

Tietenberg, Tom

Working Paper

The tradable permits approach to protecting the commons: What have we learned?

Nota di Lavoro, No. 36.2002

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Tietenberg, Tom (2002) : The tradable permits approach to protecting the commons: What have we learned?, Nota di Lavoro, No. 36.2002, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/119646>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Fondazione Eni Enrico Mattei

The Tradable Permits Approach to Protecting the Commons: What Have We Learned?

Tom Tietenberg

NOTA DI LAVORO 36.2002

JUNE 2002

CLIM- Climate Change Modelling and Policy

Tom Tietenberg, *Colby College, Department of Economics*

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:

http://www.feem.it/web/attiv/_attiv.html

Social Science Research Network Electronic Paper Collection:

http://ssrn.com/abstract_id=XXXXXX

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei

The Tradable Permits Approach to Protecting the Commons: What Have We Learned?

Summary

This essay reviews the implementation experience with three main applications of tradable permit systems: air pollution control, water supply and fisheries management. Opening with a brief summary of the theory behind these programs and both the economic and environmental consequences anticipated by this theory, it proceeds with a description of the common elements these programs share and the design questions posed by the approach. These include the setting of the limit on access, the initial allocation of rights, transferability rules (both among participants and across time) as well as procedures for monitoring and enforcement. It continues by examining how these design questions have been answered by these three applications and how the answers have been influenced by changing technology, increased familiarity with the system and a desire to respond to some of the controversies surrounding the use of these approaches. The hard evidence on the economic and environmental consequences of adopting these approaches is juxtaposed with the expectations created by the economic theory of tradable permits. The final section draws together some tentative lessons that can be drawn from this experience.

Keywords: Emissions trading, individual tradable quotas, water rights, pollution control policy, economic incentives, tradable permits

JEL: Q22, Q25, Q28

Address for correspondence:

Tom Tietenberg
Mitchell Family Professor of Economics
Department of Economics
5242 Mayflower Hill Drive
Colby College
Waterville, ME 04901-8852
Phone: (207) 872-3143
Fax: (207) 872-3263
E-mail: thtieten@colby.edu

This paper has been presented at the 1st Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, December 3-4, 2001.

The author is indebted to Gary Liebcap, Nives Dolsak and two anonymous reviewers for helpful comments on a previous draft.

The Tradable Permits Approach to Protecting the Commons: What Have We Learned?

INTRODUCTION

BACKGROUND

One of the new institutional approaches for coping with the problem of rationing access to the commons involves the use of tradable permits. Applications of this approach have spread to many different types of resources and many different countries. A recent survey found 9 applications in air pollution control, 75 applications in fisheries, 3 applications in managing water resources, 5 applications in controlling water pollution and 5 applications in land use control. [OECD, 1999, Appendix 1, pp. 18-19]. And that survey failed to include many current applications.¹

Tradable permits address the commons problem by rationing access to the resource and privatizing the resulting access rights. The first step involves setting a limit on user access to the resource. For fisheries this would involve the total allowable catch. For water supply it would involve the amount of water that could be extracted. For pollution control it typically specifies the aggregate amount of emissions allowed in the relevant control region. This limit defines the aggregate amount of access to the resource that is authorized. These access rights are then allocated on some basis (described below) to potential individual users. Depending on the specific system these rights may be transferable to other users and/or bankable for future use. Users who exceed limits imposed by the rights they hold face penalties up to and including the loss of the right to participate.

These approaches have been controversial.² The controversy arises from several sources, but the most important concerns the allocation of the wealth associated with these resources. While these approaches typically do not privatize the resources, as conventional wisdom might suggest, they do privatize at least to some degree access to (and use of) those resources. And because the access rights can be very valuable when the resource is managed efficiently, the owners of these rights may acquire a substantial amount of wealth. While the ability to reclaim the previously dissipated wealth for motivating sustainable behavior is an important strength of the system, the ethical issues raised by its distribution among competing claimants are a significant and continuing source of controversy. (Mc Cay 1999)

Another source of controversy involves a broad class of externalities. In general externalities are effects on the ecosystem or on other parties that are not adequately reflected in the decisions by those holding the

¹ Three examples of existing programs that did not make the list include the NOx Budget air pollution control program in the Northeastern US (Farrell, Carter et al. 1999), programs to control conventional air pollutants in several states (Solomon and Gorman 1998) and the EU carbon trading proposals. For a large on-line bibliography covering these systems see <http://www.colby.edu/personal/t/ttieten/>.

² Consider just three examples. In air pollution control a legal challenge was brought in Los Angeles during June 1997 by the Los Angeles-based Communities for a Better Environment. (Tietenberg 1995a). In fisheries a challenge was brought against the halibut/sablefish tradable permits system in Alaska. (Black 1997) and Congress imposed a moratorium on the further use of a tradable permits approach in US fisheries. (National Research Council Committee to Review Individual Fishing Quotas 1999). Though both legal cases were ultimately thrown out, as of this writing the moratorium is still in effect, despite a recommendation by the National Research Council to lift it.

access rights. This incomplete internalization of externalities could involve such diverse concerns as adverse effects on species of fish other than those regulated by tradable permits, on the spatial concentration of emissions, or on the consequences of particular upstream water uses on downstream users.

A final source of controversy is ideological. It suggests that since capitalist property rights are the major source of the problem, it is inconceivable that these same rights could be part of the solution.³

OVERVIEW

In this essay I review the experience with three main applications of tradable permit systems: air pollution control, water supply and fisheries management.⁴

The next section provides a brief summary of the theory behind these programs and both the economic and environmental consequences anticipated by this theory. Some brief points of comparison are made with other competing and/or complementary formal public policy strategies such as environmental taxes and legal regulation.

The essay proceeds with a description of the common elements these programs share and the design questions posed by the approach. These include the setting of the limit on access, the initial allocation of rights, transferability rules (both among participants and across time) as well as procedures for monitoring and enforcement. It continues by examining how these design questions have been answered by the air pollution, fishery and water supply applications and how the answers have evolved over time. This evolution has been influenced by changing technology, increased familiarity with the system and a desire to respond to some of the controversies surrounding the use of these approaches.

The penultimate section examines the hard evidence on the economic and environmental consequences of adopting these approaches. This evidence is juxtaposed with the expectations created by the economic theory of tradable permits.

The final section draws together some tentative lessons that can be drawn from this experience.

THE BASIC ECONOMIC THEORY

VALUE MAXIMIZING, SUSTAINABLE POLICY INSTRUMENTS

One of the insights derived from the empirical literature is that traditional command-and-control regulatory measures, which depended upon government agencies to both define the goals and the means of meeting them, were, in many cases, insufficiently protective of the value of the resources.⁵ One of the principal theorems of environmental economics demonstrates that under specific conditions an appropriately defined tradable permit system can maximize the value received from the resource, given the sustainability constraint. (Baumol and Oates 1971; Baumol and Oates 1988)

The logic behind this result is rather simple. In a perfectly competitive market permits will flow toward their highest valued use. Those that would receive lower value from using the permits (due to higher costs, for example), have an incentive to trade them to someone who would value them more. The trade

³ One author, for example, compares a tradable permits system to the sale of indulgences in the Middle Ages. (Goodin 1994)

⁴ For a previous survey that also examines tradable permit systems across resource settings see Colby (2000).

⁵ For a detailed explanation of the circumstances leading to the increasing evolution of market-based approach to pollution control. See Tietenberg, Button et. al. (1999)

benefits both parties. The seller reaps more from the sale than she could from using the permit and the buyer gets more value from the permit than he pays for it.

A rather remarkable corollary (Montgomery, 1972) holds that this theorem is true regardless of how the permits are initially allocated among competing claimants. It is true regardless of whether permits are auctioned off or allocated free-of-charge. Furthermore when permits are allocated free-of-charge, any particular initial allocation rule can still support a cost/effective allocation. Again the logic behind this result is rather straightforward. Whatever the initial allocation, the transferability of the permits allows them to ultimately flow to their highest valued uses. Since those uses do not depend on the initial allocation, all initial allocations result in the same outcome and that outcome is cost/effective.

The potential significance of this corollary is huge. It implies that with tradable permits the resource manager can use the initial allocation to solve other goals (such as political feasibility or ethical concerns) without sacrificing cost/effectiveness. In Alaskan fisheries, for example, some of the quota has been allocated to communities (rather than individuals) to attempt to protect community interests.⁶ (Ginter 1995)

PRECONDITIONS

Tradable permits systems may not maximize the value of the resource if the market conditions are not right. Circumstances when the conditions may not be right include the possibility for market power (Hahn 1984), the presence of high transaction costs (Stavins 1995) and insufficient monitoring and enforcement⁷. Because tradable permits involve an aggregate limit on access, however, the consequences of market power and/or high transactions cost typically affect costs more than environmental quality. Furthermore even in the presence of these imperfections, tradable permit programs can be designed to mitigate their adverse consequences.⁸

Without effective enforcement permit holders who don't get caught may gain more by cheating than by living within the constraints imposed by their allocated permits. In contrast to the two previous mentioned imperfections, this one could lead to the degradation of the resource because the aggregate limit could be breached.

Another important precondition involves the absence of large uninternalized externalities.⁹ The presence of uninternalized externalities would imply that maximizing the net benefits of permit holders would not necessarily maximize net benefits for society as a whole even with a fixed environmental target. For example, fishermen might catch the specified amount of the covered species, but they might use gear that destroys other components of the marine ecosystem. Polluters that reduce a covered pollutant by switching inputs could well increase emissions of another unregulated pollutant. The regulation could serve to protect one environmental resource at the expense of another.

⁶ Unfortunately the usefulness of this corollary is limited whenever more than one goal needs to be satisfied by the initial allocation. This is commonly the case, for example, when the resource managers want to use the initial allocation both to build enough support to implement the program and to treat all claimants fairly. The allocations that satisfy each of those two goals may be quite different.

⁷ Inadequate monitoring and enforcement, of course, plagues all policy instruments, not just tradable permit systems.

⁸ In the case of market power in fisheries the maximum number of permits that can be held by any individual or defined group is routinely limited by regulation. (National Research Council Committee to Review Individual Fishing Quotas 1999) In the case of transactions cost it is possible to design administrative systems so as to minimize these costs. (Tietenberg 1998d)

⁹ Uninternalized externalities plague most other policy instruments as well. This precondition is not meant to differentiate tradable permit systems from other approaches, but, rather, to point out the conditions under it works more smoothly.

DESIGN CONSIDERATIONS

THE BASELINE ISSUE

In general tradable permit programs fit into one of two categories: a credit program or a cap-and-trade program. The credit program involves a relative baseline. With a credit program an individual access baseline is established for each resource user. The user who exceeds legal requirements (say by harvesting fewer fish than allowed or emitting less pollution than allowed) can have the difference certified as a tradable credit.

The cap-and-trade program involves an absolute baseline and trades allowances rather than credits. In this case a total resource access limit is defined and then allocated among users. Air pollution control systems and water have examples of both types. Fisheries tradable permit programs are all of the cap-and-trade variety.

Credit trading, the approach taken in the Emissions Trading Program (the earliest program) in the United States, allows emission reductions above and beyond legal requirements to be certified as tradable credits. The baseline for credits is provided by traditional technology-based standards. Credit trading presumes the preexistence of these standards and it provides a more flexible means of achieving the aggregate goals that the source-based standards were designed to achieve.

Allowance trading, used in the US Acid Rain Program assigns a prespecified number of allowances to polluters. Typically the number of issued allowances declines over time and the initial allocations are not necessarily based on traditional technology based standards; in most cases the aggregate reductions implied by the allowance allocations exceed those achievable by standards based on currently known technologies.

Despite their apparent similarity the difference between credit and allowance-based trading systems should not be overlooked. Credit trading depends upon the existence of a previously determined set of regulatory standards. Allowance trading does not. Once the aggregate number of allowances is defined, they can, in principle, be allocated among sources in an infinite number of ways. The practical implication is that allowances can be used even in circumstances: (1) where a technology-based baseline either has not been, or cannot be, established or (2) where the reduction is short-lived (such as when a standard is met early) rather than permanent.

The other major difference is that cap-and-trade programs generally establish an upper aggregate limit on the resource use, while the credit programs establish only an upper limit for each user. In the absence of some other form of control over additional users, an increase in the number of users can lead to an increase in aggregate use and the eventual degradation of the resource.

THE LEGAL NATURE OF THE ENTITLEMENT

Although the popular literature frequently refers to the tradable permit approach as “privatizing the resource” (Spulber and Sabbaghi 1993; Anderson 1995), in most cases it doesn’t actually do that. One compelling reason in the United States why tradable permits do not privatize these resources is because that could be found to violate the well-established “public trust doctrine”. This common law doctrine suggests that certain resources belong to the public and that the government holds them in trust for the public; they can’t be given away.¹⁰

Economists have consistently argued that tradable permits should be treated as secure property rights to protect the incentive to invest in the resource. Confiscation of rights could undermine the entire process.

The environmental community, on the other hand, has just as consistently argued that the air, water and fish belong to the people and, as a matter of ethics, they should not become private property. (Kelman, 1981a) In this view no end could justify the transfer of a community right into a private one. (McCay 1998)

The practical resolution of this conflict has been to attempt to give “adequate” (as opposed to complete) security to the permit holders, while making it clear that permits are not a property rights.¹¹ For example according to the title of the US Clean Air Act dealing with the sulfur allowance program:

“An allowance under this title is a limited authorization to emit sulfur dioxide....Such allowance does not constitute a property right. (104 Stat 2591)

In practice this means that administrators are expected to recognize the security needed to protect control investments by not arbitrarily confiscating rights. They do not, however, give up their ability to change control requirements as the need arises. In particular they will not be inhibited by the need to pay compensation for withdrawing a portion of the authorization to emit as they would if allowances were accorded full property right status. It is a somewhat uneasy compromise, but it seems to have worked.

ADAPTIVE MANAGEMENT

One of the initial fears about tradable permit systems is that they would be excessively rigid, particularly in the light of the need to provide adequate security to permit holders. Policy rigidity was seen as possibly preventing the system from responding either to changes in the resource base or to better information. And this rigidity could seriously undermine the resilience of biological systems. (Hollings 1978)

Existing tradable permit systems have responded to this challenge in different ways depending on the type of resource being covered. In air pollution control the need for adaptive management is typically less immediate and the allowance is typically defined in terms of tons of emissions. In biological systems, such as fisheries, the rights are typically defined as a share of the TAC. In this way the resource managers can change the TAC in response to changing biological conditions without triggering legal recourse by the right holder.¹² Some fisheries actually have defined two related rights.(Young 1999) The first conveys

¹⁰ For example, Article XIV of the California Constitution of 1879 denied the ownership of water to individuals and granted them a usufructory right- the right to the *use* of the water. (Blomquist 1992). The 1981 Water Code in Chile stipulates that water is a national resource for public use, but rights to use water can be granted to individuals. (Hearne 1998)

¹¹ One prominent exception is the New Zealand ITQ system. It grants rights in perpetuity. (National Research Council Committee to Review Individual Fishing Quotas 1999, . p. 97)

¹² Compare this case with a case where the rights were defined in tons. If biological conditions indicated the need to lower the TAC significantly, the need to confiscate existing rights might trigger suits seeking compensation against the resource manager.

the share of the TAC, while the second conveys the right to catch a specific number of tons of harvest in a particular year. Separating the two rights allows a harvester to sell the right to catch fish in a particular year (perhaps due to an illness or malfunctioning equipment) without giving up the right of future access.¹³

Water has a different kind of adaptive management need. Considerable uncertainty among users is created by the fact that the amount of water can vary significantly from year to year.¹⁴ Since different users have quite different capacities for responding to shortfalls, the system for allocating this water needs to be flexible enough to respond to this variability or the water could be seriously misallocated.

These needs have been met by a combination of technological solutions (principally water storage) and building some flexibility into the rights system. In American west the appropriation doctrine that originated in the mining camps created a system of priorities based upon the date of first use. The more senior rights then have a higher priority of claim on the available water in any particular year and consequently could be expected to claim the highest price.¹⁵ (Howe and Lee 1983; Livingston 1998) Other systems, most notably in Australia, use a system of proportionality that resembles the share system in fisheries. (Livingston 1998)

An alternative approach to flexibility with security, the “drop-through mechanism” involves a cascade of fixed term entitlements, a variation of an approach currently used in the New South Wales fishery. (Young 1999) and proposed for use in controlling climate change. (Tietenberg 1998) Under this scheme initial entitlements (call them Series A Entitlements) would be defined for a finite period, but one long enough to encourage investments (say, for the sake of illustration, 30 years). (Figure 1) The rights and obligations covered by the Series A entitlements would be known in advance.¹⁶ Periodically (say, for illustration, every ten years) a comprehensive review would be undertaken which would result in a new set of entitlements (Series B, Series C, etc) which would also have a 30 year duration. Emitters holding Series A Entitlements could have the option to switch to the new set of entitlements at any time earlier than the expiration of their Series A Entitlements. Once they switched they would be able to hold Series B Entitlements for their remaining life. This process would continue until such time as it appeared no more reviews were necessary.

Insert Figure 1

CAPS AND SAFETY VALVES

In all three applications the limits are defined on the basis of some notion of sustainable use. In air pollution control the limits are defined so as to assure that the resulting concentrations fall below the Ambient Air Quality Standards (AAQS). The primary AAQS are defined so as to protect human health.¹⁷ In water the aggregate limit is typically based upon expected water flow. (Easter, Dinar et al. 1998). In formal tradable permit fisheries the governing body routinely estimates the size of the fish stocks to

¹³ Other systems achieve this result by allowing rights holders to lease the rights to others for a specific period of time.

¹⁴ Livingston reports on an unpublished World Bank survey that found that out of 35 developing countries examined, more than half had rainfall variability of 40%. (Livingston 1998)

¹⁵ In the western US, the number of rights expected to be fulfilled in any given year is determined by snowpack measurements and satellite monitoring of streamflows. (Livingston 1998)

¹⁶ The scheme is sufficiently flexible that entitlements could rise over time, fall over time or be constant. The main condition is that the time path be specified for the duration of that particular series.

¹⁷ Some programs have additional requirements. In the lead phaseout program the annual limits declined over time until, in the final year, they went to zero. (Nussbaum 1992). In the RECLAIM program in Los Angeles the limits decline 8% per year. (Fromm and Hansjurgens 1996; Zerlauth and Schubert 1999)

determine the amount of fish that can be harvested in a given year so that fisheries can be sustained; this amount is termed the “allowable biological catch” (ABC). The catch level that fishermen are allowed to take, the Total Allowable Catch, would normally be equal to or less than the ABC. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 3)

In pollution, unlike fisheries, the cap is rather rigidly defined. One question that arises is how does this approach handle unexpected, and sometimes rather large, changes in circumstances that can cause the cost of achieving the cap to skyrocket. The general prescription is to allow a “safety valve” in the form of a predefined penalty that can be imposed on all emissions over the cap in lieu of meeting the cap. This penalty can be different from the normal sanction imposed for noncompliance during more normal situations. In effect this penalty would set a maximum price that would have to be incurred in pursuit of environmental goals. (Pizer, 1999)

This is not an idle concern as became clear in Los Angeles this summer. The rules that set up RECLAIM specified that if permit prices went over some threshold the program would be suspended until they figured out what to do. This summer due to a confluence of forces, including electricity deregulation, power plants were required to run full tilt and permit prices skyrocketed. An alternative fee per ton has been imposed in the interim.

INITIAL ALLOCATION METHOD

The initial allocation of entitlements is perhaps the most controversial aspect of a tradable permits system. Four possible methods for allocating initial entitlements are:

- Random access (lotteries)
- First-come, first served
- Administrative rules based upon eligibility criteria
- Auctions

All four of these have been used in one context or another. Both lotteries and auctions are frequently used in allocating hunting permits for big game. Lotteries are more common in allocating permits among residents while auctions are more common for allocating permits to non-residents. First-come, first-served was common historically for water when it was less scarce. The most common method, however, for the applications discussed here is allocating access rights based upon historic use.

Two justifications for this approach are typically offered¹⁸. First, it enhances the likelihood of adoption.¹⁹ Not only does allocating entitlements to historic users cause the least disruption from historic patterns, but it involves a much smaller financial burden on users than an auction.²⁰ (Lyon 1982; Tietenberg 1985;

¹⁸ An interesting third possibility by examination of the air pollution control experience in Chile. (Montero, 200). Apparently the use of a grandfathered system of allocation coupled with the high rents from holding those permits induced a number of previously undiscovered sources to admit their emissions in order to gain entry to the program.

¹⁹ For example, assigning rights in this way is considered one factor in how the US was able to implement a system to control acid rain after many years of failed attempts. (Kete 1992)

²⁰ From the point of view of the user, two components of financial burden are significant: (1) extraction or control costs and (2) expenditures on permits. While only the former represent real resource costs to society as a whole (the latter are merely transfers from one group in society to another), to the user both represent a financial burden. The empirical evidence suggests that when a traditional auction market is used to distribute permits (or, equivalently, when all uncontrolled emissions are subject to an emissions tax), the permit expenditures (tax revenue) would frequently be larger in magnitude than the control costs; the sources would spend more on permits (or pay more in taxes) than they would on the control equipment (Tietenberg 1985)

Hausker 1990; Grafton and Devlin 1996) Second, it allocates permits to those who have made investments in resource extraction. In this sense it serves to recognize and to protect those investments.²¹

In the absence of either a politically popular way to use the revenue or assurances that competitors will face similar financial burdens, distributing the permits free-of-charge to existing sources could substantially reduce this political opposition. Though an infinite number of possible distribution rules exist, “grandfathered” rules tend to predominate. Grandfathering refers to an approach that bases the initial allocation on historic use. Under grandfathering, existing sources have only to purchase any additional permits they may need over and above the initial allocation (as opposed to purchasing all permits in an auction market).

Grandfathering has its disadvantages. Recent work examining how the presence of preexisting distortions in the tax system affects the efficiency of the chosen instrument suggests that the ability to recycle the revenue (rather than give it to users) can enhance the cost-effectiveness of the system by a large amount. That work, of course, creates a bias toward taxes or auctioned permits and away from “grandfathered” permits. (Goulder, et. al., 1999) How revenues are distributed, however, also affects the attractiveness of alternative approaches to environmental protection from the point of view of the various stakeholders. To the extent that stakeholders can influence policy choice, “grandfathering” may have increased the feasibility of implementation. (Svendsen 1999) On the other hand the empirical evidence suggests that the amount of the revenue needed to hold users harmless during the change is only a fraction of the total revenue available from auctioning. (Bovenberg, et al., 2000) Grandfathering is apparently not inevitable, even from a political feasibility point of view.

A second consideration involves the treatment of new firms. Although reserving some permits for new firms is possible, this option is rarely exercised in practice. As a result under the free distribution scheme new firms typically have to purchase all permits, while existing firms get an initial allocation free. Thus the free distribution system imposes a bias against new users in the sense that their financial burden is greater than that of an otherwise identical existing user. In air pollution control this “new user” bias has retarded the introduction of new facilities and new technologies by reducing the cost advantage of building new facilities that embody the latest innovations.²² (Maloney and Brady 1988; Nelson, Tietenberg et al. 1993)

Other initial allocation issues involve determining both the eligibility to receive permits and the governance process for deciding the proper allocation.²³ Controversies have arisen, especially in fisheries, about both elements. In fisheries the decision to allocate permits to boat owners has triggered harsh reactions among both crew and processors.

In some fisheries the allocation to boat owners has transformed the remuneration arrangements from a sharing of the risks and revenues from a catch on a predefined share basis to a wage system. Though this transformation can result in higher incomes for crew (Knapp 1997), the change in status has been difficult to accept for those used to being co-venturers, thereby sharing in both the risk and reward of fishing. (McCay, Gatewood et al. 1989; McCay and Creed 1990)

²¹ The downside occurs when the investments being rewarded were initiated purely for the purpose of increasing the initial allocation of tradable permits. Not only are these investments inefficient, but rewarding them undermines the ethical basis for an initial allocation based upon historic use.

²² The “new source bias” is, of course, not unique to tradable permit systems. It applies to any system of regulation that imposes more stringent requirements on new sources than exiting ones.

²³ Tradable permits systems are perfectly compatible with the principles of co-management. In this case the community would play a large role in defining the goals and procedures in the system. see the discussion of this in (National Research Council Committee to Review Individual Fishing Quotas 1999, pp. 135-138)

Processors have also staked their claim for quota (especially in Alaska), albeit unsuccessfully to date. (Matulich, Mittelhammer et al. 1996) The claims are based upon the immobility of the processing capital and the fact that allocating quota to boat owners changes the bargaining relationship in ways that could hurt processors. (Matulich and Sever 1999)

Finally some systems allow agents other than those included in the initial allocation to participate through an “opt-in” procedure. This is a prominent feature of the sulfur allowance program, but it can be plagued by adverse selection problems. (Montero, 1999; Montero 2000b)

TRANSFERABILITY RULES

While the largest source of controversy about tradable permits seems to attach to the manner in the permits are initially allocated, another significant source of controversy is attached to the rules that govern transferability. According to supporters, transferability not only serves to assure that rights flow to their highest valued use, but it also provides a user-financed form of compensation for those who voluntarily decide to no longer use the resource. Therefore restrictions on transferability only serve to reduce the efficiency of the system. According to critics, allowing the rights to be transferable produces a number of socially unacceptable outcomes including the concentration of rights, the destruction of community interests and the degrading of both the environment and traditional relationships among users.

Making the rights transferable allows the opportunity for some groups to accumulate permits. The concentration of permits in the hands of a few can either reduce the efficiency of the tradable permits system (Hahn 1984; Anderson 1991; Van Egteren and Weber 1996) or it can be used as leverage to gain economic power in other markets. (Misiolek and Elder 1989; Sartzetakis 1997) Although it has not played much of a role in air pollution control, it has been a factor in fisheries. (Palsson and A.Helgason 1995)

Typically the problem in fisheries is not that the concentration is so high that it triggers antitrust concerns (Adelaja, Menzo et al. 1998), but rather that it allows small fishing enterprises to be bought out by larger fishing enterprises. Smaller fishing enterprises are seen as having a special value to society that should be protected.

Protections against “unreasonable “concentration of quota are now common. One typical strategy involves putting a limit on the amount of quota that can be accumulated by any one holder. In New Zealand fisheries, for example, these range from 20% to 35% depending upon the species. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 90-91), while in Iceland the limits are 10% for cod and 20% for other species. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 102)

Another strategy involves trying to mitigate the potential anticompetitive effects of hoarding. The US sulfur allowance program does this in two main ways. First it sets aside a supply of allowances that could be sold at a predetermined (high) price if hoarders refused to sell to new entrants.²⁴ Second, it introduced a zero-revenue auction that, among its other features, requires permit holders to put approximately 3% of its allowances up for sale in a public auction once a year.²⁵

Another approach involves directly restricting transfers that seem to violate the public interest. In the Alaskan halibut and sablefish ITQ program, for example, several size categories of vessels were defined. The initial allocation was based upon the catch record within each vessel class and transfer of quota

²⁴ This set aside has not been used because sufficient allowances have been available through normal channels. That doesn't necessarily mean the set-aside was not useful, however, because it may have alleviated concerns that could have otherwise blocked the implementation of the program.

²⁵ The revenue is returned to the original permit holders rather than retained by the government. Hence the name “zero-revenue auction”. (Svendsen and Christensen 1999)

between catcher vessel classes was prohibited (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 310). Further restrictions required that the owner of the quota had to be on board when the catch was landed. This represented an attempt to prevent the transfer of ownership of the rights to “absentee landlords”.

A second concern relates to the potentially adverse economic impacts of permit transfers on some communities.²⁶ Those holders who transfer permits will not necessarily protect the interests of communities that have depended on their commerce in the past. For example in fisheries a transfer from one quota holder to another might well cause the fish to be landed in another community. In air pollution control owners of a factory might shut down its operation in one community and rebuild in another community, taking their permits with them.

One common response to this problem involves allocating quota directly to communities. The 1992 Bering Sea Community Development Quota Program, which was designed to benefit remote villages containing significant native populations in Alaska, allocated 7.5% of the walleye pollock quota to these communities. (Ginter 1995) In New Zealand the Treaty of Waitangi (Fisheries Claims) Settlement Act of 1992 effectively transferred ownership of almost 40% of the New Zealand ITQ to the Maori people. (Annala 1996) For these allocations the community retains control over the transfers and this control gives it the power to protect community interests. In Iceland this kind of control is gained through a provision that if a quota is to be leased or sold to a vessel operating in a different place, the assent of the municipal government and the local fishermen’s union must be acquired. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 83)

A final concern with transferability relates to possible external effects of the transfer. While in theory transfers increase net benefits by allowing permits to flow to their highest valued use, in practice that is not necessarily so if the transfers confer external benefits or costs on third parties.

Such external effects are not rare. In water, for example, transfers from one use to another can affect the quality, quantity and timing of supply for other downstream users.²⁷ (Livingston 1998) In air pollution control transfers can affect the spatial distribution of pollution and that can trigger environmental justice concerns.²⁸ (Tietenberg 1995c) In fisheries quota could be transferred to holders with more damaging gear, or a higher propensity for by catch. In all cases “leakage” provides another possible external effect. Leakage occurs when pressure on the regulated resource is diverted to an unregulated, or lesser regulated, resource as when fishermen move their boats to another fishery or polluters move their polluting factory to a country with lower environmental standards.

Western US water markets attempt to solve the externality problem by giving any affected party a chance to intervene in the transfer proceeding. (Colby 1995) In the case of a third party intervention the

²⁶ This concern does not arise in all communities because in several fisheries and in air pollution control the effect of any particular transfer or set of transfers is negligible.

²⁷ These effects may be less pronounced in short river systems. This may be one of the reasons tradable permit markets in water are so active in Chile. (Hearne 1998)

²⁸ In an unprecedented complaint filed in California during June 1997, the Los Angeles-based Communities for a Better Environment contends that RECLAIM is allowing the continued existence of toxic “hot spots” in low-income communities. Under RECLAIM rules Los Angeles-area manufacturers can buy and scrap old, high-polluting cars to create emissions-reduction credits. These credits can be used to reduce the required reductions from their own operations. Under RECLAIM most California refineries have installed equipment that eliminates 95% of the fumes, but the terminals in question reduced less because the companies scrapped more than 7,400 old cars and received mobile source emission reduction credits which they credited toward their reduction requirements. The complaint notes that whereas motor vehicle emission reductions are dispersed throughout the region, the offsetting increases at the refineries are concentrated in low income neighborhoods (Marla Cone, Los Angeles Times, as cited in GREENWIRE 7/23/97). Though this particular complaint was eventually dismissed by the court, the forces of discontent that gave rise to the suit are far from silenced.

transferring parties bear the burden of establishing the absence of damage to third parties. While this probably is an effective way to internalize the externality, it raises transaction costs significantly and has resulted in many fewer transfers than would have otherwise been the case. (Livingston 1998) Technology is now making an entrance in water markets (the Water Links electronic water exchange in California, for example) to lower transaction costs. (OECD 1999)

One strategy used in US air pollution control policy to resolve the spatial externality problem is regulatory tiering. Regulatory tiering implies applying more than one regulatory regime at a time. Sulfur oxide pollution in the United States is controlled both by the regulations designed to achieve local ambient air quality standards as well as by the sulfur allowance trading program. All transactions have to satisfy both programs. Thus trading is not restricted by spatial considerations (national trades are possible), but the use of acquired allowances is subject to local regulations protecting human health via the ambient standards. The second regulatory tier protects against the harmful spatial clustering of emissions (by disallowing any specific trades that would violate the standards), while the first tier allows unrestricted trading of allowances. Because the reductions in sulfur are so large and most local ambient standards are not likely to be jeopardized by trades, few trades have been affected by this provision. Yet its very existence serves to allay fears that local air quality could be in jeopardy.

THE TEMPORAL DIMENSION

Standard theory suggests that a fully value maximizing tradable permit system must have full temporal fungibility, implying that allowances can be both borrowed and banked. (Rubin 1996; Kling and Rubin 1997) Banking allows a user to store its permits for future use. With borrowing a permit holder can use permits earlier than their stipulated date.

No existing system that I am aware of is fully temporally fungible. Older pollution control programs have had a more limited approach. The Emissions Trading Program allowed banking, but not borrowing. The Lead Phaseout Program originally allowed neither, but part way through the program it allowed banking, at least until the program officially ended and any remaining credits became unusable. The sulfur allowance program has banking, but not borrowing, and RECLAIM has neither. (Tietenberg 1998d)

Why do so few programs have full temporal fungibility? The answers seem to lie more in the realm of politics than economics.

The first concern involves the potential for creating a temporal clustering of emissions. When intertemporal trades are defined on a one-for-one basis, it is possible for emissions to be concentrated in time. Since emissions concentrated in space or time cause more degradation than dispersed emissions (due to a nonlinearity in the dose-response function), regulators have chosen to put *a priori* restrictions on the temporal use of permits despite the economic penalty that imposes.

A second concern has arisen (particularly in the global warming context) where imposing sanctions for noncompliance is difficult. Some observers have noted that enforcing the cumulative emissions budget envisioned by the Kyoto Protocol on a nation that had borrowed heavily in the earlier years would become increasingly difficult over time. (Tietenberg, Grubb et al. 1998) Given the inherent difficulties in enforcing international commitments under the best of circumstances, opponents of borrowing propose to forestall this difficulty by eliminating any possibility of borrowing. They view the resulting increased compliance cost as a reasonable price to pay for taking the pressure off future enforcement.

MONITORING AND ENFORCEMENT

Regardless of how well any tradable permit system is designed, noncompliance can prevent the attainment of its economic, social, and environmental objectives. Noncompliance not only makes it more

difficult to reach stated goals, it sometimes makes it more difficult to know whether the goals are being met.²⁹

Although it is true that any management regime raises monitoring and enforcement issues, tradable permit regimes raise some special issues. One of the most desirable aspects of tradable permits, their ability to increase the value of the resource, is a two-edged sword because it also raises incentives for noncompliance. In the absence of an effective enforcement system, higher profitability from cheating could promote illegal activity. Insufficient monitoring and enforcement could also result in failure to keep a tradable permit system within its environmental limit.³⁰

Do monitoring and enforcement costs increase under tradable permit programs? The answer depends both on the level of required enforcement activity (greater levels of enforcement effort obviously cost more) and on the degree to which existing enforcement resources are used more or less efficiently. Higher enforcement costs are not, by themselves, particularly troubling because they can be financed from the enhanced profitability promoted by the tradable permit system.³¹

Monitoring

In addition to the obvious potential for quota busting that all tradable permit approaches face, fisheries can also face problems with poaching (harvests by ineligible fishermen), unreported highgrading (discarding low valued fish to make room in the quota for higher valued fish) and bycatch discards (nontargeted species caught and discarded).³²

Whether these problems are intensified or diminished by the implementation of a tradable permit program depends (in part) on the economic incentives confronting participants. The incentives for highgrading, for example, depend on the magnitude of price differentials for various types and sizes of targeted species. As the price premium for fish of a particular size and type increases, the incentive to use quota for especially valuable fish increases along with the incentive to discard less valuable fish. (Anderson 1994)

Incentives for bycatch can vary considerably as well. (Boyce 1996; Larson, House et al. 1998) The more leisurely pace of fishing afforded by IFQs allows fishermen to avoid geographic areas or times when bycatch is more likely. At the same time, the more leisurely pace reduces the opportunity cost of hold space and, consequently, may also provide fishermen with new opportunities to retain a greater proportion of the bycatch as joint products. For example, the halibut fishery encounters significant bycatches of rockfish. Although most rockfish and thornyheads command high exvessel prices, most of this bycatch was discarded during the derby fishery because halibut were even more valuable. A greater portion of this bycatch is now being retained.

²⁹ In fisheries, for example, stock assessments sometimes depend on the size and composition of the catch. If the composition of the landed harvest is unrepresentative of the actual harvest due to illegal discards, this can bias the stock assessment and the total allowable catch that depends upon it. Not only would true mortality rates be much higher than apparent mortality rates, but the age and size distribution of landed catch would be different from the size distribution of the initial harvest (prior to discards). This is known in fisheries as "data fouling".

³⁰ Prior to 1988, the expected positive effects of ITQs did not materialize in the Dutch cutter fisheries due to inadequate enforcement. Fleet capacity increased further, the race for fish continued, and the quotas had to be supplemented by input controls such as a limit on days at sea. (National Research Council Committee to Review Individual Fishing Quotas 1999. p. 176)

³¹ Not only has the recovery of monitoring and enforcement costs become standard practice in some fisheries (New Zealand, for example), but funding at least some monitoring and enforcement activity out of rents generated by the fishery has already been included as a provision in the most recent amendments to the US Magnuson-Stevens Act. The sulfur allowance program mandates continuous emissions monitoring financed by the emitting sources.

On the other hand, implementing an IFQ regime may favor some technologies over others. If the favored technologies typically involve more bycatch, bycatch rates can rise in the absence of enforcement.

Ultimately, therefore, whether highgrading, bycatch, and bycatch discard increase or decrease under an IFQ regime depends on local circumstances, on whether highgrading and bycatch discards are legal (or even required), and on the enforcement response.

Every monitoring system must identify both the information that is needed to monitor the operation of the tradable permit program and the management component that will gather, interpret, and act on this information. Data should also be collected on transfers so that monitoring and analysis of the market can take place. Effective monitoring systems are composed of data, data management, and verification components.

In general, the smooth implementation of a tradable permit program requires two different kinds of monitoring data. First, periodic data on the condition of the resource are needed to evaluate the effectiveness of the program over time. These data are used as the basis for adjusting environmental limits as conditions warrant. Second, managers need sufficient data to monitor compliance with the various limitations imposed by the regulatory system.

Monitoring compliance with a tradable permit program requires data on the identity of permit holders, amount of permits owned by each holder, permit, and permit transfers. Where programs have additional restrictions on permit use (such as type of equipment) or on quota transfers (only to “eligible” buyers) the data must be complete enough to contain this information and to identify noncomplying behavior in a timely manner.

One key to a smoothly implemented tradable program is ensuring that all data are input to an integrated computer system that is accessible by eligible users on a real-time basis. Such a system provides up-to-date information on permit use to both users and enforcement agencies. It would ideally also allow short-notice transfers, such as when a vessel heading for shore has a larger than expected bycatch and needs to acquire additional quota for the bycatch species before landing. Facilitating this kind of flexibility would reduce the enforcement burden considerably by giving permit holders a legal alternative to illegal discarding without jeopardizing the objectives of the program.

The computer system should also provide easy data entry. Card swipe systems, such as used in the Alaska halibut and sablefish IFQ fisheries, automatically input all the necessary identification data so that only landings (and hence permit use) need to be recorded. It is also possible to have the harvest level recorded directly from the scales (with appropriate adjustments for “ice and slime” or the degree to which the fish are already processed). Entry terminals that are connected to the master computer system should be available at all authorized landing sites.

Technology has also played an important role in the US sulfur allowance system. (Kruger, McLean et al. 1999) Both the collection and dissemination of the information derived from the continuous emissions monitors is now handled via the web. Special software has been developed to take individual inputs and to generate information both for the public and for EPA enforcement activities. According to Kruger et al., (1999) the development of this technology has increased administrative efficiency, lowered transactions costs and provided greater environmental accountability.

Information technology also permits greater accountability by making the information transparent. Evidence suggests that making the information available on-line to the public may further increase compliance. It also increases the possibilities for public pressure and even legal action from non-governmental environmental agencies and/or citizens.(Tietenberg, 1998a)

To ensure the accuracy of reported data, it is necessary to build a number of safeguards into the program. In fisheries proper control procedures include both onshore and at-sea components. An onshore system of checks would normally include a requirement that sales only be made to registered buyers and that both buyers and quota shareholders cosign the landing entries. These measures create an audit trail that could be electronically monitored for instances in which a comparison of processed product weight and recorded purchases suggests suspiciously high product recovery rates. The at-sea component would include both onboard observers, where the fishery is profitable enough to bear the cost, and random checks at sea by the appropriate authority (or perhaps by video monitoring). Onboard observers may be particularly important in fisheries where bycatch and highgrading are expected to be problems.

Enforcement

A successful enforcement program requires a carefully constructed set of sanctions for noncompliance. Penalties should be commensurate with the danger posed by noncompliance. Penalties that are unrealistically high may be counterproductive if authorities are reluctant to impose them and fishermen are aware of this reluctance. Unrealistically high penalties are also likely to consume excessive enforcement resources as those served with penalties seek redress through the appeals process.

In many cases, predetermined administrative fines can be imposed by the enforcing agency itself for “routine” noncompliance. For example, the Alaskan IFQ programs allow overages of up to 10% above the fisherman’s remaining IFQ balance to be deducted from the next year’s IFQ permit amount. Overages greater than 10% are considered a violation and are handled by enforcement personnel. In an ideal system, more serious noncompliance in terms of either the magnitude of the offense or the number of offenses could trigger civil penalties (fines and possible seizure of catch, equipment, and quota). Criminal penalties should be reserved for falsification of official reports and the most serious violations.

Other sanctions are possible. In the sulfur allowance program, for example, those found in noncompliance must not only pay a substantial financial penalty for noncompliance; they also must forfeit a sufficient number of future allowances to compensate for the overage. It is also possible to only allow those in compliance to transfer permits. Any egregious violations can lead to forfeiture of the right to participate in the program at all.

Income levels from fishing are generally bolstered by the implementation of an effective IFQ program. An effective program presumes effective enforcement. Honest fishermen should be willing to contribute some of their increased rent to ensure the continued existence of an effective IFQ management regime.

GOVERNANCE STRUCTURES

The academic community (particularly the political science community) has emphasized the importance of co-management of environmental resources with users having a substantial role. This is presumed to increase compliance.³³

Although tradable permit systems in principle allow a variety of governance systems, the current predominant form in all three applications seems to be a system of shared management with users playing a smaller role than envisioned by most co-management proposals. For those resource regimes in the United States it is common for the goals to be set by the government (either at the national or state level) and considerable “top-down” management to be in evidence.

³³ Some empirical support for this proposition in implemented programs is beginning to appear. For example, one study of compliance behavior in the United Kingdom fishery (which was not an ITQ fishery) found that individuals who felt more involved in the management system were found to have a statistically significantly lower probability of a violation. (Hatcher, et. al, 2000)

In the case of air pollution specific quantitative ambient standards are set at the national level and all programs must live within those limits. In the sulfur allowance program, a national program, the emissions cap is also set at the national level. In the RECLAIM system the local air quality management district set the emissions cap, but the district is subject to the oversight of the national EPA and must show how its choice will enable it to meet the nationally set ambient standards.

Fisheries have a somewhat similar governance arrangement. The Secretary of Commerce and his implementing agency, the National Marine Fisheries Service use their oversight and approval powers to attempt to assure that locally created approaches meet the various requirements of the Magnuson-Stevens Act as amended.³⁴ Unlike the ambient standards, which are quantitatively precise, these objectives are more vaguely specified. That allows the Secretary more discretion, which can be used either to exercise stronger control or to allow more community discretion.³⁵ Subject to this oversight regional fisheries councils define both the caps and the rules. While representatives of access right holders are usually represented on these councils, other groups are represented as well.

While the use of true co-management in air pollution control is rather rare, some limited forms are beginning to appear in both fisheries and water. Water user associations, for example, play a considerable role in allocating water resources in Chile. Although the *Dirección General de Aguas* (DGA) has broad authority in water resource management, much of the actual control over river flows is exercised by the *Juntas de vigilancia* (JDVs), associations made up of all users and users associations on a common section of a river. (Hearne 1998)

The absence of centralized control by California over its groundwater has resulted in the growth of a number of basin authorities controlled by water producers. The transfers of rights that take place among producers of groundwater can be seen as “informal” tradable rights markets.³⁶ These informal markets appear to be much more likely to involve user-defined rules.

In fisheries, particularly those involving highly sedentary species such as lobsters, substantial local control by users is typically exercised.³⁷ For example, Maine controls its lobster fishery by means of a zonal system and fishers within these zones play a considerable role in defining the rules that govern fishing activity within their zone. Though none of the zones currently involve the use of tradable permits, that is an option that is being discussed.

Following the US Congress-imposed moratorium on ITQs, some self-regulation alternatives arose in fisheries. In the Pacific whiting fishery in the Bering Sea, the annual TAC of whiting is divided among various sectors, including the catcher-processor vessels, which hold 34% of the 1997-2001 TAC. (National Research Council Committee to Review Individual Fishing Quotas 1999: 130). In April 1997, the four companies holding limited entry permits in the catcher-processor sector agreed to allocate the

³⁴ Requirements of the act include the duty to end overfishing, to rebuild overfished stocks, to protect essential fish habitat, to reduce bycatch, and to consider fishing communities. (National Research Council Committee to Review Individual Fishing Quotas 1999)

³⁵ At least one major analysis of this relationship makes it clear that the Secretary of Commerce and the National Marine Fisheries Service has erred on the side of micro management rather than delegating too much authority to the regional councils. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 8)

³⁶ Consider the following example from the Raymond Basin in California: "Under the Water Exchange Agreement, each party must offer to the "exchange pool" its rights to water in excess of its needs for the coming year, at a price no greater than the party's average water production cost. Parties anticipating that their access to water will be inadequate to meet their needs for the coming year submit requests to the exchange pool. The watermaster matches the offers to the requests, with the lowest priced water allocated first, then the next lowest, and so on. The actual allocation does not involve the transfer of water, but rather the right to pump specific quantities of water. (Blomquist 1992, pp. 87-8)

³⁷ McCay (2000) provides examples of other forms of co-management in fisheries. Most of her examples do not involve ITQs and those that do have limited participation by users.

quota amongst themselves, forming a cooperative for the purpose. To avoid possible anti-trust prosecution, a potential barrier to user-based management agreements in the United States, members submitted their proposal to the Department of Justice, which approved it. Though this is not a formal tradable permit system, the negotiations over allocations among participants have begun to take on some of the attributes of an informal market.

It should not be surprising that although tradable permit systems potentially allow for a considerable co-management role, only in fisheries and water is there any evidence of an evolution in this direction. The pollution and natural resource cases exhibit an important asymmetry. For air pollution control the benefits from resource protection fall on the victims of air pollution, not on the polluters who use the resource; from a purely self-interest point of view resource users (polluters) would be quite happy to degrade the resource if they could get away with it. On the other hand water users and fishers can both benefit from protection of the resource. Their collective self-interest is compatible with resource protection. This suggests that the incentives for collective action should be, and apparently are, quite different in these two cases.

EVALUATION CRITERIA

In assessing the outcomes of these systems I focus on three major categories of effects. The first is implementation feasibility. A proposed policy regime cannot protect the common pool resource if it cannot be implemented or if its main protective mechanisms are so weakened by the implementation process that it is rendered ineffective. What matters is not how a policy regime works in principle, but how it works in practice. The second category seeks to answer the question “How much protection did it offer not only to the common pool resource, but also other resources that might have been affected either positively or negatively by its implementation?” Finally, what were the economic effects on those who either directly or indirectly use the resource?

IMPLEMENTATION FEASIBILITY

The record seems to indicate that resorting to a tradable permits approach in the domestic context to controlling resources usually only occurs after other, more familiar, approaches have been tried and failed. In essence the costs of implementing a system like this are generally recognized as large so incurring such large costs can only be justified when the benefits have risen sufficiently to justify the transition. (Liebcap 1990)

Most fisheries that have turned to these policies have done so only after a host of alternative input and output controls have failed to stem the pressure being placed upon the resource. A similar story can be told for air pollution control. The offset policy, introduced in the US for controlling air pollution, owes its birth to an inability of any other policy to reconcile the desire to allow economic growth with the desire to improve the quality of the air.

It is also clear that not every attempt to implement a tradable permit approach is successful. In air pollution control attempts to establish a tradable permits approaches have failed in Poland (Zylicz 1999), Germany (Scharer 1999) and the United Kingdom (Sorrell 1999). Programs in water pollution control have generally not been very successful. (Hahn and Hester 1989)

On the other hand it does appear that the introduction of new tradable permit programs becomes easier with familiarity. In the U. S. following the very successful lead phaseout program new supporters appeared and made it possible to pass the sulfur allowance program.³⁸

³⁸ It is frequently suggested that new programs should be of the “cap and trade” type because they reduce transaction costs. While I agree that they reduce transactions costs, it is less clear to me that “cap and trade”

It also seems quite clear that, to date at least, using a grandfathering approach to the initial allocation has been a necessary ingredient in building the political support necessary to implement the approach.³⁹ Existing users frequently have the power to block implementation while potential future users do not. This has made it politically expedient to allocate a substantial part of the economic rent that these resources offer to existing users as the price of securing their support. While this strategy reduces the adjustment costs to existing users, it generally raises them for new users.⁴⁰

The design features of the programs are not stable over time; they evolve with experience. The earliest use of the tradable permit concept, the Emissions Trading Program, overlaid credit trading on an existing regulatory regime and was designed to facilitate implementation of that program. Trading baselines were determined on the basis of previously determined, technology-based standards and created credits could not be used to satisfy all of these standards. For some the requisite technology had to be installed.

More recent programs, such as the Acid Rain and RECLAIM programs, replace, rather than complement, traditional regulation. Allowance allocations for these programs were not based on preexisting technology-based standards. In the case of RECLAIM the control authority (the South Coast Air Quality Management District) could not have based allowances on predetermined standards even if they had been inclined to do so. Defining a complete set of technologies which offered the necessary environmental improvement (and yet were feasible in both an economic and engineering sense) proved impossible. Traditional regulation was incapable of providing the degree of reduction required by the Clean Air Act.

The RECLAIM program, however, shows that initial feasibility may not guarantee a sustainable program. The events of last summer placed pressures on the cap sufficient to cause the normal implementation procedures to be replaced by a (presumably temporary) system of fees for cap violations. How feasible the RECLAIM program proves in the long run cannot be judged as this is being written.

ENVIRONMENTAL EFFECTS

One common belief about tradable permit programs is that their environmental effects are determined purely by the imposition of the aggregate limit, an act that is considered to lie outside the system. Hence, it is believed, the main purpose of the system is to protect the economic value of the resource, not the resource itself.

That is an oversimplification for several reasons. First whether it is politically possible to set an aggregate limit may be a function of the policy used to achieve it. Second, both the magnitude of that limit and its evolution over time may be related to the policy. Third the choice of policy regime may affect the level of monitoring and enforcement and noncompliance can undermine the achievements of the limit. Fourth the policy may trigger environmental effects that are not covered by the limit.

The demonstration that the traditional regulatory policy was not value-maximizing had two mirror-image implications. It either implied that the same environmental goals could be achieved at lower cost or that better environmental quality could be achieved at the same cost. In air pollution control while the earlier programs were designed to exploit the first implication, later programs attempted to produce better air quality and lower cost.⁴¹

programs can always achieve the political will to be implemented without gaining familiarity though the more heavily controlled credit programs. My own reading of the US case suggests that we would not currently have “cap and trade” programs if we had not proceeded first to implement credit programs. These served as a training ground for the various stakeholders before moving to the more flexible programs.

³⁹ One exception is the ITQ program used in Chilean fisheries. Here the permits are allocated by auction. (Bernal and Aliaga 1999)

⁴⁰ New users have to buy into the system while existing users retain their traditional entitlement.

⁴¹ In an interesting analysis of the cost and emissions savings from implementing an emissions trading system for light-duty vehicles in California, (Kling 1994) finds that although the cost savings from implementing an emission

Setting the Limit

In air trading programs the lower costs offered by trading were used in initial negotiations to secure more stringent pollution control targets (acid rain program, ozone depleting gases, lead phaseout and RECLAIM) or earlier deadlines (lead phaseout program). The air quality effects from more stringent limits were reinforced by the use of offset ratios for trades in nonattainment areas that were set at a ratio greater than 1.0 (implying a portion of each acquisition would go for better air quality). In addition environmental groups have been allowed to purchase and retire allowances (acid rain program). Retired allowances represent authorized emissions that are not emitted.

In fisheries the institution of ITQs has sometimes, but not always, resulted in lower (more protective) TACS. In the Netherlands, for example, the plaice quota was cut in half (and prices rose to cushion the income shock). (Davidse 1999)

Meeting the Limit

In theory the flexibility offered by tradable permit programs make it easier to reach the limit, suggesting the possibility that the limit may be met more often under tradable permits systems than under the systems that preceded it. In most fisheries this expectation seems to have been borne out. In the Alaskan Halibut and Sablefish fisheries, for example, while exceeding the TAC was common before the imposition of an ITQ system, the frequency of exceedences dropped significantly after the introduction of the ITQ. (National Research Council Committee to Review Individual Fishing Quotas 1999)

A recent OECD review concludes:

“The results of individual quota management on resource conservation have been mixed. For the most part, IQs and ITQs have been effective in limiting catch at or below the TAC determined by management authorities. Catch was maintained at or below the TAC in 24 out of 31 fisheries for which information on this outcome was available. ...In most cases, insufficient monitoring and enforcement allowed catches to exceed TACs. “ (OECD 1997, p. 80)

Enforcing the Limit

Sometimes the rent involved in transferable permit programs is used to finance superior enforcement systems. In the sulfur allowance program, for example, the environmental community demanded (and received) a requirement that continuous emission monitoring be installed (and financed) by every covered utility. Coupling this with the rather stringent penalty system has meant 100% compliance.

The rents generated by ITQs have also provided the government with a source of revenue to cover the costs of enforcement and administration. In the many of the IQ fisheries in Australia, Canada, Iceland, and New Zealand, industry pays for administration and enforcement with fees levied on quota owners.

Not all uses of tradable permits, however, offer as convincing a solution for the monitoring and enforcement problems. With respect to fisheries one comprehensive review found:

“Higher enforcement costs and or greater enforcement problems occurred in 18 fisheries compared to five that experienced improvements. Enforcement proved particularly difficult in the high value fisheries, in multispecies fisheries, and in transnational fisheries. Support from industry for increased enforcement is common, as quota holders recognize that the illegal fishing by others damages the value of their quota rights and have an incentive to aid authorities with enforcement. ITQ

trading program (holding emissions constant) would be modest (on the order of 1% to 10%), the emissions savings possibilities (holding costs constant) would be much larger (ranging from 7% to 65%).

management has led to increased co-operation between fishers and enforcement authorities in several cases, including the New Zealand fisheries in general, and the US wreckfish fishery....Underreporting of catch and data degradation was documented for 12 fisheries, but improvements were made in six fisheries.” (OECD 1997, p. 84)

Effects on the Resource

In air pollution the programs have typically had a very positive effect on reducing emissions. In both the lead phaseout and ozone-depleting gas programs the targeted pollutants were eliminated, not merely reduced. Both the acid rain and RECLAIM programs involve substantial reductions in emissions over time. (Tietenberg 1999)

In the fisheries what have been the effects on biomass? The evidence has been mixed. In the Chilean squat lobster fishery the exploitable biomass has rebounded from a low of about 15,500 tons (prior to ITQs) to a level in 1998 of between 80,000-100,000 tons. (Bernal and Aliaga 1999) The herring fishery in Iceland has experienced a similar rebound. (Runolfsson 1999)

On the other hand one review of 37 ITQ or IQ fisheries, found that 24 experienced at least some temporary declines in stocks after instituting the programs. These were largely attributed to a combination of inadequate information on which to set conservative TACs and illegal fishing activity. Interestingly 20 of the 24 fisheries experiencing declines had additional regulations such as closed areas, size/selectivity regulations, trip limits, vessel restrictions, etc. (OECD 1997 p. 82) These additional regulations were apparently also ineffective in protecting the resource.

Other Effects

In water one significant problem has been the protection of “instream” uses of water. In the U. S. some states only protected private entitlements to water if water was diverted from the stream and consumed. Recent changes in policy and some legal determinations have afforded more protections to these environmental uses of water.

In air pollution control several effects transcend the normal boundaries of the program. In the climate change program, for example, it is widely recognized (Ekins 1996) that the control of greenhouse gases will result in substantial reductions of other pollutants as a side effect. Other, more detrimental, effects include the clustering of emissions either in space or time.

In fisheries two main effects have been bycatch and highgrading. Bycatch is a problem in many fisheries, regardless of the means of control. The evidence from fisheries on how the introduction of ITQs affect bycatch and highgrading is apparently mixed. Two reviews found that bycatch and highgrading may increase or decrease in ITQ fisheries depending on the fishery. (OECD 1997. p. 83,) (National Research Council Committee to Review Individual Fishing Quotas 1999 p. 193)

ECONOMIC EFFECTS

While the evidence on environmental consequences is mixed (especially for fisheries), it is somewhat clearer for the economic consequences. In the presence of adequate enforcement tradable permits do appear to increase the value of the commons to which it applies. In air pollution control this takes the effect of considerable savings in meeting the pollution control targets. (Hahn and Hester 1989; Tietenberg 1990) For water it involves the increase in value brought about by transferring the resources from lower valued to higher valued uses. (Easter, Dinar et al. 1998). In fisheries it not only involves the higher profitability from more appropriately scaled capital investments (resulting from the reduction in overcapitalization), but also from the fact that ITQs frequently make it possible to sell a more valuable

product at higher prices(fresh fish rather than frozen fish). (National Research Council Committee to Review Individual Fishing Quotas 1999) One review of 22 fisheries found that the introduction of ITQs increased wealth in all 22. [OECD, 1997, p. 83]

In both water and air pollution the transition was not from an open access resource to tradable permits, but rather from a less flexible control regime to a more flexible one. The transition has apparently been accomplished with few adverse employment consequences, though sufficient data to do a comprehensive evaluation do not exist. (Goodstein 1996)

The employment consequences for fisheries have been more severe. In fisheries with reasonable enforcement the introduction of ITQs has usually been accompanied by a considerable reduction in the amount of fishing effort. Normally this means not only fewer boats, but also less employment. The evidence also suggests, however, that the workers who remain in the industry work more hours during the year and earn more money. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 101)

The introduction of ITQs in fisheries has also had implications for crew, processors and communities. Traditionally in many fisheries crew have co-venturers in the fishing enterprise, sharing in both the risk and reward. In some cases the shift to ITQs has shifted the risk and ultimately shifted the compensation system from a share of profits system to a wage system. Though this has not necessarily lowered incomes, it has changed the culture of fishing. (McCay, Gatewood et al. 1989; McCay and Creed 1990)

Processors can be affected by the introduction of ITQs in a number of ways. First the processing sector is typically as overcapitalized as the harvesting sector.⁴² Since the introduction of ITQs typically extends the fishing season and spreads out the processing needs of the industry, less processing capacity is needed. In addition the more leisurely pace of harvesting reduces the bargaining power of processors versus fishers. In some areas such as Alaska a considerable amount of this processing capital may lose value due to its immobility. (Matulich, Mittelhammer et al. 1996; Matulich and Sever 1999)

Communities can be, and in some cases have been, adversely affected when quota held by local fishers is transferred to fishers who operate out of other communities. Techniques developed to mitigate these effects, however, seem to have been at least moderately successful. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 206)

Generally market power has not been a significant issue in most permit markets despite some tendencies toward the concentration of quota. In part this is due to accumulation limits that have been placed on quota holders and the fact that these are typically not markets in which accumulation of quota yields significant monopoly-type powers.⁴³ In fisheries some concern has been expressed (Palsson 1998) that the introduction of ITQs will mean the demise of the smaller fishers as they are bought out by larger operations. The evidence does not seem support this concern.⁴⁴

LESSONS

What can be gleaned from this necessarily brief survey of the theory and implementation experience with tradable permits?

⁴² In derby fishing the harvest is landed in a relatively short period of time, creating the need for more peak capacity.

⁴³ In many fisheries, for example, the relevant markets are global with many different sources of supply. In air pollution the number of participants is typically quite high.

⁴⁴ An OECD review concludes " There was very little evidence to support the hypothesis that small scale fishers would be eliminated." (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 84)

EVALUATION

- The air pollution programs, on balance, seem to be the most successful in achieving both economic and environmental objectives. In part this seems to be due to the presence of fewer (though certainly not zero) externalities in these programs. Fisheries must cope with potentially severe bycatch problems in multispecies fisheries. And water control authorities must cope with the consequences of trades on downstream users. These small-scale, complex resources with multiple externalities may be better managed by cooperative arrangements.
- The academic community has emphasized the importance of co-management of environmental resources with users having a substantial role. Although tradable permit systems in principle allow a variety of governance systems, only in fisheries and water is there any evidence of an evolution in this direction. The current predominant form in both air pollution control and fisheries seems to be a system of shared management with users playing a smaller role than envisioned by most co-management proposals. For those resource regimes located in the United States it is common for the goals to be set at the national level and considerable “top-down” management to be in evidence. The management of water resources seems closest to user-controlled co-management schemes. And in those systems the rights markets are at the “informal” end of the spectrum.
- It should not be surprising that although tradable permit systems potentially allow for a considerable role for users, a nontrivial co-management role exists only in fisheries and water. The pollution and natural resource cases exhibit an important asymmetry. For air pollution control the benefits from resource protection fall on the victims of air pollution, not on the polluters who use the resource. From a purely self-interest point of view resource users (polluters) would be quite happy to pollute the air if they could get away with it. On the other hand water users and fishers can both benefit from protection of the resource. Their collective self-interest is compatible with resource protection. This suggests that the incentives for collective action should be quite different in these two cases and this difference could well explain the lower propensity for collective self-governance in the air pollution case.
- A main element of controversy in tradable permits systems involves both the processes for deciding the initial allocation and the initial allocation itself. These problems seem least intense for air pollution and most intense for fisheries. Though a rich set of management and initial allocation options exists, current experience seems not to have been very creative in their use.
- Tradable permit programs are sometimes held to be a relatively rigid approach to resource management. This expectation is created by the belief that once instituted property rights cannot be changed. In fact implemented tradable permit programs have exhibited a considerable amount of flexibility. A variety of new design features (such as zero revenue auctions, bycatch quotas, safety values and drop-through mechanisms) have emerged that are tailored to the characteristics of particular resources. These offer greater flexibility in meeting the needs of particular resource systems. For example, programs designed to protect resources with a higher degree of supply variability (fisheries and water) have evolved especially flexible adaptive management systems. In pollution control the main source of flexibility seems to have come from the use of “safety valves”, imposing predefined fees on pollution overages to kick in when permit prices exceed limits deemed tolerable.
- In their most successful applications tradable permits have been able to simultaneously protect the resources and provide sustainable incomes for users. Technology advances, such as computerized exchanges, are helping to lower transaction costs, thereby facilitating the capture of more of the rent.
- The two elements that most jeopardize the success of a tradable permits are inadequate enforcement and uninternalized externalities

UNFULFILLED THEORETICAL EXPECTATIONS

Two important expectations flowing from the economic theory have proved to be an inaccurate characterization of reality.

- The first example comes from the theoretical expectation that transferable permit programs do not effect conservation of the resource because that is handled by the cap and setting the cap is considered to be outside the system. Hence, it is believed, the main purpose of the system is to protect the economic value of the resource, not the resource itself. That is an oversimplification for several reasons. First whether it is politically possible to set an aggregate limit may be a function of the policy used to achieve it. The use of grandfathered permits in the acid rain program, for example, made it possible to establish the limit on sulfur emissions. Second, in both fisheries and air pollution control the evidence suggests that both the magnitude of the implemented limit and its evolution over time may be related to the policy. The flexibility and lower cost of meeting the limit offered by tradable permits systems can, and has, resulted in the acceptance of more stringent limits. Third the choice of policy regime may affect the level of monitoring and enforcement and noncompliance can undermine the achievements of the limit. Experience suggests that depending on the context, transferable permits can either improve or degrade the monitoring and enforcement situation. Fourth the policy may trigger environmental effects that are not covered by the limit. Activity may be diverted from covered to uncovered resources.
- The second theoretical expectation that falls in the light of implementation experience involves the tradeoff between efficiency and equity in a tradable permits system. Traditional theory suggests that tradable permits offer a costless trade-off between efficiency and equity, since, regardless of the initial allocation, the ability to trade assures that permits flow to their highest valued uses. This implies that the initial allocation can be used to pursue efficiency goals without lowering the value of the resource. In practice implementation considerations almost always allocate permits to historic uses whether or not that is the most equitable allocation. This failure to use the initial allocation to protect equity concerns has caused other means to be introduced to protect equity considerations (such as restrictions of transfers). The additional restrictions generally do lower the value of the resource. In practice, therefore, tradable permits systems have not avoided the trade-off between efficiency and equity so common elsewhere in policy circles.

This evidence seems to suggest that tradable permits are no panacea, but they do have their niche.

REFERENCES

Adelaja, A., J. Menzo, et al.

1998 Market Power, Industrial Organization and Tradeable Quotas. *Review of Industrial Organization* 13(5): 589-601.

Anderson, L. G.

1991 A Note on Market Power in ITQ Fisheries. *Journal of Environmental Economics and Management* 21(2): 291-296.

Anderson, L. G.

1994 An Economic Analysis of Highgrading in ITQ Fisheries Regulation Programs. *Marine Resource Economics* 9: 189-207.

Anderson, L. G.

- 1995 Privatizing Open Access Fisheries: Individual Transferable Quotas. *The Handbook of Environmental Economics*. D. W. Bromley. Oxford, UK, Blackwell: 453-474.

Annala, J. H.

- 1996 New Zealand's ITQ System: Have the First Eight Years Been a Success or a Failure? *Reviews in Fish Biology and Fisheries* 6: 43-62.

Baumol, W. J. and W. E. Oates

- 1971 The Use of Standards and Prices for Protection of the Environment. *Swedish Journal of Economics* 73: 42-54.

Baumol, W. J. and W. E. Oates

- 1988 *The Theory of Environmental Policy*. Cambridge, England, Cambridge University Press.

Bernal, P. and B. Aliaga

- 1999 ITQ's in Chilean fisheries. *The Definition and Allocation of Use Rights in European Fisheries: Proceedings of the Second Workshop held in Brest, France, 5-7 May 1999*. A. Hatcher and K. Robinson. Portsmouth, UK, Centre for the Economics and Management of Aquatic Resources.

Black, N. D.

- 1997 Balancing the Advantages of Individual Transferable Quotas Against Their Redistributive Effects: The Case of Alliance Against IFQs v. Brown. *International Law Review* 9(3(Spring)): 727-746.

Blomquist, W.

- 1992 *Dividing the Waters: Governing Groundwater in Southern California*. San Francisco, CA, ICS Press.

Bovenberg, A. L. and L. H. Goulder

2000. Neutralizing Adverse Impacts of 2000 CO₂ Abatement Policies: What Does it Cost? *Behavioral & Distributional Effects of Environmental Policy*. C. E. Carraro and G. E. Metcalf. Chicago, University of Chicago Press.

Boyce, J. R.

- 1996 An Economic Analysis of the Fisheries Bycatch Problem. *Journal of Environmental Economics and Management* 31(3): 314-336.

Colby, B. G.

- 1995 Regulation, Imperfect Markets and Transactions Costs: The Elusive Quest for Efficiency in Water Allocation. *The Handbook of Environmental Economics*. D. W. Bromley. Oxford, UK, Blackwell: 475-502.

Colby, B. G.

- 2000 Cap and Trade Challenges: A Tale of Three Markets. *Land Economics* 76 (4): 638-658.

Davidse, W.

- 1999 Lessons from Twenty Years of Experience with Property Rights in the Dutch fishery. *The Definition and Allocation of Use Rights in European Fisheries: Proceedings of the Second Workshop held in Brest, France, 5-7 May 1999*. A. Hatcher and K. Robinson. Portsmouth, UK, Centre for the Economics and Management of Aquatic Resources: 153-163.

Easter, K. W., A. Dinar, et al.

- 1998 Water Markets: Transactions Costs and Institutional Options. *Markets for Water: Potential and Performance*. K. W. Easter, A. Dinar and M. W. Rosegrant. Boston, MA, Kluwer Academic Publishers: 1-18.

Ekins, P.

- 1996 The Secondary Benefits of CO₂ Abatement: How Much Emission Reduction do they Justify? *Ecological Economics* 16(1): 13-24.

Farrell, A., R. Carter, et al.

- 1999 The NO_x Budget: Market-based Control of Tropospheric Ozone in the Northeastern United States. *Resource and Energy Economics* 21(2): 103-124.

Fromm, O. and B. Hansjurgens

- 1996 Emission Trading in Theory and Practice: An Analysis of RECLAIM in Southern California. *Environment and Planning C - Government and Policy* 14(3): 367-384.

Ginter, J. J. C.

- 1995 The Alaska Community Development Quota Fisheries Management Program. *Ocean and Coastal Management* 28(1-3): 147-163.

Goodin, R. E.

- 1994 Selling Environmental Indulgences. *Kyklos* 47(4): 573-96.

Goodstein, E.

- 1996 Jobs and the Environment - an Overview. *Environmental Management* 20(3): 313-321.

Goulder, L. H., et al.,

- 1999 The Cost-Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting *Journal of Public Economics* 72(3):329-360.

Grafton, R. Q. and R. A. Devlin

- 1996 Paying for Pollution - Permits and Charges. *Scandinavian Journal of Economics* 98(2): 275-288.

Hahn, R. W.

- 1984 Market Power and Transferable Property Rights. *Quarterly Journal of Economics* 99(4): 753-765.

Hahn, R. W. and G. L. Hester

- 1989 Marketable Permits: Lessons from Theory and Practice. *Ecology Law Quarterly* 16: 361-406.

Hatcher, A., S. Jaffry, et. al.

- 2000 Normative and Social Influences Affecting Compliance with Fishing Regulations *Land Economics* 76 (3): 448-461

Hausker, K.

- 1990 Coping with the Cap: How Auctions Can Help the Allowance Market Work. *Public Utilities Fortnightly* 125: 28-34.

Heal, G. M.

- 1998 *Valuing the Future: Economic Theory and Sustainability*. New York, Columbia University Press.

Hearne, R. R.

- 1998 Institutional and Organizational Arrangements for Water Markets in Chile. *Market for Water; Potential and Performance*. K. W. Easter, M. W. Rosegrant and A. Dinar. Boston, MA, Kluwer Academic Publishers: 141-157.

Hollings, C. S.

- 1978 *Adaptive Environmental Assessment and Management*. New York, John Wiley & Sons.

Howe, C. W. and D. R. Lee

- 1983 Priority Pollution Rights: Adapting Pollution Control to a Variable Environment. *Land Economics* 59(2): 141-149.

Kete, N.

- 1992 *The U.S. Acid Rain Control Allowance Trading System. Climate Change: Designing a Tradeable Permit System.* T. Jones and J. Corfee-Morlot. Paris, Organization for Economic Co-operation and Development Publication: 69-93.

Kling, C. L.

- 1994 Environmental Benefits from Marketable Discharge Permits or an Ecological Vs Economical Perspective on Marketable Permits. *Ecological Economics* 11(1): 57-64.

Kling, C. and J. Rubin

- 1997 Bankable Permits for the Control of Environmental Pollution. *Journal of Public Economics* 64(1): 99-113.

Knapp, G.

- 1997 Initial Effects of the Alaska Halibut IFQ Program: Survey Comments of Alaska Fishermen,. *Marine Resource Economics* 12(3): 239-248.

Kruger, J. A., B. McLean, et al.

- 1999 A Tale of Two Revolutions: Administration of the SO2 Trading Program. Draft Report. Washington., DC, US Environmental Protection Agency.

Larson, D. M., B. W. House, et al.

- 1998 Bycatch Control in Multispecies Fisheries: A Quasi-rent Share approach to the Bering Sea/Aleutian Islands Midwater Trawl Pollock Fishery. *American Journal of Agricultural Economics* 80(4): 778-792.

Libecap, G. D.

- 1990 *Contracting for Property Rights.* Cambridge, UK, Cambridge University Press.

Livingston, M. L.

- 1998 Institutional Requisites for Efficient Water Markets. *Markets of Water: Potential and Performance.* K. W. Easter, M. W. Rosengrant and A. Dinar. Boston, MA, Kluwer Academic Publishers: 19-33.

Lyon, R. M.

- 1982 Auctions and Alternative Procedures for Allocating Pollution Rights. *Land Economics* 58(1): 16-32.

Maloney, M. and G. L. Brady

- 1988 Capital Turnover and Marketable Property Rights. *The Journal of Law and Economics* 31(1): 203-226.

Matulich, S. C., R. C. Mittelhammer, et al.

- 1996 Toward a More Complete Model of Individual Transferable Fishing Quotas: Implications of Incorporating the Processing Sector. *Journal of Environmental Economics and Management* 31(1): 112-128.

Matulich, S. C. and M. Sever

- 1999 Reconsidering the Initial Allocation of ITQs: the Search for a Pareto-Safe Allocation Between Fishing and Processing Sectors. *Land Economics* 75(2): 203-219.

McCay, B. J.

- 1998 *Oyster Wars and the Public Trust: Property, Law and Ecology in New Jersey History*. Tucson, AZ, The University of Arizona Press.

McCay, B. J.

- 1999 Resistance to Changes in Property Rights Or, Why Not ITQs? A paper presented to Mini-Course, FishRights 99 at Fremantle, Australia, November 1999

McCay, B. J.

- In Press. Community-Based and Cooperative Solutions to the 'Fishermen's Problem' in the Americas," in *The Commons Revisited: An Americas Perspective*, Joanna Burger, Richard Norgaard, Elinor Ostrom, David Policansky, and B.D. Goldstein. Washington, D.C.: Island Press.

McCay, B. J. and C. F. Creed

- 1990 Social Structure and Debates on Fisheries Management in the Mid-Atlantic Surf Clam Fishery. *Ocean & Shoreline Management* 13: 199-229.

McCay, B. J., J. B. Gatewood, et al.

- 1989 Labor and the Labor Process in a Limited Entry Fishery. *Marine Resource Economics* 6: 311-330.

Misiolek, W. S. and H. W. Elder

- 1989 Exclusionary Manipulation of Markets for Pollution Rights. *Journal of Environmental Economics and Management* 16(2): 156-66.

Montero, J. P.

- 1999 Voluntary Compliance with Market-Based Environmental Policy: Evidence from the U.S. Acid Rain Program *Journal of Political Economy* Vol. 107, No. 5 (1999): 998-1033.

Montero, J. P.

- 2000a A Market-Based Environmental Policy Experiment in Chile. Working Paper of the Center for Energy and Environmental Policy Research, MIT-CEEPR 2000-005 WP (August)

Montero, J.P.

- 2000b Optimal Design of a Phase-in Emissions Trading Program *Journal of Public Economics* 75(2): 273-291.

Montgomery, W. D.

- 1972 Markets in Licenses and Efficient Pollution Control Programs" *Journal of Economic Theory* 5(3): 395-418.

National Research Council Committee to Review Individual Fishing Quotas

- 1999 *Sharing the Fish: Toward a National Policy on Fishing Quotas*. Washington, National Academy Press.

Nelson, R., T. Tietenberg, et al.

- 1993 Differential Environmental Regulation: Effects On Electric Utility Capital Turnover and Emissions. *Review of Economics and Statistics* 75(2): 368-373.

Nussbaum, B. D.

- 1992 Phasing Down Lead in Gasoline in the U.S.: Mandates, Incentives, Trading and Banking. *Climate Change: Designing a Tradeable Permit System*. T. Jones and J. Corfee-Morlot. Paris, Organization for Economic Co-operation and Development Publication: 21-34.

OECD

- 1997 *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources*. Paris, Organization of Economic Co-operation and Development.

Palsson, G.

- 1998 The Virtual Aquarium: Commodity Fiction and Cod Fishing. *Ecological Economics* 24(2-3): 275-288.

Palsson, G. and A.Helgason

- 1995 Figuring Fish and Measuring Men: The Individual Transferable Quota System in Icelandic Cod Fishery. *Ocean and Coastal Management* 28(1-3): 117-146.

Pizer, W.

- 1999 Choosing Price Or Quantity Controls For Greenhouse Gases, Resources for the Future Climate Issues Brief No. 17, Washington, DC

Rubin, J. D.

- 1996 A Model Of Intertemporal Emission Trading, Banking, and Borrowing. *Journal Of Environmental Economics and Management* 31(3): 269-286.

Runolfsson, B.

- 1999 ITSQs in Icelandic Fisheries: a Rights-based Approach to Fisheries Management. The Definition and Allocation of Use Rights in European Fisheries: Proceedings of the Second Workshop held in Brest, France, 5-7 May 1999. A. Hatcher and K. Robinson. Portsmouth, UK, Centre for the Economics and Management of Aquatic Resources: 164-193.

Sartzetakis, E. S.

- 1997 Raising Rivals' Costs Strategies via Emission Permits Markets. *Review of Industrial Organization* 12(5-6): 751-765.

Scharer, B.

- 1999 Tradable Emission Permits in German Clean Air Policy: Considerations on the Efficiency of Environmental Policy Instruments. *Pollution for Sale: Emissions Trading and Joint Implementation*. S. Sorrell and J. Skea. Cheltenham, UK, Edward Elgar Publishing Limited: 141-153.

Solomon, B. D. and H. S. Gorman

- 1998 State-level Air Emissions Trading: The Michigan and Illinois Models. *Journal of the Air & Waste Management Association* 48(12): 1156-1165.

Sorrell, S.

- 1999 Why Sulphur Trading Failed in the UK. *Pollution for Sale: Emissions Trading and Joint Implementation*. S. Sorrell and J. Skea. Cheltenham, UK, Edward Elgar Publishing Limited: 170-210.

Spulber, N. and A. Sabbaghi

- 1993 *Economics of Water Resources: From Regulation to Privatization*. Hingham, MA, Kluwer Academic Publishers.

Stavins, R. N.

- 1995 Transaction Costs and Tradeable Permits. *Journal of Environmental Economics and Management* 29(2): 133-148.

Svendsen, G. T.

- 1999 Interest Groups Prefer Emission Trading: A New Perspective. *Public Choice* 101(1-2): 109-28.

Svendsen, G. T. and J. L. Christensen

- 1999 The US SO₂ Auction: Analysis and Generalization. *Energy Economics* 21(5): 403-416.

Tietenberg, T. H.

- 1985 *Emissions Trading: An Exercise in Reforming Pollution Policy*. Washington, DC, Resources for the Future.

Tietenberg, T. H.

- 1990 Economic Instruments for Environmental Regulation. *Oxford Review of Economic Policy* 6(1): 17-33.

Tietenberg, T. H.

- 1995a Design Lessons from Existing Air Pollution Control Systems: The United States. *Property Rights in a Social and Ecological Context: Case Studies and Design Applications*. S. Hanna and M. Munasinghe. Washington D.C., The World Bank: 15-32.

Tietenberg, T. H.

- 1995b Tradeable Permits for Pollution Control When Emission Location Matters: What Have We Learned? *Environmental and Resource Economics* 5(2): 95-113.

Tietenberg, T. H.

- 1998a Disclosure Strategies for Pollution Control. *Environmental & Resource Economics* 11(3-4): 587-602.

Tietenberg, T. H.

- 1998b Economic Analysis and Climate Change. *Environment and Development Economics* 3(3): 402-405.

Tietenberg, T. H.

- 1998c Ethical Influences on the Evolution of the US Tradeable Permit Approach to Pollution Control. *Ecological Economics* 24(2,3): 241-257.

Tietenberg, T. H.

- 1998d Tradable Permits and the Control of Air Pollution-Lessons from the United States. *Zeitschrift für Angewandte Umweltforschung* 9: 11-31.

Tietenberg, T. H.

- 1999 Lessons From Using Transferable Permits to Control Air Pollution in the United States. *Handbook of Environmental and Resource Economics*. J. C. J. Van den Bergh. Cheltenham, UK, Edward Elgar: 275-292.

Tietenberg, T. H.

- 2000 *Environmental and Natural Resource Economics*, 5th ed. Reading, MA, Addison-Wesley.

Tietenberg, T., M. Grubb, et al.

- 1998 International Rules for Greenhouse Gas Emissions Trading: Defining the Principles, Modalities, Rules and Guidelines for Verification, Reporting and Accountability. Geneva. United Nations. UNCTAD/GDS/GFSB/Misc.6

Tietenberg, T. H., K. Button and P. Nijkamp

1999 Introduction in *Environmental Instruments and Institutions*. T. H. Tietenberg, K. Button and P. Nijkamp,. Cheltenham:UK, Edward Elgar. xvii-xxvi.

Van Egteren, H. and M. Weber

1996 Marketable Permits, Market Power and Cheating. *Journal of Environmental Economics and Management* 30(2): 161-173.

Weitzman, M.

1974 Prices vs. Quantities *Review of Economic Studies* 41:447-491.

Young, M. D.

1999 The Design of Fishing-right Systems - the NSW Experience. *Ecological Economics* 31(2): 305-316.

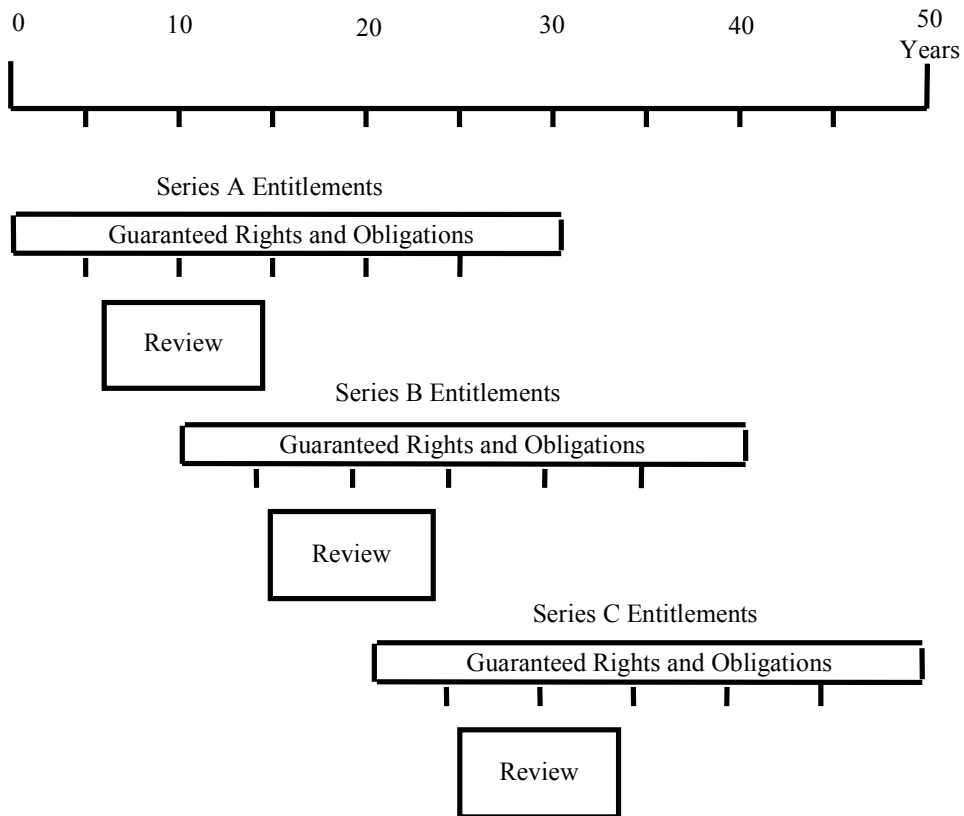
Zerlauth, A. and U. Schubert

1999 Air Quality Management Systems in Urban Regions: An Analysis of RECLAIM in Los Angeles and its Transferability to Vienna. *Cities* 16(4): 269-283.

Zylicz, T.

1999 Obstacles to Implementing Tradable Pollution Permits: the Case of Poland. *Implementing Domestic Tradable Permits for Environmental Protection*. OECD, Organization for Economic Co-Operation and Development: 147-165.

Figure 1. Building Resilience into Tradable Permit Systems



Source: Based upon Figure 7-1 in Young, M. D. and B. J. McCay (1995). Building Equity, Stewardship and Resilience into Market-Based Property Right Systems. Property Rights and the Environment: Social and Ecological Issues. S. Hanna and M. Munasinghe. Washington, DC, Beijer International Institute of Ecological Economics and the World Bank; 102.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Papers Series

Our working papers are available on the Internet at the following addresses:

Server WWW: WWW.FEEM.IT

Anonymous FTP: FTP.FEEM.IT

http://papers.ssrn.com/abstract_id=XXXXXX

SUST	1.2001	<i>Inge MAYERES and Stef PROOST:</i> <u>Should Diesel Cars in Europe be Discouraged?</u>
SUST	2.2001	<i>Paola DORIA and Davide PETTENELLA:</i> <u>The Decision Making Process in Defining and Protecting Critical Natural Capital</u>
CLIM	3.2001	<i>Alberto PENCH:</i> <u>Green Tax Reforms in a Computable General Equilibrium Model for Italy</u>
CLIM	4.2001	<i>Maurizio BUSSOLO and Dino PINELLI:</i> <u>Green Taxes: Environment, Employment and Growth</u>
CLIM	5.2001	<i>Marco STAMPINI:</i> <u>Tax Reforms and Environmental Policies for Italy</u>
ETA	6.2001	<i>Walid OUESLATI:</i> <u>Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital</u>
CLIM	7.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI:</i> <u>Kyoto Commitment and Emission Trading: a European Union Perspective</u>
MGMT	8.2001	<i>Brian SLACK (xlv):</i> <u>Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy</u>
VOL	9.2001	<i>Giulia PESARO:</i> <u>Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors</u>
VOL	10.2001	<i>Cathrine HAGEM:</i> <u>Climate Policy, Asymmetric Information and Firm Survival</u>
ETA	11.2001	<i>Sergio CURRARINI and Marco MARINI:</i> <u>A Sequential Approach to the Characteristic Function and the Core in Games with Externalities</u>
ETA	12.2001	<i>Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS:</i> <u>Inflation and Welfare in an OLG Economy with a Privately Provided Public Good</u>
KNOW	13.2001	<i>Paolo SURICO:</i> <u>Globalisation and Trade: A "New Economic Geography" Perspective</u>
ETA	14.2001	<i>Valentina BOSETTI and Vincenzina MESSINA:</i> <u>Quasi Option Value and Irreversible Choices</u>
CLIM	15.2001	<i>Guy ENGELEN (xlii):</i> <u>Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making</u>
SUST	16.2001	<i>Julie Catherine SORS:</i> <u>Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches</u>
SUST	17.2001	<i>Julie Catherine SORS:</i> <u>Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools</u>
CLIM	18.2001	<i>Johan ALBRECHT and Niko GOBBIN:</i> <u>Schumpeter and the Rise of Modern Environmentalism</u>
VOL	19.2001	<i>Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO (xliii):</i> <u>Participation Incentives and the Design of Voluntary Agreements</u>
ETA	20.2001	<i>Paola ROTA:</i> <u>Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs</u>
ETA	21.2001	<i>Paola ROTA:</i> <u>Empirical Representation of Firms' Employment Decisions by an (S,s) Rule</u>
ETA	22.2001	<i>Paola ROTA:</i> <u>What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes</u>
PRIV	23.2001	<i>Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD:</i> <u>Optimal Privatisation Design and Financial Markets</u>
KNOW	24.2001	<i>Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI:</i> <u>Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy</u>
ETA	25.2001	<i>Klaus CONRAD:</i> <u>Locational Competition under Environmental Regulation when Input Prices and Productivity Differ</u>
PRIV	26.2001	<i>Bernardo BORTOLOTTI, Juliet D'SOUZA, Marcella FANTINI and William L. MEGGINSON:</i> <u>Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry</u>
CLIM	27.2001	<i>Frédéric BROCHIER and Emiliano RAMIERI:</i> <u>Climate Change Impacts on the Mediterranean Coastal Zones</u>
ETA	28.2001	<i>Nunzio CAPPUCCIO and Michele MORETTO:</i> <u>Comments on the Investment-Uncertainty Relationship in a Real Option Model</u>
KNOW	29.2001	<i>Giorgio BRUNELLO:</i> <u>Absolute Risk Aversion and the Returns to Education</u>
CLIM	30.2001	<i>ZhongXiang ZHANG:</i> <u>Meeting the Kyoto Targets: The Importance of Developing Country Participation</u>
ETA	31.2001	<i>Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN:</i> <u>An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control</u>
MGMT Coalition Theory Network	32.2001	<i>Roberta SALOMONE and Giulia GALLUCCIO:</i> <u>Environmental Issues and Financial Reporting Trends</u>
ETA	33.2001	<i>Shlomo WEBER and Hans WIESMETH:</i> <u>From Autarky to Free Trade: The Impact on Environment</u>
	34.2001	<i>Margarita GENIUS and Elisabetta STRAZZERA:</i> <u>Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods</u>

NRM	35.2001	<i>Carlo GIUPPONI</i> : <u>The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture</u>
KNOW	36.2001	<i>Raffaele PACI and Francesco PIGLIARU</i> : <u>Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe</u>
PRIV	37.2001	<i>Bernardo BORTOLOTTI</i> : <u>Privatisation, Large Shareholders, and Sequential Auctions of Shares</u>
CLIM	38.2001	<i>Barbara BUCHNER</i> : <u>What Really Happened in The Hague? Report on the COP6, Part I, 13-25 November 2000, The Hague, The Netherlands</u>
PRIV	39.2001	<i>Giacomo CALZOLARI and Carlo SCARPA</i> : <u>Regulation at Home, Competition Abroad: A Theoretical Framework</u>
KNOW	40.2001	<i>Giorgio BRUNELLO</i> : <u>On the Complementarity between Education and Training in Europe</u>
Coalition	41.2001	<i>Alain DESDOIGTS and Fabien MOIZEAU</i> (xlv): <u>Multiple Politico-Economic Regimes, Inequality and Growth</u>
Theory		
Network		
Coalition	42.2001	<i>Parkash CHANDER and Henry TULKENS</i> (xlv): <u>Limits to Climate Change</u>
Theory		
Network		
Coalition	43.2001	<i>Michael FINUS and Bianca RUNDSHAGEN</i> (xlv): <u>Endogenous Coalition Formation in Global Pollution Control</u>
Theory		
Network		
Coalition	44.2001	<i>Wietze LISE, Richard S.J. TOL and Bob van der ZWAAN</i> (xlv): <u>Negotiating Climate Change as a Social Situation</u>
Theory		
Network		
NRM	45.2001	<i>Mohamad R. KHAWLIE</i> (xlvii): <u>The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean</u>
NRM	46.2001	<i>Mutaseem EL-FADEL and E. BOU-ZEID</i> (xlvii): <u>Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation</u>
NRM	47.2001	<i>Eva IGLESIAS, Alberto GARRIDO and Almudena GOMEZ</i> (xlvii): <u>An Economic Drought Management Index to Evaluate Water Institutions' Performance Under Uncertainty and Climate Change</u>
CLIM	48.2001	<i>Wietze LISE and Richard S.J. TOL</i> (xlvii): <u>Impact of Climate on Tourist Demand</u>
CLIM	49.2001	<i>Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI</i> : <u>Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol</u>
SUST	50.2001	<i>Roberto ROSON</i> (xlviii): <u>Carbon Leakage in a Small Open Economy with Capital Mobility</u>
SUST	51.2001	<i>Edwin WOERDMAN</i> (xlviii): <u>Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?</u>
SUST	52.2001	<i>Richard N. COOPER</i> (xlviii): <u>The Kyoto Protocol: A Flawed Concept</u>
SUST	53.2001	<i>Kari KANGAS</i> (xlviii): <u>Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe</u>
SUST	54.2001	<i>Xueqin ZHU and Ekko VAN IERLAND</i> (xlviii): <u>Effects of the Enlargement of EU on Trade and the Environment</u>
SUST	55.2001	<i>M. Ozgur KAYALICA and Sajal LAHIRI</i> (xlviii): <u>Strategic Environmental Policies in the Presence of Foreign Direct Investment</u>
SUST	56.2001	<i>Savas ALPAY</i> (xlviii): <u>Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights</u>
SUST	57.2001	<i>Roldan MURADIAN, Martin O'CONNOR, Joan MARTINEZ-ALER</i> (xlviii): <u>Embodied Pollution in Trade: Estimating the "Environmental Load Displacement" of Industrialised Countries</u>
SUST	58.2001	<i>Matthew R. AUER and Rafael REUVENY</i> (xlviii): <u>Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe</u>
SUST	59.2001	<i>Onno J. KUIK and Frans H. OOSTERHUIS</i> (xlviii): <u>Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland</u>
ETA	60.2001	<i>Carlo CARRARO, Alessandra POME and Domenico SINISCALCO</i> (xlix): <u>Science vs. Profit in Research: Lessons from the Human Genome Project</u>
CLIM	61.2001	<i>Efrem CASTELNUOVO, Michele MORETTO and Sergio VERGALLI</i> : <u>Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto</u>
PRIV	62.2001	<i>Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO</i> : <u>On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects</u>
CLIM	63.2001	<i>Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH</i> : <u>A Note on Testing for Environmental Kuznets Curves with Panel Data</u>
CLIM	64.2001	<i>Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI</i> : <u>Endogenous Induced Technical Change and the Costs of Kyoto</u>
CLIM	65.2001	<i>Guido CAZZAVILLAN and Ignazio MUSU</i> (l): <u>Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset</u>
CLIM	66.2001	<i>Giovanni BAIOCCHI and Salvatore DI FALCO</i> (l): <u>Investigating the Shape of the EKC: A Nonparametric Approach</u>
CLIM	67.2001	<i>Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI</i> (l): <u>Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence</u>
CLIM	68.2001	<i>Alexey VIKHLYAEV</i> (xlviii): <u>The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context</u>
NRM	69.2001	<i>Gary D. LIBECAP and Zeynep K. HANSEN</i> (li): <u>U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s</u>

NRM	70.2001	<i>Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER</i> (li): <u>Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon</u>
CLIM	71.2001	<i>Claudia KEMFERT</i> : <u>Economy-Energy-Climate Interaction – The Model WIAGEM -</u>
SUST	72.2001	<i>Paulo A.L.D. NUNES and Yohanes E. RIYANTO</i> : <u>Policy Instruments for Creating Markets for Biodiversity: Certification and Ecolabeling</u>
SUST	73.2001	<i>Paulo A.L.D. NUNES and Erik SCHOKKAERT</i> (lii): <u>Warm Glow and Embedding in Contingent Valuation</u>
SUST	74.2001	<i>Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP</i> (lii): <u>Ecological-Economic Analysis and Valuation of Biodiversity</u>
VOL	75.2001	<i>Johan EYCKMANS and Henry TULKENS</i> (li): <u>Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem</u>
PRIV	76.2001	<i>Axel GAUTIER and Florian HEIDER</i> : <u>What Do Internal Capital Markets Do? Redistribution vs. Incentives</u>
PRIV	77.2001	<i>Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO</i> : <u>Privatisation around the World: New Evidence from Panel Data</u>
ETA	78.2001	<i>Toke S. AIDT and Jayasri DUTTA</i> (li): <u>Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation</u>
ETA	79.2001	<i>Alberto PETRUCCI</i> : <u>Consumption Taxation and Endogenous Growth in a Model with New Generations</u>
ETA	80.2001	<i>Pierre LASSERRE and Antoine SOUBEYRAN</i> (li): <u>A Ricardian Model of the Tragedy of the Commons</u>
ETA	81.2001	<i>Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT</i> : <u>An Evolutionary Approach to the Climate Change Negotiation Game</u>
NRM	82.2001	<i>Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD</i> : <u>Is the Irrigation Water Demand Really Convex?</u>
NRM	83.2001	<i>Unai PASCUAL and Edward BARBIER</i> : <u>A Model of Optimal Labour and Soil Use with Shifting Cultivation</u>
CLIM	84.2001	<i>Jesper JENSEN and Martin Hvidt THELLE</i> : <u>What are the Gains from a Multi-Gas Strategy?</u>
CLIM	85.2001	<i>Maurizio MICHELINI</i> (liii): IPCC “Summary for Policymakers” in TAR. Do its results give a scientific support always adequate to the urgencies of Kyoto negotiations?
CLIM	86.2001	<i>Claudia KEMFERT</i> (liii): <u>Economic Impact Assessment of Alternative Climate Policy Strategies</u>
CLIM	87.2001	<i>Cesare DOSI and Michele MORETTO</i> : <u>Global Warming and Financial Umbrellas</u>
ETA	88.2001	<i>Elena BONTEMPI, Alessandra DEL BOCA, Alessandra FRANZOSI, Marzio GALEOTTI and Paola ROTA</i> : <u>Capital Heterogeneity: Does it Matter? Fundamental Q and Investment on a Panel of Italian Firms</u>
ETA	89.2001	<i>Efrem CASTELNUOVO and Paolo SURICO</i> : <u>Model Uncertainty, Optimal Monetary Policy and the Preferences of the Fed</u>
CLIM	90.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI</i> : <u>Kyoto Protocol and Emission Trading: Does the US Make a Difference?</u>
CLIM	91.2001	<i>ZhongXiang ZHANG and Lucas ASSUNCAO</i> : <u>Domestic Climate Policies and the WTO</u>
SUST	92.2001	<i>Anna ALBERINI, Alan KRUPNICK, Maureen CROPPER, Nathalie SIMON and Joseph COOK</i> (lii): <u>The Willingness to Pay for Mortality Risk Reductions: A Comparison of the United States and Canada</u>
SUST	93.2001	<i>Riccardo SCARPA, Guy D. GARROD and Kenneth G. WILLIS</i> (lii): <u>Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England</u>
CLIM	94.2001	<i>Ming CHEN and Larry KARP</i> : <u>Environmental Indices for the Chinese Grain Sector</u>
CLIM	95.2001	<i>Larry KARP and Jiangfeng ZHANG</i> : <u>Controlling a Stock Pollutant with Endogenous Investment and Asymmetric Information</u>
ETA	96.2001	<i>Michele MORETTO and Gianpaolo ROSSINI</i> : <u>On the Opportunity Cost of Nontradable Stock Options</u>
SUST	97.2001	<i>Elisabetta STRAZZERA, Margarita GENIUS, Riccardo SCARPA and George HUTCHINSON</i> : <u>The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites</u>
NRM	98.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Alberto LONGO</i> : <u>Integrated Coastal Zone Management in the Venice Area – Perspectives of Development for the Rural Island of Sant’Erasmus</u>
NRM	99.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Julie SORS</i> : <u>Integrated Coastal Management in the Venice Area – Potentials of the Integrated Participatory Management Approach</u>
NRM	100.2001	<i>Frédéric BROCHIER and Carlo GIUPPONI</i> : <u>Integrated Coastal Zone Management in the Venice Area – A Methodological Framework</u>
PRIV	101.2001	<i>Enrico C. PEROTTI and Luc LAEVEN</i> : <u>Confidence Building in Emerging Stock Markets</u>
CLIM	102.2001	<i>Barbara BUCHNER, Carlo CARRARO and Igor CERSOSIMO</i> : <u>On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol</u>
SUST	103.2001	<i>Riccardo SCARPA, Adam DRUCKER, Simon ANDERSON, Nancy FERRAES-EHUAN, Veronica GOMEZ, Carlos R. RISOPATRON and Olga RUBIO-LEONEL</i> : <u>Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan</u>
SUST	104.2001	<i>R. SCARPA, P. KRISTJANSON, A. DRUCKER, M. RADENY, E.S.K. RUTO, and J.E.O. REGE</i> : <u>Valuing Indigenous Cattle Breeds in Kenya: An Empirical Comparison of Stated and Revealed Preference Value Estimates</u>
SUST	105.2001	<i>Clemens B.A. WOLLNY</i> : <u>The Need to Conserve Farm Animal Genetic Resources Through Community-Based Management in Africa: Should Policy Makers be Concerned?</u>
SUST	106.2001	<i>J.T. KARUGIA, O.A. MWAI, R. KAITHO, Adam G. DRUCKER, C.B.A. WOLLNY and J.E.O. REGE</i> : <u>Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study</u>
SUST	107.2001	<i>W. AYALEW, J.M. KING, E. BRUNS and B. RISCHKOWSKY</i> : <u>Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program</u>

SUST	108.2001	<i>Gianni CICA, Elisabetta D'ERCOLE and Davide MARINO: <u>Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse</u></i>
SUST	109.2001	<i>Clem TISDELL: <u>Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment</u></i>
SUST	110.2001	<i>M.A. JABBAR and M.L. DIEDHOU: <u>Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa</u></i>
SUST	1.2002	<i>K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW: <u>Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa</u></i>
ETA	2.2002	<i>Efrem CASTELNUOVO and Paolo SURICO: <u>What Does Monetary Policy Reveal about Central Bank's Preferences?</u></i>
WAT	3.2002	<i>Duncan KNOWLER and Edward BARBIER: <u>The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea</u></i>
CLIM	4.2002	<i>Andreas LÖSCHEL: <u>Technological Change in Economic Models of Environmental Policy: A Survey</u></i>
VOL	5.2002	<i>Carlo CARRARO and Carmen MARCHIORI: <u>Stable Coalitions</u></i>
CLIM	6.2002	<i>Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA: <u>Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets</u></i>
ETA	7.2002	<i>Effrosyni DIAMANTOUDI and Eftichios S. SARTZETAKIS: <u>Stable International Environmental Agreements: An Analytical Approach</u></i>
KNOW	8.2002	<i>Alain DESDOIGTS: <u>Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus</u></i>
NRM	9.2002	<i>Giuseppe DI VITA: <u>Renewable Resources and Waste Recycling</u></i>
KNOW	10.2002	<i>Giorgio BRUNELLO: <u>Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries</u></i>
ETA	11.2002	<i>Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE: <u>Endogenous Fluctuations and the Role of Monetary Policy</u></i>
KNOW	12.2002	<i>Reyer GERLAGH and Marjan W. HOFKES: <u>Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?</u></i>
NRM	13.2002	<i>Michele MORETTO and Paolo ROSATO: <u>The Use of Common Property Resources: A Dynamic Model</u></i>
CLIM	14.2002	<i>Philippe QUIRION: <u>Macroeconomic Effects of an Energy Saving Policy in the Public Sector</u></i>
CLIM	15.2002	<i>Roberto ROSON: <u>Dynamic and Distributional Effects of Environmental Revenue Recycling Schemes: Simulations with a General Equilibrium Model of the Italian Economy</u></i>
CLIM	16.2002	<i>Francesco RICCI (I): <u>Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity</u></i>
ETA	17.2002	<i>Alberto PETRUCCI: <u>Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy</u></i>
Coalition Theory Network	18.2002	<i>László Á. KÓCZY (liv): <u>The Core in the Presence of Externalities</u></i>
Coalition Theory Network	19.2002	<i>Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR (liv): <u>Single-Peakedness and Disconnected Coalitions</u></i>
Coalition Theory Network	20.2002	<i>Guillaume HAERINGER (liv): <u>On the Stability of Cooperation Structures</u></i>
NRM	21.2002	<i>Fausto CAVALLARO and Luigi CIRAOLO: <u>Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems</u></i>
CLIM	22.2002	<i>Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI: <u>Back to Kyoto? US Participation and the Linkage between R&D and Climate Cooperation</u></i>
CLIM	23.2002	<i>Andreas LÖSCHEL and ZhongXIANG ZHANG: <u>The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech</u></i>
ETA	24.2002	<i>Marzio GALEOTTI, Louis J. MACCINI and Fabio SCHIANTARELLI: <u>Inventories, Employment and Hours</u></i>
CLIM	25.2002	<i>Hannes EGLI: <u>Are Cross-Country Studies of the Environmental Kuznets Curve Misleading? New Evidence from Time Series Data for Germany</u></i>
ETA	26.2002	<i>Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS: <u>Environmental Policy and Technological Change</u></i>
SUST	27.2002	<i>Joseph C. COOPER and Giovanni SIGNORELLO: <u>Farmer Premiums for the Voluntary Adoption of Conservation Plans</u></i>
SUST	28.2002	<i><u>The ANSEA Network: Towards An Analytical Strategic Environmental Assessment</u></i>
KNOW	29.2002	<i>Paolo SURICO: <u>Geographic Concentration and Increasing Returns: a Survey of Evidence</u></i>
ETA	30.2002	<i>Robert N. STAVINS: <u>Lessons from the American Experiment with Market-Based Environmental Policies</u></i>
NRM	31.2002	<i>Carlo GIUPPONI and Paolo ROSATO: <u>Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon</u></i>

NRM	32.2002	<i>Robert N. STAVINS: <u>National Environmental Policy During the Clinton Years</u></i>
KNOW	33.2002	<i>A. SOUBEYRAN and H. STAHN : <u>Do Investments in Specialized Knowledge Lead to Composite Good Industries?</u></i>
KNOW	34.2002	<i>G. BRUNELLO, M.L. PARISI and Daniela SONEDDA: <u>Labor Taxes, Wage Setting and the Relative Wage Effect</u></i>
CLIM	35.2002	<i>C. BOEMARE and P. QUIRION (lv): <u>Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences</u></i>
CLIM	36.2002	<i>T. TIETENBERG (lv): <u>The Tradable Permits Approach to Protecting the Commons: What Have We Learned?</u></i>

(xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.

(xliii) This paper was presented at the International Workshop on "Voluntary Approaches, Competition and Competitiveness" organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26, 2000.

(xliv) This paper was presented at the International Workshop on "Green National Accounting in Europe: Comparison of Methods and Experiences" organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000

(xlv) This paper was presented at the International Workshop on "New Ports and Urban and Regional Development. The Dynamics of Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.

(xlvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001

(xlvii) This paper was presented at the RICAMARE Workshop "Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits", organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001

(xlviii) This paper was presented at the International Workshop "Trade and the Environment in the Perspective of the EU Enlargement", organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001

(xlix) This paper was presented at the International Conference "Knowledge as an Economic Good", organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001

(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

2002 SERIES

CLIM *Climate Change Modelling and Policy* (Editor: Marzio Galeotti)

VOL *Voluntary and International Agreements* (Editor: Carlo Carraro)

SUST *Sustainability Indicators and Environmental Evaluation*
(Editor: Carlo Carraro)

NRM *Natural Resources Management* (Editor: Carlo Giupponi)

KNOW *Knowledge, Technology, Human Capital* (Editor: Dino Pinelli)

MGMT *Corporate Sustainable Management* (Editor: Andrea Marsanich)

PRIV *Privatisation, Antitrust, Regulation* (Editor: Bernardo Bortolotti)