Evaluating Landscape Performance of Six Native Shrubs as Alternatives to Invasive Exotics

Jessica D. Lubell¹

ADDITIONAL INDEX WORDS. american filbert, *Corylus americana*, buttonbush, *Cephalanthus occidentalis*, northern bush honeysuckle, *Diervilla lonicera*, steeplebush, *Spiraea tomentosa*, sweet fern, *Comptonia peregrina*, sweet gale, *Myrica gale*, japanese barberry, *Berberis thunbergii*, winged euonymus, *Euonymus alatus*

SUMMARY. There is increased interest in using native plant alternatives to invasive species for landscaping. Several invasive shrubs are used extensively in landscaping since they perform well in challenging landscapes, such as parking lot island plantings, which are dry, nutrient-poor, and sun and heat exposed. This study evaluated the landscape suitability of six underused Connecticut native shrubs [american filbert (*Corylus americana*), buttonbush (*Cephalanthus occidentalis*), northern bush honeysuckle (*Diervilla lonicera*), steeplebush (*Spiraea tomentosa*), sweet fern (*Comptonia peregrina*), and sweet gale (*Myrica gale*)] by planting them in a large commuter parking lot on the University of Connecticut (UConn) campus in Storrs. Two nonnative invasive species, ‘Crimson Pygmy’ japanese barberry (*Berberis thunbergii*) and ‘Compactus’ winged euonymus (*Euonymus alatus*), were also planted as controls. Buttonbush, sweet fern, and sweet gale performed as well as controls and had aesthetic quality index (AQI) ratings similar to controls throughout the study, which spanned three growing seasons. These findings were surprising for buttonbush and sweet gale, which are found in the wild occupying predominantly wet areas. Buttonbush plants readily established at the site as indicated by a 930% increase in plant size over the first growing season. Sweet fern and sweet gale produced attractive, dense, and uniform mounds consistently throughout the study. Northern bush honeysuckle and american filbert were slower to establish, but by the second and third year, respectively, plants were highly attractive and had AQI ratings similar to controls. Despite its attractive floral display, steeplebush performed poorly and developed powdery mildew (*Sphaerotheca*) symptoms in the first and second years, which contributed to a lower AQI compared with controls. Aesthetic quality for american filbert, buttonbush, and steeplebush was reduced because of variation resulting from seed propagation. For certain native species, plants received from the nursery were not robust, which may have had a greater influence on establishment and early performance than their inherent landscape adaptability. This study identified five underused native shrubs that are adaptable and able to replace invasive plants in landscapes.

The nursery and landscape industry is facing the loss of some of its most important landscape shrub crops, such as japanese barberry and winged euonymus, because of their invasive tendencies. Consumer awareness of invasiveness has reduced sales of profitable species (McCoy, 2011) and plant bans have eliminated the crops in some areas. Both japanese barberry and winged euonymus have been banned in Massachusetts (Massachusetts Department of Agricultural Resources, 2005) and New Hampshire (New Hampshire,

2004), and two counties in Long Island, NY, have legislation in place that will ban these species in 2016 (Cornell University Cooperative Extension, 2009a, 2009b). The Connecticut Nursery and Landscape Association (CNLA) enacted a voluntary ban on high-fruited japanese barberry cultivars in 2010 (CNLA, 2010). Major wholesale nursery producers in Connecticut indicate that sales of japanese barberry and euonymus are down as

much as 60% (M. Sellew, personal communication).

A widely recognized solution to the loss of invasive shrubs is the increased use of native shrubs for landscaping. A survey of 270 members of the CNLA found that growers strongly favored the promotion of native plants as a solution to the invasive plant problem (Gagliardi and Brand, 2007). Japanese barberry and winged euonymus are among the most popular landscape shrubs because they are highly adaptable to variable landscapes and perform well under difficult growing conditions such as parking lot island plantings. If native plants are going to be successful as replacements for invasive species, it is critical that they be well adapted to challenging landscape sites. The majority of commercial landscape situations involve relatively harsh conditions, which might include reflected light, high temperatures, inadequate water supply, infertile soil, road salt, and pedestrian pressure. One of the issues associated with native shrubs has been their blind recommendation without knowing landscape suitability and the false notion that all native plants are well suited for landscape purposes. Failed attempts in using native shrubs to replace invasive species may result in future reluctance of homeowners, landscapers, and growers to embrace native species as alternatives to invasive species.

Some native plants are already widely used for landscaping and have proven themselves to be adapted to commercial landscape situations. The nursery industry needs a substantially broadened palette of versatile and adaptable native plants to meet the growing desire of landscapers and consumers to use native plants in landscaping. Native plants such as american filbert, buttonbush, northern bush honeysuckle, steeplebush, sweet fern, and sweet gale exhibit wide adaptability in natural settings (Dirr, 2011; Hightshoe, 1988), making them prime candidates for development as

Assistant Professor, Department of Plant Science and Landscape Architecture, University of Connecticut, 1376 Storrs Road, Unit 4067, Storrs, CT 06279-4067

¹Corresponding author. E-mail: jessica.lubell@uconn.edu.

Units			
To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
28.3495	oz	g	0.0353

native landscape plant alternatives for difficult sites. Much of the native plant evaluation work done to date has been more empirical than quantitative, where a single plant is installed and observed over time. If this individual fails, the cause of failure, whether due to poor planting site, weak initial root system, damage from people or animals, or something else, is usually unknown. The objective of this study was to determine whether these six native shrubs are well adapted to landscape use. The identification of well-adapted native plants will enable the nursery industry to produce plants that will be successful in landscaping and profitable over time.

Materials and methods

Six Connecticut native shrub species [american filbert, buttonbush, northern bush honeysuckle, steeplebush, sweet fern, and sweet gale (Table 1)] were selected for this study. American filbert, buttonbush, and steeplebush were sexually propagated and northern bush honeysuckle, sweet fern, and sweet gale were asexually propagated and the plants used were clonal. American filbert and buttonbush were obtained as #1 containers and steeplebush as #2 containers from Pierson Nurseries (Biddeford, ME). Northern bush honeysuckle was obtained as #2 containers from Prides Corner Farms (Lebanon, CT). Sweet fern and sweet gale were propagated and grown by the author and finished in #2

containers at the UConn Plant Science Research and Education Facility (Storrs). Plants were installed in parking lot islands in a commuter parking lot on the UConn campus (Storrs) in U.S. Department of Agriculture hardiness zone 6a on 1 June 2010. Two nonnative, invasive species, 'Crimson Pygmy' japanese barberry and 'Compactus' winged euonymus, also were planted and used as controls. These species were asexually propagated. Control plants were obtained as #2 containers from Prides Corner Farms.

The experimental design was a randomized complete block design with six replications and the experimental unit consisted of five individual plants of a species. A block consisted of a planting row, which was divided into eight equal sections or experimental units and each section contained five individual plants of a species. Each block contained 40 plants and 240 plants in total were installed for the study. Four blocks were installed in a single parking lot island and two blocks in a separate parking lot island. Each block was within 5 ft of asphalt parking lot or concrete sidewalk. One week before planting, block perimeters were marked and the grassy vegetation was sprayed with glyphosate herbicide. Shrubs were installed with the top of the root ball at or slightly higher than the surrounding landscape soil. Plants were arranged in two staggered rows with 4-ft centers within row and 3 ft between rows.

The five individual plants per experimental unit were arranged so that three plants occupied one row and two plants occupied the other row in positions directly opposite (but staggered). Blocks were mulched with shredded softwood bark to a depth of 4 inches. Plants were irrigated by hand with a watering wand immediately after planting, three times weekly for the first 4 weeks, and twice weekly for the next 6 weeks. Each shrub was irrigated with 3 L of water at each irrigation event. After the 10 weeks following planting, shrubs did not receive supplemental irrigation for the remainder of the study. Plants were fertilized on 2 May 2011 with 30 g of granular 10N-4.4P-8.3K in the area 12 to 24 inches from the crown. Blocks were mulched a second time on 22 May 2011 with shredded softwood bark to a depth of 2 inches. The soil at the parking lot site had sandy loam texture, pH 5.9, and 4.3% organic matter.

Plant height and width, and survival and aesthetic quality were evaluated over three growing seasons (June 2010 to Aug. 2012). Plant width was measured twice, at right angles to each measurement, and averaged. For every plant, plant height and width were recorded immediately following planting and at 10, 62, and 115 weeks after planting. Plant size was calculated as the product of the height and two perpendicular widths. Percent increase in plant size was calculated by: $[(\text{new value} - \text{old value}) / \text{old value}] \times 100\%$.

Table 1. Nomenclature and plant description of six Connecticut native shrub species. Plant descriptions are based on observations in Connecticut and literature sources.

Common name	Source of plant	Plant description ^a
American filbert	Seed	Upright habit with strong vertical shoots. Zigzagging stems and alternate, simple leaves that are broadly oval with a pointed tip. Roughened upper leaf surface and sharply toothed margins. Edible nut.
Buttonbush	Seed	Upright and rounded habit with overarching branches. Opposite, simple dark green, glossy leaves. Cream-colored flowers clustered in balls 1 to 1¼ inch across. Attracts butterflies. Fruits, reddish then black, persist.
Northern bush honeysuckle	Cutting	Low-growing shrub, 2 to 4 ft tall. Shoots cascade outward from center. Opposite, lance-shaped leaves taper to a point. Reddish tinged new growth. Tubular yellow flowers in bunches. Long bloom period.
Steeplebush	Seed	Upright with vertical, suckering shoots. Broadly, elliptic leaves with tan pubescence below. Dense, long, rosy-pink flower panicles with brown tomentose.
Sweet fern	Cutting	Dense, mounded habit up to 4 ft tall. Sweet scented, dark green, fern-like foliage. Spreads slowly by underground rhizomes. Nitrogen fixing.
Sweet gale	Cutting	Upright but spreading, mounded, multistemmed habit. Low growing, up to 3 ft tall. Alternate leaves have a whorled appearance on stems. Leaves are narrow, spatulate, toothed at ends and a frosty lime green. Foliage is aromatic. Nitrogen fixing.

^aInformation adapted from Cullina (2002), Dirr (2011), and Hightshoe (1988); 1 inch = 2.54 cm, 1 ft = 0.3048 m.

All plants were visually rated during the third week of July 2010, 2011, and 2012 with an AQI consisting of density and uniformity of shape; foliage color; and disease, insect, or deer damage. For the AQI, each of the three categories consisted of a scale from 1 to 3. For density and uniformity of habit, 1 represented a sparse, asymmetrical plant and 3 represented a dense, uniformly proportional plant. For foliage color, 1 represented a chlorotic plant and 3 represented the darkest green color for each species. For disease, insect, or deer damage, 1 represented significant damage due to disease, insects, or deer and 3 represented no evidence of disease, insect, or deer damage. Three independent observers rated each plant for the three categories. A composite AQI for each plant was calculated to be the sum of the AQI for each of the three categories and averaged for the three observations. AQI data were subjected to analysis of variance using the PROC MIXED procedure and mean separation using Fisher's least significant difference test ($P \leq 0.05$) using SAS (version 9.2 for Windows; SAS Institute, Cary, NC).

Results and discussion

The nonnative controls, 'Crimson Pygmy' japanese barberry and 'Compactus' winged euonymus, performed well in the challenging parking lot conditions as expected. Every season 'Crimson Pygmy' japanese barberry and 'Compactus' winged euonymus had, statistically, the highest AQI ratings (Table 2). AQI ranged

from 9.0 to 8.6 for 'Crimson Pygmy' japanese barberry and 8.8 to 8.6 for 'Compactus' winged euonymus. 'Crimson Pygmy' japanese barberry height and width increased throughout the study (Table 3) and demonstrated 80% to 100% increase in plant size each year (Table 4). Over the course of the three-year study, plants exhibited all of the qualities that have made 'Crimson Pygmy' japanese barberry a popular landscape ornamental, such as compact size, dense foliage, bright color, and deer resistance (Fig. 1). The only potential drawback with this species is that because plants are low growing and have brittle shoots, they occasionally suffer damage by snow load, pedestrians, or lawn mowers. One 'Crimson Pygmy' japanese barberry plant in this study was severely damaged and did not survive the first winter. Several other plants suffered minor physical damage. For 'Compactus' winged euonymus, height and width increased very little over the first year (Table 3) producing only 10.3% increase in plant size (Table 4). The small increase may be attributed to the fact that, unlike 'Crimson Pygmy' japanese barberry, 'Compactus' winged euonymus produces only one flush of growth per season and in general it requires a longer time to establish. However, by the second and third year of the study, 'Compactus' winged euonymus had increased in size by 88% and 156%, respectively (Table 4). All 'Compactus' winged euonymus plants survived until the end of the study. Like 'Crimson Pygmy' japanese barberry, 'Compactus' winged euonymus plants demonstrated

all of the qualities that have made it a popular ornamental, such as dense habit, uniformity of shape, and outstanding red fall color (Fig. 1). In all three years of the study, plants produced fruit, suffered some deer browse, and occasionally produced off-color, yellow shoots, a trait that has been observed for this species in other circumstances.

All american filbert plants installed in the parking lot survived until the end of the study. In year 1, the AQI for american filbert was 6.6, which was significantly lower than the controls (Table 2). However, over the next two years, american filbert's AQI gradually improved and by the third and final year of the study, its AQI was 8.8 and statistically similar to the controls. Increases in plant height and width for this species were small over the first two years (Table 3), and in both years, the plants suffered slight to moderate deer browse. In year 3, plants increased in size by 103% (Table 4) and no deer browse was observed. American filbert plants received from the nursery were sparse, consisting of few shoots, and not very robust. This poor initial plant quality may have contributed to their low AQI and small size increase for the first two years. By the third year of the study, plants had established themselves in the landscape and produced highly attractive, dense, uniform mounds with average height and width of 36 and 38 inches, respectively (Table 3). American filbert leaves are larger than those of the other species evaluated and they provide interesting texture, by way of a roughened upper surface and coarsely toothed margins, and russet orange to maroon fall color. Plants produce edible nutlets with interesting ruffled involucre.

American filberts prefer dry, gravelly, well-drained soils and can be found growing in the wild along rock walls, the edges of woods, on hillsides, in clearings, and in thickets (Cullina, 2002). Plants from the nursery were grown in a typical nursery container medium, which is high in organic content and water-holding capacity (Davidson et al., 2000). Based on my experience with american filbert container culture and observations of this plant in the wild, plants in the nursery would probably have benefited from a potting media with less organic content and water-holding

Table 2. Aesthetic quality index (AQI) for six Connecticut native and two nonnative shrub species established in a commuter parking lot on the University of Connecticut campus (Storrs) evaluated in July 2010, 2011, and 2012.

Species	AQI ^a		
	2010	2011	2012
Native species			
American filbert	6.6 b ^y	7.7 b	8.8 a
Buttonbush	8.7 a	8.5 a	8.6 a
Northern bush honeysuckle	6.3 b	8.7 a	8.5 a
Steeplebush	5.0 c	6.8 c	7.7 b
Sweet fern	9.0 a	8.8 a	8.9 a
Sweet gale	8.5 a	8.7 a	9.0 a
Nonnative species			
'Crimson Pygmy' barberry	8.6 a	8.7 a	9.0 a
'Compactus' winged euonymus	8.8 a	8.6 a	8.6 a

^aAll five plants per experimental unit ($n = 6$; except for sweet gale where $n = 4$) were rated by three people. Mean ratings are composite of separate visual ratings of 1–3 (3 = best) for each density and uniformity of shape; foliage color; and disease, insect or deer damage.

^yMean separation within columns (lowercase letters) by Fisher's least significant difference test ($P \leq 0.05$).

Table 3. Height, width, and size at the time of planting (initial) and 10, 62, and 115 weeks after planting (WAP) for six Connecticut native and two nonnative shrub species planted in a commuter parking lot on the University of Connecticut campus (Storrs) evaluated for three years (2010, 2011, and 2012).

Species	Initial			Aug. 2010 (10 WAP)			Aug. 2011 (62 WAP)			Aug. 2012 (115 WAP)		
	Ht (inches)	Width (inches) ^y	Size (1000 inch ³) ^y	Ht (inches)	Width (inches)	Size (1000 inch ³)	Ht (inches)	Width (inches)	Size (1000 inch ³)	Ht (inches)	Width (inches)	Size (1000 inch ³)
Native species												
American filbert	28.6	20.4	11.9	30.0	25.0	18.6	30.0	29.5	26.1	36.2	38.3	53.1
Buttonbush	29.0	13.9	5.6	43.3	36.5	57.7	55.3	52.0	149.5	63.8	61.5	241.3
Northern bush honeysuckle	24.8	28.2	19.7	30.6	40.0	49.0	33.9	50.3	85.7	47.9	58.8	165.6
Steeplebush	21.7	19.5	8.3	24.2	28.1	19.1	33.8	27.1	24.8	38.0	31.4	37.5
Sweet fern	26.4	23.1	14.1	28.4	32.8	30.6	35.3	47.8	80.6	42.8	59.5	151.5
Sweet gale	29.0	34.6	34.7	29.5	36.7	39.7	30.0	45.3	61.6	36.4	55.4	111.7
Nonnative species												
'Crimson Pygmy' barberry	14.5	19.6	5.6	16.0	25.3	10.2	18.2	31.7	18.3	22.9	40.1	36.8
'Compactus' winged euonymus	23.2	23.3	12.6	24.2	24.0	13.9	28.2	30.4	26.1	36.9	42.5	66.7

^xPlant width was measured twice, at right angles to each measurement, and averaged; 1 inch = 2.54 cm.

^yPlant size was the product of the height and two perpendicular widths; 1 inch³ = 16.3871 cm³.

capacity than was used in this case. Therefore, the poor performance of this species over the first two years of the study can likely be attributed to its nursery container culture rather than its adaptability to the parking lot conditions.

Buttonbush had high AQI ratings, ranging from 8.7 to 8.3, that were statistically similar to the controls from beginning to end of the study (Table 2). All buttonbush plants survived the duration of the study. Buttonbush plants produced abundant growth initially as indicated by an increase in plant size of 930% during year 1 (Table 4). By the end of the first growing season, plants were 10 times as large as they were at time of planting (Table 3). As the branching system filled out over time, the growth rate slowed and the percent increase in plant size in 2011 and 2012 was 159% and 61%, respectively. Buttonbush was the last to leaf out in the spring with shoots emerging in mid to late May. Some twig dieback was noticeable in early spring, but by early June this was no longer visible on plants. Flowering started in late July and effective flower display lasted 7 to 10 d. Some variability in plant height, leaf color, leaf thickness and shine, density of habit, new shoot color, flower production, and fruit color was noticeable. Variation in appearance resulted primarily from the seed propagation used to generate this species. It was surprising how well buttonbush adapted to the dry, well-drained parking lot soil conditions (Fig. 1), considering this plant occupies wet habitats in the wild, such as swamps and bogs and along the edges of lakes and rivers (Hightshoe, 1988).

In year 1, northern bush honeysuckle had an AQI of 6.3, which was significantly lower than the controls (Table 2). However, plant quality quickly improved and in years 2 and 3, northern bush honeysuckle had achieved AQI ratings of 8.7 and 8.5, respectively, and were not significantly different from controls. The reduced plant quality noted in the first season can be attributed to how the plants were grown in containers. Plants of northern bush honeysuckle received from the nursery had been grown too close together in the nursery and were more upright in appearance than typical for this plant. On planting, the long upright shoots

Table 4. Percent increase in plant size per growing season for six Connecticut native and two nonnative shrub species established in a commuter parking lot on the University of Connecticut campus (Storrs, CT) for three growing seasons (2010, 2011, and 2012).

Species	Increase in plant size per growing season (%) ^z		
	2010	2011	2012
Native species			
American filbert	56.3	40.3	103.4
Buttonbush	930.4	159.0	61.4
Northern bush honeysuckle	148.7	74.9	93.2
Steeplebush	130.1	29.8	51.2
Sweet fern	117.0	163.4	88.0
Sweet gale	14.4	55.2	81.3
Nonnative species			
'Crimson Pygmy' barberry	82.1	79.4	101.1
'Compactus' winged euonymus	10.3	87.8	155.6

^zPlant size was the product of the height and two perpendicular widths; percent increase was calculated by [(new value – old value)/old value] × 100.

relaxed outwards and plants appeared sparse in the center and irregular, which contributed to their low AQI in 2010.

Overall, northern bush honeysuckle plants performed well, producing dense mounds with coppery red new foliage color, which slowly faded to green (Fig. 1). Plants produced abundant growth over year 1, increasing in size by 149%. Plant size continued to increase throughout the study, and at the end of the study, plants were 48 inches tall and 59 inches wide (Table 3). At the end of Aug. 2011, three northern bush honeysuckle plants growing in one experimental block had off-color foliage, and appeared sparse and wilted in comparison with plants of this species in other blocks. This probably resulted from water-logged soil conditions around the plants because of more than average rainfall in June, July, and August coupled with heavy water runoff and subsurface drainage flow in the direct path of these plants. The total rainfall in Storrs, CT, for the months of June, July, and Aug. 2011 was 23.40 inches [U.S. Department of Commerce (USDC), 2009], which is 11.19 inches more than the average for this time period (The Weather Channel, 1995). More than half of the total rainfall (13.76 inches) came in August. The same three plants did not survive Winter 2011–12. 'Crimson Pygmy' japanese barberry plants adjacent to the affected northern bush honeysuckle plants were also affected by the heavy water runoff and subsurface flow. These 'Crimson Pygmy' japanese barberry plants did

not develop the late season vivid red foliage, typical of this species and present on plants in other blocks. In addition, the interior foliage on these 'Crimson Pygmy' japanese barberry plants appeared yellow.

Northern bush honeysuckle was one of the two earliest species to leaf out in the spring (the other being euonymus), and by the end of May, plants were fully foliated. New shoots developed from the base and plants exhibited an attractive cascading waterfall look where the shoots arched outward from center. At the start of the flowering period in June, plants produced a heavy bloom and flowered more or less continuously throughout the season into late September.

Steeplebush had an AQI of 5.0 in 2010 (Table 2), which was significantly lower than the controls. Within the first month following transplanting, plants developed powdery mildew, which contributed to their low AQI. Powdery mildew symptoms were restricted to the foliage and plants provided seasonal interest through showy flowers in early July. Despite this incidence of disease, steeplebush plants increased in size by 130% in 2010 (Table 4). Four steeplebush plants did not survive the first winter. In Spring 2011, some plants developed new shoots from the base of the plant and appeared dense, while other plants developed lateral shoots off of old wood and appeared sparse. As in 2010, plants developed powdery mildew, which contributed to their lower AQI than controls in year 2. At time of blooming in year 2, the

leaves at the interior of the plants turned yellow, and this yellowing progressed up the stem. In year 3, steeplebush plants were on average 38 inches tall and 31 inches wide (Table 3) and did not develop powdery mildew (Fig. 1). Plants were visually much improved, but AQI still failed to reach levels exhibited by controls (Table 2). Steeplebush plants established for two years in the Indiana landscape were 18 to 30 inches tall and 12 to 24 inches wide (Mickelbart et al., 2012). Indiana plants were not as large as the plants in this study possibly due to nutrient deficiencies and chlorosis resulting from high pH soils in Indiana. In a study to evaluate pruning of steeplebush, Stanton et al. (2010) showed that plant form is improved with hard pruning in the second year after planting into the landscape. Although steeplebush proved to be less suitable than controls for challenging landscapes, this species produces an attractive floral display and in situations where it can be provided greater care and cultivation, it could be a desirable planting option.

Sweet fern performed exceedingly well and had AQI ratings that were statistically similar to the controls throughout the study (Table 2). All plants survived until the end of the study. Sweet fern foliage maintained its dark green luster throughout the first growing season, with no signs of heat stress despite the unusually hot weather in Storrs, CT, including 10 d in July when temperatures reached 85 °F or higher and two heat waves (three consecutive days reaching above 90 °F), one in July and one in September (USDC, 2009). By the end of year 1, sweet fern plants had increased in size by 117% (Table 4) and were on average 28 inches tall and 33 inches wide (Table 3). Distal sections of longer shoots were slower to leaf out in the spring than the rest of the plant, but by early June, the terminals had filled in and plants were dense and uniformly mounded (Fig. 1). Sweet fern height and width increased dramatically in year 2 (Table 3), resulting in a 163% increase in plant size. Some sucker shoots within 6 to 8 inches of the mother plant were observed for this species, which colonizes by underground rhizomes. Sweet fern foliage is desirable for its sweet fragrance, which was most noticeable on warm

Fig. 1. Photographs of six Connecticut native and two nonnative shrub species planted in a commuter parking lot on the University of Connecticut campus, Storrs, two years after transplanting: (A) american filbert, (B) buttonbush, (C) northern bush honeysuckle, (D) steeplebush, (E) sweet fern, (F) sweet gale, (G) 'Crimson Pygmy' japanese barberry, and (H) 'Compactus' winged euonymus.

sunny days. Nutlets, first observed on plants in June, and male catkins present from April to May added subtle ornamental interest.

Plants of sweet gale performed well, except for two blocks, which were excluded from the study. These two blocks of sweet gale happened to be randomly placed directly adjacent to a large, established norway maple (*Acer platanoides*), where the soils were exceptionally dry. The very dry soils, in combination with the extremely

hot weather, caused sweet gale plants in these two blocks to be damaged (dried up leaves and leaf drop) because of lack of water, even with the irrigation provided. It is doubtful that any species could have survived in this location. AQI ratings for sweet gale ranged from 8.5 to 9.0 and were not significantly different from controls throughout the study (Table 2). Plant size increased by only 14% in year 1, but this rate steadily rose over the course of the study and in year 3,

plant size increased by 81% (Table 4). By the end of the study, plants were 36 inches tall and 55 inches wide (Table 3). Sweet gale plants were highly attractive and maintained a low, dense habit throughout the study (Fig. 1). This plant has an interesting candelabra-like multistemmed, suckering habit that uniformly fills an area. Sweet gale foliage is scented, especially when bruised, and the aroma was noticeable on warm days. Sweet gale is dioecious (Magee and Ahles, 1999) and all plants in this study were male and therefore did not produce nutlets.

The findings from this study show that with proper establishment techniques for planting, mulching, and supplemental irrigation, the majority of native plants evaluated here can be expected to perform as well as the invasive controls, japanese barberry and winged euonymus. Supplemental irrigation was probably the most critical input for plant establishment. The total average rainfall in Storrs, CT, for the months of June, July, and August is 12.21 inches (The Weather Channel, 1995). During these months in 2010, Storrs received 11.08 inches of rainfall, which is a deficit of 1.13 inches (USDC, 2009). Without supplemental irrigation, the AQI for all plants, including controls, would have been lower based on observed flagging of tender shoots between irrigation events.

The performance of buttonbush, sweet fern, sweet gale, and northern bush honeysuckle was particularly impressive in this study. Sweet fern and sweet gale are able to fix nitrogen through root nodule associations with actinomycete (*Frankia*) bacteria (Del Tredici and Torrey 1976; Ziegler and Huser, 1963), which may have contributed to their ability to grow in the nutrient-poor parking lot soil conditions. Sweet fern and northern bush honeysuckle have been described as having high ecological amplitude, which means they can sustain themselves in a variety of habitats (Cullina, 2012). These species have also performed well in testing of display plantings for drought tolerance at the Coastal Maine Botanical Gardens in Boothbay, ME. The findings from this study for buttonbush disagree with the conclusion of Dirr (2011) that this species is averse to dry landscape conditions and is best suited for wet areas. This study showed that

buttonbush has much greater landscape adaptability than previously recognized.

American filbert performed very well, but was slower to produce comparable performing plants to the invasive controls, largely because of the poor quality of the starting container plants. In working with these native plants, it has become obvious that the ability of plants to establish in the landscape is strongly influenced by the methods used by nurseries to produce container stock. If container production is improved, there is the potential for a superior performance from american filbert than seen in this study.

A survey of 100 gardening consumers (unpublished data) found that although consumer demand for natives is growing, consumers perceive native plants to be less attractive than cultivated exotic ornamentals. Based on plant material I received and observations of plant production in nurseries, production standards for native shrubs do not match those applied to ornamental exotic species. This may be because growers assume consumers have low expectations for native plant quality. Consumer acceptance of native shrubs would increase if native plant quality matched that of exotic species. This can be easily achieved if nursery producers provide the same degree of care to native shrubs as they do to exotic crops.

For american filbert, buttonbush, and steplebush, aesthetic quality was reduced because of the variation resulting from seed propagation. Although there may be times when seedling material is advantageous when using natives (such as restoration or ecological enhancement), for typical landscape use and to increase consumer acceptance of natives, growers should use clonal propagation of superior individuals so that plants develop uniformly in mass plantings. Crop deficiencies resulting from seed propagation and

poor cultivation methods need to be overcome if native shrubs are going to appeal to a larger gardening public.

This study looked at six novel native species and found most to be suitable landscape plants to replace exotic invasives in challenging conditions (Fig. 1). There are many other untested native shrubs, which likely also have landscape potential. Development of underused native shrubs deserves additional study and can play a major role in mitigation of crop loss due to future legislation to ban invasive species.

Literature cited

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