Overarching lessons learned from the synthesis meeting

How are BMP practices improving water quality?

- ***Significant improvements observed in the watershed and estuary have been a direct result of reductions in point source (PS) nutrient discharges, which have led to substantial improvements in water and habitat quality (e.g., SAV expansion, decreased algal blooms, increased water clarity). Some of these water quality and habitat improvements occurred rapidly (~ 1 year) while others occurred more slowly (~ 5-7 years)***
    - The most obvious improvements in the Bay tidal waters have been associated with waste water treatment plant upgrades
        - NOTE: We will include examples

- ***Results from the implementation of nonpoint source (NPS) BMPs vary in the extent of nutrient and sediment reduction as well as improvement of conditions in watershed streams, rivers and the estuary***
        - NOTE: We will list example of studies from both agricultural and urban suites of practices and we will also highlight the importance and effect of scale (e.g., that it is easier to see effects at field/plot level scales)
    - Nutrient management that focuses on reducing the initial input of nutrients into the system is one of the best ways to reduce nutrient transport off the landscape
    - Relatively large amounts of implementation are required to observe significant water quality and habitat responses since past and present nutrient additions have been high
    - Variations are due to several primary factors related to implementation and watershed properties

  Implementation factors include:
        - The type of practice being implemented
            - Some BMPs are more effective than others (e.g., stream fencing for sediment reduction and cover crops for nutrient reduction)
        - How well the practice is installed, the time it takes to reach full efficiency, and how well it is maintained
            - NPS practices such as riparian buffers can take years to reach full efficiency
            - Others are not fully efficient if implementation is not correctly timed and/or if the most effective sites are not selected, as in the case of cover crops
            - Cover crops need to be planted every non-crop season
            - The maintenance of BMPs will affect their performance over time
                - Performance of nontidal wetland BMPs that function by "trapping" constituents (e.g., nutrients and sediment) generally degrade over time and thus require maintenance

  Watershed factors include:
            - The effect of watershed characteristics (soils, relief) may all impact the efficiency of NPS BMPs
            - Other natural factors will affect the water quality response to the BMP
                - Factors include: hydrology, geological framework, size of the watershed, soil and stream chemistry, constituent sources, and

physical and chemical processes that govern the transport of constituents
        - Climate change, particularly increasing temperature and altered rainfall patterns will affect the performance of most BMPs

- ***The majority of NPS BMPs will take years to improve water quality in both the watershed and the estuary***
    - Lag times are associated with the following:
        - Time required for installation of practice
        - Time required by design for the BMP to produce an effect
        - Time required for the effect to be delivered to the water resource (groundwater lag times for N and transport times of sediment and associated P)
        - Time required for the water body to respond to the effect
        - The effectiveness of the monitoring design to measure the response
        - NOTE: Will add more info on how legacy sediment and groundwater delay the ecosystem response
    - Empirical results demonstrate a wide range in response times
        - In some cases reduced nutrient loads decreases a portion of stress on the system but may not generate all of the desired restoration outcomes
        - NOTE: Will include example - Susquehanna Flats?

How can we apply what we've learned about BMPs to improve water quality?

- ***BMPs must be focused (both type and location) to address the main sources of water quality impairment***
    - The first step in designing effective implementation strategies in a particular area is to quantify the major causes of water quality and habitat degradation
        - Need to know the scope of the problem (and the particular constituent of concern), magnitude, and source to select correct suite of BMPs to address the cause
    - Since BMP performance is variable across the Bay watershed and is influenced by multiple factors, focused implementation is needed to achieve the greatest amount of efficiency for BMPs

- ***The amount of BMPs implemented should be sufficient to match the scale of the problem***
    - A large amount of implementation is needed to achieve a large water quality response
    - To improve Bay water quality, BMPs should be focused in the areas having high nutrient and sediment loads to the Bay
    - To improve Bay water quality, policies also need to protect areas of suitable water quality and low loads to the Bay
    - Implementing a suite of BMPs is important; single BMPs are rarely sufficient to achieve adequate load reductions

- ***Improvements in water quality as a result of BMPs may be offset by increasing nutrients in other sources; restoration goals and expectations should be set with that in mind***
    - NOTE: Will elaborate on how population increases affect wastewater and increase in animal populations increase manure, which leads to an increase in constituents

How can we use adaptive management to reduce uncertainty and improve the implementation of BMPs?

- ***Improvements are needed to enhance models for targeting of BMP implementation***
    - Models must play a major role in developing effective implementation strategies, realistic expectations, and monitoring approaches for assessing progress
    - The current suite of CBP models are the best available tools for this effort. The models are currently being assessed to determine potential improvements that can be made by the 2017 evaluation of the TMDL. Model accuracy will depend on high quality information obtained from smaller scale (less than 50 sq. mile) watershed studies. Very small "field scale" studies may not be as useful as studies that use a small integrated watershed as the research design.
    - Modeled information does not replace monitoring information when discussing lessons learned from BMP studies; monitoring data show that the current Bay model that assumes that BMP efficiencies can be applied uniformly downstream in a linear fashion is not always accurate
        - Monitoring data is necessary to determine the effectiveness of management actions
            - It is important to analyze monitoring samples for major chemical forms, not just totals, in order to improve understanding and predictive ability of models

- ***Improvements are needed to enhance monitoring of BMPs as well as water quality and habitat responses***
    - Scale and design of monitoring needs to be appropriate to the questions that are asked about BMP effectiveness
        - Need to move to smaller scales (< 50 sq. mile watersheds) of monitoring/research to explain/evaluate effect of BMPs than what is currently monitored in most of the basin-wide monitoring programs
        - The monitoring design must be adequate (in terms of frequency and duration) and contain sufficient controls to separate intervention effects from natural variability of the system
        - Designing a monitoring strategy to measure the effects of a particular BMP requires consideration of spatial and temporal factors
            - If it is a storm flow driven parameter, then monitoring must be temporally intense and target sampling to storm flow periods
            - At smaller scales the importance of sampling intensity increases for capturing storm flow effects
            - Location of the monitoring station relative to the BMP(s) needs to be considered
        - It is important to monitor for both BMP implementation as well as water quality and living resources variables
            - It is important to determine which water quality and living resources monitoring variables are the most sensitive and yield the most useful information

        - Verification of BMP implementation and communicating information about BMP performance is necessary to support assessments of the practice
    - At the watershed scale, all potentially relevant factors, including those outside of the study design, should be accounted for and tracked (e.g., unexpected changes in land use/land management)
    - In order to successfully evaluate the effectiveness of a BMP project, the coordination and collaboration of monitoring and implementation information is essential.

- ***Evaluating the effectiveness of water quality and habitat monitoring programs and BMP projects will require a better understanding of lessons learned from past BMP projects and the application of those lessons through adaptive management***
    - It will require persistence and patience to observe full improvements in water quality, particularly in the case of NPS management, because responses have significant lag times
    - We need to understand the factors that influence BMP effectiveness to improve designs for practices and to improve predictions of their effects
    - Measurements of effectiveness should be coordinated so that data and results are compatible and accessible
    - Effective adaptive management will require a decision process that is able to recognize where improvements to the projects are needed in order to improve future efforts