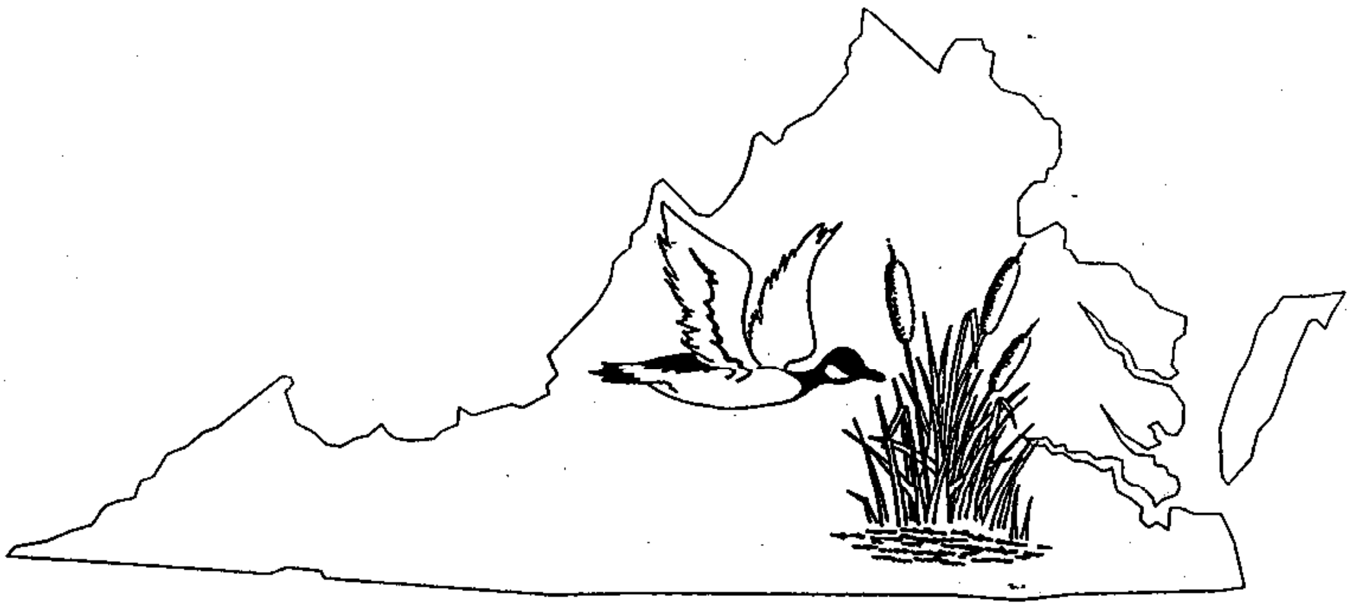
MARKET BASED STRATEGIES & NUTRIENT TRADING:

WHAT YOU NEED TO KNOW



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INTRODUCTION

A central water quality management problem in the Chesapeake Bay watershed and its tributaries is nutrient enrichment by nitrogen and phosphorous loads from point and nonpoint sources. The recent evaluation of the nutrient issue in the Potomac basin by the Virginia Department of Environmental Quality, *et al.* (1995, i) states, "water quality degradation caused by nutrient over-enrichment has played a key role in the decline of the living resources of the Potomac River and the Chesapeake Bay." Nutrient point source discharges are from industrial producers, municipal (publicly owned treatment works -- POTW) sources, and large confined livestock production facilities. Nonpoint nutrient discharges arise from forestry and agricultural operations (crop and smaller livestock operations), and urban area runoff from streets, yards and construction activities. While there have been improvements in reducing the level of nutrients entering the Bay since 1985, overall loadings from both point and nonpoint sources still pose a significant obstacle to meeting state and federal water quality goals (Virginia Department of Environmental Quality *et. al*. 1994; 1995).

Under current regulations, point source dischargers face technology-based, enforceable discharge limitations. Some urban area runoff is subject to erosion and sediment control laws. Most efforts to control nonpoint source pollution, however, are voluntary. Efforts to induce forestry and farm operators to implement controls to reduce nutrient loadings (best management practices or BMPs) have relied on a combination of educational programs, technical assistance, and cost-sharing arrangements. Politically volatile land use issues, as well as the difficulty of measuring effluent discharges from nonpoint sources, have combined to make it difficult to extend regulatory control to nonpoint sources.

In response to the nutrient enrichment problem Maryland, Pennsylvania, Virginia, the District of Columbia, and the Environmental Protection Agency established a 40 percent nutrient reduction goal for controllable nitrogen and phosphorous entering the main stem of the Bay by the year 2000. In Virginia's portion of the Potomac basin, 1995 projections indicate that total nitrogen and phosphorous reduction goals are unlikely to be met by the turn of the century under current programs (Virginia Department of Environmental Quality *et al.* 1995). While a documented need exists to reduce nutrient loadings in the Potomac Basin and other Chesapeake Bay watersheds, further reductions will be increasingly expensive to obtain. Recent estimates suggest that an additional $66.7 million to $114 million will be needed to achieve the nutrient reduction goal (Virginia Department of Environmental Quality *et al.* 1995, 70).

NUTRIENT TRADING SYSTEMS

A nutrient trading system is one of several market-based environmental policies designed to capitalize on market forces to minimize the costs of meeting the water quality objectives of a particular watershed. A nutrient trading system creates a system that would allow two sources facing different nutrient control costs to shift pollution control responsibilities in order to lower the joint costs of control. For instance, consider a nutrient source that faces high costs of controlling nutrient discharge. Instead of forcing this source to reduce nutrient discharges through expensive internal controls, a nutrient trading system would allow the high cost source to pay a low control cost source to make the same reduction. In essence, the low cost source sells their ability to control pollution to the high-cost source. Through such an exchange of control responsibility, the total pollution control requirements (basin, subbasin or local area) are met, but the aggregate cost of compliance across nutrient sources is reduced. The potential cost savings from the establishment of a nutrient trading system stems from the existence of differential pollution abatement costs between sources. Without differential pollution abatement costs, no trading would occur and no advantages would exist from creation of a nutrient trading system.

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Trades not only lower the cost of pollution control, but the existence of the trading system also creates incentives for pollution prevention. Low control cost sources seek to reduce nutrient loadings since reductions can be "sold" for profit. High control cost sources wish to minimize pollution control expenditures. Within a properly operating trading system, the financial incentives of dischargers to reduce costs drive the search for more effective nutrient control strategies. Nutrient trading systems offer the opportunity to improve overall environmental quality *and* lower the private and public costs of protecting the environment.

Types of Nutrient Trading Systems

The three types of nutrient trading systems are point-point, point-nonpoint, and nonpoint-nonpoint systems. In a ***point-point*** trading system, nutrient discharge allowances are created and assigned to each point source. A discharge allowance specifies a quantity of nutrients (nitrogen and phosphorous) that the discharger is allowed to release into a given body of water over a specified period of time. A nutrient "bubble" or "cap" is formed if the total number of pollution allowances is fixed over a specified geographical area for a group of dischargers. The total size of the nutrient bubble -- the setting of total nutrient loadings into a water body -- is determined so as to achieve a desired water quality standard. Once the allowances have been assigned, point source dischargers are allowed to trade pollution allowances as long as total nutrient discharge within the bubble does not exceed the aggregate amount defined by the pollution allowances. Thus, the operator of an industrial or municipal facility has the option of either meeting pollution allowance limits by investing in nutrient reducing processes or by purchasing additional pollution allowances from other point source dischargers -- whichever is less expensive.

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A ***point-nonpoint*** nutrient trading system expands the flexibility of a point-point system by allowing point sources to "purchase" nutrient reductions from nonpoint sources. In a point-nonpoint trade, a point source operator pays a nonpoint source -- a farmer for instance -- to implement a best management practice (BMP) that will reduce total nonpoint nitrogen and phosphorous discharge. In exchange for paying for the BMP, the point source discharger receives additional pollution allowances that are based on the estimated reduction in nutrient loadings from BMP implementation. By reducing nutrient loadings from a nonpoint source, the point source operator is permitted to increase point source discharges over its initial allowances. In essence, point source dischargers are allowed the flexibility to meet waste reduction requirements by "purchasing" (sponsoring) less expensive reductions in nutrient loadings from nonpoint or other point sources in lieu of implementing more expensive point source controls.

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As the nonpoint source's share of the nutrient water quality problem grows, nonpoint pollution sources may increasingly be faced with mandatory pollution control requirements. If a shift from voluntary to mandatory pollution control responsiblity occurs for nonpoint sources of pollution, implementing a ***nonpoint-nonpoint*** nutrient trading system becomes a more realistic policy option (Braden, Netusil and Kosobud 1994). In a nonpoint-nonpoint system a nonpoint source wishing to engage in activities that would increase nutrient loadings would have to offset that increase by reducing nonpoint discharges elsewhere (e.g. "purchasing" less expensive nutrient controls elsewhere).

Functioning Nutrient Trading Systems

There are a number of areas in the U.S. that have established nutrient trading programs. The first nutrient trading system established was a point-point trading system on a segment of Wisconsin's Fox River. In the past fifteen years, however, point-nonpoint systems have been established in Colorado and North Carolina.

Dillon Reservoir, located 70 miles west of Denver Colorado, supplies Denver with half of its total water supply and generates millions of dollars worth of recreational benefits. In the early 1980s, it became increasingly apparent that excessive phosphorous entering the reservoir jeopardized the economic value of the reservoir. About half of the controllable phosphorous loadings entering the reservoir came from four POTWs. The other half of the phosphorous loads entered the reservoir from individual septic systems and urban runoff (Apogee Research 1991b). In 1984 the Dillon Water Quality Management Plan adopted a plan to cap the total phosphorous loads entering the reservoir at 1982 levels (Apogee Research 1991b).

A point-nonpoint trading system was established to grant point sources greater flexibility in meeting the phosphorous cap. The total phosphorous load from the four point sources was limited to 1,510 pounds per year - 1,234 pounds less than 1985 projected loads. The aggregate phosphorous limit was allocated to each of the point dischargers. In meeting their individual limits point sources were granted the option to increase phosphorous discharge above their assigned limit if a corresponding decrease could be acquired from one of the three other point sources (a point-point trade). Point sources could also increase phosphorous discharges above their initial allocation by reducing phosphorous loadings from nonpoint sources that were in existence prior to 1984 (Anderson, Hofmann, and Rusin 1990).

Research conducted at the time suggested significant cost savings could be achieved through the development of such a trading system. One feasibility study reported that the annual cost of reducing phosphorous discharge for all point sources averaged $730 per pound. Phosphorous removal from nonpoint sources was much less expensive.

The total annual cost of reducing phosphorous loadings using a combination point and nonpoint source controls was estimated to be $241 (Northwest Colorado Council of Governments 1984). Thus, point sources could achieve significant cost savings in meeting their phosphorous discharge limits by exercising the option to sponsor less expensive reductions in nonpoint source controls.

A nutrient trading system has recently been established in the Tar-Pamlico Basin in North Carolina. By the mid-1980s, the Tar-Pamlico Estuary was suffering from a variety of water quality problems associated with excessive nutrient loadings. The bulk of the controllable nitrogen and phosphorous loads in Tar Pamlico comes from agricultural nonpoint sources (livestock and crop production) and POTWs.

Faced with the high costs of additional technology-based nutrient discharge limits, a coalition of point source dischargers and interested environmental groups sought more cost effective ways to reduce nutrients flowing into the basin's waters. The 1989 outcome of this coalition of diverse interests was the formation of Tar-Pamlico nutrient trading system (Apogee 1991a; Hall and Howett 1993; Riggs 1993; Jacobson, Hoag, and Danielson 1994; U.S. GAO 1995). A total of 12 POTWs and one industrial firm voluntarily formed the Tar-Pamlico Basin Association. A nutrient bubble was subsequently formed for the Association, fixing the total amount of nitrogen and phosphorous that could be discharged by the group to 425,000 kg/yr. by 1994. The Association's nutrient bubble represented an estimated 200,000 kg/yr. reduction in loadings over a status quo condition (Jacobson, Hoag, and Danielson 1994; Riggs 1993).

The Association allocates responsibility for nutrient load reductions among its members. Members can then receive nutrient credits (allowances) if they are able to reduce nutrient discharge below their allocated amounts. These credits can be traded with other Association members who need to discharge higher loads or they can be saved for future use. The ability to sell or save nutrient credits provides members with incentives to search for cost effective ways to reduce nutrient discharges below their allocated levels.

In the event that the Association's combined discharge is in excess of the 425,000 kg/yr. nutrient bubble, the Association must make contributions to the North Carolina Division of Soil and Water Conservation's Agricultural Cost-Share Program for every excess kilogram above the limit. Kept in a separate cost-share account, these excess loading payments go directly towards sponsoring the implementation of nutrient reducing agricultural best management practices.

The cost advantage of nonpoint sources in reducing nutrient loadings was the most important motivating factor for the creation of the nutrient trading program in North Carolina. When the program was being developed, it was estimated that meeting the 200,000 kg/yr. reduction through exclusive use of point source controls would cost between $50 and $100 million. Achieving the same reduction entirely through funding nonpoint source controls cost approximately $11.2 million (Jacobson, Hoag Danielson 1994; Riggs 1993; Hall and Howett 1993).

ESTABLISHING A NUTRIENT TRADING SYSTEM

Creation and operation of a nutrient trading system will require significant cooperation and commitment between state, regional, and local governments, the regulated community, and other interested stakeholders. Previous experience suggests that support from each of these groups is essential to developing a successful system (US GAO 1995). The nutrient trading systems currently in existence are all regional or local in scope. The regulated community has made significant contributions to the development and operation of the nutrient trading concept. In addition state and federal agencies to play a strong support and maintenance role in the development and operation of the trading program. Existing nutrient trading programs, for example, are partially built upon an existing system of state and federal programs.

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This section outlines the administrative, legal, and cost requirements necessary for the establishment of an effective nutrient trading system. The discussion begins with the need for development of the product to be traded -- a nutrient allowance. After the product is defined, then the demand for the product needs to be created. The creation of this demand for nutrient allowances is essential if a nutrient trading system is to operate since the demand for the nutrient allowance drives the search for cost-effective means to reduce nutrient discharges. Finally, the market environment in which potential buyers and sellers of nutrient allowances interact needs to defined.

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Defining the Product

In a nutrient trading system, the governmental entity must create the commodity that is to be traded -- the nutrient allowance. The task of creating the commodity, however, is contingent on being able to define, measure, monitor, and enforce nutrient discharges.

A Common Pollutant - Vastly different types of production processes generate different types of effluent discharges. Trading between point-point and point-nonpoint sources is possible only if potential trading parties are discharging common pollutant(s) in a similar form. If point and nonpoint sources each discharged different types or forms of pollutants, then the scientific and technical problems of establishing a tradeoff between the different types of pollution may become difficult (Riggs 1993).

Quantifying N and P Allowances - Establishing a nutrient trading system is contingent on being able to define the product to be measured. Being able to quantify nutrient discharge and therefore a nutrient allowance is contingent on being able to measure the concentration and flow of effluents. If flow and concentration can be measured, then the nutrient allowance can be expressed as total nitrogen or phosphorous released per unit of time. The quantification of total nutrient discharge from point sources is relatively straight forward. In Colorado and North Carolina point source dischargers are required to track nitrogen or phosphorous discharge through NPDES permitting process.

Quantifing nutrient discharges from nonpoint sources will also be necessary. Because nonpoint nutrient loadings enter water bodies over a dispersed area rather than a measurable and identifiable point, it is generally more expensive to directly measure nutrient loadings from nonpoint sources than point sources. Consequently, quantification of nonpoint nutrient loadings is may not be based on direct measurement of nutrient discharge (Letson 1992; Letson, Crutchfield and Malik 1993; Malik, Larson, and Ribaudo 1994). Instead, the total amount of nutrient allowances would more likely be based on the BMP *practice* implemented. In these cases, nutrient allowances would be assigned to the nutrient control practice by estimating the amount that nutrient loadings will be reduced by the proper installation and maintenance of the BMP. Thus, the reduction in nutrient loadings associated with each nonpoint source control practice may need to be established (Malik, Larson, and Ribaudo 1994). Additional research may be necessary in order to more accurately determine the potential effectiveness of nonpoint controls.

Monitoring of point source discharges and nonpoint control measures (BMPs) will need to be implemented if the nutrient trading system is to operate to protect overall water quality.

Quantifying nonpoint source pollution has been addressed in different ways in Colorado and North Carolina. In the Dillon Reservoir phosphorous trading system, nonpoint source credits are quantified based on site-by-site determination. Thus, if a point source sponsors an urban nonpoint BMP, the point source receives phosphorous credits based on how much phosphorous is reduced by the particular practice installed. In Tar Pamlico, North Carolina, the group of point sources do not acquire nutrient allowances based on implemention of a specific BMP. Instead, the association of point sources receives a nonpoint nutrient allowance by making a fixed payment ($56/kg for the first phase of the program) for excess nutrient discharges to the Agricultural Cost-Share Program. Thus, the number of nutrient credits in Tar-Pamlico is not tied directly to a specific BMP implemented but rather is based on average costs and nutrient reduction effectiveness of a group of agricultural nonpoint BMPs (Jacobson, Hoag and Danielson 1994).

__Monitoring__ - Monitoring of point source discharges and nonpoint control measures (BMPs) will need to be implemented if the nutrient trading system is to operate to protect overall water quality. Monitoring ensures an accurate quantification of nutrient discharge sufficient for trading and provides safeguards against efforts to violate the established rules. An effective monitoring system maintains the integrity of the nutrient allowance.

For a nutrient management system to operate, point sources must maintain accurate nutrient discharge records. Consequently point sources may need to install, use and maintain monitoring equipment, and regularly sample effluent (Bartfeld 1993). To facilitate the development of trading system, monitoring equipment and processes cannot be prohibitively expensive, and must be reliable. Furthermore, some governmental unit will be needed to oversee the installation and operation of the point source monitoring program.

Monitoring nonpoint sources would tend to focus on the type of controls implemented and not on effluent discharge. Thus, nonpoint source monitoring will involve some inspections into the proper implementation and maintenance of BMPs. Monitoring of the Dillon Reservoir phosphorous program, for example, is undertaken by the Colorado Water Quality Control Commission. One of several duties, the commission assigns responsibilities for maintaining and monitoring all nonpoint source controls that generate nutrient credits (Apogee Research 1991b).

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Monitoring of water quality is necessary to provide important nutrient tracking information. Instream monitoring provides valuable information linking changes in point and nonpoint discharges brought about by the nutrient trading system to the distribution and concentration of nutrients through the watershed. Instream monitoring would also function as a check to ensure that nonpoint control practices are implemented and operating properly.

Enforcement and Compliance - A well-defined nutrient allowance could quickly become worthless if dischargers could exceed their nutrient loading limit without threat of enforcement. An effective and credible enforcement system is necessary in order to channel point source discharger's motivation and behavior into searches of alternative cost control strategies and not into enforcement evasion (Bartfeld 1993). A penalty system will need to be implemented which is stringent enough to discourage rule violations. In North Carolina, point source association members have a powerful incentive to comply with the group's nutrient cap -- if the nutrient cap is violated and not offset with nonpoint source reductions, individual point sources would be subject to stringent, conventional discharge regulations.

Creating the Demand for Nutrient Allowances

The primary reason to establish a nutrient trading system is to reduce the cost of pollution compliance while improving or maintaining water quality. In order for the nutrient allowance to be valuable to the discharger, there must be meaningful limitations on discharge. Without a constraining nutrient discharge limit, there exists no financial incentive to trade allowances or invest in pollution reducing measures, and there would be no reason to establish either a point-point or point-nonpoint nutrient trading system.

Without a constraining nutrient discharge limit, there exists no financial incentive to trade allowances and no reason to establish a nutrient trading system.

Discharge Limits - The establishment of a meaningful and significant numeric nutrient discharge limit (a nutrient "bubble" or "cap") is essential in order to create the demand for pollution cost control. A meaningful discharge limit should also be accompanied by an enforceable timetable for achieving the nutrient limit.

The total discharge limit should be set to achieve some socially desirable level of overall water quality. If nitrogen and phosphorous limits are set so high (nutrient bubble too large) as to be easily met by point source dischargers, pollution control allowances will have no value. On the other hand, there would be little reason to establish a nutrient trading system if current nutrient loadings does not pose a significant threat to the water quality in a watershed. Bartfeld (1993, 692) explains, "trading occurs only when an initial allocation selected by regulators does not reflect the most cost-effective control level for individual dischargers." Braden, Netusil, and Kosobud (1994, 789) state "quantitative restrictions must be established before markets can operate."

Defining the Market

In addition to defining the nutrient allowance and creating the demand for the nutrient allowance, the trading rules of the nutrient market need to be clearly established. The establishment of this trading environment specifies when and under what conditions trades may or may not take place. Organizational structures may also be necessary to structure and oversee trades.

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Creation of a nutrient trading system should involve the careful delineation of the rights and responsibilities between trading system participants. In creating a nutrient trading system, some dischargers must be assigned or accept responsibility for pollution control activity (Shabman and Norris 1987). Under the current policy and legal setting, point sources typically are assigned the nutrient control responsibility and thus the cost burden of meeting nutrient discharge limits.[1] Thus, a point-nonpoint trade would be one directional: Point source dischargers will always be the buyers of pollution reduction allowances and nonpoint sources will always be the sellers (Malik, Larson, and Ribaudo 1994). The trades in a point-nonpoint system occur in only one direction because the decision of nonpoint source dischargers to control nutrient loadings is typically voluntary. Without a quantified pollution discharge limit or a requirement to implement certain pollution control measures, there is no economic reason for a nonpoint source to pay a point source to reduce nutrient discharges.[2] Because point sources are already regulated, the burden of reducing nutrient loadings in a point-point and point-nonpoint trading system is typically placed on point source dischargers.

Once nutrient control responsibility has been assigned, contractual arrangements and compliance conditions need to be certain, clearly articulated, and enforceable in court.

[1] Since most nonpoint sources are not required to control nutrient discharges, regulated point source dischargers maybe unwilling to acknowledge such a right system and refuse to offer cash payments to nonpoint dischargers (Crutchfield, Letson, and Malik 1994). This conflict over pollution control responsibilities, therefore, may act as a political barrier to the establishment of a point-nonpoint trading system.

[2] The absence of a legal and enforceable restrictions on the nutrient generating activities of nonpoint sources is one of the primary reasons why a ***nonpoint-nonpoint*** trading system is not feasible under the current regulatory setting (Braden, Netusil, and Kosobud 1994). If in the future nonpoint sources become more regulated, the development of a nonpoint-nonpoint system may become possible. The development of a nonpoint-nonpoint trading system would also open the possibility of two directional trades between point and nonpoint sources: nonpoint sources could purchase nutrient allowances from point sources.

Questions such as "Who is ultimately responsible for nonpoint source noncompliance?" will need to be addressed. If a nonpoint source discharger does not properly maintain an approved BMP, and as a result, the point source discharger is found to violate its total nutrient discharge allowance, is a penalty assessed against the nonpoint source discharger or against the point source discharger? Will future regulatory changes undermine the legal integrity, and thus the value, of the nutrient allowance? The structure of these legal rights and responsibilities will have a significant impact on the willingness of dischargers to trade. If these rights and responsibilities are not clearly delineated and certain, then dischargers may be reluctant to enter the nutrient allowance market.

The establishment of a nutrient trading system creates a number of administrative and organizational requirements. Administrative oversight, approval, and tracking of nutrient trades are necessary to evaluate and monitor the impact of the trading program on overall water quality. For example, a nutrient trading system sets the total level of nutrients that can be discharged over a particular watershed. Yet, nutrient allowance trades may not be distributed evenly through the watershed and localized water quality problems could develop. In these cases, point-point or point-nonpoint nutrient allowance trades might not be allowed if they would result in a violation of an ambient water quality standard in a particular location. An administrative body may have to devise mechanisms to oversee the distribution of nutrient loadings and develop trade approval criteria to establish what constitutes an acceptable trade. These standards would work to ensure that localized water quality problems do not develop. However, if the standards for an acceptable trade are too stringent, fewer trades will take place and the cost saving potential of a nutrient trading system is diminished.

The establishment of a nutrient trading system creates a number of administrative and organizational requirements.

The physical conditions surrounding nonpoint pollution sources may also require a significant and active management oversight. For point-nonpoint trades, nutrient reductions (and thus the number of nutrient allowances) associated with a given nonpoint source control (BMP) will have to be established. Reliance on point and nonpoint negotiating parties to establish nutrient reductions from BMPs would introduce obvious incentives to overstate the effectiveness of proposed nonpoint control practice, jeopardizing overall water quality. In Dillon Reservoir system, for instance, the Colorado Water Quality Commission assigns phosphorous credits (Apogee Research 1991b). Malik, Larson, and Ribaudo (1994, 477) note that one of the distinguishing features of a point-nonpoint trading schemes "is the need for close government supervision of transactions."

In an effort to deal with the uncertainty of nonpoint nutrient loadings, overseeing authorities often establish specific terms of trade between point and nonpoint sources. Setting the terms of trade involves establishing a trading ratio between point and nonpoint nutrient allowances. A 2:1 trading ratio, for instance, would require a two unit reduction in nonpoint source loadings for one point source allowance. The point-nonpoint nutrient trading ratio "is usually set higher than one to compensate for perceived uncertainty in nonpoint source control" (Bartfeld 1993, 693). Within the

Tar-Pamlico the cost of a nutrient allowance was calculated assuming a 3:1 trading ratio for agricultural BMPs and a 2:1 ratio for animal waste control (Riggs 1993). In setting the trading ratio, a balance must be struck between lowering pollution abatement costs and protecting water quality. If the ratio is set too high, then reducing nonpoint nutrient loadings may no longer be the most cost effective means for point sources to reduce nutrient discharges. In this case, no trading will occur. On the other hand, if the ratio is set too low, there is a greater risk that water quality objectives could be jeopardized (Bartfeld 1993).

The development of any nutrient trading system would be facilitated by the presence of a "broker" organization(s) that would coordinate trading between different parties.

In a functioning point-point or point-nonpoint trading system, search and negotiation costs will be incurred as dischargers seek acceptable trading possibilities. The development of any nutrient trading system would be facilitated by the presence of a "broker" organization(s) that would coordinate trading between different parties. Typically, different types of production activities are involved in discharging nutrients into a water system. A POTW may wish to sponsor several nonpoint source control practices but have little contact with the agricultural community. A broker organization can reduce information and contracting costs by acting as a trade coordinator. This broker function can be supplied by either private entrepreneurs or public agencies. In Tar-Pamlico, the Division of Soil and Water Conservation (DSWC) acts as an intermediary between point and nonpoint source to coordinate BMP identification and implementation (Riggs 1993). The DSWC is responsible for distributing nonpoint source cost share and overseeing cost-share contractual obligations and record keeping. By utilizing an existing and established organizational structure with considerable experience and contact with agricultural nonpoint sources, total negotiation and search costs are minimized.

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