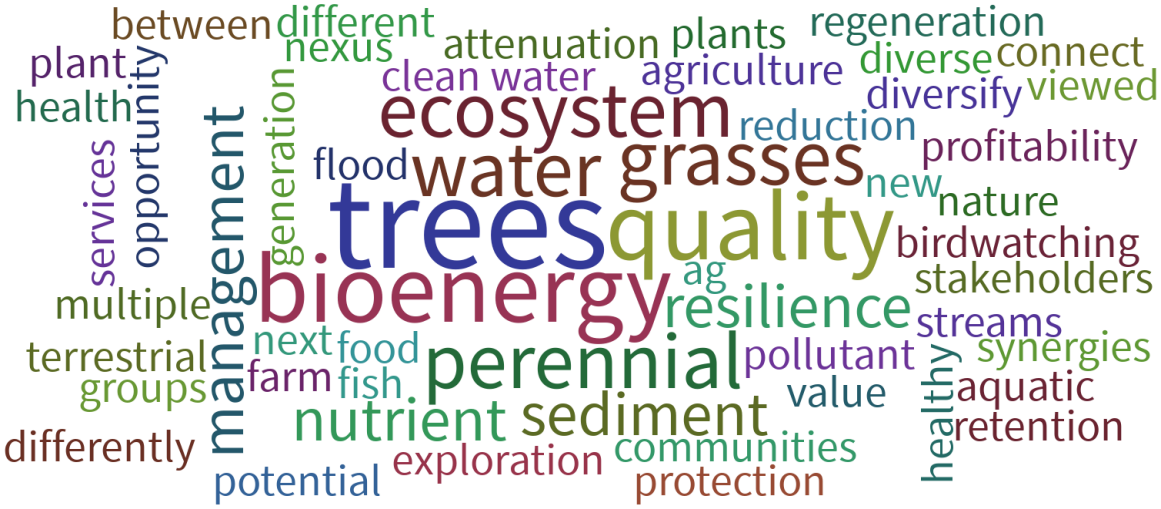
How do we accelerate riparian buffer plantings across the Chesapeake Bay with the greatest economic, social and environmental impacts?



STAC Workshop Report
November 13-14, 2018
Harrisburg, PA

STAC Publication 19-008

About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its creation in 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. For additional information about STAC, please visit the STAC website at http://www.chesapeake.org/stac.

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Cover graphic: "Word cloud" generated during the workshop using on-line software available at PollEverywhere.com – see Figure 2 in report. Word size within the cloud is proportional to the number of instances of the given word in participant responses to the question, "What are buffers?".

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Contents

Executive Summary

The Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) held a stakeholder workshop in November 2018 on the topic of market-based approaches for multifunctional buffers to identify means of accelerating riparian buffer plantings in the Chesapeake Bay with minimal government subsidies. The term "multifunctional buffers" as used in this report refers to vegetated zones that improve water quality while providing other co-benefits such as financial profits to landowners and ecosystem services. Increasing buffer mileage in the Chesapeake Bay watershed is key to reducing the nutrient and sediment loads reaching the Bay.

In 2014, the Chesapeake Bay Program (CBP) partnership developed a new Watershed Agreement that describes concrete goals and outcomes for the Chesapeake Bay. This Agreement outlines mechanisms needed to meet water quality requirements for the Bay and its watershed. The Agreement requires that nitrogen, phosphorus, and sediment control practices should be implemented by 2025 to achieve water quality standards as described in the 2010 Total Maximum Daily Load (TMDL). In an effort to reduce nutrient and sediment loads from agricultural sources, the Chesapeake Bay Program aims to "restore 900 miles per year of riparian forest buffer and conserve existing buffers until at least 70 percent of riparian areas throughout the watershed are forested" (Chesapeake Bay Program 2019). Buffers are a proven method for improving water quality through the filtration of particulates and nutrients and their removal via soil storage, denitrification, and plant uptake. Due to their ability to provide multiple system benefits, riparian buffers are an important practice in the Chesapeake Bay cleanup and protection effort.

Under the current Chesapeake Bay Watershed Agreement, each Bay jurisdiction is tasked with developing Watershed Implementation Plans (WIPs) in three phases (2010, 2012, and 2019) to guide best management practice (BMP) implementation. In this regard, Pennsylvania committed through its Phase I and II WIPs to plant 110,000 additional acres of riparian buffers (beyond those existing in 2010). As of November 2018, Pennsylvania had established less than 20% of its goal with only 18,602 acres of new buffers (Devereux 2018). At that annual implementation rate, it would take almost forty years for the Commonwealth to reach its buffer implementation goals.

By focusing on scalable solutions to promote implementation of multifunctional riparian buffers, this workshop aimed to identify ways to accelerate the rate of buffer plantings in Pennsylvania and the greater Chesapeake Bay watershed. The use of riparian buffers to improve water quality is well established as a concept (Mayer et al. 2005, Christian et al. 2009, and Hill 2019). However, implementation of buffers can take many different forms, including multifunctional buffers which provide other benefits such as improved ecoservices and marketable crops. Specific designs vary with respect to buffer vegetation, buffer width, the specific location of buffer placement, local biophysical conditions, market opportunities, and landowner preferences. In recognition of these differences, participants identified barriers to success for each market-based

opportunity and discussed potential solutions to guide and accelerate riparian buffer plantings.

The 2018 workshop was timely, as the Phase III WIPs were planned to be finalized in 2019. A committee of academics, government officials, industry representatives, conservation professionals, and STAC staff served as the steering committee for the workshop. The event brought together over fifty stakeholders and experts, including those working on Pennsylvania's Phase III WIP, to discuss market-based buffer implementation opportunities and policies designed to promote buffers. Stakeholders included farmers, scientists, cooperative extension personnel, nonprofit organizations, local, state and federal agencies, agricultural consultants, rural sociologists, and graduate students.

Workshop participants recommended that the Chesapeake Bay Program partners pursue the following six actionable solutions to guide and accelerate multifunctional riparian buffer plantings:

1. Pursue scalable and flexible solutions to planting buffers, including planting native perennial grass buffers rather than strictly focusing on forested buffers.

2. Focus on planting buffers with plants that are proven to be economically feasible.

3. Design for success by installing low maintenance plant species in buffers to reduce maintenance needs.

4. Promote demonstration projects on successful, well-operated farms to "normalize" or enhance landowner acceptance of buffer implementation as commonplace to farmers.

5. Establish strong, stable partnerships across the Bay watershed that link farmers to private funding in addition to state funding opportunities.

6. Incentivize involvement by creating a range of programs and learning opportunities at a range of educational scales, including primary, secondary, university and young professional levels.

Introduction and workshop objectives

The goal of this workshop was to identify ways to accelerate the establishment of multifunctional riparian buffers within the Chesapeake Bay watershed to meet water quality standards with minimal government subsidies. Over fifty stakeholders convened to discuss opportunities for market-based approaches to promote multifunctional riparian buffer implementation. Workshop participants included farmers, scientists, cooperative extension personnel, nonprofit organizations, state and federal agency personnel, agricultural consultants, rural sociologists, and academics.

Riparian buffers are strips of vegetation along streams and can include perennial trees or grasses and are an important "best management practice" (BMP) for the

Chesapeake Bay. Buffers contribute and provide several critical functions, including stabilizing stream banks, filtering nutrients, preventing pollution from entering streams, and providing shade and leaf litter for aquatic life. Buffers are a proven method for improving water quality through the filtration of particulates and nutrients, and their removal via soil storage, denitrification, and plant uptake. Denitrification involves permanent removal of nitrate by conversion to nitrogen gas and occurs in the absence of oxygen. In contrast, nutrients taken up by plants can be released back to the soil after plants die and decompose (Hill 1996). Moreover, the capacity of soil to store phosphorus may become saturated over time, releasing legacy phosphorous to soil water and thus to streams (Dodd and Sharpley 2016). According to Dodd and Sharpley, harvesting plants from buffers is a potential strategy to extract both phosphorus and nitrogen from the buffer zone and can be an important way to maintain buffer function over time. This is especially important where excess nutrients or legacy phosphorus are a concern.

This workshop focused on *multifunctional* buffers, which are defined for purposes of this report as vegetated zones able to improve water quality and increase landowner profits while providing other co-benefits such as ecosystem services. Ecosystem services include but are not limited to carbon sequestration, pollinator and wildlife habitat, improved soil organic matter, and aesthetics. This workshop aimed to reframe buffers as a practice not only good for water quality, but also one that provides economic and social benefits to landowners and surrounding communities. A successful multifunctional buffer is a system that landowners are motivated to implement themselves because the buffer provides profit and other valued services.

The buffers considered in the workshop included systems with both trees and grasses. Although forest buffers have been a past primary focus of management within the Chesapeake Bay watershed (due to their important ability to shade cold water fisheries), literature suggests that both forests and grass buffers can reduce nutrient and sediment pollution and improve water quality. Examples of plants that might be included for profit in a multifunctional buffer include sugar maples, hazelnuts, elderberries, persimmons, Red-Osier Dogwood, Pussy willows, perennial wildflowers, and warm season grasses like switchgrass.

Participants were asked to examine policy-based incentives for buffer implementation, rather than reviewing past findings; they focused on *multifunctional* buffers and market-based solutions as a means to meet TMDL goals. Participants assessed pollutant reduction performance of different multifunctional buffer plants that also have potential economic viability, current and future regional market opportunities that could provide positive returns on investments from often costly buffer plantings; and new markets and government policies that are needed to promote successful buffers at scale. To guide and accelerate future buffer plantings, participants identified potential barriers and pathways to success for each market-based opportunity.

Background

Increased buffer implementation is named as an important step toward achieving vital habitat goal within the CBP Agreement (2014), which includes a defined outcome to "restore, enhance and protect a network of land and water habitats to support fish and wildlife, and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed." This outcome seeks to "continually increase the capacity of forest buffers to provide water quality and habitat benefits throughout the watershed," with a target to "restore 900 miles per year of riparian forest buffer and conserve existing buffers until at least 70 percent of riparian areas throughout the watershed are forested" (Chesapeake Bay Program 2019).

As noted by workshop participants, buffer implementation progress has been slow across the Bay watershed and, on average, is far behind the 900-mile annual Bay-wide target, especially in the Commonwealth of Pennsylvania.

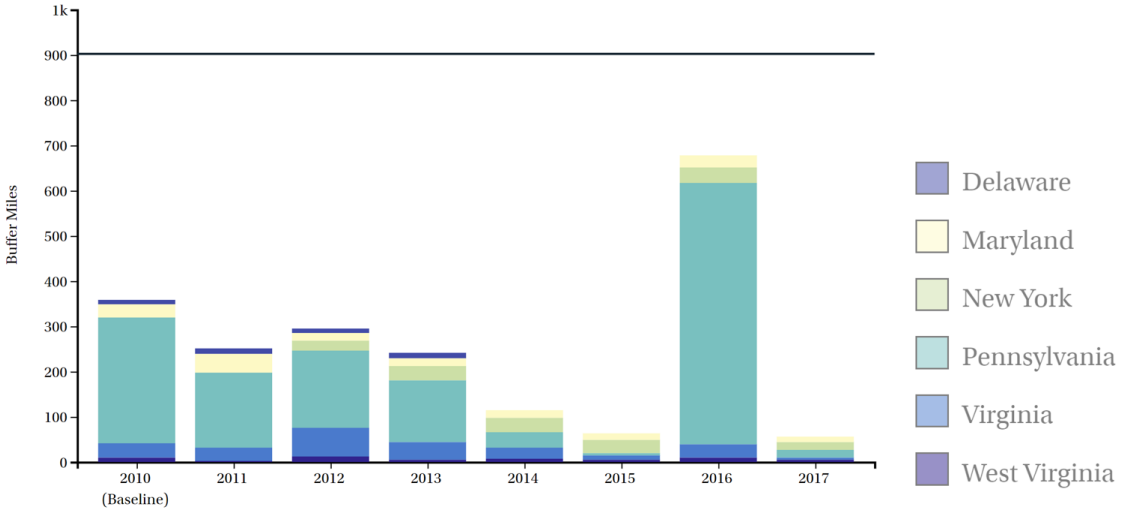

Figure 1. Miles of Riparian Forest Buffers planted in the Chesapeake Bay Watershed, 2010-2017 (Chesapeake Progress 2018) ***Note the spike in 2016 is not due to new plantings in 2016 but rather historically planted buffers being reported in 2016.***

Figure 1 shows the overall rate of riparian forest buffer attainment throughout the watershed from 2010 to 2017(Chesapeake Progress 2018). Buffer implementation has generally been well below the 900 mile/year goal, though buffer implementation in Pennsylvania has been highly variable, and in 2017, plantings were extremely low, with fewer than 20 miles planted.

Slow buffer implantation progress is problematic and reduces the Partnership's ability to reach Bay Agreement goals (2014). To this point, Pennsylvania's shortfalls are of special concern because the vast majority (~75%) of the Susquehanna River watershed lies within Pennsylvania; this tributary accounts for more than half of the freshwater inflow into the Chesapeake Bay. In 2010, the U.S. EPA estimated that the Susquehanna River was contributing roughly 40% of the total nitrogen (N) loading and

20% of the total phosphorus (P) loading into the Bay (USEPA 2010). A more recent study (Zhang et al. 2015) reported from 1979 to 2012 that the non-tidal Susquehanna contributed roughly 65% of total N loading. Based on Chesapeake Bay Program Model estimates, Pennsylvania is currently delivering more nitrogen to the Bay than any other state. Under the same modeling scenario, Pennsylvania is second only to Virginia for phosphorous loading. Moreover, Pennsylvania loads have a much stronger impact than those of Virginia on main channel hypoxia in the upper middle regions of the Bay, where dissolved oxygen criteria are especially hard to attain. A substantial portion of Pennsylvania's nitrogen and phosphorus loadings flow into the Bay as runoff from agricultural land, including from intensive row crops and animal agriculture (Zhang et al. 2016).

The Commonwealth committed to plant 110,000 acres of riparian buffers at the onset of the Watershed Implementation Plan (WIP) in 2010 to improve Chesapeake Bay water quality. However, as of 2018, only 18,602 acres (Devereux 2018) were established. At the average reported rate of 2,325 acres annually during the period from 2010 to 2018, Pennsylvania would need an additional forty years to fulfill its 2025 goals. The Pennsylvania Department of Environmental Protection (DEP) recognizes that the current rate of implementation is insufficient and understands that meeting the overall goal will be difficult even with the revised rate of implementation (Pennsylvania Department of Environmental Protection 2019). Pennsylvania's Phase III WIP drafted following this workshop now provides greater flexibility in achieving buffer requirements by allowing for 35-foot wide grass buffers on up to 15% of currently non-buffered streamside farmland and 35-foot wide forest buffers on up to 25% of similarly non-buffered streamside farmland. This would amount to approximately 50,000 acres of grass buffers and 83,000 acres of forest buffers across the Commonwealth.

Workshop participants described several reasons for the slow progress to date in establishing and maintaining successful buffers. For example, many farmers assume converting conventional row-crop acres to buffers will reduce farm profits and so farmers may be reluctant to take land out of production to plant a buffer. This assumption may or may not be valid, depending on variables such as market prices, weather, and the value of the buffer itself to the operation. The cost and value of buffers can also vary significantly across a field, especially near streams where flooding can delay planting and reduce yield. Workshop participants aimed to find and better understand financial opportunities associated with establishing multifunctional buffers for maintenance and/or increased profitability. If farm profits are a significant barrier to accelerating buffer plantings, planting multifunctional or profit-generating buffers may be a strategy to accelerate buffer implementation. Even so, changing farming practices requires effort while developing new markets involves risk. Participants noted that a clear economic model for farmers' investment of time and conversion effort is needed. Outreach and education need to be improved to increase community and farmer buy-in to implementation and to normalize the practice. Furthermore, minimizing maintenance needs in buffers or long-term maintenance assistance opportunities are needed to ensure the long-term success of buffers across the Bay.

Workshop participants also suggested barriers that may exist to establishing and maintaining multifunctional buffers. Even though by definition a portion of the buffer can be marketable, the initial financial investment and delayed return on investment due to the time to produce a harvestable product may be a barrier to farmers lacking capital. Barriers may also exist in growing and promoting a biomass-based economy ("bioeconomy") to support multifunctional buffer products, including the infancy of regional markets to purchase crops grown in buffers at scale, farmer preferences for traditional cropping systems, lack of knowledge on new crop production, lack of specialized equipment, and lack of successful and long-term multifunctional buffer examples.

This workshop aimed to address such barriers in order to bridge the gap between policy-based buffer implementation goals and the reality of agricultural operations. Workshop goals were to:

1. Summarize and disseminate current riparian buffer implementation needs, practices, and science in order to better understand (and hopefully bridge) the gaps in understanding among farmers, practitioners, scientists, and funders.

2. Understand and elucidate the perspectives of various stakeholders through facilitated breakout discussion groups. Of relevance are the perspectives, needs and capacities of farmers (e.g., their information needs and the factors driving their preferences for practices), legislators (e.g., the factors driving their choices in funding), academics (e.g., their understanding of science and ecosystem services and capacity to assist), and representatives of industry (e.g., their needs and capacity in regard to market and technology contributions).

3. Identify social and economic barriers to buffer implementation and ways to overcome them.

4. Create an actionable framework for collaboration between researchers, farmers, and industrial representatives to accelerate and sustain multifunctional riparian buffers and the bioeconomy that allows landowners to profit from buffer products.

Primary recommendations from the Workshop

As detailed in following sections of this report, the workshop was facilitated to evaluate and recommend pathways to implement riparian buffers across the Chesapeake Bay watershed. These recommendations are detailed in the final section of the report. Here, we combine and regroup some of the over-riding concepts into what we refer to as "primary recommendations." Participants recommended Chesapeake Bay Partnership, particularly the EPA Chesapeake Bay Program Office (CBPO), do the following:

1. Promote scalable and flexible solutions to planting buffers – including the option for planting native perennial grass buffers in lieu of only trees when appropriate – to allow for higher economic incentives and broader market access.

2. Focus on “planting for success” by establishing multifunctional buffers that can be grown successfully in flood-prone riparian zones, are low-maintenance, have a low financial risk profile, can compete effectively with weeds and non-native species, and have stable regional markets for crops.

3. Plant and share information about successful buffer installations on well-operated farms, highlighting multifunctional buffers that provide profit and other local benefits as well as improved water quality. The objective is to demonstrate such buffers to the broader farming community so that these practices can become common and “normal” practices.

4. Create strong, stable partnerships across the Bay watershed that include linking farmers to private and industry-based funding opportunities.

5. Engage students (primary, secondary, university) and young professionals in buffer planting and maintenance. Create support programs that incentivize students and young professionals to plant and maintain buffers in their communities.

Workshop overview

Two weeks prior to the workshop, the steering committee hosted a pre-workshop webinar where twelve stakeholders shared their experiences with water quality, buffers, and multifunctional buffers. Webinar participants had the opportunity to ask questions and share their own experiences. The webinar provided a starting point for discussions at the workshop. A recording of that webinar is available online (see also Appendix D).[1]

Participants, including farmers, scientists, extension personnel, nonprofit organizations, government representatives, agricultural consultants, rural sociologists, and academics then met for a 1 ½ day workshop at the Dixon University Center in Harrisburg, PA. The workshop commenced with a word cloud exercise. Participants were asked “What are buffers?” Figure 2 displays the results of this activity.

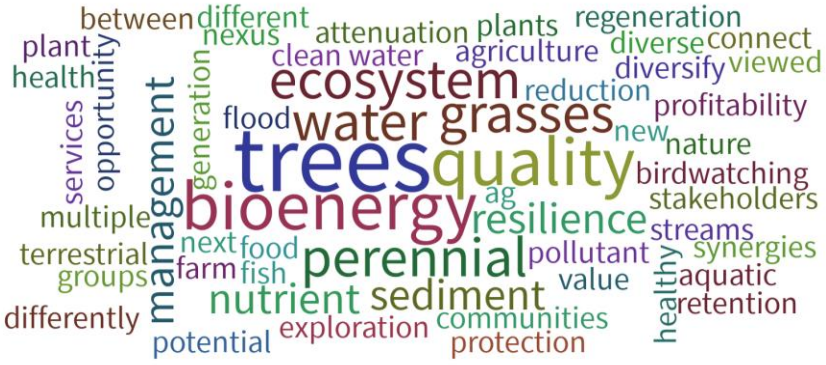

Figure 2. Results from the introductory word cloud exercise. Participants where asked “What are buffers?” and noted the variation in definitions. Size of word is proportional to the number of responses.

[1]Link to the pre-workshop webinar: https://www.youtube.com/watch?v=QqBH1dSuZBg&feature=youtu.be.

In the first breakout session, participants addressed key barriers and potential solutions for implementing buffers on the ground. In the second session, participants identified critical steps for accelerating buffer implementation. See Appendix A and C for questions used by breakout session facilitators.

Following the breakout and debriefing sessions, five people shared their successful buffer examples and concepts.

- Alyson Earl (Horn Farm Center for Agricultural Education) presented on efforts to educate conservationists to protect streams and plant buffers.

- Tracey Coulter (Pennsylvania Department of Conservation and Natural Resources (DCNR)) discussed DCNR's efforts to promote and support their multifunctional buffer program.

- Ann and Don English (Happy Hollow Farm) spoke to the audience about their success in implementing buffers on their farm by treating their buffer "as a pet."

- Austin Unruh (Crow and Berry Land Management) explained how silvopasture and rotational grazing could be an approach to normalizing multifunctional buffers while keeping some of the land available for grazing on some parts of the landscape.

- Fred Circle (FDC Enterprises) reviewed how native perennial crops like switchgrass could be planted not only along streams but along entire fields. Circle shared his experience in using 6,000 acres of switchgrass to power a bioenergy boiler to generate heat for a hospital in Virginia and generate income for local farmers. Further, Circle shared the process his company went through in garnering landowner and community support to eventually create a successful regional bioeconomy around switchgrass.

On the second day, workshop participants started with an open discussion on their thoughts and/or reactions from the previous day. Two panel discussions followed this exercise: 1) the financial opportunities from multifunctional buffers, and 2) the science and policy needs required to establish the practice. The pre-selected panelists were Adrienne Gemberling (Chesapeake Conservancy), Jon Duncan (Penn State University), Calvin Ernst (Ernst Conservation Seeds), Leon Ressler (Penn State Extension), Fred Circle (FDC Enterprises), and Ryan Davis (Alliance for the Chesapeake Bay). Each panel included two additional, empty seats that allowed for audience members to join the panelists. Notes from each session and the overall discussions are summarized in the following results sections of this report.

Results from discussion groups

Overall, workshop discussion focused on farmers, markets, program changes, funding, economics, and products. Figure 3 shows a word cloud synthesizing the top 50 words in

100+ pages of notes taken over the course of the workshop, including the breakout sessions. Participants suggested that these themes and concepts would help inform the final Phase III WIP recommendations for Pennsylvania (CBP 2018).

Figure 3. Word cloud of the top 50 words written in workshop notes

What is implemented and working?

Stakeholders expressed a technical understanding on riparian forest buffers establishment. Andrea Ferich (Penns Valley Conservation Association), Ryan Davis (Alliance for the Chesapeake Bay), Sara Xenophon (Penn State Agriculture and Environmental Center), and others shared tree planting success stories. These included planting insights and tips such as using tree cages and angular fencing instead of tree tubes for greater success; participants noted the importance of early tree buffer maintenance to address predation and invasive species concerns. They also stressed the need for both short-term maintenance and continued long-term maintenance to ensure buffer success, and expressed long-term maintenance options for landowners were often limited.

In addition, stakeholders expressed their understanding of water quality improvements expected from riparian forest buffers. The “producers” breakout group (day 1) discussed decades of research coming out of the Stroud Research Center on forested riparian buffers; for example, participants pointed to an enduring 15-year old successful riparian buffer which has consistently reduced nitrate and sediment runoff (Newbold et al., 2010). Besides increased water quality, buffers can provide many ecosystem services including wildlife habitat, shade to maintain lower stream temperatures, and enhanced biodiversity. The Chesapeake Bay Program website includes an extensive discussion of riparian buffer benefits.[2]

[2] https://www.chesapeakebay.net/issues/forest_buffers

Stakeholders had a discussion about the differences between forested versus perennial grass buffers. Some stakeholders expressed their understanding of perennial grass establishment and agreed grasses are beneficial for water quality, while others had less understanding of grass buffer establishment. Forest buffers are prioritized in this region due to their shade and litter benefits for aquatic life. Additionally, there is limited research on the potential synergies of multi-zone buffers which include streamside trees and then additional buffer width planted with grass buffers.

Although some participants did not have access to and/or would require assistance in using buffer prioritization tools, others were knowledgeable on utilizing tools to identify and prioritize where to plant buffers. For example, many stakeholders knew about the Chesapeake Conservancy restoration prioritization tool for identifying buffer gaps.[3] This tool identifies areas within 35-feet of a stream at a 1-meter resolution where there is barren or low land. While participants expressed their belief that many potential users have the technical planting skills for buffers and appreciate the need for buffer maintenance, publicizing existing tools like the prioritization tool and making them more user friendly could be an efficient opportunity for outreach.

What is lacking or not working?

Stakeholders presented examples where multifunctional buffers have been established but also shared many concerns hindering implementation, noting the relatively few cases where both water quality improvement and farm profitability were documented. The list below describes gaps identified as limitations to achieving water quality goals. Actions suggested by the workshop participants for research, policy, and education are based on the gaps the group outlined below.

1. A clear business model for farmers' investments is needed. There is a lack of understanding on what to plant for profit and where. Profit can be generated in several ways and in different zones of a multifunctional buffer. As illustrated in Figure 4, one example of a multifunctional buffer is to separate the riparian zone into three zones based on the Pennsylvania Department of Conservation and Natural Resources (DCNR) multifunctional buffer framework.

[3] https://chesapeakeconservancy.org/project/restoration-prioritization-tool/

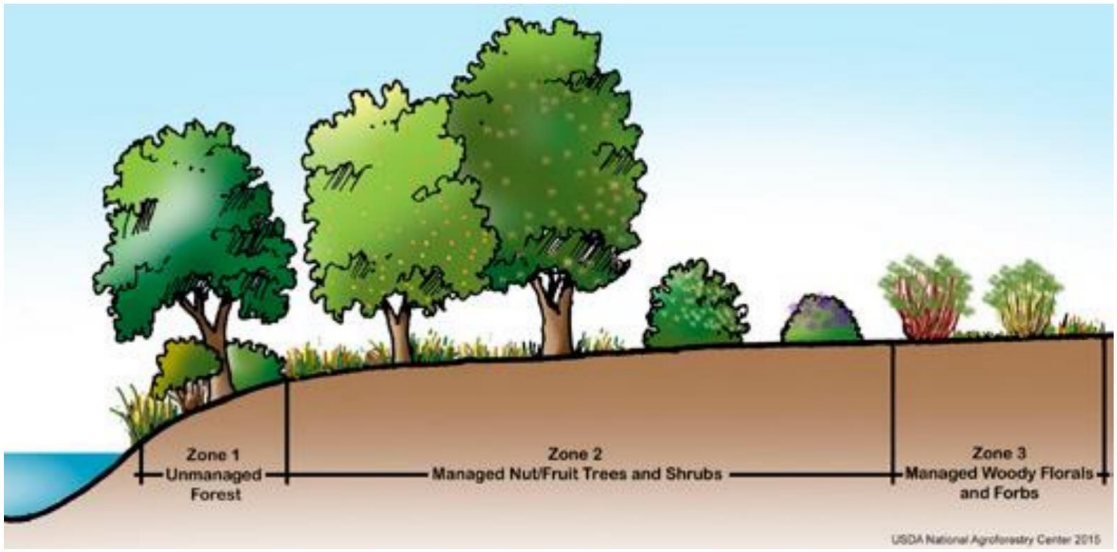

Figure 4. PA DCNR multifunctional buffer zones (PA DCNR Concept for Multifunctional Buffers; figure from USDA National Agroforestry Center 2015).[4]

Zone 1 is a traditional no-harvest forest buffer and usually includes large trees and shrubs planted to stabilize stream banks and provide shade. Zone 1 must be at least 15 feet wide if DCNR funds are used to establish the buffer. Zone 2 allows for a larger diversity of trees and shrubs and allows hand-harvesting. These plants are still intended to reduce nutrient runoff but have an added income-producing benefit. Examples of Zone 2 crops include hazelnuts and raspberries. Zone 3 is meant to provide similar environmental functions as zone 2 but expands beyond trees and shrubs to include native grasses like switchgrass and Big Bluestem and pollinator-attractors like Black-eyed Susan. The Pennsylvania DCNR suggests a minimum total width of 35 feet for Zones 1 and 2. While workshop participants understood how to plant and maintain a Zone 1 forest buffer, more case studies and demonstrations are needed to help landowners understand what and how to plant, maintain, and harvest crops and generate income from Zones 2 and 3.

2. There is a need to better understand markets to support multifunctional buffer crops, including their short and long-term capacity. Stakeholders agreed that "one size does not fit all" for buffers as local topography, soils, hydrology, and other characteristics, including especially landowner values and interests, will differ from site to site. Multifunctional plant species that are niche crops such as fruit, berries, or nuts may require specialized management and entrepreneurial market development. Other plants like switchgrass or other native grass mixtures are similar in management to perennial hay crops already widely grown and marketed in Pennsylvania. Knowledge on the short and long-term capacity of

[4]PA DCNR Multifunctional Buffer Summary:
https://www.grants.dcnr.state.pa.us/Documents/Summary_Multifunctional%20Stream%20Buffer%20Program.pdf

these markets can help farmers decide what types of multifunctional crops to cultivate.

3. There is a lack of research on how alternative crops and the multi-zone approach to multifunctional buffers would affect water quality, especially in Zones 2 and 3. Though stakeholders agreed the crops in Zones 2 and 3 are good for the environment, there was not a good understanding of measured and documented potential for water quality improvement from multifunctional crops in these zones. In this regard, differences among species in Zones 2 and 3 are not well understood.

4. There is a lack of consensus on water quality and profitability balance in buffer design. Workshop participants agreed increased flexibility of buffer implementation requirements was needed, but it is unclear how much flexibility is required to achieve the 900-mile Bay-wide annual buffer establishment goal, while supporting rural economies and local producers. There were no examples offered of business models for landowners or stakeholders to look to when designing and planning a multifunctional buffer planting meant to improve both water quality and profitability. The only known business planning document for multifunctional buffers is a fact sheet that reports current market prices for some multifunctional species such as pawpaws, hazelnuts, persimmons, and elderberries[5].

5. There is a lack of information about scaling solutions. Scalability was discussed in the context of whether markets exist to handle the multifunctional crop production in 90,000+ acres annually, whether markets can provide revenue to farmers in quantities that can return the investment in buffer plantings, and whether such markets can support an influx of product during the remainder of the TMDL implementation. Most of the markets discussed during the workshop for multifunctional species were small, niche markets. To date, there has been no organized effort to expand these kind of multifunctional business models to the scale required to meet Bay goals.

   The only potentially scalable options discussed in depth at the workshop were markets that utilizes switchgrass. During the pre-workshop webinar, Will Brandau, Chair, Association of Warm Season Grass Producers, gave a presentation about how switchgrass is being used for poultry bedding and erosion and sediment control socks. During the workshop, Fred Circle from FDC Enterprises provided a presentation showing how 6,000 acres of switchgrass is being used to power a local hospital heating system in Virginia. Calvin Ernst from Ernst Conservation Seeds also presented about how Ernst Biomass pelletizes switchgrass from about 5,000 acres for industrial absorbents. But the size, capacity, and stability of the regional switchgrass market was not known. One industry discussed at length was Diamond Sock or MKB, which currently has a 10,000-ton annual capacity.

[5] USDA National Agroforestry Center *Why add edible and floral plants to riparian forest buffers* available at: https://www.fs.usda.gov/nac/documents/workingtrees/infosheets/WTInfoSheet-MultiFunctionalBuffer.pdf

6. There was lack of consensus regarding how to engage farmers, both from the perspectives of landowners themselves and of other stakeholders present at the workshop. Stakeholders expressed the need for supportive partnerships in and outside of agriculture to support landowner acceptance of buffers as a normal farming practice, and the need for education and marketing of multifunctional buffers to producers. They noted that farmers are looking for successful buffer examples they can observe and learn from; if they see their neighbor with a successful practice, they are more likely to adopt it. Outreach must also extend beyond farmers to other landowners, as buffer acres are not just needed in cropland, but also in urban areas and other developed areas. Buffers may have a larger impact in headwater landscapes more than further downstream, so targeted outreach and incentives in these areas may be appropriate.

7. Farmers have few established demonstrations to follow. Successful examples of multifunctional buffers that provide income are lacking. Discussions centered on developing practical partners and educational materials for farmers to learn more about multifunctional buffer implementation and maintenance. An understanding of the uncertainties associated with financial success, the function and long-term resilience of buffers plantings, and the costs of establishment are also lacking. Penn State researchers are working on a project to explore these topics for perennial grass mixtures, but no data was available yet. Andrea Ferich (Penns Valley Conservation Association) provided a presentation about an example of a new buffer planted with a local herbalist. The landowner plans to use her multifunctional species in her home business; no cost data was yet available. Don and Ann English shared another example of a successful buffer on their home farm, with their success attributed in part to their excitement as landowners. Again, detailed documentation and clear indications of financial success were not available for disseminating to farmers.

   It will also be important to provide farmers with increased understanding of the risks and resilience of annual and alternative crops for comparative purposes. Stakeholders communicated that profitable buffers that diversify crops and protect against loss by flood, drought, and pests are key for long-term buffer success. New tools that identify marginal or risk-prone land areas may help landowners balance their environmental and economic values. Muth (2014) suggests that planting perennial biomass crops on marginal land can be one of the most effective ways of improving environmental quality and farm profitability.

8. Participants suggested that incorporating a large-scale, system-wide view to understand the entire landscape that buffers contribute to would be important. Participants suggested looking at entire farm landscapes and not just at the riparian zones when designing buffers for improving water quality and providing more resilient profitable agricultural systems.

9. Buffer performance as affected by weather or shade in different zones (1, 2 or 3), and response and adaptation to climate change are not well known. Increased

precipitation, flood frequency, and increased incidence of drought all need to be considered in buffer implementation, including species and site selection.

10. Landowners need a better understanding of the process and timeline from initially planting a buffer to having a mature functioning buffer. Although these issues are reasonably well understood for conventional forest buffers, they are less so than for new multifunctional buffer practices and will clearly affect the profit potential of the latter. Stakeholders noted that farmers have little to no certainty in economic return on investment, maintenance costs, the risk of invasive species, the time from planting until mature establishment, and time to canopy closure.

11. Move away from failure prone buffer plantings with high uncertainty of success toward systems that are "planted for success"— i.e., by selecting sites and plantings for which success is more reliably achieved. In this context, "planting for success" means planting useful plant species (including harvestable crops) that can compete effectively with weeds and non-native species, are low maintenance, have a low financial risk profile, and (ideally) have stable demonstrated markets for harvestable produce. Once demonstrated, such strategies for successful *multifunctional* buffer can be shared with farmers so they have more certainty in economic return on investment. Such strategies should offer less risk of invasive species, fewer maintenance requirements (in both the short and long term), and multifunctional buffers that require less time until they are well established and profitable.

Recommendations

Over the course of the workshop, numerous recommendations emerged from both plenary discussions and breakout groups. First, these include three types of "needs" for the successful planning, design and implementation of effective multifunctional buffers. Second, there are three more categories of recommendations related to (i) research, (ii) policy, and (iii) education and outreach. In this report, we have therefore organized our discussion of recommendations within these two major groupings: "Key Needs for Success" and "Detailed Recommendations".

Key needs for success

Focused primarily on multifunctional buffers and factors for success in accelerating the rate of implementation, three clear needs emerged during the workshop.

1) Creation of scalable solutions to accelerate buffer plantings at the rate required to meet Chesapeake Bay goals and outcomes.

2) Demonstration, education and normalization of multifunctional buffers to improve landowner acceptance.

3) Development of strong partnerships across all stakeholder groups.

These are planning elements that should be addressed by farmers, managers, institutions and other stakeholders to accelerate buffer implementation.

Scalable solutions

Workshop participants emphasized the need for scalable solutions to accelerate buffer implementation to meet the Chesapeake Bay Program partnership's goals and outcomes. In some cases, this may require increasing the market for products that would be grown in tens of thousands of acres of multifunctional buffers. In other cases, it may just be a question of proper site and crop selection. One solution identified as an immediate possibility was the planting of switchgrass and other native warm season grass mixtures for bioenergy markets, erosion control socks, and animal bedding. As noted above, FDC Enterprises presented about a project where 6,000 acres were planted with switchgrass and harvested to heat a hospital in Virginia. This business model could be applied to Pennsylvania and other parts of the Bay.

Enhancing widespread landowner acceptance

To promote a vision of multifunctional buffers as integral components of both agricultural and other types of developed watersheds, participants identified a need for an organization that can build profiles of successful multifunctional buffers for farmers and other landowners to consider. Participants discussed that there is connectivity on the landscape from headwaters down to watershed outlets, and that *all* landowners in these settings (not only farmers) may need to implement buffers. Buffers often have a stronger impact when implemented in headwater settings where they can help improve water quality and quantity over a longer downstream path. Participants discussed developing partnerships with large landowners in industrial and urban areas, especially in these headwater settings. Workshop participants identified a need to demonstrate how to implement successful multifunctional buffers and to share those success stories with farmers and others.

There is also a need for well-trained and knowledgeable technical assistance to help farmers and landowners. Several stakeholders expressed their belief that the most important tool needed is a legacy of successful buffers. The CBP partners need to choose plants, sites, and implementation plans that are intentionally designed for success rather than creating planting plans that require high farmer maintenance. Switchgrass was suggested as an example of a reliable crop selection, relatively low maintenance needs and low to no fertilizer requirements.

Pursuing resilient, scalable, marketable buffer crops is suggested for increasing landowner acceptance of buffers and accelerating buffer plantings across the Bay during the remainder of the TMDL. Leveraging current perennial grass markets is suggested while niche markets like hazelnuts and elderberries continue to develop and grow regionally. Leveraging risk-prone areas on the landscape for use as buffers that may be unprofitable under the threat of climate extremes may also ease the transition

for landowners from conventional cropland along streams to buffers, especially in low-profit areas in need of agricultural diversity.

Enhancing partnerships

Stakeholders agreed there is a need for strong partnerships among farmers, conservation groups, funding sources, extension, universities, industry, and government. Workshop participants suggested several important connections that should be established and maintained, as discussed below.

1. When implementation plans involving buffers are being designed, the following government agencies should be included in the conversations:

    - The jurisdiction's department of transportation (e.g., the Pennsylvania Department of Transportation or PennDOT). Such agencies own and manage land along roads and highways that can be used for planting and harvesting buffer strips. Such agencies may be interested in planting pollinator attracting species of plants that can also bring co-benefits. (Although such plantings are part of stormwater management activities, there is overlap with concepts of riparian buffers, especially when roads are adjacent to streams). More information is needed, however, about the location and extent of these land. For example, no workshop participants had information about the available acreage of PennDOT land or the percentage of the needed 90,000+ acres that could be contributed from this source. At a minimum, participants suggested there should be demonstration value.

    - The Federal Emergency Management Agency (FEMA). This agency is highly focused on developing community resilience in flood zones. FEMA offers local municipalities the choice to participate in the National Flood Insurance Program (NFIP), which can provide insurance for agricultural "structures" and their contents, although the NFIP does not insure the land itself. FEMA does not regulate or financially support any use of land, therefore, any support for harvesting would need to be provided by other federal, state, or local agencies and in accordance with all relevant zoning ordinances, local laws, and funding agency requirements.

    - The Pennsylvania Department of Fish and Wildlife, the Pennsylvania Fish and Boat Commission, and the Susquehanna River Basin Commission. Entities like these are interested in water quality of streams to support fish populations and wildlife habitat, along with other interests. Participants suggested they should be formally involved in buffer planning as well as crop planting and maintenance.

    - The Regional Conservation Partnership Program (RCPP). This program includes opportunities for support of projects with flexible funding for

landowners working with the Natural Resources and Conservation Service (NRCS).

- The Maryland Agricultural & Resource-Based Industry Development Corporation (MARBIDCO). MARBIDCO is a rural economic development organization that any jurisdiction or agency use as an example of how to financially support and promote multifunctional buffer plantings that promote farm profit and rural economic development. It is not clear whether MARBIDCO might also help and contribute to buffers in jurisdictions outside of Maryland.

2. Connections should be made with sources of funding in the private sector. Workshop participants suggested that planners might reach out to the following possible partners:

    - Local banks who might be able to fund or provide low interest loans to landowners for multifunctional buffers,

    - Power companies and landfills generating biogas who might be able to use multifunctional buffer crops such as switchgrass in their energy generation,

    - Tractor and other equipment supply companies that might be interested in the public relations aspect of helping farmers in their communities plant buffers or helping their local farmers and customers via financial support for buffers,

    - Verizon, Walmart, Giant, and other large companies for funding support in exchange for being known for helping the planet through buffers and their local communities,

    - Companies like Turkey Hill that focus on premium products that could market their products in a way that highlights their promotion and implementation of multifunctional buffers,

    - Other large institutions with streamside property that could serve as examples. One evident example was the front lawn of the building where the workshop was held (along the Susquehanna River) or the location of where the Penn State Agricultural Extension holds its “Progress Days” conference (along Spruce Creek) as a way to help landowners see more examples of successful multifunctional buffers in operation. These sites could presumably be planted with financial support from these large institutions.

3. Connections should be made with non-governmental organizations and private foundation funds. Participants suggested the following (non-comprehensive) list as a starting point.

- The Theodore Roosevelt Association. This organization is dedicated currently to fostering conservation goals that would likely align well with buffers and Bay water quality goals.

- The National Fish and Wildlife Foundation was also named as another potential source of support.

- Participants suggested connecting to large funds for global Sustainable Development Goals (SDG) such as the Global Adaptation & Resilience Investment Working Group. This group may be interested in the carbon sequestration potential of multifunctional buffers and could be interested in helping achieve a large-scale project such as the addition of 90,000+ acres of buffered land in Pennsylvania.

4. Collaborations should be established with scientists at research institutions.

    - Engage more social and behavioral scientists in buffer implementation. Participants described many barriers to success are social in nature rather than limited by our technical knowledge.

    - Engage National Laboratories, especially those that work directly on issues regarding biomass for bioenergy. The U.S. Department of Energy (DOE) is seeking to better understand and perhaps promote the planting of switchgrass and other perennial plants for possible use as biofuels. Related research and projects have obvious potential synergies with multifunctional buffer applications. Participants at the workshop included national lab personnel.

    - Engage universities in and outside of the Bay, and especially those that may have already developed a similar research focus on buffers. For example, engage with the STRIPS (Science-based Trials of Rowcrops Integrated with Prairies) program in Iowa, which is focused on planting strips of grasses and pollinator attractor species for water quality similar to buffers though often within fields, not just along the edges of fields along streams.[6]

    - Engage the U.S. Forest Service in local agroforestry projects in Pennsylvania and elsewhere where more local understanding relevant to tree selection may be needed.

    - Engage the Stroud Research Center in work across the entire Bay watershed. As described by participants of the workshop, this Center has been instrumental in educating landowners and helping accelerate buffers in southeastern Pennsylvania.

5. Collaborations for educational opportunities should be developed.

[6] https://www.nrem.iastate.edu/research/STRIPS/

- Engage students for buffer plantings and long-term maintenance. Consider providing loan forgiveness for buffer maintenance.

- Enlist AmeriCorps volunteers for long-term buffer maintenance.

- Engage with prisoners for buffer plantings and long-term maintenance. This approach was piloted in Huntingdon County, Pennsylvania and resulted in prisoners receiving a riparian buffer certificate that could help them find jobs after serving time and reduce recidivism. [7]

6. Entire communities should be engaged in implementations, and inter-community connections should be made.

    - Establish an urban-rural connection. Upstream implementations bring benefits to downstream communities. Fostering dialogue can possibly lead to cooperative efforts and shared financial responsibility.

    - Promote the recreational value of buffers. Design buffers that establish biking routes, fishing access, and other recreational opportunities to encourage more community support of buffers. This may help the urban-rural connection that is needed around buffers. Participants did recognize potential private property concerns.

    - Connect to stakeholders involved in establishing markets for products such as switchgrass and/or hazelnuts. For example, students in the Penn State Master of Business Administration program estimated (as part of work on the NewBio project[8]) that 47,588 acres of buffers could be sold to the poultry bedding and mushroom substrate industries, which have estimated annual switchgrass demands of 198,500 tons and 58,000 tons, respectively. The switchgrass erosion-control stock market is currently 10,000 tons annually in Pennsylvania. Currently, the supply does not meet the regional market demand. The hazelnut market capacity was not known at the workshop but was discussed in depth and described as a large market-based opportunity by several participants.

    - Directly market new and existing multifunctional buffers to restaurants, chefs, and catering companies as a source of local food. Participants suggested this could be a fruitful venture in areas like Lancaster County and around universities such as Penn State.

[7] https://www.cor.pa.gov/CorrectionalNewsfront/Pages/Article.aspx?post=748

[8] http://www.newbio.psu.edu/ The Northeast Woody/Warm-Season Biomass Consortium: Building Sustainable Value Chains for Biomass Energy, Agriculture and Food Research Initiative Competitive Grant No. 2012-68005-19703 from the USDA National Institute of Food and Agriculture

Detailed recommendations

Research needs

During breakout sections, participants identified research questions to address identified knowledge gaps. Proposed research questions were cross-disciplinary and addressed areas needing further study in social science, natural sciences, and economics. Research institutions such as the Stroud Center have already published extensive research on forest buffers within the Bay watershed; however, further investigation of multifunctional crops (including switchgrass, fruits, nuts, berries, and florals) is needed. Additionally, there is a general lack of research on multifunctional buffers in social sciences, economics, and demonstrated applied research.

The sections below highlight research questions suggested by participants in breakout sessions. Note, however, the listed research needs were not prioritized by the participants and therefore the order is not intended to indicate relative importance. An additional assessment could be conducted to rank research needs and prioritize future research efforts.

Social science research needs

Workshop participants in this breakout group presented research questions to be considered as points of inquiry for future research, including the following:

1. What are multifunctional buffers? While this report offers one definition, it is only a start. A clear consensus-based definition that is widely accepted among the social, environmental, and agricultural science communities is needed not only to better communicate with prospective practitioners, but also to develop government agency, legislature, and NGO support for multifunctional buffers.

2. What do farmers value in farming? What are landowner priorities on the farm? Profitability plays a major role, along with traditions and other value-based decision making. Research on farmer's valuations will help identify the best strategies to motivate farmers to establish multifunctional buffers, particularly given the need to engage more farmers in this discussion.

3. What has motivated landowners or farmers to install buffers? What can be learned from the early adopters? Is there an activation energy for farmers to make this investment of resources in terms of time, money, and effort? How much of a profit margin or potential return on investment is needed for farmers to tackle such large projects?

4. What makes people care enough about water quality and biodiversity to act and implement riparian buffers? Where buffers have already been implemented, what is known about conversion of cropland to buffer land and why someone pursued implementation?

5. What motivates consumers in purchasing products from a multifunctional buffer? If enough consumers value buffers and products produced in buffers, then there will be value in better understanding how to best inform such consumers about which agricultural products are produced in riparian buffers. Such understanding could be used to help establish markets.

6. What do farmers consider as success in agriculture? What do ecologists consider as success in agricultural systems? While it is overly simplistic to assume either of these groups have a uniform perspective, finding common ground among the many different stakeholders is necessary and will only be achieved through understanding their priorities.

7. How can the landowners and renters work together more effectively to advance buffer establishment? Research is needed to include both groups in the decision-making and development of policies and incentives. This is specifically important in Pennsylvania, where a large amount of riparian cropland is now rented and farmed by someone who does not own land along the stream.

8. What should multifunctional buffers look like? How do landowners prefer buffers to look? Social barriers, including visual detraction and community judgement, prevent farmers from implementing buffers on their property. Visualization tools and research on farmer perceptions is needed to understand how to best design a buffer that a farmer will be likely to adopt. Successful, high-profile demonstrations that normalize the presence of buffers on various farms could reduce these social barriers.

Technical science research needs

1. How do upland areas and buffer systems interact, particularly given the impact of weather extremes and hydrological impacts? What is the impact of extreme weather events such as floods and droughts on buffers? Do buffers reduce the impact of extreme weather events on the surrounding areas? Additional research on the impact of extreme weather events on buffered riparian land will clarify whether it makes sense to plant buffers in areas that are prone to flooding or droughts. This will become even more important over time, since most recent climate change projections suggest increased frequency and intensity of storms in the region of the Chesapeake Bay watershed region (Najjar et al. 2010).

2. Does it make sense to switch the landscape orientation of the Pennsylvania DCNR's multifunction buffer concept which has non-harvestable trees directly adjacent to streams followed by harvestable fruit, nut and berry trees and shrubs in Zone 2 and then grasses in Zone 3? Food crops, including from trees, cannot be harvested after a flood for food safety reasons. Participants suggested switching Zones 2 and 3, which would put native perennial grasses in the flood zone and fruits, nuts and berries upland above areas prone to flooding. For areas on the landscape subject to flooding, what is the best arrangement of crops for

farm operations, for crop resilience, and for water quality? Similar questions should be answered for drought prone soils and locations.

3. What is the impact of beavers if they are allowed into woody buffers? It would be useful to better understand if beavers can provide net cost reductions. Although increases in lost cropland are a possible concern, they may help reduce the cost of management, increase biodiversity in the near-stream areas, and perhaps provide additional water quality benefits (e.g. through enhanced denitrification). Some participants coined the slogan “Let it Be(aver).” There was no consensus at the workshop, however, in regard to whether beavers would provide net benefit or find farmer acceptance.

4. What are best practices to prevent invasive species overwhelming newly established multifunctional buffers? What practices create a healthy ecosystem that balances itself against pests including deer or spotted lanternfly or invasive plants? Natural regulatory mechanisms for buffers can reduce the cost of management, increase biodiversity in the streamside areas, and provide other benefits such as pollinator habitat.

5. What type of buffer will help address legacy sediment and phosphorus buildup? The full extent of legacy sources and sinks across the Bay watershed and in buffers across the Bay is unknown. Given that buffers are designed to trap sediment and phosphorus, however, it is reasonable to expect that these may accumulate in buffers over time. Van Meter et al. 2017 found 18% of the nitrogen loading in the Susquehanna River is greater than 10 years old. What conservation practices most effectively target these sources? Dodd and Sharpley 2016 documented that conservation practices that target particle-bound phosphorus can become sources of dissolved reactive phosphorus to stream over time as soils become saturated and the phosphorus is brought back into the active cycle by plants and microbes. More research is needed on which plant species and harvesting strategies might effectively address problematic legacy sediment and phosphorus in riparian areas.

Business and economic research needs

1. What are the current and future markets for buffer-grown products? Prices on the products, current market capacity, and future demand will help understand how much subsidy is needed to support farmer decisions to plant a buffer and help landowners decide whether to plant a buffer and what to plant in a buffer.

2. Business models are needed to show landowners multifunctional buffer options and what the return on investment for a multifunctional buffer might look like over time for various price scenarios. What are the break-even points for small and large farms applying conservation practices? What are example business plans for farmers establishing multifunctional buffers? Having example business plans can help farmers approach banks to secure loans for the new farming operations. They can also better inform a farmer’s decision making.

3. How large is the impact of plant shade on the yield of annual crops near buffers and perennial crops within buffers near trees? Participants suggested multifunctional buffers with different plant types and zones can create new financial challenges due to shading. Understanding the impact of shade on yield and economics will help landowners optimize buffer design.

4. What is the financial risk from the instability of markets and climate change for annual crops in riparian zones compared to perennial buffers? Comparing the risks of annual crops to multifunctional buffer crops can improve farmer decisions and may strengthen the case for lower risk perennials in multifunctional buffers.

5. What is the long-term market variability of perennial buffer systems? Buffer systems are planned over a longer term than annual systems; there could be additional risk associated with perennial buffer planting or additional resilience provided by a perennial multi-functional buffer.

6. How do multifunctional buffers affect recreation value? Is this a marketable aspect of a multifunctional buffer, and if so, how can buffers be designed to maximize that income by providing habitat such as for grouse or tree cover for fish habitat, or other recreational values? Can the recreational value of buffers help connect buffer owners to urban communities who may then preferentially purchase buffer products?

7. What are the markets and products that are not just niche but have the capacity to utilize the production from tens of thousands of acres of buffers and provide revenue to landowners for decades to come? Are there markets that can be applied at various scales and markets that can be expanded to the entire Bay?

8. How flexible can buffers be in their design? What tiers/grading/portfolios can be possible with different financing structures? Buffers are not one-size-fits-all solutions; depending on the property and the opportunity, farmers should have an option of establishing different types of buffers. Different types of buffers may require different funding mechanisms.

Policy recommendations

Research on buffer functions and benefits should be disseminated so that well-informed policies can be introduced to support farmers and landowners. Workshop participants suggested several policy changes to improve buffer adoption.

1. Eliminate subsidized crop insurance and other annual crop subsidies for crops planted in high-risk floodplains. Annual crop subsidies for crops in flood-risk areas may reduce farmer motivation to search for alternative crops for those areas. Adjusting subsidies for annual crops so that they do not subvert conservation programs is an example of better policy alignment that could be implemented through a mechanism like the federal Farm Bill.

2. More flexible buffer design, financing, and maintenance requirements. Farmers should be able to choose between trees, grasses, and other crops and select varying buffer width, contract lengths, and maintenance requirements. Tiers can help distinguish between buffer types and financial options for farmers. Several participants mentioned the 25-year agreement required for some DCNR funding limits the number of landowners interested in planting a buffer.

3. Use subsidized insurance to support buffer crops. Subsidizing buffer insurance could extend beyond the buffer to include reduced rates on annual cropland to those that have a streamside buffer. Alternatively, one participant suggested that restrictions be placed, such as not receiving crop insurance unless a buffer is implemented on land parcels experiencing degradation without a buffer in place.

4. Be cautious about tying buffer funding to a particular source like the federal Farm Bill. While it is inevitable that some subsidy funds will be needed to establish multifunctional buffers, such funds should be stable in the long-term while keeping up with inflation rates.

5. Support private funding for multifunctional buffers. Private funds can decrease the financial pressure on a state and address the problem of farmers not wanting to accept government money (including plain-sect farmers). Supporting such funds can be through tax reductions to private businesses that have Corporate Social Responsibility (CSR) programs to help establish buffers.

6. State-owned government land should implement multifunctional buffers and serve as an example of the benefits and feasibility of buffers. The establishment should be not only on agricultural land but also on land around roads and cities. This will help farmers and the general public see buffers as a common and accepted practice on the landscape.

7. Allow harvesting, especially of herbaceous and woody biomass, in some parts of the buffers. Treating buffers as both a conservation practice and a farming practice can help gain acceptance by farmers. For example, it would be helpful to adjust current conservation policies or create a separate Conservation Reserve Program (CRP) program that allows harvest under specific conditions.

8. Stakeholders should collaborate with the Federal Emergency Management Agency (FEMA) on projects to plant resilient crops in floodplains. Though floodplain management regulations are typically relevant only to built structures, FEMA may be interested in the resilience buffers can provide. The policy gap between federal flood insurance, crop insurance, and agricultural land management needs to be better understood to determine what collaborations are needed and will be helpful.

9. Establish bridge loans to help farmers convert the land to buffers. Perennial crops often do not return investment quickly enough to convert from annual crops

like corn and soy. Assistance to transition and establish buffers is needed, especially if new perennial crops cannot be harvested for 2 or 3 years or more.

10. Streamline the process for landowners to apply for buffer funding. The amount of documentation to apply for funding can be a barrier, so simplifying the process may increase the rate of buffer establishment. Designate an agency through which farmers can go through to get funding for buffers. The diversity of programs is confusing to stakeholders. It would help to have a clear guideline as to which agency to go to and which program to choose. Participants suggested simplify the paperwork necessary to access funding and get buffers planted on farms.

11. Consider buffers as a stormwater management strategy; integrate into the MS4 permitting program.

12. Beavers could be considered as possible aids in creating stream structures and manage woody buffers. This might reduce maintenance costs to a landowner. A reviewer noted, however, that beaver ponds may extend the amount of land unavailable for crops and also drown out trees. While beavers may improve water quality, they may not help an individual farmer and could cause unintended consequences. More research on re-establishment of beavers in key areas is needed to understand their potential impact on water quality in the Bay.

13. Support the cooperative (co-op) farmer structure through the USDA Co-op Development Program to spread resources for buffers among multiple farmers.

14. Use Pennsylvania Resource Enhancement and Protection (REAP) funds to support buffers and remove any existing caps or deterrents from farmers using these funds. Perennial and niche crops may require specialized equipment that would require more funding than the current REAP cap provides. The REAP program can help support the establishment through tax credits or other mechanisms. For example, farmers can qualify for up to a 25% tax credit covering the cost of a buffer project.

15. Develop a dedicated fund, sourced from ratepayers, to support buffer implementation. Water quality is of concern to stakeholders across the region and the benefits of reducing input from agricultural land would be extensive. Workshop participants suggested implementing an extra tax on water bills, hunting licenses, fishing licenses, or voluntary ‘opt-in’ to create funds for buffer implementation.

Education and outreach recommendations

The adoption of multifunctional buffers will require educational outreach on the economic and environmental benefits across the watershed. Participants suggested stakeholders work to engage with farmers and the public to establish multifunctional buffers using the following methods:

1. Provide shovels, trees, and other necessary equipment at conservation meetings and workshops; spend time planting a new buffer or maintaining an existing buffer as a group.

2. Transform the understanding of the “best farm” as one that applies best management practices through demonstration and outreach events, not as one with clean rows and nice tractors.

3. Consider the advice of one set of participants to “consider the buffer as a pet” – that is, as a companion/friend that will gradually mature and needs continuous care along the way. Use this idea in marketing material.

4. Engage the younger generation and train them to work on buffers. Ideas proposed by workshop participants during a brainstorming session included:

    - Similar to the woodland internship with on-the-ground training, participants pay tuition to gain practical knowledge about buffers.

    - Have a buffer alternative spring break.

    - Create a student loan forgiveness program for those who do long-term buffer maintenance.

    - Create a SIMCITY for buffers or Chesapeake Bay Program virtual reality 3D video tool for designing and normalizing buffers.

    - Create a buffer game like “POKEMON in the city” to engage the younger generation in finding buffers and buffer gaps along streams

5. Use long-term and wide-scale approaches. Teach about long-term planning and large-scale impact assessment. To create a successful buffer system, a variety of species including grasses and understory species are necessary, not just trees. Teach how to balance managing the farm for the ecosystem services and the value of production for rural communities and farmers.

6. Educate stakeholders who rely on Bay health about the benefits that buffers can provide for them. This includes boaters, watermen and landowners who could see benefits from improved water quality as a result of buffer implementation.

7. Connect to the community and community partners to gain support for buffer plantings.

    - Include buffers in the PA-preferred program. PA-preferred is a partnership between the Pennsylvania Department of Agriculture and companies that promote Pennsylvania products. PA-preferred could be expanded to include a PA-preferred buffer label. Labels could include a “sustainable water label” or “helping clean the Bay” label for farms with buffers.

- Use the Penn State Extension newsletter to alert when buffer funding is available to farmers, when new buffers go in so landowners can come and observe the site preparation and planting, or when maintenance is needed so students or other interested parties can come help.

- Start a buffer share like a Community Supported Agriculture (CSA) program to engage people around buffers.

- Discuss human health impacts of surface and groundwater quality as outreach to the broader community.

- Use buffer products in community commercial kitchens and advertise the produce is from a local buffer.

- Present the data through the food chain. For example, advertise that the dairy products for a major ice cream producer like Turkey Hill from farmers that have buffers and illustrate to customers this ice cream comes from a farm that cares about water quality.

- Improve understanding about the benefit of buffers to Bay and tributary views and farm appearance. While the first few years of establishment may look messy and established buffers could block views, a cleaner and less-eroded waterway will improve the function over time.

8. Include in the regular curriculum of high school and college courses and extension workshop and field days that buffers can be a successful BMP. Teach that buffers are part of the business plan. Teach about niche-markets and their use. Reach out to marketing professionals for help. Illustrate that it is better to prevent runoff than to treat water afterward. Show an economic analysis of what that means. Re-define sustainability as a closed loop. Let farmers explore and research. This could include incorporating video-gaming and virtual reality techniques and opportunities for farmers to use and for stakeholder engagement.

9. Develop a cell-phone application that alerts a farmer or other maintenance worker that it is time to maintain the buffer and provides the weather forecast for planning purposes. This may help with buffer maintenance and increase success of buffers.

10. Conduct outreach to educate communities about opportunities from multifunctional buffers in various locations, including, but not limited to, at work, in educational settings, in extension events, and at agricultural expos. Potential locations include the following:

    - Showcase buffers at the Pennsylvania Farm Show, Penn State Ag Progress Days, and other relevant events.

- Talk to conservationists who do not consider multifunctional buffers as “pure" conservation and discuss the benefits of harvesting. Similarly, talk to producers about the benefits of ecosystem services.

- Focus conversations on the job opportunities buffers can create. For example, biomass from crops like switchgrass can be scaled to entire field and to entire rural communities. Focus more on profit, jobs, and economic and social benefits over pure water quality or conservation.

- Publicize the farming techniques and business models that help get buffers on the ground and experiencing success at scale.

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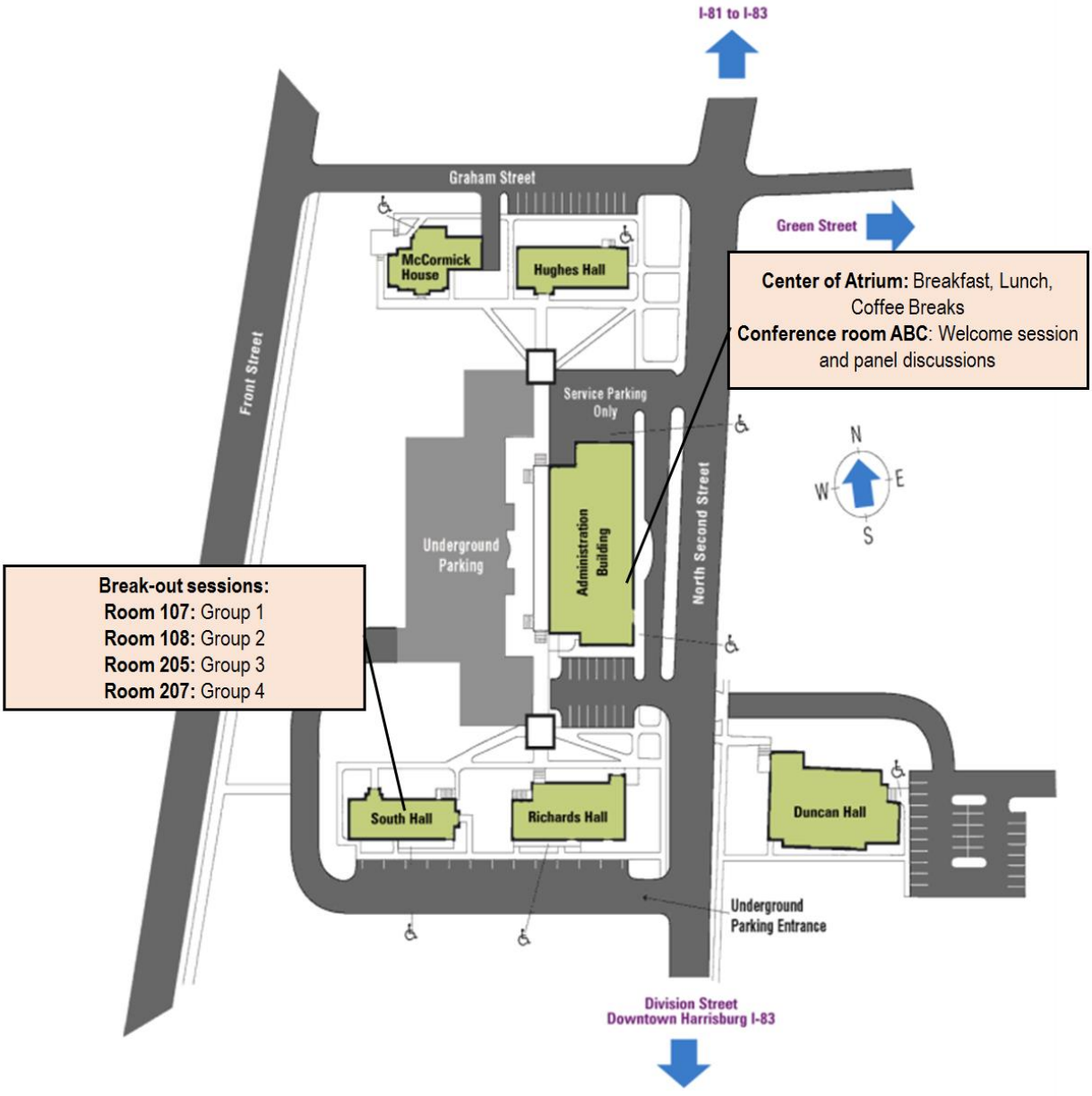
Appendix A: Workshop Agenda



STAC Workshop Day 1
November 13, 2018 8:30a-5p; networking dinner at 5:30p

8:30 – 9a	**Registration and continental breakfast**	**Admin. Atrium**
9 – 9:15a	**Welcome and overview of workshop goals** Tom Richard, Penn State Institutes of Energy and the Environment	**Admin. ABC**
9:15 – 10a	**Participant introductions and word cloud exercise** Everyone in the room provides a 30-second introduction that includes name, affiliation, and why you are interested in buffers. Please text the code on the overhead screen to join 'poll everywhere' on your phone or laptop for the upcoming word cloud or write "what buffers are to you" on the large boards in front of room. Facilitator: Lara Fowler, Penn State Institutes of Energy and the Environment	
10:00 – 10:15a	**Break, move to break-out groups**	**Admin. Atrium**
10:15 – 11:15a	**Stakeholder session 1: Solutions to barriers** Goal: What are key barriers to getting buffers on the ground and why? What solutions do you see? Break out groups: 1. Producers and practitioners Facilitator: Hannah-Brubaker-Smith, Pennsylvania Association Sustainable Agriculture Notes: Steph Herbstritt, Penn State 2. NGOs and environmental stakeholders Facilitator: Ann Swanson, Chesapeake Bay Commission Notes: Veronika Vazhnik, Penn State 3. Funding and policy stakeholders Facilitator: Robert Boos, Pennsylvania Infrastructure Investment Authority Notes: Su Fanok, The Nature Conservancy 4. Industry and academics Facilitator: Kevin Comer, Antares Group Inc. Notes: Rachel Rozum, Penn State	**South. 107** **South. 108** **South. 205** **South. 207**
11:15 – 11:30a	**Break, move to cross-pollination discussion of stakeholder session 1**	

11:30a – 12:15p	**Discussion of stakeholder session 1 (All)** Discussion moderators present their summaries to the whole group and entire group discusses outcomes Facilitators: Lara Fowler and Tom Richard	**Admin. ABC**
12:15 – 1p	**Lunch buffet, informal networking, and instructions for stakeholder session 2** Brief Remarks: Russel Redding, Secretary, Pennsylvania Secretary of Agriculture	**Admin. Atrium**
1 – 2p	**Stakeholder session 2: Key steps to implement the solutions** Goal: What steps are needed to overcome the barriers to establishing multifunctional buffers? Break out groups: 1. Producers and practitioners: Facilitator: Denise Coleman, Natural Resources Conservation Service Notes: Rachel Dixon, Chesapeake Bay Program 2. Researchers: Facilitator: Sally Claggett, Chesapeake Bay Program Notes: Steph Herbstritt, Penn State 3. Government and policy-makers: Facilitator: Marel King, Chesapeake Bay Commission Notes: Annabelle Harvey, Chesapeake Bay Program 4. NGOs and environmental stakeholders: Facilitator: Teddi Stark, Department of Conservation and Natural Resources Notes: Veronika Vazhnik, Penn State	**South. 107** **South. 108** **South. 205** **South. 207**
2 – 2:15p	**Break with refreshments**	**Admin. Atrium**
2:15 – 3:00p	**Discussion from Stakeholder Session 2: Strategies (all)** Break out session moderators present their summaries to the whole group; discussion overall. Facilitators: Lara Fowler and Tom Richard	**Admin. ABC**
3:00 – 4:15p	**Case study session: Examples where multifunctional buffers are working. What can we learn?** Examples where multifunctional buffers or buffer crops have been planted and are successful or showing promise of success, and show what markets can help generate a return on investment and payback the cost of establishing the buffer. Each presenter will	**Admin. ABC**

	share top elements that led to success and whether they are replicable. Commonalities will be discussed. Alyson Earl, Horn Farm Center for Agricultural Education Tracey Coulter, Department of Conservation and Natural Resources Ann and Don English, Happy Hollow Farm Austin Unruh, Crow and Berry Land Management Fred Circle, FDC Enterprises	
4:15 – 5:00p	**Panel and closure (Themes from day 1 and goals for day 2)** Ann Swanson, Lara Fowler, Sara Nicolas	**Admin. ABC**
5:30p	**Networking dinner in Harrisburg at Café 1500 (1500 N. Sixth Street, free street parking on-site)**	**Café 1500**

STAC Workshop Day 2
November 14, 2018 8:30a-12p

8:00 – 8:30	**Continental breakfast**	**Admin. Atrium**
8:30 – 9:00a	**Welcome and "Things that went bump in the night"** Lara Fowler	
9:00 – 10:00a	**Financial opportunities and markets rotating panel** The panel will always have 2 open seats that someone from the audience can join and to share opinions (limited to 5 minutes) Panelists: Calvin Ernst, Fred Circle, Dan Arnett Facilitator: Sara Nicholas, Department of Conservation and Natural Resources Notes: Steph Herbstritt, Penn State	**Admin. ABC**
10:00 – 10:15a	**Break with refreshments**	**Admin. Atrium**
10:15 – 11:15a	**Science and policy rotating panel** Panel will always have 2 open seats that someone from the audience can join to share opinions (limited to 5 minutes) Panelists: Alyson Earl, Adrienne Gemberling, Jon Duncan Facilitator: Ann Swanson, Chesapeake Bay Commission Notes: Veronika Vazhnik, Penn State	**Admin. ABC**

11:15a – 11:45p	**Recap, next steps and closure (all)** Tom Richard	**Admin.** **ABC**
11:45 –12:15p	**Workshop adjourns** Steering Committee meets to discuss next steps for disseminating results of workshop.	**Admin.** **ABC**

Appendix B: Workshop Participants

Multifunctional Buffers Workshop

Harrisburg, PA. Nov 13-14 2018

List of confirmed participants

NAME	POSITION	ORGANIZATION	EMAIL
Adam Tarr	Agriculture, Energy, Environment, Animal Welfare, and Native American Affairs LA	US Senator Bob Casey from Pennsylvania	Adam_Tarr@casey.senate.gov
Adrienne Gemberling	Susquahanna Technical Coordinator	Chesapeake Conservancy	agemberling@chesapeakeconservancy.org
Alisha Mulkey	Agricultural Watershed Implementation Planning Coordinator	Maryland Department of Agriculture	alisha.mulkey@maryland.gov
Alyson Earl	Executive Director	Horn Farm Center for Agricultural Education	executivedirector@hornfarmcenter.org
Andrea Ferich	Watershed Restoration and Protection Project Manager	Penns Valley Conservation Association	andreaferich@gmail.com
Ann Swanson	Executive Director	Chesapeake Bay Commission	aswanson@chesbay.us
Annabelle Harvey	Scientific and Technical Advisory Committee Staff	Chesapeake Research Consortium	harveya@chesapeake.org
Anne Hairston-Strang	Associate Director for Statewide Programs	Maryland Department of Natural Resources Forest Service	astrang@dnr.state.md.us
Austin Unruh	Owner	Crow and Berry Land Management	austin.unruh@hotmail.com
Bill Chain	Senior Agriculture Program Manager	Chesapeake Bay Foundation	bchain@cbf.org
Brion Johnson	Executive Director	Pennsylvania Infrastructure Investment Authority	bjohnson@pa.gov
Calvin Ernst	President	Ernst Conservation Seeds	calvin@ernstseed.com
Chris Keiran	Watershed Protection Program Associate	William Penn Foundation	ckieran@williampennfoundation.org
Chris Sigmund	President	Team Ag Inc.	TeamAg@TeamAgInc.com
Clare Billett	Watershed Protection Program Officer	William Penn Foundation	cbillett@williampennfoundation.org
Clare Hinrichs	Professor of Rural Sociology	Penn State	chinrichs@psu.edu
Dan Arnett	Biomass Manager	Ernst Conservation Seed	dan@ernstseed.com
David Wise	Watershed Restoration Manager	Stroud Water Research Center	dwise@stroudcenter.org
Deb Nardone	Executive Director	ClearWater Conservancy	deb@clearwaterconservancy.org
Denise Coleman	State Conservationist	US Department of Agriculture Natural Resources Conservation Service Pennsylvania	Denise.Coleman@pa.usda.gov

Don and Ann English	Owner and farmer	Happy Hollow Farm	happyhollowfarmpa@gmail.com
Eric Rosenbaum	Consultant	Rose Tree Consulting	rosetreeconsulting@gmail.com
Esther Parish	Researcher in Landscape Ecology and Regional Analysis	Oak Ridge National Laboratory	parishes@ornl.gov
Fred Circle	President	FDC Enterprises	fred@fdcenterprises.com
Gaby Gilbeau	Staff Attorney, and Program Coordinator	Penn State, and Pennsylvania Agricultural Mediation Program	gmg205@psu.edu
Hannah Brubaker-Smith	Executive Director	Pennsylvania Association for Sustainable Agriculture	hannah@pasafarming.org
James Schallenberger	Monitoring and Protection Manager	Susquehanna River Basin Commission	jshallenberger@srbc.net
Joel Semke	Resource Enhancement and Protection Coordinator	Pennsylvania State Conservation Commission	jxd523@psu.edu
Jon Duncan	Assistant Professor of Hydrology	Penn State	jsemke@pa.gov
Katie Ombalski	Conservation Biologist	Woods and Waters Consulting	katie@woodswaters.com
Kate Zipp	Assistant Professor of Environmental and Resource Economics	Penn State	kyz1@psu.edu
Kelly Shenk	Regional Agricultural Advisor	US Environmental Protection Agency	shenk.kelly@epa.gov
Kevin Comer	Principal and Senior Project Manager	Antares Group Inc.	kcomer@antaresgroupinc.com
Lara Fowler	Assistant Director for Outreach and Engagement, and Senior Lecturer	Penn State Institutes of Energy and the Environment, and Penn State Law School of International Affairs	lbf10@psu.edu
Leon Ressler	Agronomy Extension Educator	Penn State Extension	ljr@psu.edu
Marel King	Pennsylvania Director	Chesapeake Bay Commission	mking@chesbay.us
Matt Kofroth	Watershed Specialist	Lancaster County Conservation District	mattkofroth@lancastercon servation.org
May Wu	Principal Environmental Systems Analyst	Argonne National Laboratory	mwu@anl.gov
Miae Ha	Assistant Hydrologyst	Argonne National Laboratory	mha@anl.gov
Michael Cooley	Permaculture Design Consultant and Lecturer	Narrow Passage Permaculture and Agroforestry	narrowpassagepermacultu re@gmail.com
Micheal Reardon	Building Team Staff	EcoTone Inc.	mreardon@ecotoneinc.co m
Mike Jacobson	Professor of Forest Resources	Penn State	mgj2@psu.edu
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Paul Patterson	Professor of Poultry Science	Penn State	php1@psu.edu
Phil Gruber	News Editor	Lancaster Farming News	pgruber.eph@lnpnews.com

Rachel Dixon	Scientific and Technical Advisory Committee Coordinator	Chesapeake Research Consortium	dixonr@chesapeake.org
Rachel Rozum	Ph.D. Candidate in Ecology	Penn State	rkr16@psu.edu
Renee Reber	Clean Water Supply Associate Director	American Rivers	rreber@americanrivers.org
Robert Boos	Deputy Executive Director	Pennsylvania Infrastructure Investment Authority	rboos@pa.gov
Russell C. Redding	Secretary of Agriculture, and Chair of the USDA Advisory Committee on Biotechnology and 21st Century Agriculture	The Commonwealth of Pennsylvania	rredding@pa.gov
Ryan Davis	Chesapeake Forests Program Manager	Alliance for the Chesapeake Bay	rdavis@allianceforthebay.org
Sally Claggett	Program Coordinator	U.S. Forest Service	sclaggett@fs.fed.us
Sanjib Sharma	Ph.D. Student in Civil and Environmental Engineering	Penn State	sanjibsharma66@gmail.com
Sara Via	Professor of Biology	University of Maryland	svia@umd.edu
Sara Nicholas	Policy Director	Pennsylvania Department of Conservation and Natural Resources	snicholas@pa.gov
Sarah Xenophon	Watershed Technician	Penn State Agriculture and Environment Center	sxenophon1@gmail.com
Scott McGill	CEO	Ecotone Inc.	smcgill@ecotoneinc.com
Steph Herbstritt	Ph.D. Candidate in Agricultural and Biological Engineering	Penn State	stephanie.herbstritt@gmail.com
Su Fanok	Director of Freshwater Conservation	The Nature Conservancy	sfanok@tnc.org
Taylor Nezat	Campaign Manager for Watershed Advocacy	PennFuture	nezat@pennfuture.org
Teddi Stark	Riparian Forest Buffer Coordinator	Pennsylvania Department of Conservation and Natural Resources	c-tstark@pa.gov
Tom Richard	Director, and Professor of Agricultural and Biological Engineering,	Penn State Institutes of Energy and the Environment, and Penn State	trichard@psu.edu
Tracey Coulter	Agroforestry Coordinator,	Pennsylvania Department of Conservation and Natural Resources	trcoulter@pa.gov
Veronika Vazhnik	Ph.D. Candidate in Biorenewable Systems, and graduate fellow	Penn State, and Idaho National Laboratory	vzv6@psu.edu
Xiaogu Li	Ph.D. Candidate in Agricultural, Environmental and Regional Economics	Penn State	xql5271@psu.edu

Appendix C: Session Questions

Break-out sessions:

Session 1. Solutions to barriers (10:15 – 11:15 a.m.)

Main goal: **Identify what are the key barriers to getting buffers on the ground and why. What solutions do you see?**

Main questions:

- **What are the key barriers to establishing buffers?**

- **What causes those barriers?**

- **If you would fix something about the multifunctional buffers, what would you fix? How would you overcome that problem?**

Session 2. Key steps to implement the solution (1 - 2 p.m.)

Main goal: **Identify what steps are needed to overcome the barriers.**

Main questions:

- **Have you thought of additional solutions during the lunch discussions? What are those?**

- **How can the solutions you discussed in the morning and the new ideas be implemented?**

- **Who should be the main stakeholders to take those actions?**

Panel discussions:

Financial opportunities and markets (9 – 10 a.m.):

The panel will always have 2 open seats that someone from the audience can join and rotate in and out of.

Constant panelists: Calvin Ernst, Fred Circle, Dan Arnett

Key questions:

What are the financial opportunities?

What are the current and future markets?

How do we align farmers planting multifunctional buffers with industry that will buy products from those buffers?

How can we target marginal land? Should we target that land?

Do we need different financial incentives or programs? What should those be?

How do we make needed changes?

Questions from the audience:

Science and policy **(10:15 – 11:15 a.m.):**

The panel will always have 2 open seats that someone from the audience can join and rotate in and out of.

Constant panelists: Alyson Earl, Adrienne Gemberling, Jon Duncan

Key questions:

How do we align best science on buffers with where buffers are planted, and what gets planted in buffers?

Who serves this role of aligning science and action?

What policy apart from financial incentives could accelerate establishment of buffers?

What research is required to make the acceleration possible?

What source of knowledge (old, new non-existent) should practitioners and policy-makers look into?

What resources should the steering committee look into to inform the key stakeholders?

Questions from the audience:

Appendix D: Presentation Summaries

The pre-workshop webinar included several presentations shared via an online webinar. The webinar's goal was to show what multifunctional buffers look like, why they are installed and start the conversations about how to move forward with accelerating the installment of the buffers. Steph Herbstritt (Pennsylvania State University), Tracey Coulter (PA DCNR Bureau of Forestry), Brandon Tennis (Lancaster County Conservancy) and Sally Claggett (US Forest Service) discussed the goals of establishing multifunctional buffers and what policy goals exist for such buffers. Katherine Zipp (Pennsylvania State University) discussed the need for flexibility in support of multifunctional buffers. Austin Unruh (Crow and Berry Land Management), Ryan Davis (Alliance for the Chesapeake Bay), Roger Rohrer (farmer), Mike Hile (Pennsylvania State University), Will Brandau (Association of Warm Season Grass Producers) and Dan Arnett (Ernst Seeds) shared examples of fields with forested and grass riparian buffers, discussed their benefits, markets, and their experiences with the practice.

The pre-workshop webinar can be viewed online at https://www.youtube.com/watch?v=QqBH1dSuZBg&feature=youtu.be

Several case-study presentations were showcased at the workshop. Alyson Earl (Horn Farm Center for Agricultural Education) presented their center's efforts in protecting streams and educating conservationists through their Center. Tracey Coulter (PA DCNR) discussed the Pennsylvania's Department of Conservation and Natural Resources (PA DCNR) efforts in supporting buffers. Ann and Don English (Happy Hollow Farm) presented on their years of experience with buffers on their farm. Austin Unruh (Crow and Berry Land Management) explained how silvopasture and rotational grazing could be an approach to introduce multifunctional buffers while keeping some of the land available for grazing. Fred Circle (FDC Enterprises) suggested that perennial crops could be planted not only along streams but on entire fields and still make financial sense if the correct markets are available.

Appendix E: Additional Resources

Dec 7, 2018, Lancaster, Understanding Dairy Business for Conservation Professionals Workshop: https://extension.psu.edu/understanding-dairy-business-for-the-conservation-professional?j=286855&sfmc_sub=25469516&l=159_HTML&u=5589492&mid=7234940&jb=

Dec 17, 2018, Webinar or Harrisburg, PA Chesapeake Bay Program Phase 3 Steering Committee Meeting: https://www.dep.pa.gov/Business/Water/Pennsylvania%E2%80%99s%20Chesapeake%20Bay%20Program%20Office/WIP3/Pages/WIP-Steering-Committee-Actions.aspx

Phase 3 Steering Committee Actions: https://www.dep.pa.gov/Business/Water/Pennsylvania%E2%80%99s%20Chesapeake%20Bay%20Program%20Office/WIP3/Pages/WIP-Steering-Committee-Actions.aspx

Feb 6-9, 2019: Lancaster, PASA Sustainable Agriculture Conference: https://pasafarming.org/conference/

Feb 20-21, 2019: Harrisburg, Riparian Forest Buffer Summit: http://paenvironmentdaily.blogspot.com/2018/11/save-date-riparian-forest-buffer-summit.html

April 29-May 2, 2019: South Carolina, 2019 National Watershed and Stormwater Conference: https://www.cwp.org/2019-national-conference/

Chesapeake Network: https://www.chesapeakenetwork.org/

Chesapeake Riparian Forest Buffer Network: https://www.chesapeakenetwork.org/groups/chesapeake-riparian-forest-buffer-network/

Getting More on the Ground: www.gettingmoreontheground.com

PA Environmental Digest: www.paenvironmentdigest.com

STRIPS / Science-Based Trials of Rowcrops Integrated with Prairie Strips; Iowa State University; <https://www.nrem.iastate.edu/research/STRIPS/> last accessed August 1, 2019.