Assessment of Riparian Forest Buffers within the Susquehanna-Chesapeake Watershed

In June 2017, a group of researchers from a wide-assortment of Mid-Atlantic organizations and agencies presented interim results on their study, called the Assessment of Riparian Forest Buffers within the Susquehanna-Chesapeake Watershed. The link for this video presentation is here: https://vimeo.com/223303822

A summary of interim findings and thoughts/opinions from this presentation is presented below:

- This presentation was provided at the halfway point of the study, a joint research effort between the Farm Service Agency (FSA) and the USDA Agricultural Research Service (USDA/ARS). The project researchers were from an assortment of Chesapeake Bay-area universities, agencies, and other institutions.
- The presenters stressed that there are no conclusions yet, this is still an ongoing process.
- Existing riparian forest buffers were identified in watersheds in PA, VA, and MD. State foresters from each state were tasked with conducting the study fieldwork, ensuring the best possible data and knowledge. All other study procedures, assumptions, and descriptions outlined were quite impressive and thoughtful – this is a real scientific process. The results are likely to be very valuable and foundational. The field work portion of the work appears to be completed, at least initially.
- The lack of current or existing efficiency data on many of these riparian forest buffer issues was surprising. Basic functional data about forested riparian buffers is lacking, leading to big questions on measuring their effectiveness.

Initial study results include:

- One challenging aspect of the data gained so far is the tremendous variability of results. The lack of uniformity relative to the effectiveness of forest riparian buffers is a challenge, and it appears that wasn't unexpected. The lead study author, Dr. Pete Kleinman of USDA/ARS, stated that this current knowledge of variability of forest buffer effectiveness is the original motivation to conduct this project. What are the factors that cause variation? Can they hone in on variables to help measure and model riparian forest buffer BMP effectiveness?

- A few examples of their challenges and uncertainties:
    - they stated that there is insufficient research out there on factors for how slope/grade impacts forest riparian buffer effectiveness.
    - The depth/width of riparian forest buffers can be a critical factor, particularly if there is a convergent flow pattern. A slim riparian buffer strip along a stream can easily get overwhelmed if all runoff flow converges in one narrow area. A divergent and dispersed flow pattern however can work well with narrow riparian buffers. The presenters showed visual examples of this type of convergent vs. divergent flow situation. BMP effectiveness varies greatly on this variable alone. Another challenge is that flow patterns can change over time.
    - Also, the researchers documented that overall water flow patterns are very critical to riparian forest buffer BMP effectiveness. For example, one of the researchers highlighted studied forest buffers whereby of the 30 acres the BMP was designed to support, only 10 acres of the 30 was directed toward the forest buffer. The other 20 acres drained directly to a waterway through trenches that had been formed. Thus BMP effectiveness for the site (the entire 30 acres), was extremely low.
    - At another studied site, ditches and swales formed that limited the effectiveness of the BMP by routing water flow through only a small portion of the forest riparian buffer, at a rate/pace/direction that limited the ability of the BMP to absorb or limit nutrient or sediment loss. The researchers showed imaging photos from studied sites that highlighted 'microtrenches' or concentrated flow paths that negatively impact the effectiveness of forest riparian buffers. The lead study author cited this situation as the number one challenge to enhancing the effectiveness of riparian forest BMPs. They appeared surprised by these results, in that apparently this type of frequent existence and limited effectiveness due to microtrenching was new information from an actual field study/data standpoint.

Areas of Continued Focus

- Due to the high level concern from interim findings regarding microtrenching, the researchers will now focus on how to reduce nutrient and sediment loss due to the common existence of trenching and swales. The current research focus is on adding co-located grass buffers (placed within the swales and trenches) within forest buffers. In other words, the existence or formation of swales and ditches that route water away or narrowly through a BMP probably can't be prevented, but designers can focus on lining the swales and ditches with grasses, thereby slowly and enhancing the buffering capability of the site. I understood that this challenge is the primary focus of phase 2 of this project.
- From data collected in the Chesapeake watershed, the authors estimate that 22-78% of runoff water bypasses the studied riparian forest riparian buffers. Lead study author Dr. Kleinman stated that "the existence of these microtrenches are the rule, not the exception" that "there is clearly room for a change in the design of forest buffers" and "these microtrenching challenges are "ubiquitous". BMPs need to be used in their entirety in order to "take advantage of their full filtration benefits."

- According to a slide, for their studied sites (not a declaration overall at this point), the presence of microtrenches - 'bypass flow' - concentrated flow paths - reduced the effective total contributing area to the riparian forested buffers by approximately 78%. 40% less N capture efficiency when waters are not flowing properly through the BMP.
- When looked at on a broader scale, the study authors say riparian BMP topography is totally variable, yet critically important to function, and they simply don't yet understand all the mechanisms to proper function. A 'swiss army knife' approach is needed, and they are trying to figure out how to optimize riparian forest buffer BMPs using the data they are gathering from this study. It sounds like they are not near their optimization data yet.
- They had a PSU post doc researcher conduct a literature review on studies and data on riparian forest buffers. They are at 300-500 citations and reviews at this point. They are documenting what ecosystem services you get from what BMPs and ways in which these services can be optimized. They are looking for quantifiable metrics. Apparently this has never been done before, at least as far as this group knows. They are now populating this data into some sort of a model that can be used by ARS and others to help farms/organizations understand what type of buffer to use given their specific situation.

Next Steps

- It appears the next steps are two-fold. First, figure out how to reduce variability in riparian forest buffer BMP effectiveness. As of now, their data is all over the place and they are not yet able to establish or predict trends or results. Second, is to focus on integrating grass BMPs with forest BMPs. The grass BMPs would be placed in the microtrenches and swales, and their initial data shows that when used in combination, that BMP effectiveness significantly rises (if you can't beat them, join them). There were a number of slides presented supporting this dual BMP approach. They also showed slides that even in flat lands, grass buffers need to be added/paired to forest buffers to enhance effectiveness.

Final thoughts:

On September 27, 2017, a Watershed Implementation Plan (WIP) steering committee meeting took place at the PA Department of Environmental Protection. At this meeting, a chart showing the most cost effective practices for reducing nitrogen loss to the Chesapeake Bay was presented (see http://files.dep.state.pa.us/Water/ChesapeakeBayOffice/WIPIII/PA%20PhaseIIIWIP%20SC%209_27_2017%20Draft.pdf). On slide 73 of 76, the cost-effectiveness of nitrogen removal using riparian forest buffers was presented at $2 per pound of N removed, using a cost calculation tool from the Chesapeake Bay Program. It is unclear how/if this Chesapeake Bay Program BMP costing tool considers:

(1) The significant unknowns and variability of riparian forest buffer effectiveness as described from the above study researchers. What effectiveness does the Bay Program cost model consider and does that model consider the reduced effectiveness from ubiquitous microtrenching?
(2) This cost per pound estimate presumably does not include the 3:1 uncertainty ratio that the DEP applies to estimated nitrogen reductions from all modeled BMPs.

The truth is, we are probably a long way off from predicting the effectiveness of riparian forest buffers. The study authors were clear and unequivocal that the lack of consistency in performance is yet to be understood. Hence the 3:1 uncertainty ratio. The DEP WIP panel meeting at the end of September failed to disclose these added uncertainties.