A Survey of Trading Ratios Used for Generation of Credits in Water Quality Trading Programs

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Summary

The table below compiles information about trading ratios used in water pollution credit trading programs currently in effect or in development by states and other entities. The table focuses on the different numerical ratios used, as well as the different purposes for those ratios. A few initial comments are warranted to clarify the different formats trading ratios can take and the different purposes for those ratios.

For example, Virginia currently uses a 2:1 ratio for trades when a point source purchases offsets from a nonpoint source.[1] That ratio is intended to account for the uncertainty and variability of the effectiveness of practices used to generate offsets, which currently means best management practices (BMPs) installed on farms, and to address potential environmental uncertainty (such as severe weather conditions) and implementation issues. To safeguard against the possibility of overestimating the effectiveness of BMPs, and to account for the potential that nonpoint source reductions will lack parity with measurable, technological modifications by point sources, Virginia requires that purchasers buy twice as many pounds of offsets from a qualifying nonpoint source trader than the purchaser is seeking to discharge from their facility. This is not, however, the only ratio used in the Virginia program. Virginia also uses geographic delivery factors, based on EPA's Chesapeake Bay computer model, to account for the locations of the two trading partners, whether upstream or down, and their relative contributions to nutrient pollution problems in the Chesapeake Bay.[2]

Both of these factors (uncertainty and geographic separation) are included in the trading ratios used in other jurisdictions. Some jurisdictions, however, do not as clearly delineate the

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[1] 9 VA ADMIN. CODE § 25-820-70 (II)(B)(1)(b), (2012).

[2] Id.

various rationales for using one or more trading ratios. Some programs use ratios to deal with geographic differences, some use them to deal with the uncertainty of nonpoint source reductions, and some combine these purposes together in a single ratio designed to ensure that trading programs will be successful in achieving water quality goals. Further, some do not assign a program-wide numerical ratio at all. Those programs evaluate each potential trade on a case-by-case basis to determine the commensurate level of offsets to be generated. The table below includes examples of all of these purposes.

The table presents information on the various state programs that use trading ratios, as well as some programs that are currently developing trading programs and discussing the use of trading ratios. While the table offers considerable information, the format obviously does not allow for an exhaustive explanation of the various considerations that guide each trading program. These motivations are presented in the table's "Type of Ratio" column. Often more than one rationale is discussed in the state's trading program literature; the "Type of Ratio" column attempts to describe, where possible, which rationales are controlling, whether the program uses separate ratios for each rationale, and whether and in what manner rationales are combined to arrive at a particular numerical trading ratio. As illustrated below, these motivations are often combined with one another to create, in some instances, complicated trading schemes for nutrient credits. All of the nuances of these ratios cannot be fully presented in a simplified table.

We used several sources to gather the information contained in this table, including the EPA's Water Quality Trading website,[3] state program websites, and a number of studies and

[3] *Water Quality Trading Toolkit for Permit Writers*, U.S. Environmental Protection Agency, Office of Wastewater Management (published August 2007, last updated June 2009), *available at* http://water.epa.gov/type/watersheds/trading/WQTToolkit.cfm.

analytical articles on trading programs, cited more specifically where applicable below. The University of Pennsylvania's Institute for Environmental Studies compiled an earlier summary of existing trading programs in 2006. In compiling the table below, we have referred to, updated, and expanded upon the information contained in that summary wherever possible.[4] Additional resources regarding trading programs across the country can be located on the Environmental Trading Network website.[5] Some of the information on the number of trades that have taken place, contained in the last column of the table, was obtained from the June 2009 update of the Water Quality Trading Toolkit for Permit Writers, issued by EPA.[6] Although many of these sources are somewhat dated, the trading ratios and basic structures of most of the programs remain intact since this 2009 update. Any blank cell in the table below indicates that there was not enough information in available sources to determine the missing data.

Summary Observations

There are several key points that emerge from the table below. First, uncertainty ratios are meant to ensure that a specific and certain level of reductions required from a point source are offset with a commensurate level of reductions from practices where reductions are uncertain; may vary with weather, topography, and soil types; and are difficult to monitor.

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[4] Institute for Environmental Studies, University of Pennsylvania, *Water Quality Trading in the Lower Delaware River Basin: A Resource for Practitioners*, A Report to the William Penn Foundation (March 1, 2006), *available at* www.wr.udel.edu/publications/ChristinaBasin/Final%20WQT%20Report_27Feb06.pdf. (Copies located with publishing dates for both 2005 and 2006). *See* Table 2-7: Trading Ratios for Existing Water Quality Trading Programs; Table 2-8: Considerations for the Development of Trading Ratios.

[5] Environmental Trading Network, www.envtn.org/Home.html (last visited July 20, 2012).

[6] EPA has not issued a similarly comprehensive trade summary since 2009, but these numbers can serve as an indicator of the relative level of trading activity in these programs. A subsequent memo will address the current extent of trading within the nation's nutrient trading programs.

Uncertainty ratios should be distinguished from retirement credits, reserves, or other net improvement credits that are intended not just to offset a particular source, but also to provide some net improvement in water quality. Second, the 2:1 ratio used for point/nonpoint trades in Virginia, while perceived as being at the higher end of the range of ratios used by Chesapeake Bay states, is certainly in line with many other nation-wide programs.[7] Third, many programs with trading ratios that are, on their face, lower than 2:1, in fact have design elements in place that may make the actual ratio higher or account for uncertainty in other ways. Other aspects of the design of many trading programs, including the pricing of offset payments, retirement ratios, conservative assumptions about BMP performance, and closer evaluation and monitoring of individual offset transactions, mean that, in effect, many jurisdictions with lower ratios cannot be compared directly to Virginia's ratio. Fourth, some trading programs that use less conservative ratios indicate that they have relied on other safeguards built into the program, such as conservative estimates in the models used to calculate nutrient loading and BMP effectiveness. Some programs have thus taken the position that imposing an explicit 2:1 trading ratio in some instances could result in 'double-counting' uncertainties when dealing with nonpoint source pollution reductions. If a particular program is cited as having a less conservative ratio than Virginia's 2:1 ratio, it is important to look at the program details more closely to confirm the degree to which the program creates margins for uncertainty elsewhere in the design of the program.

[7] Morgan and Wolverton, *Water Quality Trading in the United States*, National Center for Environmental Economics (NCEE) Working Paper Series (June 2005).

TABLE 1 - Trading Ratios in use Nationwide

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Arizona Pinto Creek – Carlota Copper Co. Permit	Not named	Safety margins built into TMDL to account for uncertainty; values of offsets depend on the location of certain target sites along the creek.	Carlota Copper Company obtained offsets from its waste load allocation for remediating an upstream abandoned mine.	Copper	
Colorado Dillon Reservoir	2:1	Uncertainty and margin of safety.	The nation's first-established trading program uses the 2 to 1 ratio for uncertainty and to provide a margin of environmental safety.	Phosphorus	At least two trades by point sources to offset new discharges.
Chatfield Reservoir	2:1	Not specified, but likely a qualitative or uncertainty-based safeguard.	Applicants can request an exemption from the 2:1 ratio based on adequate water quality data to demonstrate better actual reductions.	Phosphorus	
Cherry Creek Watershed	1:1 (last published)		The Cherry Creek program also required a 50% reduction in phosphorus loadings before any trades could take place.[8]	Phosphorus	
Bear Creek	2:1	Not Specified.		Phosphorus	

[8] David Letson, *Point/Nonpoint Source Trading: An Interpretive Survey*, telephone interview with Cherry Creek Basin Authority (1991). The official website information on Cherry Creek trading seems to have been taken down, and the Watershed Plan is currently under review and unavailable.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Connecticut Long Island Sound (Nitrogen Credit Exchange)	Varying ratios are used for trades between point sources, derived from attenuation models. Point to nonpoint source trades may be included in further program development, and would be assessed case-by-case; no set ratio is assigned.	Point source trading ratios are based on location. Nonpoint trades may be adjusted for uncertainty.	The NCE does not include nonpoint sources as generators of offsets, but state legislation allows for future implementation of nonpoint source sales of credits, conditional on the reductions being measurable and continuous. If compliance with the baseline, monitoring, and substantiation are not available, an "equivalency factor" may be adopted to allow the particular trade (on a case-by-case basis).	Nitrogen	
Delaware Pinnacle (Vlasic Foods)	2:1 (2008 regulations require at least this ratio).	Margin of safety and location.	EPA describes a trade wherein Vlasic purchased offsets from a cornfield replanted with reed grass.	Unspecified Nutrients	At least 1
Inland Bays (Indian River, Indian River Bay, Rehoboth Bay, and Little Assawoman Bay Watersheds)	2:1	Not specified.	Trades of nonpoint source credits require first achieving baseline reductions and meeting TMDL requirements for the point sources involved in the trade, and trades are limited geographically by watershed.	Nitrogen, Phosphorus	

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Florida Lower St. Johns River (statewide guidance)	2:1 3:1 Varying (0.01 – 1.7)	Uncertainty Location	Florida's proposed rules list these ratios for urban stormwater and agricultural runoff, respectively, as sources of offsets for trade. Lower, site-specific uncertainty factors may be assigned if reliable scientific information calls either of the default ratios into question.[9] Location ratios are applied in the offset formula depending on the discharge locations of the buyer and seller.	Nitrogen, Phosphorus	
Lake Okeechobee Watershed (Florida Ranchlands Environmental Service Project)	N/A	N/A	The FRESP (funded by various governmental and nonprofit organizations) has run a 5 year pilot program to test the merits of a pay-for-services program – buying phosphorus reduction and wetland construction from farmers. Ratios are not yet in use.	Phosphorus	
Georgia Lake Allatoona	Not yet determined.	Uncertainty and location.	A research project was proposed to determine the appropriate parameters for a trading program in this Georgia lake – we could find no further information about implementation.	Phosphorus	

[9] Florida Department of Environmental Protection, *The Pilot Water Quality Credit Trading Program for the Lower St. Johns River: A Report to the Governor and Legislature* (October 2010), *available at* www.dep.state.fl.us/water/wqssp/docs/WaterQualityCreditReport-101410.pdf.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Idaho Lower Boise River	Varied See **Table 2**, below	Uncertainty and BMP effectiveness.[10] Water body location also considered.	Statewide guidance requires consideration of both uncertainty and BMP effectiveness, specific to the nature of the pollutant and water bodies involved in trading.	Phosphorus	0
Bear River Watershed	Not yet determined.	Delivery/Location	A water quality trading feasibility study was conducted for the Bear River, but a final program has not yet been implemented.	Phosphorus	
Upper Snake Rock Watershed	Varied	Not specified.	NPDES permit includes a general trading provision that must comply with Idaho's guidance, which suggests but does not set any particular trading ratio.	Phosphorus	
Illinois Big Bureau Creek Watershed	Not yet determined.	Not yet determined.	A 2009-2012 water quality trading feasibility study is being conducted, examining wetland construction and other nonpoint source reductions.	Nitrogen, phosphorus, sediment.	
Piasa Creek Watershed	2:1	Uncertainty, margin of environmental safety.	Modelers found that 1.5:1 was sufficient for conservation needs, but imposed a stricter ratio for a margin of safety. The Great Rivers Land Trust acts as broker for trades.	Sediment	

[10] In addition to the named effectiveness and uncertainty discounts for each Best Management Practice used to generate credits for nonpoint sources, Idaho also applies certain location ratios, derived to estimate each source's relative contribution to the Lower Boise River. *Toolkit*, EPA (Appendix A); CH2M Hill, *Water Quality Credit Trading: Experiences Around the Country*, presented at Nutrient Trading Training Workshop, Helena, Montana (April 13, 2011) (PowerPoint).

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Maryland	1:1[11]	Uncertainty	Maryland credits approved BMPs with known load reductions, but requires technical review for unapproved BMPs as well as other innovative BMPs on a case-by-case basis. These credited reductions likely take into account effectiveness and uncertainty to some extent.	Nitrogen, Phosphorus	
Massachusetts Wayland Business Center	3:1	Economic (based on the relatively low cost of other nonpoint source controls).	New point sources must offset their loads by linking properties with faulty septic systems to the required WWTP.	Phosphorus	
Michigan Kalamazoo Trading Pilot Program	2.1 default With a range of additional effectiveness ratios from 1.1:1 – 4:1.	Uncertainty These apply when evidence indicates that site-seasonality, directionality and/or distance are factors.	A pilot program illustrated that, most likely, dischargers could meet the TMDL without having to trade, at least for the foreseeable future.	Phosphorus	

[11] Maryland has 'built in' uncertainty ratios in the calculations of pre-approved BMPs, and indicates it will apply uncertainty ratios for newer case-by-case applications of more uncertain BMPs; it is unclear what effect these uncertainty ratios have on the otherwise default 1:1 ratio. The Chesapeake Bay Model, from which Maryland derives its BMP effectiveness calculations, makes some adjustments for geological and temporal uncertainty, but it does not explicitly account for contingencies such as severe weather (except for post-processed conservation practices) and improper installation or maintenance. USEPA, *Chesapeake Bay Phase 5.3 Community Watershed Model*, EPA 903S10002 – CBP/TRS-303-10, Chesapeake Bay Program Office, Annapolis, MD (Dec. 2010, revised May 2011). Maryland also implements a separate 'retirement' program for 10% (for nonpoint sources) and 5% (for point sources) of the credits given for proposed trades and reductions are withheld or retained by the regulator as a means of achieving a net benefit to water quality.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Minnesota State-Wide Water Quality Trading Rules (Draft)[12]	1.1:1 – point-point upstream purchaser. 1.4:1 – point-point downstream purchaser. 2.5:1 – nonpoint source seller.	Uncertainty, risk, and location.	In addition to these proposed trade ratios (April 2011 Draft, Proposed Permanent Rules Relating to Water Quality Trading), Minnesota proposed a 10% retirement purchase requirement.	Phosphorus	
Lower Minnesota River, Rahr Malting Company Permit	1 lb. phosphorus:8 $CBOD_5$ [13]	Location	For each of the three pollutants traded under the Rahr permit, the unit of trade is 1 lb of 5-day carbonaceous biochemical oxygen demand ($CBOD_5$). A reduction of one pound of phosphorus upstream was found to create 8 $CBOD_5$ credits downstream at the TMDL zone.	Phosphorus	Rahr maintains 4 ongoing projects.[14]

[12] The proposed risk trade ratios would not apply to the Minnesota River Basin general phosphorus permit (MNG420000), the Rahr Malting permit, or the Southern Minnesota Beet Sugar permit.

[13] The ratios stated for the Rahr Malting Company are used to convert to the trading unit of oxygen demand ($CBOD_5$). It is unclear from the guidance available whether any other ratios are used to determine the initial *amount* of 'credits' of reductions of phosphorus or nitrogen at the upstream location, prior to trading with a downstream emitter.

[14] Rahr's trading ratios only apply to their TMDL zone and trading program as included in their NPDES permit; outside (or upstream) of this zone, there are other BOD ratios in place for reductions of emissions. Further, beyond river mile 107, only 1% of the pounds of either nutrient removed are credited for possible trading, demonstrating a conservative stance on allowing credits for certain reduction techniques or locations thereof.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Lower Minnesota River, Rahr Malting Company Permit	1 lb. nitrogen:4 $CBOD_5$, 1 lb. nitrogen:1 $CBOD_5$	Uncertainty (as to nitrogen's effect on oxygen demand) and location.	Based on geographic differences in effects of nitrogen on oxygen demand, these ratios are assigned to reductions within the 'Metro reach,' or 'upstream reach,' respectively.	Nitrogen	
Lower Minnesota River, Rahr Malting Company Permit	1 ton sediment: 0.5 $CBOD_5$	Uncertainty (as to sediment's effect on oxygen demand).	Reducing sediment loss requires a large reduction to effectuate the same impact.	Sediment	
Southern Minnesota Beet Sugar Cooperative	2.6:1[15]	Environmental improvement, location, margin of safety.	Traders implement various BMPs, such as cattle exclusion and cover cropping – to obtain credits.	Phosphorus	500+ sites 250 cover crop contracts
Nevada Truckee River	Not yet determined (according to EPA toolkit).	Not yet determined. Will likely depend on monitoring of resulting water quality as part of study effort.	To meet their TMDL, the Truckee Meadows Water Reclamation Facilities (and two other potential trading facilities) are permitted to use offsets.	Nitrogen, phosphorus, and dissolved solids	None (EPA toolkit)
New Jersey State-wide POTW point-to-point source trades.	10:8	20% of the credits generated are retired, rather than traded using a ratio.	This program does not include nonpoint sources. The retirement of credits is used to ensure a net reduction in heavy metal pollution.	Heavy metals	2

[15] The SMBSC permit ratio of 2.6:1 reflects a combination of a 1:1 base offset ratio, a +0.6 engineering safety factor, to account for variations among sites, and a +1 'water quality improvement' factor.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Non-Tidal Passaic River Basin	Varying Additional 10% "safety reduction."	A study developed a location-based credit formula. Margin of safety.	A water quality trading program and TMDL have been proposed for the watershed – the finalized details and/or rules have not yet been published.	Phosphorus, with likely applications for nitrogen and solids.	
New York Croton Watershed (in Hudson River watershed)	2:1 3:1	Not specified, but likely uncertainty-based (or other qualitative concerns).	Pilot phosphorous offset programs allowed 3 new WWTPs to discharge conditionally with offsets purchased at a 3:1 ratio. NY's proposed permanent phosphorous offset programs suggest potential use of 2:1 ratios as well, depending on the watershed.	Phosphorus	
North Carolina Tar-Pamlico	3:1 – cropland credits 2:1 – animal waste credits	Margin of safety (likely, uncertainty-based).	Tar-Pamlico Association member dischargers make contributions to a nonpoint source fund, managed by the Department of Soil and Water Conservation, for implementation of agricultural BMPs.	Nitrogen, Phosphorus	Many
Tar-Pamlico	1.1:1	Uncertainty	Non-Tar-Pamlico Association member dischargers must offset additional discharges with payments to the same fund.[16]	Nitrogen, Phosphorus	

[16] This ratio is not for point sources looking to trade with each other, but rather for all new and expanding permitted wastewater dischargers that are not members of the Tar-Pamlico Association. In order to get their NPDES permits, they must offset their additional nitrogen and phosphorous loads by funding state-approved nonpoint source control programs at a rate of 110 percent of the cost to implement agricultural best management practices. 15A N.C. ADMIN. CODE 2B.0229.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Neuse River Basin Nutrient Sensitive Waters Management Strategy	2:1 (estimate)[17]	Cost-based (payments go to restoration fund, not farmers directly).	If the collective cap for the approximately 20 facilities in the Compliance Association is not met, payments are made to the Wetland Restoration Fund for nonpoint source controls.	Nitrogen	Unknown
Cape Fear River, Jordan Lake (in development)	Not yet determined	Uncertainty and location/delivery ratios discussed.	Nutrient offsets driven by stormwater ordinances under TMDL (includes nonpoint-nonpoint trades). Initial studies suggest that uncertainty ratios may not always be needed, given the already-conservative BMP performance assumptions.	Nitrogen, phosphorus	403[18]
Ohio Great Miami River	1:1 investor buyer into attainment water 2:1 investor buyer into non-attainment water 2:1contributor buyer into attainment water 3:1 contributor buyer into non-attainment water	Location – based on the water quality of the segment into which the discharge takes place.	Agricultural BMPs, funded through a reverse auction. "Investor" buyers participate in trades before they are required to, and "contributing" buyers are those who participate after the more strict NPDES permits go into effect.	Phosphorus	

[17] Based on an analysis of the cost of the offset payments that must be made to the Wetland Restoration Fund, set at $11/lb/year as of the publishing of EPA's toolkit, a 2:1 trading ratio may be built into the cost. Breetz et al., *Water Quality Trading and Offset Initiatives in the U.S.: A Comprehensive Survey* (August 5, 2004), *available at* www.dep.state.fl.us/water/watersheds/docs/ptpac/DartmouthCompTradingSurvey.pdf .

[18] From 2006-2007, a reported 340 projects purchased a total of 294,256 lbs of nitrogen and 903 lbs of phosphorus credits, and from 2009-2010 a reported 63 projects purchased a total of 34,256 lbs of nitrogen and 631 lbs of phosphorous credits. CH2M Hill, *Water Quality Credit Trading: Experiences Around the Country* (April 13, 2011) (PowerPoint).

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Sugar Creek Watershed – Alpine Cheese Co.	3:1 – Default 1:1 – 12:1 – Additional (positive or negative) ratios that can abate or increase the credit amount.	Uncertainty and margin of safety. Location (of source) and water quality at discharge location.	Alpine Cheese Company funded area farmers' (largely Amish) application of BMPs and other conservation techniques through Holmes Soil and Water Conservancy District, as broker.	Phosphorus	
Oregon Clean Water Services – Tualatin River Basin	2:1	Uncertainty and temporal – land changes will not immediately produce shade.	Shade credits generated by nonpoint sources keeping land out of agricultural productions (through 'enhanced CREP' program or sale as a conservation easement).	Temperature[19]	17 owners enrolled to create thermal offsets.
Pennsylvania	1:1 – Default Varying delivery ratios.	N/A Delivery, edge-of-segment, and retirement.	Pre-approved calculation methodologies for established BMPs' efficiencies, in addition to the delivery ratios, are applied on top of this base ratio of 1:1 in calculating credits.[20]	Nitrogen, Phosphorus, Sediment	
Tennessee Beaver Creek Watershed Pilot Program (Knox County)	Under development	Location ratios suggested, with uncertainty ratios possible for new BMPs on a case-by-case basis.	Pilot study done in 2009 for stormwater and nutrient credit trading. Additional uncertainty ratios were not suggested, due to conservative modeling and BMP efficiency estimates.	Phosphorus, Sediment	N/A

[19] Clean Water Services also trades in Oxygen Demand ($CBOD_5$) between and within treatment plants to meet their daily or weekly mass loads. The trade calculations utilize equivalency factors that function like trading ratios, but take place between the point source emitters.

[20] Pennsylvania also implements a credit insurance program, reserving 10% of the credits it approves, in case they fail to perform, which are then 'retired' at the end of each 'water year,' lowering the allotment pool as a whole. Further, for farms, if the seller of credits is not in compliance with the requisite 35-foot buffer zone, or a 100-foot setback, in addition to being in full regulatory compliance with all other applicable statutes, than the state will lower its credits given by 20%.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Utah	**Same as Idaho,** Bear River Watershed (see above)	…	…	…	…
Vermont	None Specified	N/A	State rules require offsets for sediment loading from new and expanded development.	Sediment	
Virginia Chesapeake Bay Watershed	2:1 for new or expanding point sources purchasing nonpoint credits Delivery ratios.	Uncertainty Location of buyer and seller of credits.	By statute, point-nonpoint source offset trades are subject to the 2:1 ratio. Delivery ratios are based on the EPA Bay model, and are in addition to the 2:1 ratio.	Nitrogen, Phosphorus	
Stormwater compliance for new development statewide	1:1	N/A	Developers may use offsets to comply with post-development stormwater rules. These offsets are not subjected to a trading ratio, but require assurances that the offsets measure are secured essentially in perpetuity.		
West Virginia Potomac Basin, Chesapeake Bay	1.2:1 - Default 1.1:1 – Nutrient-limited or regulated point source Varied Additional Ratios	Reserve[21] Edge-of-stream, location, 'special concerns.'	The 1.2:1 baseline ratio is used for nonpoint sources that measure reductions or implement peer-approved Chesapeake Bay practices. Additional uncertainty factors may be added on, as well as edge-of-stream, location, and special concerns ratios.	Nitrogen, Phosphorus	

[21] West Virginia uses a 'reserve ratio' to hold back 10% and 20% of the credits provided for WWTPs and MS4s, respectively. All credits are also discounted by an appropriate 'Delivery Factor' which takes into account a modeled estimation of what will actually reach the Chesapeake Bay, and in what manner.

State / Region	Ratio	Type of Ratio	Explanation / Credit Types	Pollutant(s)	Trades
Wisconsin Red Cedar River	2:1	Environmental improvement.	BMP modeling assigns efficiency levels for credit (i.e. nutrient management or no-till). This program places a 3-year cap on trades and farmer payments.	Phosphorus	60 + BMPs purchased
Fox-Wolf Lake	1:1 – 10:1 (in development)	Economic, but the program is moving towards more specific location, delivery, and uncertainty ratios, where appropriate.	A number of pilot programs were put in place in Wisconsin; the Fox-Wolf basin ratios are based on the costs of reductions for the traders, not on pollutant location or effects. They may move toward a more technical, merit-based program as it develops.[22]		
Rock River Basin Pilot Project	1.75:1 – 2.25:1 (in development)[23] Varied	Uncertainty (suggested) Location ratios to be developed as well.	Wisconsin's report on this and other pilot programs suggested that this range of ratios might be too cost-prohibitive to result in many trades.	Phosphorus	None

[22] Tom Dupuis et al., *Water Quality Credit Trading White Paper*, Prepared by CH2M HILL (February 11, 2011), *available at* www.fyi.uwex.edu/wqtrading/files/2011/03/GBWQCT_2-11-11_FINAL.pdf.

[23] Wisconsin recently released a Final Water Quality Trading Framework Report, laying out suggestions and findings from its pilot programs; specifically, the report noted that the state should provide a list of approved BMPs and their relative effectiveness (how many credits can be generated) and uncertainty ratios for each. Wisconsin Dept. of Natural Resources, *A Water Quality Trading Framework for Wisconsin, a Report to the National Resources Board* (July 1, 2011).

TABLE 2 – Idaho's Effectiveness and Uncertainty Ratios for Best Management Practices
(Example of a BMP-specific Efficiency Crediting System)

BMP	Effectiveness	Uncertainty Discount
Polyacrylamide	95%	10%
Filter Strip	55%	15%
Sprinkler	100%	10%
Micro-irrigation	100%	2%
Tailwater Recovery	100%	5%
Mulching	90%	20%
Crop Sequencing	90%	10%
Sediment Basin (field scale)	80%	10%
Sediment Basin (farm scale)	75%	10%
Sediment Basin (watershed scale)	65%	15%
Underground Outlet	85% (65% after 2 years)	15% (25% after 2 years)
Surge Irrigation	50%	5%
Nutrient Management	NA – doesn't assign	NA
Constructed Wetland (farm scale)	90%	5%
Constructed Wetland (watershed scale)	NA – doesn't assign	NA

Additional Background:
State and Regional Programs in Development, Pilot and Individual Trades, and States Omitted from the Table

As of March 2010, Connecticut and New York do not include nonpoint source credit trading in their Nitrogen Credit Exchange (NCE) for Long Island Sound, due in large part to the high costs (in that region) of generating nonpoint source credits and the difficulty of monitoring pollution from such diffuse sources.[24] Connecticut is included in the table above, however, for developing varying trading ratios for POTWs trading within the NCE. These ratios are geographically based, due to the varying effects on the algal blooms in the sound depending on the location of the source. As a result, the trades between municipalities are rarely based on a 1:1 ratio.[25] Separately from the NCE, both states are implementing the provisions in their regional TMDL related to MS4s, other stormwater sources, and unregulated nonpoint sources.

Georgia, Kentucky[26] and Massachusetts are currently investigating the availability of trading mechanisms for use in their watersheds and estuaries and a number of pilot programs are in place for limited trading or analysis. A few of these program details are listed above. The research that has been undertaken in Georgia includes a number of proposed projects for determining appropriate uncertainty and location-based trading ratios, depending on modeling and the characteristics of each watershed.[27]

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[24] *Connecticut's Nitrogen Credit Exchange – An Incentive-based Water Quality Trading Program*, Connecticut Department of Environmental Protection Bureau of Water Protection and Land Reuse, Hartford, CT (March 2010) *available at* http://www.ct.gov/dep/lib/dep/water/lis_water_quality/nitrogen_control_program/water_quality_trading_summary_2010.pdf.

[25] Id.

[26] Jack Schieffer, *Nonpoint Source Abatement Costs in the Kentucky River Watershed* (May 2, 2011), *available at* http://ageconsearch.umn.edu/bitstream/103633/2/Riparian_AAEA%202011%20Paper.pdf.

[27] Lawrence Mark Risse et al., *A Framework for Trading Phosphorus Credits in the Lake Allatoona Watershed*, Project Proposal, *available at* www.rivercenter.uga.edu/research/nutrient/trading.htm (publishing date unknown).

Although Massachusetts is listed on the table, it does not have a comprehensive trading program. There, one industrial discharger received additional phosphorus allocations for connecting faulty neighboring septic systems to its waste water treatment plant (WWTP), with plans for the municipality to take over the treatment facility, essentially creating a POTW. Massachusetts is studying nutrient credit trading, but it is unclear to us whether this arrangement was related to the ongoing studies about nutrient credit trading in the state in general, or whether it was an isolated transaction associated with that particular NPDES permit.[28] Research is also taking place in Texas, where currently, point sources can trade stormwater credits to comply with TMDLs in place.[29]

Ohio, which already has internal trading programs in place, is also looking to apply a similar trading platform to the Ohio River watershed. As of October 2010, a project is underway to design and implement a trading program not only among the dischargers and nonpoint sources in Ohio, but also in portions of at least eight other states in the watershed, including West Virginia, Pennsylvania, and Virginia.[30]

We are unable to locate updated information about this proposal. In 2010, the Georgia EPD only briefly mentioned the potential of future trading, specifically as to the smaller Weiss Lake, within the Allatoona Watershed. Georgia EPD, *Lake Allatoona Model Scenarios; Description and Results for Nutrient Criteria Revisions* (September, 2010).

[28] *See* Table 1, Wayland Business Center, above; Environomics, *A Summary of U.S. Effluent Trading and Offsets Projects* (November 1999); Institute for Environmental Studies, University of Pennsylvania, *Water Quality Trading in the Lower Delaware River Basin: A Resource for Practitioners, A Report to the William Penn Foundation* (March 1, 2006), *available at* www.wr.udel.edu/publications/ChristinaBasin/Final%20WQT%20Report_27Feb06.pdf.

[29] *A Water Quality Trading and Watershed Permitting Example: Lake Lewisville, Texas*, (date unknown), *available at* http://www.cfra-nc.org/documents/TradingExample-LakeLewisville.pdf; CH2M Hill, *Water Quality Credit Trading: Experiences Around the Country* (April 13, 2011) (PowerPoint).

[30] The Electric Power Research Institute (EPRI) is collaborating on the project. In August 2011, EPRI received around $1 million in funding from the U.S. Department of Agriculture and $400,000 from industry stakeholders for implementing pilot water quality trades in the Ohio River Basin.

Indiana has recently (September 2011) released a final feasibility report for water quality trading in the Wabash River watershed, which recommended a number of available techniques for determining appropriate location and delivery ratios in the watershed. The research team cautioned against overly conservative uncertainty factors, warning that a high trading ratio might make trades cost prohibitive. According to the report, uncertainty could also already be accounted for in calculations of base loads and potential reductions from the particular types of nonpoint source pollution reduction activities. On top of these built-in conservative assumptions, the report suggested that a 5% uncertainty factor might provide an adequate margin of safety. However, the final report also stated that, for nonpoint source sellers of credits, a ratio of reductions to credits of 2:1 – 2.3:1 would be used to calculate credits depending on the distance between the purchaser and the seller ("near field" or "far field"), and that buyers of credits should also apply a 'net benefit policy factor' to any credits purchased, set at a proposed rate of 1.1:1.[31] It is unclear how these rates will interact in Indiana's final guidance or rules.

In Michigan, the Kalamazoo River was potentially up for the development and application of a trading program, but a 2004 grant study revealed that the dischargers could meet the TMDL requirements without trading. Nonetheless, it has been included in the table because various ratios were discussed during program development stages.

Nevada and California appear to be in talks to establish a trading program for the Lake Tahoe region, potentially including air-borne pollutants, as well as stormwater treatment and nutrient and sediment load reductions.[32]

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[31] *Wabash River Watershed Water Quality Trading Feasibility Study*, Final Report (September 2011), *available at* www.ctic.org/media/pdf/TWG/Wabash%20WQT%20Feasibility%20Study_091411_final%20report.pdf.

[32] *Lake Tahoe*, U.S. Environmental Protection Agency, 2004 Targeted Watersheds Grant Program, *available at* water.epa.gov/grants_funding/twg/upload/2007_07_09_watershed_initiative_2004_lake_tahoe-2.pdf.

Washington State, as of 2011, did not have any active nutrient credit trading programs in place, but was developing a program for the Spokane River Watershed focused on reducing phosphorus levels. The program is being designed in accordance with a TMDL and clean-up plan already in place.