

Demonstrating and Assessing Multifunctional Riparian Forest Buffers in the Chesapeake Bay Watershed

Penns Valley Conservation Association

Andrea Ferich, M.S. Forest Resources and Human Dimensions of Natural Resources and the Environment

TABLE OF CONTENTS

Introduction

Chapter 1 Multifunctional Riparian Forest Buffer Demonstration Locations & Assessment

-Fiddler's Bend Woodward, PA

- Landowner and property overviews with designs
- Assessment of the potential financial performance of each of the MFRFB designs with species survival rates
- Demonstration of [Non-Timber Forest Product Calculator](#) ("NTFP Calculator")

-Buttonwood Forest Farm Woodward, PA

- Landowner and property overviews with designs
- Assessment of the potential financial performance of each of the MFRFB designs with species survival rates
- Demonstration of ["NTFP Calculator"](#)

Chapter 2 Overview of Potential Markets and Outlets for Products

Overview includes wholesale opportunities, restaurants, local consumers, and large urban centers such as Philadelphia and Baltimore/Washington District of Columbia.

- Wholesale Opportunities
- Retail and Value-Added Market Opportunities
- Fruits & Berries
- Nuts
- Medicinals
- Woody cut flowers, natural dye
- Nursery materials
- Labor & Cooperatives

Chapter 3 Lessons Learned

Regarding maintenance, success of trees and shrubs planted specifically for income/product generation, and tips for farmers and landowners considering installing a MFRFB. This section covers lessons learned about:

- Big picture lessons learned
- Organic methods
- Low-cost propagation
- Seed propagation
- Direct seeding
- Natural regeneration
- Alternative deer-control fencing
- Other lessons learned about fencing
- Citizen science monitoring
- Collaboration
- Challenges
- Advice for planning a MFRFB Project

Chapter 4 Ecological Assessment

Waterways and Wildlife Baseline Data

Works cited

Appendix

- Additional resources
- Cultivar descriptions
- On-going writing

Disclaimer

To the best of our knowledge the information contained herein is accurate.

Do not eat any part of wild edible plants, herbs, weeds, trees or bushes until you have verified with your health professional that they are safe for you and how to prepare for people or animals.

No liability exists against authors; nor can they be held responsible for any allergy, illness or injurious effect that any person or animal may suffer as a result of information in this resource or through using any of the plants mentioned.

This resource is intended to provide general information only. Always seek the advice of a health professional before touching or eating any plant matter. Information provided is not designed to diagnose, prescribe, or treat any illness, or injury. Always consult a health care professional or medical doctor when suffering from any health ailment, disease, illness, or injury, or before attempting any traditional or folk remedies. Keep all plants away from children. As with any natural product, they can be toxic if misused. This writing is for inspiration and entertainment purposes only, and the information contained herein should not be taken as factual.

Introduction

This initiative through the Penns Valley Conservation Association (PVCA) assessed, demonstrated, and replicated best practices and opportunities for multifunctional riparian forest buffers (MFRFBs), in the Upper Penns Creek Watershed, in eastern Centre County, Pennsylvania as an adaptable model for subbasins across the Chesapeake Bay and beyond. Particularly, opportunities for cooperatives, native plant nurseries, wholesale and value-added products, improved genetics, cultivars for nuts and berries, no-spray alternatives for establishment, and maintenance. This project includes two demonstration MFRFB locations in Central Pennsylvania as well as the economic opportunities for Non-timber Forest Products (NTFPs) within these systems in the tree crops economy. This report details those locations, the designs for those buffers, and the lessons learned demonstrating and replicating these systems as they continue to improve water quality and habitat improvements through ecosystem function.

The study area for demonstrating and assessing MFRFB is the Upper Penns Creek Watershed in Pennsylvania (Figure 1). The Penns Creek watershed (HUC 02050301) is a 67.1-mile stream flowing into the Susquehanna River. The Susquehanna River Basin drains nearly half of Pennsylvania's area, and contributes more than 50 percent of the freshwater flowing into the Chesapeake Bay (Armstrong and Stedman 2012).

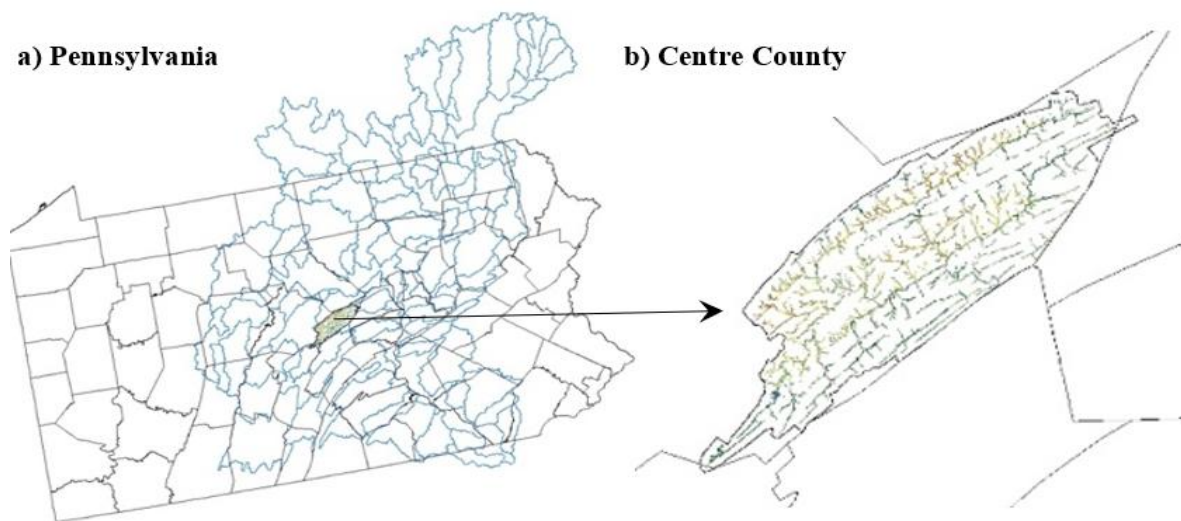


Figure 1. Location of the Upper Penns Creek Watershed, in Central Pennsylvania part of the Susquehanna River Basin in the Chesapeake Bay Watershed

NTFP product development and analysis were coupled with optimizing the health of the demonstrations riparian forest buffers, as defined by the [Chesapeake Bay Program's definition of riparian forest buffers](#): "The trees, shrubs and other plants that grow next to streams and rivers are critical to the health of the Chesapeake Bay. These forest buffers prevent pollution from entering waterways, stabilize stream banks, provide food and habitat to wildlife and keep streams cool during hot weather."

This particular writing is a final report and it is also a toolkit of resources helping to lay out the economic opportunities for MFRFBs in the Chesapeake Bay Watershed, lessons learned in installing these buffers, and how to assess them. Most of the intended audience for this booklet includes landowners, natural resource providers, and collaborators. It is part of a collection of writings on the ecological and socioeconomic opportunities in multifunctional riparian forest buffers and the tree crops across the Mid-Atlantic. The project is funded through a \$63,000 grant from the Chesapeake Bay Trust (CBT) through the Environmental Protection Agency (USEPA), with the PA Department of Conservation and Natural Resources Bureau of Forestry (PA DCNR) GIT. This specific project funded the Penns Valley Conservation Association (PVCA) toward their mission as a watershed organization. The implementer of the demonstration projects and author of this report is Andrea Ferich, Consulting Forester and former Executive Director of PVCA. Ferich runs two businesses, Ironwood Forestry as a Consulting Forester and Ironwood Specialty Crops LLC, her farm and work growing, processing, and aggregating non-timber forest products (NTFPs), in collaboration with the Keystone Tree Crops Cooperative. Both of these businesses were developed as offshoots of this project.

From November 2017-June 2021 Ferich implemented two demonstration locations in the Upper Penns Creek Watershed in Centre County to demonstrate and assess the economic opportunities of multifunctional riparian forest buffers as a model for the Chesapeake Bay Watershed. The demonstration locations were focused on the 3-zone design as described by PA DCNR, as well as the best practices of riparian buffer establishment and maintenance within the multi-tier planting design. Within the timeframe of this project the multifunctional riparian forest buffer framework was replicated, by Ironwood Forestry, planting and distributing over 20,000 trees and shrubs with more than 50 landowners in Pennsylvania.

This initiative demonstrated organic methods for establishment, low-cost propagation, alternative deer exclusion concepts, resources on growing for production in agroforestry systems, improved genetic tree crop material, and collaboration. The demonstration locations as well as most of the replication areas were committed to no-spray establishment. A variety of socioeconomic and ecological indicators were utilized in the selection of the two locations including; corridor mapping, the use of the Chesapeake Conservancy's high-resolution BMP prioritization tool, the accessibility of the locations, as well as landowner interest and leadership capacity in working with NTFPs. The two projects are establishing and are in different stages of production with diverse NTFPs, less than two miles away from each other.

One of the deliverables of this work and contributions to outreach and implementation efforts is the analysis of the bottlenecks of the multifunctional riparian forest buffer economy. This project includes the demonstration of the USDA NRCS National Agroforestry Center's (NAC) NTFP Calculator. Kate MacFarland Agroforester with the USDA National Agroforestry was contacted about the project, specifically related to demonstrating this economic assessment tool. Costs and revenue were calculated to reflect economic potential of perennial agroforestry systems through this tool located at the following web address:

<https://www.fs.usda.gov/nac/resources/tools/ntfp.shtml>

Although this report and toolkit are stand-alone pieces, they are also part of a collection of on-going writing and resources in the NTFPs economy. The on-going collaborative writing also includes expert practitioners, neighbors, and other professionals from across the mid-Atlantic. One of the collaborating authors, herbalist and midwife Sarah DePasquale, owns one of the multifunctional riparian forest buffer demonstration locations profiled in this report. DePasquale collaborates with Ferich toward organizing around herbal products supply, scaling capacity, processing, and aggregation bottlenecks. Another collaborating author, Zach Elfers, owns [Future Forest Plants](#) nursery in York, PA (see Resources). He has been collecting and propagating many of the best available genetics of tree crops for the Mid-Atlantic. During the time of this project Elfers and Ferich (along with others) launched the [Keystone Tree Crops Cooperative](#) (KTCC, see Resources). KTCC works to promote right livelihood through bioregional tree crops addressing issues of conservation, climate change, food security, and land justice through building the connections between the supply and demand of strategic tree crops. The on-going work includes making connections between the old orchards, new growers, gatherers, and consumers, while increasing processing capacity. Currently this work is focused on American hazelnut, Bitternut hickory, chestnut, elderberry, and Black chokeberry opportunities in the Mid-Atlantic. This body of work has also been largely influenced by the incredible agroforestry work of Eliza Greenman of [HogTree](#) in Purcellville, Virginia and Co-founder of [Fruit Explorers](#), a collaborative of orchardists, foragers, fruit historians, nurserypeople and value-added producers across the United States chasing the best tree crops genetics across the United States and beyond.

Other project collaborators include: PA DCNR, U.S. Fish and Wildlife Service (USFWS), U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS), Trout Unlimited, the Centre County Conservation District, local businesses, and brilliant dedicated landowners. Aspects of wildlife and water quality assessments were built upon the outstanding writing and monitoring work of Nell Hanssen, Lisa Williams, Joe Gyekis, and Craig and Linda Ferich. The theoretical framework and praxis of working with private landowners as well as the art and science of silviculture have been greatly influenced by the work and legacy of Dr. Jim Finley. This booklet is also accompanied by a [toolkit](#) including a [species matrix](#), and [monitoring tools](#).

The [Appendix](#) includes additional resources for agroforestry as well as descriptions of the cultivars.

Multifunctional Riparian Forest Buffer Demonstration Locations & Assessment

- Demonstration Location 1: Fiddler's Bend – A midwife herbalist's perspective
- Demonstration Location 2: Buttonwood Forest Farm – A chef caterer baker

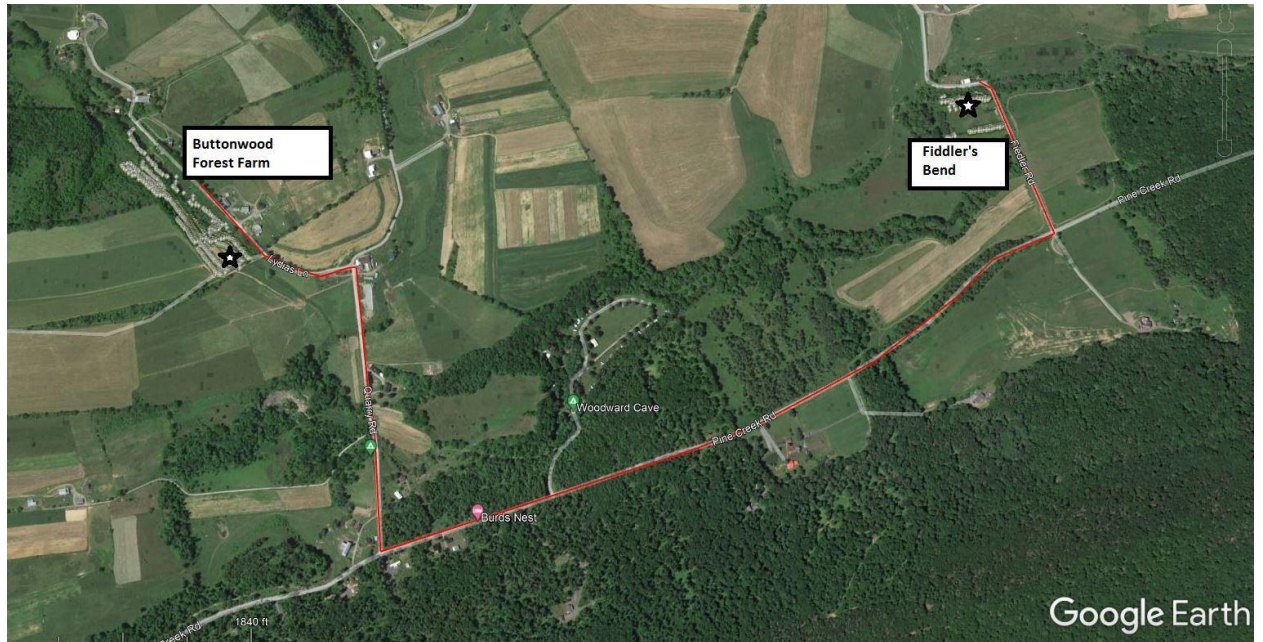


Figure 2. The two demonstration MFRFBs located in Woodward, Pennsylvania, two miles from each other by road

Demonstration Location 1: Fiddler's Bend

Fiedler Road Woodward, PA

Landowners Sarah DePasquale and Jim Baughman 2-acre project

Medicinal Multifunctional Riparian Forest Buffer with Medicinal Riparian Hedgerow

Landowner and Property Overview with Designs

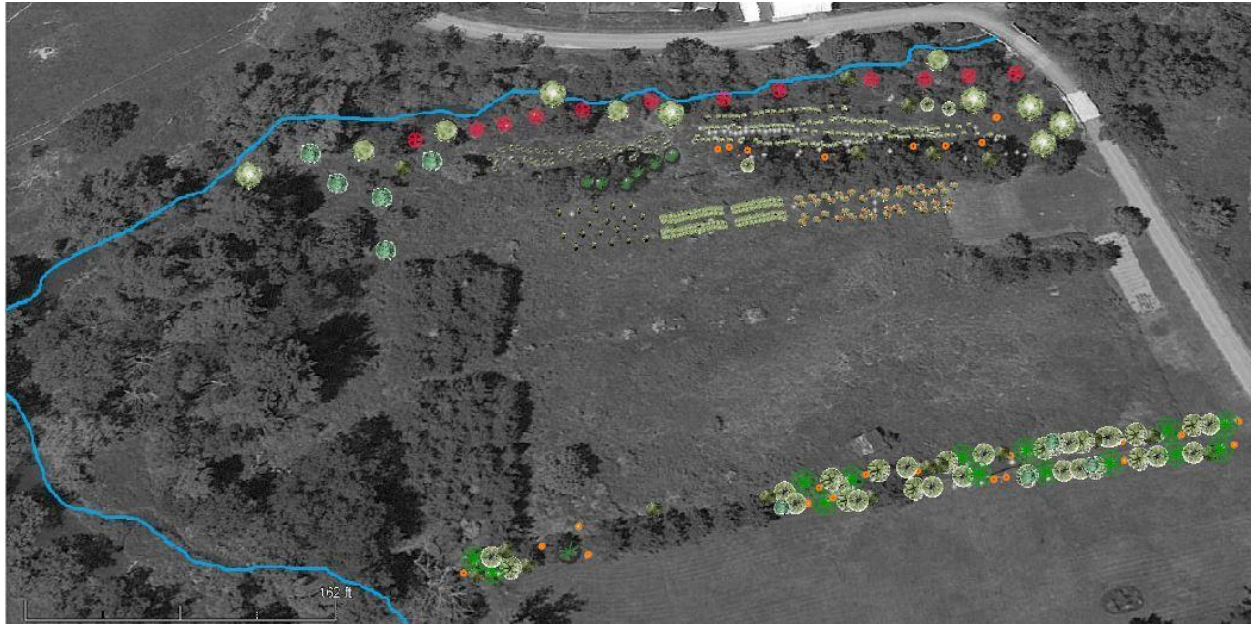


Figure 3. Fiddler's Bend Multifunctional Riparian Forest Buffer design along Pine Creek in Woodward, PA

The Fiddler's Bend MFRFB includes an approximate 450' length of Pine Creek. The property is an excellent location demonstrating and assessing medicinal and edible production capacity in a three-zone design. This buffer provides a significant opportunity to shade the stream, targeting buffer gaps supplementing an existing buffer, reducing erosion and sedimentation while growing edible, medicinal products through organic methods. The landowners, Jim and Sarah, are passionate about demonstrating the opportunities for alternatives to spraying on their property where they had been living for only a year at the start of the project. Sarah is a midwife and herbalist who currently harvests and works with many of the species from the buffer design in her profession. She is an experienced land manager, and is also seen as a community health leader, having worked with both Amish and "English" neighbors as an herbalist and midwife. Sarah is also a beekeeper, which led to the planting of a variety of species good for honey bees, including Black locust and American basswood.

This riparian area is Black walnut dominant, reflected in the design. There are some areas without Black walnut where the Black chokeberries were planted, due to walnut sensitivity. All three zones of the buffer were regularly weed-whacked and hand-weeded, approximately every other week during establishment. The second and third zones were sheet mulched as an alternative to spraying glyphosate. This led to tremendous success of survival and growth rates in most sections, with the added economic opportunity of marketing organic products. However, the sections of the buffer in quickly moving floodwaters were washed-out due to extensive

flooding in the fall of 2018. The active management of the landowners has resulted in a successful no-spray project.

Landowner Reflection:

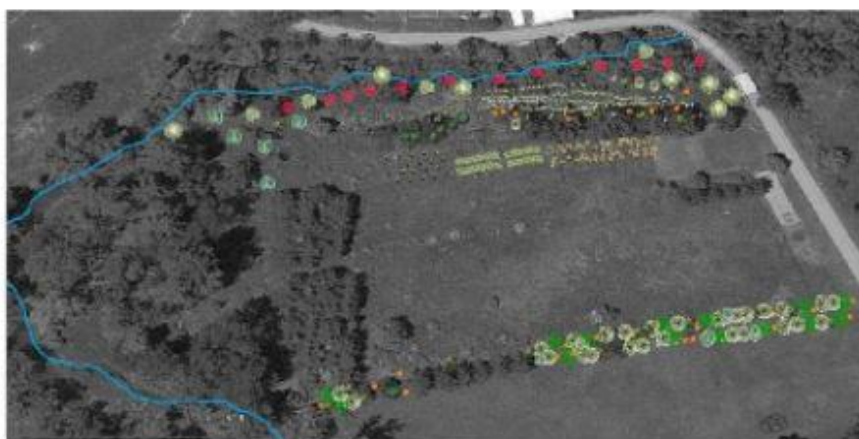
“Our buffer has revitalized a low-lying stream bank and turned what had been an annual wash area between mature Black walnut and Pine Creek into a thriving, diversified native planting. In two years with drastically different weather conditions, the plants have stabilized the streamside soil and provide excellent habitat for the many native songbirds in our area. As a practicing herbalist, I am thrilled to see the success primarily of the elderberry, which I currently market as value-added syrup. Already the market for syrup and fresh berries outstrips the supply from these two-year-old plants and I look forward to harvesting more as the plants mature.

The process of design and planting couldn't have been easier. Our forester customized a planting design based on my goals and priorities, and installation was straightforward and mostly done for us. One benefit of the MFRFB that I didn't anticipate was how easy it is to maintain relative to other installations such as an orchard or garden- native trees and shrubs in moist soil want to survive! “-Sarah DePasquale, landowner

Assessment of the Potential Financial Performance of the MFRFB Designs with Species Survival Rates

The focus of economic opportunities for the Fiddler's Bend project are:

- Fruit
- Nuts
- Medicinals



LEGEND	
COMMON NAME	QTY
FLOWER, EDIBLE	
RASPBERRY	100
BLUEBERRY	20
FLOWER, PERENNIAL	
BLACK COHOSH	44
SHRUB, DECIDUOUS	
AMERICAN ELDERBERRY	125
CHOKEBERRY, BLACK	50
HAZELNUT, AMERICAN	5
WITCH-HAZEL	10
TREE, DECIDUOUS	
BASSWOOD, AMERICAN	5
BIRCH, RIVER	12
CRABAPPLE, AMERICAN	16
HAWTHORN, WASHINGTON	14
LOCUST, BLACK	14
OAK, SWAMP WHITE	7
PAUPAULI	6
PLUM, AMERICAN	18
REDBUD, EASTERN	30
SASSAFRAS	8
GYCAMORE, AMERICAN	1
TULIP TREE	3

Figure 4. Fiddler's Bend demonstration location design with species composition

The table below includes both the existing and planted trees and shrubs in the multifunctional riparian forest buffer at Fiddler's Bend. This table is also part of the multifunctional [Species Matrix](#) spreadsheet, included with this toolkit. The Species Matrix identifies the existing and planted species by each zone as well as the economic opportunities and the Fall 2020 survival rates. The matrix is also broken down further by economic opportunity types such as nuts, fruits, medicinals, cut florals, tonal hardwoods, natural dyes, mushroom logs, and oils. Also included are the known retail and wholesale opportunities and documented survival rates. Many of the species below are included in the demonstration of the NAC NTFP calculator economic analysis of the specific designs. The Species Matrix also includes a collection of the ecological and economic species lists for riparian buffers from experts such as Penn State, PA DCNR, NRCS, municipalities, and businesses. In Table 1 the species list from the Fiddler's Bend demonstration location are listed by [planting zones](#).

Table 1: Fiddler's Bend MFRFB species composition of existing and planted trees and shrubs by zone with survival rates and economic opportunities				
Zone 1	Common name	Latin	Survival rate	Economic opportunities
Existing:				
	Silky dogwood	<i>Cornus amomum</i>		Cut flower, silvopastural, nursery material
	Black walnut	<i>Juglans nigra</i>		Medicinal, edible, natural dye, tonal hardwood
	American basswood	<i>Tilia americana</i>		Medicinal, tonal hardwood, wildlife
	American Sycamore	<i>Platanus occidentalis</i>		Mushroom, tonal hardwood
Planted:				
	River birch	<i>Betula nigra</i>	10/12=83.3%	Silvopastural
	Tulip poplar	<i>Liriodendron tulipifera</i>	3/3=100%	Mushroom, tonal hardwood
	Eastern redbud	<i>Cercis canadensis</i>	11/14=78.6%	Edible, cut flower
	Sassafras	<i>Sassafras albidum</i>	5/8=62.5%	Edible, medicinal, natural dye
	Witch hazel	<i>Hamamelis virginiana</i>	7/10=70%	Medicinal, cut flower
	American basswood	<i>Tilia americana</i>	4/5=80%	Medicinal, tonal hardwood, wildlife
Zone 2				
Existing:				
	Black walnut	<i>Juglans nigra</i>		Medicinal, oil, edible, tonal hardwood, natural dye
Planted:				
	American elderberry	<i>Sambucus canadensis</i>	124/125=99.2%	Medicinal, edible, natural dye, nursery material
	Black chokeberry	<i>Aronia melanocarpa</i>	26/26=100%	Medicinal, edible
	Pawpaw	<i>Asimina triloba</i>	6/6=100%	Edible, wildlife
	American hazelnut	<i>Corylus americana</i>	5/5=100%	Edible, oil
	Witch hazel	<i>Hamamelis virginiana</i>	4/6=66.7%	Medicinal, cut flower
	Swamp white oak	<i>Quercus bicolor</i>	5/7=71.4%	Wildlife, silvopastural, tonal hardwood
Zone 3				
Existing:				

	Black walnut	<i>Juglans nigra</i>		Medicinal, oil, silvopastural, tonal hardwood, natural dye
	Black raspberry	<i>Rubus occidentalis</i>		Edible, medicinal, natural dye
	Common milkweed	<i>Asclepias syriaca</i>		Nursery material, wildlife, natural fiber
Planted:				
	Raspberry cultivars	<i>Rubus sp</i>	95/100=95%	Edible, nursery material, natural dye
	Highbush blueberry cultivars	<i>Vaccinium sp.</i>	18/20=90%	Edible
	Black cohosh	<i>Actaea racemosa</i>	40/44=90.1%	Medicinal
Zone 3 continued				
Medicinal riparian hedgerow				
Existing:				
	Common milkweed	<i>Asclepias syriaca</i>		Fiber, nursery material, wildlife
	Black raspberry	<i>Rubus occidentalis</i>		Edible, medicinal, natural dye
Planted:				
	Black locust	<i>Robinia pseudoacacia</i>	13/14=92.9%	Silvopastural, lumber, nitrogen-fixing, bee pollination, edible (flowers), natural dye
	American plum	<i>Prunus americana</i>	15/18=83.3%	Edible, silvopastural, early successional, cut flower
	Washington hawthorn	<i>Crataegus sp.</i>	12/14=85.7%	Medicinal, early successional, cut flower
	American crabapple	<i>Malus sp.</i>	13/16=81.3%	Medicinal, early successional, cut flower
	Eastern redbud	<i>Cercis canadensis</i>	12/15=80%	Edible, cut flower
	American basswood	<i>Tilia americana</i>	4/5=80%	Medicinal, tonal hardwood, wildlife



Figure 5. Fiddler's Bend landowners harvesting American elderberries in their multifunctional riparian forest buffer 18 months after planting. The original plant material was 1-gallon stock and established with organic methods. Photo credit Michelle Johnsen Photography

The edible hedgerow buffer at the Fiddler's Bend property was thriving after 18 months grown from bare root seedlings. Approximately half of the 65 trees and shrubs planted were above deer browse after 18 months of growth.

The landowners at the Fiddler's Bend property began harvesting elderberries planted from one-gallon pots purchased from Octoraro Nursery within 18 months of planting. They were 2-3' shrubs at the time of purchase, some growing to 13' tall, branching 7' wide. The landowners harvested approximately 2 pounds, 18 months after planting. At Fiddler's Bend the landowners have taken over the active management of their MFRFB. Sarah's products are available on her [Etsy](#) page.

As more of the products in their buffer go into production, they will likely be available on her Etsy page as well as local and regional collaborative marketing.



Figure 6. Landowners of Fiddler’s Bend walking in extended third zone of their riparian buffer spreading Common milkweed seeds. This medicinal hedgerow wildlife corridor was planted with 12”-18” bare root stock eighteen months prior. Photo credit Michelle Johnsen Photography

American elderberries coming into production within the first year at Fiddler’s Bend is one of the biggest successes of the project. Planting 1-gallon *Sambucus canadensis* in the spring 2018 began producing enough fruit for harvest and making syrup. These elderberries were established organically with intensive weed-whacking and mowing every other week from the middle of May until November for two years. Weedwhacking around the 125 elderberry bushes lasted approximately 3 hours. The bare root elderberries planted in similar conditions as the 1-gallon 2.5’ plants went into production 2 years after planting. Managing 1/3 acre of American elderberries is a reasonable task to accomplish by hand weeding and mowing. Issues of scale need to be considered in organic establishment, as they are labor intensive. It is a manageable productive scale for a committed elderberry farmer. The success of the establishment was related to intensive management, including watering the elderberry bushes during droughts with a hydropump.

Selling elderberries fresh fetches \$12/pound destemmed from local wineries and kombucha brewers (Ironwood Forestry experience), whereas dried elderberries offer more shelf-stability and value-added opportunities. Through the innovation of an elderberry destemming machine, approximately 25 pounds can be destemmed per hour with a machine that cost \$150 to make.

On a larger scale the economics of elderberries was presented by River Hills Nursery Harvest elderberry products at the Homesteading Life Conference. Below are the net income opportunities for elderberry value-added products in Missouri, calculated for 2,000 pounds of processed elderberries, estimated for 2 acres:

- As juice 2500 bottles \$20/bottle, \$50,000
- Syrup 4,000 bottles 12-ounce \$15/bottle= \$60,000
- Jelly 13,000 8-ounce jars \$7/jar= \$91,000
- Shrub 8,000 bottles \$15/bottle= \$120,000

The economics of elderberries are vastly different depending on the processing that occurs both before and after harvest. In Missouri the Elder Hills Harvest and the Midwest Elderberry Cooperative both work with processing large volumes of locally grown elderberries, and process them in one central location with elderberry destemming machines and in some cases mechanized harvesters. The planting and harvesting methods in the project were done by hand. However, a destemming machine was prototyped by retired forester, Gary Gilmore. The machine was presented as an innovation at the Pennsylvania Association for Sustainable Agriculture (PASA) Conference.

The third zone includes Black cohosh, raspberry cultivars, and 25 Highbush blueberries. The planting area was sheet mulched with purchased Uline rolls of cardboard, and donated composted horse manure from a local farmer. Both the Black cohosh and raspberries are integrated into Sarah's herbalism practice. A wooden t-post and wire system of design was utilized for raspberry maintenance by the landowners. Extensive mowing, weed whacking, and hand weeding were conducted at the property in on-going maintenance. Descriptions of the Highbush blueberry and raspberry cultivars planted in the third zone are found in the [Appendix](#). Viking Black chokeberry Aronia cultivars (15) were also planted as well as Pawpaw, American basswood, American sycamore, Tulip poplar, Northern spicebush, River birch, and a variety of live-stakes. The natural generation of wild elderberries and Joe-pye weed, Boneset and lobelias is a testament to integrated organic methods in riparian buffers. A handful of the American elderberries planted at this property produced flowers during the second year and are spreading well. The resiliency of the elderberry at this property is a must-see; they survived three days of a flooded Pine Creek in late summer 2018, with no mortality.

Landowner Sarah DePasquale gave a virtual tour of her medicinal multifunctional riparian forest buffer. Below is a digital collection of vignettes walking with the herbalist-midwife landowner in her buffer. Walk with Sarah as she gives us a tour of her multifunctional riparian forest buffer while she:

- [Describes the herbal products in her third zone](#)
- [Visits the Black walnuts of her second zone](#)
- [Harvests elder flowers from the American elderberries in her second zone](#)
- Leads a conversation with Andrea Ferich, an overview of multifunctional riparian forest buffers [demonstrating how to prepare the elderflowers on the Penns Valley Conservation Association's YouTube channel](#)

Demonstration of National Agroforestry Center (NAC) Non-timber Forest Product (NTFP) Calculator: Calculating Expense and Revenue at Fiddler's Bend

The NAC NTFP Calculator is a resource for landowners and natural resource providers to calculate the on-going expenses and revenues by species and as a whole design for NTFPs across the landscape at 10-year and 25-year intervals. It aids in understanding the net present value and the number of years required before the design breaks even, economically. The NAC NTFP calculator is available for free online at <https://www.fs.usda.gov/nac/resources/tools/ntfp.shtml>, where landowners can utilize the Calculator as a spreadsheet workbook with fillable forms in .xlsm format. NAC describes the tool as follows:

“This tool provides general estimates of income potential from harvesting and selling non-timber forest products from a conservation planting. This scoping tool only provides rough numbers for exploring this enterprise alternative. A more detailed enterprise budget will be necessary to determine the economic viability of the enterprise.”

The calculator includes the woody cut floral products Pussy willow and dogwood shrubs, as well elderberry, Pawpaw, and American persimmon for fruit production, and hybrid hazelnuts for their nuts. Not all of these species were grown at Fiddler's Bend, however they were all grown at the second demonstration site, Buttonwood Forest Farm. Improved American hazelnut genetics were grown at Buttonwood instead of hybrid hazelnuts.

The first section in the first sheet of the calculator workbook is entitled “Plant Selection.” The number of plants and product price can be changed; however, the species names, area required, and product units are static. The number of plants that were originally planted should be entered here as the survival rates are entered elsewhere. Any box with the red corner can be clicked on for further information. The “Area Required” portion of “Plant Selection” section was not

accurate for 3' high density plantings for woody floral species.

PLANT SELECTION

Select the types and number of plants to be grown. Product Price is a default value based on growers' experience. Initially, leave the prices on the default values.

Afterwards, one can adjust product price to see effect on overall profitability.

Species	# Plants	Area Required (sq ft)	Product Price	Product Unit
Pussy Willow	25	1800	\$0.4	price/stem
Dogwood	25	1800	\$0.4	price/stem
Pawpaw	25	2700	\$1.5	price/lb
Elderberry	12	6000	\$1.1	price/lb
Hybrid Hazelnut	25	2250	\$3.0	price/lb
Persimmon	25	10000	\$2.7	price/lb
Totals	250	24550		

Figure 7. Demonstration of NAC NTFP Plant Selection section

The second section is the financial results table. The interest rate is included in the calculation if money is borrowed to implement the project. The financial indicators include:

- Present Value of Revenues (summation of the revenues for the NTFP planting over the time period, discounted at the selected interest rate)
- Present Value of Costs (summation of costs for the NTFP planting over the time period, discounted at the selected interest rate)
- Net Present Value (the difference between the Present Value of Revenues and the Present Value of Costs)
- Internal Rate of Return (the discount rate that makes the Net Present Value (NPV) of all cash flows from a particular project equal to zero). The Internal Rate of Return is the rate at which the investment is expected to grow
- Years to Break Even (the number of expected years before positive cash flow), and
- The Annual Equivalent Value (an estimate of a level income stream that would have the same net present value as the actual income streams).

Actual income streams for NTFP planting may be positive one year and negative another; however, with the annual equivalent value, a level income estimate is established. The Alternative Comparison includes the Crop Annual Equivalent Value (Estimated annual equivalent for the crop alternative on the same amount of land as the NTFP alternative) and the Forage Annual Equivalent Value (estimated annual equivalent forage alternative on the same amount of land as the NTFP alternative). The bar graphs are the comparison of steady income from the NTFPs, with the crop and forage equivalents.

FINANCIAL RESULTS

Select interest rate. This calculator only considers basic variable costs and not fixed costs such as land price and taxes. Select the Additional Information button for more detail on the tool and

NTFP Project area (ac):	0.56	
Pick Interest Rate:	3%	
Financial Indicators	10 Yr Period	25 Yr Period
Present Value of Revenues	\$58,863	\$86,972
Present Value of Costs	\$24,445	\$63,221
Net Present Value	\$34,418	\$23,752
Internal Rate of Return	62%	30%
Years to Break Even	4	6
Annual Equivalent Value (AEV)	\$4,035	\$1,364
Alternative Comparison		
Crop Annual Equivalent Value	\$226	\$226
Forage Annual Equivalent Value	\$189	\$189

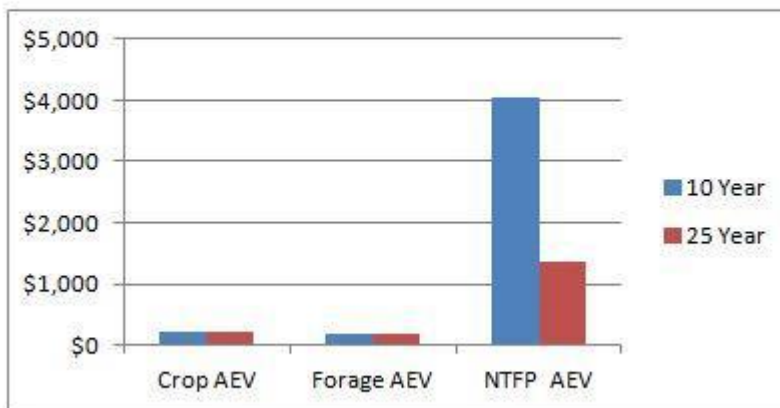


Figure 8. Demonstration of NAC NTFP Financial Results table.

The third section, entitled Potential Income Comparison, calculates the potential incomes from a variety of different crop and forage types.

POTENTIAL INCOME COMPARISON

Potential income if area in proposed conservation planting is used instead for crop or forage production. Adjust values to reflect your operation.

Crop Alternative		Forage Alternative	
Crop Type:	Corn	Forage Type:	Alfalfa
Expected Yield (bu/ac)	15	Production (tons/ac)	3
Expected Price (\$/bu)	\$4.00	Forage Value (\$/ton)	\$15
Production Costs (\$/ac)	\$20	Production Costs (\$/ac)	\$11
Annual Net (ac):	\$400	Annual Net (ac):	\$335

Figure 9. Demonstration of NAC NTFP Potential Income Comparison.

And the fourth section, Sensitivity Analysis, is the section where the plant survival rate can be entered.

SENSITIVITY ANALYSIS

Adjust the Interest Rate and Product Price to estimate the impact on potential profitability.
Adjust Plant Survival Rate to determine impact of plant loss during the first year with no followup

Adjust Plant Survival Rate	% Survival
Pussy Willow	100%
Dogwood	100%
Pawpaw	85%
Elderberry	100%
Hazelnut	100%
Persimmon	100%

Figure 10: Demonstration of NAC NTFP Sensitivity Analysis.

The second sheet in the calculator include additional resources and tools:



Figure 11. Second sheet in the NAC NTFP calculator, showing additional resources and tools.

The second sheet, “Additional Info,” covers specific aspects of assumptions for exploring NTFP economic alternatives in the calculator, specifically what is not included, such as land costs, fencing, equipment, variable labor costs, economies of scale, market fluctuations, replanting, or value-added processing.

The third sheet includes a breakdown of all the specific elements of the species’ present values of both revenue and costs by year, break even points for the full design, as well as crop and forage alternatives, Net Present Value, and Annual Equivalent Values, as well as other calculations for species level data.

The NAC NTFP Calculator then includes 12 more sheets for entering specific cost and revenue estimates for Pussy willow, dogwoods, Pawpaw, elderberry, hybrid hazelnuts, and persimmons for 10 and 25 years as seen in Figure 12 for Pussy willow.

Woody Cut Floral Financial Analysis										
Pussywillow										
	Number of plants:	25	Hourly Wage:	\$7.25	Price per stem:	\$0.40	# Stems/plant:	54	Survival Rat	100%
Years	Activity Description	Cost per plant	Revenue per plant	Total Revenue	Total Cost	Discount	3%			
							3%			
						PV revenue	PV cost			
0	Site Prep	\$0.25			\$6.25	\$0.00	\$6.25			
0	Planting Stock	\$2.50			\$62.50	\$0.00	\$62.50			
0	Weed barrier and mulch	\$3.75			\$93.75	\$0.00	\$93.75			
0	Manual Planting	\$0.50			\$12.50	\$0.00	\$12.50			
1	Mowing	\$0.08			\$2.00	\$0.00	\$1.94			
2	Mowing	\$0.08			\$2.00	\$0.00	\$1.89			
2	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$102.51			
2	Fresh Stem Sales		\$21.60	\$540.00		\$509.00	\$0.00			
3	Mowing	\$0.08			\$2.00	\$0.00	\$1.83			
3	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$99.52			
3	Fresh Stem Sales		\$21.60	\$540.00		\$494.18	\$0.00			
4	Mowing	\$0.08			\$2.00	\$0.00	\$1.78			
4	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$96.62			
4	Fresh Stem Sales		\$21.60	\$540.00		\$479.78	\$0.00			
5	Mowing	\$0.08			\$2.00	\$0.00	\$1.73			
5	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$93.81			
5	Fresh Stem Sales		\$21.60	\$540.00		\$465.81	\$0.00			
6	Mowing	\$0.08			\$2.00	\$0.00	\$1.67			
6	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$91.08			
6	Fresh Stem Sales		\$21.60	\$540.00		\$452.24	\$0.00			
7	Mowing	\$0.08			\$2.00	\$0.00	\$1.63			
7	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$88.42			
7	Fresh Stem Sales		\$21.60	\$540.00		\$439.07	\$0.00			
8	Mowing	\$0.08			\$2.00	\$0.00	\$1.58			
8	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$85.85			
8	Fresh Stem Sales		\$21.60	\$540.00		\$426.28	\$0.00			
9	Mowing	\$0.08			\$2.00	\$0.00	\$1.53			
9	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$83.35			
9	Fresh Stem Sales		\$21.60	\$540.00		\$413.87	\$0.00			
10	Mowing	\$0.08			\$2.00	\$0.00	\$1.49			
10	Harvest, Grade & Market	\$4.35			\$108.75	\$0.00	\$80.92			
10	Fresh Stem Sales		\$21.60	\$540.00		\$401.81	\$0.00			
					*****	\$1,173.75	\$4,082.04	\$1,014.14		
						NPV =		\$3,067.90		
Sources:										
Meyer, Christine M., et al. (2007). "A Grower's Guide to Producing Woody Floral Stems." Publications. Nebraska Forest Service. http://nfs.unl.edu/documents/SpecialtyForest/growersguideweb2007.pdf .										
Saska, M. M., Kuzovkina, Y.A., Ricard, R. M. 2010. North American Willow Cut-stem Growers: A Survey of the Business Identities, Production Practices, and Prospective for the Crop. HortTechnology, 20(2), 351-356.										
						3%				
						PV Revenue	PV Costs			
Year 1						\$0.00	\$176.94			
Year 2						\$509.00	\$104.39			
Year 3						\$494.18	\$101.35			
Year 4						\$479.78	\$98.40			
Year 5						\$465.81	\$95.53			
Year 6						\$452.24	\$92.75			
Year 7						\$439.07	\$90.05			
Year 8						\$426.28	\$87.43			
Year 9						\$413.87	\$84.88			
Year 10						\$401.81	\$82.41			
						\$4,082.04	\$1,014.14			

Figure 12. NAC NTFP calculator sheet showing cost and revenue estimates for pussy willow.

One of the more difficult aspects of the NAC NTFP Calculator is what to do if the riparian buffer design does not include the exact species included in the NAC NTFP Calculator (for example, the calculator does not include Black chokeberry) or when value-added processing is necessary for certain products, such as drying the roots of certain medicinal products (such as Black cohosh). In some circumstances it makes sense to substitute for other species, as in the case of Black chokeberries, as they can be substituted for elderberries without too many changes. The layout of the calculator does not allow for additional sheets to be created without reformatting the calculator formulas. In these cases individual species were entered into the calculator sheets, with all other species set to zero to understand the impact of the species on the economic

viability of the design. Below are the species of economic interest included in the Fiddler's Bend design. Note that only six species can be entered into the calculator at a time.

Fiddler's Bend Economic Assessment

Table 2: Fiddler's Bend MFRFB economic assessment with conservative wholesale estimates for use in the NAC NTFP Calculator				
Number of plants	Common name	<i>Latin</i>	NAC NTFP price per unit, conservative estimates	Economic opportunities
12	Black walnut	<i>Juglans nigra</i>	\$5/25 pounds (mature trees already present)	Medicinal, oil, edible, tonal hardwood, natural dye
124	American elderberry	<i>Sambucus canadensis</i>	\$12/pound fresh	Medicinal, edible, natural dye, nursery material
26	Black chokeberry	<i>Aronia melanocarpa</i>	\$20/pound fresh	Medicinal, edible
95	Raspberry cultivars organic	<i>Rubus sp</i>	\$6/pound	Edible, nursery material, natural dye
18	Highbush blueberry cultivars	<i>Vaccinium sp.</i>	\$6/pound	Edible
40	Black cohosh	<i>Actaea racemosa</i>	\$26/pound	Medicinal
15	American plum	<i>Prunus americana</i>	\$3/pound	Edible, silvopastoral, early successional, cut flower
12	Washington hawthorn	<i>Crataegus sp.</i>	\$6.42/pound	Medicinal, early successional, cut flower
13	American crabapple	<i>Malus sp.</i>	\$5/pound	Medicinal, early successional, cut flower

The American elderberries grown at Fiddler's Bend are perhaps one of most productive examples of success, as can be seen in this NAC demonstration. The American elderberry cost and revenue for this demonstration location were entered into the NAC NTFP Calculator for a better sense of production capabilities in this buffer. Here are the results over 25 years for survival rate of 100%:

Table 3: Elderberry Financial Analysis in NTFP Calculator						
		Number of plants	125		Price per lb	\$12.00
Years	Activity Description	Cost per plant or lb of fruit harvested	Revenue	Cost	Discount rates:	0%
					0%	
					PV revenue	PV cost
0	Site Prep	\$0.17		\$21.25	\$0.00	\$21.25
0	Cuttings as planting stock	\$2.00		\$250.00	\$0.00	\$250.00
0	Manual Planting	\$1.00		\$125.00	\$0.00	\$125.00
0	Weed barrier and mulch	\$2.50		\$312.50	\$0.00	\$312.50

0	Fertilization	\$0.08		\$10.00	\$0.00	\$10.00
1	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
1	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
2	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
2	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
2	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
2	Manual Harvest	\$0.40		\$50.00	\$0.00	\$50.00
2	Berry Sale w/ Stems (estimated @ 1/lb per shrub)		\$1,500.00		\$1,500.00	\$0.00
3	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
3	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
3	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
3	Manual Harvest	\$0.40		\$125.00	\$0.00	\$125.00
3	Berry Sale w/ Stems (estimated @ 2.5/lb per shrub)		\$3,750.00		\$3,750.00	\$0.00
4	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
4	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
4	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
4	Manual Harvest	\$0.40		\$175.00	\$0.00	\$175.00
4	Berry Sale w/ Stems (estimated @ 3.7/lb per shrub)		\$5,550.00		\$5,550.00	\$0.00
5	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
5	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
5	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
5	Manual Harvest	\$0.40		\$275.00	\$0.00	\$275.00
5	Berry Sale w/ Stems (estimated @ 4.7/lb per shrub)		\$7,050.00		\$7,050.00	\$0.00
6	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
6	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
6	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
6	Manual Harvest	\$0.40		\$300.00	\$0.00	\$300.00
6	Berry Sale w/ Stems (estimated @ 5.5/lb per shrub)		\$8,250.00		\$8,250.00	\$0.00
7	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
7	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
7	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
7	Manual Harvest	\$0.40		\$325.00	\$0.00	\$325.00
7	Berry Sale w/ Stems (estimated @ 6/lb per shrub)		\$9,000.00		\$9,000.00	\$0.00
8	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
8	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
8	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
8	Manual Harvest	\$0.40		\$325.00	\$0.00	\$325.00
8	Berry Sale w/ Stems (estimated @ 6.5/lb per shrub)		\$9,750.00		\$9,750.00	\$0.00
9	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
9	Mowing	\$0.08		\$10.00	\$0.00	\$10.00

9	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
9	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
9	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
10	Fertilization	\$0.31		\$38.75	\$0.00	\$38.75
10	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
10	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
10	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
10	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
11	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
11	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
11	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
11	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
12	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
12	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
12	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
12	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
13	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
13	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
13	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
13	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
14	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
14	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
14	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
14	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
15	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
15	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
15	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
15	Berry Sale w/ Stems (estimated @ 7/lb per shrub)		\$10,500.00		\$10,500.00	\$0.00
16	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
16	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
16	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
16	Berry Sale w/ Stems (estimated @ 6.5/lb per shrub)		\$9,750.00		\$9,750.00	\$0.00
17	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
17	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
17	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
17	Berry Sale w/ Stems (estimated @ 6.5/lb per shrub)		\$9,750.00		\$9,750.00	\$0.00
18	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
18	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
18	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00

18	Berry Sale w/ Stems (estimated @ 6.5/lb per shrub)		\$9,750.00		\$9,750.00	\$0.00
19	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
19	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
19	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
19	Berry Sale w/ Stems (estimated @ 6/lb per shrub)		\$9,000.00		\$9,000.00	\$0.00
20	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
20	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
20	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
20	Berry Sale w/ Stems (estimated @ 6/lb per shrub)		\$9,000.00		\$9,000.00	\$0.00
21	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
21	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
21	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
21	Berry Sale w/ Stems (estimated @ 5.5/lb per shrub)		\$8,250.00		\$8,250.00	\$0.00
22	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
22	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
22	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
22	Berry Sale w/ Stems (estimated @ 5.5/lb per shrub)		\$8,250.00		\$8,250.00	\$0.00
23	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
23	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
23	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
23	Berry Sale w/ Stems (estimated @ 5/lb per shrub)		\$7,500.00		\$7,500.00	\$0.00
24	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
24	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
24	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
24	Berry Sale w/ Stems (estimated @ 4.5/lb per shrub)		\$6,750.00		\$6,750.00	\$0.00
25	Mowing	\$0.08		\$10.00	\$0.00	\$10.00
25	Manual Pruning	\$1.00		\$125.00	\$0.00	\$125.00
25	Manual Harvest	\$0.40		\$350.00	\$0.00	\$350.00
25	Berry Sale w/ Stems (estimated @ 3.7/lb per shrub)		\$5,550.00		\$5,550.00	\$0.00
			\$201,900.00	\$11,860.00	\$201,900.00	\$11,881.25
					NPV =	\$190,018.75
					0%	
					PV Revenue	PV Costs
				Year 1	\$0.00	\$767.50
				Year 2	\$1,500.00	\$223.75
				Year 3	\$3,750.00	\$298.75
				Year 4	\$5,550.00	\$348.75

				Year 5	\$7,050.00	\$448.75
				Year 6	\$8,250.00	\$473.75
				Year 7	\$9,000.00	\$498.75
				Year 8	\$9,750.00	\$498.75
				Year 9	\$10,500.00	\$523.75
				Year 10	\$10,500.00	\$523.75
				Year 11	\$10,500.00	\$485.00
				Year 12	\$10,500.00	\$485.00
				Year 13	\$10,500.00	\$485.00
				Year 14	\$10,500.00	\$485.00
				Year 15	\$10,500.00	\$485.00
				Year 16	\$9,750.00	\$485.00
				Year 17	\$9,750.00	\$485.00
				Year 18	\$9,750.00	\$485.00
				Year 19	\$9,000.00	\$485.00
				Year 20	\$9,000.00	\$485.00
				Year 21	\$8,250.00	\$485.00
				Year 22	\$8,250.00	\$485.00
				Year 23	\$7,500.00	\$485.00
				Year 24	\$6,750.00	\$485.00
				Year 25	\$5,550.00	\$485.00
					\$201,900.00	\$11,881.25

This table indicates that over 25 years the 124 surviving elderberry bushes will net \$201,900. If all plants survive, replacements are not needed.

Another type of species demonstrated in the NAC NTFP Calculator were those already existing on the demonstration site, such as Black walnuts. They were already existing in the riparian buffer, mature, and productive. There are little to no establishment costs with these 12 trees. Ferich substituted hybrid hazelnuts in the NAC NTFP Calculator with Black walnuts, but with many of the establishment costs set to zero. The Keystone Tree Crops Cooperative is currently purchasing burlap feed sacks (approximately 25 pounds) full of whole Black walnuts in their hulls, wholesale for \$5/25 pounds. Another aspect of substituting Black walnuts into the NAC NTFP Calculator is that these existing mature trees are already producing years 0-3, unlike the hazelnuts. Rows were added to reflect the immediate income generation; however, the calculator was not able to interpret added lines, survival rate 100%:

Table 4: Black walnut Financial Analysis in NTFP Calculator

Number of plants			12	Price per Lb		\$0.20
Years	Activity Description	Cost per plant or lb of nuts harvested	Revenue	Cost	Discount rates:	0%
					0%	
					PV revenue	PV cost
0	Site Preparation	\$0.00		\$0.00	\$0.00	\$0.00
0	Bare root or tubelings	\$0.00		\$0.00	\$0.00	\$0.00
0	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
0	Harvesting (cost/lb sold)	\$0.10		\$0.24		\$0.24
0	Tree tube/mat kit	\$0.00		\$0.00	\$0.00	\$0.00
0	Manual Planting	\$0.00		\$0.00	\$0.00	\$0.00
1	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
1	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
1	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
1	Harvesting (cost/lb sold)	\$0.10		\$0.24		\$0.24
2	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
2	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
2	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
2	Harvesting (cost/lb sold)	\$0.10		\$0.24		\$0.24
3	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
3	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
3	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
3	Harvesting (cost/lb sold)	\$0.10		\$0.24		\$0.24
4	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
4	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
4	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
4	Harvesting (cost/lb sold)	\$0.10		\$0.24		\$0.24
5	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
5	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
5	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
5	Harvesting (cost/lb sold)	\$0.10		\$0.48		\$0.48
6	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
6	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
6	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
6	Harvesting (cost/lb sold)	\$0.10		\$1.20		\$1.20
7	Fertilization	\$0.00		\$0.00	\$0.00	\$0.00
7	Mowing	\$1.00		\$12.00	\$0.00	\$12.00
7	Unshelled Nuts (estimated 200lbs/tree)		\$40.00		\$40.00	\$0.00
7	Harvesting (cost/lb sold)	\$0.10		\$1.68		\$1.68

8	Fertilization		\$0.00	\$0.00	\$0.00
8	Mowing	\$1.00	\$12.00	\$0.00	\$12.00
8	Unshelled Nuts (estimated 200lbs/tree)		\$40.00	\$40.00	\$0.00
8	Harvesting (cost/lb sold)	\$0.10	\$1.92		\$1.92
9	Fertilization	\$0.00	\$0.00	\$0.00	\$0.00
9	Mowing	\$1.00	\$12.00	\$0.00	\$12.00
9	Unshelled Nuts (estimated 200lbs/tree)		\$40.00	\$40.00	\$0.00
9	Harvesting (cost/lb sold)	\$0.10	\$2.40		\$2.40
10	Fertilization	\$0.00	\$0.00	\$0.00	\$0.00
10	Mowing	\$1.00	\$12.00	\$0.00	\$12.00
10	Unshelled Nuts (estimated 200lbs/tree)		\$40.00	\$40.00	\$0.00
10	Harvesting (cost/lb sold)	\$0.10	\$2.40		\$2.40
			\$440.00	\$131.28	
				\$440.00	\$131.28
				NPV =	\$308.72
				0%	
PV Revenue					
Year 1		\$40.00			
Year 2		\$40.00			
Year 3		\$40.00			
Year 4		\$40.00			
Year 5		\$40.00			
Year 6		\$40.00			
Year 7		\$40.00			
Year 8		\$40.00			
Year 9		\$40.00			
Year 10		\$40.00			
		\$400.00			

The Black walnut Net Present Value per tree in this design is \$308.72 per tree over 10 years, as well as over 25 years with no major increase in productivity or establishment. The complete economic analysis of the Fiddler Bend design is included in the species matrix

Demonstration Location 2: Buttonwood Forest Farm

Lydia's Lane Woodward, PA

Landowner Annie Stubbs

6-acre project

Landowner and Property Overview with Designs



Figure 13. Buttonwood Forest Farm multifunctional riparian forest buffer in Woodward, PA along unnamed tributary to Pine Creek

Buttonwood Forest Farm is a 6-acre area of a 10-acre riparian buffer on a 40-acre property which ranked as a Tier 2 location in the Chesapeake Conservancy's Ag BMP prioritization tool utilizing high-resolution suitability analysis to prioritize riparian buffer planting. This property includes 1,500' of an unnamed tributary flowing into Fiedler Run near its confluence with Pine Creek, downstream from the Fiddler's Bend demonstration location. The land is down-slope from a dairy farm concentration feeding area. The water quality and wildlife have already begun to show signs of improvement during the transition into a riparian buffer. Approximately 3 acres of this riparian area were converted from vegetable row crops to a thriving MFRFB after the heavy rainfall in 2018. Landowner Annie Stubbs had allowed a local Amish farmer to farm the riparian buffer for years, but after the unprecedented rains during the fall of 2018, he realized it was too wet and no longer continued to grow vegetable crops in this area. Stubbs is a long-time baker and caterer, formerly a chef in Atlanta working with diverse communities until the 1990's. She has also taught her Amish neighbors the lessons of working with sourdough. She is passionate about working with diverse grains, tree crops, and nutritious superfoods.

The design of this MFRFB is an adapted alley cropping system with an extensive third zone transitioning into a hedgerow thicket downslope from the neighbor's cattle concentration feeding area. This MFRFB now separates a livestock pasture from the tributary. Water quality improvements are expected to be noticeable as the buffer continues to establish. Buttonwood

Forest Farm is a multifunctional demonstration of American elderberry, Black chokeberry, and improved American hazelnut genetics. A variety of 7 cultivars of elderberries (Bob Gordon, Adams I, Adams II, Pocahontas, York, Wyldewood, and Ranch) as well as wild selections of American elderberry have been planted 6' on center with rows 10' feet apart. Additionally, two rows of Viking Aronia (Black chokeberry) cultivars have been planted 5' on center with rows 10' feet apart, growing for production. The American hazelnuts (8' on center), as well as American plums, American persimmons, hybrid chestnuts, hickories, and Hardy pecans, were part of the collaborative work of the Keystone Tree Crops Cooperative with improved selections of genetics for production.

One of Ironwood's favorite early successional species, Quaking aspens from the Chesapeake Bay Foundation Keystone 10 Million Tree Partnership were also planted to grow as nurse trees to help the other species grow taller, straighter, faster, while creating habitat for the American woodcock. They were planted throughout zone 1 and in zone 2. They are grown for wildlife habitat, and are central to early-successional regeneration management through cutting and coppicing. According to wildlife biologists, a mature Quaking aspen tree can regenerate somewhere near 600-700 new aspen trees from the root sprout, sometimes up to 50' away, if cut and then protected from deer. The Quaking aspen and Big-tooth aspen trees are native to much of the Mid-Atlantic. Their value cannot be underestimated in terms of establishing the stands of early-successional young forests. The aspens connect the root systems of the trees together with the mycorrhizal network. Additionally, close to 200 wild-collected American elderberry cuttings were live-staked throughout wet buffer areas at Buttonwood Forest Farm. They were collected by Ferich at a local farm, where she extensively pruned a grove of elderberries. This hard-pruned stand showed much growth and reduced the amount of die-back in the grove. At Buttonwood Forest Farm the Aronia (Black chokeberry) is starting to come into production and we are looking forward to finding creative ways to harvest hundreds of bushes. They were planted with enough room to allow for mechanical harvesting within the 3-zone design. However, until there is access to harvesting and processing equipment, whether through innovation or a cooperative-style model, a hand tool similar to those used in harvesting blueberries might be a good option, [a comb-style berry picker](#).

An elderberry destemming machine was invented through a collaboration at this location with forester Gary Gilmore. This machine was presented at the PASA conference in the innovation hall. There was great interest in the machine which led to some networking with regional growers and on-going market opportunities.

The design also includes two rows of high-density woody cut flowers, which include varieties of native and non-native dogwoods, Buttonbush, and Pussy willow. Two rows of Pawpaws were planted between hybrid chestnuts and American persimmons in the more upland third zone of the buffer, 10' on center with 30' rows. A hedgerow with American hazelnut, Washington hawthorn, Black locust, and Black chokeberry was also planted. Sunflower seeds were planted in the alleys. In addition to the beauty and food for wildlife these seeds offer, the allelopathic properties of the sunflowers greatly helped to reduce weeds. The local feed mill offers no-spray watershed friendly bird seed and feed mixes, including some with sunflowers—selling locally-grown sunflower seed to the feed mill is a promising on-going opportunity. Additionally, oil sunflower growers collaborate with Susquehanna Mills where they are pressed for oil, in a KernKraft

machine that can also be used for hemp, hickories, and hazelnuts. The shells on the Bitternut hickory (orange bud) are so thin they can be pressed for oil without needing to remove the shell in these machines. The tannins in the bitternuts are water-soluble, resulting in delicious, nutritious, abundant high-heat cooking oil.

The [alley cropping](#) system design at Buttonwood has had successful low-cost maintenance, including mowing, weed whacking, and hand-weeding. The landowner utilizes her Kubota tractor to mow and till in the alleys. In addition to the beauty and food for wildlife these seeds offer, the allelopathic properties of the sunflowers greatly helped to reduce weeds. See the photo below.



Figure 14. Alley cropping system design of multifunctional riparian forest buffer at Buttonwood Forest Farm in Woodward, PA with tubed elderberries, Black chokeberries, and improved American hazelnuts in rows with sunflowers in alleys. Photo credit Michelle Johnsen Photography

Landowner Reflection:

"I love to see wildlife and green, making less of a footprint of our own, and seeing the wildlife coming back the way it used to be, it is balance. Growing an old crop that used to be abundant in PA, elderberry is incredibly healthy for people, and good for birds, bringing the beauty that can make amazing liqueur, drinks, desserts, dyes. It really is a good medicine, a cancer treatment in parts of Europe. The whole process of designing, planting and stewarding the buffer has just been wonderful fun, it's dreamy, with a fantastic aesthetic. Seeing the bobcats come back onto the property helped to put balance back into the ecosystem. Who needs art when you have wildlife?" Annie Stubbs, landowner

Annie was inspired to plant her buffer for wildlife, fruit and nut opportunities, and beauty. At the Buttonwood Forest Farm demonstration site, the Silky dogwoods were planted along waterways and in hydric soils with a variety of other species, including Quaking aspens, Washington hawthorn, Black locust, American crabapple, and viburnum species. The Red-osier dogwood cuttings were collected locally with landowners across the Upper Penns Creek subbasin, including from a local florist pruning selections of her dogwoods. Over 1,000 live-stake cuttings were shared with the demonstration locations from collaborations between the Chesapeake Conservancy, the PA DCNR Bureau of Forestry, as well as landowners, organizations, and agencies forming a live-stake cooperative for collecting and sharing live-stakes for low-cost propagation for riparian restoration.

Assessment of the Potential Financial Performance of Each of the MFRFB Designs with Species Survival Rates

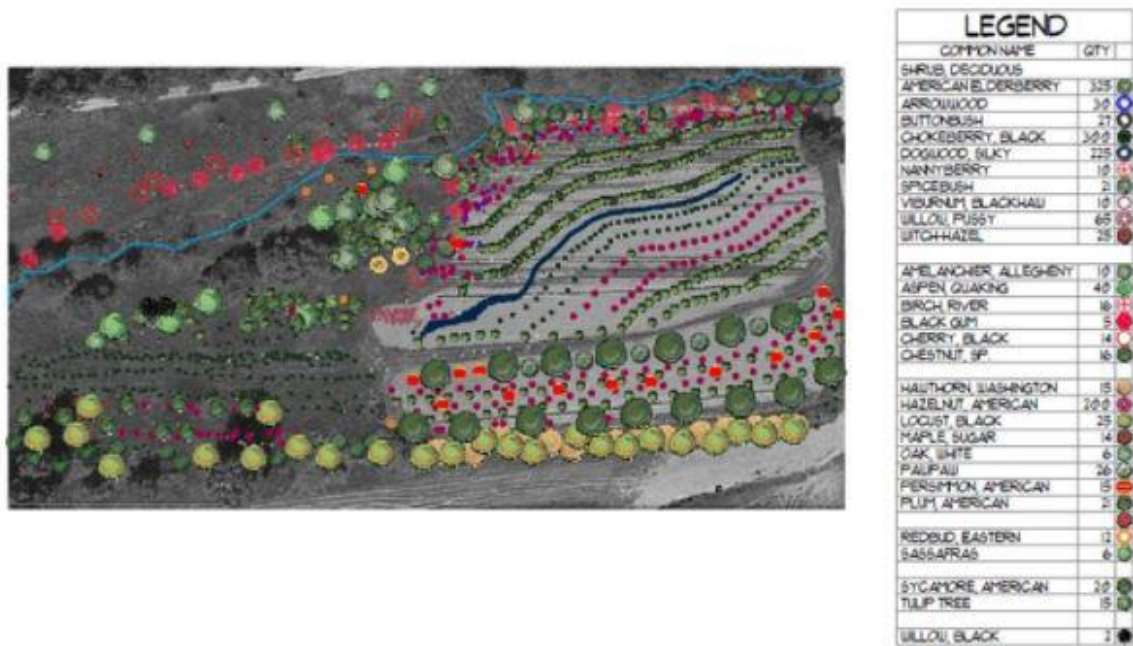


Figure 15. Detailed Buttonwood Forest Farm design with species composition.

The table below includes both the existing and planted trees and shrubs in the riparian forest buffer. The survival rate for the species were conducted in Fall 2020, as well as the economic opportunities. The survival rates of the existing species were not tracked.

Table 5: Buttonwood Forest Farm survival rates and economic opportunities of existing and planted trees and shrubs in three zone design				
Zone 1	Common name	Latin	Survival	Economic opportunities

Existing:				
	Black walnut	<i>Juglans nigra</i>		Edible, medicinal, tonal hardwood, natural dye, oil
	Box-elder maple	<i>Acer negundo</i>		Maple sugaring, tonal hardwood
	Black willow	<i>Salix nigra</i>		Medicinal, wildcrafting, resin, natural dye, cut flower
	Washington hawthorn	<i>Crataegus sp.</i>		Medicinal, early successional, cut flower
	Bitternut hickory	<i>Carya cordiformis</i>		Oil, natural dye, tonal hardwood
Planted:				
	Viburnum, sp	<i>Viburnum sp</i>	37/40=92.5%	Wildlife, medicinal, cut flower
	River birch	<i>Betula nigra</i>	14/16=87.5%	Silvopastural
	American plum	<i>Prunus americana</i>	5/11=45.4%	Edible, silvopastural, early successional, cut flower
	Swamp white oak	<i>Quercus bicolor</i>	4/6=66.7%	Wildlife, silvopastural, tonal hardwood
	Sassafras	<i>Sassafras albidum</i>	5/6=83.3%	Edible, medicinal, natural dye
	Eastern redbud	<i>Cercis canadensis</i>	10/12=83.3%	Edible, cut flower
	Tulip poplar	<i>Liriodendron tulipifera</i>	13/15=86.7%	Mushroom, tonal hardwood
	American hazelnut	<i>Corylus americana</i>	182/200=91%	Edible, oil, cut flower
	American sycamore	<i>Platanus occidentalis</i>	18/20=90%	Mushroom, tonal hardwood
	Black willow	<i>Salix nigra</i>	2/2=100%	Medicinal, wildcrafting, nursery material, resin, natural dye, cut flower
	Serviceberry	<i>Amelanchier sp.</i>	8/10=80%	Edible
	Black cherry	<i>Prunus serotina</i>	12/14=85.7%	Edible, medicinal, tonal hardwood
	Quaking aspen	<i>Populus tremuloides</i>	27/30=92.5%	Wildlife, early successional, resin
Zone 2				
Existing:				
	Cool season grasses			Silvopastural
Planted:				

	American elderberry	<i>Sambucus canadensis</i>	23/25=92%	Medicinal, edible, natural dye, nursery material
Planted:	Elderberry cultivars	<i>Sambucus sp</i>	186/300=62%	Medicinal, edible, natural dye, nursery material
	Black chokeberry	<i>Aronia melanocarpa</i>	247/300=82.3%	Medicinal, edible
	American hazelnut	<i>Corylus americana</i>	183/200=91.5%	Edible, oil, cut flower
	Serviceberry	<i>Amelanchier sp.</i>	8/10=80%	Edible
Zone 3:				
Existing:				
	Cool season grasses			Silvopastural
	Black walnut	<i>Juglans nigra</i>		Edible, medicinal, tonal hardwood, natural dye, oil
	Bitternut hickory	<i>Carya cordiformis</i>		Oil, natural dye, tonal hardwood
Planted:				
	Black locust	<i>Robinia pseudoacacia</i>	24/25=96%	Silvopastural, lumber, nitrogen-fixing, bee pollination, edible (flowers), natural dye
	Pussy willow	<i>Salix caprea</i>	63/65=96.9%	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
	Buttonbush	<i>Cephalanthus occidentalis</i>	25/27=92.6%	Cut flower, wildlife
	Silky dogwood	<i>Cornus amomum</i>	212/225=94.2%	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
	Witch hazel	<i>Hamamelis virginiana</i>	21/25=84%	Medicinal, cut flower
	Pawpaw	<i>Asimina triloba</i>	21/26=80.8%	Edible, wildlife
	Hybrid chestnut	<i>Castanea sp.</i>	15/16=93.8%	Edible, natural dye
	American persimmon	<i>Diospyros virginiana</i>	13/15=86.7%	Edible, silvopastural
	American plum	<i>Prunus americana</i>	8/10=80%	Edible, silvopastural, early successional, cut flower

	Washington hawthorn	<i>Crateagus sp.</i>	12/15=80%	Medicinal, early successional, cut flower
	Spicebush	<i>Lindera benzoin</i>	16/21=76.2%	Wildlife, cut flower
	Black chokeberry	<i>Aronia melanocarpa</i>	23/25=92%	Edible, medicinal
	Quaking aspen	<i>Populus tremuloides</i>	10/10=100%	Wildlife, early successional, resin

Demonstration of National Agroforestry Center (NAC) Non-timber Forest Product (NTFP) Calculator: Calculating Expense and Revenue at Buttonwood Forest Farm

Through talking with experts with the Chesapeake Bay Initiative, such as agroforester Katherine MacFarland with the National Agroforestry Center, as well as individuals with the Savanna Institute, the focus on high-value, fast-growing Non-timber Forest Products in Multifunctional Riparian Forest Buffers became a key strategy. The Keystone Tree Crops Cooperative has gleaned from these experts that it is advisable to start with specific high-demand fast-growing products. Therefore, strategic efforts at this demonstration location focused on hazelnuts, American elderberries, Black chokeberry, while other slower-growing species are establishing.

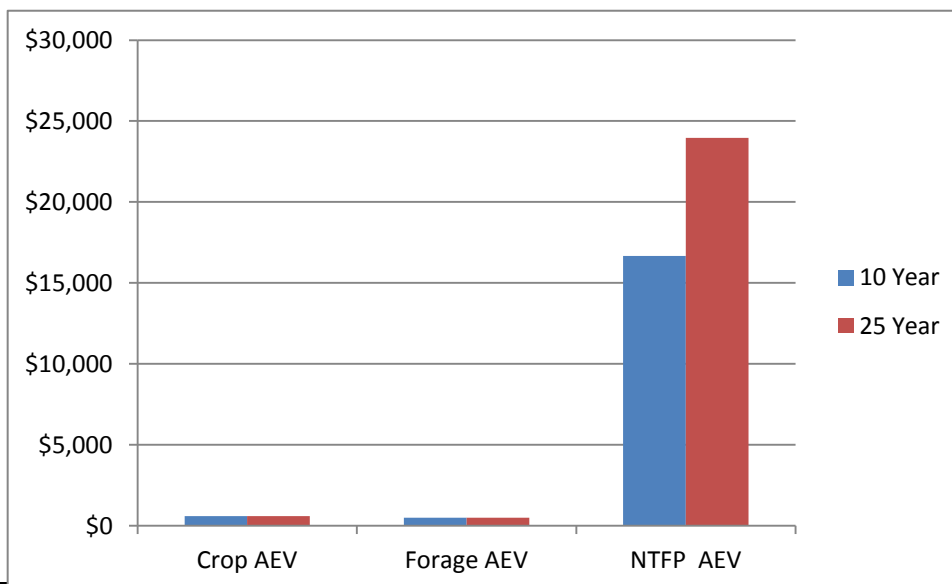
Table 6: Buttonbush Forest Farm MFRFB economic assessment with conservative estimates for use in the NAC NTFP Calculator				
Number of plants	Common name	Scientific name	Price per pound	NTFP use
200	American hazelnut	<i>Corylus americana</i>	\$6/pound whole cured in shell	Edible, oil, cut flower
25	American elderberry	<i>Sambucus canadensis</i>	\$12-\$15/pound fresh	Medicinal, edible, natural dye, nursery material
300	Elderberry cultivars	<i>Sambucus sp</i>	\$12-\$15/pound fresh	Medicinal, edible, natural dye, nursery material
300	Black chokeberry	<i>Aronia melanocarpa</i>	\$20/pound fresh	Medicinal, edible
65	Pussy willow	<i>Salix caprea</i>	\$6.90/10 stems	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
225	Silky dogwood	<i>Cornus amomum</i>	\$5.25/10 stems	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
26	Pawpaw	<i>Asimina triloba</i>	\$10/pound fresh	Edible, wildlife
16	Hybrid chestnut	<i>Castanea sp.</i>	\$13.99/pound	Edible, natural dye
15	American persimmon	<i>Diospyros virginiana</i>	\$10/pound fresh	Edible, silvopastural

Below is the 10-year analysis of the design at Buttonwood Forest Farm, analyzing the species that are included in the NAC NTFP Calculator. Two changes were made to the Calculator for this analysis: Hourly wage was set at \$15/hour, and elderberry cuttings were set at \$3 each.

Table 7: 10-Year Analysis of the Design at Buttonwood Forest Farm in NTFP Calculator

Tree/Shrub	0%	
	Total PV Revenues	Total PV Costs
Pussywillow	\$21,121.39	\$2,971.41
Dogwoods	\$32,733.56	\$17,482.89
Pawpaw	\$13,445.12	\$3,347.41
Elderberry	\$109,574.40	\$8,744.45
Hazelnut	\$9,427.06	\$5,100.10
Persimmon	\$26,335.13	\$8,413.55
Totals	\$212,636.65	\$46,059.82
NPV	\$166,577	
AEV	\$16,658	
Internal Rate of Return	115%	

	10 Year	25 Year
Crop AEV	\$581	\$581
Forage AEV	\$487	\$487
NTFP AEV	\$16,658	\$23,962



	Years									
	1	2	3	4	5	6	7	8	9	10
Revenues	\$0.00	\$8,479.88	\$12,223.88	\$16,413.69	\$21,154.70	\$24,364.42	\$28,076.66	\$31,359.59	\$36,542.39	\$34,021.43
Costs	\$7,879.2	\$2,492.85	\$2,581.38	\$3,013.52	\$3,968.17	\$4,471.91	\$4,922.42	\$5,276.4	\$5,726.9	\$5,726.9

Yearly Net Revenue	\$7,879.22	\$5,987.03	\$9,642.50	\$13,400.17	\$17,186.53	\$19,892.51	\$23,154.24	\$26,083.15	\$30,815.44	\$28,294.48
Cumulative Net	\$7,879.22	\$1,892.19	\$7,750.32	\$21,150.49	\$38,337.01	\$58,229.53	\$81,383.76	\$107,466.92	\$138,282.36	\$166,576.84
Break Even?	False	False	True	True	True	True	True	True	True	True
Years to Break Even:	3									

	Years									
	1	2	3	4	5	6	7	8	9	10
Crop Net Revenue	\$400.00	\$400	\$400.00	\$400.00	\$400.00	\$400.00	\$400.00	\$400.00	\$400.00	\$400.00
Crop NPV (ac)	\$4,000.00									
Crop AEV (ac)	\$400.00									
Crop AEV for project area	\$581.16									
Forage Net Revenue	\$335.00	\$335	\$335.00	\$335.00	\$335.00	\$335.00	\$335.00	\$335.00	\$335.00	\$335.00
Forage NPV (ac)	\$3,350.00									
Forage AEV (ac)	\$335.00									
Forage AEV for project area	\$486.72									

25 YEAR ANALYSIS PERIOD		
Tree/Shrub	0%	
	Total PV Revenues	Total PV Costs
Pussy willow	\$56,323.71	\$14,185.89
Dogwoods	\$87,289.49	\$14,170.11
Pawpaw	\$71,427.20	\$9,860.95
Elderberry	\$335,961.60	\$20,850.05
Hazelnut	\$42,312.16	\$13,829.20
Persimmon	\$114,118.88	\$35,483.90
Totals	\$707,433.03	\$108,380.10
NPV	\$599,053	
AEV	\$23,962	
Internal Rate of Return	123%	

CHAPTER 2 Overview of Potential Markets and Outlets for Products

This overview of potential markets and outlets for non-timber forest products includes wholesalers, restaurants, local consumers, and large urban centers such as Philadelphia and Baltimore/Washington District of Columbia. Products overviewed here include:

- Fruit
- Nuts
- Medicinals
- Cut flowers/natural dye
- Nursery materials
- Innovations, cooperatives, and additional value-added opportunities

Below is a table of the plants either grown or existing in the demonstration locations. The list is then further divided into types of products or processing required. This section is meant as an overview of the types of markets currently available for these plants.

Table 8: Overview of common non-timber forest products in MFRFBs, their economic uses, the species matrix		
Common name	Scientific name	NTFP uses
American basswood	<i>Tilia americana</i>	Medicinal, edible, tonal hardwood, wildlife
American crabapple	<i>Malus sp.</i>	Medicinal, early successional, cut flower
American elderberry	<i>Sambucus canadensis</i>	Medicinal, edible, natural dye, nursery material
American hazelnut	<i>Corylus americana</i>	Edible, oil, cut flower, nursery material
American persimmon	<i>Diospyros virginiana</i>	Edible, silvopastural
American plum	<i>Prunus americana</i>	Edible, silvopastural, early successional, cut flower, mushroom
American sycamore	<i>Platanus occidentalis</i>	Mushroom, tonal hardwood

Bitternut hickory	<i>Carya cordiformis</i>	Oil, natural dye, tonal hardwood, mushroom
Black cherry	<i>Prunus serotina</i>	Edible, medicinal, tonal hardwood
Black chokeberry	<i>Aronia melanocarpa</i>	Medicinal, edible
Black cohosh	<i>Actaea racemosa</i>	Medicinal
Black locust	<i>Robinia pseudoacacia</i>	Silvopastural, lumber, nitrogen-fixing, bee pollination, edible (flowers), natural dye
Black raspberry	<i>Rubus occidentalis</i>	Edible, medicinal, natural dye
Black walnut	<i>Juglans nigra</i>	Edible, medicinal, tonal hardwood, natural dye, oil
Black willow	<i>Salix nigra</i>	Medicinal, wildcrafting, resin, natural dye, cut flower, nursery
Box-elder maple	<i>Acer negundo</i>	Maple sugaring, tonal hardwood, mushroom
Buttonbush	<i>Cephalanthus occidentalis</i>	Cut flower, wildlife
Common milkweed	<i>Asclepias syriaca</i>	Nursery material, wildlife, natural fiber
Eastern redbud	<i>Cercis canadensis</i>	Edible, cut flower
Elderberry cultivars	<i>Sambucus sp</i>	Medicinal, edible, natural dye, nursery material
Highbush blueberry cultivars	<i>Vaccinium sp.</i>	Edible
Hybrid chestnut	<i>Castanea sp.</i>	Edible, natural dye, nursery material, mushroom
Pawpaw	<i>Asimina triloba</i>	Edible, wildlife
Pussy willow	<i>Salix caprea</i>	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
Quaking aspen	<i>Populus tremuloides</i>	Wildlife, early successional, resin, mushroom
Raspberry cultivars	<i>Rubus sp</i>	Edible, nursery material, natural dye

River birch	<i>Betula nigra</i>	Silvopastural
Sassafras	<i>Sassafras albidum</i>	Edible, medicinal, natural dye
Serviceberry	<i>Amelanchier sp.</i>	Edible
Silky dogwood	<i>Cornus amomum</i>	Cut flower, wildlife, wildcrafting, silvopastural, nursery material
Spicebush	<i>Lindera benzoin</i>	Wildlife, cut flower
Swamp white oak	<i>Quercus bicolor</i>	Wildlife, silvopastural, tonal hardwood, mushroom
Tulip poplar	<i>Liriodendron tulipifera</i>	Mushroom, tonal hardwood
Viburnum, sp	<i>Viburnum sp</i>	Wildlife, medicinal, cut flower
Washington hawthorn	<i>Crataegus sp.</i>	Medicinal, early successional, cut flower
Witch hazel	<i>Hamamelis virginiana</i>	Medicinal, cut flower

Market opportunities for NTFPs are based in building relationships, collaborations, and reaching out to networks of product consumers. One thing that is clear is that there is not a central, standard price sheet for the NTFPs that can be grown in MFRFBs. The literature indicates that research related to NTFP sales in the U.S. is lacking. However, the specialty markets are there and the demand is growing.

Many of the specialty crops grown in MFRFBs can be marketed as health foods. The health food market share has sky-rocketed since the beginning of COVID-19. The economic opportunities presented below are not the same ones included in the NAC NTFP calculator, as those prices are based upon conservative estimates of unprocessed raw materials. This section is more exploratory in nature, with value-added opportunities for producers and processors.

Certainly not all market opportunities for NTFPs are equal. Some species come into production faster, such as American/Black elderberries, hazelnuts, Black chokeberries, raspberries, and a variety of herbal products in the 3-5 plan. Other crops take longer to grow but may have a high demand due to taste, cultural influence/legacy. Although some of these high-value NTFPs take a longer time to grow, some already surround us in mature orchards or in the forests, including species such as chestnuts, hickories, Pawpaws and American persimmons.

There is an increasing body of literature measuring the significance of NTFPs grown and gathered in urban and suburban areas with proximity to large markets and international communities, which are often more accustomed to eating and cooking with certain fruits or nuts (see, for example, this [Assessment of Nontimber Forest Products in the United States Under](#)

[Changing Conditions](#).) Some of the literature also covers the enabling and constraining factors for small and medium-sized growers, such as this 2019 review, [“The Processing of Non-Timber Forest Products through Small and Medium Enterprises,”](#) published by Kathrin Meinhold and Dietrich Darr.

Shelf stability and value-added processing capacity will continue to be some of the bottlenecks of wholesale opportunities for nearly all NTFPs in regional metro markets. Some fruits rot within a few days, most herbal products need to be cleaned and dried, nuts need to be dried, cured, pressed, or in the case of the chestnut go through a water bath to kill weevils. However, with the rise of the local foods movement since the 1990’s more restaurants and chefs have made a name through in-season cooking with local crops, and unique forest products such as mushrooms, fruits, and nuts. Yet there are gaps in the knowledge of both the supply and demand for NTFPs, as well as wholesale and retail pricing. Below is a list of resources and locations for NTFP marketing exploration:

- 1) [Health food stores by zip code](#), [listed by state](#), or [Yelp Reviews](#) by location
- 2) [The Common Market Mid-Atlantic](#). The Common Market partners with a wide variety of wholesale and retail customers to help increase access to sustainable farm foods grown in the Mid-Atlantic:
 - Colleges & Universities
 - Community Organizations
 - Corporate Cafeterias
 - Early Childcare Facilities
 - Elder Care Facilities
 - Hospitals
 - Private Schools
 - Public Schools
 - Restaurants & Caterers
 - Retailers
 - Workplaces
- 3) Websites such as [Foodie Travel USA](#) include lists of restaurants by state in the Mid-Atlantic as well as links to buy local guides. Websites and listservs are helpful to find local and regional consumers.



Figure 16. Zach Elfers of Keystone Tree Crops Cooperative showcasing Bitternut hickory syrup and oil

Wholesale Opportunities

A review of wholesale specialty crops at [terminal markets standard pricing](#) was conducted to better understand the current and potential wholesale opportunities available for NTFPs grown in multifunctional riparian forest buffers in the Mid-Atlantic. These prices are from the fall of 2021, and are updated weekly. This USDA market news website also includes information on conventional vs. organic availability, retail prices, volume, and the steadiness of the market. Prices for the same items last year and in previous weeks are also included in their weekly report.

Below are the wholesale terminal markets standard reports for NTFPs grown in MFRFBs:

Table 9: Specialty Crops Terminal Markets Standard Report
Baltimore
BERRIES
---BLUEBERRIES: MARKET STEADY. flats 12 1-pt cups with lids PE med-lge 40.00 occas higher and lower
---MISC BERRIES: MARKET STEADY. flats 12 6-oz cups with lids GU Blackberries lge 18.00-20.00 mostly 20.00 MX Blackberries lge 22.00
---RASPBERRIES: MARKET STEADY. flats 12 6-oz cups with lids MX Red lge 29.00-32.00
---PLUMS: OFFERINGS LIGHT. 28 lb cartons loose CA Various Black Varieties 30-35
Medicinals: None
Nuts: None
Boston
ORGANIC
BERRIES
---MISC BERRIES: flats 12 6-oz cups with lids MX Blackberries med 30.00
---RASPBERRIES: flats 12 6-oz cups with lids CA Red med 36.00

---STRAWBERRIES: flats 8 1-lb containers with lids CA med 24.00-25.00
Medicinals: None
---FILBERTS: OFFERINGS LIGHT. MARKET STEADY. 50 lb sacks OR U.S. One jbo 130.00 cartons 32 1-lb packages OR U.S. One jbo 90.00
---MIXED NUTS: OFFERINGS LIGHT. MARKET STEADY. 50 lb sacks Repacked Enroute 150.00 cartons 32 1-lb packages Repacked Enroute 100.00
---PECANS: OFFERINGS LIGHT. MARKET STEADY. 50 lb sacks GA Natural Polished exlge 170.00
---WALNUTS: OFFERINGS LIGHT. MARKET STEADY. 50 lb sacks CA English Hartley jbo 120.00 cartons 24 1-lb packages CA English Hartley jbo 60.00 SHELLED Cartons 25lb \$95.00
New York
BERRIES
---BLUEBERRIES: OFFERINGS VERY LIGHT. flats 12 1-pt cups with lids 42.00-45.00
---MISC BERRIES: OFFERINGS LIGHT. flats 12 6-oz cups with lids CA Blackberries lge fineappear 27.00-30.00
---RASPBERRIES: OFFERINGS LIGHT. flats 12 6-oz cups with lids CA Red lge 24.00-27.00 holdovers 15.00-18.00 fineappear 27.00-30.00
---PLUMS: OFFERINGS LIGHT. 28 lb cartons loose CA Angeleno 35 sz fineappear
NUTS
---CHESTNUTS: OFFERINGS INSUFFICIENT TO QUOTE. 25 lb sacks CL 60-65s offerings insufficient to quote IT 38-40s none
---FILBERTS: OFFERINGS LIGHT. 50 lb sacks per lb OR jbo 1.98 cartons 32 1-lb packages OR lge 87.00
---MIXED NUTS: OFFERINGS LIGHT. 50 lb sacks per lb TX 2.44 cartons 32 1-lb packages TX 83.00
---PECANS: OFFERINGS LIGHT. 50 lb sacks per lb GA Natural exlge 2.56 cartons 32 1-lb packages GA Natural 141.00
---WALNUTS: OFFERINGS LIGHT. 50 lb sacks per lb CA English Hartley jbo 1.64 25 lb cartons per lb CA English Hartley jbo 3.20 cartons 24 1-lb packages CA English Hartley jbo 60.00
Philadelphia
BERRIES
---BLUEBERRIES: MARKET STEADY. flats 12 1-pt cups with lids PE med-lge 34.00-35.00
---CRANBERRIES: OFFERINGS VERY LIGHT. cartons 24 12-oz film bags NJ Howe 28.00-29.00 WI Howe 30.00-32.00 fineappear 33.00-35.00
---MISC BERRIES: OFFERINGS VERY LIGHT. flats 12 6-oz cups

---RASPBERRIES: OFFERINGS VERY LIGHT. flats 12 6-oz cups film wrapped MX Red lge 19.00 flats 12 6-oz cups with lids CA Red lge 28.00
---STRAWBERRIES: OFFERINGS LIGHT. flats 8 1-lb containers with lids CA med-lge 20.00
---PLUMS: MARKET STEADY. 28 lb cartons loose CA Marked Black Plum 20 sz 46.00
NUTS
---ALMONDS: OFFERINGS OFFERINGS LIGHT. 50 lb sacks CA U.S. One Peerless 140.00 " West Mixers "
---CHESTNUTS: 55 lb sacks IT 38-40s 136.00
---PEANUTS: MARKET STEADY. 50 lb sacks GA Virginia jbo 60.00 NC Virginia Roasted And Salted jbo 53.00 25 lb cartons NC Virginia Roasted And Salted jbo 30.50 bushel mesh sacks FL Virginia Green jbo 50.00-60.00 mostly 57.00
---PISTACHIOS: MARKET STEADY. 25 lb sacks CA White 132.00 cartons 24 12-oz packages CA White 99.00-110.00 mostly 105.00

Some additional ideas on selling NTFPs can be found in the National Agroforestry Center document, [“Working Trees.”](#)

Also of interest for those looking to develop markets for NTFP’s is the document, [“An Overview of Non-Timber Forest Products in the United States Today.”](#)

Additionally, [the Food and Agriculture Organization of the United Nations report on NTFPs in the U.S.](#) includes some of the opportunities as well as issues related to product development.

Retail and Value-Added Market Opportunities

In addition to these wholesale markets there are retail markets and value-added opportunities for urban and rural communities. There are a variety of organizations that focus on building the networks of the food system such as the [Pennsylvania Association for Sustainable Agriculture](#), [Community Food Security Coalition](#), [offices of food systems](#) in most cities or [regional planning](#), [orchard projects](#), and Chambers of Commerce with lists of restaurants and market places.

Connecting with local processors or cooperatives is a good first step for increasing opportunities for NTFPs through increasing value-added product capacity through shelf stability, building economy of scale with other regional producers, tapping into the large wholesale metropolitan markets, while also collectively working toward higher quality products. One of the top indicators of a successful marketing of NTFPs in urban markets or to restaurants is high-quality products with extended seasonality. Continuing to make connections between the suppliers and demand of wholesale products is a powerful first step in developing the markets. This must be done while addressing bottlenecks such as processing and labor. Although each of the NTFPs in the MFRFBs can be detailed at length, this report includes general overall concepts and opportunities, with a few examples detailed in each section.

Fruits & Berries

Table 10: MFRFB Fruit and berry species list with economic opportunities				
Common name	Scientific name	NTPF uses	Market value	Market source
American elderberry/ Black elderberry	<i>Sambucus canadensis/nigra</i>	Medicinal, edible, natural dye, nursery material	\$29/pound dried organic berries	Mountain Rose Herbs
American persimmon	<i>Diospyros virginiana</i>	Edible, silvopastural	\$20/pound dried	Nuts.com
American plum	<i>Prunus americana</i>	Edible, silvopastural, early successional, cut flower	\$12.99 per pound organic dried	Nuts.com
Black chokeberry	<i>Aronia melanocarpa</i>	Medicinal, edible	Dried organic \$29/pound	Amazon
Black raspberry	<i>Rubus occidentalis</i>	Edible, medicinal, natural dye	\$14.50/pound dried raspberry leaves	Mountain Rose Herbs
Highbush blueberry cultivars	Vaccinium sp.	Edible	Organic dried blueberries \$26.49/pound	Food To Live
Pawpaw	<i>Asimina triloba</i>	Edible, wildlife	\$10-\$20 / pound frozen pawpaw pulp products	Integration Acres
Raspberry cultivars	<i>Rubus sp</i>	Edible, nursery material, natural dye	\$8.99/ 2 ounce freeze dried	Nuts.com
Serviceberry	<i>Amelanchier sp.</i>	Edible	\$12.90 jam 6.7 ounces	My Panier

Many of the fruits grown in MFRFBs are currently being processed into beer, wine, spirits, juices, kombucha, and jams. Some of the fruits are sold fresh, frozen, pulped, dried, or freeze-dried. Processing fruit into beer, wine, juice, kombucha, or spirits has a longer window than fresh products. A fresh ripe Pawpaw only has a few days before it is no longer fresh, whereas Pawpaws made into a brandy at Zoetropolis in Lancaster, PA created a higher-value product with less urgent timeframe for marketing. Elderberries grown and harvested in Centre County, PA were made into wine at Pisano's Winery in Millheim, PA. Aronia Black chokeberry juice was sold to the local coffee shop. The opportunities networking with chefs, brewers, and aggregators are built upon the relationships, the quality of the products, and in some cases scalability or consistency.

One approach for finding local and regional market opportunities across the Chesapeake Bay Watershed is to reach out to vendors through their website, visit their facility, or a location where they market their products. Ironwood Specialty Crops, LLC has sold to wineries, restaurants, breweries, distilleries, coffee shops, and kombucha producers since 2017. In addition to these connections, other opportunities include wholesale to health food stores, selling to processors who have presses, drying facilities, flour mills, certified kitchens for processing opportunities, connecting with metropolitan terminal markets, online sales, and considering pick-your-own or seasonal festivals at the farm (i.e., Elderberry festival). In some instances, working with larger farmer's markets have shown to be successful. Taste testing and sampling can be helpful for some of the less commonly known NTFPs.

There are abundant resources on the internet to connect with local breweries, wineries, and kombucha makers across the region, as well as restaurants and wholesale distributors for the Mid-Atlantic. There are far more resources than what are listed below, but some include:

- [Mid-Atlantic Wineries](#)
- [Mid-Atlantic Breweries](#)
- [Breweries of Pennsylvania](#)
- [Distilleries by state](#)
- [Mid-Atlantic Kombucha trail in PA](#)
- [and the Kombucha Brewers Union](#)

Another approach to market opportunities in the Mid-Atlantic metro areas is to find existing types of specialty products that include multifunctional species. This can be a good focus for pitching new opportunities. Some examples of establishments that work with specific species include:

- [Magic Hat Elderberry beer](#)
- [Millworks Pawpaw beer in Harrisburg](#)
- [The Appalachian Brewing Company Raspberry Imperial Stout](#)

Extensive research on the growing, processing, marketing, and aggregation of specialty crops is available online. What follows are some of the market opportunities for several of the more common fruits and berries: American elderberries, Black chokeberries, American plum, American persimmon, and Pawpaw.

American elderberries, *Sambucus canadensis*

"Elderberry syrup is high in antioxidants and research studies demonstrate antiviral properties and potential as a cancer treatment." -Sarah DePasquale

Highly medicinal and edible for pies, wine, elderberry syrup; tolerant of the juglone in Black walnut, elderberry thrives across the landscape and propagates well from dormant live-stake cuttings. Both the flowers and the fruit show tremendous potential for market development in the Mid-Atlantic. Fast growing, elderberry goes into production in 3-5 years, with already established and thriving farms for production in the Midwest.

According to market research reports such as [Nutritional Outlook](#) and SPINS (Chicago) elderberry sales grew 168.9% in the U.S. in 2020, much of which occurred during the COVID-19 pandemic, part of what has been an upward trajectory for years as consumers sought immune-support products. [The same report identifies the difficulty of meeting market demands](#) when the market grew four times over in one year, coupled with substantial distribution challenges of raw materials during the pandemic.

Economic assessment for elderberry:

- Elderberries sold to cottage market syrup producers offer a steady demand for dried or freeze-dried online elderberry sales year-round. The shipping costs of these products are far more reasonable than juice, \$29/pound online sales.
- Fresh elderberries available during the month of August, whole (\$12-\$15/pound), juice (\$35/quart), or puree (variable).
- Elderflowers are also high demand with local processors purchasing flowers \$45/pound wholesale.
- Frozen elderberries require freezer space and utility costs, as compared to dried berries with a lower shipping cost.
- Elderberry processing/aggregation economy offers tremendous potential with development of processing hubs such as destemming machines.
- A pound of elderberries produces the equivalent of a pint of processed elderberry puree.
- Twenty pounds of destemmed American elderberries are the equivalent of 1.25 gallons of elderberry juice.

Projections: year 3-5

- 2 acres 1,000 plants 10,000 pounds
- 10-12 pounds per plant
- \$12-\$15/pound fresh/frozen
- \$80,000/year gross dried berries (2 acres)
- [Dried organic berries \\$29/pound](#)

Additional resources and examples

- [The University of Vermont extension guide](#) is very useful, and describes some of the details about growing elderberries for production.
- [Karnak Farm grows elderflowers for tea production](#) with drying facility.
- [The River Hill Harvest Elderberry Growers](#) from the Midwest Elderberry Cooperative, a network of farmers growing elderberries for production.
- Elderberry markets on Facebook such as [Elderberry Entrepreneur](#), [River Hills Harvest](#), and the [Midwest Elderberry Coop](#).
- [Elderberry destemming machine](#), costing \$7,000.
- [A webinar discussion of MFRFBs and elderflower tincture making](#) with Andrea Ferich and Sarah DePasquale.
- [Elderberry finance information](#) from the University of Missouri Center for Agroforestry.
- University of Missouri Center for Agroforestry (2013). Growing and Marketing Elderberries in Missouri, [Growing Elderberry Guide](#).
- [Intro Sheets on Elderberry](#) from the University of Kentucky.

- [Minnesota Elderberry Coop](#)
- [The basics of Elderberry cultivars](#), a helpful video.

Black chokeberry, *Aronia*

Black chokeberry, also called *Aronia*, can be marketed in a manner similar to elderberries, as a medicinal superfood. As with most members of the rose family, it is not tolerant of the Black walnut juglone. *Aronia* has become more commonly used by landscapers, and was even seen planted on Penn State's campus. It was found in markets in Austria, France, Belgium, Germany, and the Netherlands. Although native to the Mid-Atlantic, Black chokeberry was made popular in European markets and is now available in certain markets in the U.S., such as the Ithaca, NY farmers market. Considered a superfood, *Aronia* is highly medicinal, edible, and thrives across the landscape. *Aronia* is fast growing and native but is not commonly found in the wild. [In a Market Watch feasibility study of Aronia market shares](#), market observers note that “*Aronia* berries are a berry which grows on shrubs native to North America. *Aronia* berries can be eaten raw off the bush, but are more frequently processed. They can be found in wine, jam, syrup, juice, soft spreads, tea, salsa, chili starters, extracts, beer, ice cream, gummies and tinctures.”

Projections: year 3-5

- 1 acre 900 plants 12,000 pounds
- Similar estimated costs, harvesting equipment, and marketing as elderberry without the need to destem, but with slightly longer time to harvest and additional shelf stability
- [Dried organic \\$29/pound](#)
- [Extract powder \\$40/pound](#)
- [Dried organic \\$40/pound](#)

Additional resources

- Jensen, Jeff (2014). [Agroforestry on the Farm](#): Aronia Berry at Winding Creek, Belmond Iowa.
- University of Maine Extension (n.d.). [Culture of Aronia for Fruit Production](#).
- [Aronia Berry Feasibility Study](#)
- [Current Aronia prices at Superberries.com](#)



Figure 17. Display of fresh Black chokeberry, *Aronia* and marketing materials of Juneberry Farm at the Ithaca, NY Farmer's Market August 2018

American plum, *Prunus americana*

Forming thickets and growing quickly, American plums are relatively easy to harvest and process. While they have shown sensitivity to juglone causing mortality, they thrive across the landscape and can also be grown for cut flower potential. One successful marketing of American plums has recently taken place at Rising Locust Farm in Lancaster, PA, where farmers grew a hedgerow of American plums and began selling them to a local brewery at \$3 wholesale and \$5 per pound fresh at market within 3-5 years of planting. There is also a market for selling the seeds of improved genetics as well as seedlings.

Economic assessment for American plum:

- [\\$27.50 per gallon juice concentrate](#)
- [\\$12.99 per pound organic dried](#)

American persimmon, *Diospyros virginiana*

American persimmon can be found in the forests throughout much of the Mid-Atlantic. They show tremendous opportunities for ongoing improved genetics and have been the work of fruit explorers, including the fruit from the JW Hershey forest farm. In addition to eating fresh, persimmon, persimmon gravy is relatively easy to process. According to some sources American

persimmons have shown sensitivity to juglone. Some experts suggest projects should have at least five to seven specimens of varied genetics to ensure germination.

Economic assessment for American persimmon:

- [\\$12.99 per pound organic dried](#)
- [\\$20 per pound dried](#)

Pawpaw, *Asimina triloba*

An understory tree that is walnut tolerant, pawpaw mature to production in 8-10 years and currently fetch about \$10/pound. Extremely labor intensive to process the pulp, Pawpaws desire shade for the early years, but increase production with age in full sun. Similar to fruits listed above, there are cultivars that have been selected for larger fruit and better taste. Pawpaw fruit is only consumable for 2-3 days at room temperature or about a week in refrigeration. Pawpaw pulp is often made for value-added products such as salsa, ice cream, preserves, and beer. Pawpaws also have the ability to continue ripening off the tree, and can last in cold storage for up to three week and will ripen when taken out of refrigeration, known as climacteric ripening (Petersen Pawpaws, n.d.).

Economic assessment and resources for pawpaw:

- [\\$10-\\$20 / pound frozen pawpaw pulp](#) and other value-added products
- [Pawpaw information from the Agricultural Marketing Center](#)
- Kentucky State University (2009). [Pawpaw Planting Guide](#)

Additional Fruits

- Raspberries, *Rubus* sp., [\\$38/gallon juice concentrate](#)
- Highbush blueberries, *Vaccinium corymbosum*
 - [\\$35.80/gallon juice concentrate](#)
 - [\\$24.99/pound dried berries](#)
 - Freeze-dried \$40/lb
- Washington hawthorn, *Crataegus* sp.
 - [Dried \\$12.00/pound](#)
- Serviceberry/Shadbush/Juneberry, *Amelanchier* sp., [some details on making wine](#)
- Mulberries, *Morus* sp.
 - \$12.99/pound, organic dried
 - \$6.99/pound, Mulberry leaf powder
- Highbush cranberry, *Viburnum* sp.
 - [\\$30/pound dried](#)
- American Crabapple, *Malus* sp.
 - [Flower essence](#)

Nuts

There are indeed tremendous opportunities for wholesale nut production and processing in the Mid-Atlantic. The Keystone Tree Crops Cooperative has strategically selected hazelnuts, chestnuts, and Bitternut hickories for market development. Some of the hazels are destined for the KernKraft40 oil press, with different products resulting in the “feed cake” byproduct, some for meal or flour, and some for animal feed. The chestnuts are processed in a water bath to kill chestnut weevils, with the whole chestnuts marketed wholesale in metro areas or made into flour. In addition to the oil press, processing equipment for dehulling, shelling, cracking, roasting and a variety of stages of milling and concentrating are being explored for the Shagbark and Shellbark hickories, as well as for hazelnuts. There are antiquated relics of nut processing equipment around in rural areas, with some parts of Pennsylvania in legacy Black walnut harvesting regions. The work of the Keystone Tree Crops Cooperative includes building relationships with existing legacy nut orchards and with members of the North American and Pennsylvania Nut Growers Association, many of whom are eager to pass on generations of valuable improved genetics. Zach Elfers of the Keystone Tree Crops Cooperative wrote a booklet on the legacy of hickory nuts as an offshoot of this project. It is available [free and online at this link](#).



Figure 18. Hardy pecan, Hican, Shagbark hickory, Heartnut, Black walnut, and Hybrid chestnut improved genetics from the JW Hershey Forest Farm

Table 11: MFRFB Nuts species list with economic opportunities				
Common name	Scientific name	NTFP uses	Market value	Market source
American hazelnut/ Hybrid hazelnuts	<i>Corylus sp.</i>	Edible, oil, cut flower, nursery material	Raw no shell \$12.99/pound	Nuts.com
Black walnut	<i>Juglans nigra</i>	Edible, medicinal, tonal hardwood, natural dye, oil	Cured pieces \$15/pound	Nuts.com
Hybrid chestnut	<i>Castanea sp.</i>	Edible, natural dye, flour	Dried nuts \$13.99/pound	Nuts.com
Hickory	<i>Carya, sp.</i>	Oil, natural dye, tonal hardwood, mushroom	Whole cured in shell \$18/pound	Variable



Figure 19. Hybrid hazelnuts harvested from Rising Locust Farm

Hazelnuts

Hazelnuts are sometimes sold unshelled, whole, ground, diced, pressed, and milled. Hazelnuts have been predominately grown in Oregon with developing hazelnut production in the eastern United States. There are four major components in the on-going development of growing capacity in the Mid-Atlantic in our work with the Keystone Tree Crops Cooperative: 1) Breeding

and collection efforts s, 2) Expanded access to select cultivars, 3) Improved capacity for processing and distribution and 4) Increased consumer awareness and expanded market opportunities. See [“Developing Hazelnuts for the Eastern United States”](#) for more.

Below are market highlights taken from the industry report [Global Hazelnut Market: Growth, Trends, COVID-19 Impact, and Forecasts \(2021 - 2026\)](#).

- *The global hazelnut consumption is projected to grow at a compound annual growth rate (CAGR) of 10.1% during the forecast period (2020-2025).*
- *With increasing demand from consumers and high health benefits, the market is expected to grow over the forecast period. Hazelnut is a rich dietary source of protein, unsaturated fatty acids, and linoleic acid. It contains a higher concentration of alpha-tocopherol (vitamin E) than any other nut.*
- *Turkey dominates the hazelnut production, with an estimated share of 65%, globally. Europe is expected to register the highest CAGR of 7.6% during the forecast period, due to the increasing demand for hazelnuts from the chocolate industries of Europe.*
- *Research studies show that consuming hazelnuts can lower LDL (bad) cholesterol and increase HDL (good) cholesterol, which is increasing the sales of hazelnut. Hazelnuts are used in desserts, such as cakes, muffins, chocolate dishes, praline, or pastries. With the growing demand for the product various producers are entering into the market with innovative products. Bühler, the world’s largest provider of nut processing technology, had announced that it expanded into the natural hazelnut market in May 2018, with the Turkish launch of its innovative combination of sorting technologies, leading to natural hazelnut processing systems.*
- *With the impact of COVID-19 there has been an inclination towards healthy eating including fruits and nuts. Nuts, which are included in most of the healthy dietary patterns, are characterized by their high energy density as a result of their high lipid content. They also contain plant-protein and significant amounts of polyphenols, phytosterols, vegetable fiber, and micronutrients. Nuts including hazelnut, contain all these nutrients, therefore the consumption of this food group might help regulate immunologic and inflammatory responses. Hence, the demand for hazelnut is anticipated to grow in the future.*

Economic assessment and resources for hazelnut:

- [\\$12.99/pound raw, shelled](#)
- Superfood roasted hazelnuts [\\$17.37/26 ounces](#)
- Oregon farm to table hazelnuts [\\$14.99/pound specialty](#)
- Hazelnuts wholesale
 - [\\$5.99 inshell raw](#)
- [Rutgers University](#) Hazelnut resources
- Fischbach, Jason & Braun, Lois (2017). [A Production and Economic Model for Hedgerow Hazelnut Production in the Midwestern United States](#)
- Grimo Nut Nursery (2017). [Hazelnut Farming for Profit.](#)
- Zarnowski, Jeff & Dawn (2016). [Hazelnut Trees Are Easy!](#)

Hickories

The developing hickory nut products include whole, pieces, roasted, oil, and flour. Zach Elfers wrote a detailed Hickory report to share with this project, [which is available here](#).

Economic assessment and resources for hickory:

- Bitternut hickory oil
- Shelled, cracked, whole
- Dried mixed nuts
- Whole in shell [\\$18/pound](#)

Walnut and Butternut

The Mid-Atlantic has a vast history of Black walnuts and Butternut harvesting and production. However, most walnuts consumed in the market are English walnuts grown in California. The delicious Butternut is no longer common on our landscape due to a Butternut canker disease caused by a fungus (*Ophiognomonia clavignenti-juglandacearum*).

The nuts of Black walnuts can be sold whole or in pieces. The oil offers another marketing opportunity. Black walnut hulls are sold as a medicinal product for women's health, natural dyes and inks, as well as a natural cleaner of metals. People in the Upper Penns Creek Watershed often use old-fashioned corn huskers to shell the Black walnuts. Cement mixers can also be used for the removing of hulls.

Economic assessment and resources for Black walnut and Butternut:

- University of Missouri Center for Agroforestry (2009). [Growing Black Walnut for Nut Production](#).
- Black walnut oil [\\$10.99 8 ounce bottle bulk](#)
- Walnut oil [\\$5/pound](#)
- Black walnut leaves [\\$31.58/pound](#)
- Black walnut hull [\\$37.92/pound](#)

Chestnuts

Chestnut trees are generally not known as a riparian species, they grow in drier soils in more upland areas. According to experts, soil type is the limiting factor for growing healthy chestnuts. [Web soil survey](#) is a great resource for identifying soil types. The American chestnut was the king of tree crops before the Chestnut blight, however most of the commercial orchards grow hybrid chestnuts. Successful chestnut cooperatives in the Midwest frequently talk about the opportunities for marketing chestnuts with immigrant communities.

Economic assessment and resources for chestnuts

- [Managing chestnuts for biomass](#)
- Growing Chestnuts: [Michigan State University](#)

- Black, Roy, Betz, Rodger, Lizotte, Erin, & Fulbright, Dennis. (2013). [Commercial Chestnut Cost of Production and Comparative Analysis with Tart Cherry Production](#)
- [University of Missouri Center for Agroforestry growing chestnuts for production](#)
- [\\$14.99/ pound flour](#)
- [\\$39 pound dried](#) wholesale
- [Etsy \\$38.95/pound raw](#)

Pecans

Economic assessment and resources for pecan:

- [Organic pecans, raw no shell \\$21.99/pound](#)
- [Organic pecan pieces \\$19.99/pound](#)
- [Organic, raw, in shell \\$12.99/pound](#)
- Halved Georgia Pecans [\\$34.28/ pound](#)
- [University of Missouri Center for Agroforestry](#) Pecan resources
- Missouri North Pecan Growers, LLC (2013) [Distinguishing an organic, geographically-based product identity.](#)

Medicinals

Table 12: Medicinals species list with economic opportunities				
Common name	<i>Scientific name</i>	NTFP uses	Market value	Market source
American basswood	<i>Tilia americana</i>	Medicinal, tonal hardwood, wildlife	\$35/Lb dried organic leaves and flowers	Mountain Rose Herbs
American crabapple	<i>Malus sp.</i>	Medicinal, early successional, cut flower	Flower essence \$20/7 ounces	Herbs Direct
American elderberry/ Black elderberry	<i>Sambucus canadensis/nigra</i>	Medicinal, edible, natural dye, nursery material	\$29/pound dried organic berries	Mountain Rose Herbs
Black cherry	<i>Prunus serotina</i>	Medicinal, tonal hardwood	\$21/pound dried bark	Mountain Rose Herbs
Black chokeberry	<i>Aronia melanocarpa</i>	Medicinal, edible	Dried organic \$40/pound	Frontier Coop

Black cohosh	<i>Actaea racemosa</i>	Medicinal	\$26/pound dried roots	Mountain Rose Herbs
Black raspberry	<i>Rubus occidentalis</i>	Edible, medicinal, natural dye	\$14.50/pound dried raspberry leaves	Mountain Rose Herbs
Black walnut	<i>Juglans nigra</i>	Edible, medicinal, tonal hardwood, natural dye, oil	Dried organic \$15/pound hull	Mountain Rose Herbs
Black willow	<i>Salix nigra</i>	Medicinal, wildcrafting, resin, natural dye, cut flower	unknown	
Sassafras	<i>Sassafras albidum</i>	Edible, medicinal, natural dye	\$67.50/pound dried bark	Mountain Rose Herbs
Viburnum, sp	<i>Viburnum sp</i>	Wildlife, medicinal, cut flower	\$15-\$20	Mountain Rose Herbs
Washington hawthorn	<i>Crataegus sp.</i>	Medicinal, early successional, cut flower	Dried berries, leaves, flowers \$10-\$30/pound	Starwest Botanicals
Witch hazel	<i>Hamamelis virginiana</i>	Medicinal, cut flower	Bark powder \$24/pound	Mountain Rose Herbs

There are opportunities and challenges for “scaling up” medicinal products production and processing capacity in the Mid-Atlantic. [Mountain Rose Herbs](#) and [Gaia Herbs](#) are examples of large-scale herbal product companies. Many herbalists purchase products from these companies even though those same products can be grown and processed in the Mid-Atlantic but are not, due to the lack of processing capacity.

Some of the medicinal products sold are even invasive or noxious weeds such as Japanese knotweed and Teasel root sold for their medicinal properties. The Mid-Atlantic is lacking large-scale herbal product processing hubs similar to the [Appalachian Harvest Herb Hub](#). There are opportunities for herbal product processing hubs to be cleaning, drying, and processing herbal products in towns and communities across the Mid-Atlantic. There are urban and rural examples of people who are processing herbal products, such as Susquehanna Apothecary and Lancaster Farmacy. Through this project, contact was made with [Natural Hope Herbals](#) located outside Harrisburg, PA, a business that grows, purchases, and processes wholesale herbal products.

Additional economic assessment and resources for common medicinals:

- Black cohosh, [\\$55/pound dried roots](#)
- Washington hawthorn, [Leaf and flower \\$21.50/pound](#)
- Witch hazel, [\\$8.50/pound extract](#), dried leaves [\\$21/pound](#)
- Black haw bark [\\$59/pound](#)
- Cedar leaf [\\$36.50/pound](#)
- American basswood dried flowers and leaves [\\$35/pound](#)
- Sassafras Root

- [Bark \\$67.50/pound](#)
- [Oil \\$49.50](#)
- Basswood Leaves [dried \\$21/pound](#)
- Dried shiitake powder \$48.42/pound. Rising Locust Farm in Lancaster County, PA grows and sells shiitake mushrooms in a shaded area near their riparian buffer. Fresh shiitake mushrooms \$11/pound wholesale and \$14 per pound retail.
- [Violets dried \\$36.67/pound](#)
- [Dried birch leaves \\$20/pound](#)
- Birch bark \$25/pound
- [Juniper berries, Organic dried whole \\$35.42](#)

Woody Cut Florals

There are ongoing market opportunities available for wholesale cut flower growing. Two of the MFRFB replication projects include collaborations with cut flower growers including the PA Cut Flower Growers Network as well as Centre Markets, a wholesale online farmers market that came about during the beginning of COVID. Species such as Silky dogwood and Pussy willow are planted 3' on center within the grid of 3 rows to encourage straight vertical stem growth in high-density planting. In addition to working with florists, cut flower growers might find economic opportunities for many of the cut floral species in wild-crafting such as basketry, [natural dyes and pigments](#), event planners such as weddings, and for vegetatively propagating nursery material and restoration materials such as live-stakes dormant cuttings.

Below is a list of the projected wholesale cut floral prices, as determined by analyzing Midwestern markets and other market trends from wholesale cut flower growers:

Table 13: Woody cut floral species species list with economic opportunities					
Common name	Scientific name	NTPF uses	Length of cutting	Size of bundle	Price per bundle
American crabapple	<i>Malus sp.</i>	Medicinal, early successional, cut flower	5-6'	3-5 stem	\$30.00
American hazelnut	<i>Corylus americana</i>	Edible, oil, cut flower, nursery material	2'-3'	10 Stems	\$9.25-10.85
American plum	<i>Prunus americana</i>	Edible, silvopastoral, early successional, cut flower	5-6'	3-5 stem	\$30.00
Black willow	<i>Salix nigra</i>	Medicinal, wildcrafting, resin, natural dye, cut flower	2'-3'	12 Stems	\$6.15

Buttonbush	<i>Cephalanthus occidentalis</i>	Cut flower, wildlife	2'-3'	5 stems	\$21.00
Eastern redbud	<i>Cercis canadensis</i>	Edible, cut flower	2'-3'	5 Stems	\$7.75
Pussy willow	<i>Salix caprea</i>	Cut flower, wildlife, wildcrafting, silvopastural, nursery material	24"	10 Stems	\$6.90
Silky dogwood	<i>Cornus amomum</i>	Cut flower, wildlife, wildcrafting, silvopastural, nursery material	2'-3'	10 Stems	\$5.25
Spicebush	<i>Lindera benzoin</i>	Wildlife, cut flower	unknown		
Viburnum, sp	<i>Viburnum sp</i>	Wildlife, medicinal, cut flower	2'-3'	10 Stems	\$9.25-10.85
Washington hawthorn	<i>Crataegus sp.</i>	Medicinal, early successional, cut flower	unknown		
Witch hazel	<i>Hamamelis virginiana</i>	Medicinal, cut flower	unknown		

Economic assessment and resources for woody cut florals and natural dyes:

- The book Woody Cut Stems. [Available from the ASCFG](#).
- There are some growers that specialize in just growing this crop. [Green Park Nursery](#) in Canada and [Star Valley](#) in Wisconsin are two large scale woody growers.
- Also see the book, [Specialty Cut Flower Production](#)

Nursery Materials

There are significant gaps in the supply for nursery materials, which translates into low-hanging fruit for landowners and farmers interested in the riparian buffer economy. Economic opportunities for nursery products in MFRFBs are realized through different methods of plant propagation, from dormant cuttings, root-tips, seeds, and grafting. Consumers will pay more

money to purchase seeds or plant material grown from local, improved genetics and for grafting scion material.

Table 14: Nursery material species list with economic opportunities			
American elderberry	<i>Sambucus canadensis</i>	Medicinal, edible, natural dye, nursery material	Cuttings, plants, seed
American hazelnut	<i>Corylus americana</i>	Edible, oil, cut flower, nursery material	Seed, plants
Black willow	<i>Salix nigra</i>	Medicinal, wildcrafting, resin, natural dye, cut flower, nursery	Cuttings
Hickories	<i>Carya sp</i>	Edible, oil, natural dye, nursery material	Seed, plants
Common milkweed	<i>Asclepias syriaca</i>	Nursery material, wildlife, natural fiber	Seed
Elderberry	<i>Sambucus sp</i>	Medicinal, edible, natural dye, nursery material	\$3/cutting
Hybrid chestnut	<i>Castanea sp.</i>	Edible, natural dye, nursery material	Seed, plants
Pussy willow	<i>Salix caprea</i>	Cut flower, wildlife, wildcrafting, silvopastoral, nursery material	Cuttings
Raspberry cultivars	<i>Rubus sp</i>	Edible, nursery material, natural dye	Root tipping plants
Silky dogwood	<i>Cornus amomum</i>	Cut flower, wildlife, wildcrafting, silvopastoral, nursery material	Cuttings
*Wide range of other nursery opportunities for many other species			

Labor and Cooperatives

In addition to processing and distribution, skilled labor is one of the bottlenecks in the tree crops economy. In the work of planting and maintaining multifunctional riparian forest buffers, the seasonal nature of planting buffers in the spring and fall has prevented the growth of full-time year-round work. In the work of Ironwood Forestry replicating these projects, trained individuals are paid \$20-\$35 an hour to plant trees, depending on their level of leadership with the crew, skills, and capacity to work. However, it remains difficult for independent contractors to maintain ongoing work for laborers throughout the year. One opportunity for increasing summer and winter work includes the integration of more maintenance work as well as harvest and value-added processing opportunities. Off-season nursery production could also enhance the business model.

The Keystone Tree Crops Cooperative is actively looking for specialty fruit and nut crops grown across the Mid-Atlantic for shared processing, marketing, and distribution to meet growing demand across the region, specifically in urban markets. Recently, the cooperative has purchased an oil press for working with nut crops in collaboration with SilvoCULTURE. The stated

purpose for this cooperative is to serve as a model for generating right livelihood and economic equitability for those who work with bioregional tree crops.

Cooperatives and community-oriented non-profits and tree nurseries:

- Keystone Tree Crops Cooperative (KTCC) <http://www.keystonetreecrops.com/>
- SilvoCulture <http://www.silvoculture.org>
- Route 9 Cooperative <https://route9cooperative.com/>
- Black Squirrel Farms <https://www.blacksquirrelfarms.net/>
- Acornucopia Project <https://www.acornucopiaproject.com/>
- Nutty Buddy Collective (NBC) <https://nuttybuddyclollective.com/>
- New York Tree Crops Alliance (NYTCA) <https://www.nytca.org/>
- New England Acorn Cooperative <https://newenglandacorncooperative.com/>
- Philly Orchard Project (POP) <https://www.phillyorchards.org/>
- Horn Farm Center <https://hornfarmcenter.org/>
- Route 9 Cooperative, OH <https://route9cooperative.com/>
- Red Fern Farm, IA www.redfernfarm.com
- Forrest Keeling, MO <https://www.fknursery.com/>
- Honeyberry USA, MN <http://www.honeyberryusa.com/>
- Ave Maria Acres, NE <https://www.avemariaacres.com/>
- Burnt Ridge Nursery & Orchards, WA <https://www.burntridgenursery.com/>
- Oikos Tree Crops, MI <https://oikostreecrops.com/>
- Richters Herbs, Canada (seeds only) <https://www.richters.com/>
- Raintree Nursery, WA <https://raintreenursery.com/>
- OneGreenWorld, OR <https://onegreenworld.com/>
- Edible Acres, NY <https://www.edibleacres.org/>
- Silver Run Forest Farm, VA <https://silverrunforestfarm.org/>
- Perfect Circle Farm, VT <https://www.perfectcircle.farm/>
- Gitmo Nut Nursery, Canada <https://www.grimonut.com/>
- Brambleberry Permaculture, IN <https://www.brambleberrypermaculture.com/>
- Cold Stream Farm, MI <https://www.coldstreamfarm.net/>
- Twisted Tree Farm, NY <http://www.twisted-tree.net/>
- England's Orchard & Nursery, KY <http://www.nuttrees.net/>

Other Organizations:

- Pennsylvania Nut Grower's Association (PNGA) <http://pnga.net/>
- New York Nut Grower's Association (NYNGA) <http://nynga.org/>
- Northern Nut Growers Association (NNGA) <https://nutgrowing.org/>
- Savanna Institute <https://www.savannainstitute.org/>
- Village Acres Farm and Foodshed <https://villageacres.com/>

CHAPTER 3 Lessons Learned

This project demonstrating, replicating, and analyzing MFRFBs is transdisciplinary in nature. It is the work of forestry, and the food system, it is about managing for American woodcocks, community-based forestry, ecological justice, and the economics of restoration. Multifunctional riparian forest buffer projects are the stories of the people, watershed communities, our shared values, and what inspires landowners to plant or maintain multifunctional riparian forest buffers. The lessons learned are intersectional from experience and conversations with other natural resource professionals, landowners, and researchers working together toward ecosystem function and abundant tree crop economies.

In addition to this project demonstrating and assessing multifunctional riparian forest buffers, consulting forester Andrea Ferich was researching the human dimensions of multifunctional riparian forest buffer landowners in the same watershed. In studying land use data, environmental values, behaviors, and sociodemographic variables this research explained who is most likely to plant or maintain multifunctional riparian forest buffers, what we know about them, and their relationship with the land (Ferich 2021). One of the biggest lessons learned came with Ferich's research demonstrating that homemakers and women are most likely to desire planting riparian forest buffers for non-timber forest products (Ferich 2021). Understandably, these findings reveal great opportunities for a shift in focus in landowner outreach efforts as well as the opportunities for natural resource professionals to more intentionally involve and even focus on women-led households and female-run farms. This research points to the strongest opportunities bringing voices together within households and shared communities. Ask the women of the land and the children what they would love to plant. Ask them about what they cook, what they grow in their gardens, and what kind of flowers they like. Ask them about the medicine they take, what they feed their children, and what their mothers "canned" or put-away. Ask them what they think is beautiful, what they would like to share with their neighbors, ask them what inspires them, and why they would like to plant trees and even help them grow bigger.

Big Picture Lessons Learned

"Perhaps one of the greatest successes is the increase in cultural imagination—that it is possible to have a beautiful multifunctional riparian forest buffer with ecosystem function and profitability."

Both ecological and economic development demonstration and assessment opportunities were central in evaluating this project. Both ecosystem function and economic opportunities are dependent upon the planted trees and shrubs reaching maturity or entering into a regenerative state. Focusing on quick growing, high-value, more easily propagated species is the key to maximizing profit. Plant as many large elderberries, hazelnuts, chokeberries as soon as possible.

The Chesapeake Bay Foundation Keystone 10 Million Trees Partnership began during the time of this project with the goal of planting 10 million trees and shrubs in Pennsylvania over ten years. The Foundation offers trees, shrubs, tubes, and stakes for riparian buffer projects. This program, launched in 2018, offers a great deal of flexibility for riparian buffer projects, with increased outreach to landowners not generally interested in grants, such as the Amish.

There are some tremendous successes from this project demonstrating and assessing MFRFBs for the Chesapeake Bay Watershed. Since the program began, Ironwood Forestry has worked with over 50 landowners planting and distributing 20,000 trees and shrubs toward MFRFB goals between Centre and Lancaster County. The strategic locations of these projects as well as the diversity of landowners and their values allows for increased access to entry for new and diverse landowners connecting with more experienced landowners they can learn from. Perhaps one of the greatest successes is the continued normalization of perennial tree crop farming opportunities in the Mid-Atlantic. As landowners continue to learn from their neighbors and see more demonstration locations, see more of the products on the shelves, and connect with the financial opportunities, so does their interest. Perhaps one of the greatest successes is the increase in cultural imagination—that it is possible to have a beautiful multifunctional riparian forest buffer with ecosystem function and profitability.

The first success relates to the ability of the landowners and the general public to experience the feasibility of economic success growing the MFRFB crops. The focus on elderberries brought together a diverse population around a common product. Elderberries are old, new, they are country and they are urban. During the last 3 years, elderberries seemingly had their rise to stardom. The demand for elderberry products has sky-rocketed, now available at most grocery stores and pharmacies. Elderberries developed product recognition by the general public in the last 4 years and increased during COVID for immune boosting properties.

Other key successes and lessons learned include:

- The connection between the supply and demand of the tree crops is essential to the success of growing MFRFBs.
- The demonstration of the resilience of the MFRFB locations in extreme weather events, both 12” rain events and extreme droughts.
- The establishment of MFRFBs by early adopter Amish.
- Development of the elderberry destemming machine and potential for mobile dryer of NTFP products.

In many riparian buffers, Black walnut is sometimes dominant. Since Black walnut is allelopathic, many species of horticultural and agricultural crops are not resistant to the chemical emitted by the Black walnut, juglone. The species selected for this demonstration riparian forest buffer are listed as compatible with Black walnut. The planting scheme in areas without Black walnut focused on growing of Black chokeberry Aronia as well as American plum.

Organic Methods

In a location like the Upper Penns Creek Watershed, home to Pennsylvania Certified Organic and birthplace of Pennsylvania Association for Sustainable Agriculture (PASA), there is a long-standing legacy of local landowners who do not use chemicals on their property. However, conventional agriculture and the many practices of forestry rely on spraying herbicides for site preparation and silvicultural forest management. Large-scale ecological restoration or forestry projects without the use of glyphosate are hard to find in the body of literature. Practitioners are often not trained in these methods. There are a wide variety of no-spray resources available to fight persistent noxious weeds in the support of tree establishment, however, not every landowner or location is open to the use of fire, controlled grazing with goats, or has the

economic resources or time for extensive competition reduction through human-scale methods such as mowing, weed-whacking, or hand weeding. Site specific conditions can make it difficult for sheet mulching, over-seeding, or weeding. This project demonstrated some of the resources for organic establishment of these systems. The tools of growing for production and alternative deer exclusion methods can be utilized with the range of spraying projects along the spraying-spectrum. These systems are based upon deep bed preparation with a broad fork, sheet mulching, weed suppression mats, and the possibility of over-seeding with a native seed mix, as the budgets allow. Hand weeding, weed-whacking, and mulching the plantings are central to regular maintenance during establishment.

Natural regeneration flourished in these buffers with the existing seed bank in the soil contributing to the success of the project, Cardinal Flower, Boneset, American elderberries. The water pump that has been purchased has also contributed to high survival rates as well as the reduction of time required in on-going maintenance. The plantings are regularly inspected visually by the land manager, at both locations.

Biodegradable weed mats were purchased and installed to demonstrate no-spray organic methods of buffer establishment. The trees and shrubs were also mulched, a decision that was strongly motivated by the extreme drought from the summer of 2020 and great success in Sarah DePasquale's demonstration with sheet-mulching, outside the concentrated flowpath areas. However, mulching should only occur in areas with active weeding to deter mole/vole/mouse habitat.



Figure 20. Spring 2018 Fiddler's Bend extended third zone sheet-mulching and planting

Below is a photo from the Ironwood Forestry Instagram page showing the weed mats prior to mulching. The "Ironwood Forestry" Instagram page posts photos of regular demonstrations, and

videos from this project as well as others. Other experts and practitioners in agroforestry practices comment frequently, and is a great place for sharing information and resources.

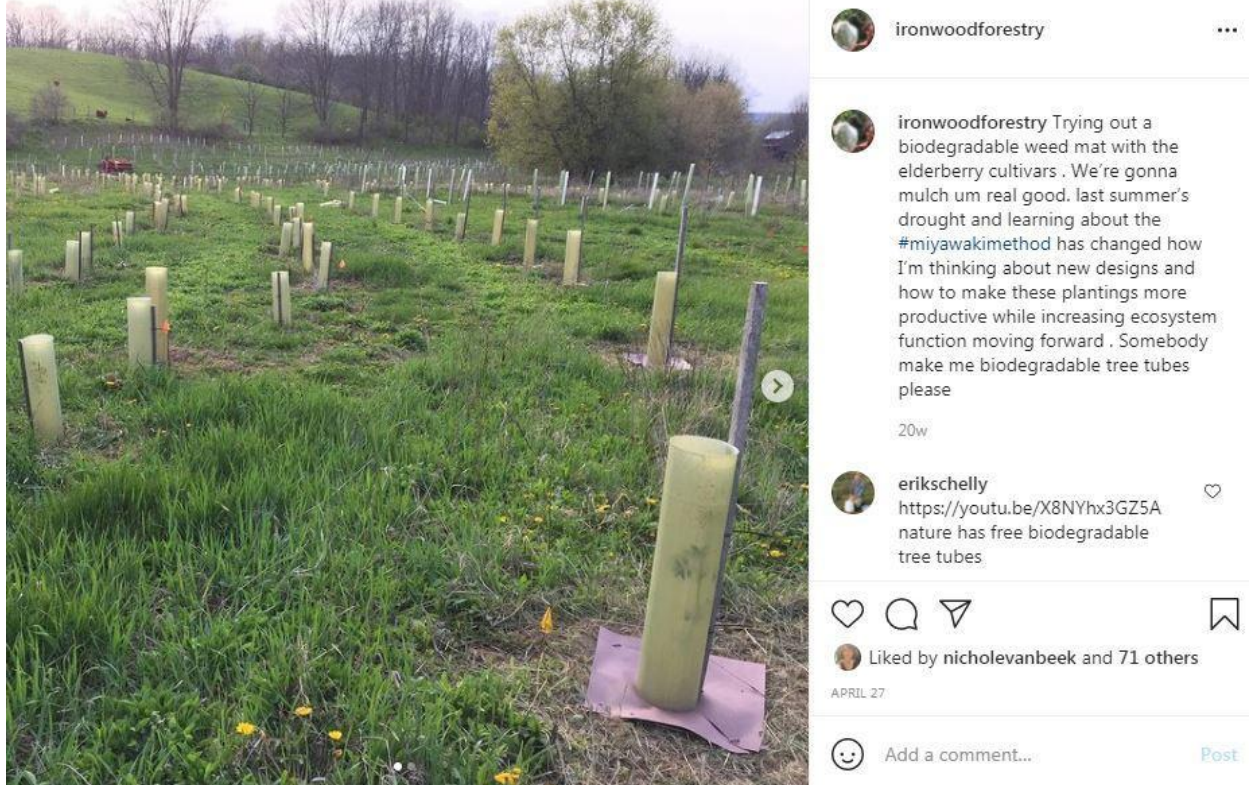


Figure 21. Weedmats at Buttonbush

As can be seen in the photo below, weedmats can also be made from rolls of thick cardstock grade paper purchased in the painting section of stores such as Lowe's, sold as drop clothes.



Figure 22. Materials used in the construction of cages at replication location

Low-cost Propagation

The focus on the demonstration of low-cost propagation served a variety of purposes. During the last few decades of riparian forest buffer implementation and maintenance, project managers did not have access to free plant material. In the beginning of the project access to plant material was often the bottleneck in implementation. Focusing on low-cost propagation allows for more landowners to implement MFRFBs, as well as allowing more points of entry for landowners who are less likely to enroll in grant-funded programs, such as the Amish community and landowners with smaller parcels ineligible for USDA funding or located in places without funding opportunities.

There were three main low-cost propagation techniques demonstrated through this project:

1. Live-staking with dormant cuttings
2. Seed propagation in the Ironwood Tree Crops Nursery with improved genetics, an offshoot of this grant opportunity
3. Direct seeding in the projects (historically difficult in wet soils)

Live-staking was conducted with elderberries and a variety of additional cut flower and dye species including Pussy willow, Black willow, Basket willow, Silky dogwood, Red-osier dogwood, Speckled alder, and others. An average of approximately 1,000 cuttings a year were made and planted in the demonstration locations or the replication sites by Ironwood Forestry. Early successional elderberries have shown to increase production through regular pruning. These cuttings can be successfully live-staked into wet soils. Approximately 200-500 elderberries were grown this way annually. During the time of this project the PA DCNR live-

stake cooperative was established. Cuttings were received from this cooperative in 2019, and then the cooperative was put on hold due to complications related to the pandemic.



Figure 23. Live-stake materials for woody cut florals and nursery material: red-osier dogwood, silky dogwood, pussy willow, and Black willow.

A live-stake basically looks like a stick or a bundle of sticks approximately 12-18” long and as thick as a finger. These cuttings are made during the dormant season and then pushed into the ground (and sometimes hammered) into the earth when it can be worked, before budbreak and the end of dormancy in the spring. There are networks of people who collect, share, and propagate live-stakes, including the Watershed Committee for the Penns Valley Conservation Association and partners. Educational videos of live-stake preparation can be found on the [Ironwood Forestry Instagram channel](#).

American elderberry cultivar cuttings were purchased from two growers in Missouri, River Hills Farm and Elder Farms, and are growing and being propagated at both demonstration locations. There are tremendous economic opportunities to grow these elderberry cultivars for nursery material for propagation, as there are no known growers in the Mid-Atlantic. Unfortunately, the elderberry cultivars had a low success rate in 2020 due to complications of COVID at the nursery resulting in late shipments arriving during a drought in July 2020. Having local cutting blocks and availability of elderberry cultivars would help with the stability of the elderberry markets, supply of improved genetics, and breeding opportunities for the Mid-Atlantic.

Elderberries have arguably had their Johnny Appleseed moment, perhaps with the availability of Elderberry Destemming Machines as well as PTO harvesting innovations such as those at The Savannah Institute. [The Midwest Elderberry Cooperative has a collection of their presentations available online](#) as well as [collaborative presentations with the Savannah Institute](#) on harvesting.

Seed Propagation

One of the offshoots of this project included great connections with horticulturalists across the Mid-Atlantic region specializing in the collection of improved genetics for production. Improved genetics were planted including Shellbark hickory, Shagbark hickory, American plum, American persimmon, Hardy pecans, varieties chestnuts for nut and timber production, as well as improved American hazelnut genetics. Many of these tree crops were purchased from wild collectors such as Zach Elfers of [Future Forest Plants](#) and of the [Keystone Tree Crops Cooperative](#). Many of the trees grown by Ironwood Forestry were donated to the project. Most of these seeds collected or purchased for this project and offshoots of this project originated in the JW Hershey Forest Farm in Downingtown, PA as well as unique locations identified by the PA Nut Growers Association, Fruit Explorers, and the extensive work of Zach Elfers.

Direct Seeding

Both of the projects provided opportunities to not only demonstrate MRFBs, but the hybrid integration with other agroforestry systems such as alley cropping, hedgerows, silvopasture, windbreaks, and aspects of forest farming. The alley cropping design at the Buttonwood Forest Farm created an opportunity to direct seed the alleys with sunflowers for cut flowers, beauty, weed suppression, and the potential for birdseed product development in collaboration with the local feed mill. Pawpaw and American persimmon seeds were also direct seeded in the third zone at the Buttonwood Forest Farm.

Natural Regeneration

Quaking aspens from the Chesapeake Bay Foundation Keystone 10 Million Tree Partnership were also planted to grow as nurse trees to help the other species grow taller, straighter, and faster. They were planted throughout zone 1 and in zone 2 at Buttonwood. They are grown for wildlife habitat, and are central to early-succession regeneration management through cutting and coppicing (in Zone 2). According to wildlife biologists, a mature Quaking aspen tree can regenerate somewhere near 600-700 new aspen trees from the root sprout, sometimes up to 50' away, if cut and then protected from deer. The Quaking aspen and Bigtooth aspen trees are native to much of the Mid-Atlantic. Their value cannot be underestimated in terms of establishing the stands of early-successional young forests. The aspens connect the root systems of the trees together with the mycorrhizal network.

Species such as Black locust, Pawpaws, American plums, elderberries, and hazelnuts, among other species are known for their regenerative capacity through clonal root system sprouting. Black locust poles in an intensively managed agroforestry system can produce high-quality timber within 12 years.

Alternative Deer Control Fencing

Alternatives to tree tubes and deer exclusion fencing are arguably one of the most pressing issues in the establishment of and maintenance for both organic and conventional agroforestry systems. The plastic 5' and 2' rigid plastic tree tubes have an array of short-comings. The concept is how to design a more environmentally friendly and cost-effective tree shelter, optimizing tree and shrub growth, while leading to increased landowner and technical service provider adoption. Achieving these objectives would greatly increase landowner adoption in tree plantings across the Northeast while reducing plastic waste.

A visit from our local PA DCNR Service Forester, Tim Cole, at the two demonstration projects affirmed the importance of developing alternatives to the use of plastic tree tubes, as Tim is a strong advocate of constructing metal cages for the trees. A 100' roll of 5' tall welded wire 14 gauge fencing with 2"x4" holes costs \$125. Each of the cages are cut to an approximate 52" circumference resulting in enough cages to protect approximately 23 trees or shrubs at around \$5.43 each. Depending on location, terrain, and shape of the buffer approximately 30 cages can be cut, fabricated into a cage, and secured with stakes around the tree in an 8-hour day. At \$25 an hour the labor costs for constructing, and placing these cages is approximately \$6.50 for installation, once the materials are on location. However, the shape and conditions of some of the riparian buffers make some much more difficult than others. A 4-acre buffer can be 35' wide and 5,000' long, or a 4-acre buffer might be 300' wide and 580' long. Some buffers are far more expensive to implement than others. With survival rates and requirements at 225 stems per acre, the cost for metal cage installation is \$3,150/acre for cages. The price point is too high, without resources such as the Chesapeake Bay Foundation's Keystone 20 Million Tree Initiative offering trees and shrubs, plastic tubes and stakes for riparian buffer plantings. On slopes it is difficult for the cages to stay in place, so landscape fabric staples at the base of the cages were added to help them stay in place. Here are some of the other alternative deer exclusion approaches and techniques demonstrated through this project:

1) Larger plant material

The quicker the plant material grows above deer browse height, the better. Although still susceptible to deer browse a 6' tree needs a lot less protection than a 6" seedling. For one year the CBF Keystone 10 Million Tree Partnership offered larger stock to Centre County. This plant material was desirable. Unfortunately, Centre County is no longer considered a priority for the distribution of large plant material. Larger plant material was purchased for both demonstration locations through this project, with proven success in establishment, especially for the elderberries.

2) Fiddler's Bend fencing

The fencing constructed by a contractor around the second zone of the Fiddler's Bend location was successful in keeping the deer out in the establishment of the elderberries. The landowners placed peanut butter on the fence which attracted the deer, and zapped their noses on the wire. This fencing system cost \$3,000.

At Fiddler's Bend in the third zone/upland buffer the medicinal buffer utilized a variety of different types of cages to protect bare root seedlings. The rows were sheet-mulched with many of these seedlings having tremendous growth rates with over 50% of these 70

trees and shrubs growing from 6-12” to the 5-6’ within two years of planting. Although the chicken-wire fencing was proven successful there were relative trade-offs between the expense of the material and the time spent managing the materials. The more rigid material was more expensive, but stayed in place better.

3) *5 acres+*

During a conversation with Tim Cole, PA DCNR Service Forester in Centre County he shared that PA DCNR has calculated that if a planting project is 5 acres or larger it is more cost-effective to fence the whole area with deer fencing then to protect the trees individually.

4) *Portable electric fencing*

Portable electric fencing was installed at the Buttonwood Forest Farm with a solar charger. Although the trees in this project were tubed and staked this did not prevent the cattle from knocking over the tree tubes, breaking the stakes, eating all the live-staked material and regenerating elderberries. The on-going struggle with loose neighborhood cows resulted in the need to install portable electric fencing.

5) *Crib-style fencing*

The U.S. Fish & Wildlife Service in recent years has begun implementing what they call “crib-style” fencing. They determined that there are methods that exclude deer based on their behavioral instincts. Although deer are fully capable of jumping over a 4’ high fence, deer will not jump inside an enclosure that has certain elements that make them feel trapped. The largest area that has successfully excluded deer with the 4’ high fencing is approximately 40’x12’. Too much larger than that and the deer will jump inside the area. USFWS also determined the cost of installation of these structures with materials (welded wire fencing and 5’ t-posts) and labor to be \$3.50/linear foot. The USFWS installed crib-style fencing in a replication project in Spring Mills, PA. This design also works with the scale and design of the high-density Miyawaki afforestation method.



Figure 24. Crib-style fencing in a replication location

6) *Double-wide crib-style*

Similar to the crib-style fencing, the double-wide crib-style fencing is based upon behavioral instincts of deer to not jump inside an area where they feel trapped. However, this design is for larger-scale restoration projects. The entire perimeter of a large planting area (think a few acres) is surrounded by a double-wide 4' high fence that is approximately 8-12' between the two perimeter fences. This "enclosed" area around the perimeter of the large area prevents the deer from jumping into the planting area. The double-wide 8-12' distance is too close for the deer to jump inside (because they feel trapped), and it's too wide for them to jump over both into the planting area.

7) *Crib-style with nylon string*

The 40'x12' single crib design has been adapted by Ironwood Forestry at one of the replication locations in George's Valley (Spring Mills, PA), an area known for high numbers of deer per acre. Ironwood Forestry has taken the traditional design of these cribs and is using 5' wooden stakes wrapped with nylon string, instead of fencing, to behaviorally deter the deer. It has been successful with the deer so far, but selected planting stock should be larger than 2' to not be susceptible to rabbits.

8) *Coyote urine*

Coyote urine is currently on trial at a few replication locations. Products are marketed to prevent deer, groundhog, and small mammals (such as rabbits, moles, and voles). Due to

the rainy June and July in the summer of 2021 on-going reapplication is the biggest struggle in keeping up with the use of this product. It appears to not be a feasible method in isolation nor on projects larger than an acre. These products should be used in combination with other methods.

Other Lessons Learned About Fencing

So, here's the thing: Even at Fiddler's Bend with a more permanent deer fencing, there's still rabbits and destructive groundhogs. Farmers have traditional and unconventional methods for controlling groundhogs, generally speaking killing and trapping.

Even with the absolute best deer exclusion methods, with tubes, and cages, and fancy fences, having neighbors with cows or goats can completely upend every aspect of protection in the design and prescription. Natural resource professionals have to stay flexible and anticipate as much of what can go wrong as possible learning from each other and visiting projects.

Extreme weather continues to be more common. Some of the demonstration and replication location buffers are prone to swift floodwaters and other locations do not have overland flow. The nature of these systems is extreme. In some of the agricultural demonstration locations that have transitioned from conventional corn and soybeans, the drought conditions are more extreme due to lack of organic matter, persistent chemical use, and highly compacted soils. The 6-week drought in the summer of 2020 decreased survival rates and made establishment more difficult. Implementers of MFRFBs should take soil samples.

Citizen Science Monitoring

Monitoring data for the demonstration locations as well as the gathering of monitoring resources and techniques played a crucial role in measuring baseline data for the project as well as showcasing for others how to monitor for MFRFB ecological success. The monitoring data of the demonstration locations are included in the monitoring section of this report, in the last chapter.

Citizens can participate in monitoring, including:

- Temperature
- Sediment
- Macro-invertebrates
- Chemical
- Survival rates

A collection of resources for monitoring water quality and habitat can be found in the toolkit [here](#).

Collaborations

Collaborations were key to the success of the project, from technical assistance to the sharing of methods and improved genetic material. Other key collaborations were with inventors who fabricated elderberry destemming machines to the development of processing equipment. Some of the key collaborators include:

- PA DCNR- Tim Cole, Tracey Coulter, Kelsey Miller, and Matt Keefer visited the demonstration locations to offer suggestions
- USFWS visited the demonstration locations to offer suggestions
- Kate MacFarland, agroforester for the USDA National Agroforestry Center (NAC)
- Keystone Tree Crops Cooperative (KTCC) and Fruit Explorers
- [SilvoCULTURE](#) Nuts for the future purchased a shared oil press
- The Alliance for the Bay is connecting MFRFB projects with harvesters for establishing funding for on-going maintenance
- Herb Grove is a local farmer and machinist who constructs processing equipment such as elderberry destemmers and hemp/ herbal products drier
- Gary Gilmore is a machinist and forester who worked to develop an elderberry destemming machine
- USDA NRCS- Scott Heckman visited the demonstration locations to offer suggestions
- Centre County Conservation District offered technical assistance for watershed management and organic establishment
- Clearwater Conservancy visited the demonstration locations to offer suggestions
- PVCA provided ongoing long term stream monitoring efforts
- The Ecological Gardening Guild of Southcentral PA aided in the growing of the skilled labor force
- Chesapeake Conservancy provided high-resolution land use data and Ag BMP prioritization tools

Challenges

A handful of the greatest challenges during the project resulted in the greatest successes: The advent of the elderberry destemming machine, the Keystone Tree Crops Cooperative, the collection of economic opportunities, and the species matrix tool. Some of the greatest challenges, not yet resolved, will continue to be roadblocks to future success, as well as the greatest opportunities for innovation. However, there are many challenges still remaining, some of which were compounded with COVID19. Major challenges included:

1) Tree tubes vs. cages

The use of plastic tree tubes on a large scale questionably has far lasting unintended consequences for the net carbon footprint in the work of MFRFBs. Although the tree tubes have been successfully utilized on the landscape in the establishment of the buffers, the reliance on single-use plastics has created a false façade of environmentally-friendly tree planting efforts.

2) Organic labor—sheet mulching, mulching, weed mats

The implementation of organic methods continues to be a roadblock, in that organic methods and practices have a higher demand for skilled labor. In Ferich's experience, the difficulty of maintaining a trained workforce who knows how to properly plant, reliably use shovels, talk with landowners, and understand basic species identification and site design has been a roadblock to success. After the labor pool has been trained and experienced, Ironwood Forestry has paid labor \$25/hour for retention, yet the work is grueling, for some, day in and out, year after year. The seasonality of the work has made it difficult to retain good labor. Ironwood Forestry is attempting to create a calendar year

full of employment opportunities for skilled labor in the tree crops economy. The development of the Miyawaki method has increased summer labor opportunities with deep bed preparation. Perhaps the advent of value-added processing capacity such as elderberry syrup and hemp fiber row covers will create more year-round opportunities and more retention of skilled labor.

3) *Processing bottlenecks*

Processing bottlenecks continue to be one of the most limiting factors for MFRFB product opportunities. The demand for these products is clear, it is growing, and so too is the supply. Yet the processing capacities and aggregation of raw and value-added products is perhaps one of the biggest challenges for scalability, adoption, and profitability. Certain MFRFB products require drying, hulling, pressing, pulverizing, or in the case of the Pawpaw scooping and cleaning by hand. In some cases, the processing of the NTFPs makes it consumable, such as in the case of the removal of stems from the elderberries. In other instances, the processing keeps the products from being destroyed by pests, as in the case of the chestnut weevil and water bath, and in some instances the processing into value-added products is what adds value such as with hickory oil and even shelf stability as with elderberry syrup. Some of these processing bottlenecks are related to labor as in picking raspberries or processing Pawpaw pulp, and some of these processing bottlenecks are equipment oriented as in drying Black raspberry leaves or elderberries with an industrial dryer. Again, the challenges are also the opportunities, as some of these more labor-intensive products might be better suited for festivals or pick-your-own style farms.

4) *Neighbor's cattle*

The Buttonwood Forest Farm design and demonstration had difficulties related to the neighbors' cattle. From April-July 2020 up to a dozen cows a day were grazing through the demonstration area. The neighboring farmer was contacted repeatedly by Ferich. The farmer finally resolved it in August 2020, at the end of the drought, in the middle of COVID. This delayed the crops going into production as well as the accuracy of survival rates. Establishment rates can have unpredictable obstacles ranging from neighbor's cattle, Brood X cicadas, or local ordinances.

5) *Extreme weather*

The duration of this project was marked by extreme weather events, both droughts and flooding, but mainly flooding. As temperatures soared and the rains stopped, it became evident that in order to ensure optimal growth at both locations a watering system needed to be implemented to increase survival and growth rate. Being that the projects are riparian, a water pump made the most sense; however, electricity is not available at either location. A generator did not make any practical sense, so a \$300 heavy duty water pump with 4-stroke engine, the Generac CW10K, was purchased from the Millheim Small Engine Shop. This pump is favored amongst the Amish farmers, is lightweight, heavy duty, and has far exceeded the expectations of the land manager and landowners, thus far. However, it is not a practical solution with waterways that disappear when the water is needed most.

While drought was a challenge, flooding also presented problems. As can be seen in the figure below, the riparian buffer area at the Fiddler's Bend demonstration location was under swift moving water for over three days in 2018, from a major 12" rain event in the Penns Valley Area.



Figure 25. Fiddler's Bend multifunctional riparian forest buffer underwater after multiple 3-inch rain events in the fall of 2018



Figure 26. Fiddler's Bend multifunctional riparian forest buffer after floodwaters subsided with no mortality

There was much uncertainty how this flood event was going to impact the survival rates of the planting that had occurred in the spring of 2018. Luckily, the only mortality that occurred during this and other flooding events was the Sassafras trees. They were unable to survive full submersion for three days. Similarly, the Eastern redbud trees planted in one of the lowest parts of the riparian buffer struggled after three days of sitting water, and the species is not recommended for slow draining areas. While tree tubes on the Aronia washed away and debris covered many of the elderberries and Aronia as well as the bottom strands of the fencing, there was minimal dieback on the American elderberry and Aronia, and they had established their root systems. The cardboard and mulch system utilized as weed control in riparian area failed, and the cardboard washed away. The sheet mulching method is not recommended for the flood plain.

While flooding was a challenge, it also allowed for the land manager as well as the landowners to have a better understanding of the successes and failures in the designs, learning from the rain events. The series of photographs that follow focus on the before and after conditions of the upland riparian medicinal hedgerow at Fiddler's Bend—the significance of an unknown flow path through the buffer flowing into Pine Creek can be seen during the peak of the August flooding.



Figure 27. Winter 2018 Fiddler's Bend extended third zone site prep with flooded conditions 5 months later



Figure 28. Fall 2018, successful establishment of bare root seedlings in medicinal buffer, 6 months growth from 6-18" seedlings with organic methods

The flood events of August and September 2018 had a different effect on the Buttonbush Forest Farm. The topography of the location includes one of the largest mid-valley hill

slopes in the subbasin directly adjacent to the tributary. During the actual flooding event the water table was saturated and numerous seeps or springs were identified throughout the property. Surface water sheetflow flowed off the hillslope for numerous days after the flood event, and the groundwater was saturated for weeks after the flood event. As can be seen in the photograph below, the groundwater of the southern portion of the riparian buffer, which had not been planted yet, was completely saturated in the beginning of October, weeks after the major flood events.



Figure 29. Buttonwood Forest Farm after significant rainfall in the fall of 2018, just prior to transition from vegetable farm to multifunctional riparian forest buffer

Extreme weather can greatly change the perceptions of landowners related to perceived roadblocks to adoption. In Ferich's thesis research she determined that in wet years, such as the fall of 2018 with 12" rain events, farmers and landowners identified seeing demonstration locations as the limiting factor, whereas in dry years, time was the limiting factor (Ferich 2021). The extreme weather also impacted various aspects of establishing the crops as well as monitoring, at times it was difficult to get into the locations, and planting was delayed. The fall of 2018 was full of mosquitos, lost thermal monitors, flooded planting areas, high amounts of debris, lost tree tubes, and the mortality of some species, such as Sassafras. The large volume of mosquitoes led to outbreaks of West Nile Virus, impacting the avian communities. The drought of the summer 2020 led to a serious reduction in survival rates with live-stake and bare root material, the inability to monitor the water in the smaller tributaries that dry up, and increased labor needs related to watering.

6) *Global pandemic*

One of the clearest struggles was related to COVID19. Field trips were cancelled, landowners were impacted in different ways, agencies had different policies related to site visits. The food system greatly shifted during COVID, which made it difficult to research and write about the economic opportunities for the MFRFB products.

Advice for planning a MFRFB Project

There are a handful of different pieces of advice for natural resource providers or landowners considering similar projects. The first piece of advice is visit demonstration or replication projects, get a feel for the aesthetic, maintenance requirements, and different stages of production. Ferich also suggests finding projects that have failed and successful projects, spend a day volunteering at both, find a project in a place that has noxious weeds or uncontrollable deer pressure. Find mature trees or shrubs that have gone into production, a crop that you would like to work with, and become familiar with harvesting, processing, marketing, value-added product development, and timing. Species such as Pawpaws require far more work than most people anticipate and are perhaps better suited for a pick-your-own model or a festival. Landowners should become familiar with the products they would like to produce before planting hundreds or thousands of that tree or shrub.

Above all else the advice Ferich would give landowners is to be flexible, expect more deer browse than you can imagine, anticipate wild extreme weather conditions, anticipate new emerging invasive pests and diseases, and diversify your species. Work to connect with landowners who are active in their land management, and find ways to inspire community-based landscape restoration through activities such as asset mapping, finding common ground, and spending time observing the changing rhythms. Additionally, take soil samples, look at historical maps, try and find intact riparian ecosystems near the project, and work to collaborate with as many partners as possible.

CHAPTER 4 Ecological Assessment

Monitoring: Waterways and Wildlife

Ecological monitoring was conducted at both demonstration locations. The results generated baseline data. It can be difficult to extrapolate quantifiable ecological impacts that are direct results of this project, as both of these projects are new. The water quality data is influenced by variables outside of the project such as floods, new neighbors upstream, changes in land use, technological advances, or new farming practices. The flooding in the fall of 2018 broke statewide precipitation records. The amount of rainwater not only changes the chemistry and temperature of the water, it also generally increases sedimentation through erosion. The extreme flooding all around the Susquehanna River Basin increased mosquito populations to a level that caused a West-Nile Outbreak that made noticeable impacts on the bird communities the following spring. On-going monitoring data will be made available on the Penns Valley Conservation Association website as it becomes available (www.pennsvalley.net). Detailed analysis of monitoring outcomes in thermal, chemical, and biological factors at the upstream and downstream reaches of both locations are included below. The macroinvertebrate survey and chemical analysis were conducted by members of the Water Quality Volunteer Coalition and Andrea Ferich. The macro assessments utilize a biological index to calculate the overall water quality score.

There is a tributary flowing into the Fiddler's Bend section of Pine Creek. There was extensive logging upstream on this tributary with cattle in the stream. Although we would like to demonstrate that there are improvements to the water quality as it flows through this property, there are variables that are difficult to include. There are also high-concentration feeding areas located to the east and the west of the Buttonwood Forest Farm, with on-going shifts in land use. Additionally, the extreme weather that occurred from 2018-2020 makes monitoring outcomes difficult to interpret. The fall of 2018 saw extreme flood conditions, whereas the fall of 2020 was an extreme drought. The data will continue to be compiled and brought together. Although it is difficult to demonstrate and assess that riparian buffers have an impact on water quality and instream habitat within only a few years due to annual climatic fluctuations this data is extremely important in monitoring the long-term changes and assessments of the waterway, as well as demonstrating techniques for others. Chemical data such as dissolved oxygen, nitrate, ortho-phosphate, pH, conductivity, salinity, total dissolved solids, and alkalinity were collected annually in November, when possible, upstream and downstream at both locations. Macroinvertebrate data was also collected at this time. Temperature data was also collected upstream and downstream at both locations as well during this time.

Table 15: Fiddler's Bend Chemical Data Upstream			
	Nov-18	Nov-19	Nov-20
Air temperature	48 °C	46°C	45°C
Water temperature	6.3°C	9.1°C	7.3°C
Dissolved oxygen	12.54 mg/L	9.44 mg/L	9.44 mg/L
Nitrate	0.8 mg/L	1.0 mg/L	1.0 mg/L
Ortho-Phosphate	0.1 mg/L	0.03 mg/L	0.03 mg/L
pH	8.08	8.08	8.08
Conductivity	87.8 uS/cm	93.4 uS/cm	93.4 uS/cm
Salinity	41.5	36.7	36.7
Total dissolved solids	61.9	66.2	66.2
Total Alkalinity	40 mg/L CaCo3	60 mg/L CaCo3	60 mg/L CaCo3

Table 16: Fiddler's Bend Chemical Data Downstream			
	Nov-18	Nov-19	Nov-20
Air temperature	48 °C	46°C	45°C
Water temperature	10.9 °C	9.6°C	7.4°C
Dissolved oxygen	8.86	11.5 mg/L	8.67 mg/L
Nitrate	1.5 mg/L	2.4 mg/L	6.5 mg/L
Ortho-Phosphate	0.4 mg/L	0.12 mg/L	0.09 mg/L
pH	7.34	7.75	8.15

Conductivity	563 uS/cm	204 uS/cm	440 uS/cm
Salinity	268	95.4	172
Total dissolved solids	400	145	314
Total Alkalinity	340 mg/L CaCo3	80 mg/L CaCo3	160 mg/L CaCo3

Table 17: Buttonwood Forest Farm Chemical Data Upstream			
	Nov-18	Nov-19	Nov-20
Air temperature	48 °C	46°C	45°C
Water temperature	11.3 °C	8.9°C	Dry no data
Dissolved oxygen	9.86	10.8 mg/L	Dry no data
Nitrate	1.3 mg/L	2.3 mg/L	Dry no data
Ortho-Phosphate	.25 mg/L	0.12 mg/L	Dry no data
pH	7.49	7.89	Dry no data
Conductivity	607 uS/cm	554 uS/cm	Dry no data
Salinity	288	261	Dry no data
Total dissolved solids	429	393	Dry no data
Total Alkalinity	380 mg/L CaCo3	320 mg/L CaCo3	Dry no data

Table 18: Buttonwood Forest Farm Chemical Data Downstream			
	Nov-18	Nov-19	Nov-20
Air temperature	48 °C	46°C	45°C
Water temperature	10.9 °C	9.6°C	7.4°C
Dissolved oxygen	8.86	11.5 mg/L	8.67 mg/L
Nitrate	1.5 mg/L	2.4 mg/L	6.5 mg/L
Ortho-Phosphate	0.4 mg/L	0.12 mg/L	0.09 mg/L
pH	7.34	7.75	8.15
Conductivity	563 uS/cm	204 uS/cm	440 uS/cm
Salinity	268	95.4	172
Total dissolved solids	400	145	314
Total Alkalinity	340 mg/L CaCo3	80 mg/L CaCo3	160 mg/L CaCo3

Macroinvertebrate Inventory

The results from the macroinvertebrate surveys are pictured below. At the Fiddler's Bend property macroinvertebrate water quality score greatly increase from the upstream to downstream reaches, with little to no observable change over time. However, at Buttonwood Forest Farm the opposite occurs. Results conclude that macro health is greater at the upstream reaches of the property scoring 23.2 in water quality health (Fair) whereas the bottom reach scored 18 (Poor), along the heavily cultivated row crop area, and neighboring animal concentration areas.

Table 19: Fiddler's Bend Macro Invertebrate Upstream Data	
2018	2020
Group I-Sensitive (nothing)	Not enough flow
Group II- Somewhat sensitive (1 Scud)	Not enough flow
Group III- Tolerant (4 Aquatic Worm, 1 snail)	Not enough flow
Water Quality Score- 5.6 Poor	Not enough flow

Table 20: Fiddler's Bend Macro Invertebrate Downstream Data	
2018	2020
Group I- sensitive (100 Mayfly, 23 Stonefly)	Group I-sensitive (7 water penny, 10 mayfly, 1 stonefly)
Group II- somewhat sensitive (13 Scuds, 4 Crane fly, 12 Net spinning caddisfly, 100+ Sowbug)	Group II-somewhat sensitive (45 Net spinning caddisfly, 1 sowbug, 3 crayfish)
Group III-tolerant (5 Aquatic Worm, 18 Midge, 1 Snail)	Group III- tolerant (25 midge)
Water quality score= 26.4 (fair)	Water quality score=26.5 (fair)

Table 21: Buttonwood Forest Farm Upstream Macro Invertebrate Data	
November 2018	November 2020
Group I- Sensitive (2 Riffle Beetle adult, 1 Mayfly)	Dry no data
Group II- Somewhat Sensitive (17 Crane fly, 8 Net spinning caddisfly)	Dry no data
Group III- Tolerant (13 Aquatic worms, 13 Midge, 18 Blackfly)	Dry no data
Water Quality Score- 23.2 Poor	Dry no data

Table 22: Buttonwood Forest Farm Downstream Macro Invertebrate Data		
2018		2020
Group I- Sensitive (5 Mayfly)		Dry no data
Group II- Somewhat Sensitive (100 Scuds, 6 Net spinning caddisfly, 3 Sowbug)		Dry no data
Group III- Tolerant (9 Aquatic worm, 12 Blackfly, 12 Midge, 16 Snail)		Dry no data
Water Quality Score- 18.9 Poor		Dry no data

Temperature Data

Below is a collection of thermal data from June-November at both upstream and downstream reaches. This data serves as baseline data for on-going monitoring efforts.

Fiddler's Bend 2018

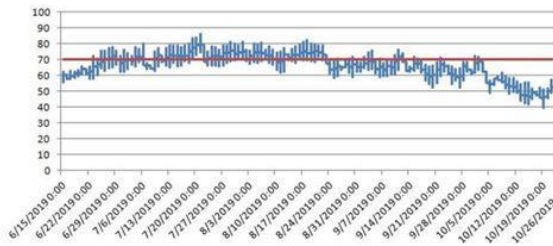
Pine Creek (DePasquale Upstream)*



35. Pine Creek (DePasquale downstream)*
Lost in the great flood of 2018

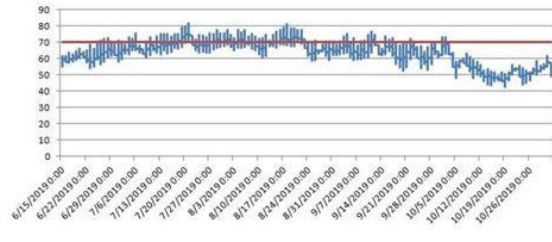
Fiddler's Bend 2019

Pine Creek 1



Minimum	39.783
Maximum	86.074
Average	65.30953

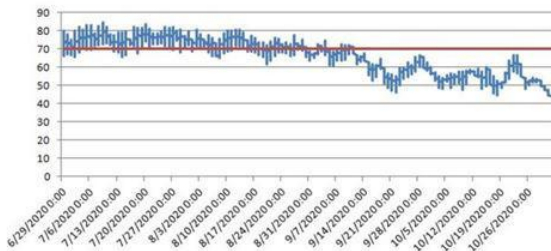
Pine Creek 2



Minimum	42.663
Maximum	81.775
Average	63.94417

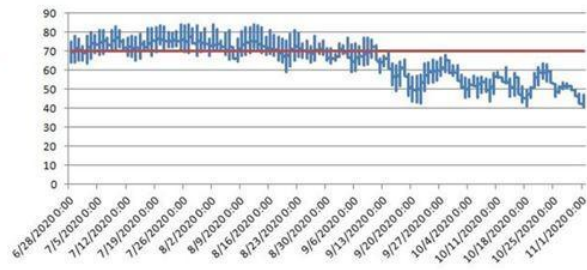
Fiddler's Bend 2020

Pine Creek 1



Minimum	43.671
Maximum	84.407
Average	65.75452

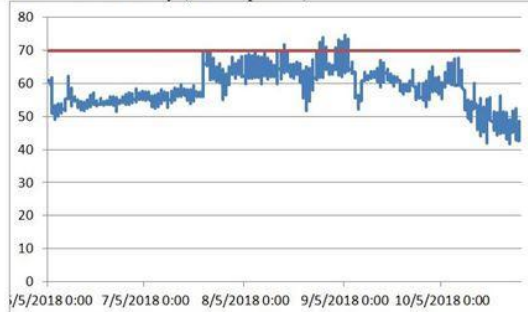
Pine Creek 2



Minimum	40.764
Maximum	84.227
Average	65.2076

Buttonwood Forest Farm 2018

Unnamed Pine Creek Tributary (Stubbs upstream)*



*Portions of data incomplete from drought and flood
Minimum 41.8°F
Maximum 74.6°F
Average 58.5°F

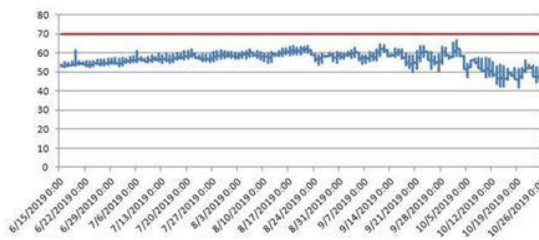
Unnamed Pine Creek Tributary (Stubbs downstream)



Minimum 42.7°F
Maximum 69.0°F
Average 55.8°F

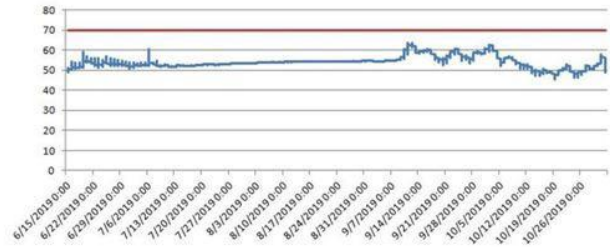
Buttonwood Forest Farm 2019

Pine Tributary 4



Minimum	42.109
Maximum	66.643
Average	56.51384

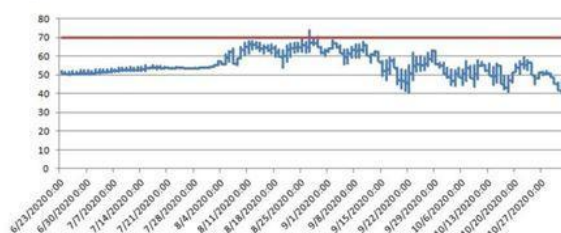
Pine Tributary 5



Minimum	45.624
Maximum	63.732
Average	53.93248

Buttonwood Forest Farm 2020

Pine Tributary 4



Minimum	39.924
Maximum	73.774
Average	55.71418

Out of water- no data

Table 23: Maximum Temperature

	2018	2019	2020
Buttonwood Upstream	74.6	66.6	73.8
Buttonwood Downstream	69	63.7	n/a
Fiddler's Bend Upstream	n/a	86.1	84.4
Fiddler's Bend Downstream	n/a	81.8	84.2

Wildlife

As stated previously, the monitoring data is treated as a baseline. The ornithological data was entered during bird walking events with local citizen scientist Joe Gyekis. Extensive data can be found online regarding [the habitat requirements of American woodcock early successional habitat](#), in collaboration with the Penns Valley Conservation Association and project partners.

Detailed annual species inventories of the two locations can be found on ebird, on the links below:

<https://ebird.org/checklist/S72876486>
<https://ebird.org/checklist/S72868498>

<https://ebird.org/checklist/S48671621>
<https://ebird.org/checklist/S48673768>

<https://ebird.org/checklist/S55522247>

Additional on-going resources as well as cultivar descriptions can be found in the [Appendix](#).

Works Cited

Acker, Judy. Audubon Pennsylvania. French Creek, PA. Native PA species shrubs and trees eligible for stormwater credits in Crawford County. 2016. [accessed 2018 August 1]. https://pa.audubon.org/sites/default/files/crawford_trees_and_shrubs_eligible_for_storm_water_credits.pdf

Alexander SJ, McLain R. 2001. An overview of non-timber forest products in the United States today. v. 13. Journal of Sustainable Forestry.
https://www.researchgate.net/publication/43269115_An_Overview_of_Non-Timber_Forest_Products_in_the_United_States_Today

Armstrong A, Stedman R. 2012. Landowner willingness to implement riparian buffers in a transitioning watershed. Landscape and Urban Planning. 105(3): 211-220.
doi:10.1016/j.landurbplan.2011.12.011.

Baumflek MJ. Assessment of nontimber forest products in the United States under changing conditions. 2020. Ashville, NC. USDA Forest Service Research and Development. Eastern Forest Environmental Threat Assessment Center.
https://forestthreats.org/products/publications/Regional_summaries_of_nontimber_forest_products-Northeast.pdf

Chesapeakebay.net: Forest Buffers. 2021 Annapolis, MD: Chesapeake Bay Program; [accessed 2021 August 1]. https://www.chesapeakebay.net/issues/forest_buffers

Ferich A. 2021. Landowner attitudes toward multifunctional riparian forest buffers in the Chesapeake Bay Watershed. [thesis]. University Park: Penn State University.

Fishbach J, Braun L. (2017). A production and economic model for hedgerow hazelnut production. Upper Midwest Hazelnut Development Initiative (UMHDI). V.4 [accessed 2021 August 1].

- https://www.midwesthazelnuts.org/uploads/3/8/3/5/38359971/production_and_economic_model_for_hedgerow_hazelnut_production_v4.pdf
- Iowa State University. Agricultural Marketing Research Center. 2021. Pawpaw. Ames, Iowa. [accessed 2021. August 1]. <https://www.agmrc.org/commodities-products/fruits/pawpaw>
- Jensen J. 2014. [Agroforestry on the Farm](#): Aronia Berry at Winding Creek, Belmond Iowa. Trees Forever. Iowa State University. Ames, Iowa. Leopold Center Publications and Papers. [accessed 2021 August 1]. https://lib.dr.iastate.edu/leopold_pubs/papers/14
- [Jones SC, Peterson RN, Turner TA, Pomper KW, Layne DR. Pawpaw planting guide. 2009. Kentucky State University. Frankfurt, KY. \[accessed 2021 August 1\]. http://www.pawpaw.kysu.edu/pawpaw/ppg.htm](#)
- Kashian R. 2016. Aronia Berry Feasibility Study: An evaluation to determine the feasibility of Aronia berries at the Kohler Company. Whitewater, Fiscal & Economic Research Center (FERC). [accessed 2021 August 1]. <https://static1.squarespace.com/static/5cca3d22af4683c0da45b361/t/5d1acafed6d53f000156764e/1562036994252/Aronia+Berry+Study+for+Kohler+Co++1.18.16.pdf>
- Krawiec S. 2021. How elderberry became an immune-health superstar last year. 2021 ingredient trends to watch for food, drinks, and dietary supplements. Nutritional Outlook Vol. 24 No.1, Volume 24, Issue 1. [accessed 2021 August 1]. <https://www.nutritionaloutlook.com/view/how-elderberry-became-an-immune-health-superstar-last-year-2021-ingredient-trends-to-watch-for-food-drinks-and-dietary-supplements>
- MarketWatch. 2021. Aronia berries market 2021 share top manufacturers market segmentation types technology trends and forecasts. [accessed 2021 August 1]. https://www.marketwatch.com/search?q=aronia&Link=MW_SearchAC&mod=keyword_search
- Meinhold K, Darr D. 2019. Kleve, Germany. The processing of non-timber forest products through small and medium enterprises—A review of enabling and constraining factors. University of Applied Sciences. MDPI Forests. V. 2. [accessed 2021 August 1]. https://mdpi-res.com/d_attachment/forests/forests-10-01026/article_deploy/forests-10-01026-v2.pdf
- [Molnar TJ, Goffreda JC, Funk CR. Developing Hazelnuts for the Eastern United States. Rutgers University. New Brunswick, NJ. \[accessed 2021 August 1\]. https://www.arborday.org/programs/hazelnuts/consortium/documents/developing-hazelnuts-eastern.pdf](#)
- Mordor Intelligence. Global hazelnut market- growth, trends, COVID-19 impact, and forecasts

- (2021-2026). 2021. [accessed 2021 August 1].
<https://www.mordorintelligence.com/industry-reports/global-hazelnut-market>
- Pennsylvania Association of Conservation Districts. PA conservation reserve enhancement program. 2016. [accessed 2020 August 1]. <https://www.creppa.org/about/>
- Pennsylvania Department of Conservation and Natural Resources. Buffer zones species fact sheet. 2018. Harrisburg, PA. [accessed 2018 August 1].
<http://elibrary.dcnr.pa.gov/PDFProvider.ashx?action=PDFStream&docID=1743387&checksum=&revision=0&docName=Buffer+Zones+Species+Fact+Sheets+FINAL&nativeExt=pdf&PromptToSave=False&Size=980810&ViewerMode=2&overlay=0>
- Rhea D. Extension.psu.edu: 2020. Multifunctional Riparian Forest Buffers- More than just trees. Penn State Extension. [accessed 2021 August 1].
<https://extension.psu.edu/multifunctional-riparian-forest-buffers-more-than-just-trees>
- Slattery, Britt E., Kathryn Reshetiloff, and Susan M. Zwicker. 2003. Native Plants for Wildlife Habitat and Conservation Landscaping: Chesapeake Bay Watershed. U.S. Fish & Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD. 82 pp. [accessed 2017 August 1].
<https://www.fws.gov/Chesapeakebay/pdf/NativePlantsforWildlifeHabitatandConservationLandscaping.pdf>
- Thevathasan N, Gordon A. 2014. University of Guelph: Association for temperate agroforestry. Alley cropping could help Canada meet Kyoto Protocol commitments. [accessed 2021 August 1]. Vol. 13. <https://www.aftaweb.org/latest-newsletter/temperate-agroforester/90-2005-vol-13/april-no-2/105-alley-cropping-could-help-canada-meet-kyoto-protocol-commitments.html>

University of Maine Extension. 2021. Culture of Aronia for Fruit Production. Cooperative Extension. Agriculture. Orono, Maine. [accessed 2021 August 1]. <https://extension.umaine.edu/agriculture/aronia/culture/>

USDA Agricultural Marketing Service. 2021. Specialty crops terminal market standard reports. [accessed 2021 August 1]. <https://www.ams.usda.gov/market-news/fruit-and-vegetable-terminal-markets-standard-reports>

USDA National Agroforestry Center. 2014. Working trees. Lincoln, Nebraska. [accessed 2021 August 1]. https://www.fs.usda.gov/nac/assets/documents/workingtrees/infosheets/WTInfoSheet_EdiblesNFTP.pdf

USDA Natural Resource Conservation Service. Conservation Reserve Program PA. Harrisburg, PA. [accessed 2020 August 1]. <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/pa/programs/financial/?cid=nrcseprd1124008>

U.S. Forest Service. USDA. 2020. Washington, D.C. Natural dye plants. [accessed 2021 August 1]. <https://www.fs.fed.us/wildflowers/ethnobotany/dyes.shtml>

Xerces society for Invertebrate Conservation. Pennsylvania hedgerow planting (422) for pollinators. 2018. Portland, OR.[accessed 2018 August 1]. <https://www.xerces.org/publications/habitat-installation-guides/pennsylvania-hedgerow-planting-422-for-pollinators>

