Search for the northwest passage: the assignation of NSP (non-point source pollution) rights in nutrient trading programs

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Abstract The search for solutions to the problem of non-point source pollution (NSP) includes alternatives based on theories associated with the use of tradable pollution permits. Tradable permit programs have received significant support as a promising policy for the reduction of effluent discharges but programs in practice have not been regarded as successful. The lack of success is ascribed to the design of the programs. However, this may be a design problem which is insurmountable due to the nature of the NSP problem. Tradable permit solutions are based on an assumption that the assignation of quantifiable rights to both point and nonpoint sources, based on some predetermined ambient water quality measure, is possible. The conclusion here is that there are significant features particular to NSP that hinder the introduction of rights and significantly decrease the utility of tradable permit solutions.

Keywords NPS; property rights; tradable permits

Introduction
Northwest Passage: “a passage for ships from the Atlantic Ocean into the Pacific by the northern coastal waters of the American continent, long sought for, and at last discovered in 1850–1 by Sir R. McClure. The discovery is not of practical utility.”(Websters, 1970).

The reduction of nutrients (nitrogen and phosphorus) in water bodies, in particular water basins, is a primary goal of environmental policy. This has led to the search for policy solutions to achieve reductions, a search based either on reducing source loads or on increasing the assimilative capacity of the ecosystem. The use of tradable discharge permits (TDP) is an alternative that has received a great deal of attention and support and is generally regarded as one of the more promising policy alternatives for the reduction of effluent discharge from nonpoint sources into water basins (Harrington et al., 1985; Hahn and Hester, 1989; Freeman III, 1992; Letson et al., 1993; Stephenson and Shabman, 1996; EPA, 2000, 2001).

Although there have been critical voices with regard to the viability of trading programs (Letson, 1992; Crutchfield et al., 1994; Malik et al., 1994; Colby, 2000), there is an anomaly with regard to their potential for addressing nonpoint source effluent discharges. Even though reviews of the few existing point/nonpoint source nutrient trading programs draw the conclusion that these programs have not been successful, there still remains an unbridled enthusiasm and support for these programs as evidenced by the number of programs under development for both large and small water basins (EPA, 2001). This paper is an analysis of this anomaly. Why is there such fervent support for discharge trading programs in spite of the consistent lack of success of these programs in practice? Can these programs be successful and fulfill their promise or are they like the Northwest Passage, a promising concept with little practical utility?

The paper begins with an introduction to tradable permit programs, including a description of the economic efficiency argument which makes these programs popular as a policy
alternative. This section is followed by a description of the relationship between property rights, and how assignment of these rights affect the performance of tradable permit schemes. The performance of one point/nonpoint nutrient trading program (the Tar-Pamlico river basin) is discussed to demonstrate how the assignment of property rights, or rather the problems associated with assigning these rights, affect program success. The final section summarises the argument and draws conclusions.

** Tradable permit programs**

The use of trading programs in pollution control originated with air pollution control programs in the US in the mid-1970s. The success in these programs led to enthusiasm for their application to other pollution areas, such as water quality and the discharge of effluents (Faeth, 2000). There is a well documented “increasing interest in using incentive-based mechanisms, such as tradable permits, to achieve environmental goals” (Hahn, 2000). In Table 1 below, the current status of projects described in a recent EPA report lists more than 30 effluent trading programs approved, implemented or under development (EPA, 2001). However, with regard to these programs this report concludes that “Despite many academic studies showing the potential benefit of effluent trading and considerable effort by EPA and the states to implement the concept, effluent trading has yet to live up to its full promise” (EPA, 2001).

**The efficiency of trading**

Pollution trading programs are a market oriented environmental policy. They offer an opportunity for least cost solutions by providing flexibility in the allocation of abatement measures within the set of possible measures. In principle, trading offers an unconstrained set of solutions bounded only by caps on the resource or individual sources, and transaction costs. All technological solutions may be found within this solution set, trades reveal which combination is the least cost alternative. Regulated solution alternatives based on existing technology are a subset of the possibilities within a trading program but may not represent efficient points within that set.

Assume, as an illustration, that there are two sources of N loading (point source and agricultural nonpoint source) within a water basin. In Figure 1 the load from each source is read along the respective axis. The current total load in the basin is point A, with nonpoint sources contributing L_{NPS} and point sources contributing L_{PS}. A load limit (“cap”) placed on total discharge from all sources set at 50% of present total discharges is represented by the line T_{NPS} – T_{PS}. The slope of the line describes the trading ratio between the two sources (see Malik et al., 1993). Points below and along this line define the entire set of acceptable loads given this cap. They represent the most flexible set of solutions.

If positive costs for abatement are assumed for each sector and there are no possibilities for banking reductions (reductions from one period cannot be carried as credits to following periods), then efficient solutions lie along this line. In addition, if property rights are assigned for N-loading based on this cap then this point also is somewhere on this line. Making these property rights tradable allows for movement from the initial allocation to

<table>
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<tr>
<th>Project stage</th>
<th>Number of current projects</th>
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<tbody>
<tr>
<td>Implementation</td>
<td>16</td>
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<tr>
<td>Approved</td>
<td>6</td>
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<tr>
<td>Under development</td>
<td>9</td>
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<td>Other stages</td>
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<td>Total</td>
<td>35</td>
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points along the line. There may be movement from the original load assignation if there is a difference in the value of the assigned load by source. This difference in value, if present, would be due to varying abatement costs for each source. In general, it is assumed that abatement costs are lower for nonpoint sources; in particular, that abatement costs vary greatly between site specific nonpoint sources depending on weather, proximity to water courses, physical characteristics and land use.

If transaction costs, including information costs, are assumed to be internalised by each source, then movement from the initial allocation, driven by the exploitation of comparative abatement cost advantages, leads to trade and a new point along the line. This point represents new load levels by sector but it is still within the cap. In theory, the “invisible hand” of economic efficiency leads to movement driven by exploitation of economic opportunity, until a point is defined where there are no abatement cost advantages left to exploit. At this point, the marginal cost of abatement is equal across all sources. This represents the global least cost solution, the minimum total expenditures needed to achieve a given load cap. Knowledge of abatement cost functions, represented by the total abatement expenditures curve, for dischargers could also be used by regulators to determine this economic efficient distribution of loads as well (“command and control”). If this were the case, and treatment of transaction costs were the same as for the trading solution (assumed to be zero), then the two policies are equally efficient.

Given the set of assumptions described above, a tradable discharge permit policy always leads to a global least cost solution. It is trivial to show that comparison of this result with any policy which includes additional constraints, can only confirm the cost efficiency (cost savings) of tradable permit policies. Assuming for example, that as in Figure 2, the cap is still set at 50% but each source is constrained to reduce load discharges by at least 25% from their original load level (A) and where trading is allowed for the remainder based on

Figure 1 N-loading by source in a water basin with a total load cap

Figure 2 N-loading by source in a water basin with a total load cap, and source caps
permits, then the set of efficient solutions is reduced to the set of solutions bordered by the bold line in Figure 2, line \( T_{\text{NPS}} - T_{\text{PS}} \). In Figure 2, the cap set on nonpoint sources is not binding, as the total load cap restricts the load from these sources by more than 25% of the pre-cap levels. However, there is no guarantee that the global least cost solution, minimum total abatement expenditures (Figure 1), will lie along this line segment. The cost savings advantage of the tradable system is that it offers an inclusive solution set, complete flexibility, given only one constraint, the total load cap. Other types of loading constraints, such as source caps or other types of source regulation, lead to a loss in flexibility of the type shown in Figure 2. This simple example of the efficiency of trading between two sources can be extended and applied generally.

In summary, trading systems have the greatest value (are the most useful) when abatement costs for individual producers are different from each other and where the marginal abatement costs are known to the individual producer but this information is not available to other producers or regulators. Studies which compare trading programs with other policy alternatives result in cost savings from tradable permit policies (see Faeth, 2000 for example) for the reasons described above. This cost savings, based on the flexibility of trading programs, is the economic efficiency argument which is one of the factors that explains the popularity of these programs among policymakers. However, the argument rests on quantitative identification of loads by source.

**Property rights and tradable permit programs**

“Rights are antecedents to markets. You cannot exchange what is not publicly acknowledged as yours.” (Schmid, 1995).

**Water quality and property rights.** The concept of excludability endows a right to the use of a resource. Excludability is possible either in an institutional setting of rights and duties or in the absence of institutions, in a Darwinian world of guile, cunning and physical strength. While certain aspects of the latter are even possible in an institutional setting, the very existence of institutionalized rights is the attempt to limit their viability. The possibility of limiting access to a good (excludability) implies institutionally a set of defined rights.

The assignation of rights “depends on many factors including the objectives of management, the physical characteristics of the resource, the benefits generated by the stock and flow of the resource, history and the institutional environment.” (Grafton, 2000). However, it is the state as an arbitrator of rivalry over resource, use which makes market solutions possible through the assignation of rights. Schmid (1995) concludes that the “Government (some collective process) determines who is owner (seller) and who is non-owner (buyer), that is, who can coerce whom. Rights are a public phenomenon.”

Water quality refers to a bounded system of some sort, a water basin for example. The complexity of the system in many instances makes setting boundaries difficult when it comes to water quality. Flows within the basin may be limited, simple, extensive, linear directionally or multiple and complex. When we try to describe how water quality may be appropriated we also face a problem.

For some users water quality is a relevant description of a characteristic that affects appropriation rates, for others this description is not applicable. For dischargers, water systems are sinks which are impacted by their activities but which do not regulate the rate of these activities. Water quality is not important as a direct attribute to this group but only in the respect that it either directly impacts their consumption activities (recreation or withdrawal) or indirectly impacts their activities through pressure from other groups of appropriators. The capacity of a water system to absorb flows of nutrients such as nitrate and still physically maintain absorption capabilities is relatively open if other attributes are disregarded.
Property rights and the design of tradable permit programs. As described above, well defined and allocated pollution rights for individual emission sources when combined with pollution controls which lead to scarcity of rights for producers and low transaction costs for trading, can produce a distribution of abatement measures which from a social perspective are the most economically advantageous. The movement from one system of rights and responsibilities to a new system is dependent on the state and the use of its authority. Action by the state is a necessary condition for implementation of a market for pollution permit trading. The role of the state is to determine an environmental quality standard, assign rights, enforce the standard and defend rights.

The state has generally been able to determine an environmental quality standard for the water resource, such as a standard based on ambient qualities, and to a reasonable degree is able to monitor compliance with the standard. However, the other three roles listed above are inextricably tied together which makes performance of the role for the state dependent on its ability to monitor dischargers. Enforcement of the standard demands that violators can be identified, and if the violation is due to an abuse of assigned rights, that the abuse be quantifiable by source. For point sources identification is not problematic and a number of policy alternatives exist which can lead to reductions in the discharge of effluents, including tradable permit programs. However, for nonpoint sources the difficulty (high cost) of identification is what characterizes these as a category as differentiated from point sources. As noted by (Malik et al. (1994), there are several characteristics “which distinguish NPS water pollution from point source pollution. First NPS loadings cannot be monitored at the individual farm or source level … Second, there is imperfect knowledge about the relationship between loadings and farm-level input choices and management practices. Third, loadings depend in part on random variables such as wind, rainfall, and temperature.”

The efficiency argument for trading programs assumes that there is a quantifiable measure, a load, which is common for both point and nonpoint sources. Loading is the basis for establishing caps and as such is the defining factor for the value of trading. A paper by Malik et al. (1994) identifies the problem of measurement in trading programs explicitly, “Since nonpoint loadings cannot be measured, they cannot be traded directly.” Permits and hence tradable permit systems have no value unless they refer to a specific quantifiable loading. This quantity provides the measure which makes allocation of property rights possible based on ambient water quality defined as a limit on loading.

The difficulty in the identification of the boundaries necessary for making an assignment of rights possible, is precisely that problem which originally led to the classification of these sources as nonpoint! As Schmid (1995) acutely observes “The boundary of owners whose consent is necessary for change is what rights are all about.” The paradox of the problem is that, if rights could be assigned to nonpoint sources they would no longer be regarded as nonpoint sources and since rights can’t be assigned, they can’t be transferred. Trading programs remain an elusive paper exercise based on a rhetoric which transforms the concepts of discharge source trading into practice as a set of emission taxes where tax revenue is earmarked for specific purposes.

Tar-Pamlico basin. In 1990, a trading program was implemented in the Tar-Pamlico basin (North Carolina) as part of a nutrient management program. The trading program was designed to make it possible for an association of point source dischargers, representing wastewater treatment plants, to trade nutrient loads with nonpoint sources, farmers. The factor which would motivate trading was the difference in abatement costs for the two sources, the point sources facing high costs for abatement, the nonpoint sources low costs. Association members could choose to offset discharges above their limits by trading
with nonpoint sources at a fixed trading ratio and price (Hoag and Hughes-Popp, 1997; NCEMC, 2000; EPA, 2001).

This potential trade between the point sources and the nonpoint sources has been described as a “hybrid of a trading program and an effluent tax, since the credits are purchased at a fixed price and there is no direct connection between the credits needed by the point sources and the credits generated by the nonpoint source program” (Faeth, 2000). Based on this description, while the effluent tax part of the program is pretty clear, it is difficult to understand why there is a reference here to it being a trading program. The program was designed to channel fees paid for discharges from point sources to another program which in turn could use the funds to support measures which could reduce discharges into the same basin. As noted above, the credits were not even generated by the nonpoint sources but by the nonpoint source program! The fees were really an emissions tax on point sources with the tax earmarked for use in a specific related area. Fees and taxes of this nature are not at all uncommon but are not generally referred to as a “trading program”. A program of this type is actually a subsidy scheme as there is no reciprocity in the transactions (see Malik et al., 1994). It may more accurately be described as a “tradeoff” between source controls, with levels of control determined by a regulating agency (see Freeman III, 1992).

While there were administrative trades recorded during Phase 1 of the program (1990–1994), an actual trade between sources in the Tar-Pamlico basin could never take place because of the problem of assigning rights to discharge sources. Point source dischargers were faced with a dichotomous choice; either pay a fee for effluent discharges above the individual source cap or invest in abatement measures which would keep discharges under the cap. Nonpoint sources could either choose to invest in effluent reducing BMPs or continue with present operations (not invest). Since the introduction of BMPs would likely lead to reductions in income (see Lee, 1998) the choice to invest included a subsidy, cost-sharing, as an inducement to adopt the BMP. There was no connection between these choices by individual sources, no interdependency in the choices.

In an extensive review of the program (Hoag and Hughes-Popp, 1997), discussion of the effect of property rights on trading is included. While the authors acknowledge that markets based on property rights which are not the same for buyers and sellers are not realistic, this is not included in their summary of factors which affected trading in the Tar-Pamlico program. The “wishful thinking” in this review is that what was needed for making the trading program successful was improved information on the correlation of nonpoint discharges and BMPs (converting these sources to point sources!) to get the prices right and make trading attractive (Hoag and Hughes-Popp, 1997).

An alternative method for evaluating the performance of the trading program is to ask what decisions would change for point and nonpoint sources if the possibility of trading had not been included in the nutrient management program for the basin. Under present conditions the point source cap is not binding (see NCEMC, 2000) so there is no trading taking place and it is trivial to point out that removal of trading possibilities would have no effect. During Phase 1 when transactions took place which were recorded as trades, removing the possibility for sources to engage in trading would not have changed the decisions made by the sources. The point source decision was based only on their own abatement costs and the per unit emission fee imposed by the program. The decision was independent of how fee payments were to be used. The nonpoint source decision was based on the costs of adopting BMPs and the income support available. The decision was independent of the source of support program funding. Decisions made by individual sources were independent of each other. Trading between sources defined as a transfer of ownership between sources never took place, therefore, a removal of the program would have had no effect.
The transaction costs associated with the uncertainty of quantifying nonpoint source reductions (BMPs) made the evolution of a trading market impossible or at best an example of what (Malik et al., 1994) meant when they commented that in the presence of high transaction costs “trading is more likely to resemble a bargaining process than a competitive market.” In spite of the fact that the Tar-Pamlico trading program was not a tradable permit program but rather an emissions fee policy, it has “served as a nationwide benchmark” for nutrient trading programs (NCEMC, 2000).

**Summary and conclusions**

 Tradable discharge permit programs are economically efficient if transaction costs are internalized and individual abatement cost functions are known to permit holders (owners). This latter condition is the information needed to motivate trading. Least cost solutions are possible even when this information is not publicly known. However, discharge loads need to be quantifiable before permits can be allocated, that is, before property rights to these loads can be assigned to individual dischargers. The permits must have a common unit of measure to define value for the buyer and seller. Nonpoint source discharges of effluents are by definition difficult (expensive) to identify by individual source. If identification, monitoring, were possible (economically feasible) these individual dischargers would no longer be defined as nonpoint sources. In this case, trading programs between these point sources could lead to the efficiency gains made possible by these types of policies with respect to other types of policy solutions. However, if identification of sources and related abatement costs are public information, then there are also a number of policy alternatives which can lead to the same least cost solution. The only difference between these policies would be in the administrative and transaction costs unique to each policy.

Why then, the undaunted support for trading programs as the preferred solution in spite of their demonstrated lack of success over the last 15 years? For economists, the economic efficiency argument is attractive and has proven to be successful in point source applications, most notably for air quality improvement. For agronomists and hydrologists, the trading program argument for better models to identify discharge sources and rates, including transport and fate, validates and supports continued research in these areas. For policymakers, trading programs represent a political possibility for implementing programs based on market arguments and individual property rights, both of which are, in principle, acceptable to their constituencies. Dischargers would prefer to see themselves as owners of valuable resources rather than as perpetrators of environmental degradation subject to regulation. A tradable discharge permit policy increases the property rights of permit holders, regulatory policy diminishes the existing property rights of dischargers. This coincidence of interests among scientists, policymakers and dischargers, leads to support for nonpoint nutrient emission trading programs and the promise of an efficient path to water quality improvement. It may be time to ask whether this isn’t really the promise of a “Northwest Passage”, an attractive idea without practical utility.

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**References**