RIDOT SALT TOLERANT TREE AND SHRUB GUIDE

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16. Abstract

Access and knowledge of a salt tolerant plant list is critical for Rhode Island highways. Rhode Island has a number of unique environmental characteristics that make roadside plantings difficult to establish. These include road salt runoff and salt spray from both highways and ocean breezes. The presence of roadside vegetation has many functions that serve highway users and the state.

This study reviewed the literature available on salt tolerant trees and shrubs and consulted associated professionals for recommendations on those plant species viable for Rhode Island. The study also reviewed existing roadside plantings in the state of Rhode Island identified by the RIDOT landscape division for their success in establishing in difficult salt stressed environments.

The accompanying guide provides a list of salt tolerant trees and shrubs found in the literature review which are suitable to the Rhode Island climate. The salt tolerant plants are divided into lists by salt tolerance, plant characteristics, and groups associated by light and moisture requirements. This manual is a tool for RIDOT landscape and engineering personnel to help select plants for roadside use in Rhode Island.

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Contents

Objectives and Scope of this Manual

The intent of this manual is to provide RIDOT landscape personnel and engineers with guidelines for planting functional, durable and attractive roadside landscapes. It includes recommended planting materials that will perform well along Rhode Island roadsides despite periodic salt-stress. The guide's purpose is to provide a potential palette of planting material for use on roadsides broader than that in current use. Specific grant objectives are as follows:

1. To thoroughly evaluate available literature for information on the salt tolerance of native and introduced trees and shrubs suitable for use in southern New England. Issues to be addressed would include soil salt- and salt spray-tolerance, invasiveness, ease of maintenance and sustainability.
2. To evaluate the plants in above subset against actual roadside plantings throughout Rhode Island. This effort would be collaborative with RIDOT Landscape Division to identify critical areas where salt stress is most extreme, or where tolerant plant materials are most needed.
3. To use the above information to initiate a *RIDOT Recommended Plant Manual* encompassing trees and shrubs most suited for the establishment of attractive long-lived, low-maintenance, non-invasive plantings along Rhode Island highways. This manual would include plant characteristics, photographs and source information that could be used by RIDOT landscape architects, engineers, and contractors to save time and money on landscaping projects.

Background & Literature Review

The state of Rhode Island has identified a need for a list of trees and shrubs that perform well along Rhode Island roadsides despite periodic salt-stress. The goal of this research project is to produce a recommended plant manual, specifically of trees and shrubs for use in projects in salt-impacted areas. In order to best serve the needs of the RIDOT and the public the plant materials selected should be attractive, long-lived, low maintenance, and non-invasive; in other words, sustainable. "Sustainability can be broadly defined as the capability of natural and cultural systems to maintain themselves over time. Sustainability is supported by an individual and collective motivation to use a low impact and less consumptive approach to interaction with other people and the environment," (American Society of Landscape Architects, 2007). "The term "low-maintenance landscaping" should be kept in perspective. All landscapes require some maintenance. Plants are living organisms that require routine care to thrive" (Starbuck, 2008). That said, low maintenance plants are those that require low inputs in the forms of fertilizing/feeding, mowing, pruning, and watering, are hardy for the zone in which they are planted, and which are insect and disease resistant: reducing or eliminating the need for pesticides and reducing DOT costs.

Anti-icing and deicing operations, practices that reduce the adhesion of snow to the pavement and reduce the formation of road ice, are a significant expense for many states but return greater safety benefits than their cost (Trans. Research Board, 1999). These practices have increased over the years with the development of new highway infrastructure and increasing public safety demands (Hootman, 1994). Public safety

needs do require abrasive surfaces on highways, however the cost in damages to plant material should also be considered.

Roadside vegetation serves many functions which include: erosion control, screening headlight glare, buffering noise, indicating changes in road direction, increasing the effectiveness of traffic signs, attenuating vehicle impact, reducing mowing times, increasing maintenance safety, controlling drifting snow, blocking undesirable views, emphasizing desirable views, reducing monotony, discouraging structure graffiti, providing a buffer between pedestrian and non-motorized traffic and vehicular traffic, integrating the roadside landscape into the surroundings, contributing to the health and diversity of the regional environment, and introducing travelers to the state's regional vegetation (Barton, 2005).

There is a demonstrated cause and effect relationship of road salt application and damage to vegetation. Research in Canada has labeled sodium chloride as a toxic substance due to its biotic and abiotic effects on the environment (Environment Canada and Health Canada, 2001). Roadside salt injury to plant materials is detrimental to aesthetics, decreases property value, and increases the cost of highway maintenance when dead plant material needs to be removed and/or replaced (Hanes 1976). Damage can occur up to 200m away from roadways treated with deicing salts (Wegner, 2001), and deicing salt damages have also been noted much further away, 1000 feet or more for sensitive species (Kelsey, 1991 and Morton Arboretum). Dead plant material also no longer serves to mitigate roadside and embankment erosion (Transportation Research Board, 1999). "[The] degradation of soils and vegetation in buffer areas between roads and watercourses compromises the retention and processing of pollutants transported in

stormwater runoff and diminishes the beneficial value of buffer zones to groundwater sources and reservoirs," and salt damage degrades wildlife habitat by destroying food resources, habitat corridors, shelter, and breeding or nesting sites (Wegner, 2001). The change in soil composition caused by road salts provides a competitive edge to those species which can tolerate salt. Thus salt-tolerant species will replace local species intolerant of salts. This causes changes in the make up of a plant community adjacent to a roadway. Often seaside associated species, such as *Phragmites*, can establish alongside highways.

There is a growing concern with the presence of invasive plant species populations both nationwide and in Rhode Island. The Animal and Plant Health Inspection Service (APHIS) of the USDA addresses invasive plants: "variously referred to as exotic, nonnative, alien, noxious, or non-indigenous weeds, invasive plants impact native plant and animal communities by displacing native vegetation and disrupting habitats as they become established and spread over time," (Bargeron, 2003). As a result of salt concentrations in roadside soils, salt-tolerant halophytic plant species, formerly endemic to coastal wetlands, now colonize inland roadsides (Keating, 2001). There are some mitigation practices available to DOTs. As roads have fragmented the natural habitats of many species, vegetation management practices for wildlife habitat are being adopted by DOTs; promoting nesting and feeding by small animals such as birds and rabbits, while avoiding plantings that attract large animals to roadsides, such as deer that pose a danger to drivers (Trans. Research Board 1999).

(Top Left.) Salt injury on *Pinus strobus* needles. (Top Right.) Stands of *Phragmites australis* have colonized the roadside of this interchange. (Bottom Left.) Large stretches of the median are bare of woody vegetation. Here only *Juniperus virginiana* remains. (Bottom Right.) These two trees were the last of several to die off on this length of median which now has no woody vegetation.

Salt tolerance is defined as "the ability to withstand a concentration of sodium (Na^+ ion), or of any other salt, in the soil (or in culture), which is damaging or lethal to other plants" (NYSDOT). This principle also applies to salt spray, in such that the plant material can withstand applications of aerial borne salt directly to the plant's tissues. Over 50% of woody plant species are sensitive to NaCl (Keating, 2001). Differences in plant physiology affect their salt tolerance. Species with naked buds (i.e. lacking bud

scales) can be more susceptible to salt damage than those with scaled protected buds (Zimmerman, 2006). Deciduous trees along roads with restricted traffic speed are most likely to tolerate salt stress from the soil environment (Randrup, 1996). Healthy plants resist salt stress better than those already under stress (Appleton, 2009).

Salt is spread to the environment surrounding the road in four ways: 1) malfunctioning salting equipment 2) aerial salt drift from passing traffic or wind 3) dissolved or suspended salt runoff entering the soil, 4) snow plows push salt-laden snow and slush onto the roadside (Randrup, 1996). At this time some states employ salt alternatives and "smart salting" techniques to reduce the impact of salts on the environment and corrosive damage costs (Trans. Research Board, 1999). In addition to the volume and frequency of salt applications, the timing of applications influences the degree to which vegetation is damaged. Susceptible tree and shrub species are more easily damaged by road salt in late winter than early to mid winter (Leuty, 2007). The volume and frequency of rain events also affects salt damage. Heavy rain events wash salt spray deposits from leaves and buds and dissolve and reduce concentrations of salt in the soil (Appleton, 2009 and Pederson, 2000).

There are a number of practices recommended in the literature sources that can reduce the salt damage to roadside vegetation. Predominant is to select salt tolerant species for areas that will be under salt stress. "Use caution when planting species with naked buds and other salt-sensitive species adjacent to high-speed thoroughfares and in street planters, medians, parking lot landscapes, and other areas receiving exposure to salt spray" and "rinse above-ground plant parts after salt spray exposure in early spring" (Zimmerman, 2006 and Appleton, 2009). Use burlap or other protective covers around

trees and shrubs that will receive salt exposure (Appleton 2009 and Pederson, 2000). Increase the distances of trees from the road edge to at minimum of 2m (6.6ft) for reduction in salt deposition (Pederson, 2000). Road salt damage is most severe within 60 feet of the road edge (Morton Arboretum).

Virginia Cooperative Extension lists many practices for mitigating salt damage which involve planting design:

- Plant salt sensitive plants uphill or on berms where salty water will not drain or accumulate, and at least 50-60 feet back from paving that may be de-iced.
- Mulch to prevent water loss and evaporation and subsequent build-up of salt in the soil.
- Carefully design planting areas to reduce exposure of trees and shrubs to aerial salt spray. Establish windbreaks to prevent "wind tunnels" that can carry aerial salts farther and at higher wind speeds. Use salt-tolerant shrubs or herbaceous borders (especially denser evergreens) as windbreaks to help intercept aerial salt drift before it reaches sensitive plants.
- Group tree and shrub species to shield them from wind and drift, with the most tolerant species in higher exposure areas to shield moderately tolerant species.
- Plant in the spring when locating trees and shrubs near roads on which de-icing salts are used. This allows plants more time to become established prior to salt exposure. (Appleton, 2009)

Procedures

A literature review was conducted seeking published material concerning salt tolerant woody plant species. Following the literature review a list of salt tolerant trees and shrubs and some vines was compiled and reviewed by RIDOT landscape staff. The list was edited following their recommendations. For example, many *Quercus* species were removed from the list, though they were identified as salt tolerant, because of difficulty getting them to establish in highway conditions. The salt tolerant tree and shrub lists in this report have been compiled from a variety of sources including arboretums, government publications, university cooperative extensions, and published scientific papers journal articles and horticultural literature. It should be noted that there is a wide range of salt tolerances found in the literature for some species and that sources often cite other sources as references.

The first list shows information on the salt tolerance of tree, shrub, and woody vine species. A second list of plant characteristics contains information on plant height and spread, required soil conditions, and light exposure for optimum growth, and notes whether the species is native to Rhode Island. Further lists group plants by associated growing conditions of soil moisture and light requirements for ease in selecting species for a specific site.

Six sites throughout Rhode Island were selected by RIDOT staff to be reviewed for this report. Two additional sites were suggested for review but did not make it into this report. The existing roadside plantings were observed for overall health and stress due to salt damage. The species present at each site were compared to the literature review list. Photographs were taken to document the sites and their conditions.

The sites chosen for review were:

1. The median planting on Beach Street in Narragansett from the town beach to the Dunes Club.
2. The plantings adjacent to I-95 and Route 37 at the DOT salt shed.
3. The plantings adjacent to T. F. Green Airport along Post Road, from Montebello Road to Kilvert Street.
4. Jamestown Route 138-Helm Street connector.
5. Route 10 from Park Ave. to I-95.
6. Bald Hill median planting from the Christmas Tree Shop to the Rhode Island Mall along Routes 2 and 113.

An established salt tolerant planting near T.F. Green Airport.

Analysis

Some general observations made during the roadside analysis should be discussed prior to the individual site analyses. There are a number of influences on the salt stress magnitude of any one site. Distance from the road has already been documented as having an influence in the amount of salt deposited (Kelsey, 1991; Pederson, 2000; and Appleton, 2009). The spatial relationship of a site relative to the road, in both elevation and slope aspect, influences whether the site will receive salt spray only, or salt spray and salt deposition onto the soil. A site with elevation above the road is likely to receive only aerial-borne salt spray, whereas a site below the grade of the road will likely receive salt-laden runoff in addition to aerial-borne salt spray (Fig. 1). Sites at bottoms of slopes and areas where dissolved salts can accumulate will have a much greater instance of salts in the soil.

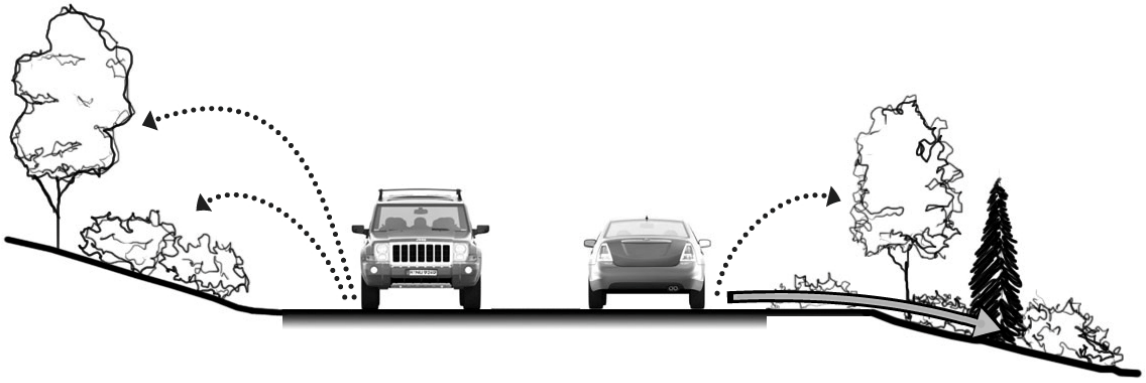


Figure 1. Vegetation elevated above roadway receives aerial salt deposition. Vegetation below roadway receives aerial salt and soil salt deposition.

The speed of the adjacent roadway influences the amount of salt removed from the road's surface to be deposited in a fine mist along the road's right of way and beyond. There is some evidence to suggest that speeds below 45 mph result in a lower degree of

salt throw than one of 45mph or greater (Kelsey, 1991). Rather than use an arbitrary speed, "greater than 45 mph or less than 45 mph" were used as a category to identify roads. Traffic volume also appears to have an effect on salt exposure. A greater number of vehicles passing will result in more salt throw to the roadside. The concentration of salts applied to a road surface would also affect amounts of salt moving from the road to the road's surroundings. Greater concentrations on the road surface can be achieved with more frequent application of salt and with a higher salt to sand ratios. Changes in salting practices as well as accumulation of soil salts over time may make a site unsuitable for plant species that had previously survived in that site.

Many sources identify that timing of salt application will affect salt damage to vegetation. Early spring applications of salt are more likely to damage vegetation that is recently emerged from dormancy, and winter sun exposure and warm temperature fluctuations can bring a plant out of dormancy and begin to uptake salts during winter and early spring months. Precipitation events (Randrup, 1996 and Appleton, 2009) can serve to wash salt deposits from leaf and branch surfaces and significant precipitation amounts can leach salts in the soil and lower the soil salt concentration. Individual plant physiology has a major role in the salt stress tolerance (either aerial-borne or soil salt) of a plant, but individual cultivar differences in habit or root system growth can also affect how a plant tolerates salt. This study noted greater damage to recently planted vegetation as compared to established plants.

Lastly identified as a source of site mortality are non-salt stresses and injuries. These include mortality from incorrectly planted trees and shrubs or lack of irrigation, improperly sited plants for the location (sun, moisture requirements, pollution tolerance),

timing of planting in relation to seasons and weather, poor maintenance practices including physical or pesticide injury, or lack of maintenance. Knowledge of the planting materials and best management practices are needed by ground maintenance crews to ensure planting longevity. Additionally vehicular collisions damage many roadside plantings.

In Rhode Island roadside vegetation is composed of three groups:

1) A majority of non-intentionally planted native vegetation (mostly White Pine, Oak species, Pitch Pine, Red Cedar, and Red Maple with smaller populations of Elderberry, Cherry species, and Serviceberry)
2) Non-native species, either planted or volunteer (Autumn Olive, Oriental Bittersweet, Honeysuckle, Catalpa, Black Locust)
3) Planted selections. (Red Cedar, Crabapple, Blue Spruce, Forsythia, Azaleas, Junipers, Inkberry, and Bayberry predominant.)

(Left.) Invasive *Celastrus orbiculatus* colonizing a median on I-295. (Right.) Native *Clethra alnifolia* planted in the Narragansett median.

Woody and herbaceous vegetation on the Narragansett median, *Rosa* in the foreground.

Site Studies.

1. Beach Street Median, Narragansett

The Narragansett median, located at the Narragansett Town Beach, receives salt spray from both the ocean and from the roadway. Road speeds are less than 45 mph, and vegetation is directly adjacent to the roadway. Portions of the site receive soil salt deposition from roadway runoff as well. Overall the slope aspect of the site is even with the road elevation. The site visit revealed a large herbaceous perennial palette of forbs and grasses with a few deciduous shrub species. These shrub species included *Clethra alnifolia*, *Hydrangea sp.*, *Potentilla fruticosa*, *Rhus aromatica*, *Spiraea species*, *Rosa*

rugosa, and an ornamental *Rosa* cultivar. *Platanus acerifolia* was the only planted deciduous tree species present along the roadway adjacent to the beach employee lot. The shrub species on site were thriving, though the *P. acerifolia* was in poor condition with extensive dieback and leaf scorch. Each of the shrub species was found in the literature review to be salt tolerant, however *R. rugosa* is no longer recommended as a planting because of its aggressive habit in shore communities. *P. acerifolia* is reported to be soil salt sensitive, which may be the reason for its poor performance at this site.

2. RIDOT Jefferson Boulevard Salt Shed

The site of the Jefferson Boulevard salt shed is located between the east and westbound lanes of RI Route 37 and along the northbound lane on Interstate 95. Road speeds are greater than 45 mph. Vegetation is directly adjacent to the roadside. Sections of the site receive direct aerial salt exposure from Interstate 95 and from RI Route 37. Other portions of the site are sheltered by the more exposed layers of vegetation and may only receive indirect salt drift. A site visit revealed a robust herbaceous ground layer with deciduous and evergreen shrubs and tree species. Both planned vegetation and volunteer growth were present. Species present included *Clethra alnifolia, Amelanchier canadensis, Juniperus virginiana, Picea glauca, Thuja occidentalis, Acer rubrum, Quercus species, and Pinus sylvestris.* Observation revealed that the partially sheltered plant palette in this location appeared to be adapting quite well.

Plantings adjacent to the east and westbound lanes of Route 37, which is elevated above the plantings, were not faring as well. These areas of the site consisted mainly of grasses, sedges and an herbaceous ground layer and *Juniperus chinensis 'Ketleeri'*, *Juniperus virginiana*, and *Thuja occidentalis*. Anecdotal evidence suggests that previous

installations of *J. virginiana* were unsuccessful in establishing at this site. With the exception of a few individuals, the plants were adapting to the site without any visible problems. Damage to these individuals can be attributed to establishment mortality and to misapplication of herbicides at the site.

These two shrubs, about 2/3 denuded are *Ilex glabra* near T.F. Green Airport. The planting of Inkberry at this site has had a tough time establishing with frequent salt exposure.

3. Post Road at T. F. Green Airport

The T.F. Green Airport roadside plantings are adjacent to Post Road in Warwick. This road has high traffic volume with road speeds less than 45 mph. Species present on the site included *Ilex glabra, Viburnum dentatum, Juniperus horizontalis, Picea pungens,*

and *Pinus sylvestris.* All species listed as salt tolerant in the literature review. This section of the site is separated from Post Road by a 6' sidewalk, and is elevated above the roadway. The site does receive runoff from an adjacent parking lot. Present species looked healthy, though anecdotal evidence suggests that *Ilex glabra* has had a difficult time establishing in this site which is supported by the few numbers and large spacing between individual *I. glabra* shrubs.

A second planting, which is adjacent to the parking garage, is set back from the roadway at least 10' at all points. The slope is elevated above the roadway. Species consists of *Platanus acerifolia*, *Picea pungens* and *Thuja occidentalis*, each of which is listed as salt tolerant in the literature review. All plant species in this section were faring exceptionally well. It is important to point out that this planting was installed by a private landscape contractor and plant material may have been more mature when originally planted, and that the site has a maintenance contract. As noted newly planted vegetation has a higher instance of salt damage than established vegetation and mortality rates may be greater.

4. RI Route 10 Interchange, Park Avenue/RI Route 12 to Elmwood Avenue

The Rt. 10 and Park Ave. site is exposed to a high volume of traffic with speeds less than 45 mph. The site has varying degrees of salt exposure throughout from differing road elevations, offering many different planting scenarios. It also has a large planting palette. Rt. 12 passes over the eastbound on-ramp to Rt. 10 and medians on either slide slope upwards to the westbound on-ramp to Rt. 10 and upwards to the Rt. 10 off-ramp. The Rt. 10 off-ramp and westbound on-ramp are thereby above a portion of

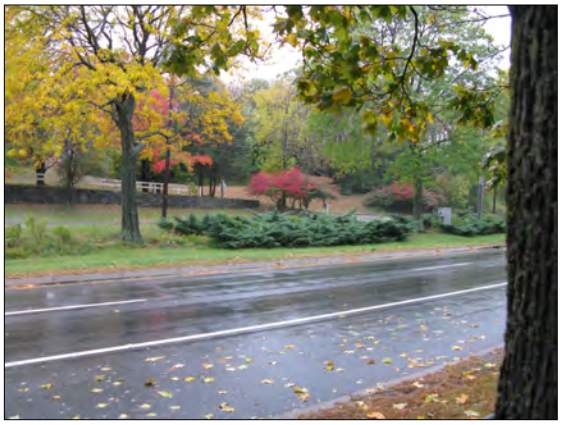
the plantings and can deposit both salt spray drift and ground surface salt. Distance of plantings to the edge of the roadway also varies.

The RI Route 10 exit ramp. Vehicle speeds decrease as motorists approach the intersection with Park Ave.

Species present on site include *Acer rubrum, Amelanchier canadensis, Juniperus horizontalis, Kalmia latifolia, Malus* cultivars*, Pinus strobus* and *P. sylvestris, Prunus serrulata, Pyrus calleryana, Viburnum sieboldii, Zelkova serrata*. Each of these species was found in the literature review to display some degree of salt tolerance. However, *Pinus strobus, Pyrus calleryana*, and *Zelkova serrata* have not been included on the recommended plant list. *Pinus strobus* has received mixed reviews on its salt tolerance. Though *P. strobus* often survives salt exposure, especially mature trees, it tends to burn severely in the spring. *Pyrus calleryana* has been removed from the recommended tree list because it tends to be weak wooded and short-lived. *Zelkova serrata* was removed

because it tends to be weak-crotched and break off branches. It appears that many of the *Z. serrata* on site have been replaced.

A planting plan from 1999 provided by the RIDOT also lists the following species found in the literature review to be salt tolerant: *Cotoneaster apiculatus, Forsythia x intermedia, Prunus cerasifera,* and *Spiraea x bumalda.* Additional species listed on the planting plan are: *Cornus kousa, Cedrus deodara, Azalea* and *Rhododendron* cultivars, *Spiraea japonica,* and *Viburnum carlesii.* Some of these plantings are in sheltered or low speed areas and some species are no longer present on the site. *Spiraea japonica* is not included on the recommended plant list, although it is salt tolerant, because it has the potential to become an invasive pest species.



These plantings of *Gleditsia triacanthos*, *Juniperus chinensis 'Pfitzeriana',* and *Ilex glabra* along RI Route 113 have successfully established.

5. RI Route 2/Bald Hill Road and RI Route 113/East Avenue.

The section of Rt. 2 studied was taken from the Quaker Lane intersection to the intersection of Rt. 113. The median planting of Rt. 113 was studied from the Rt. 2

intersection to the Rhode Island Mall east entrance. This site receives a high volume of traffic with speeds less than 45 mph regulated by nearby stop lights. The planting site is elevated above the roadway and so receives salt spray but not soil salt. A small planting palette of four species is utilized here including *Gleditsia triacanthos, Juniperus chinensis, Ilex glabra,* and *Ilex verticillata* all of which were adapting well to the site at the time of the study. Each of these species is listed as having some salt tolerance in the literature review.

The planting along RI Route 138 in Jamestown is known for its beauty, use of a strongly native palette, and establishment success with an extended maintenance contract.

6. RI Route 138 Jamestown

The site is located on Rt. 138 in Jamestown, RI and is exposed to a high volume of traffic. The posted speed limit for this section of road is 40mph. A portion of the site is located between Helm St. and Rt. 138. The plants receive both salt spray and soil salt accumulation directly off of the roads and are directly adjacent to the roadway. A large

planting palette was present consisting of many native trees and shrubs as well as some grasses. Tree and shrub species present included, *Acer rubrum, Amelanchier canadensis, Clethra alnifolia, Cornus florida, Ilex glabra, Ilex verticillata, Juniperus virginiana, Kalmia latifolia, Myrica pensylvanica, Nyssa sylvatica, Picea pungens, Rhus typhina,* and *Viburnum dentatum.* All of these species were found by the literature review to be salt tolerant.

A 1995 planting plan for the site also lists the following species found to be salt tolerant: *Aronia arbutifolia, Campsis radicans, Cephalanthus occidentalis, Lindera benzoin, Malus cultivars, Quercus bicolor, Quercus palustris, Quercus rubra, Rhododendron maximum, Rhododenron viscosum, Rosa cultivar, Sambucus canadensis, Spiraea latifolia, Thuja occidentalis, Vaccinium corymbosum, Viburnum trilobum, Weigela 'Red Prince'*. Those species listed on the planting plan that are not included on the recommended list are: *Abies fraseri, Carpinus betulus, Cornus kousa, Clematis paniculata, Hydrangea anomala petiolaris, Ilex x meservae, Pinus nigra,* and *Taxus 'Greenwave'*.

The present plantings on 138 in Jamestown seem to have successfully established. It is also important to point out that this project had an extended three year maintenance contract after completion which aided in the success of this planting. Those plants that did not survive, either from salt stress or vehicle collisions, were replaced or removed from the original plan.

Conclusions

Upon completion of the project it was determined that the six sites evaluated contained a small number of species from the accompanying plant guide out of the total number of possible selections. The majority of surviving planted species at each of the evaluation sites are found on the recommended salt tolerant list with only a few exceptions. The success of these plantings relied upon many factors including the speed of the roadway, slope aspect relative to the roadway, distance from the roadway, degree of maintenance, and proper planting.

Salt tolerant recommended species evaluated in these sites studies are:

1) *Acer rubrum*, 2) *Amelanchier canadensis*, 3) *Aronia arbutifolia*,

4) *Campsis radicans*, 5) *Cephalanthus occidentalis*, 6) *Clethra alnifolia*,

7) *Cornus florida*, 8) *Cotoneaster apiculatus*, 9) *Forsythia x intermedia*,

10) *Gleditsia triacanthos*, 11) *Hydrangea* cultivars, 12) *Ilex glabra*,

13) *Ilex verticillata*, 14) *Juniperus chinensis 'Ketleeri'*,

15) *Juniperus chinensis* cultivars, 16) *Juniperus horizontalis*,

17) *Juniperus virginiana*, 18) *Kalmia latifolia*, 19) *Lindera benzoin*,

20) *Nyssa sylvatica*, 21) *Malus* cultivars, 22) *Picea glauca*, 23) *Picea pungens*,

24) *Pinus sylvestris*, 25) *Platanus acerifolia*, 26) *Potentilla fruticosa*,

27) *Prunus cerasifera*, 28) *Prunus serrulata*, 29) *Quercus species*,

30) *Rhus aromatica*, 31) *Rhus typhina*, 32) *Rhododendron maximum*,

33) *Rhododendron viscosum* 34) *Rosa* cultivars, 35) *Sambucus canadensis*,

36) *Spiraea species*, 37) *Thuja occidentalis*, 38) *Viburnum dentatum*,

39) *Viburnum sieboldii*, 40) *Weigela florida*

The accompanying RIDOT Salt Tolerant Tree and Shrub Guide will provide a sizable bank of trees and shrubs to select from that can tolerate varying levels of salt exposure and are suitable to the Rhode Island climate. Additionally selections of plants have been divided into four main classifications of roadside plant communities based on soil moisture and light exposure: wet sun, wet shade, dry sun, and dry shade. This guide will provide a solid foundation for landscape architects within the RIDOT for selecting salt tolerant plants. This guide will also allow for future roadside plantings to become more diverse and develop as plant communities suitable to specific site characteristics.

Recommendations

The results of this study and the research process have produced several recommendations for the RIDOT to implement.

1. That RIDOT initiate a "Recommended Planting Guide for RIDOT" similar in scope to the Delaware Department of Transportation's publication Enhancing Delaware Highways: Roadside Vegetation Concept and Planning Manual.
2. That the accompanying data in the form of plant lists be used to launch pilot sites to evaluate plant species salt tolerance and viability in Rhode Island.
3. That the RIDOT initiate a study to survey the effects of roadside salt damage over time on specific sites. This study will aid in understanding the evolution of roadside plantings and in developing better management practices, designs, and planning procedures to enhance roadside plantings and reduce RIDOT costs.

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Appendix

1. Salt Tolerant Tree and Shrub Lists
2. Plants by Light and Soil Requirements
3. Tree and Shrub Characteristics Lists

Salt Tolerant Tree and Shrub Lists

TREES			
Botanical Name	**Common Name**	**Soil Salt Tolerance**	**Salt Spray Tolerance**
		T=Tolerant **M**=Moderate **S**=Sensitive **NA**=Not Available	**T**=Tolerant **M**=Moderate **S**=Sensitive **NA**=Not Available
Abies balsamea	Balsam Fir	S	T
Abies concolor	White Fir	NA	T
Acer campestre	Hedge Maple	NA	M
Acer pensylvanicum	Striped Maple, Moosewood	NA	T
Acer rubrum	Red Maple	S	M
Acer saccharum	Sugar Maple	M/S	NA
Amelanchier arborea	Downy/Common Serviceberry	NA	T
Amelanchier canadensis	Shadbush	T	T
Amelchanier laevis (x grandiflora)	Allegheny (Apple) Serviceberry	NA	T
Betula lenta	Sweet/Black Birch	M/ T	T
Betula alleghaniensis (lutea)	Yellow Birch	T	T
Betula nigra	River Birch	NA	M
Betula populifolia	Gray Birch	M/ T	M
Carpinus caroliniana	Hornbeam	NA	T
Carya glabra	Pignut Hickory	S	M
Carya ovata	Shagbark Hickory	NA	T
Cedrus atlantica	Atlas Cedar	NA	M
Celtis occidentalis	Hackberry	M	T
Chamaecyparis nootkatensis	Nootka Falsecypress	NA	T
Chamaecyparis pisifera	Japanese Falsecypress	NA	T
Chamaecyparis thyoides	Atlantic White Cedar	NA	T
Cladrastis kentuckea (lutea)	Kentucky (American) Yellowwood	NA	T
Cornus florida	Flowering Dogwood	NA	T
Crataegus crus-galli	Cockspur Hawthorn	T	M
Crataegus monogyna	Oneseed Hawthorn	NA	M
Crataegus phaenopyrum	Washington Hawthorn	NA	T
Crataegus virdis	Green Hawthorn	NA	T
Cryptomeria japonica	Japanese Cedar	NA	S
Fagus grandifolia	American Beech	NA	S/M
Fagus sylvatica	European Beech	NA	T
Fraxinus americana	White Ash	M/T	T
Ginkgo biloba	Ginkgo, Maidenhair Tree	M	M
Gleditsia triacanthos var. inermis	Thornless Honeylocust	T	T
Gymnocladus dioicus	Kentucky Coffeetree	T	T
Ilex opaca	American Holly	NA	M
Juglans cinerea	White Walnut, Butternut	NA	T
Juglans nigra	Black Walnut	T	T
Juniperus chinensis 'Ketleeri'	Ketleeri Juniper	T	NA

Salt Tolerant Tree and Shrub Lists

Botanical Name	Common Name	Soil Salt Tolerance	Salt Spray Tolerance
		T=**T**olerant **M**=Moderate **S**=Sensitive **NA**=Not Available	**T**=**T**olerant **M**=Moderate **S**=Sensitive **NA**=Not Available
Juniperus virginiana**	Eastern Red Cedar	T	T
Koelreuteria paniculata	Golden Rain Tree	M	M
Larix decidua	European Larch	NA	T
Larix kaempferi	Japanese Larch	NA	T
Larix laricina	American Larch, Tamarack	NA	T
Liquidambar styraciflua	Sweet Gum	T	T
Magnolia virginiana	Sweetbay Magnolia	NA	M
Magnolia x soulangiana	Saucer Magnolia	NA	M
Malus cultivars	Crabapple	S/M	M
Morus rubra	Red Mulberry	NA	T
Nyssa sylvatica	Black Gum; Tupelo	T	M
Ostrya virginiana	Ironwood	NA	M
Oxydendrum arboreum	Sourwood	NA	M
Picea abies	Norway Spruce	M/S	M
Picea glauca	White Spruce	T	T
Picea pungens	Blue Spruce	T	T
Picea rubens	Red Spruce	NA	T
Pinus mugo	Mugo Pine	T	T
Pinus parviflora	Japanese White Pine	NA	T
Pinus rigida	Pitch Pine	NA	T
Pinus sylvestris	Scots/Scotch Pine	S/M	T
Pinus thunbergii	Japanese Black Pine	M/T	T
Platanus occidentalis	American Sycamore	T	M
Platanus x acerifolia	London Plane	S	T
Prunus cerasifera	Cherry Plum	NA	T
Prunus pensylvanica	Pin Cherry	NA	T
Prunus serrulata	Flowering Cherry	NA	T
Prunus virginiana	Chokecherry	M/T	M
Pseudotsuga menziesii	Douglas Fir	NA	T
Salix alba	White Willow	M	M
Salix discolor	Pussy willow	NA	T
Salix purpurea	Purpleosier willow	NA	T
Styphnolobium japonicum	Japanese Pagodatree	M/T	T
Syringa reticulata	Japanese Tree Lilac	T	T
Tamarix ramosissima	Saltcedar Tamarisk	NA	M
Taxodium distichum	Bald Cypress	T	S
Thuja occidentalis	Eastern Arborvitae	M	M
Tilia americana	American Linden	NA	M
Tilia cordata	Littleleaf Linden	S	T
Tilia platyphyllos	Largeleaved Linden	NA	T

Salt Tolerant Tree and Shrub Lists

Botanical Name	Common Name	Soil Salt Tolerance	Salt Spray Tolerance
		T=**T**olerant **M**=Moderate **S**=Sensitive **NA**=Not Available	**T**=**T**olerant **M**=Moderate **S**=Sensitive **NA**=Not Available
Ulmus americana Hybrids	American Elm	M	T
Ulmus carpinifolia	Smoothleaf Elm	NA	T
Ulmus glabra 'Camperdownii'	Camperdown Elm	NA	T

SHRUBS			
Botanical Name	**Common Name**	**Soil Salt Tolerance**	**Salt Spray Tolerance**
		T=**T**olerant **M**=moderate **S**=**S**ensitive **NA**=Not Available	**T**=**T**olerant **M**=moderate **S**=**S**ensitive **NA**=Not Available
Alnus rugosa	Speckled/Hazel Alder	NA	M
Andromeda polifolia var. glaucophylla	Bog Rosemary	NA	T
Arctostaphylos uva-ursi	Bearberry, Kinnikinnick	T	T
Aronia arbutifolia	Red Chokeberry	NA	S/M
Aronia melanocarpa	Black Chokeberry	NA	M
Aronia x prunifolia	Purple Chokeberry	NA	T
Baccharis halimifolia	Groundselbush, Sea Myrtle	T	T
Buxus microphylla	Japanese Boxwod	M/T	M
Calycanthus floridus	Allspice	NA	T
Ceanothus americanus	New Jersey Tea	NA	T
Cephalanthus occidentalis	Buttonbush	NA	T
Chaenomeles japonica	Japanese Quince	NA	T
Chaenomeles speciosa	Flowering Quince	S	M
Clethra alnifolia	Summersweet/Sweet Pepperbush	NA	M/T
Clethra barbinervis	Japanese Clethra	NA	M
Comptonia peregrina	Sweetfern	NA	T
Cornus amomum	Silky Dogwood	NA	T
Cornus racemosa	Gray Dogwood	S	T
Cornus sericea (stolonifera)	Red Osier Dogwood	S	T
Corylus americana	American Hazelnut, Filbert	NA	T
Cotoneaster apiculatus	Cranberry Cotoneaster	NA	T
Cotoneaster dammeri	Bearberry Cotoneaster	NA	T
Cotoneaster divaricatus	Spreading Cotoneaster	NA	T
Cotoneaster horizontalis	Rockspray Cotoneaster	NA	T
Cotoneaster multiflorus	Many-flowered Cotoneaster	NA	T
Cotoneaster spp.	Cotoneaster species	T	T

Salt Tolerant Tree and Shrub Lists

Botanical Name	Common Name	Soil Salt Tolerance	Salt Spray Tolerance
		T=Tolerant M=moderate S=Sensitive NA=Not Available	T=Tolerant M=moderate S=Sensitive NA=Not Available
Forsythia spp.	Forsythia species	M	T
Forsythia x intermedia	Border Forsythia	M/T	M
Hamamelis virginiana	Witchhazel	NA	M/T
Hydrangea arborescens	Wild Hydrangea	NA	T
Hydrangea macrophylla	Bigleaf Hydrangea	NA	M
Hydrangea quercifolia	Oakleaf Hydrangea	NA	T
Hydrangea spp.	Hydrangea species	NA	T
Hypericum bucklei	Buckley's St. Johnswort	NA	T
Hypericum kalmianum	Kalm's St.Johnswort	NA	T
Ilex glabra	Inkberry Holly	NA	M
Ilex verticillata	Winterberry	NA	S/M
Itea virginica	Virginia Willow	NA	T
Iva frutescens (+ var. oraria)	High Tide Bush, Jesuit's Bark	NA	T
Juniperus chinensis	Chinese Juniper	T	M
Juniperus communis	Common Juniper	M/T	T
Juniperus conferta	Shore Juniper	NA	T
Juniperus horizontalis	Creeping Juniper	M	T
Juniperus procumbens	Japanese Garden Juniper	NA	T
Kalmia angustifolia	Sheep Laurel	NA	T
Kalmia latifolia	Mountain Laurel	NA	T
Kolkwitzia amabilis	Beauty Bush	NA	T
Leucothoe fontanesiana	Highland Doghobble	NA	T
Lindera benzoin	Spicebush	NA	T
Mahonia aquifolium	Holly-Grape/Hollyleaved Barberry	NA	T
Myrica (Morella) gale	Sweet Gale	NA	T
Myrica (Morella) pensylanica	Northern Bayberry	T	M
Pieris floribunda	Mountain Andromeda	NA	T
Potentilla fruticosa	Shrubby cinquefoil	T	T
Prunus maritima	Beach plum	T	T
Prunus x cistena	Purpleleaf Sand Cherry	NA	M
Pyracantha coccinea	Firethorn, Pyracantha	NA	M/T
Rhododendron maximum	Rosebay	NA	T
Rhododendron viscosum	Swamp Azalea	NA	T
Rhus aromatica	Fragrant Sumac	T	T
Rhus copallinum	Shining/Winged Sumac	NA	T
Rhus glabra	Smooth Sumac	M/T	T
Rhus typhina (hirta)	Staghorn Sumac	T	T
Rosa blanda	Early Wild Rose, Smooth Rose	NA	T
Rosa carolina	Carolina Rose	NA	T
Rosa palustris	Swamp Rose	NA	T

Salt Tolerant Tree and Shrub Lists

Botanical Name	Common Name	Soil Salt Tolerance	Salt Spray Tolerance
		T=Tolerant M=moderate S=Sensitive NA=Not Available	T=Tolerant M=moderate S=Sensitive NA=Not Available
Rosa virginiana	Virginia rose	NA	T
Sambucus canadensis	American Black Elderberry	NA	T
Sambucus racemosa	Red Elderberry	NA	T
Spiraea cantoniensis ('Lanceata')	Double Reeves Spirea	NA	S
Spiraea latifolia	Meadowsweet	NA	T
Spiraea nipponica	Snowmound spirea	NA	T
Spiraea tomentosa	Steeplebush	NA	T
Waterer'	Anthony Waterer Spirea	NA	T
Spiraea x vanhouttei	Vanhoutte spirea	T	T
Symphoricarpos albus	Common snowberry	T	T
Symphoricarpos orbiculatus	Coralberry	NA	T
Syringa meyeri 'Palibin'	Palibin Meyer Lilac	T	M
Syringa pubescens ssp. patula 'Miss Kim'	Miss Kim Korean Lilac	T	T
Syringa vulgaris	Common Lilac	M/T	T
Vaccinium angustifolium	Lowbush Blueberry	NA	T
Vaccinium corymbosum	Highbush Blueberry	NA	T
Vaccinium vitis-idaea	Cowberry, Lingonberry	NA	T
Viburnum acerifolium	Maple Leaf Viburnum	NA	M
Viburnum dentatum	Arrowwood Viburnum	NA	M
Viburnum lentago	Nannyberry Viburnum, Blackhaw	NA	M
Viburnum nudum	Possumhaw	NA	T
Viburnum nudum var. cassinoides	Witherod	NA	T
Viburnum opulus var. americanum (trilobum)	American Cranberrybush Viburnum	S/M	M
Viburnum plicatum	Viburnum	NA	T
Viburnum prunifolium	Blackhaw/Plum Leaf Viburnum	T	M
Viburnum recognitum	Southern Arrowwood	NA	T
Viburnum seiboldii	Seibold's Viburnum	NA	T
Viburnum setigerum	Tea Viburnum	NA	T
Weigela florida	Weigela	M	S

** Note on *Juniperus virginiana*: RIDOT has noticed that when planted at a small size (<3' height), transplanted within a very short time, or established naturally this tree is very hardy. *J. virginiana* should not be specified >3' in height. *Juniperus chinensis 'Ketleeri'* is a good salt tolerant substitute.

Salt Tolerant Tree and Shrub Lists

VINES			
Botanical Name	**Common Name**	**Soil Salt Tolerance**	**Salt Spray Tolerance**
		T=**T**olerant **M**=**M**oderate **S**=**S**ensitive **NA**=Not Available	**T**=**T**olerant **M**=**M**oderate **S**=**S**ensitive **NA**=Not Available
Campsis radicans	Trumpet Vine	NA	T
Clematis virginiana	Virgin's Bower	NA	T
Parthenocissus quinquefolia	Virginia Creeper	T	M
Vitis riparia	Riverbank Grape	NA	M

Plants for Dry and Sunny Sites

Trees

Amelanchier arborea	Downy/Common Serviceberry
Betula populifolia	Gray Birch
Carya glabra	Pignut Hickory
Carya ovata	Shagbark Hickory
Cedrus atlantica	Atlas Cedar
Celtis occidentalis	Hackberry
Crataegus crus-galli	Cockspur Hawthorn
Crataegus monogyna	Oneseed Hawthorn
Crataegus phaenopyrum	Washington Hawthorn
Crataegus virdis	Green Hawthorn
Gleditsia triacanthos (+var. inermis)	(Thornless) Honeylocust
Gymnocladus dioicus	Kentucky Coffeetree
Juniperus chinensis 'Ketleeri'	Chinese Juniper
Juniperus virginiana	Eastern Red Cedar
Liquidambar styraciflua	Sweet Gum
Nyssa sylvatica	Black Gum; Tupelo
Ostrya virginiana	Ironwood
Oxydendrum arboreum	Sourwood
Platanus occidentalis	American Sycamore
Prunus pensylvanica	Pin Cherry
Thuja occidentalis	Eastern Arborvitae

Shrubs

Aronia arbutifolia (Photinia pyrifolia)	Red Chokeberry
Aronia melanocarpa (Photinia melanocarpa)	Black Chokeberry
Ceanothus americanus	New Jersey Tea
Clethra alnifolia	Summersweet/Sweet Pepperbush
Cornus racemosa	Gray Dogwood
Corylus americana	American Hazelnut, Filbert
Gaultheria procumbens	Wintergreen
Hypericum kalmianum	Kalm’s St.Johnswort
Ilex glabra	Inkberry Holly
Juniperus chinensis (many varieties)	Chinese Juniper
Juniperus chinensis 'Pfitzeriana'	Pfitzer Juniper
Juniperus communis	Common Juniper
Juniperus conferta	Shore Juniper
Juniperus horizontalis	Creeping Juniper
Juniperus procumbens	Japanese Garden Juniper
Kalmia latifolia	Mountain Laurel
Myrica (Morella) pensylanica	Northern Bayberry
Potentilla fruticosa	Shrubby cinquefoil
Prunus maritima	Beach plum
Rhus aromatica	Fragrant Sumac
Rhus copallinum	Shining/Winged Sumac

Plants for Dry and Sunny Sites continued

Shrubs continued

Rhus glabra	Smooth Sumac
Rhus typhina (hirta)	Staghorn Sumac
Rosa blanda	Early Wild Rose, Smooth Rose
Rosa carolina	Carolina Rose
Rosa virginiana	Virginia rose
Sambucus canadensis	American Black Elderberry
Spiraea latifolia	Meadowsweet
Spiraea nipponica	Snowmound spirea
Spiraea tomentosa	Steeplebush
Spiraea x bumalda ‘Anthony Waterer’	Anthony Waterer Spirea
Symphoricarpos albus	Common snowberry
Symphoricarpos orbiculatus	Coralberry
Vaccinium angustifolium	Lowbush Blueberry
Viburnum acerifolium	Maple Leaf Viburnum
Weigela florida	Weigela

Vines

Campsis radicans	Trumpet Vine

Plants for Dry and Shaded Sites

Trees

Amelanchier arborea	Downy/Common Serviceberry
Celtis occidentalis	Hackberry
Ilex opaca	American Holly
Ostrya virginiana	Ironwood
Oxydendrum arboreum	Sourwood
Picea glauca	White Spruce

Shrubs

Calycanthus floridus	Eastern Sweetshrub, Carolina Allspice
Ceanothus americanus	New Jersey Tea
Cornus racemosa	Gray Dogwood
Gaultheria procumbens	Wintergreen
Kalmia latifolia	Mountain Laurel
Leucothoe fontanesiana	Highland Doghobble
Pieris floribunda	Mountain Andromeda
Symphoricarpos albus	Common snowberry
Symphoricarpos orbiculatus	Coralberry
Viburnum acerifolium	Maple Leaf Viburnum
Viburnum lentago	Nannyberry Viburnum, Blackhaw

Plants for Wet and Sunny Sites

Trees

Abies balsamea	Balsam Fir
Abies concolor	White Fir
Acer pensylvanicum	Striped Maple
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Amelanchier arborea	Downy/Common Serviceberry
Amelanchier canadensis	Shadbush
Amelchanier laevis (x grandiflora)	Allegheny (Apple) Serviceberry
Betula lenta	Sweet/Black Birch
Betula alleghaniensis (lutea)	Yellow Birch
Betula nigra	River Birch
Betula populifolia	Gray Birch
Carpinus caroliniana	Hornbeam
Carya glabra	Pignut Hickory
Carya ovata	Shagbark Hickory
Celtis occidentalis	Hackberry
Chamaecyparis nootkatensis	Nootka Falsecypress
Chamaecyparis pisifera	Japanese Falsecypress
Chamaecyparis thyoides	White Cedar
Crataegus crus-galli	Cockspur Hawthorn
Crataegus phaenopyrum	Washington Hawthorn
Crataegus virdis	Green Hawthorn
Cryptomeria japonica	Japanese Cedar
Fagus grandifolia	American Beech
Fagus sylvatica	European Beech
Fraxinus americana	White Ash
Ginkgo biloba	Ginkgo, Maidenhair Tree
Ilex opaca	American Holly
Juglans cinerea	White Walnut, Butternut
Juglans nigra	Black Walnut
Juniperus chinensis 'Ketleeri'	Chinese Juniper
Juniperus virginiana	Eastern Red Cedar
Koelreuteria paniculata	Golden Rain Tree
Larix decidua	European Larch
Larix kaempferi	Japanese Larch
Larix laricina	American Larch, Tamarack
Liquidambar styraciflua	Sweet Gum
Magnolia virginiana	Sweetbay Magnolia
Magnolia x soulangiana	Saucer Magnolia
Malus cultivars	Crabapple
Morus rubra	Red Mulberry
Nyssa sylvatica	Black Gum; Tupelo
Ostrya virginiana	Ironwood
Picea abies	Norway Spruce
Picea glauca	White Spruce
Picea pungens	Blue Spruce

Plants for Wet and Sunny Sites continued

Trees continued

Pinus mugo	Mugo Pine
Pinus parviflora	Japanese White Pine
Pinus rigida	Pitch Pine
Pinus strobus	White Pine
Platanus occidentalis	American Sycamore
Platanus x acerifolia	London Plane
Prunus pensylvanica	Pin Cherry
Prunus virginiana	Chokecherry
Pseudotsuga menziesii	Douglas Fir
Quercus palustris	Pin Oak
Salix alba	White Willow
Salix purpurea	Purpleosier willow
Tamarix ramosissima	Saltcedar Tamarisk
Taxodium distichum	Bald Cypress
Taxus cuspidata	Japanese Yew
Thuja occidentalis	Eastern Arborvitae
Tilia americana	American Linden
Tilia cordata	Littleleaf Linden
Tilia platyphyllos	Largeleaved Linden
Ulmus americana	American Elm
Ulmus carpinifolia	Smoothleaf Elm
Ulmus glabra 'camperdownii'	Camperdown Elm

Shrubs

Alnus rugosa	Speckled/Hazel Alder
Andromeda polifolia (var glaucophylla)	Bog Rosemary
Aronia arbutifolia (Photinia pyrifolia)	Red Chokeberry
Aronia melanocarpa (Photinia melanocarpa)	Black Chokeberry
Aronia prunifolia (Photinia floribunda)	Purple Chokeberry
Baccharis halimifolia	Groundselbush, Sea Myrtle
Buxus microphylla (var. koreana & var. japonica)	Korean boxwood
Cephalanthus occidentalis	Buttonbush, Honey Bells
Clethra alnifolia	Summersweet/Sweet Pepperbush
Clethra barbinervis	Japanese Clethra
Cornus amomum	Silky Dogwood
Cornus racemosa	Gray Dogwood
Cornus sericea (stolonifera)	Red Osier Dogwood
Gaultheria hispidula	Creeping Snowberry
Gaultheria procumbens	Wintergreen
Hamamelis virginiana	Witchhazel
Hydrangea arborescens	Smooth Hydrangea
Hydrangea macrophylla	Bigleaf Hydrangea
Hydrangea quercifolia	Oakleaf Hydrangea
Ilex glabra	Inkberry Holly
Ilex verticillata	Winterberry

Plants for Wet and Sunny Sites continued

Shrubs continued

Itea virginica	Virginia Willow/Sweetspire
Iva frutescens	Marsh Elder, Jesuit's Bark
Kalmia angustifolia	Sheep Laurel
Kalmia latifolia	Mountain Laurel
Lindera benzoin	Spicebush
Myrica (Morella) gale	Sweet Gale
Pinus mugo mugo	Dwarf Mugo Pine
Potentilla fruticosa	Shrubby cinquefoil
Prunus x cistena	Purpleleaf Sand Cherry
Rhododendron maximum	Rosebay Rhododendron
Rhododendron viscosum	Swamp Azalea
Rosa carolina	Carolina Rose
Rosa palustris	Swamp Rose
Sambucus canadensis	American Black Elderberry
Sambucus racemosa	Red Elderberry
Spiraea cantoniensis ('Lanceata')	Double Reeves Spirea
Spiraea latifolia	Meadowsweet
Spiraea tomentosa	Steeplebush
Spiraea x bumalda 'Anthony Waterer'	Anthony Waterer Spirea
Spiraea x vanhouttei	Vanhoutte spirea
Syringa vulgaris	Common Lilac
Vaccinium angustifolium	Lowbush Blueberry
Vaccinium corymbosum	Highbush Blueberry
Vaccinium vitis-idaea	Cowberry, Lingonberry
Viburnum nudum	Possumhaw, Smooth Witherod
Viburnum nudum var. cassinoides	Witherod
Viburnum opulus var. americanum (trilobum)	American Cranberrybush Viburnum
Viburnum plicatum	Japanese Snowball, Doublefile Viburnum
Viburnum prunifolium	Blackhaw/Plum Leaf Viburnum
Viburnum sieboldii	Siebold's Viburnum

Vines

Clematis virginiana	Devils Darning Needles, Virgin’s Bower
Parthenocissus quinquefolia	Virginia Creeper
Vitis riparia	Riverbank Grape

Plants for Wet and Shaded Sites

Trees

Abies balsamea	Balsam Fir
Acer saccharum	Sugar Maple
Betula nigra	River Birch
Carpinus caroliniana	Hornbeam

Shrubs

Buxus microphylla var. koreana / japonica	Korean boxwood
Cornus racemosa	Gray Dogwood
Gaultheria hispidula	Creeping Snowberry
Gaultheria procumbens	Wintergreen
Hydrangea arborescens	Smooth Hydrangea
Kalmia latifolia	Mountain Laurel
Lindera benzoin	Spicebush
Myrica (Morella) gale	Sweet Gale
Rhododendron maximum	Rosebay Rhododendron
Rhododendron viscosum	Swamp Azalea
Sambucus racemosa	Red Elderberry
Vaccinium angustifolium	Lowbush Blueberry

Vines

Parthenocissus quinquefolia	Virginia Creeper

Tree and Shrub Characteristics Lists

TREES					
Botanical Name	**Common Name**	**Height x Spread (ft)**	**Evergreen/ Deciduous**	**Soil**	**Light**
Abies balsamea	Balsam Fir	45-75 x 20-25	E	Moist well drained , acidic	Sun to shade
Abies concolor	White Fir	30-50 x 15-20	E	Moist well drained, sandy-loam	Sun to light shade
Acer campestre	Hedge Maple	25-35 x 25-35	D	Well drained, dry, pH adaptable	Sun to light shade
Acer pensylvanicum	Striped Maple, Moosewood	15-20	D	Moist well drained, slightly acidic	part shade
Acer rubrum	Red Maple	40-60 x varies	D	Slightly acidic, moist conditions	Sun to part shade
Acer saccharum	Sugar Maple	60-75 x 40-50	D	acidic	Sun to shade
Amelanchier arborea	Downy/Common Serviceberry	15-25	D	Moist, well drained, acidic	Sun to part shade
Amelanchier canadensis	Shadbush	15-25 x 15-25	D	Moist, well drained, acidic	Sun to part shade
Amelchanier laevis (x grandiflora)	Allegheny (Apple) Serviceberry	15-25 x 15-25	D	Moist, well drained, acidic	Sun to part shade
Betula lenta	Sweet/Black Birch	40-55 x 35-45	D	Moist, well drained, slightly acidic	Sun to part shade
Betula alleghaniensis (lutea)	Yellow Birch	60-75	D	Moist, well drained	Sun to part shade
Betula nigra	River Birch	40-70 x 40-60	D	Moist to well drained	Sun to part shade
Betula populifolia	Gray Birch	20-40 x 10-20	D	Tolerates a wide range of conditions	Full sun
Carpinus caroliniana	Hornbeam	20-30 x 20-30	D	Rich, moist, slightly acidic soils	Shade
Carya glabra	Pignut Hickory	50-60 x 25-35	D	Well drained to dry, rich soils	Sun to part shade
Carya ovata	Shagbark Hickory	60-80 x 30-40	D	Well-drained loamy soils, adaptable	Sun to part shade
Cedrus atlantica	Atlas Cedar	40-60 x 30-40	E	Well drained	Sun
Celtis occidentalis	Hackberry	75-100 x 75-100	D	Rich moist soils, adaptable	Sun
Chamaecyparis nootkatensis	Nootka Falsecypress	30-45 x 15-20	E	Moist, loamy, well drained	Sun
Chamaecyparis pisifera	Japanese Falsecypress	50-70 x 10-20	E	Moist, loamy well drained	Sun
Chamaecyparis thyoides	Atlantic White Cedar	40-50 x 10-20	E	Moist, sandy soil	Sun to part shade
Cladrastis kentuckea (lutea)	Yellowwood	30-50 x 40-55	E	Well drained, pH adaptable	Sun
Cornus florida	Flowering Dogwood	15-30	D	Well drained, acidic	Sun to part shade
Crataegus crus-galli	Cockspur Hawthorn	20-30 x 20-35	D	Moist well-drained, slightly acid	Full sun
Crataegus monogyna	Oneseed Hawthorn	20-30	D	Well drained, pH adaptable	Full sun
Crataegus phaenopyrum	Washington Hawthorn	25-30 x 20-25	D	Well drained, dry to moist	Full sun
Crataegus virdis	Green Hawthorn	20-25 x 20-30	D	Well drained, dry to moist	Full sun
Cryptomeria japonica	Japanese Cedar	40-60 x 20-30	E	Moist to well drained	Sun
Fagus grandifolia	American Beech	50-70 x 40-60	D	Moist well drained, acidic	Sun to part shade
Fagus sylvatica	European Beech	50-60 x 35-45	D	Moist well drained, acidic	Sun to part shade
Fraxinus americana	White Ash	50-80 x 50-80	D	Moist well drained, pH adaptable	Sun
Ginkgo biloba	Ginkgo, Maidenhair Tree	50-70 x 30-40	D	adaptable	Sun
Gleditsia triacanthos (+var. inermis)	(Thornless) Honeylocust	40-60 x 20-40	D	Well drained	Sun
Gymnocladus dioicus	Kentucky Coffeetree	60-76 x 40-50	D	Well drained to dry	Sun
Ilex opaca	American Holly	20-30 x 15-20	E	Moist to well drained	Sun to part shade
Juglans cinerea	White Walnut, Butternut	40-60 x 30-50	D	Moist rich, dry rocky limestone soils	Sun
Juglans nigra	Black Walnut	50-70 x 50-70	D	Moist well drained	Sun
Juniperus chinensis 'Ketleeri'	Chinese Juniper	15-20	E	Moist well drained, pH adaptable	Sun
Juniperus virginiana **	Eastern Red Cedar	30-50 x 10-20	E	Moist well drained to poor and gravelly, pH adaptable	Sun
Koelreuteria paniculata	Golden Rain Tree	20-40 x 15-35	D	Moist to well drained	Sun

Tree and Shrub Characteristics Lists

TREES					
Botanical Name	**Common Name**	**Height x Spread (ft)**	**Evergreen/ Deciduous**	**Soil**	**Light**
Larix decidua	European Larch	70-75 x 25-30	D	Moist well drained	Sun
Larix kaempferi	Japanese Larch	50-70 x 25-40	D	Moist well drained	Sun
Larix laricina	American Larch, Tamarack	30-50 x varies	D	Moist well drained	Sun
Liquidambar styraciflua	Sweet Gum	60 x 40	D	Moist to wet, acidic, upland, lowland	Sun
Magnolia virginiana	Sweetbay Magnolia	20-50 x 15-30	D	Moist to well drained	Sun to part shade
Magnolia x soulangiana	Saucer Magnolia	20-30 x 20-30	D	Moist, deep, acidic	Sun
Malus cultivars	Crabapple	varies	D	Moist well drained, acidic	Full sun
Morus rubra	Red Mulberry	40-70 x 40-50	D	Moist well drained, pH adaptable	Sun to part shade
Nyssa sylvatica	Black Gum; Tupelo	30-50 x 25-35	D	Lowland, moist to well drained	Sun
Ostrya virginiana	Ironwood	25-40 x 15-35	D	Moist well drained, slightly acidic	Sun to part shade
Oxydendrum arboreum	Sourwood	25-30 x 15-20	D	Well drained to dry	Sun to part shade
Picea abies	Norway Spruce	40-60 x 25-30	E	Moist, well-drained, sandy, acidic	Full sun
Picea glauca	White Spruce	40-60 x 10-20	E	Moist, well-drained, acidic	Sun to part shade
Picea pungens	Blue Spruce	30-90 x 10-20	E	Rich moist, tolerant most soils	Sun
Picea rubens	Red Spruce	60-70	E	Moist well drained sandy loam	Sun to Part Shade
Pinus mugo	Mugo Pine	15-20 x 25-30	E	Deep, moist well drained	Sun to Part Shade
Pinus parviflora	Japanese White Pine	20-50 x 20-50	E	loam	Full sun
Pinus rigida	Pitch Pine	40-60 x 30-50	E	Moist well drained, sandy, acidic	Sun
Pinus sylvestris	Scots/Scotch Pine	30-60 x 30-40	E	Well drained, varied soils, acidic	Sun
Pinus thunbergii	Japanese Black Pine	20-40 x 15-25	E	Well drained to xeric	Sun
Platanus occidentalis	American Sycamore	75-100	D	Rich, moist well drained, wet	Sun to part shade
Platanus x acerifolia	London Plane	70-100	D	Rich, moist well drained, lowland, wet	Sun to part shade
Prunus cerasifera	Cherry Plum	15-25 x 15-25	D	alkaline	Full sun
Prunus pensylvanica	Pin Cherry	25-40 x 15-25	D	Moist well drained to dry	Sun
Prunus serrulata	Flowering Cherry	20-25	D	Well drained, adaptable	Full sun
Prunus virginiana	Chokecherry	20-30 x 18-25	D	Moist well drained	Sun
Pseudotsuga menziesii	Douglas Fir	40-80 x 12-20	D	Moist well drained, slightly acidic	Sun
Salix alba	White Willow	75-100 x 50-100	D	Moist soils near water, ph adaptable	Full sun
Salix discolor	Pussy willow	15-20	D	Moist to wet, lowland	Sun
Salix purpurea	Purpleosier willow	8'-10'	D	Moist soils near water, ph adaptable	Full sun
Styphnolobium japonicum	Japanese Pagodatree	50-70 x 50-70	D	Well-drained	Full sun
Syringa reticulata	Japanese Tree Lilac	20-30 x 15-25	D	Well drained, slightly acidic	Full sun
Tamarix ramosissima	Saltcedar Tamarisk	10-20 x 8-12	D	Well drained to dry	Sun
Taxodium distichum	Bald Cypress	50-100 x 20-30	D	Wet, moderate soils, acidic	Sun
Thuja occidentalis	Eastern Arborvitae	40-60 x 10-15	E	Moist to well drained	Sun
Tilia americana	American Linden	60-80 x 30-40	E	Most, fertile, pH adaptable	Sun to part shade
Tilia cordata	Littleleaf Linden	60-70 x 30-45	D	Moist well drained, pH adaptable	Full sun
Tilia platyphyllos	Largeleaved Linden	60-80 x 20-40	D	adaptable	Sun to part shade
Ulmus americana Hybrids	American Elm Hybrids	60-90 x varies	D	Moist, fertile, pH adaptable	Sun
Ulmus carpinifolia	Smoothleaf Elm	50-60 x 40-50	D	Moist, fertile, pH adaptable	Sun
Ulmus glabra 'Camperdownii'	Camperdown Elm	6-7 x 20-25	D	Moist, fertile, pH adaptable	Sun

SHRUBS					
Botanical Name	**Common Name**	**Height x Spread (ft)**	**Evergreen/ Deciduous**	**Soil**	**Light**
Alnus rugosa	Speckled/Hazel Alder	15-25'	D	Wet, adaptable	Full sun to light shade
Andromeda polifolia (var glaucophylla)	Bog Rosemary	1-2 x	D	Moist acidic	Sun to light shade
Arctostaphylos uva-ursi	Bearberry, Kinnikinnick	<1' x spreading	D	Well-drained, acidic	Full sun to light shade
Aronia arbutifolia (Photinia pyrifolia)	Red Chokeberry	6-10 x 3-5	D	Moist to well drained, tolerant	Sun to light shade
melanocarpa)	Black Chokeberry	3-5 x 3-5	D	Moist to well drained	Sun to part shade
Aronia prunifolia (Photinia floribunda)	Purple Chokeberry	6-10 x 3-5	D	Moist to well drained	Sun to part shade
Baccharis halimifolia	Groundselbush, Sea Myrtle	5-12 x 5-12	D	Well drained	Sun
Buxus microphylla (var. koreana + var. japonica)	Korean boxwood	3-4 x 3-4	E	Moist well drained, roots need cool conditions	Full sun, light to moderate shade
Calycanthus floridus	Eastern Sweetshrub, Carolina Allspice	6-9 x 6-12	D	Adaptable	Sun or shade
Ceanothus americanus	New Jersey Tea	3-4 x 3-5	D	Light well-drained, tolerant of dryness	Full Sun to shade
Cephalanthus occidentalis	Buttonbush, Honey Bells	3-6 x 6	D	Wet, tolerates standing water	Full sun to part shade
Chaenomeles japonica	Japanese Quince	3-4 x 3-4	D	Adaptable, tolerant of dry soils, chlorosis in high pH soils	Full sun to part shade
Chaenomeles speciosa	Flowering Quince	6-10 x 6-10	D	Well drained	Sun to light shade
Clethra alnifolia	Summersweet/Sweet Pepperbush	3-8 x 4-10	D	Wet, moist to well drained	Sun to part shade
Clethra barbinervis	Japanese Clethra	10-20 x 10-15	D	Moist, well drained, organic rich	Part shade
Comptonia peregrina	Sweetfern	2-4 x 4-8	D	Sandy, acidic	Sun to light shade
Cornus amomum	Silky Dogwood	6-10 x 6-10	D	Adaptable, prefers moisture	Full sun to part shade
Cornus racemosa	Gray Dogwood	10-15 x 10-15	D	Adaptable, wet to dry	Sun to shade
Cornus sericea (stolonifera)	Red Osier Dogwood	7-9 x 10'	D	Adaptable, tolerates swampy soils	Sun to part shade
Corylus americana	American Hazelnut, Filbert	8-15 x 8-10	D	Well drained, loamy, pH adaptable	Full sun to light shade
Cotoneaster apiculatus	Cranberry Cotoneaster	3 x 3-6	D	Well-drained, tolerates high pH	Full sun to part shade
Cotoneaster dammeri	Bearberry Cotoneaster	1-3' x 6'	E	Adaptable, prefers well drained, rocky soils	Sun to part shade
Cotoneaster divaricatus	Spreading Cotoneaster	5-6 x 6-8	D	Well drained, loose, fertile soil, tolerant of dry, poor soils, pH adaptable	Full sun or light shade
Cotoneaster horizontalis	Rockspray Cotoneaster	2-3 x 5-8	Semi-E	Well drained, loose, fertile soil, tolerant of dry, poor soils, pH adaptable	Sun to part shade
Cotoneaster multiflorus	Many-flowered Cotoneaster	8-12 x12-15	D	Heavy clay soils	Full sun to part shade
Cotoneaster spp.	Cotoneaster	varies	D	Well drained, loose, fertile soil, tolerant of dry, poor soils, pH adaptable	Full sun to part shade
Forsythia spp.	Forsythia species	8-10 x 10-12	D	Adaptable, pH adaptable	Full sun
Forsythia x intermedia	Border Forsythia	8-10 x 10-12	D	Well drained	Sun to light shade
Hamamelis virginiana	Witchhazel	15-30 x 15-25	D	Moist well drained	Sun to part shade
Hydrangea arborescens	Smooth Hydrangea	3-5 x 3-5	D	Adaptable, prefers rich, well-drained, moist soils, pH adaptable	Part Sun to shade
Hydrangea macrophylla	Bigleaf Hydrangea	4-6 x 4-8	D	Moist well drained	Sun to part shade
Hydrangea quercifolia	Oakleaf Hydrangea	4-6 x 4-8	D	Moist, fertile, well drained	Sun to part shade

SHRUBS					
Botanical Name	**Common Name**	**Height x Spread (ft)**	**Evergreen/ Deciduous**	**Soil**	**Light**
Hydrangea spp	Hydrangea	varies	D	Moist well drained	Sun to part shade
Hypericum bucklei	Buckley's St. Johnswort	1 x spreading	D	Well drained	Sun
Hypericum kalmianum	Kalm's St.Johnswort	2-3 x 2-3	D	Well drained	Sun
Ilex glabra	Inkberry Holly	6-8 x 6-10	E	Moist to well drained	Sun to light shade
Ilex verticillata	Winterberry	6-10 x 6-10	D	Moist to well drained	Sun to light shade
Itea virginica	Virginia Willow/Sweetspire	3-5 x 4-6	D	Adaptable, fertile soils, moist to wet, drought tolerant, pH adaptable	Full Sun to shade
Iva frutescens (+ var. oraria)	High Tide Bush, Jesuit's Bark	5-9 x 5-9	D	Tolerant of wet soils	Sun
Juniperus chinensis (many varieties)	Chinese Juniper	varies	E	Well drained to xeric	Sun
Juniperus communis	Common Juniper	5-10 x 8-12	E	Adaptable to diverse soils	Full sun
Juniperus conferta	Shore Juniper	1-2 x 6-9	E	Dry soils, tolerant of poor soil	Sun
Juniperus horizontalis	Creeping Juniper	1-2 x 4-8	E	Adaptable, sandy/ rocky soils, tolerant of slightly alkaline	Full sun
Juniperus procumbens	Japanese Garden Juniper	1-2 x 10-15	E	Tolerant of many soils, tolerant of alkaline soils	Full sun
Kalmia angustifolia	Sheep Laurel	1-3 x 1-3	E	Adaptable, including wet soils	Part shade
Kalmia latifolia	Mountain Laurel	7-15 x 7-15	E	Acid, cool, moist, well drained soils	Full Sun to shade
Kolkwitzia amabilis	Beauty Bush	6-10 x 6-10	D	Well drained, pH adaptable	Sun
Leucothoe fontanesiana	Highland Doghobble	3-6 x 3-6	E	Acidic, organic	Sun to shade
Lindera benzoin	Spicebush	6-12 x 6-12	D	Moist to well drained	Sun to shade
Mahonia aquifolium	Holly-Grape/Hollyleaved Barberry	3-6 x 3-5	E	Well drained	Sun to part shade
Myrica (Morella) gale	Sweet Gale	2-4 x 2-4	D	Wet soils, drought tolerant	Full Sun to shade
Myrica (Morella) pensylanica	Northern Bayberry	5-12 x 5-12	D	Dry	Sun to part shade
Pieris floribunda	Mountain Andromeda	3-6 x 3-6	E	Acidic, well drained	Shade
Potentilla fruticosa	Shrubby cinquefoil	1-3 x 2-4	D	Moist well drained, poor sites	Sun to light shade
Prunus maritima	Beach plum	6-8 x 6-8	D	Upland, dry	Sun
Prunus x cistena	Purpleleaf Sand Cherry	7-14 x 6-10	D	Moist well drained	Sun
Pyracantha coccinea	Firethorn, Pyracantha	6-10 x 4-8	E	Well drained	Sun to light shade
Rhododendron maximum	Rosebay Rhododendron	4-15 x 4-15	E	Cool, moist, well drained	Sun to shade
Rhododendron viscosum	Swamp Azalea	1-8 x 3-8	D	Tolerant of wet soils, drought	Shade
Rhus aromatica	Fragrant Sumac	2-6 x 6-10	D	Acidic, well drained	Sun to part shade
Rhus copallinum	Shining/Winged Sumac	10-15 x 10-12	D	Tolerant of many soils	Sun to part shade
Rhus glabra	Smooth Sumac	10-15 x 10-15	D	Well drained, dry, poor	Sun to light shade
Rhus typhina (hirta)	Staghorn Sumac	15-25 x 15-25	D	Well drained, dry, poor	Sun to light shade
Rosa blanda	Early Wild Rose, Smooth Rose	4-5 x 4-5	D	Mesic to dry	Full sun to light shade
Rosa carolina	Carolina Rose	3-6 x 3-6	D	Tolerant of wet soils, drought	Full sun to light shade
Rosa palustris	Swamp Rose	3-6 x 3-6	D	Moist to wet acidic soil	Full sun
Rosa virginiana	Virginia rose	4-6 x 4-6	D	Sandy soils, drought tolerant	Full sun
Sambucus canadensis	American Black Elderberry	5-12 x spreading	D	Moist, tolerates dry	Sun

SHRUBS

Botanical Name	Common Name	Height x Spread (ft)	Evergreen/ Deciduous	Soil	Light
Sambucus racemosa	Red Elderberry	8-12 x 8-12	D	Fertile, moist, well drained	Sun, shade tolerant
Spiraea cantoniensis ('Lanceata')	Double Reeves Spirea	4-6 x 3-5	D	Moist to well drained	Sun to part shade
Spiraea latifolia	Meadowsweet	4-6 x 6-8	D	Dry to moist soil	Full sun
Spiraea nipponica	Snowmound spirea	3-5 x 3-5	D	Well drained	Full sun to light shade
Spiraea tomentosa	Steeplebush	2-4 x 4-6	D	Moist to wet, drought tolerant	Full sun
Spiraea x bumalda 'Anthony Waterer'	Anthony Waterer Spirea	3-4 x 4-5	D	Tolerant of most soils except very wet	Full sun
Spiraea x vanhouttei	Vanhoutte spirea	6-8 x 10-12	D	Moist well drained, to dry	Full sun
Symphoricarpos albus	Common snowberry	3-6 x 3-6	D	Tolerant of many soils	Sun to shade
Symphoricarpos orbiculatus	Coralberry	2-5 x 4-8	D	Tolerant of many soils	Sun to shade
Syringa meyeri 'Palibin'	Palibin Meyer Lilac	4-5 x 6-8	D	Well Drained, no wet	Sun to part shade
Syringa pubescens ssp. patula 'Miss Kim'	Miss Kim Manchurian Lilac	6-9 x 5-8	D	Well drained	Sun to part shade
Syringa vulgaris	Common Lilac	8-15 x 6-12	D	Neutral to slightly alkaline pH, moist, organic, well drained	Full sun
Vaccinium angustifolium	Lowbush Blueberry	0.5-2 x 2-4	D	Dry, acidic, poor soils, tolerant of drought and wet soils	Sun to shade
Vaccinium corymbosum	Highbush Blueberry	6-12 x 8-12	D	Moist, acid, organic, well drained soils	Sun to part shade
Vaccinium vitis-idaea	Cowberry, Lingonberry	<1' x spreading	E	Moist, well drained, acidic	Full to part sun
Viburnum acerifolium	Maple Leaf Viburnum	4-6 x 4	D	Dry soils	Deep shade tolerant
Viburnum dentatum	Arrowwood Viburnum	6-10 x 6-15	D	Well drained, adaptable	Sun to part shade
Viburnum lentago	Nannyberry Viburnum, Blackhaw	15-18 x 8-10	D	Adaptable	Sun to shade
Viburnum nudum	Possumhaw, Smooth Witherod	5-6 x 5-6	D	Moist well drained	Sun to part shade
Viburnum nudum var. cassinoides	Witherod	5-6 x 5-6	D	Moist well drained	Sun to part shade
(trilobum)	American Cranberrybush Viburnum	8-12 x 8-12	D	Moist, very well drained	Sun to part shade
Viburnum plicatum	Japanese Snowball, Doublefile Viburnum	6-7x	D	Very well drained	Sun to part shade
Viburnum prunifolium	Blackhaw/Plum Leaf Viburnum	12-15 x 8-12	D	Moist well drained, dry	Sun to part shade
Viburnum recognitum	Southern Arrowwood	6-10 x 6-15	D	Well drained, adaptable	Sun to part shade
Viburnum sieboldii	Siebold's Viburnum	15-20 x 10-15	D	adaptable	Sun to part shade
Viburnum setigerum	Tea Viburnum	8-12 x 5-8	D	Well drained, slightly acidic	Full sun to part shade
Weigela florida	Weigela	6-10 x 6-10	D	Well drained	Sun to light shade

VINES

Botanical Name	Common Name	Height x Spread (ft)	Evergreen/ Deciduous	Soil	Light
Campsis radicans	Trumpet Vine	30-40 (vine)	D	Dry	Sun
Clematis virginiana	Devils Darning Needles, Virgin's Bower	12-20 (vine)	D	Adaptable	Full sun to part shade
Parthenocissus quinquefolia	Virginia Creeper	30-50 (vine)	D	Upland, moist to well drained	Sun to shade
Vitis riparia	Riverbank Grape	10-30 (vine)	D	Moist, sandy soils	Full to part sun