How to Plan for and Plant

Streamside Conservation Buffers with Native Fruit and Nut Trees and Woody Floral Shrubs

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Introduction

One way to achieve both conservation and production in streamside zones is to choose tree and shrub species that provide useful and/or salable products. Examples include fruits, nuts, florals, timber, medicinals, and weaving and dying materials (Brooks, Gregersen, and Folliott 1994; Robles-Diaz-de-Leon and Kangas 1998; Klapproth and Johnson 2001; Shultz et al. 2009). Riparian forest buffers are areas near streams, rivers, or other bodies of water that have planted or naturally occurring trees, shrubs, and other vegetation. If riparian forest buffers are managed with food- and floral-producing trees and shrubs, they can serve multiple purposes, such as generating revenue while also providing conservation benefits (Lowrance, Leonard, and Sheridan 1985; Welsch 1991; Prichard 1993; Palone and Todd 1997). For additional information please see Klapproth and Johnson's (2009) publication addressing the science of riparian forest buffers.

Multipurpose riparian forest buffers are a temperate agroforestry practice. Agroforestry is the intensive and intentional integration of trees and/or shrubs with crops and/or livestock and includes practices such as multipurpose riparian forest buffers, silvopastures, and windbreaks. For additional information on agroforestry, see the National Agroforestry Center website (USDA-NAC 2013).

This publication addresses a set of design and planting processes for multipurpose riparian forest buffers composed of native fruit and nut trees and woody floral shrubs. We have compiled a "tool box" in appendix A that provides links to resources mentioned throughout the document. In addition, we describe the plantings at Virginia Tech's Catawba Sustainability Center (CSC) in Catawba, Va., to provide a case example of native fruit and nut tree and woody floral riparian buffer planning and planting. To learn more about the center and events, please visit the CSC Web and Facebook pages (Virginia Tech Roanoke Center 2007; CSC 2013).

Native Fruit and Nut Trees

Thousands of years before European settlers arrived in North America, Native Americans selected fruit- and nut-producing plants for desirable edible characteristics and improved strains of many edible plants, including trees and shrubs that produce fruits and nuts. Often times, these food-producing trees and shrubs were grown in fertile soils found near streams and rivers (Davies 1994).

Recently, there has been renewed interest in planting riparian areas with these native tree species to produce food for people and/or wildlife and to protect soil, water, and air quality (Brooks, Gregersen, and Folliott 1994; Robles-Diaz-de-Leon and Kangas 1998; Klapproth and Johnson 2001; Shultz et al. 2009). When these riparian areas are intentionally planted with edible plants, they can be considered "riparian food forests." Because native plants co-evolved with native pests and diseases, they tend to be less susceptible to attack compared with non-native fruit and nut species such as apples, pears, cherries, and English walnut. For this reason, they often require less intensive management.

For a list of native fruit and nut tree species in Virginia, see table 1. For more details about species in Virginia, see Virginia Cooperative Extension's publication on native fruit and nut trees (Trozzo, Munsell, and Chamberlain 2012a).

Table 1. Native fruit and nut tree species.

Scientific name	Common name
Asimina triloba	**Pawpaw**
***Amelanchier* spp.**	**Serviceberry**
Diospyros virginiana	**American persimmon**
Carya ovata	**Shagbark hickory**
Corylus americana	**American hazelnut**
Juglans nigra	**Black walnut**
Morus rubra	**Red mulberry**
Prunus americana	**American plum**
Rubus allegheniensis	**Blackberry**
Rubus occidentalis	**Black raspberry**
Sambucus canadensis	**Elderberry**

Figure 1. A clip of a riparian food forest design that uses mature crown widths drawn to scale to determine tree spacing.

Plantings of these species are designed using set spacing, such as on a 20-foot by 20-foot grid, or variable distances based on average mature crown widths (fig. 1). Most native fruit and nut tree species can be allowed to grow to their natural form, but some annual pruning to remove dead or old branches can be beneficial. Other management strategies include pruning more heavily by cutting back to the main stem every few years to increase fruit production.

Woody Florals

The term "woody florals" (also known as woody cut stems) describes trees and shrubs that produce colorful or unique stems, berries, buds, and/or flowers and are harvested every few years, indefinitely. The harvested stems are marketed to florists for use in flower arrangements, but they can also be attractive additions for landscaping. While there are many native species, there are also many that are not native but are frequently used in the floral industry. It is therefore quite common that woody floral production systems are not limited to native species.

For a list of woody floral species suited to Virginia, see table 2. For more information, see Virginia Cooperative Extension's woody floral publication (Trozzo, Munsell, and Chamberlain 2012b).

Woody florals are typically managed using coppice pruning. Coppicing is when shoots of a plant are periodically cut back to the main stem to encourage sprouting of new stems (fig. 2). The coppice cycle for woody

Table 2. Woody floral species.

Scientific name	Common name
Aronia arbutifolia	**Red chokeberry**
***Callicarpa* spp.**	**American beautyberry**
Calycanthus americana	**Sweet shrub**
Cornus sericea	**Red and yellow twig dogwood**
***Hydrangea* spp.**	**Hydrangea**
Salix discolor	**Pussy willow**

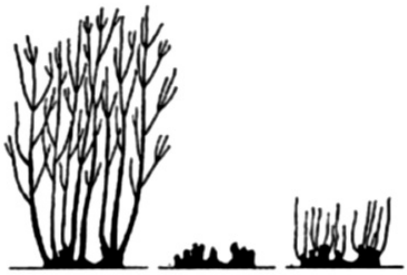

Figure 2. Woody florals are managed as coppiced trees and shrubs. The stems are cut every two to three years and grow back (Wilson and Wilson 2012).

florals includes an establishment period of about one to three years where the plant is allowed to grow. Once established, the plant shoots are cut back to the main stem near the ground to encourage sprouting of new stems and serve as an initial harvest of woody florals. Periods of vigorous growth follow coppice pruning and last one to three years or until the stems are at an appropriate maturity for harvesting. Once harvested and cut back to the stem, the cycle resumes.

The spacing and design of woody floral systems often depends on the landscape and production objectives; however, a commonly used spacing is 4 to 6 feet between shrubs within a row. This set spacing is possible because the plants are pruned back to the ground every few years, never getting much larger than a tall shrub. Spacing between rows is usually influenced by the size of equipment used to manage grass and other groundcover between plants, as well as the equipment used for harvesting the stems.

Multipurpose Riparian Forest Buffers

The structure of riparian forest buffers can differ based on site characteristics and management objectives (Palone and Todd 1997). If managing for aquatic insects and wildlife, for example, Weigel et al. (2005) argue that buffer width should be 120 feet. On the other hand, Castelle, Johnson, and Conolly (1994) suggest that buffer widths of 100 feet are needed to manage for biological health, whereas stream physiology objectives only require a width of 50 feet. The USDA recommends a three-zone system that is especially useful for understanding how native fruit and nut trees may fit into a riparian buffer planting (fig. 3; Welsch 1991).

Zone 1 – At least 15 feet wide and directly adjacent to the stream. It often includes trees and shrubs that are fast-growing and flood-tolerant. This zone is not intended for production, but rather to stabilize stream banks, protect water quality, and improve terrestrial and aquatic habitat.

Zone 2 – Upslope from Zone 1, 60 feet or more in width, and available for tree- and shrub-based production.

Zone 3 – Upslope from Zone 2, at least 20 feet wide, and often comprises grasses or short-rotation woody vegetation. Zone 3 disperses surface water as it enters the riparian buffer and can be grazed, grown for hay, or periodically mowed or thinned.

More intensive production practices, such as annual crop production, may occur beyond the third zone (Schultz et al. 2009).

The three-zone agroforestry system is just one template for planting a riparian buffer. Design could also be as simple as a planted area that spans 35 to 100 feet in width from the creek. However, the multizone template is particularly useful for designing and establishing riparian food forests because it emphasizes planting quick-growing, flood-tolerant plants directly adjacent to the stream and allows a space for native fruit and nut trees in the second zone, a bit up from the creek where they would grow more naturally.

Woody florals might require a slightly different arrangement because they are often managed as a coppice system and, therefore, are more appropriate as an addition to a standard riparian forest buffer at least 35 feet wide. They could also be integrated into Zone 2 of a multizone buffer if interspersed with larger trees that make up the greatest percentage of this section. For additional information on deciding on the width of a buffer, see table 2 in Klapproth and Johnson's (2009) publication.

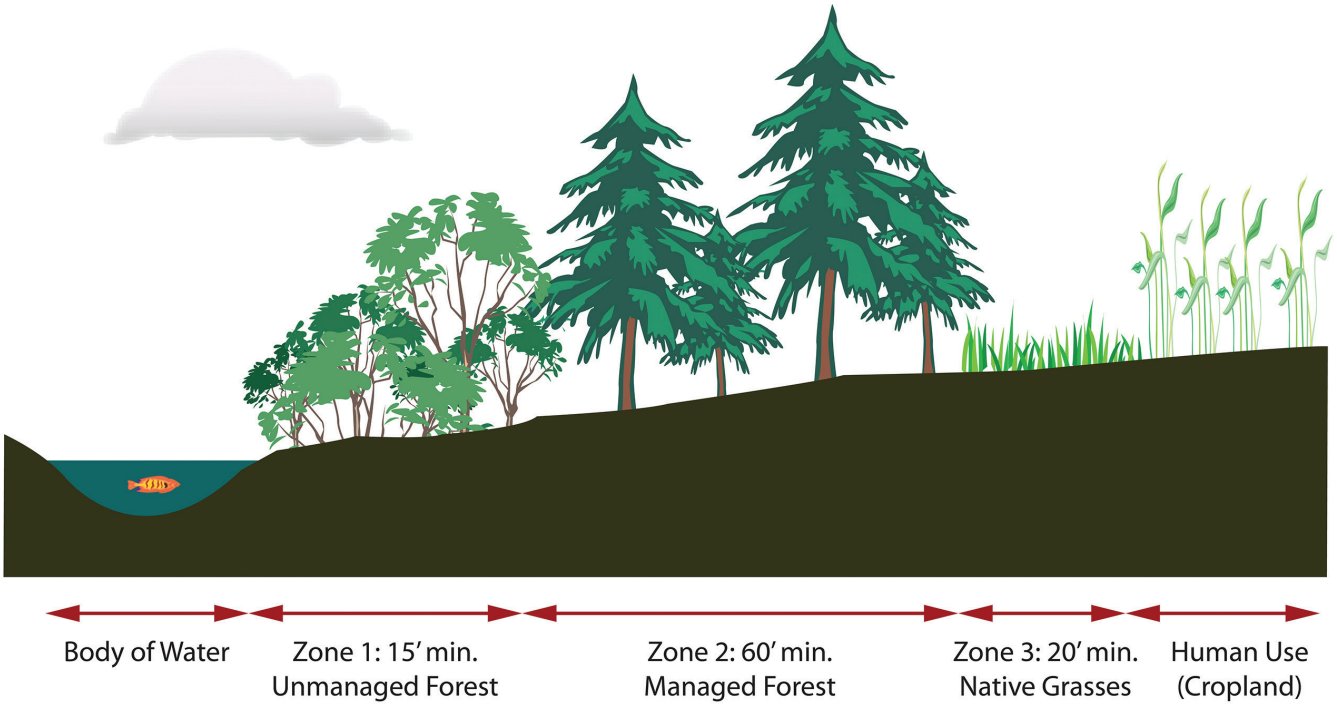

Figure 3. Three-zone agroforestry riparian buffer structure recommended by the U.S. Department of Agriculture (Virginia Outdoors Foundation 2010).

While not applicable in all cases, cost-share assistance programs that cover a portion of the costs of buffer establishment are available through state and federal agencies (see a list of links in appendix B). It is important to note that each program has a different set of requirements and guidelines. Native fruit and nut tree plantings may be more appropriate than woody florals for enrollment in cost-share programs because harvesting the fruits and nuts does not typically involve cutting trees. In most programs, tree cutting is not permitted until the commitment term ends.

The Conservation Reserve Enhancement Program, the Conservation Stewardship Program, and the Wildlife Habitat Incentive Program may be most applicable for native fruit and nut trees. Local Virginia Cooperative Extension agents, Natural Resources Conservation Service agents, soil and water conservation districts, or state forestry professionals may know of other useful programs and opportunities for native fruit and nut tree and woody floral riparian forest buffers. For information on design criteria and enrollment in cost-share programs with NRCS, see the NRCS "Conservation Practice Standard: Riparian Forest Buffer" (USDA-NRCS 2010).

Riparian plantings can be costly and time-intensive. Time spent planning can decrease on-the-ground mistakes as well as reduce cost. Below are steps for designing and planting native fruit and nut tree and woody floral creek-side forest buffers. We intend to give an idea of how the design and planting process may unfold, but keep in mind that additional assistance is available at NRCS, your local Virginia Cooperative Extension office, Virginia Department of Forestry, and often the soil and water conservation districts.

Design Process

1. Define Objectives and Goals

It is important to define what is desired from a multipurpose riparian forest planting to assist with design decisions. Some questions to consider are:

- What do you want to derive from the buffer? How much area will this require?
- Will the planting need to comply with a particular assistance program? If so, how does your plan fit with program requirements?
- What are your conservation objectives? Water quality, fish habitat, wildlife habitat, stream bank stabilization?
- Do you want to produce fruit and nuts for commercial production, for personal consumption, or for wildlife?
- If for commercial production:
  - How much production is necessary to make the venture worthwhile?
  - Is there an established market for your products?
  - How will you market and sell your products?
  - How will you harvest your products?
  - Will the harvesting time fit within your work schedule?
  - If you are interested in enrolling in a program, is production of your preferred product allowed?
- Will your production objectives and design be compatible with conservation objectives?
- Do you want to intensively produce woody florals to sell to the floral industry or simply provide color along the edge of your creek?
- Do you want a diverse array of species or just a few?

Answers to these questions will define objectives and goals as well as identify a preferred buffer width and composition.

2. Create an Aerial Photo Base Map

Base maps allow for scaled design. An example of an aerial base map can be seen in figure 4. Important information to include in a base map are property lines, aerial imagery, topography, soil types, and hydrography. Possible places to acquire this information are your county planning office, the local Natural Resources Conservation Service office, the local Virginia Cooperative Extension office, Google Earth, Google Maps, and geographic information system (GIS) software such as ArcGIS.

It is important to know the map scale so that you can use an engineer's ruler to draw trees and plants to scale for designing. Common scales are 1:10 (i.e., 1 inch on the map equals 10 feet on the property) or 1:20 — both of which allow for detailed design using the base map.

Figure 4. An aerial base map developed from Google Earth that allows for scaled design.

Common sizes for base maps are 24 inches x 36 inches or 11 inches x 17 inches. An engineer's ruler is a prism-shaped ruler that has various fixed scales that allow for easy measurements of designs such as 1 inch = 10 feet or 1 inch = 20 feet.

3. Analyze and Assess the Site

Use tracing paper and the base map to analyze and assess the planting site (Jacke and Toensmeir 2005). Tracing paper is an incredibly useful tool for designing landscape plantings. It is a special transparent paper that allows for multiple layers of information or iterations of designs without drawing on the printed base map. Tracing paper can be purchased at art or craft stores. It is usually positioned over a base map for reference, but the actual drawing occurs only on the tracing paper.

Render site information such as sun and shade, slope, water flow on land and in streambeds, wildlife location and movement of populations to protect and control, soil characteristics, and human access and pathways. Elements can be combined onto one piece of tracing paper or each given their own page to overlay upon each other. For more information on general site assessment, see Cornell University's publication (2003) on tree planting site assessment. For additional information about site assessment of riparian buffers, see page 1 of Klapproth and Johnson's (2009) riparian buffer establishment publication.

It is also important to understand soil conditions. Information about soil provides important insight to improve decisions about plant selection, placement, and potential amendments such as fertilizer or lime. Acquire this information by taking and analyzing a soil sample and sending it to the Virginia Tech Soil Testing Lab or using soil maps found on the NRCS website soil survey (USDA-NRCS 2013). For details about taking a soil sample, see Virginia Cooperative Extension's home soil sampling publication (Hunnings, Donohue, and Heckendorn 2011).

4. Select Buffer Structure

A clear decision about buffer structure will fundamentally drive planting design. For example, if the USDA's three-zone system is preferred,

- Zone 1 should be planted with fast-growing and flood-tolerant species at a distance of at least 15 feet from the stream bank. Alternatively, it could be left alone to vegetate naturally.
- Zone 2 is where managed native fruit and nut trees and shrubs can be grown.
- Zone 3 provides a filter strip of grasses and shrubs, which can be grazed, grown for hay, or periodically mowed or cut.

If objectives and the site warrant, an alternative is planting a 35-foot buffer with selected trees and shrubs and adding woody florals as an extension to the design. It could be that one row of woody florals is added to a riparian forest buffer to increase visual quality and enhance conservation capabilities or that four rows of standalone floral shrubs are planted for production. If enrolled in a cost-share program, the buffer may be influenced by the guidelines and recommendations of that program.

5. Select Plants

It is important to research species to determine which may best meet your objectives and goals and then gather detailed design information for those selected. For example, it is useful to know the crown width, height, and soil and sun requirements of desired species. Good

sources of information on native fruit and nut trees are "Manual of Woody Landscape Plants" (Dirr 1998), "Native Trees for Urban and Rural America: A Planting Design Manual for Environmental Designers" (Hightshoe 1978), and "Native Trees, Shrubs and Vines: A Guide to Using, Growing, and Propagating North American Woody Plants" (Cullina 2002).

Organize species information to assist your decision. This information will allow you to choose species that have a better chance of growing successfully on the selected site. As an example, see the chart found in Virginia Cooperative Extension publication "Native Fruit and Nut Trees and Shrubs of the Virginia Mountains and Piedmont" (Trozzo, Munsell, and Chamberlain 2012a) and shown in appendix C.

Woody florals are much simpler because they are typically managed using a 4- to 6-foot width between rows, which allows for two to three years of growth for the rotation. An additional requirement for most woody floral species is that they require full sun in order to fully develop desired characteristics. A useful reference for determining which species to grow and understanding cultivation requirements is "Woody Cut Stems for Growers and Florists: Production and Post-Harvest Handling for Flowers, Fruit, and Foliage" (Greer and Dole 2009).

In both types of systems, it is important to decide whether you would like a broad or narrow planting palette.

- A **broad planting palette** consists of many different species, which has the advantage of diversity in case one crop fails or loses its market value along with the possible disadvantage of more complicated management and harvesting.

- A **narrow planting palette** consists of a few species, which has the advantage of efficiency in management and harvesting but is subject to greater risk in terms of crop production and marketing.

6. Design

Develop potential configurations of trees and shrubs using information and materials gathered during the previous steps (Jacke and Toensmeir 2005). Site analysis and species characteristics will, in most cases, narrow down the species best suited to the site. Useful tools and materials for design are a scaled aerial base map, tracing paper, masking tape, markers or colored pencils, an engineer's ruler, and a calculator.

Begin by designing in general and then get more specific and detailed as promising configurations present themselves. In detailed design, selected tree and shrub species are often placed based on projected mature crown widths (fig. 5). If there is a range for average mature crown width, pick a value that is conservative and most easy to use. For example, if elderberry's crown varies between 4 and 8 feet in width and hazelnut's ranges between 6 and 8 feet wide, both could be spaced about 8 feet apart to simplify planning. Woody floral plants are typically spaced 4 to 6 feet apart within each row and are much simpler to design (fig. 6).

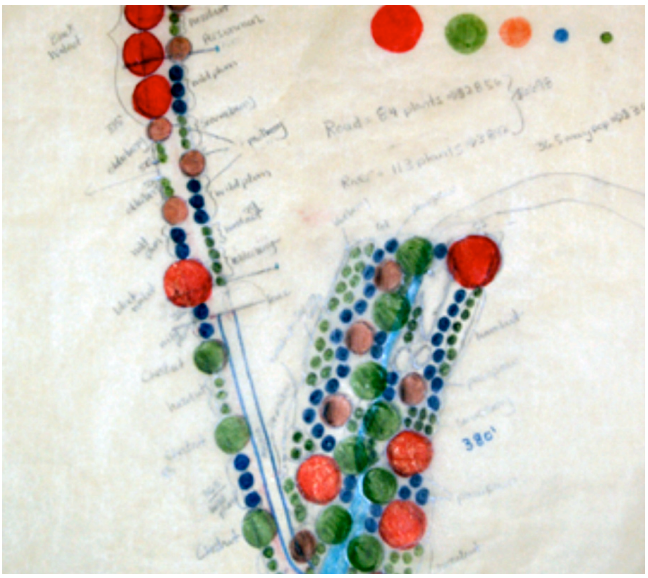

Figure 5. Native fruit and nut tree planting design on tracing paper using average mature crown width, base map, and engineer's ruler to place plants.

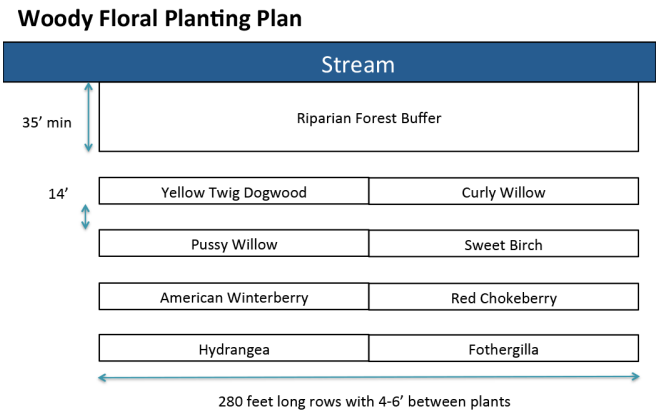

Figure 6. Woody floral planting design where all species are placed on 4-foot centers in rows that are 14 feet apart.

Mortality of individual trees may occur. Some people choose to plant additional seedlings in anticipation that some may not survive. Others may choose to carry out a follow-up planting to replace seedlings that do not survive. Either way, some mortality is likely and it is important to account for this within the project budget and design.

7. Plan for Protection From Wildlife

Protection from wildlife is important for guarding the initial investment of planting. Overall, wildlife protection should be adaptive and based on cost, desired effectiveness, installation effort, and ease of maintenance. Wildlife threats include deer, moles, voles, and beavers. The most common threat is deer browse. Designing the system well in advance of planting allows time for ordering and receiving construction materials before planting.

There are many options for protecting plants from deer browse and the most appropriate deer protection is influenced by your objectives. For example, if your objective is to sell products to the floral industry, deer protection should include substantial measures such as a double-line electric fence or tall permanent barrier. Wire cages around each plant may not be as useful because woody florals often are grown very close together. In other cases, where a few native fruit and nut trees are planted, wire cages may be more appropriate rather than installing an electric fence. Different types of deer protection are listed for quick reference in table 3.

Cages can be constructed around individual plants using concrete reinforcement wire and half-inch electric conduit used as stakes. Alternatively, woven wire can be used with T-posts or wooden stakes. In both cases, constructing wire cages is often expensive, installation is labor intensive, and accessing the tree for maintenance can be difficult. However, this method is highly effective at preventing deer damage to newly planted trees.

Eight-foot-tall permanent fences are another option and can be constructed with many choices of construction materials ranging from T-posts to locust logs, welded wire, or plastic mesh. In most cases, constructing a permanent fence is expensive and labor intensive. On the other hand, they are highly effective and allow easy access for maintenance.

Electric fences are a cheaper and easier alternative to something permanent. A double-stranded, solar-powered electric fence is easy to install and fairly effective at obstructing deer.

Repellents are another method, but must be applied every few months and are not very effective over long periods of time. The type of repellent may need to be changed often because deer may become desensitized.

Tree tubes are a common and low-cost method that are easy to install and fairly effective at preventing deer browse. This method works best with bare-root seedlings.

Other efforts that may decrease deer browse include keeping dogs nearby and deer hunting. A final option is to plant more trees than needed, knowing that some may not survive the impact of deer.

Table 3. List of methods available to prevent deer damage on newly planted trees and shrubs.

Type	Cost	Effectiveness	Installation
Wire cages	**High**	**High**	**Difficult**
Tall permanent fence	**High**	**High**	**Difficult**
Electric fence	**Medium**	**Medium**	**Medium**
Repellants	**Medium**	**Medium to low**	**Easy but frequent**
Tree tubes	**Low**	**Medium (bare-root seedlings)**	**Easy**
Hunting	**Low**	**Medium**	**Medium**

Moles and voles are often best protected against by using tree tubes. They can be used on their own or in combination with other deer protection methods. If managing for both small animals and deer, it is generally wise that the tube protects to just above deer browsing height. The tubes can be shortened to about 1 to 2 feet and used in combination with the other methods to protect from small mammal damage.

8. Create a Management Plan

Plant mortality and weed competition can be huge hurdles in achieving a successful and fully stocked planting. Too much money and time is invested in design and planting to risk failure due to lack of maintenance. Creating a management plan before planting will help guide follow-through and account for future needs.

Management plans should consider watering, weed control, protection from wildlife, mortality, and, in some instances, staking and fertilization. It is also wise to plan for more maintenance during plant establishment. Once established, maintenance requirements decrease. For more information on riparian buffer planting maintenance, see the management section of Klapproth and Johnson's (2009) publication.

Planting Process

1. Order Planting Stock

After species have been selected and the quantity of each species is known, planting stock can be ordered. There are several types of planting stock outlined in table 4, shown in figure 7, and detailed in the following text.

Figure 7. Four types of planting stock available for riparian plantings.

- **Containerized stock** are seedlings that have been grown in pots — commonly up to 1 gallon in size — for at least one growing season. Because of its maturity, this stock can have higher survival rates when compared to other stock, but can take more time and care in planting. Containerized stock is also not limited to spring planting. Typically, it can be purchased in small or large quantities from a nursery or distributor. Lower prices may be available if purchasing in larger quantities.

- **Potted liners** are plants grown in small tubes instead of gallon containers and are usually only available when purchasing in bulk. Potted liners are often purchased and transplanted to 1-gallon containers in order to further establish before planting. In some circumstances, potted liners can be directly planted in the ground if ample time is provided for them to

Table 4. Approximate average price, survivability, and planting season of types of planting stock available for purchasing and planting.

Type of stock	Approximate average price/plant	Survival	Planting season
Containerized 1 gallon (nursery price)	$20	High	Fall and spring
Containerized 1 gallon (bulk price)	$7	High	Fall and spring
Potted liners	$3	Variable	Fall and spring
Bare root	$2	Medium	Spring

establish before the first frost, if planting in the fall, or after the last frost if planting in the spring.

- **Bare-root seedlings** are trees and shrubs sold with no soil around the root ball. Bare-root seedlings are much less expensive to mail and transport when compared to containerized stock or potted liners. However, planting must occur in early spring because bare-root seedlings are harvested when dormant and survivability is related to planting before dormancy is broken. Therefore, cold temperatures must be provided before, during, and after shipping to keep the seedlings dormant. Bare-root seedlings can have lower survival rates when compared to containerized stock but are cheaper, easier to mail, and easier to plant, making them a commonly used planting stock for large-scale landscape and riparian plantings.

- **Live stakes** are cuttings about 1 inch or smaller in diameter that look like twigs or small branches and are planted directly in the ground. Only certain tree or shrub species have the ability to produce roots from cuttings. Live stakes are often limited to early spring plantings and can have low survival rates, but they are very inexpensive. Because of their size and lack of fragile roots, they are generally easy to transport and plant. However, because it is ideal for live stakes to remain dormant before planting in early spring, stakes must be kept cold during and after shipping to keep the stems from breaking bud.

Live stakes could be a good option for a low-cost Zone 1 planting, where the conditions make survival likely. It is also possible to obtain cuttings for free from existing plants that have the ability to root from twigs, such as willow, silky dogwood, buttonbush, and elderberry. For an extensive list of species capable of rooting, see the NRCS publication about planting materials (Burgdorf 2006).

Regardless of the planting stock chosen, it is important to order well in advance of the planting period to secure desired species at a reasonable price.

If one objective is to sell woody florals to the floral industry, purchasing known cultivars is important to guarantee consistent and desirable color, form, and size. However, if planting woody florals for home use or aesthetics, known cultivars are less important, and this flexibility can save money because known cultivars are often more expensive than wild-type seedlings. The same is also true of native fruit and nut trees where established cultivars that will guarantee a certain fruit form, size, and flavor are often more expensive than purchasing the species that are wild-type seedlings. In the case of native fruit and nut trees, if wildlife habitat is the main objective, wild type seedlings can meet that goal. However, if fruit quality is desired, established cultivars might be more appropriate.

2. Construct Protection From Wildlife

Use your deer and wildlife protection design along with some type of measurement mechanism, such as pacing, a 100-foot tape, or a measuring wheel to lay out and construct the protective system. Constructing protection before planting is often ideal as it can increase efficiency of planting as well as achieve optimal protection from browsing wildlife. In the case of tree tubes and tree cages, however, protection may be best installed directly after planting the tree. Make sure to have all the materials corralled and ready for installation and account for additional time and labor for installation.

3. Decide How Trees Will Be Planted and Coordinate

There are several options for conducting tree plantings. A common option is to hire a planting crew, which could take over part or all of the site preparation, planting, and wildlife protection. Another is to hire a consultant to design and implement the buffer according to your goals and objectives. Other options are to plant the trees on your own or to gather a group of friends, community members, or volunteers. In all cases, coordinating the planting should be done well in advance of the desired planting date. If using a contractor, the remaining steps of the planning process will still be useful to understand but may not need to be individually implemented.

4. Select Tools and Materials

The type of tools required is dependent on the planting stock, total quantities of seedlings, and who will be planting. It is important to determine the tools and materials that are needed and where to purchase, rent, or borrow them at least a week before site preparation and planting. In most cases, digging tools such as shovels and/or pick axes will be required. It is also important to corral the materials required for deer protection and secure the tools required for installation.

Be sure to schedule plant delivery or pickup at least a few days prior to planting and protect them from winds that may cause stress. If ordering earlier, be sure they have adequate water. However, it is advisable to withhold watering a few days before planting so the root ball will not be too moist.

5. Prepare the Site

Appropriate site preparation before planting can increase the survival rate and growth of the planted riparian buffer. Site preparation usually includes grass removal, loosening of the soil, addition of soil amendments, and sometimes mulching.

Grass removal can be achieved through mowing and mulching or herbicide application. In riparian areas, mowing and mulching may be the most ideal way to kill grass; however, this technique may not be realistic in some cases, and certain water-safe herbicides can be used to kill grass or competing growth. For more information about how to safely use aquatic herbicides in riparian areas, contact your local extension office or the Virginia Tech Pesticide Programs (2013). Grass removal should be conducted well before the planting to ensure competition is limited.

Loosening the soil can occur before planting using a tractor or tiller if the design is conducive to this type of preparation. Otherwise, digging a good planting hole and loosening the soil two to three times the width of the root ball will be adequate.

The soil test results should indicate whether amendments are needed for tree planting. If amendments are recommended, make sure to incorporate them when the soil is turned or when the planting hole has been dug.

For woody florals, site preparation may consist of mulching well in advance with weed block fabric underneath, turning the soil, or eradicating competitive growth with herbicides. For row plantings of fruit and nut trees, the soil could be turned and the site prepared in a similar fashion. At a minimum, it is important to dig a sizeable hole for each tree before or when planting. For more information about how to properly plant a tree, see Virginia Cooperative Extension publication "Tree and Shrub Planting Guidelines" (Appleton and French 2009).

6. Stake Out the Design

To avoid confusion during planting, stake out the area in advance. Calculate the planned distance between each plant before planting to avoid confusion and last-minute calculations. The final scaled design on tracing paper is useful for this purpose. Set the plants in their location no more than two days before planting and after site preparation. In the field, use a measuring tape, measuring wheel, or pacing to place labeled pin flags where particular trees or shrubs should be planted. Pacing is a method of measurement by walking and is very convenient for measuring distances in the field. See the North Carolina Cooperative Extension publication on how to calculate your pace (Bardon 2009).

7. Planting Day

On planting day, it is important to have all tools, equipment, materials, and planting stock staged for easy access. Types of tools will depend on the planting stock as well as the total quantities to be planted. If planting with volunteers or friends, begin with a demonstration to teach everyone the proper way to plant a tree. Oversight of the planting process, whether using volunteers, friends, or contractors, can help ensure the planting conforms to your vision and expectations.

- Planting steps of containerized stock include cutting encircling roots on the root ball, planting the tree so the soil is level with the root collar, and loosening the soil in about a 2-foot radius from the center of the planting hole (fig. 8). For further details on planting

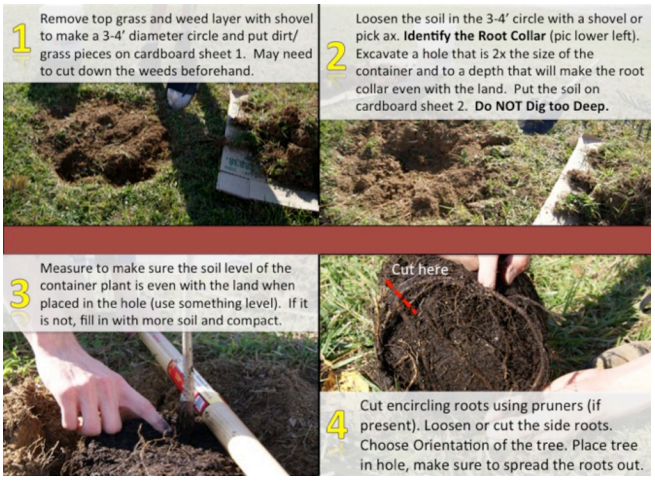

Figure 8. Important steps in properly planting a containerized tree or shrub seedling.

containerized trees, see Iowa State University Forestry Extension publication "Tips for Proper Planting of Containerized Trees" (Smith 2002).

- Planting bare-root seedlings includes using a dibble bar or shovel to open up a hole for the seedlings, being careful to arrange the roots radially, and closing the hole. A dibble bar is a small flat tool that resembles a shovel but is inserted into the ground and wiggled back and forth to make an opening for the bare-root seedling. For more information on planting bare-root seedlings, see the Univeristy of Tennessee's publication on planting procedures for bare-root seedlings (Mercker 2005).

- Planting live stakes involves scarring the bottom part of the stem about 1 to 2 inches on at least two sides to allow for easier rooting. Either use a mallet to hammer the live stake into the ground or a dibble bar or piece of rebar to make a hole where the stake can be inserted. It is important to plant the stake with the buds pointing up and slanting slightly out if on a slope. If using a dibble bar, make sure all sides of the stake are touching the soil by packing the soil around it well. For more information on planting live stakes, see the Washington State University Cooperative Extension (2013) guide for planting live stakes.

8. Maintenance

Carry out the management plan you created in the design phase including — but not limited to — watering, controlling weeds, staking trees for support, and replacing plantings for those that did not survive. Maintenance is critical the first few weeks after planting and especially important during the first few years. Once established, the trees will most likely need less frequent maintenance.

While sometimes complex, designing and establishing riparian forest buffers that meet multiple objectives allow diverse benefits within one area of land. These systems can contribute to production and help landowners achieve conservation goals. To provide additional insight, the following section outlines an example of the planning and planting of native fruit and nut tree and woody floral riparian buffers at the Catawba Sustainability Center near Roanoke, Va.

Catawba Sustainability Center Example

Virginia Tech's Catawba Sustainability Center hosts two multipurpose riparian forest buffer demonstrations. The first demonstrates the use of native fruit and nut trees and the second demonstrates the use of woody florals. In this section, we highlight the costs and processes used to establish the CSC demonstrations. Decisions were based on site objectives and a preferred timeline for planting. For this reason, the CSC design may not be appropriate in all situations.

Native Fruit and Nut Tree Riparian Planting

The native fruit and nut tree buffer was planted in fall 2011 with the help of Catawba community members and students and faculty members from Virginia Tech (figs. 9 and 10). Planting stock consisted mostly of 1-gallon

Figure 9. Virginia Tech students and Catawba community members plant a serviceberry tree at the Catawba Sustainability Center.

Figure 10. Virginia Tech students and Catawba community members plant and mulch trees and install deer protection in the riparian buffer.

Table 5. Planting details for the native fruit and nut tree riparian buffer at the Catawba Sustainability Center near Roanoke, Va.

Dimensions of planting area	350 ft along the stream x 75 ft wide
Area	26,250 sq ft = 0.6 acre
Number of plants	80
Scaled number of plants per acre	160
Labor	About 40 hours
Estimated survival	80%

Table 6. Costs associated with the native fruit and nut tree riparian buffer at the Catawba Sustainability Center near Roanoke, Va.

Item	Cost estimate
Total tree cost for 80 trees (average cost per tree from containerized nonbulk stock = $17)	**$1,360**
Total deer fence cost (7 rolls of concrete reinforcement wire for deer fence at $600 and 80 pieces of 10-ft electric conduit wire [1/2 in] cut in half for stakes for deer fence at $150)	**$750**
Total mulch cost (free load of mulch and cardboard)	**$0**
Total planting cost (not including labor)	**$2,110**

containerized stock purchased at nonbulk price. Wire cages were used for deer protection and constructed from concrete reinforcement wire with 8-foot electric conduit pipe cut in half for stakes. Planting details are outlined in table 5, and costs associated with the planting are listed in table 6, followed by general reflections on the planting.

Lessons Learned

Planning and Design

Planning occurred over the course of two months starting in late August. With more time, it may have been possible to purchase planting stock at a lower price. Native plants often must be ordered further in advance (season prior to planting). Additionally, a grid pattern could have made for easier planting and maintenance when compared to the variable configuration that was used. However, one goal was to demonstrate as many species as possible, rather than plant only a few species in simple rows.

Purchasing Planting Stock

We purchased 1-gallon containerized seedlings at nonbulk price. Our purchase could have been at bulk rates because of the large quantities ordered, but we were unable to order well enough in advance of the planting. We could have used bare-root seedlings, which are less expensive, but opted for containerized stock to improve chances for survival and growth. Planting the containerized stock also allowed us to plant in the fall.

Deer Protection

The native fruit and nut tree planting occurred in tandem with a fruit and nut tree fencerow planting along a roadside. Deer protection for both the roadside and creek-side plantings incorporated cages. Other options for the creek-side planting were possible because the trees were closer together than those in the roadside planting. Solar-powered, double-line electric fencing is one alternative. Cages make it difficult to access the trees to mulch, prune, and weed.

Planting

A large group of volunteers worked over the course of one day to plant the native fruit and nut tree stock. Site preparation, planting, and deer protection were all conducted on the same day. We learned it would be helpful to prepare the site before volunteers come to plant to increase planting efficiency.

Maintenance

Survivability may have been much greater if maintenance were planned for and implemented in a more concerted way. Limitations of funding and infrastructure made adequate maintenance difficult. Ideally, a management plan would have been in place to highlight the amount of work required during the establishment phase and funds could have been allocated accordingly. We also had no running water to the plantings, as they were far off from any wells. Therefore, watering had to be performed by hand and bucket, which limited the frequency. The cages for deer protection could also have been constructed to open more easily and the mulch could have extended beyond the cage diameter to ease weed control.

Woody Floral Riparian Planting

The woody floral demonstration was planted at the Catawba Sustainability Center in fall 2012 with the help of volunteers and participants of a workshop on planting income-producing trees in riparian areas (figs. 11 and 12). Planning for the woody floral planting began in spring 2011 with species selection and ordering planting stock. The stock was primarily bare-root and potted liners that were transplanted into 1-gallon containers for the summer growing season and provided with irrigation. The remaining stock was purchased as quart-size potted liners and planted well before the first frost date in the fall.

Figure 11. Virginia Tech students and Catawba community members plant sweet birch seedlings for the woody floral planting.

Figure 12. Four 4-foot-wide rows of woody florals spaced 14 feet apart with double-strand, solar-powered electric deer fence.

Site preparation occurred by laying down four rows of 4-foot-wide weed cloth, spaced 14 feet apart with 2 to 3 inches of wood mulch on top. Double-line, solar electric fencing was chosen for deer protection and installed the weekend before planting. The trees were spaced 4 feet within the rows with 14 feet between rows. The woody floral planting is adjacent to a 35-foot riparian buffer and expands the protective capacity of the buffer. Planting details are outlined in table 7 and costs listed in table 8, followed by general reflections on the process.

Lessons Learned

Purchasing Planting Stock

Space at a tree nursery was used to grow the plants from small potted liners to fill out a 1-gallon container. This may not be feasible for most landowners unless they have the means and desire to nurture growth of preplanted stock. Potted liners are less expensive to receive by mail than containerized stock. Quart-size potted liners are also available and can be grown to 1-gallon size or planted directly in the field if extra time is allowed before the first frost.

Table 7. Planting details of the woody floral riparian buffer at the Catawba Sustainability Center near Roanoke, Va.

Dimensions of planting area	**300 ft along the stream by 80 ft wide**
Area	**24,000 sq ft = 0.55 acre**
Number of plants	**275**
Scaled number of plants per acre	**550**
Labor	**40 hours**
Estimated survival	**80%**

Table 8. Woody Floral Planting Cost Estimate by Item.

Item	Cost estimate
Total plant cost for 275 plants (estimated cost per tree bought as starters and grown to 1 gal at $3)	**$825**
Total deer fence cost (solar-powered, double-strand electric fence with step-in posts)	**$650**
Total mulch cost (weed block fabric 1,100 ft total covers 4 rows of 280 ft at $250; plus a dump truck of mulch from city of Roanoke, delivery not included at $30)	**$280**
Total riparian buffer cost estimate (not including labor)	**$1,755**

Planning

We planted the woody florals in fall 2012, but started planning in spring 2011. When compared to the native fruit and nut tree planting, ample time for planning was allowed. It was useful to have extra time to shop for affordable plants and to research deer protection and mulch options. We conducted site preparation and installation of deer protection before the planting, which improved manageability of the planting day.

Design

Four rows spaced 14 feet apart were used to ensure tractor access between rows. This may seem excessive in the early stages of growth, but it could be useful after plants mature. It could be that 10 feet allow for enough space, depending on the type of tractor or weed trimmer used. The rows could even be closer if using a smaller lawn mower and harvesting with a cart.

Planting

Site preparation prior to planting helped improve efficiency. The general design of the woody floral system is intensive with trees very close together, which made for easy planting. This also required fewer volunteers, which improved manageability and decreased labor and potential costs.

Maintenance

The design of the woody floral system better accounted for maintenance requirements than the previous planting and is more manageable because the plants are located in close proximity to one another. Water is still an issue and is limited because of infrastructure.

Conclusion

Multifunctional riparian forest buffers can be used to achieve various objectives for landowners. These types of riparian forest buffers are unique in that they allow for areas next to streams to provide opportunities for production and conservation. This publication addressed the design and planting of riparian forest buffers composed of native fruit and nut trees and woody floral shrubs. The case example at the CSC provides details and lessons learned about recent plantings. This information can be used as a starting point for others working through establishing similar planted systems in riparian areas.

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Appendix A. Tool Box: Summary of Resources

The sections below correspond to headings in this publication. Additional information about the resources cited below can be found in the References section.

Introduction

- Information about riparian forest buffers: Virginia Cooperative Extension publication 420-155 (Klapproth and Johnson 2009) covering the science of riparian forest buffers – http://pubs.ext.vt.edu/420/420-155/420-155_pdf.pdf.
- Information on agroforestry: National Agroforestry Center website (USDA-NAC 2013) – http://nac.unl.edu/.
- Information about the Catawba Sustainability Center (CSC 2013; Virginia Tech Roanoke Center 2007) – www.vtrc.vt.edu/catawba/ and www.facebook.com/VTcatawba.

Native Fruit and Nut Trees

- Details about native fruit and nut tree species: Virginia Cooperative Extension publication ANR-23NP (Trozzo, Munsell, and Chamberlain 2012a) – http://pubs.ext.vt.edu/ANR/ANR-23/ANR-23NP_pdf.pdf.

Woody Florals

- Information about woody floral species: Virginia Cooperative Extension publication ANR-22NP (Trozzo, Munsell, and Chamberlain 2012b) – http://pubs.ext.vt.edu/ANR/ANR-22/ANR-22NP_pdf.pdf.

Multipurpose Riparian Buffers

- Information on deciding on the width of a buffer: table 2 of Virginia Cooperative Extension publication 420-155 (Klapproth and Johnson 2009) – http://pubs.ext.vt.edu/420/420-155/420-155_pdf.pdf.
- The Natural Resources Conservation Service Riparian Forest Buffer standard: outlines design criteria for enrollment in NRCS cost-share programs (USDA-NRCS 2010) – ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/391.pdf.

Design Process

Step 3. Analyze and Assess the Site

- Information on general site assessment: Cornell University's (2003) publication on planting site assessment – http://dnr.wi.gov/topic/UrbanForests/documents/TreePlantingSiteAssessment.pdf.
- Information about site assessment of riparian buffers: Klapproth and Johnson's (2009) riparian buffer establishment document, page 1 – http://pubs.ext.vt.edu/420/420-155/420-155_pdf.pdf.
- NRCS soil survey website (USDA-NRCS 2013) – http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.
- Information on collecting and sending soil samples to the Virginia Tech Soil Testing Lab (Hunnings, Donohue, and Heckendorn 2011) – http://pubs.ext.vt.edu/452/452-129/452-129_pdf.pdf.

Step 5. Select Plants

- Useful references for collecting information on native fruit and nut trees: "Manual of Woody Landscaping Plants" (Dirr 1998); "Native Trees for Urban and Rural America" (Hightshoe 1978); and "Native Trees, Shrubs and Vines" (Cullina 2002).
- An example of a species research chart: Virginia Cooperative Extension publication ANR-23NP (Trozzo, Munsell, and Chamberlain 2012a) – http://pubs.ext.vt.edu/ANR/ANR-23/ANR-23NP_pdf.pdf.
- A useful reference for determining which woody floral species to grow and understanding cultivation requirements: "Woody Cut Stems for Growers and Florists" (Greer and Dole 2009).

Planting Process

Step 1. Order Planting Stock

- An extensive list of species capable of rooting: Natural Resources Conservation Service publication (Burgdorf 2006) about planting materials – www.plant-materials.nrcs.usda.gov/pubs/mipmctn7266.pdf.

Step 5. Prepare the Site

- For information about how to safely use aquatic herbicides in riparian areas: Contact your local Virginia Cooperative Extension office (see www.ext.vt.edu/offices) or Virginia Tech Pesticide Programs (2013) – http://vtpp.ext.vt.edu/.

- Detailed information about how to properly plant a tree: Virginia Cooperative Extension publication 430-295 (Appleton and French 2009) – http://pubs.ext.vt.edu/430/430-295/430-295.html.

Step 6. Stake out the Design

- Information about how to calculate your pace: North Carolina Cooperative Extension's publication (Bardon 2009) about pacing – www.ces.ncsu.edu/forestry/pdf/WON/won39.pdf.

Step 7. Planting Day

- Details on planting containerized trees: Iowa's forestry extension publication (Smith 2002) – www.iowadnr.gov/portals/idnr/uploads/forestry/container_planting.pdf.

- Detailed information for planting bare-root seedlings: University of Tennessee's publication (Mercker 2005) on planting procedures for small, bare-root seedlings – www.tn.gov/twra/pdfs/treeplanting.pdf.

- Detailed information on planting live stakes: Washington State University Cooperative Extension (2013) live stake planting guide – www.wnps.org/education/resources/documents/Garden_Links/hardwood_cuttings_and-live-stakes.pdf.

Appendix B. Riparian Buffer Cost-Share and Incentive Programs

Program	Agency	Contact information
Conservation Reserve Enhancement Program	**USDA Farm Service Agency**	**www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep** **Check with a local NRCS agent for more detailed information.**
Conservation Stewardship Program	**Virginia Department of Forestry**	**www.dof.virginia.gov/mgt/costshare/csp.htm** **Contact the Virginia Department of Forestry for more information.**
Environmental Quality Incentives Program	**USDA Natural Resources Conservation Service**	**www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip** **Check with a local NRCS agent for more detailed information.**
Riparian Buffer Tax Credit	**Virginia Department of Forestry**	**www.dof.virginia.gov/tax/credit/riparianbuffer/index.htm** **Contact the Virginia Department of Forestry for more information.**

Appendix C. Native Fruit and Nut Tree Design Considerations

Common name	Species name	Form	General spacing	Crown width	Height	Soils
American hazelnut	*Corylus americana*	Shrub	10 feet	10-12 feet	15-18 feet	Prefers well-drained soils
American plum	*Prunus americana*	Small tree or suckering shrub	15 feet	15-25 feet	15-25 feet	Is well-adapted to poor soils
Blackberry	*Rubus allegheniensis*	Bramble	5 feet	4-8 feet	3-6 feet	Prefers well-drained and composed soils
Black raspberry	*Rubus occidentalis*	Bramble	5 feet	4-8 feet	3-6 feet	Prefers moist or mesic, rich soils
Black walnut	*Juglans nigra*	Large tree	50 feet	50-75 feet	50-75 feet	Prefers deep, rich, moist soils; tolerates drier soils but grows slower
Blueberry	*Vaccinium corymbosum*	Shrub	10 feet	8-12 feet	6-12 feet	Prefers moist, acid, organic, well-drained soils (pH 4.5-5.5)
Elderberry	*Sambucus canadensis*	Shrub	10 feet	6-10 feet	8-12 feet	Prefers moist soils but can handle drier soils
Persimmon	*Diospyros virginiana*	Medium tree	35 feet	35-50 feet	40-60 feet	Prefers moist, well-drained, sandy soils but will do well on low-fertility, dry soils
Pawpaw	*Asimina triloba*	Small tree or suckering shrub	20 feet	20-35 feet	15-20 feet	Prefers moist, fertile, deep, slightly acid soils
Red mulberry	*Morus rubra*	Medium tree	40 feet	40-50 feet	40-70 feet	Prefers rich, moist soils
Serviceberry	*Amelanchier* spp.	Medium tree or pruned to shrub	30 feet	30-40 feet	30-40 feet	Prefers moist, well-drained, slightly acid soils but will grow in drier conditions