species were potentially invasive plant species that have naturalized, at some level, in North Carolina. Three nonnative taxa that are generally presumed to be noninvasive were included for comparison purposes and include *Camellia spp.* (Camellia), *Rhododendron subgenus Tsutsii spp.* (evergreen azaleas), and *Liriope ssp.* and or *Ophiopogon spp.* (Lily-Turf/Mondo Grass) species. The potentially invasive species were identified by NCNLA members and North Carolina land managers in a prior survey. Plant species identified by other state assessments, such as the Florida protocol (Fox et al. 2005), as damaging invasive species and available in the horticultural industry in North Carolina were also examined using the North Carolina model and included with the survey.

Estimated wholesale value for each species per respondent was calculated based on the midpoint of response ranges. Estimated statewide wholesale value for each species was calculated from mean sales percentages for each species, divided by the total sales captured by the survey (\$37,927,250), and multiplied by the wholesale value of the entire nursery industry (\$890 million, North Carolina Agricultural Statistics 2008).

## RESULTS

*Survey response rate.* Of the 881 NCNLA members that received the link to the online survey, 30 individuals completed the survey for a response rate of 3.4%. Of the 30 respondents, 29 provided information regarding the total gross value in sales for nursery crops from 2008. Table 3.1 shows the distribution of reported total annual sales for responding NCNLA members compared with the distribution in the 2007 Census of Agriculture (USDA 2009). The survey covered a greater percentage of larger farms compared to smaller producers and included >6% of the 3 largest sales categories. These larger operations may be more stable and account for a greater proportion of the products sold.

Table 3.1. Distribution of reported total annual sales for responding NCNLA members compared with the distribution of the 2007 Census of Agriculture

<b>Reported annual sales*</b>	<b>Respondents</b>	<b>Nursery, greenhouse, floriculture, and sod farms in the 2007 census</b>	<b>Survey coverage of census population</b>
≥ \$1 million	10	124	8.1
\$500,000 – \$999,999	5	80	6.3
\$200,000 – \$499,000	8	114	7.0
\$100,000 – \$199,999	2	285	0.7
\$40,000 – \$99,999	0	158	0.0
\$10,000 – \$39,999	3	703	0.4
\$2,500 – \$9,999	1	549	0.2
\$1 – \$2,499	0	304	0.0

\*The sales categories used in the 2009 NCNLA survey and the 2007 Census of Agriculture are similar but not identical.

*Current nursery sales.* About 80% of responding nurseries indicated that they sell at least one of the 18 potentially invasive species. The percent of respondents who grow each species is shown in Table 3.2, with the total estimated annual sales and estimated mean annual sales attributed to each. *Miscanthus sinensis* (Chinese silvergrass), *Liriope* and/or *Ophiopogon* species, *Buddleja davidii* (Butterfly bush), and *Nandina domestica* (Heavenly bamboo) are some of the most commonly grown taxa among responding nurseries. Estimated mean annual sales of \$100,000 or more may be attributed to *Camellia*, *M. sinensis*, and *Liriope* and/or *Ophiopogon* species.

Table 3.2 Number of respondents that sell each species, total estimated annual sales, and estimated mean annual sales attributed to each species for those respondents.

<b>Taxa</b>	<b>Number of respondents who sell species</b>	<b>Estimated total annual sales (\$)</b>	<b>Estimated mean annual sales (\$)</b>
<i>Albizia julibrissin</i>	3	7,996	2,665
<i>Berberis thunbergii</i>	15	687,093	45,806
<i>Buddleja davidii</i>	16	445,216	29,681
<i>Camellia</i>	14	1,761,470	125,819
<i>Celastrus orbiculatus</i>	1	250	250*
<i>Elaeagnus pungens</i> and/or <i>E. x ebbingei</i>	8	82,608	10,326
<i>Euonymus alatus</i>	13	222,494	17,115
Evergreen azaleas	14	1,238,313	88,451
<i>Hedera helix</i>	10	339,119	33,912
<i>Ligustrum japonicum</i>	9	622,595	69,177
<i>Ligustrum sinensis</i>	10	372,483	37,248
<i>Mahonia bealei</i>	12	503,869	41,989
<i>Miscanthus sinensis</i>	17	1,674,117	98,478
<i>Nandina domestica</i>	16	1,149,080	71,818
<i>Liriope</i> and/or <i>Ophiopogon</i>	17	1,756,093	103,300
<i>Pyrus calleryana</i>	7	161,606	23,087
<i>Spiraea japonica</i> and/or <i>S. x bumalda</i>	15	583,608	38,907
<i>Ulmus parvifolia</i>	9	568,333	63,148
<i>Vinca minor</i>	12	875,854	72,988
<i>Vitex rotundifolia</i>	1	100,000	100,000*
<i>Wisteria floribunda</i>	8	363,998	45,500

and/or <i>W. sinensis</i>			
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\*Only one respondent sells this species.

The estimated percentage of total annual sales attributed to each species is shown in Table 3.3. Growers reported that sales of these species account for a wide range of their total annual sales. *Celastrus orbiculatus* (Chinese bittersweet) and *Vitex rotundifolia* (Beach Vitex), two species regulated as noxious weeds in North Carolina, account for a very small percentage, <1%, of total annual sales and were sold by two respondents. Among respondents, the majority of taxa contribute up to 5% of total annual sales. Five growers indicated that the sale of *Miscanthus sinensis*, *Ligustrum japonicum* (Japanese privet), *Liriope* and/or *Ophiopogon* species, and *Nandina domestica* made up 26 to 50% of total annual sales.

Table 3.3 Number of respondents with reported estimated percentages of total annual sales attributed to each species

<b>Taxa</b>	<b>&lt; 1%</b>	<b>1 – 5%</b>	<b>6 – 10%</b>	<b>11 - 25%</b>	<b>26-50%</b>	<b>Total</b>
<i>Albizia julibrissin</i>	2	1	0	0	0	3
<i>Berberis thunbergii</i>	4	9	0	1	0	14
<i>Buddleja davidii</i>	8	8	0	0	0	16
<i>Camellia</i>	3	8	2	1	0	14
<i>Celastrus orbiculatus</i>	1	0	0	0	0	1
<i>Elaeagnus pungens</i> and/or <i>E. x ebbingei</i>	5	3	0	0	0	8
<i>Euonymus alatus</i>	10	2	1	0	0	13
Evergreen azaleas	4	7	2	1	0	14
<i>Hedera helix</i>	7	1	2	0	0	10
<i>Ligustrum japonicum</i>	1	6	1	0	1	9
<i>Ligustrum sinensis</i>	5	4	0	1	0	10
<i>Mahonia bealei</i>	7	5	0	0	0	12
<i>Miscanthus sinensis</i>	13	2	0	0	2	17
<i>Nandina domestica</i>	3	10	2	0	1	16
<i>Liriope</i> and/or <i>Ophiopogon</i>	4	10	0	2	1	17
<i>Pyrus calleryana</i>	5	2	0	0	0	7
<i>Spiraea japonica</i> and/or <i>S. x bumalda</i>	6	8	1	0	0	15
<i>Ulmus parvifolia</i>	2	5	1	1	0	9
<i>Vinca minor</i>	7	3	1	1	0	12

<i>Vitex rotundifolia</i>	1	0	0	0	0	1
<i>Wisteria floribunda</i> and/or <i>W. sinensis</i>	6	2	0	0	0	8

*Estimated annual statewide wholesale value.* The entire survey captured approximately 4.3% (\$37,927,250) of the wholesale value of the entire nursery (\$890 million) in 2007 (North Carolina Agricultural Statistics 2008). The total state-wide wholesale value for all species included in the survey was estimated at \$317 million. The estimated wholesale value of the 18 potentially invasive species was \$206 million. Table 3.4 shows the estimated wholesale value and percentage of the total state-wide nursery sales attributed to each species for North Carolina. Total economic output impact is greatest for *Camellia* and *Liriope* and/or *Ophiopogon* species at about \$41 million each. Among potentially invasive species, total economic impact is greatest for *Miscanthus sinensis* (Chinese silvergrass) at \$39 million, followed by *Nandina domestica* (Heavenly bamboo) at \$27 million and *Vinca minor* (Common periwinkle) at \$21 million. Sales of *Albizia julibrissin* (Mimosa), *Celastrus orbiculatus* (Chinese bittersweet), *Elaeagnus pungens* and/or *E. x ebbingei* (Thorny elaeagnus), *Euonymus alatus* (Burning bush), *Pyrus calleryana* (Callery pear), and *Vitex rotundifolia* (Beach vitex) account for less than 1% of total state-wide nursery sales. The combined sales of all 21 species account for about 35.6% of total industry sales in North Carolina, with 23.1% of sales from the 18 potentially invasive species.

Table 3.4 Estimated annual statewide wholesale values attributed to 21 nonnative species, including 18 potentially invasive species, in North Carolina

<b>Taxa</b>	<b>Estimated state-wide wholesale value (\$)</b>	<b>Species % of total state-wide nursery sales</b>
<i>Albizia julibrissin</i>	187,600	<1
<i>Berberis thunbergii</i>	16,123,300	1.8
<i>Buddleja davidii</i>	10,447,400	1.2
<i>Camellia</i>	41,334,600	4.6
<i>Celastrus orbiculatus</i>	5,900	<1
<i>Elaeagnus pungens</i> and/or	1,938,4500	<1



<i>E. x ebbingei</i>		
<i>Euonymus alatus</i>	5,221,000	<1
Evergreen azaleas	29,058,200	3.3
<i>Hedera helix</i>	7,957,800	1.0
<i>Ligustrum japonicum</i>	14,609,800	1.6
<i>Ligustrum sinensis</i>	8,740,700	1.0
<i>Mahonia bealei</i>	11,823,800	1.3
<i>Miscanthus sinensis</i>	39,284,800	4.4
<i>Nandina domestica</i>	26,964,300	3.0
<i>Liriope</i> and/or <i>Ophiopogon</i>	41,208,400	4.6
<i>Pyrus calleryana</i>	3,792,200	<1
<i>Spiraea japonica</i> and/or <i>S. x bumalda</i>	13,694,900	1.5
<i>Ulmus parvifolia</i>	13,336,500	1.5
<i>Vinca minor</i>	20,552,800	2.3
<i>Vitex rotundifolia</i>	2,346,600	<1
<i>Wisteria floribunda</i> and/or <i>W. sinensis</i>	8,541,600	1.0
Total sales	317,170,800	35.6

## DISCUSSION

The 18 potentially invasive ornamental plant species examined in this study have substantial value to the nursery industry in North Carolina. Total statewide sales attributed to these potentially invasive plants are estimated to be about \$206 million, or 23.1% of state-wide industry sales. The economic value of these crops should be considered along with the environmental risks of selling these potentially invasive plants in North Carolina.

The data generated by this survey of North Carolina Nursery and Landscape Association (NCNLA) members is being used to evaluate species using the North Carolina Invasive Species Assessment System. The North Carolina protocol incorporates a unique component to address the economic value of potentially invasive plant species and directly includes the economic rating, in the form of negative point values, as a factor in the overall recommendation for a species. With the survey data, the economic benefits of a species can be weighed against the ecological risk of potential invasiveness.

However, the response rate for this survey was lower than expected, and our economic impact values are only a general estimate of the production and percentage of total annual sales attributed to potentially invasive ornamental species. The economic impact of potentially invasive ornamental plants in North Carolina could be better understood with greater survey response rates and additional economic data.

With a low response rate, there is a risk that the wholesale value associated with each species may be overestimated. While the survey response rate was lower than expected, the survey included a greater percentage of large, high-value producers that may account for a greater proportion of the products sold in the state and enhance the survey coverage.

The survey results, and in turn, the North Carolina Invasive Species Assessment System, could be strengthened with increased responses from NCNLA members. In addition, the geographic distribution of sales across the state was not considered in the survey. As Wirth et al. (2004) demonstrated, the geographic clustering of sales may cause limitations on the sale of certain invasive species to differentially affect regions of North Carolina.

Wirth et al. (2004) indicated that economic impact results may not necessarily translate to economic losses for the nursery industry, since consumers may purchase alternative plants to replace any that may be phased-out. Research regarding the development of sterile cultivars or suitable replacements for especially valuable potentially invasive species would be desirable.

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