Analyzing the Structural Shifts in U.S. Boxwood Production Due to Boxwood Blight[1]

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Abstract

The purpose of this study is to examine the changes in the sales of boxwood (*Buxus* spp.) that have occurred in boxwood production states. We theorize that some of the shifts in production areas over the period from 2009 to 2019 have been impacted by the introduction of boxwood blight into the United States. Boxwood blight (*Calonectria pseudonaviculata*) was first observed in the U.S. in 2011 by plant pathologists in 8 states: Connecticut, Maryland, Massachusetts, New York, North Carolina, Oregon, Rhode Island, and Virginia. The disease has now been seen in 30 states plus the District of Columbia. The data used for this analysis is from the Census of Horticultural Specialties (CHS), a survey administered by the United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) every five years. The findings from this analysis of the Census of Horticultural Specialties data from 2009 to 2019 indicate that there were already shifts occurring in boxwood markets prior to the introduction of boxwood blight. However, boxwood blight has exacerbated the supply chain challenges for green industry participants by limiting production in certain areas of the country, increasing the costs of producing boxwood compared to other evergreen shrubs, and perhaps dampening the demand from what might have been without the existence of the blight.

Index words: economics, horticulture, nursery, landscaping, ornamental, woody plants, sales.

Species used in this study: Boxwood (*Buxus* spp.), Boxwood Blight [*Calonectria pseudonaviculata* (Crous, J.Z. Groenew. & C.F. Hill) L. Lombard, M. J. Wingf. & Crous].

Significance to the Horticulture Industry

The green industry remains an important contributor to the U.S. economy and to individual states and regions. The green industry is extremely broad-based, with the landscape services and wholesale-retail trade sectors existing in virtually all communities in the nation. Boxwood shrubs represent an important genus within the evergreen shrubs category and boxwood blight threatens to undermine its economic importance. The findings in this report are critical to our understanding of the boxwood market and issues affecting the green industry from boxwood blight. Participants in the green industry now have access to data to assist them in making strategic decisions regarding future investments to mitigate the effect of boxwood blight in their respective businesses. In addition, policymakers have better information to inform their decisions regarding efficient allocation of resources in combating this disease.

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Introduction

During the 1980s and 1990s, the green industry was one of the fastest-growing sectors of the U.S. economy, due to robust demand for ornamental plants and related products and services from commercial and residential development and rising affluence. However, during the early 2000s, industry growth started slowing due to maturing consumer demand (Hall 2010). Obviously, the severe economic recession of 2008 to 2009 placed considerable financial strain on green industry businesses, as well as most other sectors of the global economy, due to reduced home values and homeownership rates and declining disposable household income in inflation-adjusted terms.

In spite of slowed growth and decreased economic activity in some sectors in recent years, the green industry remains an important contributor to the U.S. economy, and to individual states and regions. The green industry is extremely broad-based, with the landscape services and wholesale-retail trade sectors existing in virtually all communities in the nation, while the production and manufacturing sectors are increasingly concentrated in some states and contribute to regional economies disproportionately because shipments to other states bring new money into the local economies (Hall et. al. 2011). The estimated total economic contributions of the U.S. green industry in 2018, including indirect and induced regional economic multiplier effects of exports, were $348.08 billion (Hall et. al. 2020). Direct industry output (or sales revenue) for all sectors was $159.57 billion. Direct employment by green industry firms was 1,286,135 full-time and part-time jobs, and the total employment contribution (including multiplier effects) in the broader economy was 2,315,357 jobs.

Boxwood is an important ornamental plant in the U.S. green industry. With its economic importance as the number one selling evergreen shrub, it continually ranks

among the top revenue-generating plants in the industry. However, in recent years, the influence of a new disease, boxwood blight, has promulgated several structural shifts among states that produce boxwood. Boxwood blight (*Calonectria pseudonaviculata*) (Lombard et. al. 2010) was first observed in the U.S. in 2011 by plant pathologists in Connecticut, Maryland, Massachusetts, New York, North Carolina, Oregon, Rhode Island, and Virginia, and has now been detected in 30 states plus the District of Columbia (Daughtrey 2019). Boxwood crops in these 30 states, accounting for about 95% of the nation's total, are now at high risk. The disease quickly destroys entire boxwood crops at production nurseries and disfigures both public/private gardens and residential/commercial landscapes, resulting in significant economic and social repercussions.

The purpose of this study is to examine the changes in the sales of boxwood that have occurred in boxwood production states. Some of the shifts in production areas over the period of 2009 to 2019 are theorized to have been impacted by boxwood blight introduction to the U.S.

Methodology

The data used for this analysis is from the Census of Horticultural Specialties (CHS) (USDA-NASS 2020), a survey administered by the United States Department of Agriculture, National Agricultural Statistics Service (USDA-NASS) every five years that is designed to cover all operations from which $10,000 or more of horticultural products were produced and sold, or normally would have been sold, during the census-taking year. Horticultural products include annual bedding/garden plants, potted flowering plants, cut flowers, cut cultivated florist greens, trees, shrubs, ground covers, vines, fruit and nut trees, sod, dry bulbs, greenhouse-produced vegetables, commercial vegetable transplants, vegetable and flower seeds, Christmas trees, short rotation woody crops, aquatic plants, unfinished or prefinished plants, propagation materials, and other nursery or greenhouse plants. Boxwood are included in the evergreen shrubs category (Tables 18 and 19 in the CHS) (USDA-NASS, 2020).

Since USDA-NASS no longer generates a Nursery Crops report (since 2007), the Census of Horticultural Specialties is one of the main sources of data regarding the production of horticultural crops in the green industry. Because this census contains both farm and non-farm records, the response rate is an indicator of who replied to the census data collection effort but does not reflect whether those responding met the farm definition or had the items of interest for the census. Response rate is an indicator of the quality of data collection methods, and it is generally assumed that if a response rate was close to 100 percent, the potential for non-response bias is small. Using the fourth response rate formula (RR4) from the American Association of Public Opinion Research's Response Rate Standard Definitions manual (American Association for Public Opinion Research 2016), the response rate for the 2019 Census of Horticulture Specialties survey is 66.3 percent. This compares to 68.9 percent for the 2014 Census of Horticulture Specialties survey.

The Census of Horticultural Specialties (CHS) has been conducted every 5 years since 2009. Prior to that, the CHS was conducted every 10 years. In addition, slight refinements were made in the survey instruments used after 2009. For these reasons, only the last three CHS surveys were used in this analysis, spanning a period of the last 15 years. For each state, comparisons were made between changes in boxwood sales from 2009 to the 2014 reporting period, and subsequently looking at the sales changes during the 2014 to 2019 time period. Since boxwood blight was discovered in the U.S. in 2011, data from 2009 would be considered a pre-boxwood blight period, data from 2014 would be considered as representative of the early years of boxwood blight, and 2019 would be representative of a period in which boxwood blight was widespread, well-known, and likely to be taken into consideration by many boxwood growers and consumers (Fig. 1). For each time period, the positive or negative change in actual sales dollars was measured, as well as the percentage change in sales during that period. Lastly, the sales trends during the entire 15-year period were also observed.

Observations Regarding the Value of Boxwood Sales from 2009 to 2014

The value of boxwood sales in the U.S. increased from $102.9 million in 2009 to $126.4 million in 2014 (Table 1), which represented a 23% increase in boxwood sales nationally (compared to an 11% increase in the sales of all nursery stock in the same period and a 2% increase in the broadleaf evergreen category). Within the broadleaf evergreen category specifically, boxwood accounted for 13%, 16%, and 17% of all broadleaf evergreen sales in 2009, 2014, and 2019, respectively. Interestingly, the number of operations (growers) nationally that sold broadleaf evergreens decreased during the entire 15-year period (4,042 in 2009, 3,891 in 2014, and 2,974 in 2019), but the number of operations that sold boxwood increased then decreased during the same period (1,952 in 2009, 1,958 in 2014, and 1,653 in 2019). The top three states included Oregon, Ohio, and California, representing about 36% of total U.S. boxwood sales. Collectively, North Carolina, Maryland, Illinois, New Jersey, Virginia, Connecticut, and Tennessee finish out the top ten states, representing another 35% of total boxwood sales in 2014. Though spread throughout the country, the top ten states represent about 71% of boxwood sales, a fairly high concentration ratio for the industry. By the end of 2014, a total of 18 states had boxwood in landscapes or in the nursery trade that had tested positive for boxwood blight (Fig, 1, Table 1).

Comparing 2009 pre-boxwood blight sales to 2014 sales (the early years of boxwood blight being introduced), a total of 18 states experienced an increase in boxwood sales. Of the states that increased, 7 increased by more than $2 million, and the largest percentage increases were in New York, Indiana, and Georgia. Each of these states went from very little boxwood production in the state to having almost $12.5 million in sales among them – a sizable increase but still less than 4.5% of total boxwood production in the U.S.

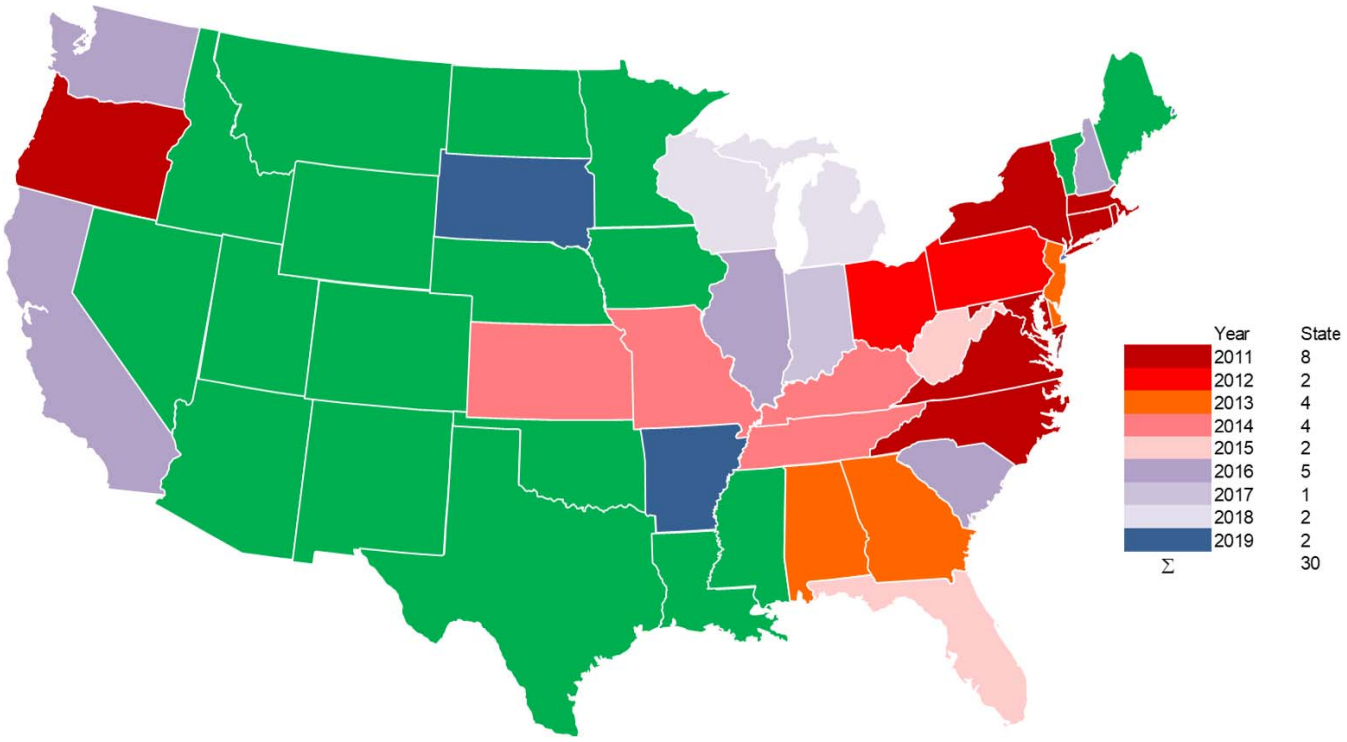

Fig. 1. Boxwood bight tracker illustrating the chronology of boxwood blight spread in the U.S. by year.

Of the 14 states that reported a decrease in boxwood production from 2009 to 2014, two of them (Texas and New Mexico) experienced the largest decline. Interestingly, they were both states in which boxwood blight had not been recorded up until that time. Anecdotally, the loss of several large nursery growers in the Southwest probably represented a large portion of this decrease. Other states experiencing a significant decline in boxwood production included Arkansas, Missouri, Rhode Island, and Massachusetts, but they are relatively minor players in the boxwood market, so their decreases did not represent a significant share of the U.S. for formatting consistency production.

Observations Regarding the Value of Boxwood Sales from 2014 to 2019

During the next 5-year time period, the value of boxwood sales in the U.S. increased from $123.7 million in 2014 to $140.9 million in 2019 (Table 1), which represented an 11% increase in boxwood sales nationally (compared to an 7% increase in the sales of all nursery stock in the same period and a 6% increase in the sales of broadleaf evergreens). The top three states included Oregon, California, and Ohio, representing almost 40% of total U.S. sales. Collectively, New Jersey, Illinois, Virginia, North Carolina, Maryland, Florida, and Louisiana finish out the top ten states, representing another 33% of total boxwood sales. Though spread throughout the country, the top ten states represent about 73% of boxwood sales, which was a slightly higher concentration ratio for the industry than during the previous 5 years. However, one big difference was that the membership of the top 10 shifted with Connecticut and Tennessee being replaced by Florida and Louisiana. Both Connecticut and Tennessee were hit hard by the blight disease (as reflected in the 50.5% and 46% decrease in sales, respectively), while Louisiana remains blight-free and Florida is generally too hot for the disease. Another important difference was that the rank order of the other top 8 shifted a bit, with the most significant change being that North Carolina, another blight hard-hit state, moved from number 4 to number 7 nationally in boxwood sales.

Of the total number of states reporting boxwood sales in the Census of Horticultural Specialties in 2019, 5 states have no reports of boxwood blight to date, while 26 states have had positive verification of boxwood blight (Fig. 1). Even with the ever-present possibility of boxwood blight, however, the value of boxwood sales has increased as indicated above. These data seem to indicate that boxwood remain a popular choice among today's gardening and landscaping consumers.

Comparing 2014 sales to 2019, 14 states experienced an increase in sales, with 11 of them blight-positive and the remaining 3 states blight-negative to date (Table 2). Of these 14 states, 5 of them experienced an increase in sales of over $2 million including OR (+17.1%), CA (+34.8%), FL (+69.7%), LA (+91.7%), and NJ (+34.9%). Of these, Louisiana is the only state that is blight-free to date. Sales in Ohio and Virginia both increased between $1 million and $2 million, while 7 other states experienced sales increases of less than $1 million. Interestingly, the 14 states that experienced an increase in their boxwood sales in 2019 represented 70.5% of the total value of boxwood sales in the U.S.

While 17 states experienced decreases in boxwood sales in 2019 compared to 2014, only 3 decreased by more than

Table 1. Sales of boxwood and percent of total U.S. boxwood sales in the 2009, 2014, and 2019 Census of Horticultural Specialties.

State [z]	2009 value of boxwood sales by state ($1,000)	2014 value of boxwood sales by state ($1,000)	2019 value of boxwood sales by state ($1,000)	Percent of total U.S. boxwood sales in 2009 [y]	Percent of total U.S. boxwood sales in 2014	Percent of total U.S. boxwood sales in 2019
Alabama **	3,511	3,537	3,158	3.41%	2.80%	2.24%
Arizona	81	(D)	(D)	0.08%		
Arkansas ***	116	65	48	0.11%	0.05%	0.03%
California ***	9,491	11,124	14,999	9.22%	8.80%	10.65%
Colorado	365	413	(D)	0.35%	0.33%	
Connecticut **	2,408	4,592	2,273	2.34%	3.63%	1.61%
Delaware **	(D) [x]	(D)	(D)			
Florida ***	3,551	3,130	5,311	3.45%	2.48%	3.77%
Georgia **	751	3,119	3,943	0.73%	2.47%	2.80%
Idaho	14	(D)	111	0.01%		0.08%
Illinois ***	6,711	6,562	7,521	6.52%	5.19%	5.34%
Indiana ***	374	1,779	1,507	0.36%	1.41%	1.07%
Iowa	277	(D)	252	0.27%		0.18%
Kansas **	(D)	854	348		0.68%	0.25%
Kentucky **	728	1,532	1,194	0.71%	1.21%	0.85%
Louisiana	1,955	2,331	4,468	1.90%	1.84%	3.17%
Maine	(D)	(D)	(D)			
Maryland **	3,321	8,866	6,313	3.23%	7.01%	4.48%
Massachusetts **	643	129	203	0.62%	0.10%	0.14%
Michigan ***	4,189	3,978	3,625	4.07%	3.15%	2.57%
Minnesota	478	(D)	885	0.46%		0.63%
Mississippi	213	182	286	0.21%	0.14%	0.20%
Missouri **	305	175	150	0.30%	0.14%	0.11%
Montana	(D)	(D)	(D)			
Nebraska	237	376	174	0.23%	0.30%	0.12%
Nevada	731	(D)	(D)	0.71%		
New Hampshire ***	(D)	8	(D)		0.01%	
New Jersey **	(D)	6,098	8,227		4.82%	5.84%
New Mexico	6,197	31	(D)	6.02%	0.02%	
New York **	50	2,742	2,507	0.05%	2.17%	1.78%
North Carolina **	4,194	8,899	6,714	4.08%	7.04%	4.77%
North Dakota	(D)	(D)	(D)			
Ohio **	7,339	11,950	13,844	7.13%	9.45%	9.83%
Oklahoma	(D)	(D)	(D)			
Oregon **	21,823	23,168	27,135	21.21%	18.33%	19.27%
Pennsylvania **	1,218	2,204	2,193	1.18%	1.74%	1.56%
Rhode Island **	597	459	1,050	0.58%	0.36%	0.75%
South Carolina ***	603	532	304	0.59%	0.42%	0.22%
South Dakota ***	(D)	(D)	2			0.00%
Tennessee **	4,272	4,000	2,162	4.15%	3.16%	1.53%
Texas	8,238	2,994	3,798	8.01%	2.37%	2.70%
Utah	23	(D)	29	0.02%		0.02%
Vermont	25	82	23	0.02%	0.06%	0.02%
Virginia **	2,232	5,648	7,030	2.17%	4.47%	4.99%
Washington ***	602	565	454	0.59%	0.45%	0.32%
West Virginia ***	214	513	(D)	0.21%	0.41%	
Wisconsin ***	1,030	1,020	1,666	1.00%	0.81%	1.18%
Wyoming	(D)	(D)	(D)			
Total reporting	99,107	123,657	133,907	96.3%	97.8%	95.1%
Total other (D)	3,797	2,754	6,943	3.7%	2.2%	4.9%
Total U.S.	**102,904**	**126,411**	**140,850**	100.0%	100.0%	100.0%

[z]States in which boxwood blight was observed or confirmed by the end of 2014 are indicated with "**" and from 2014 to the end of 2019 are indicated with "***"

[y]Shaded cells indicate states that are in the top 10 in boxwood sales according to the Census of Horticultural Specialties that year.

[x](D) means there were too few firms reporting and data were withheld to avoid disclosure.

$2 million: Maryland, Connecticut, and North Carolina. Tennessee also had decreased sales, but only by $1.8 million, while the remaining 13 states underwent decreases of less than $1 million each. All 17 states experiencing decreases only represented 21.9% of the total boxwood market, with 15 of the states blight-positive and 2 of them blight-negative.

There are 17 states for which sales are not reported in 2014, 2019, or both. These states are designated with "(D)" in the Census table to specify that these data were "withheld to avoid disclosing data for individual farms." In other words, firms were too few in number to guarantee anonymity. Given this, it is not evident whether sales increased or decreased in these respective states even if data is provided for 5 of the firms in 2019 (but not for 2014) and 4 of the firms in 2014 (but not in 2019). We simply cannot make the determination with only part of the data, particularly for the 8 states where data was withheld for both years. That being said, since we know there are 5 states with too few firms to report in 2014 but with more than the minimal number of firms to be able to report data in 2019, then we know for sure they experienced an increase in the number of growers to pass the disclosure threshold. If it is further assumed that boxwood sales increased in those states as well, then these states could also be added to the number of states with increasing boxwood sales above. These, along with their respective increases (in $1,000), included Minnesota (+$885), Iowa (+$252), Idaho (+$111), Utah (+$29), and South Dakota (+$2). South Dakota was boxwood blight-negative when the 2019 survey was conducted, while all of the other four states remained negative in 2021 (Fig. 1).

Comparing the production among the states that have either increased or decreased boxwood sales as described above, boxwood blight appears to have promulgated some shifts in the market as to where boxwood production and sales occur, with some production shifting to states that remained free of blight or have limited blight presence, particularly Texas, Louisiana, and Mississippi. The overriding conclusion from this analysis, however, is that boxwood remain a popular feature in U.S. gardens and landscapes, thus it is imperative to have efficacious blight mitigation strategies at all levels of the green industry supply chain to ensure its landscape legacy in the future.

Observations Regarding the Value of Boxwood Sales from 2009 to 2019

Table 2 and Figures 2–4 summarize the trending in the data across both of the aforementioned time periods. Between each census (2009-2019), there has been a decrease in the number of operations that sold broadleaf evergreens, the units of broadleaf evergreens sold, and the total sales value of broadleaf evergreens. However, the number of operations that sold boxwood actually increased slightly (by 6 operations nationally) from the 2009 CHS to the 2014 CHS, while the number of units of boxwood sold decreased and the value of sales increased 23%. The reverse was true from the 2014 CHS to the 2019 CHS: the number of operations that sold boxwood continued to decrease (by about 300 firms), but both the numbers of boxwood sold and the value of boxwood sales both increased. For each CHS from 2009 to 2019, boxwood accounted for an increasingly larger proportion of the broadleaf evergreen category. There are 14 states (3 that are boxwood blight positive) that did not have sufficient data to determine their trend in boxwood production. These are states that have one or more years of CHS data that have been withheld by USDA-NASS to avoid disclosure because there were too few firms reporting (designated with a "(D)" in the tables).

There are five other states that have two of the three data points (West Virginia, Colorado, New Jersey, New Mexico, and Kansas), but are missing the third data point necessary to establish the trend accurately. That leaves 29 firms for which data were complete and these fell into one of four major categories: (1) those states whose boxwood production increased during both time periods, (2) states whose production decreased during 2009-2014 but increased the next five years, (3) those states whose production increased during 2009-2014 but decreased during 2014-2019, or (4) states whose boxwood production fell during both time periods.

A total of 6 states experienced increased boxwood production during both the 2009-2014 and the 2014-2019 time periods: Ohio, California, Louisiana, Ohio, Virginia, and Georgia. Of these, all have had boxwood blight reported with the exception of Louisiana that experienced a 19.2% increase in boxwood production during 2009-2014, as well as a 91.7% increase during 2014-2019.

Conversely, 6 states experienced a decrease in boxwood production during the entire 2009-2019 time period. These include, along with their respective decrease, Arkansas (70.1%), Missouri (56.9%), Washington (25.8%), South Carolina (54.6%), Michigan (13.9%), and Tennessee (52.3%). Obviously, boxwood production is now less than half of what it was pre-boxwood blight in 3 of these states.

Of the 10 states that increased boxwood production initially in 2009-2014, but subsequently experienced a decrease, Connecticut, North Carolina, and Maryland were those that had the largest production decrease, particularly important since they are in the top 10 states boxwood-producing states that had almost doubled their production in the first time period, only to have a 24.6% and 28.8% decline, respectively, in the most recent time period. These were all states which reported boxwood blight in 2011, the first year that the disease was known in the U.S.

Lastly, of the 7 states (Florida, Illinois, Texas, Wisconsin, Rhode Island, Mississippi, and Massachusetts) that were on the decline from 2009-2014, but have increased boxwood production since then, the largest increase in sales was in Florida (+$2.18 million). Rhode Island's increase was also significant, more than doubling the boxwood production in that state. In New Jersey, although data for the first time period was missing, boxwood production increased by $2.13 million in the 2014-2019 time period, a 34.9% increase.

Discussion and Conclusions

Other data available regarding green industry production trends and marketing practices are collected as part of the

Table 2. Boxwood sales in the 2009, 2014, and 2019 Census of Horticultural Specialties and the difference and percentage change in sales between the 2009 to 2014 censuses and the 2014 to 2019 censuses.

State [z]	2009 value of boxwood sales by state ($1,000)	2014 value of boxwood sales by state ($1,000)	2019 value of boxwood sales by state ($1,000)	Difference between 2009 and 2014 sales [y]	Percentage decrease or increase in sales (2009-2014)	Difference between 2014 and 2019 sales	Percentage decrease or increase in sales (2014-2019)
Oregon **	21,823	23,168	27,135	1,345	6.2%	3,967	17.1%
California ***	9,491	11,124	14,999	1,633	17.2%	3,875	34.8%
Louisiana	1,955	2,331	4,468	376	19.2%	2,137	91.7%
Ohio **	7,339	11,950	13,844	4,611	62.8%	1,894	15.8%
Virginia **	2,232	5,648	7,030	3,416	153.0%	1,382	24.5%
Georgia **	751	3,119	3,943	2,368	315.3%	824	26.4%
Florida ***	3,551	3,130	5,311	-421	-11.9%	2,181	69.7%
New Jersey **	(D)[x]	6,098	8,227			2,129	34.9%
Illinois ***	6,711	6,562	7,521	-149	-2.2%	959	14.6%
Texas	8,238	2,994	3,798	-5,244	-63.7%	804	26.9%
Wisconsin ***	1,030	1,020	1,666	-10	-1.0%	646	63.3%
Rhode Island **	597	459	1,050	-138	-23.1%	591	128.8%
Mississippi	213	182	286	-31	-14.6%	104	57.1%
Massachusetts **	643	129	203	-514	-79.9%	74	57.4%
Pennsylvania **	1,218	2,204	2,193	986	81.0%	-11	-0.5%
Vermont	25	82	23	57	228.0%	-59	-72.0%
Nebraska	237	376	174	139	58.6%	-202	-53.7%
New York **	50	2,742	2,507	2,692	5384.0%	-235	-8.6%
Indiana ***	374	1,779	1,507	1,405	375.7%	-272	-15.3%
Kentucky **	728	1,532	1,194	804	110.4%	-338	-22.1%
Alabama **	3,511	3,537	3,158	26	0.7%	-379	-10.7%
North Carolina **	4,194	8,899	6,714	4,705	112.2%	-2,185	-24.6%
Connecticut **	2,408	4,592	2,273	2,184	90.7%	-2,319	-50.5%
Maryland **	3,321	8,866	6,313	5,545	167.0%	-2,553	-28.8%
West Virginia ***	214	513	(D)	299	139.7%	-	
Colorado	365	413	(D)	48	13.2%	-	
Arkansas ***	116	65	48	-51	-44.0%	-17	-26.2%
Missouri **	305	175	150	-130	-42.6%	-25	-14.3%
Washington ***	602	565	454	-37	-6.1%	-111	-19.6%
South Carolina ***	603	532	304	-71	-11.8%	-228	-42.9%
Michigan ***	4,189	3,978	3,625	-211	-5.0%	-353	-8.9%
Kansas **	(D)	854	348			-506	-59.3%
Tennessee **	4,272	4,000	2,162	-272	-6.4%	-1,838	-46.0%
New Mexico	6,197	31	(D)	-6,166	-99.5%	-	
Arizona	81	(D)	(D)				
Delaware **	(D)	(D)	(D)				
Idaho	14	(D)	111			+	
Iowa	277	(D)	252			+	
Maine	(D)	(D)	(D)				
Minnesota	478	(D)	885			+	
Montana	(D)	(D)	(D)				
Nevada	731	(D)	(D)				
New Hampshire ***	(D)	8	(D)			-	
North Dakota	(D)	(D)	(D)				
Oklahoma	(D)	(D)	(D)				
South Dakota ***	(D)	(D)	2			+	
Utah	23	(D)	29			+	
Wyoming	(D)	(D)	(D)				

[z]States in which boxwood blight was observed or confirmed by the end of 2014 are indicated with "**" and from 2014 to the end of 2019 are indicated with "***" (as shown in Fig. 1)
[y]Light-colored shading represents sales increased in that state during that time period; dark shading represents sales decreased.
[x](D) means there were too few firms reporting and data were withheld to avoid disclosure.

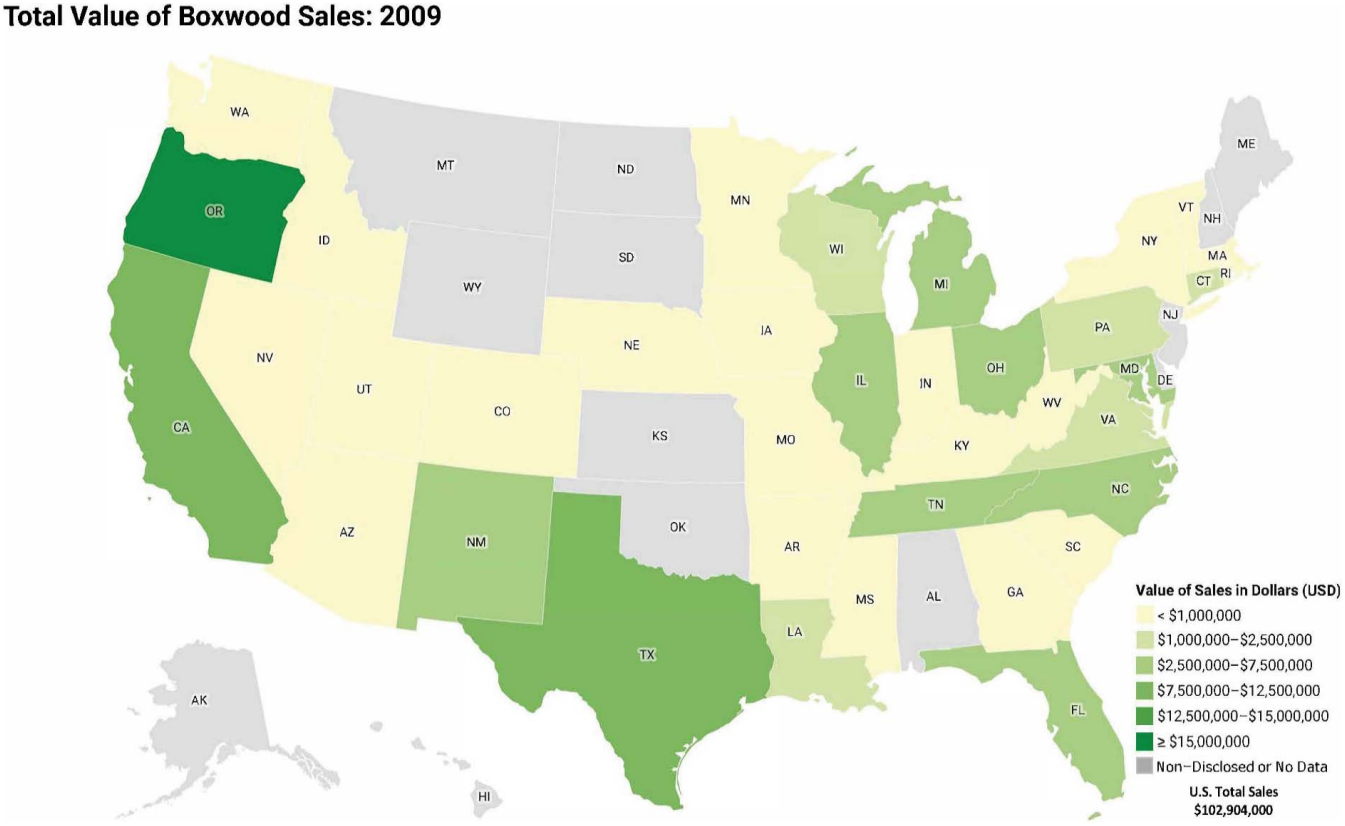

Fig. 2. Map of boxwood production and total sales by state in 2009 using data from the 2009 Census of Horticultural Specialties.

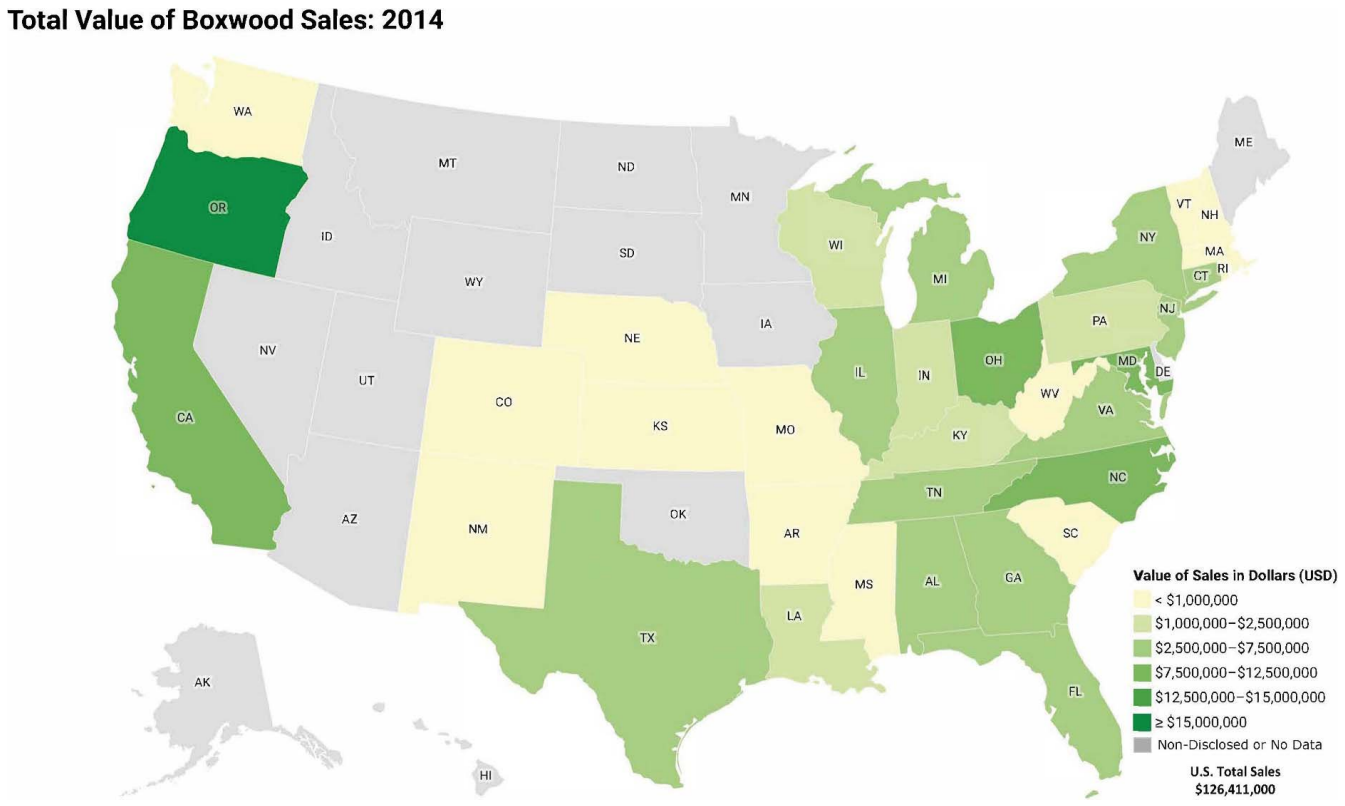

Fig. 3. Map of boxwood production and total sales by state in 2014 using data from the 2014 Census of Horticultural Specialties.

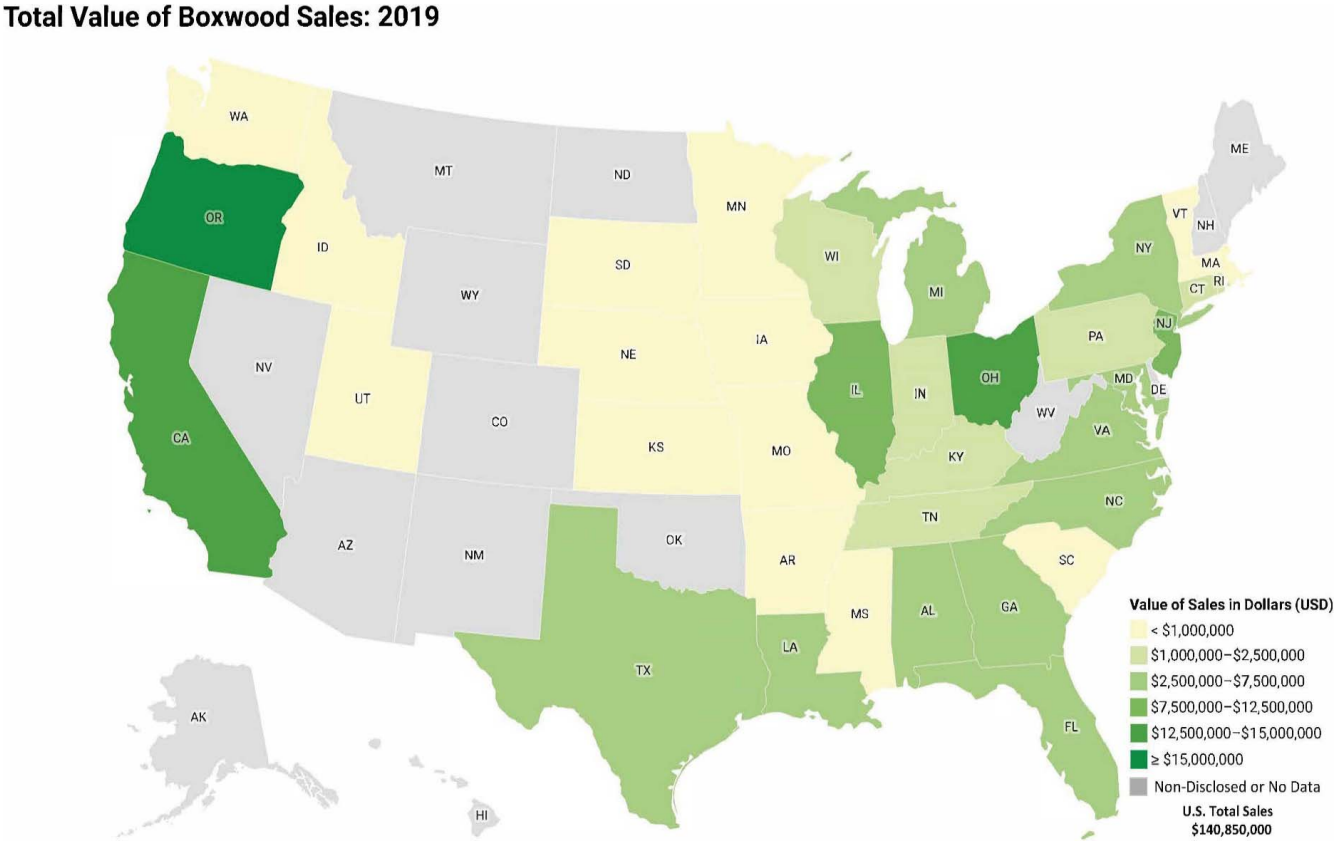

Fig. 4. Map of boxwood production and total sales by state in 2019 using data from the 2019 Census of Horticultural Specialties.

National Green Industry Survey conducted every five years by the Green Industry Research Consortium, a group of horticulturists and agricultural economists that collaborate as part of a USDA-NIFA multi-state project. The key data provided in previous reports were related to the production efforts (plant types and forms grown, irrigation methods and water sources, pest management), marketing practices (market distribution channels, selling methods, advertising forms) and a range of factors affecting pricing strategies and overall business growth and opportunities. The reports also summarize regional trade flows of finished products and propagation materials for each U.S. region and reporting period (Brooker et al. 1990, 1995, 2000, 2005, Hodges et al. 2010, Hodges et al. 2015a, Khachatryan et al. 2016).

Findings from the most recent survey reveal that most of the output by growers is sold to destinations within their home region (74%), which underscores the costs associated with long-haul transportation and the perishable nature of the live plant products. While there is some evidence that regions with high home sales also maintain relatively high inter-regional trade volume (e.g., Southeast), at least two regions had relatively lower within-home-region sales and a higher proportion of inter-regional sales (e.g., the Appalachian and Pacific regions). This implies that inter-regional trade is not directly proportional to the total output by the firms in a particular region.

Second, the origin and destination linkages and trade volumes can be determined by both proximity of markets (i.e., transportation distance/cost) and population density, which is positively correlated with economic activity in the region. Consider the Southeast region, which had the largest inter-regional trade in 2018 and shipped most of its production to Appalachian destinations. Among the top four regions in inter-regional trade volume (Southeast, Northeast, Appalachian, and Midwest), the Appalachian region had the most inter-regional trade with third-order neighbor regions (i.e., separated by two regions in between). International trade has spiked both in the 5-year and 10-year time span for nearly all the regions, experiencing 11.3 percent growth since 2013 and 12.0 percent since 2008. Finally, considering the total trade flows (both intra- and inter-regional), the Great Plains and Pacific are the largest purchasing regions, accounting for over 54.1 percent of the purchases nationwide. Compared with 2008, these two regions had a 9.9 and 1.5 percent increase, respectively, in purchase volume across all regions, including intra-regional sales. From 2008 to 2018, intra-region sales decreased in most regions except for the Southcentral region. This could be because business owners are adapting to demand changes. While these data from the National Green Industry Survey refer to all nursery crops, including, but not limited to, boxwood, none of the findings from our boxwood analysis contradict the findings by the Green Industry Research Consortium.

The findings from this analysis of the Census of Horticultural Specialties data from 2009-2019 indicate that there were already shifts occurring in boxwood markets from the exiting of several large nurseries in the Southwest even prior to the introduction of boxwood blight. However, boxwood blight has exacerbated the supply chain chal-

lenges for green industry participants by limiting production in certain areas of the country, increasing the costs of producing boxwood compared to other evergreen shrubs by relying on the use of fungicides and developing best management practices such as rigorous sanitation practices (Daughtrey 2019), and perhaps dampening the demand from what might have been without the existence of the blight. For example, the boxwood market grew 23% from the 2009 CHS to the 2014 CHS and only grew 11% from 2014 to 2019. However, during each of the time periods, the growth in boxwood sales outpaced the growth of the entire nursery stock category, which grew 11% from 2009-2014 and grew 7% from 2014-2019, reflecting the popularity of boxwood within the overall nursery marketplace. But while the growth in boxwood sales was more than double the growth rate of nursery stock in general during 2009-2104, the growth in boxwood sales slowed considerably during the 2014 to 2019 time period.

It is important to note that the effects studied in this analysis are only at the grower level. Further economic impacts from the boxwood blight have disrupted the boxwood market downstream in the supply chain with not only the loss of these boxwood shrubs in public gardens, estate gardens, and other public and private venues, but also the generation of a need for additional labor, materials, and other management costs for landscape service firms. As such, it is imperative to develop a full arsenal of tools for mitigating the effects of boxwood blight before it inflicts further damage on the industry.

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