Overarching lessons learned from the synthesis meeting

BMP Performance: how are certain practices working?
i.e, stream fencing, point sources, lag times before water-quality improvements are evident

- Reductions in point sources have resulted in improvements to water quality and SAV
  - We have seen the largest improvements in the Bay tidal waters associated with waste water treatment plant upgrades
- Some BMPs have more of an immediate effect than others
  - i.e., Fencing animals out of a stream and wetlands
- Lag times are present at multiple levels:
  - Associated with how long it takes to implement the BMP(s)
  - Associated with the amount of N & P stored in the sediment and groundwater delay the ecosystem response
- It takes relatively large improvements to see water quality responses
  - Higher amounts of implementation are more likely to yield positive ecosystem results
- Location of BMPs in relation to WQ monitoring station is critical. The closer the BMP, the more likely that improvements can be seen
- Determination of success is more likely at smaller scales, such as edge-of-field or very small basins
  - Evidence of how a single practice affects a water quality parameter can only be obtained in situations where the effects of that practice can be isolated from the effects of all other factors that affect that parameter. This usually only is possible in small scale controlled settings with a single land use.
- Timing versus amount of application is important in nutrient management.
- Can manage for either P or N but not both, especially where there are tile drains.
- Soil characteristics, such as natural drainage properties and pre-existing P concentration, can be very important.
  - There is good evidence that riparian buffers and restored wetlands can be sinks for nutrients and sediments but their effectiveness varies greatly with setting (e.g. drainage patterns, soils moisture, and physiographic province may influence performance of riparian buffers,) and scaling (e.g. buffer width, wetland size relative to catchment, water retention time, area vs. volume, etc.).
- The effect of restoring riparian buffers or wetlands is not subject to lag times due to groundwater transit because they can treat groundwater as it emerges into streams. However, there may be lag times related to establishment of vegetation and soil organic matter after restoration.
- After riparian buffers or wetlands are restored, they may continue to remove nutrients for many years without significant maintenance costs. However, wetlands may eventually fill with sediment and require excavation to restore their performance.
- There is good evidence that cover crops can be effective at reducing nutrient (especially N) loss but cover crops need to be used every year that excess N is leftover after cropping. The effects of cover crops on stream water are subject to the lag time of groundwater transit to streams.

- Load reduction is best achieved by simply reducing the amount of N and P introduced to the watershed wherever possible. All other BMPs are focused on reducing nutrients already introduced and they all suffer from variable performance. Using less is 100% effective.
- Ecosystem response to BMPs is generally slow (>>2yrs, although shorter term responses can be found e.g. freshwater SAV), and often cryptic. Reduced nutrient load may ultimately be just a reduction in complex stresses on a system, and thus ease pressure on the systems resilience without generating easily observable structural changes. This is still very important because of the stochastic stresses such as storm events which, absent stress relief, could push the system over a threshold. (SAV and Agnes vs. Irene; HAB occurrence)
- BMP effectiveness is not constant. Performance of BMPs that function by "trapping or sequestering" pollutants, generally degrade over time. Climate change (particularly increasing temps and altered rainfall patterns) will affect the performance of most nutrient BMPs.

BMP Efficiency: how to better design and implement BMPs?
i.e, suites of BMPs, improved monitoring, targeting sources

- The location of the BMP impacts its success
  - Factors specific to location that influence this success include: hydrology, geology and size of the watershed
- Management practices should be scaled appropriately to the scale of the source (e.g. don't expect a small wetland to trap much of the nutrients released by a large watershed).
- Implementing a suite of BMPs is important
  - WQ goal attainment will require application of suites of BMPs pretty much everywhere. Single BMPs are rarely sufficient to achieve adequate load reductions anywhere, so implementation should focus on integrated sets of BMPs rather than individual practices.
- Success depends on what factors are used to determine success
- It's hard to control for multiple factors associated with success
  - i.e., Unexpected changes in land use/land management
- Need to know the scope of the problem (and constituent), magnitude, and source to implement targeted BMPs
  - Suggest doing a "back of the envelope calculations" to assess potential impact of a particular BMP
  - The effects of a particular practice on a water quality parameter will depend on the extent to which that practice alters the primary mechanisms affecting that water quality parameter. The first step in designing an effective implementation strategy is to quantify the drivers of existing water quality at the mechanistic level.
- Management practices must be targeted to address the main sources of water quality impairment (e.g. target agricultural sources in agricultural watersheds and urban sources in urban watersheds, riparian buffers and wetlands must be positioned to receive nutrients released from source areas).
  - Verify implementation of management practices and share the information about the practices as needed to support assessments of the effectiveness of the practices.
  - Targeted implementation is the only way to achieve efficiency, since BMP performance is quite variable across the multiple landscape settings in the Bay watershed. The only BMPs likely to produce consistent pound/dollar reductions across the watershed are

WTP upgrades. The performance of almost all other BMPs is context specific – not that we know the relationships at this point.

- There is a need for monitoring to ensure effectiveness of BMPs
    - Scale of monitoring and quality/extent of the monitoring records will determine what questions can be answered about BMP effectiveness
    - Collaboration in monitoring and implementation is essential for a BMP project to be successfully evaluated
    - Designing a monitoring strategy to measure the effects of a particular implementation effort requires consideration of spatial and temporal aspects of the impacts. If it is a storm flow driven parameter, than monitoring must be temporally intense enough to sample storm flow. At smaller scales the importance of sampling intensity increases for capturing storm flow effects. Where high storage capacity aquifers are involved in the delivery mechanism, such as is the case for nitrate in the Coastal Plain, close consideration must be given to the relationship between reductions in leaching rates and changes in loads delivered in stream baseflow.
- If you reduce the pollutant load in the basin by enough, it will lead to a load reduction in the stream
    - Need nutrient management to decrease nutrients
    - BMPs sometimes just re-route the pollutant to the groundwater instead of the stream
- To observe full improvements will require persistence and patience, particularly in the case of nonpoint source management
    - Need to understand that responses do not and will not happen overnight
- Implementation should take into account near-stream buffer as well as upland-area sources.
- To measure improvements due to BMPs, the pre-BMP study area needs to be sufficiently degraded.
- Models need to play a major role in identifying the relative magnitude of various delivery mechanisms and are critical to the development of effective implementation strategies, realistic expectations, and monitoring approaches for assessing progress. Current Bay watershed model is deficient in this capacity.
- Model accuracy will depend on high quality information obtained from smaller scale research studies of infield practices and watershed hydrology and attenuation mechanisms.
- Where improvements to fish communities are desired, physical habitat improvements may not be enough. Populations may need to be reintroduced as well.
- Targeted areas need to consider potential sources of P that can be resuspended or from long-term soil storage, in addition to obvious sources of P (such as barnyards).

Reduce Uncertainty: What do we have to do to better to reduce uncertainties and learn?
i.e, adaptive management

- Need to have increased explanation of land activities and relate to monitoring information
- Scale of monitoring stations (greater than 50 sq miles) still too large to explain what practices are working
    - Need to get down to targeting small watershed scale (field level) to explain cause and effect
    - Need to move to smaller scales of monitoring/research to explain/evaluate effect of BMPs

    - Detection of intervention signals will require monitoring at watershed scales much smaller than current network designs. The monitoring design must be adequate (in terms of frequency and duration) to allow application of analytical techniques to separate intervention effects from natural variability of the system.
- Modeled information does not replace monitoring information when discussing lessons learned; model assumes that BMP efficiencies can just be scaled/added up over space. Monitoring data is necessary to have in order to determine the effectiveness of management actions
- Need to know pollutant sources to help develop BMPs
- It is very difficult to manage a complex system; only have control over a small piece of it
- We are under informed about which BMP(s) do and don't work and at what scale
- Could be very important to analyze samples for species of chemical forms, not just totals, in order to improve the predictive ability of models.
- May be able to supplement project data by asking around for archived data, especially sediments.
- More information might be gleaned from running a broad range of analytes on fewer samples than fewer analyses on more samples.
- Don't just do water and ignore the sediments.
- The effectiveness of management practices should be measured, especially for practices involving changes to land use and land cover, which vary greatly in effectiveness. We need to understand the factors that influence effectiveness to improve designs for practices and to improve predictions of their effects.
- Measurements of effectiveness should be coordinated so the resulting measurements are comparable and data are shared to allow comparisons of multiple applications of a given type of practice. Assessments of the effectiveness of management practices would likely be more efficient, objective, and comparable if they are not done separately by each group implementing the practice.
- The spatial scale for assessments should allow for resolving the effect of the management practice being assessed from effects of other management practices and other pollution sources. The effects of a given management practice or pollution source cannot be clearly distinguished from comparisons of watersheds with multiple types of management practices and multiple types of pollution sources. Targeted application of BMPs that facilitates monitoring of effectiveness (i.e. adequate replication of BMP suites in similar landscapes) will be necessary to detect and understand BMP performance.
- Effective adaptive management will require a decision process that is willing and able to recognize and accept determinations of "failure". Currently we are all about putting everything possible (and some things we are only imagining) on the ground everywhere possible. We do not have a process in place to determine efficacy and delete unsuccessful practices.