Critical Issues in Implementing Nutrient Trading Programs in the Chesapeake Bay Watershed

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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) partnership on measures to restore and protect the Chesapeake Bay. As an advisory committee, STAC reports periodically to the Management Board (MB) and annually to the Executive Council (EC). Since its creation in December 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 conferences and workshops, and (5) service by STAC members on CBP subcommittees and workgroups. In addition, STAC has mechanisms in place that allow STAC to respond quickly to *ad hoc* requests from the CBP for scientific and technical input. This allows STAC to provide the CBP subcommittees and workgroups with information and support needed as specific issues arise while working towards meeting the goals outlined in the current partner agreements. STAC also acts proactively to bring the most recent scientific information to the Bay Program and its partners. For additional information about STAC, please visit the STAC website at www.chesapeake.org/stac.

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Introduction

In 2010 the U.S. Environmental Protection Agency (EPA) established a Total Maximum Daily Load (TMDL) for the Bay. The Chesapeake Bay TMDL is the largest ever developed by EPA in geographic coverage. It sets discharge limits for nitrogen, phosphorus, and sediment across the Bay jurisdictions that are believed necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments. Waste load allocations (WLA) for point sources such as Publicly Owned Treatment Works (POTWs) will require significant upgrade costs to meet their new discharge limits and to accommodate future growth. To help reduce the costs of meeting these limits, EPA is encouraging the development of water quality trading programs that allow regulated sources such as POTWs to meet their permit requirements by purchasing offsets or credits from other point or nonpoint sources (NPS) such as agriculture. Under this approach, entities with an assigned waste load allocation are given flexibility in how they achieve their cap load limits and nonpoint sources are provided an incentive to provide a greater share of overall nutrient abatement, thereby potentially lowering total costs of meeting the TMDL. Nutrient point source-nonpoint source (PS-NPS) or point-to-point source (PS-PS) credit trading and offset programs must provide credible, effective, verifiable, and economical tools to meet water quality goals where they are implemented. In doing so, water quality credit trading programs are expected to reduce the cost of meeting point-source waste load allocations, and of managing new or increased loadings of nitrogen, phosphorus, and sediment. The workshop focused on PS-NPS trading and alternative NPS incentive programs.

Overview of the Workshop

States currently have or are developing rules for point-nonpoint trading programs, and trades are already occurring in Pennsylvania. However, STAC felt it important that the experiences with trading programs elsewhere be reviewed while state rules are still being revised. Point-nonpoint trading has not had an encouraging history, and an abundant literature highlights the various impediments to trading. Based on this history, design and implementation choices are critical for giving trading a chance to succeed.

To address these issues, STAC sponsored a one-day workshop entitled “Critical Issues in Implementing Trading Programs in the Chesapeake Bay Watershed,” held on May 14, 2013 at the Sheraton Hotel in Annapolis, MD. A copy of the full workshop agenda is included in Appendix A. The goal of the workshop was to start a discussion about how NPS-PS trading policies might be improved. This was accomplished by assembling top researchers, state trading program officials, and experts in trading policies to share their research and experiences with trading. Attendees included key staff from state agencies responsible for trading, federal agencies supporting states’ efforts, academics, and non-governmental organizations that are integral to supporting buyers and sellers in trading markets (see Appendix B).

The initial presentation (Appendix C) by Shortle reviewed the experiences of water quality trading programs and highlighted some of the important lessons learned about what factors contribute to a successful program, as well as factors that contribute to failure. Meals then reviewed experiences with watershed-scale programs that provided incentives to farmers to adopt best management practices (BMPs) for addressing particular watershed-scale water quality problems. Many of these programs failed to result in expected water quality gains, and Meals covered issues of monitoring, gaining farmer commitment, BMP verification procedures, and understanding social dynamics in the farm community as important factors that must be adequately addressed. Jackson-Smith's presentation lent support to Meals' conclusions. Jackson-Smith emphasized the need to properly establish pre-program farmer behavior (management) and the importance of ground-truthing adoption and maintenance of BMPs.

Ribaudo's presentation focused on trading baselines, a critical design feature in trading programs. Each of the Bay states has selected a different baseline for nonpoint source eligibility to trade. Ribaudo presented research findings on how baseline choice can influence the economic and environmental outcomes of a credit or offset market. Using the baseline to achieve multiple goals, such as encouraging additional nonpoint source abatement to meet load allocation goals, may be counter-productive.

We also heard presentations from agency representatives of Maryland, Pennsylvania, and Virginia about their respective trading programs, including verification and monitoring procedures and baseline choices. Panel discussions at several points in the workshop enabled broad audience participation in discussions about verification, baselines, and other issues related to the trading programs developed by the States, and trading in general.

The closing presentation by Nees presented some options for when trading is not the most appropriate tool to address the TMDL. He discussed how the market principles that drive trading can also be applied in other policy approaches, such as using auctions to award financial incentives for conservation practices, and basing payments on environmental performance.

This report expands on the material from the presentations and general discussions to provide more detailed treatments of what we consider to be the most important issues derived from the workshop. These are by no means the only issues with trading, but identifying critical aspects of some these issues should help States choose their best courses of action.

Important Take-Away Messages

- The intended purpose of trading is to reduce the costs of the regulated sector for meeting their legal discharge limits.

- Achieving the environmental and economic goals of point source - nonpoint source trading is difficult in practice largely due to constraints imposed by policy, but also due to underlying scientific and social challenges.
- Programs that have successfully attracted farmers to participate in trading or incentive programs rely heavily on existing embedded ties with farmers and intensive personal interactions.
- Uncertainty in the performance of BMPs – measured or predicted – and in long-term farmer participation impedes the development of viable markets because the steps taken to reduce uncertainty (point-nonpoint source trading ratios greater than 1:1, inspections, and monitoring) are expensive and make markets inefficient.
- The use of stringent baselines to obtain additional voluntary nonpoint source reduction can be counter-productive to achieving the intended goal of trading (to reduce the costs to point sources) and the non-traditional goal of incentivizing agricultural participation.
- Point-nonpoint trades do not have to occur for a point-nonpoint trading program to be successful, in terms of reducing point source abatement costs. Point sources may be able to take measures that are less costly than those from nonpoint sources.
- Experience with trading among point sources demonstrates that the opportunity to lower costs is closely related to the degree to which point sources are granted decision-making flexibility. The same is expected to hold for point source – nonpoint source trading.
- Due to lack of credit demand and the resultant incentives for agricultural sources, nutrient trading programs developed by Bay states to comply with the TMDL cannot be expected to make substantial progress toward meeting agricultural sector reduction goals on their own. However, these programs can be a key component to the Bay states' overall strategy to meet the TMDL reduction goals.
- The economic principles and tools behind point-nonpoint trading can be used to obtain more reductions per dollar spent in voluntary incentive programs.

What Have We Learned About the NPS Role in Trading?

The use of markets to protect water quality was first proposed by John Dales in 1968 (Dales, 1968). Success in applications to fisheries and air, and pressure on states to implement effective tools for achieving TMDLs in impaired watersheds, spurred increasing interest in water quality trading in the 1990's. Point-nonpoint trading allows regulated sectors to reduce the cost of meeting their permit requirements by allowing the trading of allowances or credits with other point sources or with unregulated nonpoint sources. A 2008 survey identified 57 water quality trading programs (experiments, pilot programs, and demonstration projects) in various stages of implementation (Greenhalgh and Selman, 2012; Selman et al., 2009). Twenty-six had established trading rules and the opportunity for trading to occur, 21 are under development, and

10 are complete or inactive. All but 6 are in the U.S. Significant trading initiatives are also in Canada, New Zealand, and Australia. These programs offer some insights into how trading performs once it moves from the textbook to the real world (Shortle, 2013).

The primary objective of any PS-NPS trading program is to meet or improve water quality goals at least cost. The environmental goal is best achieved if the environmental cap (i.e., total nutrient load) can be enforced, local hot spots (areas where regulated dischargers tend to purchase offsets) can be prevented, and if the environmental performance of management practices can be ascertained or estimated at relatively low cost and with reasonable assurance. The cost-efficiency goal is best attained if three conditions are met: a) sources have significant cost-differentials so that potential gains from trade are large; b) the number of polluting sources and the frequency of trading is large enough to stimulate enough trades to drive prices to their optimal levels; and c) there is flexibility in when, where, and how trades are made (Fisher-Vanden and Olmstead, 2013).

In addition, the success of a trading program depends on a stable set of rules that clearly define what is being traded and the rules of exchange. Trading rules and procedures establish who can trade, what is traded (credit definition), duration of a credit, baseline requirements (for calculating credits), accepted procedures for calculating credits, how the trade occurs, trading ratios, verification, liability rules, and enforcement procedures. Trading institutions are created and implemented by regulators to facilitate trading, and include property rights assignment (e.g., definition of the commodity), exchange mechanisms (e.g., clearing houses), market services (aggregators), and information services (education).

Trading outcomes also depend on the skill and objectives of participants. Textbook trading assumes market participants have full information about the cost and effectiveness of their abatement options and can instantly and, at little to no cost, obtain information on credit market prices and quantities. However, in the real world people are faced with limited time, resources, skills, and orientation toward markets. Complex rules and inadequate institutional design can result in poor buyer or seller participation, coordination failures, and lack of desired outcomes. U.S. PS-NPS trading programs have taken two general forms (Shortle, 2013). One is an offset agreement, under which regulated point sources can meet permit requirements through negotiated reductions of pollution at other facilities or projects (also known as bilateral trades). The second form is intended to facilitate routine trading between multiple sources that are contributing pollutants to impaired bodies of water. In either case abatement costs are reduced by encouraging low-cost abaters to bear a larger share of pollution control through an opportunity to sell abatement “credits” to willing buyers. Additional goals of trading are to encourage innovation, to increase the role of nonpoint sources in meeting water quality goals, and to speed compliance.

How is Trading Working Out?

Ex-post assessments of PS-NPS water quality trading programs have generally been negative about their performance (Breetz et al., 2004, 2005; Hoag and Hughes-Popp, 1997; King and Kuch, 2003; Newburn and Woodward, 2012; Ribaudo and Gottlieb, 2011; Shabman and Stephenson, 2002, 2011). Most have seen little or no trading activity. This is not necessarily a sign of failure, if regulated point sources were able to find less expensive ways of meeting their discharge permits (as in North Carolina, where point sources in the Tar-Pamilco system were able to meet their reduced discharge limits through internal processes rather than through trades). But in most cases, the expected role for nonpoint sources was not realized. A number of reasons have been presented including a lack of trading partners (due to limited regional scale or underlying economics), inadequate regulatory incentives (discharge cap was not sufficiently binding or regulated firms to seek trades), uncertainty about trading rules and practice performance, excessively high point-nonpoint trading ratios (increase the cost of nonpoint credits), legal and regulatory obstacles (including liability concerns), high transaction costs, and participant unfamiliarity and inexperience.

During the workshop, Shortle reviewed some of the successful programs to identify those factors that appear to be important for success. Three of the programs Shortle discussed are actually PS-PS programs, which provide some contrast for PS-NPS programs. Australia's Hunter River Salinity Trading program was developed and administered by the New South Wales water quality management agency. It caps saline discharges from 22 coal mines and power generators discharging into the Hunter River. Trades are organized through an online trading clearinghouse. Assessments indicate water quality goals have been achieved at a cost that is lower than prior regulations.

The Connecticut Nitrogen Credit Exchange was established by the Connecticut Department of Environmental Protection to facilitate reducing nutrient discharges into the Connecticut River as required by the Long Island Sound TMDL. Seventy-nine waste water treatment plants (WWTPs) are annually assigned individual discharge limits. Plants generate credits when they over-comply with their permits. Plants that under-comply must acquire credits to cover the shortfall. Credit price is set by the Nutrient Credit Advisory Board, appointed by the State legislature. Buyers and sellers do not interact in a market. Steady progress is being made toward achieving the TMDL, and cost savings of $300 to $400 million have been estimated compared to a uniform discharge limit.

The California Grassland Farmers trading program was developed and managed by an association of 7 irrigation districts to achieve a cap on selenium discharges from irrigation return flows in the San Joaquin Valley. It essentially converted a nonpoint problem into a point source problem by regulating metered selenium in collected drain water. Prices and trades were arranged at monthly association meetings. Thirty-nine trades occurred in 2 years of operation (1999-2000). Trading was suspended after the installation of a selenium recycling facility. The South Nation River trading program in Canada was designed to use agricultural offsets to reduce the costs of regulated point sources for meeting a zero discharge limit on new or expanded facilities. The program was managed by South Nation Conservancy, a long established watershed management agency providing grants to farmers to install BMPs. Payment by point sources into the program is one of several sources of BMP funding. Credits are sold at a price set by the program administrator to cover the average cost of installing agricultural BMPs. Farmers do not trade directly with point sources, but treat the program as a traditional cost-share program. Through 2009, 269 agricultural projects were funded. Significant cost savings were achieved compared to no trading and water quality is improving.

The Greater Miami Watershed Trading pilot trading program was established and administered by the Miami Conservancy District in 2005. The program pooled funding from federal United States Department of Agriculture (USDA) grants and voluntary donations from point sources. Participating municipal WWTPs have the option to purchase agricultural credits on favorable terms in advance of an expected tightening of discharge standards. The program then uses the accumulated funds to implement agricultural BMPs during bi-annual reverse auctions. Farmers submit applications through participating Soil and Water Conservation Districts (SWCDs). The SWCDs then provide technical assistance to farmers: they can also add their costs for assistance and annual inspections to farmers' bids to cover some of the transaction costs. Funding for the BMPs comes from participating WWTPs and grants from EPA and USDA. As of March, 2013, 11 rounds of project submittals resulted in potential funding for 397 agricultural projects for adopting water quality-improving BMPs. These projects will generate 1.14 million credits (572 tons of nutrients) over the life of the projects, and $1.6 million in credit sales to farmers. However, credits have yet to be sold to the WWTPs, as discharge caps have yet to be set. The abatement efforts of nonpoint sources are best viewed as trades-in-waiting. The Greater Miami pilot program also provides insights for how a non-trading program could use market-like incentives and competitive processes to cost effectively allocate funds for nonpoint source reductions (see the last section for a more extensive discussion).

Lessons

A number of lessons can be gleaned from the successes and failures of past trading programs.

PS-PS Trading Success

While trading between point and non-point sources has, for the most part, failed to deliver desired environmental and economic benefits, trading among point sources has shown more successes in reducing costs of compliance for WWTPs. This *within-sector* trading occurs within a well-defined regulatory framework and overcomes many public concerns of PS-NPS trading, including the technical barrier of judging the equivalence between nutrients emitted directly into the water with nutrients emitted on land. Successful programs were able to lower transaction costs and regulatory risks by establishing permitting options that overcame rigidities within conventional individual permits. Within-sector trading has therefore been seen as carrying a lower risk of environmental harm and has been more politically acceptable. This form of trading requires that emitters be given *group caps* so that they can share responsibility for a load to a waterbody. The opportunity to lower costs is closely related to the degree to which point sources are granted decision-making flexibility on how to meet nutrient load limits, during or after technical upgrades. By regulating performance, instead of regulating how to comply, plants have been able to experiment and find new approaches to reducing nutrients (Shabman and Stephenson, 2007).

An important caveat to the PS-PS success story is that trading has generally not been used to forgo major investments in technological approaches to reducing nutrients (Pomeroy et al., 2005). Rather, it has been primarily used to provide flexibility in scheduling upgrades and reducing costs by allowing emitters to make upgrades at convenient times. It would be expected that even greater cost savings could come from avoiding costly infrastructure investments. For example, it is generally considered less efficient to install state-of-the-art technology at small WWTPs that emit alongside major WWTPs because the relatively small reduction in nutrient loads from such investments can come at a high cost.

PS-NPS Markets Fail to Thrive

Market-oriented trading between PS and NPS sectors, in which individual buyers find individual sellers, is limited. Many reasons for this have been proposed and they include technical, social, and institutional barriers, only some discussed in this report. A foremost concern for some buyers is the risk that they might pay a NPS emitter to reduce nutrients but be held legally liable if the approach is not successful for any reason. Further, buyers do not want the extra effort of re-establishing trading contracts every year or every few years. Concern has also been expressed that water quality goals will not be met because of the difficulty of predicting how BMPs will perform; expected abatement may not materialize. Major issues that limit trades include:

- **Equivalence**. Water pollution trading between point and nonpoint sources requires complex commodities and trading rules in order to ensure that what is traded has environmental equivalence (trading apples for apples). Because nonpoint source emissions are largely unobservable and stochastic, models are used to judge equivalence across sectors. However, current tools rely on limited data to assess performance and largely fail to take into account important characteristics such as time lags for non-point source reductions (Hirsch et al., 2013). Further, the institutional design factors needed to address differences in locations, temporal response, and uncertainty, such as trading ratios, greatly complicate the definition of scientifically and legally sound commodities and trading rules. High trading ratios are a significant barrier to trading and a very crude way to address uncertainty. Research and verification can reduce uncertainty to some extent and provide guidance setting regional- or practice-specific ratios. However, such performance uncertainty raises the question of whether simple rules to target incentives to farmers might generate more participation and thereby outperform a system that requires complex calculations to be legally viable.

- **Market Size**. Water quality trading markets are watershed-based, resulting in "thin" markets with relatively few participants when watersheds are small or homogenous. The economic efficiency benefits of trading are best achieved when there are many players with diverse costs for reducing pollution. Thus, programs that expand who can participate will promote higher volumes of trading.

- **Regulation**. Nonpoint sources are the main source of potential cost savings in a point-nonpoint trading program, but the historic lack of regulation on cropland management decisions makes farmers particularly sensitive to trading rules when deciding whether to voluntarily participate in a trading program. When nonpoint sources are unregulated, trading program developers must develop rules to prevent leakages (account for actions on a farm outside of contracted BMPs), and to assure additionality (ensuring that BMPs adopted by farmers would not have been adopted without the trading program). Point sources may also face a number of regulatory barriers that limit their ability to trade.

- **Baselines**. Baseline requirements can be a barrier to trading that can diminish participation and cost savings (more below).

- **Market Efficiency.** High transaction costs can reduce the efficiency gains from a market. Economic efficiency gains depend on minimal interference from government in market operations and low administrative costs. For example, a case-by-case review of each trade by the government is expensive and does not improve market function (Henriquez, 2013). The trading of nonpoint sources does necessitate verification; however, that can be expensive.

- **Relationships**. Trust and embedded relationships are critical when dealing with farmers. Successful point-nonpoint trading programs all made use of existing relationships between trusted local intermediaries (representing the government) and farmers (Breetz et al., 2005; Mariola, 2012). Trust is a critical feature when participation is voluntary. Trusted local intermediaries with long-standing relationships with farmers, such as soil conservation district agents, may have a better chance of convincing farmers to enroll in a program and to successfully fulfill their contracts.

- **Ongoing Investments.** Public sector involvement cannot end with rules development, implementation, and enforcement. Investments in the market place are needed to get people to participate and to achieve gains from trade. This includes research and information programs and services for market participants.

- **Demand**. Demand for NPS credits is often overestimated. When confronted with new regulatory requirements and given the discretion to devise their own nutrient control strategies, point sources often find ways to meet requirements at a cost lower than analysts and the dischargers themselves thought possible. Trading encourages feedback, learning, and technical improvements, lowering PS compliance costs and thus the demand for NPS credits.

We have learned that point-point trading programs can protect and improve water quality at lower costs compared to traditional effluent standards (e.g., Grassland Farmers, Hunter River, Connecticut Nitrogen Exchange). We have also learned that trading can result in agricultural BMPs on the ground given effective incentives and institutions (South Nation and Greater Miami) (Shortle, 2013; Wainger and Shortle, 2013). For these reasons, trading is still a good idea in principle and well worth continued exploration and development. The successful trading programs generally devoted significant effort to developing acceptance among stakeholders. However, given the paucity of evidence, we do not yet know whether point-nonpoint trading programs can deliver water quality goals at low cost and on time. BMP performance uncertainty, spatial uncertainty, temporal uncertainty (lags), and high transaction costs are proving to be difficult impediments. Experience suggests that implementation should be context-specific in the sense of building off existing institutions, but also that flexibility and simplicity have a role to play in promoting success. Science (including models) must be adequate to define trading rules consistent with water quality protection goals. BMP adoption costs and public and private transaction costs must be worth the expected benefits. Spatial, temporal, and other uncertainties must be confronted in goals and rules. A full consideration of the effects of trading rules on market performance will provide more realistic expectations of the role trading might provide in the programs developed to address the TMDL.

Uncertainty in Point-Nonpoint Trades

Many of the problems experienced by existing trading programs originate in uncertainties inherent in nonpoint source pollution. These cover a broad range of issues related to deficiencies in information about water quality and farmer behavior, and policy design and implementation features that are intended to address them.

Nutrient credit trading requires the creation of a uniform, transferable commodity (credit or allowance) (Stephenson et al., 2009). The commodity must be defined to produce the same water quality services across discharge sources. For example, nutrient trading programs define credits (reduction in loads) or allowances (permission to discharge load) as the quantity of nutrients delivered to a particular waterbody within a specific period of time. Defining such a commodity requires the translation of discharge action and behavior into quantification of mass load discharged and delivered to the target waterbody for all participating sources.

PS-NPS trading presents challenges to defining a uniform commodity (producing equivalent water quality outcomes) since point and nonpoint source loads have different characteristics. A critical difference between the point and nonpoint sources is the level of certainty about the annual loads. Uncertainty in annual loads can arise from multiple sources including stochastic events (weather), incomplete load accounting (unknown and unaccounted for shifting of loads, called leakage), and incomplete knowledge or unknown error in quantifying loads. Discussions of uncertainty in trading programs tend to focus on the latter (and are the focus here).

What is certain about the amount and timing of nutrient load varies substantially across point and nonpoint sources. Differences in the degree of certainty in quantifying loads between the two types of sources can be highlighted by the simple depiction of the origin of point and nonpoint loads to the Bay in Figures 1 and 2, respectively.

In Figure 1, point source managers make decisions about the operation of nutrient removal technologies and processes. Point sources *directly measure* nutrients discharged at the source. Permit systems require point sources to measure the flow (flow meters) and concentration of nutrients in wastewater (defined sampling protocols).[1] However, the delivery of point source loads to the Bay is based on model-derived attenuation ratios. The primary uncertainty is in the extent to which models accurately measure and represent load transport through the riverine system.

Figure 1. Point Source Nutrient Load

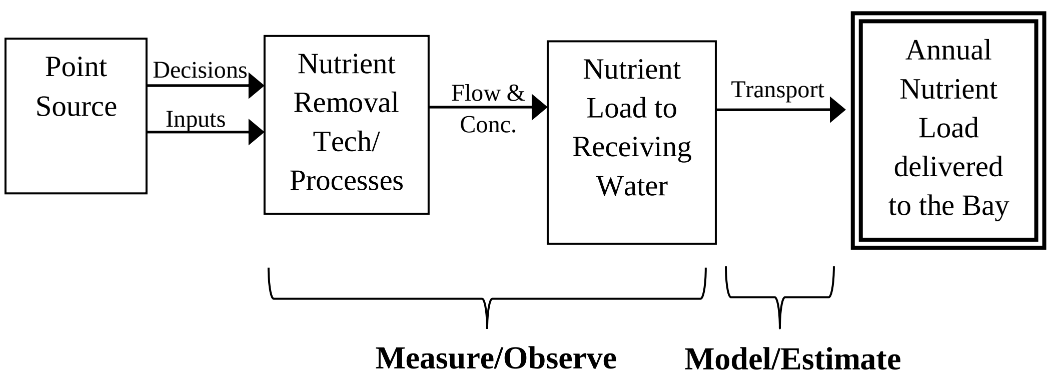
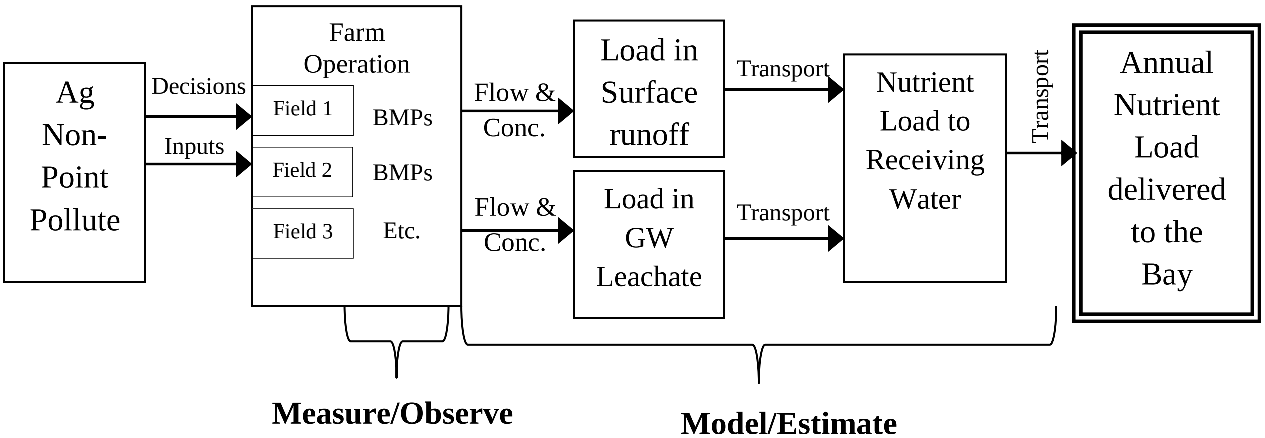


Figure 2 outlines the fate and transport of agricultural nonpoint source loads. Farmers may adopt some technology or change in production practices that alter the concentration of nutrient in runoff and/or volume of runoff from multiple fields or sites. Surface runoff may then travel some distance before entering a stream channel, necessitating the need to estimate changes in transport and loss of nutrients in the process. BMPs also change the level of nutrients leached to groundwater. Nutrients are stored in groundwater until discharged to surface water, with

[1]End-of-pipe point source loads are not known with absolute certainty. Uncertainty can occur due to unknown measurement error. For example, point source measurement error may occur if concentration sampling is not representative of actual discharge or due to errors in laboratory analysis or instrumentation. However, given permitting requirements and laboratory quality assurance protocols, water quality managers generally believe that uncertainty about end-of-pipe point source loads is relatively small.

variable and uncertain lags in delivery to tidal waters (Hirsch et al., 2013). Once entering the stream, nutrients are transported to the Bay. At no point in the process are agricultural nutrient loads observed or measured directly. Instead, they are estimated by imperfect models. The installation of practices can often be directly observed, but practices based on behavioral change (nutrient management) are not directly observable and their use must be either assumed, or verified through other means.

Figure 2. Quantifying Nonpoint Source Nutrient Load



Uncertainty dominates discussions of quantifying nonpoint source loads (Ribaudo et al., 2010). The figures above highlight that there are two general types of uncertainty associated with quantifying nonpoint source load, unique and additional to that associated with point source loads. First, uncertainty exists about the ability to accurately and completely measure/observe the level of BMP implementation, operation, and maintenance. Second, a number of scientific and modeling uncertainties exist about the ability to estimate the performance of properly implemented and maintained nonpoint source control practices and processes. Third, embedded above in 'flow' and 'transport' there is uncertainty in the generation and movement of nonpoint source pollution due to the variability in weather.

BMP Implementation

During the workshop, Jackson-Smith summarized research on the maintenance and implementation of agricultural BMPs. There are several reasons why assumed BMP implementation might diverge from expected behavior and practices as they are implemented on the landscape.

- **Correspondence between actual BMP management behaviors and BMP management is assumed to occur in estimating loads.** While BMP design standards exist, the management of some types of BMPs can be quite diverse and specific management may diverge from assumed behavior. For instance, nutrient management plans and animal waste storage BMPs generally proscribe certain behaviors and models estimate loads based on these assumed behaviors. Actual implementation of manure BMPs, however, is quite diverse. On-farm situational circumstances and logistical constraints can cause farmers to deviate from planned or expected manure management behavior.

- **Implementation and maintenance will not always occur.** BMPs credited with reductions assume the practices will be implemented and maintained. Research into the implementation behavior of voluntary cost-share programs finds substantial levels of noncompliance (Osmond et al., 2012). For example, a case study in a small Colorado watershed found that about a third of all originally contracted BMPs no longer existed (over a 10 to 15 year period). Furthermore, management BMPs (e.g., crop rotations, grazing practices, nutrient management) had a higher attrition rate than structural BMPs (Jackson-Smith, 2013; Osmond et al., 2012).
- **BMP Verification**. Confirming that expected BMP implementation and maintenance has in fact occurred may also be subject to uncertainty. The implementation and maintenance of some BMPs are more easily observed, measured, and verified than others. For instance, the implementation of streambank fencing (livestock exclusion) and cover crops could be relatively easily verified as to whether the BMP is effectively implemented. However, nutrient management plans that specify the application of manure and fertilizer (application method, timing, amount) are less easily observed and verified. Meals and Jackson-Smith both stressed the need for follow up visits and ground truthing to ensure implementation, but there are still limits to what can be verified by observation. It may be necessary to take field measurements (for nutrients) or monitor local water quality to ascertain whether a practice is being used. This can be expensive.

BMP Performance (Estimating Edge of Stream Load Reductions)

Translating BMP practice implementation into load estimates is also subject to uncertainty. The uncertainty is due to both scientific and model uncertainty.

- **Scientific Uncertainty (on BMP removal effectiveness).** Assuming there is good knowledge on BMP implementation, there is incomplete information and knowledge about the nutrient losses (nutrient removal effectiveness) from nutrient processes and cycles at the field and farm level. Quantifying and measuring nutrient loses are complicated by unique site-specific circumstances and complex physical, biological, and chemical causal relationships governing nutrient movement and transformations in soil, water, and atmosphere. Models are developed based on laboratory and field level studies, but such studies themselves often use different and incomplete field measurements to quantify and track nutrient fluxes. These uncertainties are readily observed and acknowledged in the literature. This same literature can report wide variations in observed effectiveness for the same BMP. Furthermore, the amount of study and level of knowledge also vary considerably across BMP types. While the CBP has a well-established program for reviewing BMP effectiveness, estimates represent averages of sparse literature and are often based on best professional judgment (Simpson and Weammert, 2009; VDEQ, 2013).

- **Modeling uncertainty.** Models synthesize known scientific relationships into computational algorithms that estimate loads from different, assumed individual behavioral and practice changes. Every model is a simplification of underlying processes that give rise to agricultural nutrient losses (outlined in Figure 2), which generate error. In a review of intensive watershed studies of agricultural BMP implementation, Osmond et al. (2012) found that, in general, the "…complexity and nonlinear nature of watershed processes overwhelm the capacity of existing modeling tools to reveal water quality impacts of conservation practices" (p. 125A). Osmond et al. (2012) also report that "…models grossly overestimated the effectiveness of conservation practices" (p. 215A).

The cumulative scientific and modeling uncertainty in load quantification through the process represented in Figure 2 is substantial. Meals (2013) reviewed evidence of the linkage between the implementation of BMPs and measured watershed outcomes. Such research establishes water quality monitoring protocols in selected watersheds to identify any changes in ambient water quality from concentrated conservation efforts. Despite considerable level of implementation, in many cases it has been challenging to link the level of BMP implementation to improvements in water quality (Inamdar et al., 2001; Osmond et al., 2012). In a recent USDA investigation (Conservation Effects Assessment Program (CEAP), Osmond et al., 2012) of 13 case study watersheds, five were able to demonstrate water quality changes from the implementation of conservation practices.

Addressing Measurement Uncertainty Between Point and Nonpoint Sources

- **Measures to reduce uncertainty.** Nonpoint source load uncertainty can be reduced to some degree by monitoring and verification of BMP implementation and maintenance. During the workshop, state representatives reviewed the current and proposed efforts to verify BMPs credited in state trading programs. Reducing BMP implementation uncertainty, however, generally comes at a cost of increased agency inspection effort (transaction costs). Based on comments from state agency representatives at the workshop, existing business processes need to be streamlined to ensure existing staff resources are effectively utilized to expand the states' monitoring and verification efforts or staffing levels must be increased.

Implementation uncertainty might be addressed through a better understanding of social interactions. The decision of agricultural managers to enter into trading contracts is voluntary. Participation and performance are a function of attitudes towards land and stewardship. Important factors such as flexibility and use of trusted sources for information and follow up influence participation and follow-through. Follow up is critical.

- **Accounting for Uncertainty (measurement and delivery uncertainty).** Uncertainty can never be totally eliminated through observation and monitoring. The uncertainty that remains has to be addressed through trading design. Different policy mechanisms can be used to account for uncertainty in nonpoint source performance (relative to point source). The most common approach is to impose point-nonpoint source trading ratios. Draft EPA guidance recommends a 2:1 trading ratio (EPA, in prep.). However a 2:1 trading ratio implicitly assumes that all nonpoint source trades reflect the same level of uncertainty. This ratio does not have much (if any) scientific research to justify it. Different nonpoint control practices will have different levels of scientific understanding or have different degrees of implementation certainty. In fact, some research finds trading ratios close to 1:1 might be justified (Horan, 2001; Horan and Shortle, 2005, 2011). Unique trading ratios could be tied to specific variables depending on the relative degrees of uncertainty about BMP effectiveness.

Role of Social Connections

While not a specific topic of the workshop, the presentations by Shortle, Meals, Jackson-Smith, and Nees all touched upon an important issue when including the agricultural community. Namely, how a trading program accommodates a farmer's belief system has a major impact on the success of a trading program in achieving the desired economic and environmental goals. The general assumption is that a farmer is an "economic" actor and responds to economic incentives in a predictable way, similar to other business entities. However, a farmer is best viewed as a "social" actor (Mariola, 2013) meaning that social variables such as trust and embedded relationships are at least as important as market signals in guiding management decisions. Basing expectations for the role of nonpoint sources in a market on an assumption that farmers behave as predictable economic agents can lead to disappointment/failure in the eventual outcome.

If trust issues are not addressed by a trading program, the expected supply of credits will fail to materialize despite the apparent economic benefits to the farmer. Economic logic alone is not sufficient to guarantee farmer participation in a complex and unfamiliar market (Mariola, 2013). The successful trading programs discussed by Shortle all used existing relationships to garner farmer trust and participation. Either existing institutions that farmers trust can be brought into a trading program (ideal) or such an institution be developed (much more difficult). An important lesson is that adequate staffing is needed to establish and maintain the close social interactions required to obtain participation and the proper implementation of contracted conservation measures. As trading programs ramp up in size (including Municipal Separate Storm Sewer Systems [MS4s] as a source of demand) and geographic scale (interstate trading), it is questionable whether the economies of scale that are seen with point sources (such as POTWs) can be applied to agriculture. The need for agency staffing may have to increase in step with the size of the trading program.

Role of Baselines

In a point-nonpoint trading program, point source discharges above permitted levels (i.e., above their individual WLA) are replaced or offset by equivalent reductions from unregulated nonpoint sources that would not have occurred in the absence of the trading market. In order for water quality to be protected, there must be an assurance that the nonpoint source reduction is identical in quality to the point source reduction and would not have occurred without the incentive provided by the market (the credit is "additional") (Gillenwater, 2012). This is the role of the baseline. The policy challenge is to define a reference level of discharge from which to measure the change in loads from nonpoint nutrient reduction activities that can be sold as credits when nonpoint source pollution is unobservable and difficult or costly to measure.

Nonpoint source baselines can be defined in a number of ways. Some trading programs define a baseline in terms of practices (and implied level of discharge) in place during the current year or a historical reference year. If defined as the current year, the number of credits calculated is the difference between discharge before and after the implementation of a new BMP. A current practice baseline would make any farmer eligible to generate credits, as long as they were meeting applicable current regulations.

Another option is to define a baseline in terms of a reference level of performance determined by the resource management agency (a performance-based baseline). The CBP favors performance-based baselines, consistent with guidance provided by the EPA when a TMDL is present. EPA's trading policy states that where a TMDL is in place, the load allocation should serve as the threshold for nonpoint sources to generate credits (EPA, 2007).

In a sense, the baseline becomes a representation of the TMDL load allocation implemented at the field scale, akin to the WLA for point sources being incorporated into the individual National Pollutant Discharge Elimination System (NPDES) permits. Performance can be defined in terms of a set of management practices that must be in place before trading can occur, or as a level of environmental performance, such as nutrient loss from a field estimated with a model. Fields not meeting the baseline criteria cannot produce credits for sale in a market until the baseline criteria are achieved. In this case the number of credits is the difference between discharge before and after the implementation of a new BMP *once the baseline is met.* Any abatement created by meeting the baseline cannot be sold as credits, but is instead credited to meeting the load allocation for agriculture.

A performance-based baseline has important implications on the cost of credits supplied in a trading market. In Figure 3, the lower curve shows the farm-level supply of credits given a current-practices baseline. A performance baseline based on a TMDL's load allocation requires that a farmer abates some pollution to achieve the baseline before he can trade. This increases the marginal cost of credits from a farm by the cost of attaining the baseline, shifting the farm's credit supply curve up. A farmer would only be willing to create and sell credits if the expected credit price is high enough to cover the cost of meeting the baseline *plus* the cost of any measures taken to produce additional abatement. In aggregate, the sector credit supply curve shifts to the left, reflecting the higher cost of supplying credits. Higher credit costs will reduce the amount of credits purchased by point sources. The amount of the shift depends on the share of cropland not currently meeting baseline and the amount of abatement farmers must achieve before being eligible to trade.

In the Chesapeake Bay watershed, Pennsylvania, Maryland, and Virginia have all established baselines that require that a level of stewardship above and beyond commonly used practices be attained before credits can be sold. Voluntary approaches, such as financial incentives and technical assistance, are most often used to encourage farmers to adopt management practices. In the Bay TMDL, such incentives might be used to bring farmers into compliance with their baseline requirements. Having all farmers in compliance with baseline requirements is consistent with the agricultural sector meeting its Load Allocation. However, even though agriculture meeting its load allocation is the goal, one cannot assume that this will be achieved in a voluntary framework, which is likely to have less than 100% participation by farmers. As pointed out in the presentations of this workshop, voluntary programs have a poor track record for achieving watershed-scale water quality goals. The heavy reliance on voluntary approaches outlined in the Watershed Implementation Plans (WIPs) is unlikely to provide adequate incentive for agriculture to achieve its TMDL load allocation (which is the *de facto* baseline for trading).

The WIPs establish a stewardship-based baseline for trading essentially requiring a farm to contribute to the TMDL's load allocation before being able to sell credits, as a condition of trading. The ability to sell credits is expected to be a strong enough incentive for farmers to be willing to provide this voluntary abatement. For farmers already meeting baseline (one could consider these to be "good" stewards), any additional conservation actions would produce credits for trading program. Farmers who are not using the BMPs would be the ones most likely to have to adopt some conservation measures in order to meet baseline. The more stringent the baseline, the greater the percentage of farmers who would need to provide additional voluntary abatement in order to trade. Because off the lack of regulatory requirements on farms, farmers wishing to enter a trading program would have to adopt management practices that other farmers are generally not *required* to adopt.

Stephenson et al. (2010) found that when the baseline is more stringent than current practices, agricultural credit costs for nitrogen can surpass costs per pound (for marginal abatement) for point sources because the baseline has claimed the lowest-cost pollutant reductions. Ghosh et al. (2011) found that Pennsylvania's baseline requirements significantly increased the cost of entering a trading program, making it unlikely that nonpoint sources that could reduce nutrient losses for the lowest unit costs would enter the market. Wisconsin has expressed concern that

EPA's approach to defining baselines could obstruct agricultural sources' participation in trading programs and possibly impede water quality improvements (Kramer, 2003). The concern is that fewer nonpoint source credits would be purchased by point sources, and total abatement costs for regulated sources will be higher than they could have been. None of these studies examined the load allocation implications of the baseline.

Ribaudo and Savage (2013) used data from the Natural Resource Conservation Service (NRCS) Conservation Effects Assessment Project for the Chesapeake Bay and other sources to demonstrate how selection of baseline could affect trading in the Bay watershed. Nitrogen credit supply curves for a hypothetical trading market that encompasses the entire watershed were estimated for a current-practices baseline (reflecting business as usual), and performance baselines of 65, 45, 35, 25, and 15 lbs. of nitrogen loss per acre of cropland. This hypothetical market scenario assumes no point source barriers to purchasing nonpoint source credits. Baselines more stringent than current practices are intended to provide nitrogen abatement for meeting the load allocation of the TMDL. A baseline criterion of 15 lbs./acre is much more stringent than a criterion of 65 lbs./acre. The analysis also assumes farmers bear the full cost of reaching the baseline (no cost shares).

The "current practices" baseline provides the most credits at lowest cost to point source buyers, as all fields are eligible to supply credits with the implementation of a practice. In this scenario 31.65 million lbs. of N are sold to POTWs at a price of $3.13/lb. (Table 1). All abatement goes to point sources and none to load allocation. Since all farms can immediately enter the market, most of the credits are coming from fields with high N losses and few BMPs. Installing practices on such fields produces high amounts of nitrogen reduction for a low unit cost. Fields already under conservation measures cannot provide as much additional abatement and the abatement provided is more costly.

When an N loss performance baseline is used to provide more abatement for load allocation, supply curves shift to the left, as expected, since some fields cannot sell credits until the baseline is met. Since abatement going to meeting the baseline cannot be sold, there are fewer credits supplied. The cost of credits that are supplied reflects the cost of meeting baseline, plus any additional measures taken to reduce N losses. The more stringent the baseline, the fewer the available credits (and the further left the supply curve shifts). Under the most stringent baseline (15 lbs. N loss/acre) the equilibrium price in the market would be $16.49, and only 3.29 million credits would be traded (Table 1). Some fields not meeting baseline would still find it profitable to meet baseline and sell credits in the market. The result is that 3.54 million lbs. of N abatement would go towards load allocation.

The amount of abatement going to load allocation increases as the baseline is relaxed (see Table 1). While relaxing the baseline reduces the amount of abatement allocated to the load allocation from low-load fields (BMPs already in place), it increases the reduction efforts from farmers that were previously left out of the market by a greater amount. At the least stringent baseline we examined (65 lbs. N/acre) more nonpoint source abatement is produced at the equilibrium price than under the “current practices” baseline. The reason is that market prices are high enough to induce fields that do not quite meet baseline, but can produce high levels of abatement at low cost, to adopt the necessary practices. If a goal of the program is to maximize total nonpoint source abatement above and beyond offsetting reductions with point sources, then a carefully chosen baseline could accomplish this. However, the equilibrium credit price is still higher than under the “current practices” baseline and the economic benefits to regulated point sources are reduced.

Discussion of Results

Existing voluntary nonpoint source programs have not produced sufficient behavioral change from the agriculture sector to achieve the levels of reduction needed to meet load allocations outlined in the TMDL. Existing trading baseline rules are intended partly to encourage achievement of sector TMDL load allocation and to reduce the risk of non-additional credits entering the market. Load allocation-based baselines for point-nonpoint trading may be unnecessarily limiting trades that will produce both net improvements in water quality (reductions toward the TMDL) and cost-saving trades for regulated sources.

The major policy-relevant conclusion of the analysis presented here is that **baselines more stringent than business-as-usual did not result in much abatement for achieving the agricultural load allocation, while significantly reducing the volume of credits traded**. Relaxing the baseline increased abatement for both the market (benefitting point sources) and for load allocation. This analysis does not consider market design features such as trading ratios and limits to the geographic extent of markets that would further restrict trading and increase credit prices. Given that impediments to trading are many (King and Kuch, 2003; Ribaudo and Gottlieb, 2011; Shortle, 2013; Woodward and Kaiser, 2002) and the stated need to reduce the costs facing regulated point sources for meeting the TMDL, baseline choice has a major influence on whether point sources can reduce their costs.

The argument made against relaxing the baseline requirements is that it will erode the TMDL cap by allowing more overall pollution. However, what the analysis suggested is that less of the reduction that counts towards load allocation is achieved under stringent baselines compared to more relaxed baselines. This may seem counterintuitive but it shows how meeting the load allocation is dependent on widespread participation in trading by farmers. Strict baseline rules, as well as other program rules that increase the time or difficulty of participation, reduce both overall participation and nutrient and sediment reductions from the agricultural sector.

An important consideration in designing trading is that the worst polluters tend to have the largest range of abatement possibilities. **The most effective abatement program of any kind (trading or otherwise) has to incentivize these farms to participate.** Without a regulatory means of forcing these producers to adopt management practices consistent with the load allocation of the TMDL, the consequences of choosing a baseline take on greater importance. However, it should be noted that in order for most jurisdictions to comply with their WIPs and meet load reduction goals, the agriculture community must participate, or the jurisdictions either cannot meet their required load reductions or would be expected to have substantially higher costs relative to a plan that included agricultural sector participation.

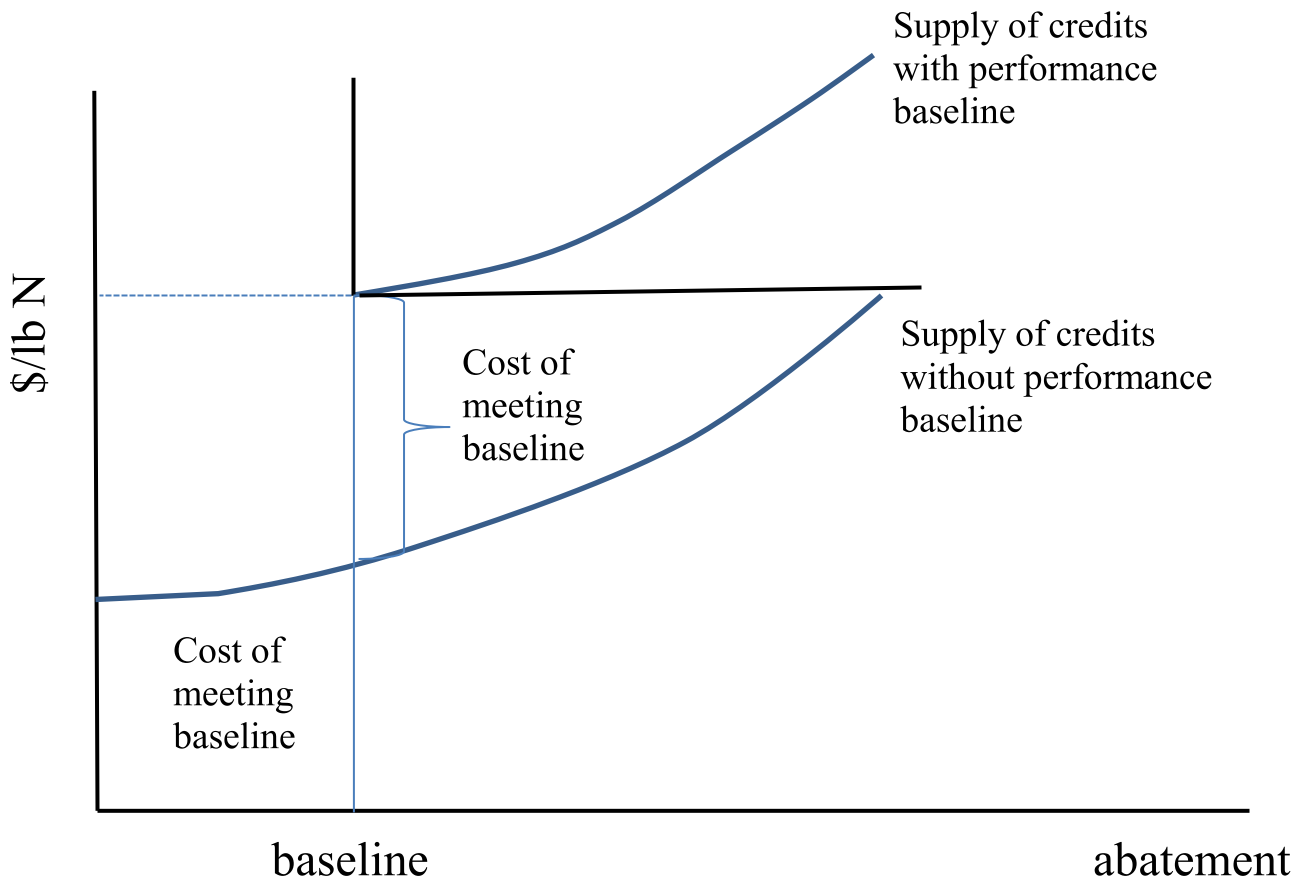
If existing baselines remain in place, an option for encouraging low cost abaters to enter the market would be to provide financial assistance for meeting baseline. This would reduce the cost of the worst polluters for entering the market and make additional progress toward meeting the sector load allocation. However, the abatement that results from meeting baseline could not be used to generate credits in the market. Only additional abatement activities once baseline is met would be eligible. Therefore, the number of credits in the market might be less than if the baseline were set at current practices.

Finally, it should be worth noting that regardless of the baseline rules established, PS-NPS trading alone will not be sufficient to achieve the load allocation goals in the TMDL. Achievement of the agricultural nonpoint source load goals will require other policy initiatives.

Table 1. Abatement going to the market (credits) and to Load Allocation under different baselines.

Baseline lbs N/acre	Equilibrium price ($/lb N)	Equilibrium quantity (1 million lbs N)	Abatement towards ag. nonpoint load allocation (1 million lbs N)	Total ag nonpoint abatement (1 million lbs N)
Current practices	3.13	31.65	0	31.65
15	16.49	3.29	3.54	6.83
25	10.28	6.25	7.49	13.74
35	8.26	11.62	12.59	24.21
45	7.23	14.72	18.13	32.85
65	5.41	20.19	26.42	46.61

Figure 3. Impact of baseline on credit supply at the farm level



Alternatives to Trading to Achieve NPS Reduction Goals

This report discusses some of the reasons why PS-NPS trading is unlikely to generate large volumes of trading in the Bay watershed. This result is a problem for two main reasons: 1) PS-NPS trading was intended to provide an incentive for farmers to voluntarily comply with the TMDL by offering the potential to earn profit from doing more than baseline requirements; and 2) trading is supposed to reduce the extremely high costs associated with TMDL requirements in other sectors, particularly some types of stormwater and wastewater discharges associated with future population growth. Thus, without trading, the WIPs must rely on traditional education and financial assistance programs to achieve full compliance with TMDL agricultural load caps, an approach that has not yet produced the level of reductions necessary to meet the Bay water quality goals (or has achieved watershed goals elsewhere).

When we consider what the alternatives are to trading, we can look to the "what we have learned" section as a starting point. Three main points emerge:

1. Vigorous markets for trades between PS and NPS sectors have not generally occurred.
2. Trading within regulated sectors (PS-PS) has been successful at reducing costs of achieving an environmental goal, with no loss of water quality.
3. Efforts to engage non-regulated sectors (i.e., voluntary actions by non-point sources) have worked when they have used pay-for-performance programs.

Trading-Like Results From Non-Trading Programs

PS-NPS trading programs have failed to generate substantial nonpoint source trades primarily because the weak demand for nonpoint source credits (Breetz et al., 2004; Shortle, 2013). As discussed above, the limited demand can be attributed to a variety of factors including lower than expected buyer nutrient control costs, high transaction costs, or the high costs (and legal risks) of ensuring equivalency between NPS and PS. On the other hand, nutrient trading programs have demonstrated how market-like incentives can cost-effectively secure nonpoint source reductions, in select cases. These successes can provide lessons to improve the effectiveness of voluntary nonpoint source reduction efforts, both within and outside of trading programs.

Voluntary non-trading NPS incentive programs rely on a different class of buyers – buyers interested in securing water quality improvements rather than directly offsetting specific loads. Demand comes from government programs using general program funds or funds from fees, taxes on polluters, from nonprofit organizations using government grants, legal settlements, or donations. These programs can use market-like forces to purchase offsets from nonpoint sources more cost-effectively than a traditional cost-share program and with lower transaction costs than a trading program.

Most voluntary nonpoint incentive programs do not target nonpoint source reductions directly, but rather subsidize the adoption of practices that might lead to reductions. The farmers and program managers do not generally rely on information on how specific practices in specific locations will change nutrient loads to water. In fact, conventional cost share programs provide farmers with limited knowledge and incentive to understand how specific practices that can be implemented on their farm will work to improve water quality.

Theory and experience suggest the following market-based lessons for making buying nonpoint source policies more cost-effective (Goulder and Parry, 2008; Shabman and Stephenson 2007; Shortle and Horan, 2001). First, successful policies are designed to attain specific environmental performance goals rather than simply to encourage expenditures on problems or to encourage the adoption of particular pro-environment technologies. Second, successful policies target producers differentially based on their ability to address environmental problems. Policies that target producers who either are incapable of producing significant environmental impacts (e.g., because their choices generate little environmental harm to begin with) or can only do so at very high cost will be ineffective or waste resources. Third, successful policies offer producers flexibility in how to meet performance goals. Flexibility allows producers to make use of specialized knowledge in their individual circumstances to achieve performance goals more cheaply than rigid regulations, and encourages environmentally-beneficial innovation. Achieving market-like performance from non-trading programs generally involves changing what is paid for (when compared to a traditional cost-share program), and how the payment is determined.

Performance-based payments – Trading programs are performance-based, in that the amount of payment is based on the level of environmental performance provided (nutrient reductions). Paying for performance can be used on more conventional conservation programs, where the tools used to calculate credits in trading programs can be used to calculate the payments a farmer can receive from the government. Another model is to charge a fee on excess emissions for point sources that choose to exceed their permits. The government then uses the revenue to purchase offsets from nonpoint sources. Buyers and sellers respond to the fees and payment rates as they would prices in a market. Point sources seek to avoid fees through source reductions and nonpoint sources aim to provide cost-efficient pollution reductions to earn revenues. For such a system to be effective, the government must find an efficient set of fees and payment rates. Such fee and payment systems have been seen to generate more activity than markets where PS buyers and NPS sellers conduct bilateral trades.

Tying policies to performance goals will help address the shortcoming of traditional conservation programs of making the same cost-share payments to producers who provide very different amounts of abatement, while at the same time providing a mechanism for evaluating program success and for updating programs to improve performance (Shortle et al., 2011).

Several state programs and federal agencies have made substantial investments in nutrient trading programs to translate farm practice changes into loading estimates. These are typically in the form of field-based models that estimate field level nutrient loads and to give farmers the capability to relatively easily translate change in farm practices into outcomes. These same tools can be used to implement market-based voluntary pay-for-performance systems. Public agencies and private donors could use these tools to more cost effectively buy nonpoint source reductions. Market-based principles can produce more cost-effective outcomes, allowing more reductions to be secured with the same budget. In the West, the federal program salinity in the Colorado River moved from a conventional pay-for-practice program to a competitive bid program based on paying for environmental outcomes. By altering the incentives offered to farmers and irrigation districts, salinity reduction costs were reduced by half (Adler, 2009).

Another program that incorporates performance payments is USDA's Conservation Security Program (CSP). CSP pays participants for conservation performance – the higher the performance, the higher the payment. Performance is measured with the Conservation Measurement Tool. Using a point-based scoring system, the environmental benefits associated with each activity are assessed. Additional activities receive a higher payment rate than existing activities. This creates an incentive for landowners to provide more conservation than a simple cost-share might.

How the payment price is determined is a major factor in determining the cost-effectiveness of a program. In a fixed price system, farmers are offered a fixed price for reductions below some reference level. Farmers who can profit from the payment have an incentive to enter the program and implement practices. However, this approach allows some farmers with low abatement costs to receive payments that may be well above costs. This hurts cost-effectiveness. A variable-price system uses an auction system to obtain nonpoint source reductions. Such an approach improves overall cost-effectiveness by encouraging farmers with low abatement costs to offer lower bids than their competitors in order to get into the program. Several of the success stories reported by Shortle use this approach, including South Nations and Greater Miami.

Auction-based financial assistance can also be applied to any program that offers financial assistance for conservation, including a traditional cost-share. A centrally administered fund has some advantages for ensuring money is used efficiently. A common technique is to request bids for projects and to rate those bids in terms of environmental performance. Armed with this "reverse auction" data, administrators can compare the cost-effectiveness of many options before choosing what to fund. This approach has been shown to work well for agricultural payment programs (Claassen et al., 2008). Cost-benefit bidding is a feature of the Conservation Reserve Program. In order to enroll in the program, a farmer submits a bid during a specified enrollment period to the local USDA field office stating how much land would be enrolled, management practices on the retired land, and a rental rate (price). All submitted bids are ranked by USDA on the basis of "expected" environmental benefits, estimated with an instrument known as the Environmental Benefits Index (EBI), and their cost. Bids are accepted until the acreage goal is met. Farmers can improve the chance of inclusion by reducing the rental rate they are willing to accept, or by proposing to implement certain management measures on retired land to boost their environmental score (such as planting trees rather than grass). Several studies have concluded that the bidding process has increased the cost-effectiveness of the CRP (Barbarika and Smith, 2000; Osborn and Hagedoorn, 1997).

Another major advantage of this approach is that the buyer, who is making repeated investments, can invest in developing the information needed to ensure performance and learn from past experience. Because there is high uncertainty regarding the efficiency of BMPs, the ability to ensure environmental performance will require that such uncertainty be managed and hopefully reduced over the long term. One approach in the short term is to give preference to practices that have the lowest uncertainty. The Colorado Salinity Program provided such a preference in ranking bids (Adler, 2009). In any case, performance uncertainty from these programs does not pose the threat to water quality that they used as a regulatory offset in a trading program. Evaluating the performance of promising, yet risky practices in these programs could reduce uncertainty in future trading programs.

Recommendations for Applying Market Forces to Trading and Incentive Programs

In summary, PS-NPS trading requires many conditions and much oversight to provide expected benefits. Some recommendations to state agencies regarding PS-NPS trading in the context of all policy approaches for reducing NPS loadings to the Bay are:

- Do not lose sight of the fact that trading is an economic tool. In general, trading rules need to make economic sense. How issues such as equivalence and consistency with other programs are handled can have major impacts on the economic incentives that drive markets to minimize costs.
- Recognize that setting a baseline for a PS-NPS trading program that is more stringent than what is legally required of all farmers may, perversely, reduce the total nutrient and sediment reductions from the agricultural sector because it reduces the incentives to trade and voluntarily comply with baseline requirements.
- Limit the use of PS-NPS trading to situations where adequate information and financial resources are available to minimize performance uncertainty (minimizing the use of *ad hoc* trading ratios) and to support the administrative requirements for trading.
- When possible, incentivize on-site validation of nonpoint source practices, either through inspections or monitoring (depending on practice). Validation is a critical step in reducing uncertainty in both trading and traditional conservation programs.

- Explore the use of alternative, performance-based policy approaches for addressing nonpoint source pollution. Voluntary incentive programs may generate more reductions with the same budget through the use of auctions and performance-based payment mechanisms. Existing tools for estimating nonpoint source abatement credits can be used to estimate field-level performance of management practices. An adequate source of annual funding would be required for such programs.
- Ensure that a close working relationship and some level of trust exists with the agricultural community. This likely means making use of existing agencies or institutions that have strong ties with farmers, such as soil and water conservation districts. It is important that adequate financial resources be available to support this relationship (Nees, 2013).
- Reduce uncertainty by continuing research on practice performance and the delivery of pollutants downstream. This would allow a more accurate estimation of the number of credits produced, and reduce the need for *ad hoc* trading ratios.

Final Thoughts

The workshop succeeded in spurring discussions among its participants about some of the issues related to point-nonpoint trading programs that are being developed in the Chesapeake Bay Watershed. It seems clear that states are still wrestling with trading issues, and continued dialog between the Bay partners would likely benefit by enabling the sharing of information on what works, what does not, and how understanding of market economics can be used to enhance success of programs. The CBP Trading and Offsets Workgroup was suggested as an appropriate forum for future exchanges. In addition, future workshops could bring in a wider audience of Bay stakeholders to present progress and continue to discuss issues related to trading and other policies for meeting the TMDL goals.

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Appendix A: Workshop Agenda

Critical Issues in Implementing Trading Programs in the Chesapeake Bay Watershed
Scientific and Technical Advisory Committee
Date: May 14, 2013
Workshop Agenda
Location: Sheraton Annapolis Hotel

Webinar Website:
https://chesapeakeresearch.webex.com/chesapeakeresearch/j.php?ED=213186832&UID=493654607&PW=NNjdmYzFmOWVi&RT=MiMxMQ%3D%3D
Password: Scientific2012
Toll-Free Number: 1-877-668-4493
Access Code: 737 781 532

8:00 am	**Breakfast (Provided)**
8:30 am	**Introduction and purpose of workshop – Marc Ribaudo (USDA-Economic Research Service)**
8:45 am	**What have we learned from existing trading programs? - Jim Shortle (Pennsylvania State University)**
9:30 am	**What have we learned from watershed-scale programs to protect water quality in agricultural watersheds? - Don Meals (Ice.nine Environmental Consulting)**
10:15 am	**Break**
10:30 am	**Measuring conservation practice implementation and maintenance - Douglas Jackson-Smith (Utah State University)**
11:15 am	**Panel Discussion – Verification and monitoring strategies for participants in water quality trading programs, and their costs - Susan Payne (Maryland Dept. of Agriculture), Veronica Kasi (Pennsylvania Dept. of Environmental Protection), Darrell Brown (EPA Chesapeake Bay Program Office); (Chris Pyke, moderator)**
12:15 pm	**Lunch (Provided)**
1:15 pm	**Impact of baseline on trading markets and meeting nonpoint source abatement goals - Marc Ribaudo (USDA-Economic Research Service)**
2:00 pm	**State trading program goals and baselines - Susan Payne (Maryland Dept. of Agriculture), Allan Brockenbrough (Virginia Dept. of Environmental Quality), Veronica Kasi (Pennsylvania Dept. of Environmental Protection); Darrell Brown (EPA Chesapeake Bay Program Office); (Marc Ribaudo, moderator)**
	Panel discussion of baseline issues – Susan Payne, Allan Brockenbrough, Veronica Kasi, Darrell Brown, and Marc Ribaudo; (Lisa Wainger, moderator)
2:45 pm	**Break**
3:00 pm	**Summary of major issues brought up so far - Charlie Abdalla (Pennsylvania State University)**
3:30 pm	**Trading: What is an alternative approach? - Dan Nees (University of Maryland)**
4:15 pm	**Wrap-up Discussion - Take Away Messages**
4:30 pm	**Adjourn**

Appendix B: Workshop Attendance

Workshop Presenters
Charles Abdalla (Pennsylvania State University)
Allan Brockenbrough (Virginia Department of Environmental Quality)
Darrell Brown (EPA-Chesapeake Bay Program Office)
Douglas Jackson-Smith (Utah State University)
Veronica Kasi (Pennsylvania Department of Environmental Protection)
Don Meals (Ice.Nine Consulting)
Dan Nees (University of Maryland – Environmental Finance Center)
Susan Payne (Maryland Department of Agriculture)
Jim Shortle (Pennsylvania State University)

Workshop Attendees
Bill Angstadt (Angstadt Consulting) – via webinar
Jim Baird (American Farmland Trust)
Diane Beyer (VA Department of Conservation and Recreation)
Jessica Blackburn (Alliance for the Bay)
Robert Boos (Pennsylvania Infrastructure and Investment Authority – PENNVEST)
Bevin Buchheister (Chesapeake Bay Commission)
Steve Bunker (The Nature Conservancy)
Jimmy Daukas (American Farmland Trust)
Olivia Devereux (Devereux Consulting)
Nick DiPasquale (EPA-Chesapeake Bay Program Office)
David Foster (Chester River Association)
Valerie Frances (USDA – Office of the Chief Economist)
Andrew Gray (MD Department of Legislative Services)
Chris Hartley (USDA-OCE)
George Kelly (Environmental Banc & Exchange)
Teresa Koon (WV Department of Environmental Protection)
Ryane Necessary (Maryland Department of Legislative Services)
John Rhoderick (Maryland Department of Agriculture)
Niki Rovner (The Nature Conservancy)
Brian Schlauderaff (PA Department of Environmental Protection)
David Simpson (EPA)
Eric Sprague (Alliance for the Chesapeake Bay)

Steering Committee
Charles Abdalla (Pennsylvania State University)
Matt Ellis (STAC Staff/CRC)
Chris Pyke (US Green Building Council)
Marc Ribaudo (USDA-Economic Research Service)
Kurt Stephenson (Virginia Tech)
Lisa Wainger (University of Maryland Center for Environmental Sciences)

Appendix C: Workshop Presentation Summaries

Water Quality Trading: What Have We Learned? - Jim Shortle (Penn State University)

Shortle provided a brief overview of trading initiatives including implementation and types of trading programs, overall goals of trading, and determinants of trading outcomes, and asked: What have we learned about what trading can and cannot do? And what have we learned about how to realize the potential of trading?

For stand-alone cap-and-trade programs, policy makers generally want to achieve water quality goals and cost effective control while incorporating innovation incentives. For add-on programs, which represent the main type of trade program in the United States, policy makers want to attain cost savings compared to traditional regulations, while facilitating achievement of TMDLs by increasing flexibility in pollution control methods, incorporation of nonpoint sources, and rapid compliance. They also seek the ancillary benefits of green technologies and innovation incentives.

Determinants of trading outcomes include:

- Trading rules and procedures established by regulators
- Trading institutions implemented by regulators or the market to facilitate trading within the rules
- The objectives, information, and skill of participant
- Underlying economics

So far, assessments of trading program performance have been generally negative, with most programs having little to no trading activity, and therefore, no impact. The reasons for these low or non-existent trade volumes are many: lack of trading partners; lack of adequate regulatory drivers (binding caps); uncertainty about trading rules, practice performance; excessively high point-nonpoint trade ratios; legal and regulatory obstacles to trading; high transactions costs; and programs too new to permit trades.

Shortle introduced a variety of existing programs that have seen success (Hunter River salinity cap and trade, South Nation River phosphorous cap and tax, Grassland Farmers selenium cap and trade, Connecticut nitrogen cap with compliance incentives) as well as developing programs showing promise (Mid-Atlantic nutrient baseline-and-credit trading [especially PA and VA], Minnesota River Basin phosphorous credit trading, Greater Miami baseline-and-credit nutrient trading, Lake Taupo nutrient cap-and-trade).

Lessons Learned: Water quality trading programs are harder to arrange compared to air quality trading programs; nonpoint pollution is harder to incorporate into trading programs than point pollution; well-designed point-to-point trading programs can protect/improve water quality and result in lower costs compared to traditional effluent standards; trading can result in agricultural BMPs on the ground given effective incentives and institutions; various types of institutions can facilitate trading (bilateral trading, clearing house markets, cap and tax, cap with incentives, etc.); engaging trusted conservation organizations can pay off in agricultural participation; nonpoint trades can save point sources money; high point-to-nonpoint trade ratios are a significant barrier to trading and a very crude (and possibly counterproductive) way to address nonpoint uncertainty; baseline participation requirements are a barrier to trading that can diminish participation and cost-savings; *Ex Ante* studies of the potential of markets often use the cost savings between conventional regulations and the “least cost solution;” and we do not yet know whether point-nonpoint trading programs can deliver water quality goals at low cost, on time.

Shortle concluded that trading is a good idea in principle and well worth continued exploration and development (implementation should be context specific); we need to develop and advance the science of trading through applied research and experimentation; trading rules should not be developed without consideration of their effects on market performance; and public sector development cannot end with environmental agency rules development, implementation, and enforcement.

What have we Learned from Watershed-Scale Programs to Protect Water Quality in Agricultural Watersheds? - Don Meals (Ice.Nine Consulting)

The fundamental issue of trading programs is that we know that conservation practices work at the field/farm scale, but it has been challenging to show that a program of conservation practices can improve water quality at the watershed scale. First, we need to know how conservation programs work to improve water quality at the watershed scale by: documenting the effectiveness of efforts to improve and protect water quality; advancing the state of the science; satisfying program requirements to generate results (e.g., TMDL); showing farmers that what they are doing is worthwhile off the farm; improving accountability of government programs; and improving the chances of securing and maintaining funding for programs.

Meals introduced three main case studies: Rural Clean Water Program (RCWP), National NPS Monitoring Program (NNPSMP), and USDA Conservation Effects Assessment Program (CEAP).

RCWP – Rural Clean Water Program

First national program to integrate land treatment and water quality monitoring to show that a land treatment program could improve water quality at the watershed level

Results

Significant adoption of BMPs occurred; improved cooperation and coordination among agencies and between local/state/federal interests; advanced understanding of how to plan, implement, manage, and monitor voluntary agricultural NPS pollution control efforts; individual projects document some effects on water quality; but, RCWP projects largely failed to provide clear evidence of water quality response to land treatment at the watershed level.

NNPSMP – National NPS Monitoring Program

Program objectives: Scientifically evaluate the effectiveness of watershed technologies designed to control nonpoint source pollution and improve our understanding of nonpoint source pollution. The NNPSMP involved long-term monitoring projects in paired watersheds, to document water quality improvements resulting from BMPs.

Overall Lessons Learned

- Significant water quality improvements in different eco-regions from: Grazing management and riparian restoration, erosion control, animal waste/nutrient management, and stream restoration
  - **Grazing Management/Riparian Restoration**. Improvements in water quality are mainly due to excluding animal waste from the stream, reduction of stream bank erosion, and removal of sediment and nutrients from cropland through a restored forested riparian buffer.
  - **Erosion Control**. Because of the dynamics of sediment delivery to water bodies, there may be considerable lag time between erosion control at the source and improved water quality.
  - **Animal Waste/Nutrient Management**. Animal waste management without nutrient management, riparian buffers, and management of both surface and subsurface flows (e.g., drain tiles) will not solve nutrient problems.
  - **Restoration**. Significant improvements in aquatic habitat, water temperature, stream biota, efforts to restore aquatic biota should address water quality as well as habitat and temperature issues, reductions in agrichemical inputs resulting from cropland conversion and implementation of nutrient and pesticide management lead to significant reductions of nitrates and pesticides at the watershed outlet.

Programmatic Lessons Learned

- Tracking is more effective when conducted by the water quality monitoring project in a small watershed, rather than relying on an external agency in a larger basin.
- There is no substitute for ground-based tracking of practice implementation, operations and maintenance (O & M).
- Flexibility in land treatment implementation is important-the ability to make changes/adjustments to make practice(s) work benefits the project.

CEAP – Conservation Effects Assessment Program

CEAP is a national USDA multi-agency effort to quantify the environmental effects of conservation practices and programs, and develop the science base for managing the agricultural landscape for environmental quality. All CEAP projects examine: timing, location, and implemented practices; relationships among conservation practices; social and economic factors; and optimum set of conservation practices and optimal placement.

Lessons Learned from CEAP

- Conservation planning must be done at the watershed scale with sufficient water quality and potentially modeling information.
- Before implementing conservation practices, identify the pollutants of concern and the sources of the pollutants.
- Identify critical source areas to prioritize conservation practices.
- Identify watershed farmers' attitudes toward agriculture and conservation practices to promote adoption.
- Even after conservation practices have been adopted, continue to work with farmers on maintenance and sustained use.
- Technical assistance to farmers is most effective when delivered by a trusted local contact and is very people intensive. Reduced funding is eroding the ability of NRCS, extension, and soil and water conservation districts to deliver effective programming.
- Economic incentives were often required for adoption of conservation practices not obviously profitable or fitting with current farming systems.
- Conservation practice adoption is a multivariate choice and although economics are exceptionally important, there are many other factors that are part of the decision-making process.
- Most conservation implementation projects should NOT conduct water quality monitoring.
- For projects that do conduct water quality monitoring, establish monitoring systems that are designed to specifically evaluate response to treatment and ensure that projects include the necessary resources and expertise.
- To link water quality response to land treatment changes, conservation practices activities must be monitored as intensively as water quality monitoring, and at the same temporal and spatial scales.
- Knowledge of land use, management, and conservation practices is absolutely essential to understand effectiveness of conservation programs. Such data are often unavailable due to confidentiality or incomplete.

- Watershed models are very complex. Select the correct model(s) and modify if necessary. Ensure sufficiently trained personnel, well calibrated and validated models, and adequate water quality and land treatment data, including spatial and temporal changes of these data.
- The scientific basis of modeling is still evolving. There are still many deficiencies in our knowledge and in existing modeling tools for representation of critical natural processes and key management actions at the watershed scale. In general, the complexity and non-linear nature of watershed processes overwhelm the capacity of existing modeling tools to reveal the water quality impacts of conservation practices.
- Programs have been funded since 1978 with the goal of understanding conservation practice effects at the watershed scale. Some of the lessons learned in the NIFA-CEAP [ACRONYM NIFA?]were observed in these earlier programs and projects; some are new. The lessons were RARELY integrated into most state and federal programming that funds conservation practices. With dwindling resources and mounting environmental degradation, it is essential that many of the lessons from NIFA-CEAP be integrated into policy and agency protocol if water resources are to be protected or improved.

Adoption, Maintenance and Implementation of BMPs: Implications for Nutrient Trading Programs - Douglas Jackson-Smith (Utah State University)

Jackson-Smith explained that in the history of NPS water quality trading approaches, issues have arisen not from technical deficiencies, but rather social understanding of the programs. The sources and causes of pollution are known, and BMP solutions exist already (although innovation should continue), but social behavior determines and currently limits involvement in trading.

Different approaches to behavioral change include: Education and awareness (necessary but insufficient), voluntary incentive programs (inefficient and weak, particularly if not targeted), and mandatory regulations (politically infeasible and difficult to enforce).

Trading programs are vulnerable because they rely on good BMP benefits models, which assume a BMP is actually a BMP, a BMP's net impact is known, and that an adopted BMP is properly implemented and maintained. Coefficients attached to BMPs in process models assume that a certain percentage change in pollutant outputs will occur, and that assumption of constant impact coefficients depends on a consistent BMP reality, full implementation and maintenance of BMPs, and consistent pre-BMP behaviors. Models often ignore diversity and complexity in farmer behavior.

Jackson-Smith introduced a study of the Little Bear River watershed in Utah. In that study, he and others gathered formal management practice information from NRCS files, went through files for all 90 landowners in the watershed, and created a master list of practices. Afterwards, they conducted field interviews with the 55 of the 90 participants to validate the file information and gather more feedback on BMP experiences in the watershed. Jackson-Smith found that 83% of BMPs were successfully implemented, and at the farm level, 32% of farms implemented all available BMPs, and 60% implemented more than half. But Jackson-Smith also found that 21% of originally implemented BMPs were no longer in place. This number, when combined with non-implemented practices, increases to one third of all originally contracted BMPs are no longer in place.

Implications

- Formal Program files are an imperfect guide to actual BMP use (fieldwork is required to know what is actually in place)
- Do not assume all BMPs are implemented in the same way (we need to understand variation in actual BMP use, and use in development of trading programs)
- Do not assume all BMPs are maintained through time (incentivize maintenance and adaptation, and account for changes in land use/farm size)

How can Management BMPs be implemented more effectively?

- Post-implementation follow up visits – to verify use AND gather information for adaptive management model
- Participatory development of management plans – Wisconsin model (intensive series of workshops with individual producers), greater ownership of plans, greater adaptive capacity, and more labor intensive
- Document pre-BMP behaviors – for models, surveys can document both averages and distributions; for contracts, establish baseline behaviors on cooperating farms
- Document post-BMP implementation and maintenance – invest in follow up with cooperators
- Incentivize improved management – the issue becomes how to build producer ownership and adaptive management into trading program requirements without losing control of outcomes

Verification and Monitoring Strategies in Water Quality Trading Programs - Darrell Brown (EPA-CBPO)

At the time of this presentation, there were nine technical monitoring memorandums drafted and under review. The ideas presented apply to reductions generated for use as offsets for new and increased loads, and credits used in the states' trading programs.

For wastewater treatment plants, the EPA seeks to ensure that sampling methods and frequency will support load estimates for purposes of a water quality trading program. For offset and trading programs in the Chesapeake Bay watershed, EPA is preliminarily considering a recommendation of three or more samples per week OR flow-weighted composite weekly sample.

Certification and verification of offsets and credits should occur annually on a representative sample of the watershed. Prior compliance history should be taken into account, and verification should occur after implementation and prior to sale. Verifiers are expected to be independent and trained. Brown explained that verification only addresses uncertainty in implementation, not load calculations. Point source loads are monitored, whereas nonpoint source loads are modeled, creating different assumptions between the two, primarily related to hydrology.

Permanence improves the certainty of a trading market and can be achieved by securing offsets or credits for the length of time in a permit. The presence of a spot market assures that credits are readily available.

Maryland's Verification Protocols - Susan Payne (Maryland Department of Agriculture, MDA)

Agricultural Nonpoint Source Verification, Certification, and Approval

- Submit credit registration and certification form and accompanying documents to MDA
- The program or representative will conduct field visits to verify that baseline condition and credit generation proposal is appropriate
- Approved credits are given a unique registration number and entered in the online Trading Registry
- When credits are posted to registry, all supporting documents and worksheets become subject to public inspection

During the application review, evaluators check to see that baseline requirements are correct, compliance is met, the credit generation proposal is reasonable, tract information is correct, and landowners/operators have consented to the proposal and program.

Trade Agreements

- Required elements of a nutrient trading contract
- Identification and contact information of parties including signature
- Location of credits
- Duration of contract in years
- Quantity of credits to be exchanged each year of the contract

- Method of credit generation, certification, and registry number

Required Elements of a Nutrient Trading Contract

- Obligation of the seller, including agreement to:
    - Properly maintain BMP or other specified facilities
    - Allow regular inspections by independent third party and MDA
    - Maintain compliance with all applicable federal, state, and local requirements
- Obligation of the buyer:
    - Provide independent third party inspection, minimally once yearly
    - Prompt payment for all services and specified yearly dates
    - Regulated buyer to provide provision for violation of contract terms

Accountability/Verification/Administration

- A practice can only generate credits once it is installed and functioning
- Inspection to certify standards and specifications were met and that the BMP is functional are required
- The full annual credit produced by the practice will not be certified until the year following the year of installation
- Credits are used in the year they are generated
- Credits cannot be banked for sale and used in future years
- The Maryland Department of Agriculture (or its designee) will perform annual spot checks on a minimum of 10% of all traded agricultural credits

Current Guidelines

- Practices verified at three different levels once they are part of a trade contract
    - Installation, meets standards and specifications
    - Requirements for annual inspection and verification by buyer's representative and/or MDE (Maryland Department of the Environment)
    - Random spot checks by MDA representative
- Report is issued and provided to all parties - farmer/landowner, MDA, MDE, buyer, aggregator
- Requires certification and verification by technically proficient, third party personnel with annual review of baseline practices and credit generating practices

- “Technically proficient” –Requires Nutrient Management Planner certification and demonstrated knowledge and practical application of the NRCS Technical Guide/Practice Standards

Maintenance Actions. Corrective action order issued by MDA; allow 30-day repair, back to specifications; requires re-inspection and signoff

Possible Reasons for Decertification. Credits not sold over lifetime of certification; practice installed is substantially different; practice does not meet standards and specifications; practice is not maintained; farm does not meet baseline

Decertification of Credits. Notice issued by MDA to registered credit owner with effective date, and copies to all affected parties; allows for appeal to Secretary of Agriculture; notice of decertification published on program website and emailed to all parties; does not preclude any punitive action as covered in buyer’s contract or as part of an NPDES permit.

Pennsylvania's Nutrient Trading Program - Veronica Kasi (PA Department of Environmental Protection)

Pennsylvania’s Nutrient Trading Program has been in place since 2005. Based on input from EPA and stakeholders involved in the program, Pennsylvania has been working with a workgroup since 2012 to identify enhancements to the program with several goals in mind including; (1) minimizing uncertainty and risk, (2) improving program transparency, (3) providing opportunity for public comment where appropriate, and(4) ensuring compliance with EPA requirements. The goal is to translate input from this workgroup into draft regulations by early 2014, with final regulations in place by summer, 2015. These enhancements include changes to the programmatic business processes, the creation of an Auditing Program, and the definition of baseline.

Enhancements to the monitoring and self-verification protocols currently in place are being developed to ensure that the practices installed to generate credits do exist and are being properly operated and maintained. In addition, existing monitoring and verification protocols are designed to maintain consistency and transparency. These protocols are approved by the Department before the practices are installed as part of the certification application and are based on the type of pollutant reduction activity, such as POTWs, nonpoint source (NPS) Treatment Technologies (for example, animal waste to energy facilities), and other NPS BMPs. The verification plans for POTWs and the NPS Treatment Technologies usually involve before and after monitoring and sampling, while the NPS BMPs plans usually rely on field maps, photographs, and other records. The program currently allows self-verification, but is looking to create an Auditing Program. This auditing program will act both as comment response and a check and balance tool. Credit tracking begins at the time of verification, and a registry number is assigned at the point of sale. To put the enhancements in place for monitoring and verification, and still manage the program with existing staff resources, streamlining of the existing business processes, focusing on the credit certification process, is also planned.

Kasi explained that before the TMDL existed, the goals for the Nutrient Trading Program were different, mpacting the definition of baseline. The program was originally viewed as the cornerstone of the state's Tributary Strategy to achieve the necessary reduction goals with two main purposes: (1) to provide additional resources to incentivize installation of agriculture practices and (2) mitigate costs for treatment plant upgrades. With these goals in mind, baseline was then defined as regulatory compliance plus a threshold. For a farm, this translates into the farm needing to implement an erosion and sedimentation control plan, a conservation plan, and a nutrient management plan to achieve regulatory compliance and one of the following: a 35 foot buffer next to a stream or a 100 foot setback from the stream where only commercial fertilizer can be applied, or a 20% reduction in the total number of credits generated..

Now the TMDL defines baseline. Pennsylvania is in the process of re-defining baseline to ensure compliance with the TMDL reduction goals. As a result, the goal for the program has changed to one of serving as a programmatic tool available to the state to achieve compliance with the TMDL. Pennsylvania is evaluating a number of different methodologies to calculate and define baseline. The final definition and calculation methodology needs to be defensible, based on sound science that is easy to explain and is manageable with existing resources. In addition, the level of reductions needed to achieve baseline cannot be so high as to make participation in the program impossible to achieve. The current thinking is to use a performance-based approach for calculating baseline using a county-based definition, but further evaluation is needed.

Implications of Trading Baselines on the Supply of Credits in Water Quality Trading Programs – Marc Ribaudo (USDA-ERS)

Goals of point and nonpoint trading: Reduce cost of meeting water quality goal by distributing abatement efficiently between sources with different abatement costs; and provide incentive for greater nonpoint source role in meeting water quality goals (assumes no regulatory policies for nonpoint).

Ribaudo helped define baselines – they are conditions (loads or practices) that must be met before a source (point or nonpoint) is allowed to participate in a trading program AND emissions against which changes in management are measured for the purpose of estimating credits.

The role of baselines are to ensure the environmental integrity of the credits that are traded, by increasing the likelihood that pollutant reductions would not have occurred without the economic incentive provided by the trading market, and provides extra abatement that can go towards Load Allocation under a TMDL (depends on incentive being strong enough for producers to take steps to meet baseline). Baselines can provide "good stewards" an economic advantage in the market.

The two types of baselines are current practices, which assume farmers are in management equilibrium given current markets and regulations, and practices implied by the TMDL, which assure farmers will attain a level of abatement consistent with the load allocation on their own, with or without the presence of regulations (defined as loading rate or implemented BMPs).

Ribaudo offered the empirical example of offset supply in the Chesapeake Bay Watershed in which the economic model was used to find the least-cost combination of practices for each sample observation to meet the baseline and to supply credits after baseline was achieved. This cost includes the cost of achieving that baseline for any observations not meeting the baseline requirement.

Data for Estimating Supply

- Current practices: Conservation Effects Assessment Project survey data (2001-2006); and nitrogen losses modeled with APEX, HUMUS, and SWAT [need to insert proper names]
- Abatement practices: Cover crops, nutrient management, water erosion controls (separately and in combination); yield changes modeled with APEX; cost of practices from WIPs, EPA, and other sources

Summary: Baseline selection has significant impact on potential supply of credits in trading markets: the more stringent the baseline, the smaller the scope of trading and the smaller the amount of nonpoint abatement going to load allocation. We should consider separate programs for achieving load allocation.

Baselines – Darrell Brown (EPA-CBPO)

Brown defined baselines as pollutant control requirements that apply to buyers and sellers in the absence of trades or offsets

- Sellers must first achieve applicable baselines before entering a market to sell credits
- Buyers can purchase credits to achieve baselines once they have met minimum control levels

Practice-based or performance-based methods are suitable for defining baselines and calculating credits generated as reductions to meet allowable loads under either the Bay TMDL or local TMDL, whichever is most stringent.

Model Consistency - Watershed v. Farm Scale

- For a trading model to produce loads comparable to those used to develop the Bay TMDL, the model needs to be consistent with the Bay TMDL assumptions and the scale of the allocations.

    - For example: Compare load to basin allocations for specific land uses, e.g., hay, crop, pasture, production area.

- If load reductions are not similar between the models, then the states may think they are making progress in meeting TMDL targets, when they may not be.
- Once loads are traded, those reductions are no longer available for that source, and that source could have difficulty meeting the TMDL allocation. Jurisdictions must report BMPs for the Annual Progress Review, rather than anticipated load reductions.

Modeling Suite of Practices

- To evaluate if an agricultural load meets the TMDL allocations (baseline), it must be assumed that a certain number of agricultural acres will implement a set of practices. The number of acres and set of practices can be complex.
- For example, it must be determined if the set of practices is the same for the state, or varies spatially.

The EPA is currently working with jurisdictions to evaluate baseline options.

Maryland Nutrient Trading Program Goals and Baselines - Susan Payne (Maryland Department of Agriculture)

Nutrient trading offers a new source of revenue for the financing of agricultural practices and providing supplemental farm income while improving the water quality of the Chesapeake Bay and its tributaries: The practices provide offsets to address new or increased loads associated with a growing population (WWTP, Development, Industrial facilities) and private purchase of nutrient reduction projects and practices (retirement credits).

Key Principle (1): Generators of agricultural nonpoint source credits must first demonstrate they have met the baseline water quality requirements for nitrogen and phosphorous levels in their watershed. These are the more stringent of the minimum level of nutrient reductions outlined in the Bay TMDL or applicable local TMDL requirements. Baselines provide assurance that participants are at a minimum level of conservation stewardship and are not currently impacting local water quality.

Key Principle (2): Agricultural generators must be in compliance with all local, state, and federal laws, regulations, and programs. The credit purchaser and generator cannot cause or contribute to water quality effects locally, downstream, or bay-wide.

Key Principle (3): BMPs funded by federal or state cost-share cannot be used to generate credits during their contract life. However, these BMPs can count toward baseline and can generate credits after the funded lifespan has expired.

Key Principle (4): The Agricultural Trading Program is not intended to accelerate the loss of productive farmland. Therefore, credits will not be generated under this policy for the purchase and idling of whole or substantial portions of farms to provide nutrient credits.

Key Principle (5): Trades must result in a net decrease in loads. 10% of the agricultural credits sold in a trade will be retired and permanently applied toward TMDL goals.

Key Principle (6): An agricultural practice can generate credits only when it is installed or placed in operation.

Setting the Baseline

Baseline is the maximum load of nutrients that can be lost from agricultural land while still achieving the Bay TMDL/WIP goals. Baseline was determined by calculating the basin-wide average load per land-use acre that needs to be achieved in order to achieve TMDL/WIP goals.

The MDE has developed 42 local nutrient TMDLs and 26 sediment TMDLs. 26 of the local nutrient TMDLs require agricultural load reduction lower than the Bay TMDL for nitrogen, phosphorous, and sediments.

Agricultural Nutrient Trading Credit Calculation Tool

Maryland's online nutrient tracking tool is based on the NutrientNet platform developed by the World Resources Institute and integrates the USDA/NRCS Nutrient Tracking Tool (NTT) into its calculations. The calculation component allows users to determine whether an agricultural operation meets the more stringent of the local or Bay TMDL for the applicable watershed and estimates the credits than can be generated through the adoption or installation of various practices.

NTT – APEX

The NTT application specifically arrays the output of the APEX model in terms of *delta* products or the difference between existing conditions and proposed conservation.

Existing Condition – Proposed Conservation = Nitrogen and Phosphorous saved

Commonwealth of Virginia Nutrient Trading Program: Goals and Baselines – Allan Brockenbrough (VA Department of Environmental Quality)

The VA Nutrient Trading General Permit went into effect on January 1, 2007. Currently, the state has 170 registrants. 100 of 119 “Significant facilities” trade as members of the Virginia Nutrient Credit Exchange Association. Between 2007 and 2012, point source N loads were reduced by 30% statewide, and point source P loads were reduced by 45%.

The Chesapeake Bay Watershed Nutrient General Permit tracks calendar year annual N and P load limits in a cap and trade program with “bubbling” or aggregate permits. Point-to-point source trading is used to allow existing facilities to meet their initial load cap. Point-to-nonpoint source trading is reserved to accommodate new and expanding facilities.

Baseline requirements differ for different practices associated with croplands, haylands, and pastures.

Current Status of NPS Trades in VA

Baseline practices apply to the entire Farm Service Agency (FSA) tract and a 2:1 trading ratio is currently in place. There have been no agricultural BMP-based trades to date. Land conversions and one stormwater BMP are being used to offset post-development P runoff requirements of the VA Stormwater Management Program. Credits are currently available from 8 banks and 8 more are under development.

Resource Management Plan (RMP) Process

- Plan development
- Plan review and approval
- Implementation
- Verification of implementation
- Certificate of RMP (Resource Management Plan) implementation issued
    - Valid for 9 years
    - Safe Harbor – full compliance with TMDLs and state water quality requirements
- Inspections every 3 years (minimum)
- RMP Regulation Development (http://www.dcr.virginia.gov/laws_and_regulations/lr7.shtml)

2012 Nutrient Trading Act

March 2012, General Assembly passes HB176/SB77 requiring DCR to establish regulations for the certification of nonpoint source credits (including 5% retirement), establish a credit registry, and expand the scope of the nutrient credit exchange program. An enactment clause requires reevaluation of current 2:1 trading ratio by July 1, 2013. Two advisory group meetings were held and a final report on this ratio is pending. Nonpoint source and point source credits are now available to MS4s, industrial stormwater facilities, or expanding CAFOs.

Trading: What is an Alternative Approach? – Dan Nees (University of Maryland Environmental Finance Center)

Nees provided an overview of his presentation: Define attributes of a restoration financing system, address the role of markets in that system, identify barriers to water quality market development, and identify opportunities for overcoming those barriers through an alternative implementation approach.

Nees then asked the audience to envision a restored Chesapeake Bay and ask themselves what a restored Bay and watershed looks and means to them. Nees said that regardless of what that restored Bay looks like to any particular person, a restored Chesapeake Bay will have an associated financing system that will be responsible for supporting the restoration efforts, and it will be essential for allocating and distributing fiscal resources.

That financing system must focus on and incentivize efficiency to achieve the greatest benefit per dollar spent. In turn, efficiency will require three elements: Science, performance, and cost reduction. To reduce uncertainty in the financing system and achieve restoration success, the financing system must be focused on supporting practices that make verifiable reductions in pollutants and improvements to water quality. If the metric for gauging financing effectiveness and efficiency is dollars per pound, then monies that are invested should be targeting pounds of pollution reduced – in other words: pay for outcomes vs. outputs. To achieve restoration success, a financing system must incentivize reductions in cost, whether they are associated with administration, transactions, implementation, or science.

In theory, environmental markets rely on all three financing components and in practice, these markets, especially water quality, have been slow to develop. The benefits of markets are that they provide flexibility, efficiency, and reward innovation. To achieve these benefits, markets require (or desire): Complete, or close to complete, information; accurate price signals; many buyers and sellers; and very low to non-existent transaction costs and barriers to entry.

Uncertainty in these markets is primarily a demand problem, and in many ways, environmental markets are defined by uncertainty: uncertainty about the performance of best management practices; political will and policy development; regulation and enforcement; and technology. The result is reduced information, unclear price signals, higher transaction costs, and no demand in the system.

A lack of trust also undermines the effectiveness of a market. Lack of trust is primarily a supply problem, directly related to uncertainty. The Chesapeake Bay restoration effort is defined by lawsuits, accusations, confrontation, and unyielding entrenched positions. The result of a lack of trust is much higher transaction costs and very restricted supply.

What Has Been Working?

Water quality trading programs have resulted in the foundation of an efficient, effective water quality financing system

- *Established marketplace:* Tracking and accounting
- *Significant transparency:* Verification and monitoring
- *Foundation in science:* Credits are based on performance (at least sort of…)

- *Focus on efficiency:* Pollution reductions per dollar spent
- *Innovation:* Effective engagement of the private sector

What Can Work Now?

- Growth offsets (necessary but not sufficient; systems exist to make them work now)
- In-kind market programs (locally-based programs can dramatically improve financing efficiency and significantly reduce transaction costs with greater certainty, clearer price signals, and increased trust)
    - Point-to-point
    - Nonpoint-to-nonpoint
- Performance-based subsidy programs
    - In effect, water quality trading as designed functions as a subsidy to suppliers
    - A performance-based financing system could impact significant sources of funding immediately
    - Would demonstrate the efficacy of much of the market system with much less risk politically, environmentally, and financially