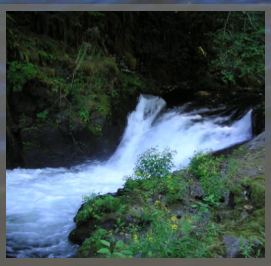
In it Together:

A How-To Reference for Building Point-Nonpoint Water Quality Trading Programs

Case Studies (Part 3 of 3)
July 2012



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About Us

Willamette Partnership is a 501c3 nonprofit working with a diverse coalition of leaders to shift the way people value, manage and regulate the environment. We continue to seek innovative ways to expand beyond the Willamette Valley in collaboration with other regional organizations with similar missions to direct investments in restoration to the places that matter most and at a scale that makes a difference.

Contact

Willamette Partnership
2550 SW Hillsboro Hwy
Hillsboro, OR 97123
503-681-5112
info@willamettepartnership.org

Layout and cover design by Joni Elteto and Nicole Gorko
Thank you to the following people for contributing photos

Clean Water Services
Joni Elteto
Kevin Hayes
Jared Kinnear
Brian Kittler
Eric Sprague
Ted Weber
USDA Forest Service, Chesapeake Bay
USDA Natural Resources Conservation Service
Willamette Restoration Initiative

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CONTRIBUTORS

In it Together was produced by the Willamette Partnership, Pinchot Institute for Conservation, and World Resources Institute. The World Resources Institute developed the North Carolina case studies and updated information on the 24 point-nonpoint water quality trading programs, and the Pinchot Institute developed the Chesapeake and Willamette case studies.

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EXPERT REVIEWERS

Carl Lucero, USDA Office of Environmental Markets
Chris Hartley, USDA Office of Environmental Markets
Valerie Frances, USDA Office of Environmental Markets
Claire Schary, U.S. Environmental Protection Agency
Bob Rose, U.S. Environmental Protection Agency
Jimmy Daukas, American Farmland Trust
Ranei Nomura, Oregon Department of Environmental Quality
Ann Roda, Pennsylvania Department of Environmental Protection
Veronica Kasi, Pennsylvania Department of Environmental Protection
Brian Schlauderaff, Pennsylvania Department of Environmental Protection
Jeremy Sokulsky, Environmental Incentives
Jessica Fox, Energy Policy Research Institute
Mark Kieser, Kieser and Associates
Dan Nees, University of Maryland
Peter Ruffier, Clean Water Services
Tracy Stanton, The Freshwater Trust
Heather Simmons-Rigdon, South Central Washington Resource Conservation District
Paul Marchetti, Pennsylvania Infrastructure Investment Authority (PENNVEST)
Joanna Silver, Markit Environmental

Table of Contents

I. Preface 6

I. North Carolina Water Quality Trading Case Study 7
1.1. Program Overview 8
1.2. Feasibility Assessment 8
1.2.1. Assessing Potential Credit Demand 9
1.2.2. Assessing Potential Credit Supply 11
1.2.3. Administration 11
1.3. Credit Quantification Methods 11
1.3.1. Method Development Process 12
1.4. Program Design Elements 14
1.4.1. Trading Area 14
1.4.2. Trading Ratios 14
1.4.3. Baseline and Additionality 14
1.4.4. Project Verification 15
1.4.5. Stakeholder Process 15
1.4.6. Trading Infrastructure 15
1.5. Current Status of Programs 16
1.6. Future Direction of Trading in North Carolina 17
1.7. Conclusions and Recommendations 17
1.8. References 19
1.9. List of Interviews 19

II. Oregon Water Quality Trading Case Study 20
2.1. Program Overview 20
2.2. Regulatory Driver(s) 21
2.2.1. Assessing Potential Credit Supply 21
2.2.2. Assessing Potential Credit Demand 22
2.2.3. Cost Effectiveness of Nonpoint Source Compliance 22
2.2.4. Legal Authority 23
2.2.5. Administering Entity 23
2.2.6. Administering Costs and Requirements 23
2.3. Credit Quantification Methods 23
2.3.1. Method Development 24
2.4. Program Design elements 24
2.4.1. Development Process 24
2.4.2. Baseline and Additionality 25
2.4.3. Trading Ratios and Accounting For Uncertainty 25
2.4.4. Determining Eligibility (Validation) 25

2.4.5. Verification 26
2.4.6. Registration 26
2.4.7. Monitoring 26
2.5. Current Status of Programs 27
2.5.1. The Tualatin River Program 27
2.5.2. The Willamette River Basin 27
2.5.3. The Rogue River Basin 28
2.6. Future Direction of Trading in the Pacific Northwest 28
2.6.1. Nutrient and Sediment Trading 28
2.6.2. The Yakima River Basin 29
2.7. Conclusions and Recommendations 29
2.7.1. Key Lessons Learned 29
2.7.2 Key Challenges 30
2.8. References 31
2.9 List of Interviews 31

III. Chesapeake Nutrient Trading Programs Case Study 32
3.1. Program Overview 32
3.2. Feasibility Assessment 33
3.2.1. Assessing Potential Credit Demand 33
3.2.2. Administration 33
3.3. Credit Quantification Methods 34
3.4. Program Design Elements 35
3.4.1. Trading Ratios 35
3.4.2. Trading Areas 36
3.4.3. Participant Eligibility 36
3.4.4. Practice Eligibility 37
3.4.5. Baseline and Additionality 37
3.4.6. Verification and Certification 39
3.4.7. Registration 39
3.4.8. Trading Infrastructure 40
3.5. Current Status of Programs 40
3.6. Conclusion and Recommendations 41
3.6.1. Key Challenges 41
3.6.2. Key Lessons Learned 41
3.7. References 44
3.8. List of Interviews 44

i. Preface

Watersheds across the United States have used different forms of water quality trading over the last decades as a flexible tool to implement water quality goals. Groups involved in those early programs have gathered successes, failures, and valuable lessons learned that can help new trading programs lay the groundwork for success. These lessons, and existing resources from USDA, the U.S. Environmental Protection Agency (U.S.EPA), and others[1], have been incorporated into this how-to reference (Trading Reference) as part of U.S. Department of Agriculture's Office of Environmental Markets (USDA-OEM) ongoing efforts to advance market-based solutions as important tools for conservation and for landowners.

Emerging water quality trading programs need not start from scratch—most programs require the same supporting infrastructure (standardized processes and technology tools), which is now available from model programs across the country. A framework has evolved that identifies what steps can be taken in order to build a water quality trading program for a local watershed. These steps include: 1) evaluating the feasibility of a program, 2) convening the right group of stakeholders, 3) designing the program itself, 4) securing some of form of program approval from regulatory agencies, 5) implementing the program, and 6) setting up an adaptive management approach that will allow for improvements and fine tuning along the way.

The Trading Reference is divided into several parts so readers can quickly access the information they need.

This **Part 3** presents case study write-ups for water quality trading programs in North Carolina, the Pacific Northwest, and the Chesapeake Bay. These case studies are meant to add to existing write-ups of other programs (e.g. Midwestern programs).

Part 1 of this Trading Reference presents an overview and current status of point-nonpoint water quality trading programs around the country. This part is a useful primer for those interested in water quality trading in general or as important background summarizing existing water quality trading programs and the lessons they provide for new programs. Lessons from trading programs across the U.S. provide illustrations about what works in building and implementing point-nonpoint trading programs.

Part 2 is a reference for building and operating water trading programs. It is essentially a manual for new or emerging programs that outlines how to move through each of the phases of trading program development and provides milestones within each phase that will help trading program designers identify and plan for the work required to walk through the process.

Throughout the Trading Reference call out boxes are used to highlight important terms and concepts. Green boxes are used to define technical terms relevant to water quality trading while blue boxes present examples and illustrations that help explain how water quality trading works.

Each Part is designed to stand on its own, however, users not familiar with the basic terminology and elements of water quality trading should begin by reading Part 1. Together, this Trading Reference should be helpful for local groups as they build programs over time. It is also meant to be a framework that will help increase the number of programs that have strategies to reduce start-up time, improve water quality, increase efficiency, and build the base of trust necessary to sustain water quality improvements over time.

Throughout the Trading Reference text boxes highlight important terms and concepts. Green boxes are used to define technical terms relevant to water quality trading while blue boxes present examples and illustrations that help explain how water quality trading works.

Audience for This Reference

The audience for this Trading Reference are the watershed stakeholders building programs for water quality trades between permitted entities under the Clean Water Act known as point sources (e.g. wastewater or urban stormwater) acting as typical *buyers*, and non-permitted, nonpoint sources (e.g. agriculture) as typical *sellers*. Trades occur when nonpoint sources can reduce their pollution beyond their Clean Water Act obligations more cheaply than a point source can with technology improvements on its own (Selman *et. al.*, 2009).

[1] This Trading Reference specifically build from NRCS guidelines on markets, USEPA policy on water quality trading, World Resources Institute's overview of water quality trading, and Willamette Partnership lessons learned on building ecosystem market programs. They also incorporate the lessons learned from programs and research funded by the NRCS Conservation Innovations Grants, USDA Agricultural Research Service, National Institute for Food and Agriculture, and the USDA Economic Research Service.

I. North Carolina Water Quality Trading Case Study

Evan Branosky, World Resources Institute

North Carolina's program helps reduce nutrient runoff into systems like these (photo courtesy of Jared Kinnear)

North Carolina first authorized water quality trading for point and nonpoint nutrient sources in 1989 through the "Agreement on the Tar-Pamlico Nutrient Trading Program" (Tedder, 1991). Since then, trading programs allowing point sources to meet their share of the wastewater sector's loading cap, and offset programs allowing developers to offset part of the nutrient load from new development, have also been developed for the Neuse River, Jordan Lake, and Falls Lake watersheds. To date, transactions in the trading programs have been informal and among point sources only. Nonpoint sources participate extensively in the offset programs, where there is also greater transaction volume.

This case study reviews the programs operating currently in North Carolina, including feasibility studies, regulatory drivers, prices, calculation methodologies for generated credits and offsets, and trading infrastructure. The programs have been successful in terms of engaging program participants and maintaining (though not improving) water quality. For those reasons, the North Carolina experience provides useful lessons for other watersheds in the United States.

The primary lessons learned are:

1) Trading and offset programs can spur private sector activity;
2) Agricultural operations can be proactive in implementing best management practices to generate credits or offsets;
3) Group allocations, such as those in the Tar-Pamlico and Neuse watersheds, spur informal point-to-point source trades but not point-to-nonpoint trades;
4) Demand can arise from multiple regulatory drivers; not just from NPDES permits of point source dischargers;
5) Programs can be designed to be financially sustainable;
6) Calculation methodologies are one of the most important program design elements for ensuring program success; and
7) Transaction volume aligns with trends in supply and demand for new housing and commercial development.

1.1. Program Overview

In North Carolina, trading and offset programs are two of several options for implementing Nutrient Sensitive Waters (NSW) management strategies under the Department of Environment and Natural Resources, Water Quality Division (DWQ). The NSW classification is unique to North Carolina but complements efforts to develop Total Maximum Daily Loads (TMDLs).[2] For example, chlorophyll-*a* levels exceeding the state water quality standard of 40 μg/L prompted the North Carolina Environmental Management Commission (EMC)[3] to designate the Tar-Pamlico River Basin as NSW in 1989 (DWQ, 2012b). Subsequently, the EMC and Tar-Pamlico Basin Association of point source dischargers agreed to fund a model that would determine the relationship between nutrient loading and ambient water quality.

Model runs were completed in 1993 and provided the basis for numeric, nutrient load reductions necessary to meet water quality standards. Those load reductions were incorporated into a TMDL that requires 30 percent nitrogen reduction and a maintained phosphorus load using 1991 as the base year (DWQ, 2012b). In 2001, the EMC established a Tar-Pamlico Nutrient Strategy consisting of rules with mitigation requirements for significant sources of nutrient loads to the estuary (e.g. agriculture, stormwater, wastewater). The process of NSW designation, modeling, reduction targets, TMDLs, and rules became a model for similar efforts in the Neuse River, Jordan Lake, and Falls Lake watersheds.[4]

The North Carolina trading and offset programs have two key components: private nutrient "banks" and a government in-lieu fee program. Each component provides developers with compliance options for offsetting the nutrient loads from new development. The in-lieu fee program, the Ecosystem Enhancement Program (EEP), also could provide wastewater treatment plants with nutrient offsets if they exceed their allocations (which has yet to occur). The EEP was originated in 2003 to generate supply of compensatory wetland credits for Department of Transportation projects, and in 2004 became a compliance option for offset requirements.

In so doing, its goals were applied to the offset program:

1) Mitigation is in place and meets established mitigation success criteria *before* transportation construction begins;
2) Mitigation is linked to watershed planning, representing a programmatic approach, rather than a project-by-project approach;
3) A single state agency is responsible for providing mitigation; and
4) Mitigation is based on functional replacement, rather than acres or feet of impact.

1.2. Feasibility Assessment

High costs are a challenge to implementing the NSW management strategies. Shortly after the EMC classified the Tar-Pamlico River Basin as NSW in 1989, the Division of Environmental Management, Water Quality Section,[5,6] requested that the Tar-Pamlico Basin Association establish cost-effective strategies for each participating point source discharger to reduce its nutrient loading (Department of Natural Resources and Community Development, 1989). Those strategies, which could include trading, were subsequently enacted. As a result, Association members continue to operate below their collective cap through a combination of informal, point-to-point source trades and targeted upgrades to biological nutrient removal technology at expanding larger facilities (Table 1.2.).[7]

[2] Water bodies on the 303(d) list of impaired waters can receive NSW classification, which is the first step in establishing pollutant-reduction requirements.

[3] The EMC is a 19-member Commission appointed by the Governor, Senate Pro Tempore and Speaker of the House. It oversees development of regulations for air quality, land resources, water quality, and water resources.

[4] Steps have not been followed in the same order in all basins. For example, TMDLs existed in the Falls Lake basin before rules were completed.

[5] Phase I of the Tar-Pamlico NSW Implementation Strategy, an immediate response to the NSW classification and precursor to the Tar-Pamlico Nutrient Strategy, requested the efficiency studies. The document was prepared by the Department of Natural Resources and Community Development, Division of Environmental Management, Water Quality Section. That entity is now the Department of Environment and Natural Resources, Water Quality Division.

[6] In 1989, the Division was the delegated authority for North Carolina's National Pollutant Discharge Elimination System.

[7] The wastewater cap is met despite costing $70 million for necessary wastewater reductions compared to $11 million for equal nonpoint source reductions (Hall and Howett, 1994).

CH2M Hill, Inc. conducted a formal feasibility study for water quality trading in the Cape Fear River Basin between 2006 and 2008. Trading was proposed as an option to manage nutrients in the three sub-watersheds of Haw River and Upper and Lower New Hope Creek which were causing elevated chlorophyll-*a* levels in Jordan Lake (CH2M Hill, Inc., 2009).[8] Funding was provided by a 2005 U.S.EPA Agency Targeted Watershed Grant awarded to the Mid-Carolina Council of Governments and Cape Fear River Assembly.[9] Subsequent to EPA's grant award, the DWQ developed nutrient TMDLs for the three subwatersheds and the EMC promulgated rules for Jordan Lake. CH2M Hill, Inc. found that cost differentials per pound of nutrient reduction supported agricultural credit sales to urban sources such as Municipal Separate Storm Sewer Systems or wastewater treatment plants (CH2M Hill, Inc., 2009).

In addition, significant differences in cost-effectiveness among individual agricultural best management practices (BMPs) and stormwater control measures (SCMs) supported intra-sector nitrogen credit transactions. There was less potential for intra-sector phosphorus transactions. Finally, CH2M Hill, Inc. forecasted that demand from urban stormwater sources would be driven predominately by requirements for new development to treat impervious surfaces. Developers given the option to install stormwater control measures onsite or buy offsets would realize cost savings from the latter option in most cases. CH2M Hill, Inc. concluded that water quality trading in Cape Fear River Basin would work based on their market design principles and draft framework.

Ad-hoc feasibility studies have been completed for other programs. For example, a graduate student at Duke University identified hurdles to realizing significant volume in the Falls Lake trading program due to the small size of the watershed, limited credit generation potential for agricultural BMPs, and lack of a business case for the program (Gordon, 2010). It is important to note however, that the analysis focused just on trading for point source dischargers and not offsets for new development. In addition, the purpose of trading provisions in the Falls Lake Rules was not to realize significant volume. Rather, they were intended as one compliance option for point source dischargers if needed. One interviewee remarked that engineering firms working for developers weigh the cost of treating more impervious surface onsite with the cost of purchasing offsets from a private nutrient offset bank or making payments to the EEP.

1.2.1. Assessing Potential Credit Demand

Credits or offsets acquired in water quality trading programs are a beneficial option for compliance with regulations. For the Tar-Pamlico, Neuse, Jordan, and Falls trading and offset programs, TMDLs or rules are two types of regulatory drivers for demand. Of the two types, rules have a greater effect on trading because they apply in the total area of all four watersheds. TMDLs may apply only to portions of impaired water bodies and may not affect all sources of credit or offset demand. Also, components of the trading and offset programs (e.g. eligibility, baseline requirements, and certification, registration, and verification processes) are developed more fully in rules than in TMDLs.

Table 1.2.: Tar-Pamlico Basin Association Members Operate Below Their Cap, Requiring No Nonpoint Source Credits (DWQ, 2012a)

	2006		2007		2008		2009		2010		% change	
Pollutant	N	P	N	P	N	P	N	P	N	P	N	P
Loading cap (kg/yr)	404,274	73,060	404,274	73,060	404,274	73,060	404,274	73,060	404,274	73,060	0	0
Actual load (kg/yr)	232,568	46,995	246,465	50,077	253,818	43,821	273,080	40,724	289,354	37,362	24.4	(20.5)
Load as % of cap	58	64	61	69	63	60	67	56	72	51		

Source: DWO1. 2012

[8] B. Everett Jordan Lake is a reservoir managed by the U.S. Army Corps of Engineers for water supply, flood control, recreation, fish and wildlife, and water quality.

[9] The Cape Fear River Assembly is a diverse group of environmental organizations, small business, academic institutions, and governments working together on restoration efforts

The national Final Water Quality Trading Policy states "EPA does not support trading to comply with existing technology-based effluent limitations [TBELs] except as expressly authorized by federal regulations" (U.S.EPA, 2003). For municipal wastewater treatment plants, such as the point source dischargers in the four watersheds, secondary treatment technology is the TBEL standard (U.S.EPA, 2012). Normally, point source dischargers faced with water quality-based effluent limits (i.e. beyond those achievable through secondary treatment because of a TMDL or rules), must upgrade to meet the more stringent requirement. The trading policy authorizes point source dischargers to compensate for the difference between secondary treatment and additional technology through credit purchases unless regulations from the designated NPDES authority preclude credit purchases as an option. In all four North Carolina programs, point source dischargers may only purchase nonpoint source credits when they exceed their share of the wastewater sector's loading cap, as awarded according to historic and forecasted future load. The rules also provide a variation on that requirement by allowing groups of point source dischargers to form associations that receive a collective allocation. In such cases, as has occurred in the Tar-Pamlico and Neuse River watersheds, member point sources prioritize upgrades amongst themselves and conduct informal point-to-point source trades to operate below their group allocation. Credit purchases are necessary when they exceed their collective cap, but that has never occurred.

NSW nutrient management strategies and some corresponding TMDLs were developed sequentially for the Tar-Pamlico Estuary, Neuse River, Jordan Lake, and Falls Lake:

1) The Tar-Pamlico Point Source Rules were introduced in three phases, with Phase I (covering 1990-1994) authorizing water quality trading. Phase II (1995-2004) and Phase III (2005-2014) made slight changes to the trading policy. In 2001, the final Tar-Pamlico Stormwater Rule established demand for a stormwater offset program (15A NCAC 02B .0258). Loads from new residential, commercial, and industrial development cannot exceed 4.480 kg/ha/yr total nitrogen and 0.448 lb/ac/yr total phosphorus. Since developers could face difficulty in meeting those requirements, the Rule establishes minimum, onsite treatment levels for new development at 6.720 kg/ha/yr total nitrogen and new commercial and industrial development at 11.200 kg/ha/yr total nitrogen. Developers may compensate for the difference between required loads and required onsite treatment levels through offset purchases from a nutrient offset bank or in-lieu fee payments to the EEP.

2) The Neuse Rules establish similar requirements to those in the Tar-Pamlico. Sections of the Neuse Wastewater Rule specify nutrient allocations for point source dischargers above and below Falls Lake (15 NCAC 02B .0234). Most of the individual allocations are combined into a group allocation through the Neuse River Compliance Association NPDES permit. Similar to the Tar-Pamlico situation, the Association must offset loads in excess of the group allocation, which has never been necessary. The Stormwater Rule, 15 NCAC 02B .0235, caps loads from new development at 4.032 kg/ha/yr total nitrogen and requires onsite treatment practices to achieve a maximum loading rate of 6.72 kg/ha/yr for residential development and 11.200 lb/ac/yr for commercial and industrial development. Developers may accommodate the difference through offset purchases.

3) The Jordan Lake and Falls Lake Rules generally follow the same model as the Tar-Pamlico and Neuse Rules. Similar requirements and compliance options extend to point source dischargers and developers. The Jordan Lake Rules establish load caps for the water bodies that flow into it, including the Haw River and Upper and Lower New Hope Creek (15A NCAC 02B .0265). In a variation on the Tar-Pamlico and Neuse Rules, the Jordan Lake and Falls Lake Rules extend load caps and onsite treatment requirements to public lands, notably North Carolina Department of Transportation (DOT) projects. The Falls Lake Rules also avoid expressing onsite treatment requirements as pounds per acre per year of nitrogen or phosphorus. Instead, development must meet a percent of the required load cap (15A NCAC 02B .0277). Finally, both rules contain provisions for existing development,[10] which requires local governments to create stormwater management programs. Local governments must consider multiple options for reducing loads from existing development; presumably, offset purchases are one option.

[10] For the Neuse River, existing development requirements are established through 15A NCAC 02B .0266, which was replaced by Session Law 2009-216. For Falls Lake, existing development is addressed in 15A NCAC 02B .0278.

1.2.2. Assessing Potential Credit Supply

In addition to generating demand, regulations also affect credit and offset supply. Prior to the Neuse Rules, credits were generated by BMPs implemented through the North Carolina Agricultural Cost Share Program (ACSP). Phase I of the Tar-Pamlico Point Source Rules established a credit price of $56/kg/yr based on findings from the Research Triangle Institute's report "The Cost-Effectiveness of Agricultural BMPs for Nutrient Reduction in the Tar-Pamlico Basin" (DWQ, 1994). Phase I also authorized the Tar-Pamlico Basin Association to pay preemptively and bank credits in anticipation of exceeding its loading cap, which never occurred. Of $850,000 contributed during the Phase I period of 1990 to 1994, $400,000 generated 7,143 kg total nitrogen (DWQ, 1994). The remaining $450,000 applied to Phases II and III, which used a revised credit price of $29/kg/yr (DWQ, 2005).

The Neuse Nutrient Offset Payment Rule, 15A NCAC 02B .0240, established the EEP and authorized it to assume the offset responsibility for regulated facilities. Similar to the precedent set by payments to ACSP, the Rule also required EEP to establish and periodically revise in-lieu fee rates. The resulting 15A NCAC 02B .0274 requires minimal, annual revisions to the rate and quarterly revisions when the rate increases by 10% or more.

Rates are calculated as:

$$\text{Adjustment Factor} + \text{ActualCosts}_{\text{PresentDay}} / \text{TotalPoundsOffset}_{\text{PresentDay}} = \text{Actual Cost Rate}$$

If actual costs exceed actual receipts, 15A NCAC 02B .0274 allows the EEP to raise additional revenue by applying an adjustment factor to the actual cost rate. The adjustment factor temporarily increases the cost of payments to the EEP, and remains in place from one to four years depending on the time necessary to raise funds and fill the revenue gap (15A NCAC 02B .0274). Once the adjustment period ends, rates return to the calculated actual cost.

It is important to note that in-lieu fees to EEP do not generate offsets for sale. Rather, according to one interviewee, payments require EEP to assume the offset responsibility of a regulated entity. Upon passage of the Neuse Nutrient Offset Payment Rule, regulated entities could pay the EEP or purchase offsets from a private nutrient offset bank. However, a Session Law passed by the North Carolina General Assembly subsequently changed the payment dynamic. Session Law 2009-337 creates preference for private nutrient offset banks. Table 1.2.2. compares nitrogen offset prices for the EEP and some private nutrient offset banks.

Table 1.2.2.: Nitrogen Offset Prices Vary Among the EEP and Private Banks Reporting Prices ($/lbs N/Yr)

Ecosystem Enhancement Program (average across subbasins)	Little River Farm Bank	Flat Swamp Mitigation Bank	Lane Island Nutrient Bank	Wellons Farm Nutrient Bank
$18.12	$20.00 - $22.00	$25.00	$15.00	$15.00

Note: Reported prices are lower in subbasins that experience significant transaction volume, which are the majority of subbasins

1.2.3. Administration

The revenue generated by the ACSP, EEP, and private nutrient offset banks fully covers the administration of the trading and offset programs. For ACSP, the $56/kg/yr credit price under Phase I of the Tar-Pamlico Point Source Rules included administrative costs, including a dedicated position of program administrator. The Rules also planned for a 10 percent increase to $62/kg/yr in Phase II for ongoing administrative costs (DWQ, 2005).[11] For the EEP, the Actual Cost Rate includes administrative costs to run the program such as staff time, supplies, rent, and overhead (EEP, 2011a). For private nutrient offset banks, prices presumably reflect their actual costs.

1.3. Credit Quantification Methods

Description of science-based methods to define, measure, and model water quality improvements
Stakeholders interviewed for this case study (e.g. environmental agency staff, owners of nutrient offset banks, EEP staff) agreed that having and using consistent calculation methodologies among suppliers of nutrient offsets was critical for program success. As

[11] Due to lower-than-expected costs for agricultural BMPs, the actual rate was less than $62. However, administrative costs were still covered under the lower rate (DWQ, 2005).

such, calculations are fixed among projects. The DWQ uses a spreadsheet calculator to determine the nutrient reductions from implemented riparian forest buffers, which have been the sole source of offsets to date.[12]

Both the total nitrogen and total phosphorus calculations assume existing land use of agricultural or urban land. Riparian forest buffers reduce the base loading and deliver longer-term benefits through nutrient removal from nonpoint sources and from periodic overbank floods. Loading rates, nutrient removal efficiencies, and components of the calculation methodology are based on findings from literature reviews and DWQ's own analysis. Figure 1.3. explains the calculation methodology for nitrogen and phosphorus offsets.

Thus, the methodology calculates that each hectare of land including riparian forest buffer contributes 84.862 fewer kilograms of nitrogen and 5.466 fewer kilograms of phosphorus than unprotected land.

All of the North Carolina trading and offset programs also restrict the land area available for implementing certain projects to generate credits or offsets. In talking with one interviewee, projects generating credits or offsets can extend up to 100 feet from a jurisdictional stream or other water body However, riparian forest buffers for the North Carolina Riparian Buffer Mitigation program can only extend 50 feet. Depending on the number of credits or offsets a landowner wants to generate, and the land available to generate those credits or offsets, two different BMPs may be necessary. For example, a farmer wanting to implement a one-hectare practice to generate 2,546 kg TN over a 30-year period (i.e. 84.862 * 30) could plant a riparian forest buffer beginning at a stream bank and extending 50 feet from the bank. Since a hectare equals 107,639 feet^2, the riparian forest buffer would extend 2,153 feet along the stream bank (i.e. 107,639/50=2,153). If, however, 2,153 feet are not available, the landowner could implement another practice, such as riparian area restoration, up to 100 feet from the stream bank. The combined practices would extend 1,076 feet along the stream bank (i.e. 107,639/100=1,076).

The EEP program uses simple calculations to translate BMPs like this buffer into nutrient credits

1.3.1. Method Development Process

DENR has used the same calculation methodology for estimating nonpoint source loads since 1996. In developing it, DENR hired staff with particular experience in nonpoint source modeling methodologies. Then, the Department brought together staff from the Clean Water Act Section 404 permitting, NPDES, and planning programs. According to one interviewee, when the methodology was released, some environmental groups (e.g. RiverKeepers, others) criticized the process for its lack of transparency and low payment rates. However, neither the process nor offsets from EEP and private nutrient offset banks have ever been challenged in court. Environmental groups seem to appreciate the presence of some offset mechanism and developers support the program because it is simple to use.

DENR understands that fixed calculations do not accommodate the major site-specific variables affecting nutrient flow and transport. According to one interviewee, the Department is considering changes that would make the calculations more site-specific, such as using on-farm drainage factors and land use rates and

[12] The EEP may use many projects to generate nutrient offsets, including stormwater retention structures, stormwater wetland projects, vegetated buffers, and others (EEP, 2011d). However, to date, the EEP has allocated most revenue for nutrient offsets to the North Carolina Riparian Buffer Restoration Fund (Fund) that supports the Riparian Buffer Mitigation Program (Stanfill, 2011). Since the EEP manages both programs, aligning nutrient offset revenue with the Fund improves efficiency. Also, multiple revenue sources are needed to fund one project so existing Fund money combined with nutrient offset payments accelerates project implementation (Stanfill, 2011).

Figure 1.3.: Nutrient reductions accrue from land use change, additional reductions in nonpoint source runoff, and nutrient removal from periodic overbank floods

Nitrogen calculation

Existing export coefficient from agricultural or urban land:
12.970 kg/ha/yr
(-)
Riparian buf. export coefficient:
1.904 kg/ha/yr
(=)
Benefit of land use change:
11.066 kg/ha/yr

+

Nutrient concentration/buffer treatment ratio:
10.80
(*)
Existing export coefficient from agricultural or urban land:
12.970 kg/ha/yr
(*)
Nitrogen removal efficiency:
0.50
(=)
Benefit of Nutrient Removal from Nonpoint Source Runoff:
70.038 kg/ha/yr

=

Flow concentration:
2.50 mg/L*10^{-6}*10^{4}
(*)
Area:
1 (hectare)
(*)
Overboard height:
0.30*10^{3}
(*)
Nitrogen removal efficiency:
0.50
(=)
Benefit of nutrient removal from periodic overbank flood:
3.752 kg/ha/yr

=

84.862 kg/ha/yr

Phosphorus calculation

Existing export coefficient from agricultural or urban land:
2.408 kg/ha/yr
(-)
Riparian buf. export coefficient:
0.4704 kg/ha/yr
(=)
Benefit of land use change:
1.938 kg/ha/yr

+

Riparian buf. total phosphorus mass load reduction:
3.528 kg/ha/yr

=

5.466 kg/ha/yr

accounting for the diminishing returns in nutrient reductions as buffer width increases. Since changes could significantly increase offsets at some sites and decrease them at others, DENR must weigh the potential benefits of a more refined methodology with the potential setbacks of changing a program accepted by all participating stakeholders.

1.4 Program design Elements

1.4.1. Trading Area

In each of the programs, BMPs or stormwater control measures generating load reductions must be located in the same U.S. Geological Survey 8-digit Hydrologic Unit Code (HUC) as the loading activity that is being offset (15 A NCAC 02B .0240). The DWQ monitors impacts at the 10-digit level, taking a more conservative approach that reviews trades for any resulting, highly concentrated areas of nutrient pollution.

1.4.2. Trading Ratios

Because practices to reduce nutrient loads are implemented in the same watershed as the increased loading they offset, most programs lack delivery ratios. Jordan Lake is the exception in part because the CH2M Hill, Inc. study of 2006 to 2008 established them at the 14-digit level for the Haw River and Upper and Lower New Hope Creek.

1.4.3. Baseline and Additionality

The Neuse Nutrient Offset Payment Rule also notes "load reductions eligible for credit shall not include reductions used to satisfy other requirements under the same nutrient strategy" (15 A NCAC 02B .0240). Regarding water quality trading and offsets, agricultural or stormwater BMPs generating nutrient reductions for sale cannot count those reductions as progress toward meeting their own sector's rule obligations. It is important to note, however, that agricultural and

North Carolina's program tries to offset nutrient loads from new development (photo courtesy of Ted Weber)

stormwater lands can generate credits or offsets without first meeting their share of the relevant sectors' requirements for load reductions (i.e. a "baseline" requirement for ensuring additionality).

Notably, the rules allow the state to require nutrient load reductions from individual agricultural operations if the agricultural sector fails to demonstrate progress toward meeting collective goals. For one interviewee, the lack of a baseline requirement led farm advisers to caution agricultural operations against generating offsets from "low hanging fruit" nutrient reductions because those reductions could be needed for meeting any mandated load reductions. The suggestion does not appear to have affected nonpoint source participation in the offset programs.

1.4.4. Project Verification

The programs have procedures in place to ensure that projects are reviewed and verified before credits or offsets are awarded. For new offset projects, the EEP or private nutrient offset banks must submit to DWQ a proposal detailing:

- Location and site boundaries of the proposed measure;
- Existing land use conditions with enough information to support offset calculations;
- Offset calculations themselves;
- A statement on the duration of offsets and conservation easement or legal mechanisms recorded with the County Register of Deeds for that duration;
- Contact person;
- Implementation plan; and
- Monitoring and maintenance plan.

Importantly, landowners agree to grant DWQ staff access to their property for the duration of the offset project and receive a site review before offsets are verified. All entities must make payments sufficient to fund 30 years of nutrient reduction, and point source dischargers must submit evidence of the credit purchase (i.e. contract, commitment letter from the EEP or private nutrient offset bank) before an NPDES permit will be modified to include the purchase.

1.4.5. Stakeholder Process

Most stakeholders interviewed for this case study commented that there was an inclusive process used for developing each of the rules. DWQ and its predecessors convened separate working groups of developers, agricultural operations, point source dischargers and environmental groups to discuss and settle the details of the rules, including the policy elements relating to trading and offsets.

1.4.6. Trading Infrastructure

Rule requirements, the DWQ calculation spreadsheet, EEP, and private nutrient offset banks are the extent of North Carolina's trading infrastructure. The Nutrient Offset Payments Rule requires EEP and private nutrient offset banks to maintain a credit/debit ledger (e.g. registry) for BMPs and stormwater control measures until all credits and offsets are exhausted. However, unlike programs elsewhere in the United States (e.g. Maryland, Pennsylvania, Willamette Valley), there is no formal infrastructure for landowners and third parties to calculate credits using an online calculator or exchange credits or offsets in an online marketplace. Two interviews talk about how transactions are informal and usually occur through a simple phone call from an engineering firm acting on behalf of a developer to the EEP or private nutrient offset bank.

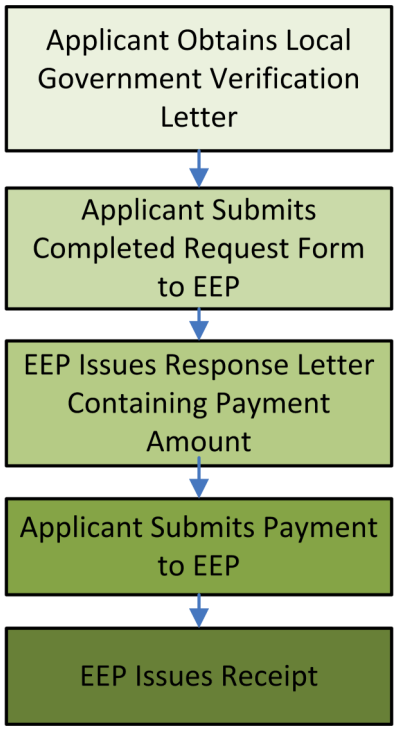
There is a process for requesting, generating, and selling credits and offsets. Entities seeking offsets first evaluate the cost savings from acquiring them in lieu of installing more onsite treatment. Often, an engineering firm evaluates the offset option on behalf of a site developer and completes the offset purchase. Once the decision to acquire offsets is made, the applicant approaches the jurisdiction where development will occur. The local government confirms the load necessary to offset and provides the applicant with a letter for EEP or the private nutrient offset bank. Once the transaction process is complete (Figure 1.4.6.), the applicant receives a receipt that confirms the offset purchase for the local government. A benefit of using the EEP is that offsets are refundable if the development project fails to go through. Applicants seeking offsets evaluate that benefit compared to lower potential rates from private nutrient offset banks.

To enroll a landowner, a private nutrient offset bank looks at historic demand in the 8-digit HUC watersheds. Then, using GIS analysis, the banker identifies large-scale landowners in those regions. As many landowners as possible are identified because bankers estimate that a quarter of those approached implement projects according to one interview. Once the bank identifies landowners, it arranges a meeting to discuss financial benefits, amount of needed land, and other details of the potential transaction. Participating landowners work with the bank to develop a Bank and Development Plan for DENR, said one interviewee. After receiving feedback and resubmitting the plan to DENR, bankers work with the landowner to secure a permanent conservation easement and generate credits or offsets. The process is similar for landowners participating in the EEP, though options to generate offsets exist beyond conservation easements such as selling land outright and entering into a fee simple agreement (EEP, 2011d).

Development process

There was no defined process for developing the trading and offset infrastructure. Rather, the process includes necessary stakeholders such as DENR and the landowner and conforms to trading and offset provisions of the relevant rules.

Figure 1.4.6.: Entities follow a 5-step process for acquiring offsets (EEP6, 2011)



1.5. Current Status of Programs

Water quality in the four watersheds remains similar to conditions during rule development according to several interviews, suggesting that NSW management strategies in place since the early 1990s in the Tar-Pamlico Estuary have yet to be effective. However, to the extent that offsets are mitigating loads from new development, the nutrient offset program has been a success at preventing further deterioration of water quality. Financially and in terms of regulatory compliance, the nutrient offset programs generate cost-effective nutrient reductions and allow development in the Durham and Raleigh regions to continue.

Since demand for trading in the North Carolina programs comes exclusively from offsetting new development, demand declined substantially during the 2008 economic downturn according to five interviewees. The EEP was also affected (Figure 1.5.) by Session Law 2009-337 that requires government agencies and private developers to seek private nutrient offsets first when a bank exists in their watershed.

Since beginning in 2003, the EEP has mitigated 680,000 kilograms of nutrients, restored 486 riparian buffer hectares, and served 3,800 landowners and clients (EEP, 2012).

1.6. Future Direction of Trading in North Carolina

Demand from the wastewater sector in any of the watersheds is unlikely to materialize in the foreseeable future. Point source dischargers that are discharging at levels nearest to their cap are only operating at 70 to 75 percent of their allocated load. Demand could materialize from unexpected events, but such events have not happened in the 20+ years since Tar-Pamlico trading was authorized. For example, extreme amounts of rainfall could increase runoff into combined sewers, which in turn would increase flow at wastewater treatment plants. Credits would provide a short-term compliance option in such situations. Informal point-to-point source trades will likely continue.

Volume in the offset program will rise with economic development. In addition, DWQ is developing rules for High Rock Lake, which will likely include an offset requirement (Division of Soil and Water Conservation, 2012). In the existing programs, demand is expected to increase around Falls Lake and areas south of it toward the Neuse River basin. Rural areas surrounding the Lake but within short commuting distance of Durham and Raleigh are in high demand for development.

Finally, DENR could include additional site-specific variables in the calculation methodology. The agency would likely include those variables only if the program remains simple to use from an administrative perspective

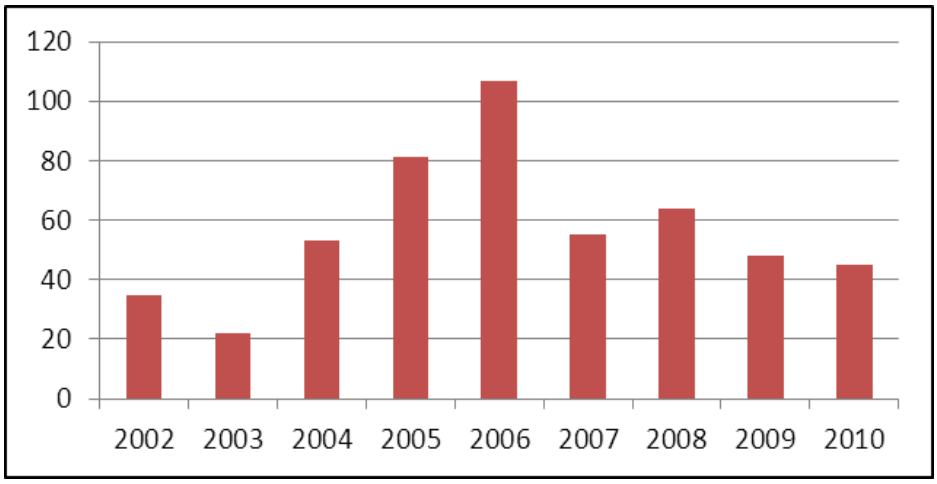
1.7. Conclusion and Recommendations

North Carolina's water quality trading and offset programs meet the purpose they were intended to serve—they provide point source dischargers and developers with a mechanism to offset loads from growth and new development. For that reason, lessons from the programs could benefit groups considering similar programs in watersheds throughout the country.

Trading and offset programs can spur private sector activity. Private nutrient offset banks operate together with the EEP to provide regulated entities with compliance options. In doing so, banks are generating revenue, creating jobs, and contributing taxes to local governments.

Agricultural operations can be proactive in implementing best management practices to generate credits or offsets. Currently in North Carolina, only one in four landowners agrees to generate offsets for new development, causing more work in recruitment and education for the EEP and private nutrient offset banks and missed opportunities for the agricultural sector. Agricultural operations might be more willing to participate if they could calculate their credits or offsets themselves before approaching a private nutrient offset bank or the EEP. Online calculation tools or marketplaces provide such functionality.

Figure 1.5.: Contract Awards for Installed BMPs Demonstrate Fluctuation in Supply And Demand (EEP2, 2011)[13]



[13] Since one EEP project generates multiple benefits (e.g. compensatory mitigation, nutrient offsets), this graph includes all contracts by project and project type.

Group allocations in the Tar-Pamlico and Neuse watersheds spur informal point-to-point source trades but not point-to-nonpoint trades. All of the rules provide point sources operating in a watershed with the option to receive a group NPDES permit and waste load allocation. In the Tar-Pamlico and Neuse, the wastewater treatment plants have never exceeded the collective load. Instead, they trade informally amongst themselves and target technology upgrades. Credits from nonpoint sources could provide a lower cost compliance option in some cases.

Demand can arise from multiple regulatory drivers; not just from point source dischargers' NPDES permits. In the North Carolina programs, most demand for nonpoint source credits comes from flow restrictions in new development. That regulation is entirely separate from effluent limits in NPDES permits, which have been the presumptive demand driver in trading programs across the country. Department of Transportation projects could also generate demand.

Programs can be designed to support themselves financially. Early versions of the North Carolina programs (i.e. ACSP), as well as the EEP and private nutrient offset banks, generate revenue to support their own activities. The programs do not need to rely on grant money or government funding.

Calculation methodologies are among the most important design elements for ensuring program success. The DWQ calculation methodology uses fixed data instead of site-specific variables and calculations. Fixed data is easy to understand and is a major reason the development community accepts the program. However, site-specific variables could provide greater environmental benefits.

Transaction volume aligns with trends in supply and demand for new housing and commercial development. Demand, and thus supply, for offsets depends on new building projects. If an economic downturn reduces new building, demand will decline.

Bald eagles rely on clean water in North Carolina's lakes

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II. Oregon Water Quality Trading Case Study

Brian Kittler, Pinchot Institute for Conservation

2.1. Program Overview

This case study synthesizes the growth and evolution of water quality trading in Oregon. This includes early temperature trading activity led by Clean Water Services as part of their NDPES permit in the Tualatin River, efforts in the Willamette led by the Willamette Partnership to establish a temperature trading program, and the City of Medford's NPDES permit in southern Oregon's Rogue River that allows for trading using the same trading program design developed for the Willamette River. Collectively, these cases are closely linked and provide challenges and lessons for how to network locally based trading programs together.

The initial focus has been on temperature trading. In these transactions, NPDES permittees (to date, only municipal wastewater facilities) have elected to offset their warm water discharges by augmenting river flows and restoring riparian shade to reduce the warming effects of solar radiation in the waters to which they discharge. While several restoration actions have been identified as a means of temperature mitigation,[1] the restoration of riparian forests to provide shade is the project type most often implemented.

With early demonstrations of riparian shading being used as an acceptable regulatory compliance option in the Tualatin River, a tributary of the Willamette River, several municipalities throughout the Willamette River Basin, the Rogue River Basin, and beyond are implementing and/or considering temperature trades. Trading programs for other pollutants, chiefly nutrients and sediments, are also being evaluated in Oregon.

Growing interest in trading in this region is due largely to early success in the Tualatin River, where regulatory flexibility from the Oregon Department of Environmental Quality (Oregon DEQ) and U.S.EPA Region 10, and leadership from Clean Water Services—the regional wastewater utility—combined to generate the first trade. Trading is now being propelled by two regional 501(c)(3) non-profits focused on restoration and ecosystem markets, the Willamette Partnership and The Freshwater Trust, who serve critical roles in trading program administration and project development.

Also highlighted in this case study is the importance of an effective stakeholder process through which market structure and restoration protocols are defined. The Counting on the Environment process has been an essential venue for agency and non-agency stakeholders involved with ecosystem restoration to define restoration protocols for key ecosystem features (e.g. riparian areas, wetlands, stream channels, upland prairies, etc.), laying the scientific foundation of ecosystem service credit protocols. This process, involving more than 30 organizations, has resulted in the soft policy documents needed to establish a common understanding of the standards and framework of ecosystem services markets, especially compliance-driven water quality markets.

What is temperature trading?

In many ways, there are few differences between temperature and nutrient trading. When water gets too hot, salmon and other fish species have a more difficult time surviving and reproducing. Municipal and industrial point sources discharge hot water that comes from people taking hot showers at home or industrial processes (e.g. making paper). Historically, riparian forests have been removed to plant crops and build cities, limiting shade that helps keep streams cool. Reducing temperature can be done at wastewater facilities with mechanical chilling equipment, restoring forests to provide shade, augmenting flows in the stream, and other actions. Temperature trading involves a point source purchasing reduced thermal energy from nonpoint sources.

[1] Other restoration actions that affect stream temperature include floodplain reconnection, wetlands restoration, stream channel modifications, removal of impoundments, flow augmentations, etc.

2.2. Regulatory Driver(s)

The entire mainstem of the Willamette River is listed on the 303(d) list of impaired water bodies for failure to meet the Oregon water temperature standard during summer months. A partial reason for this is the loss of 80% of the basin's riparian forests since European settlement, which provided shade and other ecological benefits (Sedell and Frogatt, 1990). In advance of the 2006 Willamette Total Maximum Daily Load (TMDL), Oregon DEQ worked with stakeholders from 2003 to 2004 to complete a draft management plan for reducing the temperature of surface water in the Willamette River Basin.

Shade is used in Oregon DEQ's water quality program as a surrogate for instream ambient temperature, in part because it is a simple metric to model and monitor (see discussion of credit quantification methods below). In Oregon, water quality trading is progressing in watersheds where regulated NPDES permittees have accepted, and are not litigating, TMDL allocations and where the trading option delineated by the TMDL (and more often in NPDES permits) presents cost savings for them. Trading is progressing much more slowly in areas where point sources contest their wasteload allocations or TMDLs[2].

The first temperature TMDL to use shade as a metric was developed in the Tualatin River Basin in 2001, followed by the temperature TMDL for the entire Willamette mainstem in 2006. A court settlement was driving Oregon DEQ to issue TMDLs quickly, covering increasingly larger watersheds.

Following the issuance of the Willamette TMDL, Oregon DEQ assumed that the option to trade would be attractive to point sources and that implementation of the TMDL would proceed. However, the Willamette TMDL was legally contested by point sources for nearly three years, with litigants contesting the modeling methods used by Oregon DEQ and the scale at which the TMDL analysis was completed. One of the primary concerns was that the TMDL did not address the temperature contributions of dams in the watershed. Following a legal settlement agreement, some municipal point sources in the Willamette are now considering trades. Most permitted industrial point sources are not considering trading.

While differences over the Willamette TMDL are at least partially resolved, temperature trading has not progressed in the Willamette Basin outside of the Tualatin River. Other river systems are seeing more progress. In December 2011, Oregon DEQ released a new NPDES permit for the City of Medford's wastewater treatment plant which allows and encourages temperature trading as a compliance option. Medford is projected to require nearly 30 miles of riparian shade restoration to offset its thermal load to the Rogue River (pers. comm., December 09, 2011). The next NPDES permit to include trading is expected for the City of Ashland.

2.2.1. Assessing Potential Credit Supply

Point sources needing to reduce their warm water discharge to comply with their NPDES permit have a few options. They can invest in end of pipe treatment technologies like chillers to cool the water before they discharge to the stream. They might also consider land application of wastewater (e.g. irrigating fields), or they could purchase shade credits that offset the increase in temperature associated with their discharge. In selecting among these options, point sources often carry out water quality credit analyses.

At its core, the process for estimating credit supply in a given stream reach or sub-watershed in Oregon is as follows: (1) evaluate the baseline condition of shading in the stream reach, and (2) use a model such as the Shade-a-Lator[3] to calculate reductions in solar insolation that would result from implementation of shading projects on the stream reach.

Oregon DEQ generated load allocations for riparian landowners for the Willamette TMDL by comparing the effective shade potential of riparian properties (i.e. the natural thermal potential)[4] to the actual shade of riparian parcels—essentially a comparison of baseline conditions to potential restoration actions. In their TMDL analysis, the Oregon DEQ modeled the relative impacts of these two scenarios on ambient stream

[2] The Willamette TMDL was legally contested by several point sources with final settlement occurring in 2009.

[3] http://www.willamettepartnership.org/ecosystem-credit-accounting/water-quality-temperature

[4] This was determined using a component of the Willamette Heat Source model called the Shade-a-Lator intended to evaluate site shade potential. This analysis was completed by Oregon DEQ, The Nature Conservancy, and Oregon Department of Fish & Wildlife. This group used historic vegetation information gathered during state land surveys from the 1850s to determine appropriate plant community and structure for riparian areas in the Valley (Erickson & Thieman, 2008).

temperatures during a period of low stream flow (i.e. warm summer months) during which maximum impact to the beneficial use—spawning and rearing for cold water dependent fish—occurs.

To assess basin-wide credit supply potential, the Willamette Partnership convened key stakeholders to complete a credit supply analysis. Various spatial datasets were used to determine priority restoration areas and potential for shade credit generation available in the Willamette River Basin.[5] The Willamette Partnership's market feasibility analysis concluded that the total potential supply[6] of riparian shading temperature credits generated from priority areas in the Willamette Valley was 5 billion kilocalories per day. Priority areas were defined by the Counting on the Environment process by their ability to provide shade, as well as their importance for salmonid habitat restoration.

2.2.2. Assessing Potential Credit Demand

To assess potential credit demand, the Willamette Partnership evaluated the wasteload allocations for point sources under the Willamette TMDL to determine which sources may seek to offset their wasteloads. The Willamette Partnership calculated the need for facilities to offset thermal loads by subtracting facility TMDL wasteload allocations from the excess thermal loads of these facilities.[7] This demand analysis revealed that the greatest demand was likely to come from 108 point sources in the Upper Willamette that exceeded their waste load allocations and were thus considered candidates for trading (Willamette Partnership, 2008a). In reality, according to regulatory officials interviewed, demand is constrained by social and political factors (i.e. increased probability of permits for industrial facilities to be contested in legal proceedings) ultimately limiting the number of point sources likely to trade to approximately 15 municipal wastewater treatment plants. Total expected demand created by the Willamette River temperature TMDL was estimated to be 3 billion kilocalories per day (Willamette Partnership, 2008b).

2.2.3. Cost-effectiveness of nonpoint source compliance

The Clean Water Services' (CWS) Tualatin River trading program suggests that non-point temperature load mitigation is very cost-effective (Cochran and Logue, 2011). In the first few years of this program Clean Water Services avoided spending $150 million on cooling using mechanical chillers by investing $4.6 million[8]

The Tualatin River starts off cool, but warms as it flows through urban and agricultural lands

[5] The Willamette River Basin Planning Atlas and related spatial data sets prepared by Oregon State University was selected as the basis for evaluating restoration site potential.

[6] Total potential supply does not equate to the number of landowners that are likely to actually participate.

[7] This analysis was completed assuming low flow conditions existed in the river during time of discharge, which is when the ambient temperature in the water body is likely to be highest. There is some fluctuation in the wasteload allocations in the Willamette TMDL to account for seasonal variation in ambient stream temperature associated with flow.

[8] Note that a portion of these funds that were used for landowner incentives were matched with federal conservation dollars to provide one composite payment (see Tualatin program discussion in Section 2.5.1.).

into restoring riparian forests along 35 miles of stream and augmenting flow through reservoir releases.[9] In data provided by one interviewee, the City of Medford's trading option is projected to cost $8 million rather than $16 million for the next best alternative. For facilities considering mechanical cooling towers, the cost of restoring riparian shading has been one third to one half the grey infrastructure option (PNCWA, 2011). The riparian shading option also provides ancillary benefits—provision of habitat, carbon sequestration, and avoided future electricity costs—which may or may not be factored in when a facility engineer is completing a compliance option analysis. The costs of alternative non-point source compliance options such as flow augmentation or dam removal vary significantly.

2.2.4. Legal Authority

At the state level, Oregon Revised Statute (ORS) 468B.555 provides legal authority for trading. Individual NPDES permits and associated temperature management plans are where trading is identified as an option for meeting wasteload allocations.

Oregon DEQ released an Internal Management Directive (IMD) on trading in 2009 based on several years of experience with trading in the Tualatin River.[10] This policy document is as much for internal management purposes at Oregon DEQ as it is for the interested public. For others considering trading, the IMD signals DEQ trading preferences and clearly articulates what is likely to be acceptable and not. Oregon DEQ has not issued formal rules for trading and is reluctant to do so because rule making is a time- and resource-intensive process, but more so because only one example (the Tualatin program) currently exists. As other trades emerge, the agency is required by state statute to eventually issue formal rules with regard to water quality trading (Oregon Revised Statute (ORS) 468B.555).

2.2.5. Administering Entity

Oregon DEQ is the state agency that administers trades in Oregon through their NPDES permitting program. That said, as markets expand, the Willamette Partnership appears to be carving out a role for itself as the central program administrator for ecosystem services transactions in the Willamette and beyond. This role includes accreditation of third party verifiers, development of ecosystem credit quantification and accounting methodologies and associated tools, and overseeing the process of having projects verified by a third party and subsequently registered on an independent registry. It is worth noting that in large part due to the capacity and experience of the Willamette Partnership, the Oregon DEQ made a first of its kind notation in the recently released Medford municipal wastewater NPDES permit, stating that that the trading program could formally be administered by a third party according to one interviewee.

2.2.6. Administrative Costs and Requirements

From Oregon DEQ's perspective, the costs of administering trades through the NPDES program are small and essentially no different than the costs of administering the existing permit program. Costs for monitoring, verification, and registration are spread among participants in the trades and are not borne by Oregon DEQ. In the Tualatin, water quality credits are currently reported by Clean Water Services in annual Temperature Management Plan reports submitted to Oregon DEQ. Those reports are posted on the Clean Water Services website, but Oregon DEQ does not require that all water quality credits be posted on a centralized web-based registry available to the public. The Willamette Partnership is working with Markit Environmental Registry to fill this gap, while balancing a need for transparency with a need to keep credit transaction costs low. The Freshwater Trust, the entity selling credits to the City of Medford, will get its credits verified and registered through the Willamette Partnership and Markit.

2.3. Credit Quantification Methods

Shade is used as a surrogate for stream temperature in Oregon TMDLs. So while the water quality standard is written for ambient stream temperature, the metric used in TMDLs and temperature trades is the amount of kilocalories/day blocked by shade. Oregon DEQ's Shade-a-Lator model is the tool that applies this metric in crediting scenarios.[11]

[9] The operational lifespan of chillers is estimated at around 20 years.

[10] http://www.deq.state.or.us/wq/pubs/imds/wqtrading.pdf

[11] Other models and analytical tools are used in defining temperature credits and TMDL load allocations. These include the CE-QUAL-W2 models for the Willamette mainstem and the Heat Source model for tributary shade restoration and wetland treatment projects, and the Willamette point source trading tool developed by USGS.

While slope, aspect, topography, and other features are critically important, the three main variables in credit calculations are the area of stream shaded, change in shade density, and the rate of solar insolation.

Research on solar insolation loading in streams conducted by Oregon State University and the U.S. Geological Survey and incorporating other data sources supports ongoing refinement of Shade-a-Lator. The Tualatin River trading program gave stakeholders the opportunity to evaluate the deployment of the Shade-a-Lator model and associated calculation methodologies in the context of calculating temperature offsets.

2.3.1. Method Development

The Shade-a-Lator model was developed by Oregon DEQ. The Counting on the Environment process, facilitated by the Willamette Partnership, defined some boundary conditions for applying and adapting Shade-a-Lator in watersheds across Oregon.[12] This process involved key stakeholders and technical experts in defining restoration protocols for a number of key ecosystem types of the Willamette River Basin such as riparian forests, floodplains, wetlands, bottomland hardwood forests, and prairie/savannah ecotypes.

The Counting on the Environment process and associated outputs are documented in several reports available on the Willamette Partnership website.[13] The *Methods for Defining Temperature Off-sets Credits in the Willamette River Basin*[14] report documented the state of the science in calculating temperature offsets and according to the Willamette Partnership, helped to "begin discussions with regulatory agencies about defining what would create a temperature credit."

The protocol document *Ecosystem Credit Accounting - Pilot General Crediting Protocol: Willamette Basin Version 1.1* defines how water quality and other ecosystem services credit transactions would be accounted for (Willamette Partnership, 2009a). While the TMDL and tools available prior to the Counting on the Environment process were most likely adequate to facilitate trading, the stakeholder process is viewed by virtually all market participants as an essential investment for trading to progress in a meaningful manner.

2.4. Program Design Elements

2.4.1. Development Process

Involving diverse stakeholder groups modulates the evolution and development of trading programs by bringing in varying perspectives, beliefs, and values, while encouraging collaborative development of program structure.

In Oregon, the Willamette Partnership spent more than three months developing a stakeholder process that would move a diverse set of stakeholders toward consensus-based decisions about key water quality trading questions. This led into an eight month stakeholder process that split discussions into five separate groups each tasked with advancing their own issues: a project management team, a stakeholder working group, a small executive coordinating team, a

Shade from riparian forests help keep cold water cold

[12] That process was funded by a USDA Natural Resources Conservation Service (NRCS) Conservation Innovation Grant.

[13] http://willamettepartnership.org/ongoing-projects-and-activities/nrcs-conservation-innovations-grant-1/counting-on-the-environment

[14] http://willamettepartnership.org/publications/es-cornerstones-july-2008-final.pdf

technical focus group, and a policy group. This stakeholder process ultimately yielded a Joint Statement of Agreement signed by 25 stakeholders including representatives from major non-governmental organizations and director level staff of key state and federal agencies (e.g. Oregon DEQ) to pilot water quality trading and other ecosystem markets in the Willamette River Basin using the standards developed by the Counting on the Environment process.

Going forward it is anticipated that this full Counting on the Environment working group will be convened annually, while a smaller more active coordinating team will oversee and advise trading program operations on a more consistent basis. According to the Willamette Partnership, this coordinating team includes representatives from the major agencies, environmental groups, buyers, and sellers of credits (pers. comm., March 07, 2012).

2.4.2. Baseline and Additionality

In Oregon's temperature trading market there is a two-step baseline for landowner participation in riparian shading projects. First, parcels on which credit projects are undertaken must meet natural resource regulations of local jurisdictions, state level regulatory requirements of the Oregon Forest Practices Act (ORS 527.722), which regulates the management of existing forested buffers, and Agricultural Water Quality Management Plans (often called Senate Bill 1010 plans), which require agricultural producers to apply best management practices (BMPs).[15] Second, the parcel must have the opportunity for increased shading.

Shade credit projects need to demonstrate that they provide additional benefits beyond what is required under current regulations and business-as-usual. In Oregon, farmers must provide a setback from streams that are not actively farmed. There are no regulations that compel a landowner to actively restore riparian forests. Any active riparian restoration is additional. Oregon agencies issued guidance[16] in 2008 restricting the use of cost share funds to generate credits, and the Willamette Partnership's accounting systems can track use of multiple funding sources and sale of multiple credits to avoid paying twice for the same benefits (called double dipping).

2.4.3. Trading Ratios and Accounting for Uncertainty

The protocol for temperature trading defined by Oregon DEQ's Internal Management Directive and the Counting on the Environment process outlined a series of ways in which uncertainty is accounted for in temperature trades in Oregon. For instance, the main way of accounting for uncertainty is through the application of a 2:1 trading ratio, meaning that buyers are required to purchase twice as many credits for compliance. The Clean Water Services and Medford NPDES permits both use the 2:1 ratio. The use of reserve buffer pools is also being considered.

2.4.4. Determining Eligibility (Validation)

At the beginning of a credit project, the seller submits necessary project documentation, including a project validation checklist, to the Willamette Partnership. At this stage, the seller is either proving or stating that the project is additional, suitable, and sustainable. This documentation includes proof of title to the land, proof of rights to credits, and initial plans for the restoration

Prior to this broader effort to gain agreement around trading within the Willamette River Basin, the Tualatin River trading program used a stakeholder committee chaired by a local farmer/landowner, and informed by scientific data, to develop the riparian shading protocols. The Stream Protection Opportunities Technical Advisory Committee (SPOTAC) membership included another influential farmer/landowner, three representatives of the Washington County branch of the Oregon Small Woodlands Association, the USDA Farm Services Agency, and the Tualatin Soil and Water Conservation District (SWCD).

[15] Agricultural BMPs are intended to prevent excessive bank erosion, manage nutrients, improve infiltration of overland flow, and manage stream temperature.

[16] http://www.fws.gov/oregonfwo/LandAndWater/Documents/PublicFunding-final.pdf.

project. Upon receipt of this information, the Willamette Partnership provides a notice to the seller that their projects are eligible and ready to be verified as soon as BMPs are installed (Willamette Partnership, 2009a).

2.4.5. Verification

For the City of Medford's credits and any credits generated using Willamette Partnership's ecosystem crediting protocols, all credits need to be verified by accredited third parties. The Willamette Partnership accredits soil and water conservation districts, consultants, and other experts as verifiers. These entities evaluate restoration projects against standards for riparian shade restoration projects agreed upon by the participants in the Counting on the Environment process. Simplistic examples of standards include percent natural vegetation cover, percent vegetation cover that is non-native invasive plants, diversity of plant species, stems per acre, etc.

Verification begins when a project developer submits credit calculations[17] to the Willamette Partnership for verification. The verifier reviews all documentation to determine whether: 1) the project is additional, 2) there is a long-term stewardship plan and funds to implement the plan, 3) the plants are in the ground and meet the standards, and 4) the calculations were done correctly. If the credit value is plus or minus 15% of the claimed credits than the seller's calculation is determined to be valid. If this is not the case, the seller can choose to ask for another verifier, accept the verification report and make implementation adjustments, or formally dispute the matter with the Willamette Partnership's coordinating team (Willamette Partnership, 2009b).

2.4.6. Registration

The Willamette Partnership offers registration of credits through the Markit Environmental Registry[18], but registration is not required by Oregon DEQ. NPDES permittees submit annual reports of their credit transactions to Oregon DEQ.

2.4.7. Monitoring

In the Tualatin Program, Oregon DEQ requires Clean Water Services to monitor a sample of their plantings annually for five years following initial planting (Clean Water Services, 2010). Clean Water Services reports on effective shade for individual projects and monitors ambient temperatures in watershed monitoring stations throughout the Tualatin.

The protocol for monitoring Tualatin projects includes the creation of photo points for each 500 linear foot stream segment, with a minimum of three monitoring

Third parties can verify inputs into the temperature crediting models in Oregon

[17]For temperature credits the Shade-a-Lator tool is used. For the various habitat credit protocols developed by the Counting on the Environment process, calculators developed by the Willamette Partnership are used.

[18] http://www.markitenvironmental.com/

points per project. A combination of photo points and densiometer readings at the streambank and the middle of the channel are taken to measure shade.

Monitoring of Tualatin credit projects in the first four years following planting documented an 82% rate of compliance with protocols for tree stem density, invasive species cover, plant survival, and other related attributes. Projects (or the portion of credits) not meeting performance standards do not count toward meeting temperature requirements (Cochran and Logue, 2011).

For trades outside of the Tualatin Program, third party verifiers administered by the Willamette Partnership will monitor credit projects using protocols developed by the Counting on the Environment process.

2.5. Current Status of Programs

Water quality trading programs in Oregon have occurred along an evolutionary gradient from nascent pilot projects to active trading programs.

Just as programmatic, policy, and institutional innovations have occurred within the sphere of water quality trading in Oregon, the role of actors participating in these markets has evolved. This evolution sees intermediary organizations such as The Freshwater Trust and Willamette Partnership set to play a significant role and municipal wastewater treatment plants being less involved in developing entire trading programs in the way that Clean Water Services did. This institutional evolution has occurred as participants learn from the experience of early pilot efforts and expand their core competencies around the logistics of ecosystem services markets.

2.5.1. The Tualatin River Program

The Tualatin river valley has experienced significant urban growth over the last half century resulting in significant impacts to water quality. The temperature trading program is administered by Clean Water Services working with cities and the Tualatin Soil and Water Conservation District to implement riparian forest restoration projects.

Credits are created in the Tualatin by timed releases of cool water from behind a reservoir, planting trees with farmers, and planting trees in urban areas. A full case study of the Clean Water Services program was written in 2011 (Cochran and Logue, 2011). Agricultural landowners participate in the Enhanced Conservation Reserve Enhancement Program (ECREP) and get a fixed price to provide access to their lands for restoration.

Since 2005, the agricultural portion of the Tualatin program has established approximately 23 miles[19] of riparian shade with just over 500,000 native trees and shrubs planted. Based on interviews with Clean Water Services staff, approximately four new projects are enrolled in the trading program annually with an average project size of 10 acres. Criticism voiced during the deployment of the Tualatin River program centered on whether restoration project locations are optimized in terms of providing beneficial shade, rather than relying on opportunities presented by willing landowners. From one interview, there was a perception among some that ambient temperature is not monitored, while others are less comfortable with relying on uncertainty ratios to account for the time lag between when trees are planted and when shade benefits accrue. Another complaint is that riparian shading is not as effective in mitigating temperature impacts as recycling water or using it for irrigation according to one interview.

2.5.2. The Willamette River Basin

Water quality trades have not yet been completed in the Willamette River Basin outside of the Tualatin[20] because of lawsuits against the TMDL. With legal settlements in place, two municipal wastewater utilities are now considering buying credits to meet future temperature requirements. One professional working on wastewater management issues in the central Willamette Valley saw water credits playing a significant role in their compliance within the next five years.

Third party groups like the Willamette Partnership and The Freshwater Trust are likely to play a role, because few of the other utilities have the restoration and regulatory affairs capacity of a Clean Water Services. According to one interviewee, municipalities would not run their own programs like Clean Water Services, but

[19] CWS has paid for a total of around 50 miles, much of which has not gone through ECREP and occurs in an urban setting. In sum CWS has paid to implement around 67 projects since 2004.

[20] Trades have been completed for wetland and salmon habitat credits.

would likely stand back and "*go to The Freshwater Trust and say we need X million kilocalories of credit for Y dollars; go get it for us.*" This is happening in part because the wastewater services community has seen the demonstrated success of Clean Water Services and has witnessed the growth in capacity of the Willamette Partnership and The Freshwater Trust, but also because The Freshwater Trust is willing and able to share a substantial portion of the risk involved.

2.5.3. The Rogue River Basin

In December 2011, Oregon DEQ issued the City of Medford's NPDES permit that allowed for temperature trading. The City of Ashland is also considering trading in its new permit. Both are towns in southern Oregon's Rogue River Basin.

Based on the wasteload allocation for the Medford wastewater treatment plant, the temperature offset needed over the next 10 years is roughly equivalent to 310 million kilocalories worth of shade credits, or roughly 25 – 30 stream miles (Oregon Department of Environmental Quality, 2011). Medford has contracted The Freshwater Trust to recruit landowners and the Trust will make annual lease payments to those landowners in exchange for the right to restore their riparian forests. As of March 2012, the first planting has already garnered favorable attention from President Barack Obama who referred to the Rogue temperature trade during a White House conservation conference on March 02, 2012.[21]

2.6. Future Direction of Trading in the Pacific Northwest

Temperature trading is becoming a standard approach to dealing with wasteload allocations in Oregon. Emerging programs in the Rogue River Basin show promise and the Willamette is likely not far behind.

2.6.1. Nutrient and Sediment Trading

Nutrient trading is being considered in multiple watersheds in Oregon (e.g. Tualatin and Klamath). In the Klamath Basin there is interest among several stakeholders in nutrient trading, as phosphorus is cited as a limiting factor for water quality. However, the current TMDL in the basin is being challenged and the level of potential demand among NPDES permittees

Landowners on Gales Creek generate revenue generating shade credits from the first year after riparian forest planting

[21] http://www.whitehouse.gov/photos-and-video/video/2012/03/02/president-obama-speaks-conference-conservation

remains largely unknown. In addition to nutrients, some treatment plants in Oregon are interested in trading Total Suspended Solids (sediments), and agriculture and forestry interests have also expressed an interest in some Mid-Cost Range watersheds impaired by sedimentation associated with intensive silvicultural operations. If numerical limits for MS4 stormwater permits can be established in the future, urban and suburban growth could become another driver for sediment and nutrient trading.

2.6.2. The Yakima River Basin

The Willamette Partnership is beginning to offer technical assistance to emerging stakeholder processes in Washington State, particularly the Yakima Basin Clean Water Partnership. It started with a point source working group that began discussions about pre-compliance actions that can be taken by point sources. This process is in the early stages of an analysis of supply and demand for temperature credits and is looking into some of the more technical aspects of what would be needed to justify trades. Another issue that will need to be addressed is whether the credit calculation tools developed in western Oregon can be used in the State of Washington, and on the dry side of the Cascade Mountains. Still, the fact that a coalition of actors in an adjacent state are seeking to draw from the knowledge, tools, and experience of the Willamette Partnership is evidence of success. Expansion of the crediting framework beyond water quality, to terrestrial habitats, is another indication of positive growth.

2.7. Conclusion and Recommendations

2.7.1. Key Lessons Learned

The experience with water quality trading in Oregon has yielded significant knowledge gains:

- *Permittees and non-governmental organizations can play a significant role in advancing water quality trading.* The Tualatin River program, which in large part contributed to the development of the Willamette Partnership, is proof that when given the resources to think creatively, permittees are willing and able to find creative and cost-effective solutions that yield ancillary environmental benefits beyond traditional grey infrastructure approaches.

- *Early investments in institutional development are paying off.* Non-governmental organizations like the Willamette Partnership and The Freshwater Trust have emerged as important players in ecosystem services markets nationally and locally and they are helping to drive innovation and efficient deployment of cost-effective non-point source compliance options.

- *Early investments in science are paying off.* Oregon has measured stream temperature for decades. Advances in freshwater ecology, water quality management, and restoration practice are playing out in the field. Stream temperature models are becoming increasingly robust while translating complex science into something that multiple interests can easily understand. Using shade as a surrogate allows for a simple, scientifically rigorous method of calculating the effect on stream ambient temperature of blocking additional solar radiation from warming the water body.

- *Focusing on metrics and environmental goals and using the best available science pays off.* The experience with the Counting on the Environment process has been a success in getting agreement on restoration principles and ultimately restoration protocols. The Counting on the Environment process successfully attained agreement on restoration principles and ultimately restoration protocols. This process is viewed by virtually all market participants as an essential investment needed in order for trading to progress in a meaningful manner.

- *Uncertainty in nonpoint source credits manifests itself as reduced demand for credits in the marketplace.* Reducing or removing the uncertainty associated with nonpoint compliance options has significant value and the costs of removing this uncertainty is a key program design element that can otherwise prove to be prohibitively high. If an organization like The Freshwater Trust exists that can cover the costs of riparian buffer installation upfront with no charge to the buyer until credits are certified, this can go a long way to reducing or removing uncertainty.

- *Creativity and flexibility within the regulatory sector can be essential for outside-of-the-box market-based solutions.* Oregon DEQ has displayed this type of creativity writing trading into permits.

- *It can be beneficial for water quality regulators to discuss trading with stakeholders during development of TMDLs.*

- *There will always be a need to get landowners involved early on in the program development process of any point-nonpoint source trading program.*

2.7.2. Key Challenges

As evidenced throughout this case study, Oregon has proven to be a center of innovation in water quality trading in recent years. Still, challenges to expansion exist:

- *Lack of credit demand can surface for a number of reasons:*

  1. Point sources contesting TMDLs and/or their wasteload allocations, postponing any consideration of trading;

  2. Point source preference for what they perceive to be compliance certainty offered by grey infrastructure options. Even though these options are more expensive, they offer a level of certainty that nonpoint source trading options do not;

  3. Engineering consultants working with point sources on compliance options have a track record in preferring the built option. Engineers are comfortable with steel and concrete and their pay schedule rewards them for supporting these options;

  4. Policy uncertainty for point sources limits trading volume. There is a tension between a need for both clear federal oversight of trading programs and continued innovation at the state policy level that has occurred in places like Oregon. Policy uncertainty in the Clean Water Act has prohibited some point sources (industrial facilities mostly) from considering trading seriously even when the state DEQ has made it clear that it is an acceptable compliance option.

- *Nutrient trading is expected to be more difficult than temperature trading in the Northwest for several reasons.* Two of the most prominent reasons for this are the age of treatment plants and challenges with integrating the complex hydro-geomorphology of the region into the Nutrient Tracking Tool. Older treatment plants facing future upgrades would likely be unwilling to trade with nonpoint sources when they face certain upgrades in the reasonably near future that will likely include enhanced nutrient removal technology capable of meeting wasteload allocations.

- *Tension between riparian shade restoration projects and other restoration actions.* Some of the most effective ways to reduce temperature may be reconnecting streams to floodplains and removing dams, but the science is not available to quantify those actions. The science connecting riparian forests to shade have been written into Oregon TMDLs, making it easiest to trade the benefits of shade. This creates tension among restoration practitioners, planners, trading projects, and conservationists who have a different vision of restoration.

Oregon is now exploring nutrient trades from farms like these

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III. Chesapeake Nutrient Trading Programs Case Study

Eric Sprague, Brian Kittler, Mindy Selman and Sara Walker

3.1. Program Overview

The Chesapeake Bay is the nation's largest estuary. Its watershed stretches across more than 64,000 square miles, encompassing parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia—and the entire District of Columbia. The Bay's ecosystem is incredibly complex, sustaining sizeable fisheries and recreational interests and providing important habitats for a large number of diverse species. This ecosystem also holds significant economic, cultural, and historic value for the region and its residents. However, most of the Bay and many of its tidal tributaries are impaired. The overabundance of sediment and nutrients—in the form of nitrogen and phosphorus—has degraded the Bay's water quality. These pollutants enter the Bay from both point sources (primarily wastewater treatment plants) and from nonpoint sources (primarily run-off from agricultural, urban, and suburban lands) (Chesapeake Bay Program, 2012a).

In 2002, five of the seven Chesapeake Bay jurisdictions—Maryland, Virginia, Pennsylvania, West Virginia, and the District of Columbia—joined an effort to restore ecological functions within the Bay watershed by signing the Chesapeake Bay Water Quality Initiative (WQI). As part of the Water Quality Initiative, each jurisdiction agreed to develop a voluntary Tributary Strategy for its portion of the Bay watershed that would outline steps and goals for achieving agreed-upon pollutant reductions allocated to them for nutrient and sediment loads by 2010, prior to the development of a Total Maximum Daily Load (TMDL) for the Chesapeake Bay by the end of 2010.

Around the same time as the WQI, states began to assess the ability of nutrient trading programs to lower the costs associated with meeting nutrient limits, and to allow for growth under the allocation caps. Virginia, Pennsylvania, and Maryland have all developed trading programs and are substantially relying on them to offset future nutrient loads from new development. This is significant as the Chesapeake Bay Program expects the Bay watershed's population to grow by 3 million people by 2030 (Chesapeake Bay Program, 2012b).

The entire Bay region is now operating under a TMDL that sets pollutant limits at levels necessary to meet water quality standards in the Bay and its tidal rivers. There is some uncertainty on how the TMDL may influence the existing trading programs and whether the TMDL will drive long-term demand for nonpoint source credits.

The three state trading programs are similar in that they are helping facilitate the adoption and maintenance of Chesapeake Bay water quality goals. These programs are also similar in that the volume of trading has been low since program establishment. However, while they share a common goal and a similar level of market activity, they are three separate programs. There is considerable on-going discussion on the merits and ability to harmonize trading program rules and infrastructure.

A heron fishes in the Chesapeake Bay

3.2. Feasibility Assessment

There have been several on-going efforts to assess credit potential in Maryland watersheds. In an interview with the Maryland Department of Agriculture, between 40% and 50% of farms were eligible to trade nutrient credits since their farms were meeting necessary nutrient reduction levels—baseline requirements.

The Pennsylvania Infrastrucure and Investment Authority (PENNVEST), a state administrator of loans to wastewater treatment plants to complete technological upgrades, now requires construction loan applicants to evaluate the costs of credits versus technology upgrades. With water quality trading available as an alternative to meet permit requirements, PENNVEST uses this analysis to determine if construction loans are the best use of their money. A participant in Pennsylvania's water quality trading program noted that in addition to alternative financing for meeting permits, engineers are recommending that treatment plants design plants and plant upgrades to treat wastewater beyond requirements in order to have "credits" available to sell to other plants.

The World Resources Institute has conducted feasibility assessments for each of the Chesapeake Bay states and completed an analysis of supply and demand potential by trading area. General findings for the entire region conclude that depending on the eventual prices of credits, trading has the potential to:

> "Generate new revenue for the agricultural sector and other credit generators at an amount comparable to current levels of annual public funding for agriculture conservation cost-share programs for the Bay; Reduce nitrogen removal costs for some in the wastewater sector by as much as 60 percent; and Save the municipal stormwater sector (the fastest growing source of pollution delivered to the Bay) hundreds of millions of dollars per year." (Jones, Branosky, Selman, & Perez, 2010, p. 2).

3.2.1. Assessing Potential Credit Demand

In each case, NPDES permits are being issued consistent with the Chesapeake Bay TMDL, and those permits are driving demand for nutrient credits.[1] The TMDL, established in 2010, set Bay watershed limits of 185.9 million pounds of nitrogen (a 25% reduction), 12.5 million pounds of phosphorus (a 24% reduction), and 6.45 billion pounds of sediment (a 20% reduction) per year (U.S.EPA, 2010a). As described in Section 10 and Appendix S of the TMDL, one of the underlying assumptions of the TMDL is that all new or increased growth will be offset (U.S.EPA, 2010b). In addition, federal regulations require that NPDES permits be "consistent with the assumptions and requirements of any available waste load allocation."[2] Therefore, the TMDL is one of the significant drivers for the reduction and maintenance (i.e. the offsetting of new sources) of pollutant limits in the Bay watershed.

To assist with pollutant reductions, Maryland, Virginia, and Pennsylvania developed trading and offset programs. These programs provide guidance and facilitate point-to-point and point-to-nonpoint trading for nitrogen and phosphorus. The states have not yet developed guidance to facilitate trading of sediment credits. Virginia provides for trading to meet stormwater pollution loads. Each of the states is also working on programs that will guide and facilitate offsets of new or increased sources of pollutants (e.g. urban development).

3.2.2. Administration

A network of state agencies and third parties administer water quality trading programs in each of the three states. The state agency responsible for implementing the Clean Water Act is the lead agency and the state natural resource departments are involved to various degrees with administering nonpoint source involvement. Third parties can be involved as program administrators, aggregators, verifiers, etc.

Maryland

The Maryland Department of the Environment (MDE) has the authority to establish trading eligibility and requirements for point sources under the NPDES permit process and other regulatory programs. MDE also certifies point-to-point nutrient trades. The State Legislature gave the Maryland Department of Agriculture (MDA) the authority to establish a voluntary nutrient credit certification program, establish its requirements, and suspend or revoke credits.[3]

[1] The TMDL is actually a combination of 92 smaller TMDLs for individual Chesapeake Bay tidal segments (U.S.EPA, 2012).

[2] 40 CFR 122.44.(d)(1)(vii)(B)

[3] Maryland Agriculture Code Annotated, Chapter 447

MDA certifies point-nonpoint source contracts and has authority to inspect installation and performance of credit projects. The state maintains an online Nutrient Trading Tool[4] that assists landowners with credit calculations, finding buyers, and registering credits.

In addition to nutrient trading, Maryland is deciding whether to integrate additional ecosystem service markets. MDA is currently requesting legislative authority to certify agricultural sediment credits. Maryland's Greenhouse Gas Reduction Act of 2009 requires MDA to add or "stack" carbon credit onto its nutrient trading program. The carbon credit component is still being developed, so how it will deal with issues like additionality is unknown.

The costs associated with program and tool development, stakeholder outreach, and administration have been largely funded through USDA NRCS's Conservation Innovation Grant program. The federal grant allows the state to subsidize program administration to avoid fees that would otherwise be applied to transactions to cover programmatic costs. This is being done in an effort to reduce costs for buyers and sellers in order to encourage transactions. In the future, transaction fees will be needed to maintain the trading infrastructure.

Pennsylvania

The Pennsylvania Department of Environmental Protection (DEP) administers the trading and offset program. The agency certifies and registers credits and approves offsets.[5]

Municipalities own many of the wastewater treatment plants in the state and are required to use competitive bidding for any plant upgrades. Credit auctions were designed to meet these requirements. The state's infrastructure financing authority, PENNVEST, was chosen to facilitate credit auctions given its long-term relationship with these local governments and its role in financing infrastructure improvements. Credit transactions can happen outside of PENNVEST auctions, but it is expected that PENNVEST will lower transaction costs for participants and be the primary clearinghouse for credits.

According to PENNVEST, the organization has invested about $100,000 per year to administer the program and run auctions. The organization is collecting fees to offset costs, but state funding is still needed to support the program.

Virginia

Virginia's Department of Environmental Quality currently administers both point-point, point-nonpoint trading and offset programs.[6] Virginia is currently developing new rules that will designate the Department of Conservation and Recreation as the certifying organization for nonpoint source credits and stormwater offsets from new development.[7]

3.3. Credit Quantification Methods

Each state program relies on the scientifically peer-reviewed Chesapeake Bay Program's[8] best management practice (BMP) nutrient removal efficiencies to calculate nonpoint source credits. These BMPs are integrated into state trading tools. Trading ratios are then applied to these practices to compensate for delivery and attenuation, uncertainty in performance, net water quality improvement, and insurance. Some of these trading ratios are directly tied back to the suite of pollution transport and attenuation models that comprise the Chesapeake Bay Watershed Model.

Shenandoah West Virginia - riparian planting (Photo courtesy of Brian Kittler)

[4] The Nutrient Trading Tool combines USDA NRCS's Nutrient Tracking Tool and World Resources Institute's NutrientNet.

[5] 25 Pa. Code § 96.8

[6] §62.1-44.19:12

[7] SB 77 Nutrient credit certification; regulations, Nutrient Trading Act is established, penalty, http://leg1.state.va.us/cgi-bin/legp504.exe?ses=121&typ=bil&val=sb77.

[8] The Chesapeake Bay Program is a federal state partnership administered by the U.S.EPA with participants from across multiple governmental and non-governmental organizations, http://www.chesapeakebay.net/.

3.4. Program Design Elements

3.4.1. Trading Ratios

Delivery
In an effort to account for nutrient and sediment retention as the pollutants make their way toward the Chesapeake Bay, Maryland, Pennsylvania, and Virginia express credits in terms of nutrient loads delivered to the open water Bay (i.e. the mainstem). Trading programs use two delivery ratios: one for the attenuation of pollutants from the edge-of-field into the stream, and a second for the attenuation of nutrients from the field downstream to the Chesapeake Bay. Delivery ratios are derived from the science and modeling tools of the Chesapeake Bay Program.

Uncertainty
Uncertainty ratios compensate for uncertainty about the actual reductions that are achieved through implementation of a BMP. Pennsylvania does not apply an uncertainty ratio. Virginia uses a 2:1 uncertainty ratio (meaning that a point source must purchase two pounds of nutrients for every pound of nutrients they need for compliance). Maryland uses no uncertainty ratios for BMPs approved by the Chesapeake Bay Program, and reserves the right to apply an uncertainty ratio for practices under review.

Other Ratios
Pennsylvania imposes a 10% reserve ratio on all certified credits. The reserve ratio is meant to generate a state-held reserve of credits that can be drawn upon by regulated point sources in extreme circumstances. Maryland imposes a 10% retirement ratio on nonpoint source credits in order to provide net water quality benefits (Selman, Sprague, Walker, & Kittler, 2010). As part of Virginia's plan to expand the use of nonpoint source credit trading, five percent of all registered credits will be retired (Secretary of Natural Resources, Commonwealth of Virginia, 2012).

The Chesapeake Bay Program manages the adoption and revision of BMPs and nutrient removal efficiencies through a workgroup process. In 2008, the Chesapeake Bay Program revised the pollutant removal efficiencies for several BMPs. BMPs undergo a technical review using studies based inside and outside of the Bay watershed. The resulting studies were then assessed in a consistent manner and efficiency estimates were agreed upon for each practice by the relevant Chesapeake Bay Program workgroups (Simpson & Weammert, 2009).

Table 3.4.1. Trading Ratios in Chesapeake Bay Trading Programs (Branosky et al., 2011; Secretary of Natural Resources, Commonwealth of Virginia, 2012)

Type	Maryland	Pennsylvania	Virginia
Delivery	Provided by Chesapeake Bay Watershed Model		
Edge of segment	Provided by Chesapeake Bay Watershed Model		
Reserve	None	10% of all certified credits	None
Retirement	5% for point source-generated credits and 10% for nonpoint source generated credits	None	5% of certified credits
Uncertainty	10%; Greater for nonpoint source credits generated by BMPs not approved by the Chesapeake Bay Program	None	For every one pound of pollutant offset required, buyers must purchase two pounds of the same pollutant

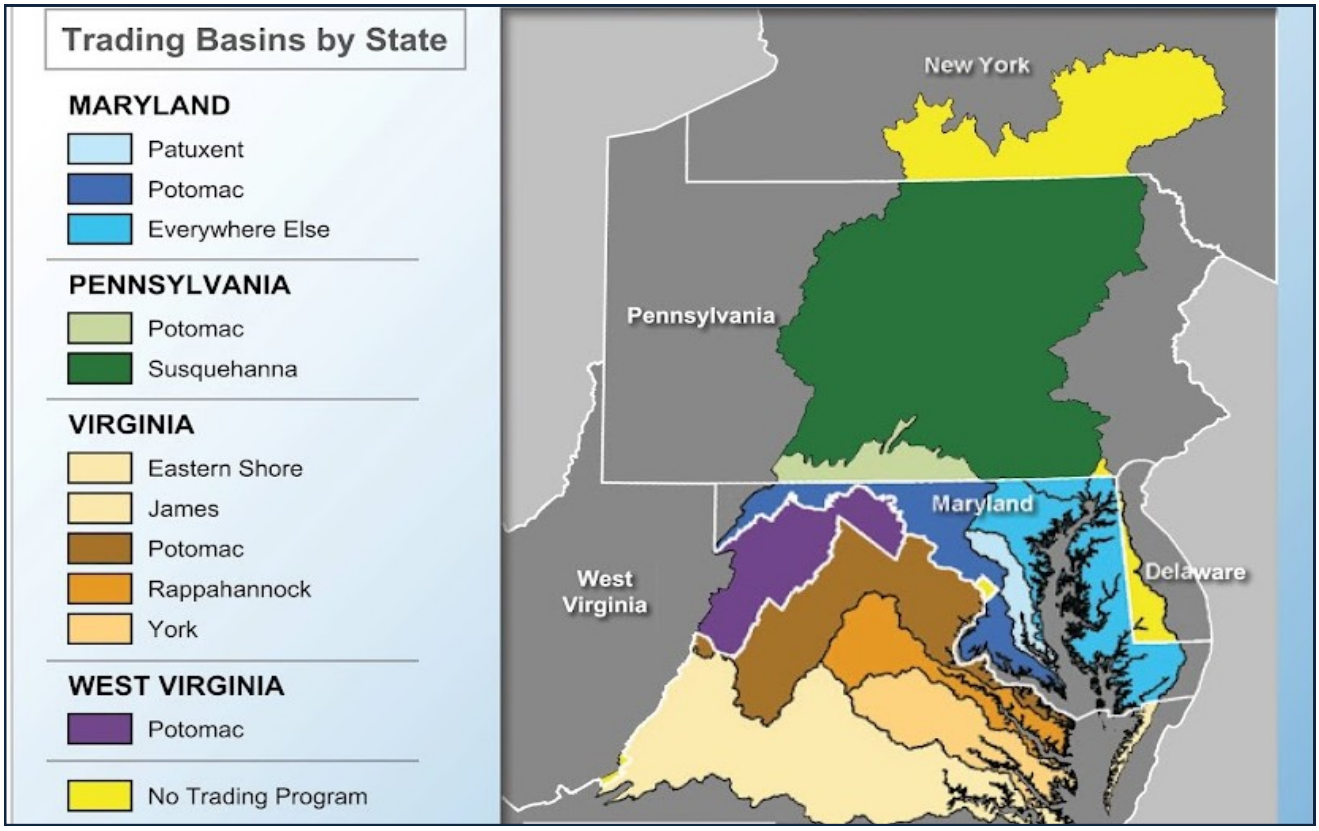

Figure 3.4.2. Chesapeake Trading Basins (Courtesy of Pinchot Institute)

3.4.2. Trading Areas

Each state has established geographic trading areas that define where trades can occur (see Figure 3.4.2.). Maryland and Pennsylvania have stated that interstate trading within shared river basins will be allowed (e.g. trading between Maryland's Potomac basin and Pennsylvania's Potomac basin).

Virginia has also specified that it will allow the Blue Plains wastewater treatment plant, located in the District of Columbia, to trade in Virginia's Potomac basin. Some inter-basin trading is being piloted between the Potomac and Susquehanna River Basins. The trading areas are based on the major tributaries, except for one portion of Maryland where trading is a combination of the Susquehanna and multiple Eastern Shore basins.

3.4.3. Participant Eligibility

In Maryland and Virginia, point sources can trade with nonpoint sources to offset new and expanding sources of pollutants, but cannot trade to meet TMDL wasteload allocations. In Pennsylvania, point sources can trade amongst each other or with nonpoint sources to meet NPDES permit limits.

Virginia requires that point sources acquire credits through a public or private entity working on behalf of a landowner (e.g. conservation districts, private brokers, etc.). Maryland and Pennsylvania do not have this restriction, but given the complexities and risk involved in transactions, these third party entities will likely be the primary sellers on the supply-side.

3.4.4. Practice Eligibility

Owners and/or operators of agricultural operations have several options for generating nutrient credits. These range from implementing cover crops to installing riparian forest buffers.

Virginia has a select set of practices that can generate credits:

- Implementing a Soil Conservation Plan with a Continuous No-Till practice;
- Implementing a Nutrient Management Plan with a 15% enhanced nitrogen removal rate from corn crops;
- Increasing the size of the minimum 35-foot livestock stream exclusion;
- Increasing the size of the required 35-foot riparian buffer; and
- Converting land to less intensive use.

One stakeholder of the Virginia's nutrient trading program expressed that future credit projects to offset MS4 stormwater loads could result in substantial funding being made available for converting marginally productive agricultural and abandoned land to forests.

Maryland's trading program restricts land conversion projects to only minimal conversion of marginal agricultural land under a state goal to support working farms. To maintain flexibility, no thresholds or guidance on what constitutes "minimal conversion" exists.

3.4.5. Baseline and Additionality

Before a farmer can generate a nutrient credit, farmers need to have already established a level of nutrient reductions as described in individual states' trading policies and be compliant with other requirements. These "baselines" were originally set in each tributary strategy, but now are being adapted to the levels necessary to meet the TMDL. The development and use of baselines in nutrient trading is based on U.S.EPA policy and guidance (U.S.EPA, 2003). Agricultural baseline requirements describe the minimum set of practices that must be in place, or the minimum performance that must be achieved, in order to qualify to participate in the water quality trading program. Once baseline requirements have been met, the farmer may sell any nutrient reductions that go beyond those required by the baseline.

Maryland and Virginia baseline requirements are equal to the TMDL requirements for agriculture. For Maryland, the agricultural baseline requirement is expressed as a per-acre nitrogen and phosphorus load that must be achieved before generating credits. Virginia's baseline requirements are described as a minimum set of practices that must be implemented on the farm.

Pennsylvania defines baseline as meeting regulatory requirements, which includes having a Nutrient Management, Manure, Conservation, and/or Sediment and Erosion plan. Before generating credits, farms must also meet a "threshold" of a 100-ft setback of farming from streams, a 35-foot buffer, or a 20% reduction in nutrient loads. Pennsylvania and U.S.EPA are currently determining how the Pennsylvania baseline may need to be modified to meet the TMDL (U.S.EPA, 2011).

Beyond the use of baselines to ensure additionality, the states differ in their approaches to allowing public cost-share financing to generate credits. In Maryland and Virginia, costshare can be used to achieve baseline requirements, but cannot be used to generate credits. In Pennsylvania, unless the Department of Environmental Protection has expressly prohibited the use, government portions of costshare can be used to generate credits. There is some question to whether this feature will stand under scrutiny from the U.S.EPA given the additionality concerns. One Pennsylvania aggregator will not use cost-share funding for fear of lawsuits down the road.

Table 3.4.4. Selected agricultural best management practices' nutrient and sediment reduction efficiencies (Selman et al., 2010)

BMP	Nitrogen	Phosphorus	Sediment
Riparian Forest Buffers	Land use conversion credit[§] AND 19%-65% reduction in N loads from 4 upland acres (efficiency based on geographic region).	Land use conversion credit AND 30%-45% reduction in P load from 2 upland acres (efficiency based on geographic region).	Land use conversion credit AND 40%-60% reduction in P load from 2 upland acres (efficiency based on geographic region).
Continuous No-Till	10% (above fall line) 15% (below fall line) (from existing load)	20% (above fall line) 40% (below fall line) (from existing load)	70% (above fall line) 70% (below fall line) (from existing load)
Streambank Fencing (with off-stream watering)	Land use conversion credit	Land use conversion credit	Land use conversion credit
Animal Waste Management Systems (Poultry)	75% (from existing feedlot load)	75% (from existing feedlot load)	N/A

*Chesapeake Bay Program Watershed Model Efficiencies, 2/9/2011

[§]The land use conversion benefit assumes the land use changes from cropland to forest. In addition, this land is credited with the ability to treat an upland area four times its size.

Table 3.4.5. Current State Baseline Requirements for Agriculture (Selman et al., 2010)

State	Agricultural Baseline Requirements
PA	To meet baseline, farmers must have a Nutrient Management, Manure, Conservation, and/or Sediment and Erosion Plan. They must also meet a threshold of having one of the following prior to generating credits: • setback of farming or manure application within 100 feet of surface water; • installation of a 35-foot, permanent vegetated buffer between the field and surface water; or • a reduction of 20% in the farm's overall nutrient load beyond baseline compliance. • There are no surface waters on or within 100 feet of the farm.
VA	To meet baseline, farmers must implement the following best management practices that are applicable to their operation: • soil conservation plan; • implemented nutrient management plan (i.e. site-specific plan that guides farmers in the proper application of fertilizer, manure, and sewage sludge); • cover crops (late planting); • stream bank fencing with a minimum 35 foot set-back (pasture only); and • 35 foot vegetated riparian buffers.
MD	To meet baseline, farmers must achieve modeled TMDL nitrogen and phosphorus load levels for agricultural land. These loads will vary by trading area (e.g. the nitrogen baseline in the Potomac Basin is 11.1 pounds per acre per year).

3.4.6. Verification and Certification

After receiving an application for credit verification, the Maryland Department of Agriculture (MDA) reviews applications to ensure:

- baseline requirements are met;
- credit calculations are correct;
- conservation compliance requirements are met;
- credit-generation proposal is reasonable;
- the landowner/operator has consented to generating credits; and
- necessary USDA/Farm Service agency tract information has been provided.

As part of the verification review process, MDA may conduct a field visit to ensure baseline requirements have been met and the credit proposal is reasonable. Following verification, credits in Maryland are certified and given a unique identification number and stored in its registry (see below). Buyers can view available credits on the state's Nutrient Trading Tool and then purchase credits with landowners through a private contract. Before the Department of the Environment approves credits as part of a permit, the practices must be installed.

In Maryland, third parties[9] inspect implemented practices like cover crops twice a year and structural BMPs like riparian buffers once a year. The Maryland Department of Agriculture, through its soil conservation district (SCD) offices, spot checks 10 percent of all traded credits each year (Maryland Department of Agriculture, 2012). MDA is considering creating an accreditation process for verifiers. If the buyer is an NPDES facility, the Maryland Department of Environment has the right to verify the practice.

The credit issuance process begins similarly in Pennsylvania as a farmer submits their baseline determination, credit calculations, and technical plans to the Department of Environmental Protection (DEP) for review. Additionally, a 30-day public comment period accompanies any application (Pennsylvania Department of Environmental Protection, 2012).

BMPs must be verified before any credits are registered by the agency. Verification requires demonstration that the pollutant reduction activity was implemented as described in the verification request form and that other requirements are met (e.g. baseline requirements). BMPs can be verified by the project implementer, third party, or by DEP as appropriate (Pennsylvania Department of Environmental Protection, 2012).

Pennsylvania and Maryland both certify the credits for a 5-year timeframe and those credits are used by a treatment facility toward annual compliance. The credits have to be verified each year. At the end of the term, the sellers must reapply for renewal of their credits. In Virginia, credits are reverified each year on the basis of information provided in annual maintenance reports.

In all states, buyers retain rights to credits throughout the 5-year contract with sellers. If laws, policies, or scientific understanding changes during a contract period, credits are grandfathered for the contract period.

3.4.7. Registration

Both Maryland and Pennsylvania maintain credit registries and Virginia's is underdevelopment. Maryland tracks traded and retired nonpoint credits through their online nutrient trading tool. All nonpoint source credits have their own registration number that is unique to the farm since each farm can have several different practices. Pennsylvania's DEP tracks contract information in a central spreadsheet and PENNVEST is working with Markit Environmental Registry to provide registry services for its credit auctions. Discussion is underway between DEP and PENNVEST on how formally to link the two registries.

[9] Third parties can be soil conservation districts, certified crop advisors, USDA NRCS technical service providers, and professional engineers.

3.4.8 Trading Infrastructure

Maryland and Pennsylvania have both invested heavily in nonpoint trading infrastructure in order to ease adoption by buyers and sellers.

Maryland's online NTT facilitates and tracks multiple aspects of a nutrient trade, from a baseline assessment of an agricultural property, to the generation of credits, to facilitating transactions. The states expect that the tool will ease the credit development process and lower transaction costs by:

- enabling practice planning and scenario testing;
- pre-loading credit calculation methodologies, Chesapeake Bay Program practice efficiencies, and other required data sets;
- estimating progress toward meeting nutrient baselines;
- easing credit verification process; and
- hosting an online marketplace that provides credit listings for potential buyers.

Pennsylvania Department of Environmental Protection (DEP) operates a similar trading tool to Maryland's, but according to one stakeholder interviewed for this report it includes an older version of the Chesapeake Bay Watershed Model and is not currently being used. The state is working to update the tool and expects that it will be an important part of their program in the future.

DEP's tool does not include a formal marketplace like Maryland's Nutrient Trading Tool. Instead, PENNVEST runs the Nutrient Credit Clearinghouse in partnership with Pennsylvania DEP and holds multiple credit auctions throughout the year. In addition to providing the clearinghouse function, PENNVEST removes some of the risk of participating in the trading program by providing guaranteed credits at known prices over multiple years. PENNVEST provides the credits to purchasers even if the original credit generator is unable to produce credits, or sufficient credits.

Maryland and Pennsylvania's tools are built off the World Resources Institute's NutrientNet. Maryland's version is currently being enhanced with USDA's Nutrient Tracking Tool (NTT). NTT will serve as the primary credit calculator. Through a USDA NRCS Conservation Innovation Grant, WRI is now developing a single NutrientNet/NTT platform for the entire region. There have been other tools developed to assist farmers with assessing progress toward baseline and evaluating nutrient credit scenarios (notably, Water Stewardship, Inc's Nutrient Load Estimator), but Maryland requires users to use the Nutrient Trading Tool or its underlying credit methodologies.

The Pinchot Institute for Conservation operates a credit development tool for the Chesapeake region, Ecosystem Crediting Platform. The tool facilitates the credit development process (i.e. credit scenario testing, verification, certification, registration, and monitoring) for forest mitigation credits and voluntary habitat conservation credits. Pinchot Institute is seeking to integrate this platform with the nutrient trading tools.

3.5. Current Status of Programs

All three programs are currently functional. Pennsylvania has more than 3 million certified nutrient credits that are ready to be sold to treatment facilities. The state is tracking 11 contracts and during the "true up" period in 2011, 13 facilities purchased credits to meet their permit limits. Aggregators interviewed for this report noted that credit prices are low at this time ranging from $3.00 to $6.00 per pound of nutrients per year.

In Maryland, one aggregator has thousands of certified credits ready for sale. At this point, no transactions have occurred, so it remains to be seen what credits will be worth. The aggregator expects the price to be between $50-80 per pound of nitrogen.

Point to nonpoint source trades in Virginia have not occurred due to a lack of demand. This will likely change as the state develops guidance to accommodate new development and increased loads through an offset program. Stormwater offsets for phosphorus reductions have been transacted and they are quite expensive—selling for around $20,000 per pound according to one interviewee. The Department of Conservation and Recreation require offsets to be protected with permanent easements.

3.6. Conclusion and Recommendations

3.6.1. Key Challenges

A new strategy
Despite being seen as national models for nutrient trading, the state programs are still new strategies in the overall Chesapeake Bay restoration effort. Landowners, state employees, extension offices, regulated entities, environmental groups, and other stakeholders are still becoming comfortable with the concept. This healthy skepticism is layered with decades of Chesapeake Bay politics.

Similarly, wastewater treatment plants and other regulated entities have a long history of relying on technological upgrades to meet new requirements. Obtaining offsets, particularly nonpoint source offsets, to meet permit requirements is something entirely different. A key component to this is that regulated sources are liable even if a landowner's actions degrade the pollutant removal of a practice. This puts substantial risk on a buyer.

According to interviews with Maryland stakeholders, agricultural landowners have been hesitant to sell credits that let urban/suburban sources of pollution continue to pollute.

Baselines and accountability
For a landowner to be eligible to generate nutrient credits, their farm must achieve a baseline level of nutrient reductions. Establishing this baseline has been a contentious process and is implemented differently in each state program (see Table 3.4.5. above). Practice-based baselines as used in Virginia are easy to communicate to landowners and implement. The ability of a core set of practices to prevent nutrients from entering waterways can vary widely, though, so market participants will not always know the environmental outcomes of a project. Performance-based baselines like those used in Maryland can offer better certainty on the environmental outcomes of credit projects, yet interviews showed that enhanced accounting of nutrient pollution on private lands may trouble some farmers.

3.6.2. Key Lessons Learned

Nutrient trading program design and policy objectives greatly influence the ability of trading to generate cost-effective water quality improvements
Maryland is the only state program that does not allow some form of trading for point sources to meet regulatory limits, outside of that associated with new growth. The state instituted a "flush tax" on residents to finance upgrades to wastewater treatment plants' pollution removal technology. This strategy has certainly been good for the Bay, but has restricted potential credit demand and, perhaps, led to less cost-effective nutrient reductions.

Pennsylvania made a policy decision with similar effects in that it allowed wastewater treatment plants planning to upgrade technology to come into compliance by submitting a construction schedule even though the water quality benefits were years off. According to one market participant, if the state had required offsets during the construction process, demand for nonpoint source credits would have increased and at the same time would have given plants time to become familiar with trading program.

Additionally, program requirements can drive unexpected credit projects. Of the credit transactions completed in Pennsylvania, most were generated using "manure transport" out of the watershed to a nitrogen-limited region. A local aggregator had hopes of primarily implementing land restoration projects, but verification costs were too high. Right now, despite not being the most ecologically valuable practice, manure transport is the easiest credit-eligible practice for aggregators to "pencil out." Interviewees also expressed concern that there is not enough monitoring post-manure transport to determine if commercial fertilizers have replaced the manure and reduced net water quality benefits.

Incorporate a phased baseline to allow for nonpoint source nutrient credit supply
While demand for credits in the Bay states will be relatively strong in the coming years, supply of nonpoint credits will be limited by high baseline requirements. To comply with a TMDL, nutrient trading programs must set agricultural baselines at a level that satisfies the agricultural sector's TMDL

allocation. These high baselines will affect credit supplies in two ways:

- fewer farmers, at the outset, will qualify to generate credits because many farmers will not be able to afford the practices necessary to meet baseline requirements; and
- those farmers that have met baseline will likely have implemented the easy and inexpensive practices to achieve them. Therefore, any potential reductions that can be achieved beyond TMDL obligations will be more difficult and/or relatively more expensive to attain.

Development of a phased baseline would allow farmers to trade credits above a certain percentage of the baseline for a limited time. For example, once a landowner has achieved greater than 40% of the nutrient reductions needed to meet the TMDL a landowner can trade 40% of their full baseline credit potential. The landowner could continue to trade at various levels of baseline implementation until the landowner has reached 100% of their requirements.

Tools offer potential to lower transaction costs
Transaction costs are a significant barrier to market activity. They can account for upwards of 50 percent of the total price of the credit, with the majority of transaction costs associated with educating buyers and sellers (Selman et al., 2010). Given the light trading volume over the past few years, it is difficult to determine how helpful tools such as Maryland's Nutrient Trading Tool have been in reducing transaction costs for participants. States and other stakeholders do believe that benefits will develop over time as they help to educate market participants and facilitate transactions.

Movement to permanent offsets for new development
The duration of credits varies among the three state programs. Pennsylvania does not require anything beyond an annual contract, Maryland has a five year minimum and Virginia's nutrient trading program requires stormwater offsets for new development to be protected in perpetuity since the new loads are, in effect, perpetual. A regional credit aggregator believes that any new development will want "to make one payment and be done with it" so there are no lingering obligations. Maryland officials envision that they too will transition to permanent offsets to offset new growth given these issues.

Encourage regulated entities to assess the costs and benefits of purchasing credits versus new technology
PENNVEST requires any construction loan applicant to conduct a cost-benefit analysis to make informed decisions about which option (credit purchase or facility upgrades) might be the most cost-effective choice. Other state programs can offer similar requirements or assistance.

There are a number of wastewater treatment plants in small Pennsylvania municipalities that are operated by volunteer boards. This lack of capacity limits the consideration of strategies like nutrient offsets. Targeted technical assistance could be a valuable addition to trading programs that face similar conditions.

Potomac River Headwaters, West Virginia (photo courtesy of Brian Kittler)

Harmonize state requirements to better facilitate interstate trading

There is some debate on the merits of interstate trading at this point in the development of Chesapeake nutrient markets, but in the future it could:

- provide more certainty to a jurisdiction's ability to accommodate planned growth;
- help create a level playing field among the states for growth;
- minimize jurisdictional inequalities due to differing rules and requirements among the states;
- make the cheapest credits in the Bay watershed available to all buyers, not just those in a restricted geographical area;
- increase competition among credit sellers, leading to lower credit prices;
- preclude credit monopolies or artificially restricted supplies;
- create additional opportunities for generating credits; and
- produce a more stable and reliable supply of credits.

Yet, interstate trading is hindered by a number of factors including differing methods of establishing baselines, verification procedures, eligible practices and local resistance to dollars being spent outside of their jurisdiction.

The U.S.EPA recently assessed the trading and offset programs of the states in the Chesapeake Bay watershed (U.S.EPA, 2011). The results of that assessment have helped clarify the U.S.EPA's perception of the programs, but potential buyers and sellers are still wary of getting involved if there is a chance that the U.S.EPA may invalidate credits in the future. The states have been busy implementing the TMDL and their watershed implementation plans. Given this work load, the role of trading and offset programs has not been at the forefront.

Many stakeholders have expressed desire for a more formal opinion on the state programs from U.S.EPA. Additionally, some have expressed an interest in developing a common "exchange rate" to better evaluate the relative value of credits in different states. Consensus is that the U.S.EPA will need to support the outcome of this process.

In 2009, President Obama issued Executive Order (EO) 13508 aimed at accelerating and targeting investments in Bay restoration and calling for bold new approaches to demonstrate progress (Federal Leadership Committee for the Chesapeake Bay, 2010). The EO Strategy identified environmental markets as an emerging innovative tool for facilitating restoration of the Chesapeake Bay and its watershed. This initiative could help raise the prominence of these issues.

Focus on developing performance-based and adaptive trading programs

It is important that credit buyers know what they are paying for, especially when nutrient credits are directly written into permits. Performance-based programs do this by focusing on the per-pound cost of nutrient reductions and not just expected outcomes of practices.

As discussed above, the on-the-ground effects of practices can vary widely depending on the size of farm, location, etc. A practice-based program could be enhanced if it included more regular feedback on the performance of specific practices in specific places. This program would require a more adaptive management approach than is currently used.

The state nutrient trading programs all base nutrient reductions off the BMP removal efficiencies included in the Chesapeake Bay Program Watershed Model. The Chesapeake Bay Program reviews and updates practices periodically. This region-wide scrutiny of practice efficiencies is a built-in advantage for state programs.

However, the Chesapeake Bay Watershed Model is not designed for the agricultural field scale where practices are implemented and credits generated. NutrientNet helps to model field scale effects of different practices. However, these are still modeled interactions and not based on outcomes. Integrating an adaptive management approach will help use nutrient trading to finance water quality improvements while including the best available and most local information.

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