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State Regulation of Open-Access, Common-Pool Resources

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Abstract.

Open-access, common-pool resources, such as many fisheries, aquifers, oil pools, and the atmosphere, often require some type of regulation of private access and use to avoid wasteful exploitation. This paper summarizes the arguments and literature associated with this problem. The historical and contemporary record of open-access resources is not a happy one, and many of the problems persist, despite large aggregate gains from resolving them. The discussion here suggests why that is the case. The paper focuses on government responses to the common pool, the private and political negotiations underlying them, and the information and transaction costs that influence the design of property rights and regulatory policies. Understanding the type of institution that emerges and its effects on the commons depends upon identifying the key parties involved, their objectives, and their political influence. Further, it requires detailed analysis of the bargaining that occurs within and across groups. The paper summarizes the open-access problem and provides case analyses of regulation of common-pool fisheries, oil reservoirs, and the atmosphere. The final section summarizes the general themes and the advantages of the New Institutional Economics (NIE) approach to analyzing the common pool.

“But still another inquiry remains; one often agitated by the more recondite Nantucketers. Whether, owing to the almost omniscient look-outs at the mast-heads of the whaleships, now penetrating even Behring’s straits, and into the remotest secret drawers and lockers of the world; and the thousand harpoons and lances darted along all continental coasts, and so remorseless a havoc; whether he must at last be exterminated from the waters, and the last whale, like the last man, smoke his last pipe and then himself evaporate in the final puff.” (Melville, *Moby Dick*, 1922, 425).¹

I. Introduction.

Open-access, common-pool resources, such as many fisheries, aquifers, oil pools, and the atmosphere, often require some type of regulation of private access and use to avoid wasteful exploitation.² In the absence of constraints on users, such as those provided by informal community norms, more formal property rights, or other types of state regulation, individuals competitively exploit the resource rapidly and wastefully. Short-term horizons dominate, with little investment or trade to channel the resource across time or across users to higher-valued applications. This excessive extraction, which amounts to private plunder, continues so long as it is in the interests of the individual parties, even if society would be better off with less intensive and extensive use. Without some limits on individual behavior to better reflect broader, social benefits and costs, only private net benefit calculations govern resource use decisions.

The historical and contemporary record of open-access resources is not a happy one. The depletion of valuable fisheries, the overdrawing of critical aquifers, the stranding of rich oil deposits following excessive, competitive extraction, and the dumping of smoke and other pollutants into the air are examples of the common pool. Unfortunately, many of these open-access problems persist, and the discussion here suggests why that is the case. Throughout this chapter, the terms common pool, commons, and open access are used interchangeably. They do not refer to common property, which is a type of solution to the open-access, common pool, as described below.

Despite the documented losses of the commons, it is not always in society’s interest to completely confront the problem. Too many resources may be required,

¹ I am grateful to Jim Smith who brought this passage to my attention. In this chapter, I cite selections from the literature on regulation of the common pool. The literature is a large one, and the list referenced here is only suggestive, not exclusive.

² Prepared for *The Handbook of the New Institutional Economics*, edited by Claude Menard and Mary Shirley. I benefited from comments and suggestions provided by the editor and referees, Joe Bial, Ryan Johnson, Dean Lueck, Steve Salant, and Jim Smith. The International Center for Economic Research (ICER) Turin, Italy provided research support.

relative to the benefits achieved. In some cases, for example, where very large geographic scales or highly mobile resources are encountered, the transaction costs of defining and enforcing even loose constraints can be prohibitive, at least compared to the value of the resource at stake. In other cases, where there are large numbers of heterogeneous parties competing for the asset, the transaction costs of reaching agreement among the competitors on access and use restrictions also can be very high, relative to the anticipated gains. Or, in a third case, information may be so limited or controversial regarding the benefits of controlling entry and use that no consensus is achieved on the need to take action. Such information problems arise from high transaction costs of collecting and conveying data regarding the status of the resource being exploited. In all of these situations, the “commons” persists because of transaction costs. It is too costly to place boundaries around the resource; it is too costly to secure agreement to limit individual actions; and it is too costly to obtain enough information to determine the proper course of action to protect the resource. In these cases of high transaction costs, continuation of the commons is efficient, as Coase (1960, 39) has taught us.

By contrast, in other situations where information is clearer about the costs of the common pool and where monitoring entry and agreeing on acceptable uses can take place with relatively lower transaction costs, then community rules can reduce open-access losses. Indeed, if a common resource is accessed locally by a comparatively small number of parties with similar or generally homogeneous objectives and production costs, then the problem of overuse often can be effectively addressed through informal rules or norms that constrain individual actions. Under these circumstances it can be relatively easier for a small group of similar people who have a history of interaction with one another to gather and interpret information about the resource’s status and to agree upon the types of uses and constraints necessary to conserve it. They also can accept the distribution of the costs and benefits (and ultimately, of wealth and political power) within the community that is inherent in any definition and assignment of use privileges, even under informal arrangements. Community management of regional agricultural irrigation water, pastures, or inshore fisheries provides examples of successful mitigation of the losses of the commons.

These solutions to open access are termed, “common property.”³

When transaction costs rise due to larger numbers of heterogeneous competitors, perhaps attracted by exogenous forces, such as price increases or technological changes, that raise the value of the asset or that lower the costs of entry, then local, informal arrangements, such as community norms may no longer be effective in combating the wastes of open access. The demands of new entrants who have not been part of the previous arrangement now have to be addressed. The previous allocation of costs and benefits of resource use must be reassigned among a larger group of claimants. Old claimants receive less as more of the resource is diverted to the new parties. It will be difficult for both parties to agree to the required new division. They have had either limited or no past interaction and share no common, verifiable information about the state of the resource. They are unlikely to have common norms regarding resource use or income and cost distribution, and they likely have very different time constraints that govern harvest practices. All of these factors, together with the shear increase in the number of competing parties, raise the transaction costs of agreeing to and abiding by informal community rules (Olson, 1965).

When community rules break down, more formal state intervention may be required, if open-access losses are to be avoided.⁴ The coercive power of the state transcends or at least mediates the claims of any one group. Through the political process summarized below the state can define and enforce new access and use arrangements and provide more formal mechanisms for arbitrating disputes. Indeed, there are a variety of possibilities for state involvement to reduce the wastes of the common pool.

One response is the assignment and enforcement of more definite property rights to the resource, whereby only owners are granted access. If completely defined, a system of private property rights equates private incentives with social benefits and costs. The owner becomes the residual claimant of the resulting benefits and costs from

³ Ostrom (1990) provides a theory and empirical evidence regarding successful local collective action to address common-pool resource (CPR) problems. Experiments and more field studies are included in Ostrom, Gardner and Walker (1994). Other case studies and conceptual arguments are in the readings included in McCay and Acheson (1987); Ellickson (1991); Hess (1996); Burger, Ostrom, Norgaard, Policansky, and Goldstein (2001); and Ostrom, Dietz, Dolsak, Stern, Stonich, and Weber (2002). Useful summaries of the uses of NIE in examining commons problems are found in the readings included in Acheson (1994).

⁴ For discussion of the development of property rights in the Amazon frontier, see Alston, Libecap, and Schneider (1996); Alston, Libecap, and Mueller (1999, 2000). Deacon (1999) examines the relationship between deforestation of the common forest and property rights arrangements.

resource use decisions. Property owners have the right to sell or otherwise exchange the asset or to pass it along to their heirs.

Under these circumstances, socially-optimal resource use decisions result, even though the actions are made by private parties. Reliance on private property rights reduces the role of state regulation to one of enforcing ownership, arbitrating disputes, and refining rights through the judiciary or legislative process as relative prices or technologies change.⁵

Another response to the common pool is state ownership, whereby the state retains formal property rights and controls individual access and use through a variety of entry and production restrictions. Under state ownership, resource use decisions will be made by government officials, either politicians or bureaucrats, who technically are not residual claimants. They are not “owners,” but authorized agents or managers. Because they are not to be guided by private pecuniary objectives in their decisions, production, investment, and exchange decisions involving state-owned assets are determined by political factors as described below. Under these circumstances, there may or may not be a close blending of private and social considerations when the agents make resource use decisions. Accordingly, distortions may result, but they may be socially acceptable if private rights either are not possible or are not politically feasible for reasons to be examined shortly.

A third response to the problem of open access is a hybrid of private ownership and state regulation, whereby individuals hold property rights, but the range of resource options is heavily constrained by regulatory restrictions and taxes. The regulations define how much of the resource can be extracted at any point in time, when it can be accessed, the types of investment that can be made, and the nature of allowable exchange. Receipts from sales are taxed to reduce private returns from harvesting or otherwise using the resource in order to better preserve the stock. A related hybrid arrangement retains government ownership but delegates use privileges to private parties. Again, the private use privileges are sharply limited by regulation and fees to close the margins through which resource rents would otherwise be dissipated.

The type of state response selected depends upon a number of factors. One is the physical nature of the resource and whether private property rights to it can be assigned and monitored at reasonable cost. As noted earlier, broadly-spread resources,

⁵ See the development of property rights and the limited role of the state as enforcer in Anderson and Hill (1975); Libecap (1978, 1989); and Barzel (1989).

such as the atmosphere, or mobile resources, such as ocean fisheries, are examples where private property rights may not be feasible. The higher the cost of assigning and enforcing private property rights, the more likely is reliance upon government ownership and regulation of private use. Indeed, some ubiquitous resources often are viewed by the population as “common” or public resources precisely because restricted access historically had not been possible. Distributional objections can impede government actions to limit access and use of what had been viewed as a “public” resource. Sustained resistance to the charging of fees to public beaches or parklands to ration use is an example of this problem.

Another factor affecting the nature of state response to open-access losses is resource value. More valuable resources attract greater competition for control and potentially, greater rental losses as the parties compete to appropriate the asset. Under these circumstances, government ownership and regulation of private access and use is unlikely to be as effective in maximizing resource values as is a system of private property rights. Private property rights better align incentives for effective resource use because, as noted earlier, “owners” are residual claimants, unless there are critical externalities involved. By contrast, under state ownership there is no clear residual claimant.

If there are important third-party effects associated with private ownership and use, however, private property rights may not be socially-optimal, even when resource values are high. It is often asserted, for example, that very special or unique national assets with high amenity values be retained and managed under public ownership. National parks for the management of important natural regions or phenomena are an example.

A third, and related factor that influences the nature of the state response to the commons is equity. Equity issues dominate politics and political action. The assignment of more precise private property rights to avoid rent dissipation implicitly involves an assignment of wealth and political power. Exclusion is required if property rights are to have any meaning, and exclusion means that some parties will not be able to use or earn a living from a resource that previously been available to them. This situation may raise equity concerns, especially if the new rights arrangement importantly changes *status quo* economic and political rankings.⁶

⁶ Demsetz (1967) notes the role of social norms in influencing the type of property system selected.

The new rights assignment may lead to a more skewed wealth distribution than has previously been acceptable. Politicians may respond to these equity concerns by adopting tax schemes to reduce the wealth gains of rights holders. Although such actions might address equity concerns, they can have efficiency consequences, allowing some of the losses of the commons to continue. For example, taxation reduces the expected private returns from otherwise desirable long-term investment, and as a result, it is neglected.

This chapter focuses on government responses to the common pool, the private and political negotiations underlying them, and the information and transaction costs that influence the design of property rights and regulatory policies. Understanding the type of institution that emerges and its effects on the commons depends upon identifying the key parties involved, their objectives, and their political influence.⁷ Further, it requires detailed analysis of the bargaining that occurs within and across groups. The analytical problem is compounded if the common resource crosses political boundaries or if citizens of multiple jurisdictions or nations are involved. In these cases, intergovernmental regulations are required, so that political bargaining within and across jurisdictions must be examined as well.

Among the transaction costs involved in addressing the commons, information problems play an especially important role. There may be limited or controversial data regarding the magnitude of the open-access problem. If this is the case, it will be difficult for the parties to predict how they will be affected by any institutional change to address the commons. If there is no consensus on the size of waste or risk to the stock associated with the commons, then it will be even more difficult to agree to a distribution of the rewards and costs as part of any proposed regulation or property rights arrangement. Disagreements over the seriousness of the losses of the common pool increase if the problem cannot be readily observed and verified by generally-available information. Similarly, disputes are likely if the scientific or engineering evidence on the problem is obscure, inconclusive, or asymmetrically held. Since these conflicts increase the transaction costs of taking action, they delay responses to open-access situations.

Resolving information disputes not only requires additional data, but agreement on their interpretation and implications for the distribution of the aggregate benefits and

⁷ For analysis of bureaucratic incentives, see Johnson and Libecap (1994).

costs of controlling the commons. Reaching agreement on all fronts may not be easy if the data remain controversial and if the negotiating parties are very different in how they access and react to the data. How these bargaining or negotiation problems are resolved and the time that it takes to do so, influences the nature of the institutions adopted, when they are implemented, and their ultimate impact on common-pool externalities.

Disputes over solutions to the commons are not merely academic. Successful policies require that some parties be denied access and that others have their use practices significantly constrained. This may curtail access and use that has spanned generations with important distributional consequences. The more severe the open-access problem, the greater the needed restrictions on individual behavior. More and more parties must be expelled or have their access sharply constrained and regulated. Current income from resource use for many parties will fall dramatically. Others who are granted property rights or regulated, controlled-access, may find their wealth position sharply improved. As a result, the costs and benefits of resolving the commons are unlikely to be uniformly spread.

Some parties see themselves made worse off from institutional change, absent compensation, even in the face of potentially large aggregate gains. Others see clear improvements, unless their gains are taxed away. Accordingly, the seriousness of the problem, the nature of the solution, the identities of who gains and loses, the compensation to be paid, and its form are the issues that dominate both private and political debate over state regulation of the common pool. Even though intervention might reduce losses in the aggregate, politics determines the nature of the outcome, the distribution of the benefits and costs, and the resulting institutional response may bear little resemblance to what an ideal solution might be.

With its attention to the transaction costs associated with the bargaining that must take place among heterogeneous parties, private, politicians, bureaucrats, and judges, all of whom will act with limited and/or asymmetric information, the New Institutional Economics (NIE) provides a useful way of analyzing state regulation of the common pool.⁸ The NIE helps explain why regulation is often delayed, takes different forms across jurisdictions and countries, and why the suggested approach using a strict, neo-classical framework, which routinely abstracts from transaction costs, most likely

⁸ For summaries of the approaches of the NIE, see Williamson (1975, 1979), Eggertsson (1990), Furubotn and Richter (1997). Allen (1991) discusses transaction costs.

will not be the observed solution to open access.⁹ Consideration of transaction costs helps to make clear why property rights or regulation take the forms that they do. As such, the NIE makes possible a better understanding of actual human behavior, institutions, and resource outcomes.

Section II briefly reviews the common-pool problem, and Section III describes some of the transaction costs associated with assigning more complete property rights or devising alternative regulatory solutions. Sections IV through VI examine common-pool fisheries, oil reservoirs, and the atmosphere. The final section summarizes the general themes and the advantages of the NIE approach.

II. The Common Pool.

H. Scott Gordon (1954), Anthony Scott (1955) and Steven N.S. Cheung (1970) describe the problem of the commons in their classic articles.¹⁰ Using open-access fisheries to define the issue, Gordon discusses the motivation and effects of infinite entry by homogeneous fishers, operating under the rule of capture. According to Gordon, entry occurs so long as the private marginal costs of access and harvest are less than or equal to the average returns for all fishers. Continued entry and the associated fishing pressure eventually dissipate all economic rent. He identifies the institutional conditions underlying this dismal outcome (Gordon, 1954, 124): “There appears then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by no one because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another...The fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today.”

As noted in the Introduction, open-access conditions usually arise when the costs of defining and enforcing restrictive boundaries are high relative to potential benefits. Hence, low-valued resources that are migratory or otherwise difficult to delineate often exist as a common pool. Other resources may lie within the commons due to cultural,

⁹ Similarly, see North's (1990) observation that property rights institutions that promote efficient resource use are the exception rather than the norm.

¹⁰ The wastes of the common pool also are outlined in Libecap (1998a). Heller (1998) and Buchanan and Yoon (2000) describe the counter problem of under utilization of a resource when the right to exclude is held by multiple parties. Brooks, Murray, Salant, and Weise (1999) model common property extraction using two approaches. Bial (1998) examines interstate arrangements in the Ohio River valley to control water pollution prior to federal intervention. Early discussion of open access and private roads is in Frank Knight's classic article on social costs (1924).

legal, or political precedents that mandate free and open access, at least to particular parties. In either case, individuals who use the resource do not bear the full social costs of their actions, and because of this, they exploit it too intensively and do not invest in the long term. The benefits of individual actions are narrowly focused, but the costs are spread among all parties. With the resulting relentless pressure to extract the commons, total output or use exceeds the social wealth-maximization point, where total social costs and benefits are equated. The rush to produce and accompanying ownership uncertainty leads to waste as competing claimants divert labor and capital inputs to predation and defense.¹¹ Violence is characteristic, particularly if external factors lead to a rise in resource values or lower access and use costs.

For example, Alston, Libecap, and Mueller (2000) describe violent conflict over land in the Brazilian Amazon frontier. As access roads are provided, lowering transportation costs, competition for open agricultural land increases, and land values rise. Yet, property rights on the frontier are unclear and enforcement of claims uncertain. Accordingly, infringement of holdings and occupancy of land claimed by others results in disputes, sometimes with deadly outcomes.

The problem of the commons also is outlined by Garrett Hardin in his 1968 *Science* article, “The Tragedy of the Commons.” In discussing incentives among competitive herders to overgraze a common pasture, he concludes (1968, 1244): “Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest...” Johnson and Libecap (1980) describe the empirical case of Navajo herders in the American southwest that illustrates the problem raised by Hardin. Since rights to rangeland are not formally defined or enforced on the Navajo Reservation, each herder is motivated to have his sheep occupy and graze the land completely. Individual control of a particular part of the range is respected only so long as the sheep occupy the land. If they are withdrawn, other herders move their animals onto the range. Any grass that is left by one herder for the future by reducing harvest, only invites entry from neighboring herders. The incentives to overgraze open-access pastures are clear, and over time the land gradually erodes and loses its productive capacity.

¹¹ Bohn and Deacon (2000) argue that insecure ownership can reduce investment and use of natural resources when capital costs for extraction are relative high. This result counters the usual case of higher extraction rates when rights are poorly defined.

Hardin's solution (1968, 1247) to the tragedy of the commons is coercive regulation of individual behavior—"mutual coercion, mutually agreed upon" to escape the "horror of the commons." And he notes, but does not develop, the critical problem of regulating the commons--distributional outcomes that are not acceptable to key parties. He asserts, however, that "injustice is preferable to total ruin." But total ruin is not so obvious to all parties in many common-pool settings. As mentioned above, the parties often disagree with the timing and appropriate form of intervention, and they object to the allocation of the costs and benefits associated with addressing the commons. These concerns raise the transaction costs of reaching agreement on the commons problem, affecting both the timing and nature of the action taken.

III. Regulation of Open Access.

The losses of the common pool often seem so apparent that difficulties in devising effective regulation come as a surprise. In fact, unfortunately, by the time the wastes associated with open access become very visible, much of the damage already has been done.¹² Avoiding these losses motivates collective action to define more exclusive property rights or to assemble regulatory policies for controlling access and use. Historical and contemporary experiences with large commons problems, however, reveal that the process of institutional change is neither very smooth nor complete.¹³ Indeed, state intervention typically occurs late in resource use and depletion, when there is finally a political consensus among the parties regarding the extent of the common-pool losses and the distribution of the benefits and costs of taking action.

This pattern of late responses is repeated in the examples provided below for fisheries and oil. Without considering the costs of gathering, interpreting, and conveying information about the resource stock as well as the costs of negotiating among the relevant parties for institutional change, it is not possible to understand the timing and form of state intervention.

The larger the expected aggregate gains from controlling open access, the more likely some institutional change in the form of regulation and/or the assignment of property rights will take place. As Garrett Hardin (1968, 1248) argues, the commons can be tolerated so long as the magnitudes of the waste are low, but as they rise, the

¹² See the summary in Brown (2000) regarding the timing of management efforts.

¹³ Libecap (1989); North (1990).

social benefits of resolving it increase. Still as noted, broad agreement on the wastes of open access and the means to resolve it may take considerable time.¹⁴

A general consensus that common-pool losses are large is not always sufficient to bring about a successful institutional response due to conflicts over the distribution of benefits and costs among the various constituencies involved. These include competing private parties, politicians, and regulators, and in the design of regulation each attempts to maximize their private net gains. Lobby groups are formed to advance the objectives of particular groups, and interest groups in turn, negotiate to build larger coalitions in favor of desired arrangements. When state action is required, politicians are lobbied to implement the proposed regulation or property rights. Logrolling exchanges and other compromises are necessary within the political arena in order to devise a solution that has sufficient support to be enacted. Each of these layers of negotiation involves different transaction costs that mold the institutions that eventually result.¹⁵

Negotiations within and across groups of resource users are more difficult the greater the number and heterogeneity of the parties involved. With larger numbers, more claims to the resource must be resolved and more must be excluded (Olson, 1965). With greater heterogeneity in terms of objectives, production costs, and access to information, it is more difficult to reach a policy consensus, and to enforce agreement. This is a standard outcome in cartels and other collective action settings (Schmalensee, 1987), and it plagues negotiations over institutional change and the common pool.

Parties who anticipate that new regulation or assignment of property rights will make them worse off relative to the *status quo* will see few benefits from the new regime and will attempt to block it, unless compensation is forthcoming.¹⁶ Conversely, proponent constituencies anticipating improved access to the resource will, along with their political representatives and administrative agencies, seek either enhanced regulatory authority or preferential property rights.

Information and measurement problems, however, raise uncertainty about the actual nature and distribution of the benefits and costs of regulating the commons. For instance, a resource's response to reduced harvest pressure may be understood very imperfectly. This is a common problem, for example, in fisheries where fishing pressure is only one of many factors influencing the health of the stock. Similarly, good

¹⁴ For examples in the case of oil fields and global warming, see Wiggins and Libecap (1985), and Bial, Houser, and Libecap (2002).

¹⁵ Libecap (1989, 10-28).

¹⁶ Johnson and Libecap (1982); Lueck (1995).

information about the precarious nature of the resource often is held asymmetrically by advocates, but their claims are viewed with skepticism by opponents who view the claims as self-serving. In cases, such as the oil example provided below, the status of the resource cannot not be conveyed credibly by proponents because data interpretation typically is *ad hoc* and not easily replicated. Some parties, as we will see below, take advantage of these information and measurement problems to opportunistically advance their own interests that are only tangentially related to the commons problem.¹⁷ With limited data it can be very costly for using parties to sort through the claims that are made regarding the need for regulation.

As noted above, measurement costs are lower for observable, stationary resources, and conversely are higher for larger, mobile, unobservable resources. Compliance must be verified in order to maintain an effective coalition for reducing the losses of the commons. The aggregate benefits of any institutional response to open access, as well as individual shares of those benefits, depend upon general adherence. Otherwise, harvest pressure will be not reduced and the commons not addressed. Cheating by some reduces incentives of all parties to adhere to the arrangement.

Within political negotiations to address the common pool, side payments in the form of preferential regulation, subsidies, or property rights to the resource often are proposed to mitigate opposition from those who otherwise expect to be harmed by any new constraint on general access. As illustrated below, this practice occurred when small oil producers in Texas in the 1940s and 1950s were offered beneficial production quotas within a proposed regulatory framework to control output. Small producers had opposed regulation because they had taken advantage of open-access conditions to drain their larger neighbors. Larger producers, however, were willing to agree to these preferential quotas as a means to secure political support for regulation.

When side payments like these are offered to mitigate potential losses from restricting the commons, there must be agreement on which parties will be affected; the magnitude of the harms involved; whether compensation is warranted; and its size, source, and form. Measurement problems raise the costs of assessing competing claims in negotiations over transfer payments. Compensation requires some agreement on the value of current and proposed uses of the open-access resource so that an acceptable level of taxation can be determined to fund the transfers. Valuation is controversial if

¹⁷ Williamson (1975, 1979) discusses opportunism.

there are information asymmetries among the parties, which impedes consensus on the value of resource use with or without regulation. Further, there may be political opposition to the form of compensation to be paid. Cash transfers typically involve the fewest economic distortions because real resources are not involved, but if the political visibility of cash payments makes them unacceptable, less efficient alternatives must be devised. This situation, for example, explains why small oil producers in Texas received preferential production quotas, even though they led to wasteful extra drilling and output. The alternative of cash payments to certain producers to retire their production was too transparent to be politically acceptable and too difficult to calculate effectively. The granting of special production quotas, in contrast, was simpler and less obvious to general taxpayers.

Compensating side payments to broaden support for regulation or a change in property rights may not be possible for some key parties. They may not have legal standing for such transfers and measurement of claims may be very difficult. One important group affected are politicians, who might lose constituents if the closing of the commons dramatically reduces the population of communities that previously had exploited the open resource. Another group is regulatory officials whose mandates are reduced if a system of private property rights replaces a regulated commons. A third group are those parties who supply inputs or otherwise provide services to those who use the commons. Successful regulation of open access resources, however, reduces their customers by lowering both production and the number of accessing parties. Absent compensation, these groups can be expected to strongly oppose institutional change, and politicians, especially, may be in an excellent position to block or mold any response to the commons.

Finally, precedents affect the range of feasible options for addressing the common pool. A legacy of past informal or formal property rights can give some parties a vested interest in the commons. They will oppose institutional changes, even ones that promise aggregate benefits, unless they can be made better off under the proposed arrangement. It may not be possible, however, to improve their welfare and still maintain the advantages of the institutional change, especially if they must be denied access to the resource and full compensation is not provided. Groups with vested interests may have advantages in political bargaining relative to other groups through lower costs of collective action. Their current position in the system binds them together to make them a relatively cohesive bargaining group. They also have

beneficial ties to established political processes and leaders. These advantages make vested interests effective political lobbyists, biasing institutional change toward maintenance of the commons and limiting successful resolution of common-property problems. This situation is illustrated in the examples that follow, and it suggested that institutional change generally will involve only incremental adjustments from open access.

These information and bargaining issues complicate accord on political side payments to draw in recalcitrant parties and they raise the transaction costs of reaching agreement on new property rights arrangements or regulations to reduce the losses of open access. By contrast, if transaction costs were zero or very low, then action could be taken quickly. Indeed, if transaction costs were zero, there would be no open-access problem to begin with. It would be possible to costlessly devise restrictions on access and use (Coase, 1960). But in practice, transaction costs are high, allowing commons problems to develop and persist, and solutions in some cases may only be slow in developing.¹⁸

III. Regulation of a Classic Common-Pool Resource: Wild Ocean Fisheries.

Wild ocean fisheries are characterized by open access and competing fishers who have no ownership in the stock. Except for relatively stationary inshore shellfish fisheries, private property rights to fish stocks are not feasible due to high definition and enforcement costs. Rights to migratory species that cover wide expanses of the ocean also require coordination across multiple political jurisdictions. Inshore species that remain within more limited spaces, such as in a bay or restricted coastal region, can have more clearly defined ownership institutions. Examples include private leases for oyster beds and territorial rights in U.S. coastal lobster fisheries. In Japan, fishers' associations manage local inshore stocks.¹⁹ In some cases, however, even where potentially feasible, private ownership of fish stocks have met with opposition by those who object to such broad grants of property rights to wild species.²⁰ In the 1950s the U.S. Department of Justice rejected, as violations of the Sherman Act, attempts by

¹⁸ Yoram Barzel (1989) emphasizes transaction costs and measurement problems in implementing property rights regimes

¹⁹ For territorial rules and their enforcement in U.S. oyster beds, see Agnello and Donnelley (1975). For the U.S. Northeast lobster fishery, see Acheson (1975, 1988) who provides details on the institutions that lobster fishers have developed. Berkes (1986) describes local management of inshore fisheries in Turkey. For Japan, see, Asada, Hirasawa, and Nagasaki (1983) and Yamamoto (1995).

²⁰ See discussion by Lund (1980) and Lueck (1989, 1991).

fishery unions to control access to inshore bay fisheries.²¹ The result of these actions, which were prompted by excluded fishers, was to return the fishery to a common pool.

Historically, addressing commons problems in fisheries has started with denying some groups access to a fishery. Usually these arrangements involve giving preference to well-defined political constituencies, such as a country's citizens relative to non citizens, sports relative to commercial fishers, inshore relative to offshore fishers, or large boat owners relative to small boat owners. This approach temporarily, at least, reduces entry and total fishing pressure while avoiding politically-controversial distributional issues in regulating the catch of those allowed to remain.²² Limited-access controls without accompanying harvest restrictions, however, increase individual returns and eventually, encourage new entry and rent depletion by group members. When this occurs, other regulations must be added, such as reductions in the allowable number of fishing days, as well as boat size and gear restrictions that raise fishing costs. Monitoring and enforcement problems reduce the effectiveness of these controls, and fishers compete on unregulated dimensions, dissipating the economic value of the fishery. The underlying problem is that the regulatory structure does not make fishers residual claimants in the stock.

One effort aimed at forestalling the depletion of large, coastal fisheries was the adoption of 200-mile exclusive economic zones, beginning in 1976 by the U.S and other countries.²³ The exclusive zones at least meant that foreign fishers could be denied access, thereby reducing harvest pressure. Domestic fishers, however, increased their intensity in response. In the U.S., for instance, a frenzy of investment in new boats and equipment soon replaced the excluded foreign fishers. Fisheries outside the 200-mile limit remained under open-access, and international efforts have had no power to exclude and no jurisdiction for enforcement. Within the 200-mile zones, attempts at regulation to maintain fish stocks have mostly been unsuccessful due to opportunistic maneuvering by fishers, processors, regulators, and politicians representing depressed

²¹ See discussion of court cases in Johnson and Libecap (1982).

²² For example, Higgs (1982) describes the rise of sport fishers as an effective interest group in lobbying for regulations that constrained commercial fishers in the Pacific Northwest salmon fishery. Similarly, in the Gulf of Mexico shrimp fishery analyzed by Johnson and Libecap (1982) inshore, bay shrimpers and offshore Gulf shrimpers competed to place differential constraints on one another, rather than to find more comprehensive management arrangements. General fishery regulation problems are described in Johnson and Libecap (1982); Karpoff (1987); Wilen (1985, 1988, 2002); Anderson and Leal (1993); Homans and Wilen (1997); De Alessi (1998); Arnason, Hannesson, and Schrank (2000); and Hannesson (2002).

²³ The Law of the Sea Convention of 1982 authorized 200-mile exclusive economic zones. For discussion see Hollick and Cooper (1997, 148-9) and Sebenius (1984).

fishing communities. In addition, the effects of harvest cannot always be convincingly separated from natural factors, such as fluctuations in ocean currents and temperature, and as a result, fishers have not accepted arguments for stricter rules.

In cases where agreement can be reached on the condition of the stock and appropriate total allowable catch (TAC), it must be divided among eligible fishers. Here, however, there are critical distributional effects with important political ramifications. The tighter the limits, the more fishers who must exit and the greater the political outcry, especially from politicians from fishing communities where there are few alternative economic opportunities. Additionally, Johnson and Libecap's (1982) examination of fishery regulation points out how restrictions can have differential impacts on fishers who vary according to ability, capital equipment, and size. In particular, very productive fishers, who have adapted well to the common pool, will be harmed if regulations involve the assignment of politically-popular uniform catch quotas.²⁴ Uniform catch quotas are popular among many fishers, politicians, and regulators because they are comparatively easy to define, at least compared to quotas that vary across fishers; they do not require the information necessary to verify past catch, which is often the alternative basis for assigning quotas; and they do not explicitly provide differential rights and wealth assignments to what had previously been an open or "common" resource. For all of these reasons, uniform catch quotas involve lower transaction costs of definition and assignment. But they obviously can make better fishers who had been successful under open access, worse off under the new regulatory regime.

Accordingly, with differential histories of productivity among fishers, some may have a stake in maintaining the commons and resisting regulations that could redistribute income. When the fishery is virtually depleted these distributional concerns can become less important, allowing for agreement on tighter controls. Many fishers have left the fishery, and those that remain are more homogeneous with regard to expected future prospects and are more likely to see themselves made better off from new arrangements. Under such conditions, regulation is more likely to be adopted and to be more successful, but by this time, the stock may be critically damaged.

²⁴ Uniform rules are popular with regulators because the ease of design and enforcement, and they are attractive to politicians because they do not appear to grant preferential privileges to the fishery. Similarly, Lueck (1995) has argued that very productive parties within a common-pool setting may seek to maintain *status quo* first-possession rules, even though broad social costs might be involved.

In the meantime, regulations that do not explicitly redistribute income, such as fixed fishing seasons, can be adopted without much controversy. These general regulations, however, allow fishers to compete in other ways, usually through increased capitalization--larger boats with more costly search and harvest gear. These investments increase catch and deplete the stock, forcing even shorter seasons, which in turn, lead to a new round of wasteful competitive capitalization.

The Pacific Northwest halibut fishery is an example. A limited entry regime was put into place in 1979 in British Columbia with the maximum number of vessel licenses set at 435, gear restrictions, total allowable catch within the fishing season, and minimum fish size rules. A fishing derby ensued as fishers competed by adding vessels, crews, and times spent fishing. The number of vessels rose quickly from 333 in 1980 to the limit of 435 by 1988, when total harvest peaked at 12,859,562 pounds, up 128 percent from 1980. The halibut stock declined, forcing regulators to reduce the allowable season to ensure the TAC was not exceeded. By 1990 the season had shrunk to 6 days from 65 days in 1980. With a very short fishing season, the catch had to be stored frozen for the rest of the year, denying consumers higher-valued fresh fish.²⁵ This unsatisfactory situation led to a new regulatory approach, the introduction of Individual Transferable Quotas (ITQs) in British Columbia in 1991 and in Alaska in 1995. Through quota exchanges, gradually the number of vessels declined, the stock rebounded, and the season was extended, reaching 245 days by 1993.²⁶

Under a ITQ regime, a total allowable catch is determined by the regulatory authority, based on evaluation of the stock and ocean conditions and then divided among fishers as harvest quotas.²⁷ These quotas are valuable use rights that are exchanged among fishers and gradually accumulated by those who are most productive and have lowest fishing costs. In this manner, fishing effort is adjusted to maximize returns. Although there are enforcement problems and incentives to discard less

²⁵ Gaudet, Moreaux, and Salant (2002) argue that the ability to privately store a common-pool resource can accelerate extraction and increase waste. Further, if there are both common-pool and privately-owned resources, the race to extract and store can shift the of exploitation to the common resource.

²⁶ Discussion of regulation of the Halibut fishery is provided in Grafton, Squires, and Fox (2000); Wilen and Homans (1998); and Wilen (2002).

²⁷ Even so, ITQs do not grant property rights to the stock. Such rights could allow for the adding of fertilizer to increase the growth of plankton and other food sources for fish. For additional discussion of ITQs, see Johnson, (1995) and the readings included in Arnason and Gissurason (1999). The readings included in the two volumes edited by Shotton (1999) provide a very complete discussion of property rights issues and regulation in fisheries, including why ITQs are often resisted, despite their many beneficial attributes. The volumes also include histories of management efforts across a variety of fisheries and countries.

valuable fish under ITQs, they represent a more effective method of regulating the fishery commons.

Nevertheless, ITQs are controversial. The issue hinges on who will get them and the wealth they represent. There must be some limits on the quotas in order for them to have value and for the fishery to be protected. One method is to assign quotas to those who have a history of fishing in the industry, but this arrangement disadvantages potential new entrants, and they mobilize in opposition.²⁸ Uniform allocations harm “highliners,” those captains who consistently outperform other fishers. There are other objections to granting certain fishers ownership windfalls to a common resource. Windfall-profit taxes and the distribution of quotas through auctions would allow the state to capture more fishery rents, but are naturally opposed by fishers. ITQs were adopted in New Zealand in 1986, and in 1991 in Iceland, two nations that depend critically on their fisheries and conservation of the stock. In other countries, ITQs have had more limited experiences. Political opposition in the U.S. resulted in them being placed on hold in 1996. In Norway ITQs have been resisted by regulatory officials, politicians from small fishing villages, and some processors. Even where they have been adopted, small fishing boats have been exempted.²⁹

As a result of the slow and fitful movement of regulation, most wild ocean fish stocks are at precariously low levels due to heavy fishing pressure. Myers and Worm (2003) estimate that the large predatory fish biomass in the world’s oceans is only about 10 percent of pre-industrial levels. These include some of the most commercially valuable species. Hence, despite a large and (in some cases) old literature in economics and biology on fishery management and equally large and expensive fishery management regimes, many of the world’s leading fisheries remain under some variant of open access. The high costs of controlling entry; the information problems associated with determining fish stocks and the usefulness of various regulatory policies; the equity concerns raised in denying entry to some fishers; and the related transaction costs of forming and implementing effective property rights and regulatory programs help explain why the record of closing the commons in major fisheries is such a disappointing one.

²⁸ See Lueck (1995) for discussion of the right of first possession.

²⁹ For discussion of the political economy of Icelandic regulation, see Gissurarson (2000); for New Zealand, see Clark, Major, and Mollett (1989) and Sharp (2002); and for Norway, see Hannesson (1985). Regulation in these and other fisheries also is discussed in the readings included in Shotton (1999).

IV. Regulation of a Common Resource: Oil.

As with wild ocean fisheries, subsurface oil and gas reservoirs can be a common-pool resource. The condition arises when multiple parties competitively extract hydrocarbons from a subsurface reservoir. Under the rule of capture, ownership of the oil is obtained only upon extraction. In the U.S. the problem occurs because ownership of the mineral rights to a single reservoir often is fragmented, with many firms seeking the same migratory oil. The problem also occurs to a lesser degree in places like the North Sea and Caspian Sea where reservoirs are partitioned by international boundaries with separate production concessions within each partition.³⁰ Because fragmentation is less severe in the North Sea, competitive extraction is less of a problem, but it still occurs along concession boundary lines.

In either case, producing firms have incentives to maximize the economic value of their holdings, rather than that of the reservoir as a whole. They competitively drill and drain, including the oil of their neighbors to increase their private returns, even though these actions reduce the overall value of the reservoir. Capital costs are driven up with excessive investment in wells, pipelines, and surface storage, and production costs rise with too-rapid extraction. This practice leads to the premature venting of natural gas or other fluids that help drive the oil to the surface. Total oil recovery is reduced. As in fisheries, the commons problem in oil production has been recognized for a very long time, and the property rights/regulatory responses have been similarly complex and controversial.

The number of firms involved in competing for oil provides a sense of the scope of the problem. On the Yates, Hendrick, and Seminole fields of Texas and Oklahoma, all discovered in the 1920s, there were respectively, 16, 18, and 40 different firms with extraction leases, and on the huge East Texas field discovered in 1932, over 1,000 firms were pumping its oil by 1933.³¹ A possible solution was early consolidation of production rights, at least in domestic U.S. oil fields. Empirically, however, buy-outs to internalize externalities were not the solution to the common pool. The early or ‘gusher’ stage of field development with its fury of production and waste, was the time of least information about the value of individual holdings, limiting the possibilities for exchange.³² The conflicting strategic bargaining positions of so many independent

³⁰ Libecap (1998, 643).

³¹ Libecap and Wiggins (1984, 89-94).

³² Some of the problems of asymmetric information in valuing leases are addressed in Wiggins and Libecap (1985).

agents, compounded by the problem of holdouts, posed insurmountable difficulties in consolidating production leases or in privately coordinating production programs.

As a result in the U.S., state regulations were implemented in the 1930s to limit the drilling of wells, control their spacing, and constrain the extraction of oil and gas through assignment of production quotas. These regulations were supported by some producers, resisted by others, and the policies that emerged were molded by political factors. The compromises necessary to build a political consensus for regulation ultimately weakened its ability to address the common-pool externality, although it was still an improvement over open access. In Texas, the Railroad Commission set monthly statewide production levels and allocated the total among regulated wells. The production rules were applied uniformly to all fields, even though each oil field had a unique physical configuration and optimum production potential. This approach raised production costs relative to what might have occurred with alternative regulatory designs. Further, as noted earlier the numerous and politically-influential owners of high-cost wells were exempted from production controls altogether.³³ Small, high-cost producers (often called “independents”) were located in almost every Texas county and they had close ties to local politicians. Further, they were serviced by local oil-field supply firms and they hired local labor. These firms were comparatively homogeneous and effectively organized for political action as the Texas Independent Producers Organization (TIPRO). Larger producers (the so-called, “majors”) often were headquartered out-of-state and hence, viewed as “foreign.” Moreover, they were located on the largest, most productive fields, which were in fewer parts of the state. They often had internal oil-field supply support and brought in their own labor. For all of these reasons, despite their wealth and size, the major oil firms were less politically effective in designing oil production regulation in Texas than were the independents.

Unitization, which placed the management of the reservoir under a single firm, while granting other producers shares in the net revenues, became an increasingly popular alternative response to the common pool by the 1940s.³⁴ Although it offered an effective remedy to production externalities, its progress was limited. The key issue was conflict over a share formula to divide the net proceeds of unit production among the various parties. Agreements often were not forthcoming until late in a reservoir’s productive life, when enough common information had emerged about the nature and

³³ See Libecap and Smith (forthcoming).

³⁴ For more on unitization, see James L. Smith (1987); Libecap (1998b); Libecap and Smith (1999, 2001).

value of both the reservoir and individual leases. If unit contracts were to succeed, they had to award each party a fixed share of production and costs, making them residual claimants to reservoir-wide rents. If such uniform shares could not be agreed to, then either no unit was formed or less effective contracts were concluded.

In their analysis of unitization negotiations on seven fields in the United States, Wiggins and Libecap (1985, 377-83) found that on average it took six years for agreements to be reached. During the process, many parties became discouraged and dropped out of unitization efforts. The bargaining problem was so widespread that even as late as 1975 only 38 percent of Oklahoma and 20 percent of Texas production came from unitized fields.³⁵ Similarly, because the parties on the immense Prudhoe Bay field of Alaska could not reach agreement on the value of their respective leases so as to assign cost and revenue shares to a complete unit, the reservoir was partitioned in 1977 into an “oil rim” and “gas cap.” Two unit operators were selected for each partition, and there were separate allocations of production costs and benefits among the parties in each partition, even though they covered the same reservoir. Conflicting motivations for production developed, resulting in serious waste until 1999 when company mergers and consolidation of holdings finally (after 22 years) completely unitized the reservoir.³⁶

In face of these problems, state governments adopted legislation to force unitization through majority rules. Compulsory unitization laws were adopted in most states, but in Texas political resistance by small firm owners blocked enactment. Small firm owners sought to protect the production advantages they held under existing regulation.³⁷ Compulsory unitization laws facilitated the adoption of units, and where the problem was due to holdouts by those seeking a greater share of reservoir rents and the reservoir contained only oil, the effect was to improve welfare. But in cases where the reservoir contained both oil and natural gas, the impact of compulsory unitization was not so straightforward.³⁸ Because future relative oil and gas prices were uncertain, the respective owners often held disparate expectations about lease values, making it impossible to agree on the terms of trade necessary to assign overall unit shares.³⁹ When the coercive power of the state was used to force trades and unitization, the resisting

³⁵ Libecap and Wiggins (1985, 702).

³⁶ Libecap and Smith (2003).

³⁷ Libecap and Wiggins (1985).

³⁸ Such situations have been frequent since 63 percent of the largest U.S. oil fields have contained significant volumes of natural gas along with oil. See Libecap and Smith (forthcoming).

³⁹ Libecap and Smith (2001).

parties could be made worse off because they were forced into an exchange that was no longer voluntary. The terms of trade under these conditions is conceived by reluctant parties as offering less than what they require for full compensation for resource. Hence, what otherwise appeared to be an obvious government solution to a breakdown in private bargaining may not have improved welfare.

V. State Regulation of the Common Pool: Air Pollution.

Air pollution also is a common-pool resource problem. Because there historically has been no effective means of assigning property rights to the atmosphere to control private access and use, the air has been a convenient, low-cost medium for disposing of the byproducts of production. The emissions from one plant are carried into the atmosphere, spreading the costs of pollution and diluting any negative effects on the polluter. In the same manner, however, the benefits of controlling emissions are distributed across multiple parties and regions, whereas the costs of regulation are directly born by the owners of the plant. This setting creates collective action problems for combating polluting, while plant owners have incentives to resist or minimize the effects of regulation.

If pollution is localized, then it may be possible for private negotiations to take place among those emitting the pollutants and those seeking cleaner air.⁴⁰ Similarly, where large industrial plants are involved, firms have incentive to recognize the effects of emissions on their workers and equipment because they internalize at least some of the pollution costs and because only one or two parties are involved in negotiating and implementing controls. Where pollution problems are more broadly spread, however, the transaction costs of private collective action are much higher. The number of parties involved is greater as are the incentives to free ride. Monitoring compliance is more difficult. The fundamental theorem regarding such transaction costs in dealing with externalities was developed by Ronald Coase. He made clear that consideration of the costs and benefits was essential and that in some cases "...it would cost too much to put the matter right" (Coase, 1960, 39).

Some form of state regulation, then, may be the only reasonable means of controlling air pollution.⁴¹ Traditionally, emission regulation has relied upon "cap-and-

⁴⁰ Similarly, see James Buchanan's (1972) interpretation of the possibilities for private negotiation to resolve conflicts between owners of red cedar trees and owners of apple trees.

⁴¹ Kolstad (1999, 135-54) outlines some of the major issues in environmental regulation.

control” rules issued from regulators regarding setting overall pollution targets, defining allowable discharges from particular sites, and requiring installation of scrubbing technology and filter equipment. Much of the attention has been directed to electric utilities as major sources of pollution. Since plants vary as to their age, technology used, and fuel source—natural gas, high-sulfur coal, low-sulfur coal--the costs of compliance vary sharply. Accordingly, the way in which regulation is administered affects both the overall cost of achieving air quality standards and the competitive positions of utilities, their customers, and fuel suppliers. There is opportunity for molding regulation to the advantage of the politically influential in ways that do not necessarily assist in meeting air quality objectives.

For instance, the first significant federal air pollution legislation in the U.S. was the 1970 Clean Air Act. It established national maximum standards for ambient concentrations of SO₂ and created new source performance standards (NSPS) for new or refurbished power plants and factories. The NSPS required upgrades of pollution controls whenever plants were constructed or improved. Further, the 1977 Clean Air Act Amendments required that all new coal-powered plants adopt scrubbers even if they burned low-sulfur coal. This rule weakened the competitive advantage of low-sulfur western coal and those utilities that used it relative to high-sulfur eastern coal. The “new source bias” of regulation raised the costs of shifting to new, less polluting plants and extended the economic lives of older, dirty plants that were not burdened by new control costs. Although overall SO₂ emissions declined after enactment of the 1970 Clean Air Act, by 1990 over two-thirds of remaining discharges came from the less-regulated older plants constructed before 1970.⁴² This example, as in the case of oil regulation, demonstrates how bargaining positions and political influence mold the design of regulatory policies to address open access. The resulting design may bear little resemblance to an idealized solution and may be comparatively less effective in reducing the wastes of the commons.

Another example of political manipulation of the design of regulation to address the commons is the Prevention of Significant Deterioration (PSD) requirement of the Clean Air Act of 1970. This provision of the law prohibited deterioration of air quality in any region where it exceeded national standards.⁴³ The PSD, inserted by

⁴² Joskow and Schmalensee (1998, 45) examine the complex political economy of air pollution regulation.

⁴³ Pashigian (1985).

congressional representatives from the Northeast, was designed to limit plant migration to the South and West, where industrial pollution was less severe and where regulation compliance would be less costly. The PSD, however, did not improve overall air quality since the closing of old, polluting plants in the Northeast and the construction of new cleaner ones elsewhere could have reduced pollution.⁴⁴

The potential for political opportunism increases if policy evaluation requires scientific information that generally is not available to citizens. For example, extension of the ethanol subsidy of over \$10 billion since 1979, in part, depends upon the manipulation of information by proponents, chief of which are representatives of Midwestern corn farmers. Although, ethanol is alleged to improve air quality, its effects are mixed. Adding ethanol to gasoline can reduce carbon monoxide emissions from automobiles, but it increases discharge of nitrogen oxide and other pollutants into the atmosphere.⁴⁵ Taxpayers have little easy access to the kind of information necessary to evaluate the claims of ethanol producers. With the costs of the subsidy and the pollution broadly spread across the population and the benefits narrowly focused on a few constituencies, there has been no strong incentive for lobby groups to form to challenge ethanol with the relevant information.⁴⁶

More effective regulatory tools are tradable pollution permits, which were first authorized by Title IV of the Clean Air Act Amendments of 1990 to reduce SO₂ emissions. Tradable permits are alternatives to centralized regulation of pollution sources. They are property rights to pollute, and because they can be exchanged, they allow for flexibility and efficiency in meeting pollution standards. As such, they are similar to ITQs in fisheries and unit shares in oil and gas reservoirs in more effectively addressing common-pool problems. Plant owners who can comply with regulation at lower cost sell their emission allowances to those who have higher compliance costs, allowing pollution to be reduced at lower total cost.

Joskow, Schmalensee, and Bailey (1998) found that the emissions rights market in the U.S. had become reasonably efficient by 1994, lowering the costs of compliance

⁴⁴ The PSD rule was the result of successful political action by representatives of northeastern states. On the other hand, Joskow and Schmalensee (1998) find mixed results for political lobbying. Representatives of polluting states, which had been successful in obtaining preferential rules under Phase I of the Clean Air Act Amendments, did not do as well with Phase II regulations.

⁴⁵ Johnson and Libecap (2001, 123).

⁴⁶ MTBE producers who were competitors for ethanol did have some incentive to challenge the claims made by ethanol producers. MTBE, however, had problems of its own—contamination of ground water and has been banned in many areas.

with clean air rules. Aggregate annual targeted SO₂ emissions are prorated among plants, determining their individual emission allowances. If a plant is to discharge more than it is authorized and not face penalties, its owners must secure allowances from another plant that will pollute less than allowed. Brokers also purchase unused allowances and are a source of tradable permits.⁴⁷ Accordingly through this process, permits are transferred from newer, “clean” plants to older, “dirty” ones where it would be very costly to meet SO₂ caps. The success of emission permits in SO₂ regulation has led to proposals to expand their use to regulate other air pollutants, such as nitrogen-oxygen compounds and mercury nationally and CO₂ internationally. The rising value of clean air and associated controls on open access, the comparative ease in which emission permits have been defined and traded, and the fact that these exchanges have been generally between larger, more homogeneous firms, assisted by brokers, explain why “air rights” have emerged in these cases.

Air pollution often crosses political boundaries, and thereby involves international negotiations. These raise special bargaining problems for developing effective state policies as illustrated by international efforts to control greenhouse gas (GHG) emissions in order to slow or reverse possible global warming.⁴⁸ There is a great deal of uncertainty about the magnitude of the overall global warming problem, how to address it, and the distribution of benefits and costs across countries and constituencies within them. The scientific information remains controversial, and there are concerns about treaty compliance by sovereign countries. Abatement by any country benefits others as a public good, but if abatement is costly to a country’s citizens, its politicians have incentive to invest less in reduction efforts than would be globally optimal. Moreover, representatives of developing countries have demanded concessions to reduce the costs of any treaty. They base their demands on equity grounds, arguing that developed countries were the source of much of past GHG emissions and that developing countries should not be saddled with the costs of regulation. These

⁴⁷ There are also some allowances issued through EPA auctions. See Joskow, Schmalensee, and Bailey (1998) for details on the emission permit markets. See also Joskow and Schmalensee (1998). A thorough discussion of the history and operation of U.S. acid rain regulation is provided in Ellerman et al, (2000). Hahn (1984) outlines some implications for market power resulting from how transferable rights are allocated.

⁴⁸ These include the United Nations Framework Convention on Climate Change (FCCC) signed at Rio de Janeiro in 1992 where countries pledged to voluntarily reduce carbon emissions to 1990 levels by 2000; a meeting in 1995 in Berlin of the Conference of Parties (COP), created at the Rio conference, to define a structure for further action; and the Kyoto Protocol on Global Warming of December 1997. For analysis of the political bargaining issues involved, see Bial, Houser, and Libecap (2002). Rose (2002) examines tradable environmental allowances that could be used in global warming regulation.

information problems, compliance issues, and differential demands made by representatives of both developed and developing countries have raised the transaction costs of designing comprehensive GHG regulation.

Further, the expansive scope of the problem involves many constituencies, some that might be harmed by the imposition of taxes or other regulations to control emissions and others that might be benefited. Heterogeneous constituencies and the uncertainty confronting each party in calculating the net effects of the GHG regulation create political problems for country politicians in formulating bargaining positions in international negotiations. These problems and the transaction costs noted above explain why GHG regulation has been so controversial and is unlikely to be effective for some time. As more information is generated in the future regarding the seriousness of the problem and the distribution of the costs and benefits of regulation, agreement on global warming policies may be more likely, just as it has been in fisheries and in oil pools.

VI. State Regulation of the Common Pool: Concluding Remarks.

Theory and research regarding collective action to regulate common-pool problems comes when: a). there is broad consensus or agreement on the aggregate benefits to be gained, b).the parties perceive positive net gains from agreement, and c).they are homogeneous with respect to bargaining objectives and in the distribution of the costs and benefits to be incurred. Agreements reached under these conditions tend to be self-enforcing because it is in the interest of all parties to insure success. Collective action may also achieve its objectives if the parties are heterogeneous with respect to the net gains from cooperation if: a). the spread is not too great, b). there is little uncertainty as to the consequences of agreement, and c). there are bases for constructing side payments to compensate those parties that may bear more costs or receive fewer gains. The side payments must be long term and predictable, and there must be enforcement arrangements. When these conditions are not met, then responding to the commons will be less straightforward.

In the cases examined in this chapter, the political processes of designing regulation and property rights have been complex, influenced by the positions of the bargaining parties involved and the transaction costs of reaching and enforcing agreements. Even so, there is a gradual trend from centralized, “command-and-control” regulation to greater reliance on individual property rights. In oil and gas, the focus is

on promoting unitization; in fisheries, ITQs; and in air quality regulation, tradable emission permits. Property rights are more flexible, and they better link individual incentives with socially-efficient outcomes.⁴⁹ As a result, they can lower the costs of addressing the commons. This pattern is consistent with the predictions made by Harold Demsetz (1967) who argued that property rights would emerge gradually as it became cost-effective to do so.

Understanding the process of regulatory change, the institutions that emerge, and the observed effects of regulation requires attention to bargaining among the affected parties and the transaction costs involved. This approach is a hallmark of the NIE, and it provides valuable insights into the nature and results of state regulation of the common pool.

⁴⁹ Hahn and Hird (1990) and Hopkins (1996) examine costs of regulation.

References.

- Acheson, James M., 1975, "The Lobster Fiefs: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry," *Human Ecology*, 3: 183-207.
- _____, 1988, *The Lobster Gangs of Maine*, Hanover, N.H.: University Press of New England.
- _____, ed., 1994, *Anthropology and Institutional Economics*, Monographs in Economic Anthropology, No. 12, Lanham, Maryland: University Press of America.
- Agnello, Richard J. and Lawrence P. Donnelley, 1975, "Property Rights and Efficiency in the Oyster Industry," *Journal of Law and Economics*, 18: 621-34.
- Allen, Douglas W., 1991, "What Are Transaction Costs?," *Research in Law and Economics*, 14: 1-18.
- Alston, Lee J., Gary D. Libecap, and Robert Schneider, 1996, "The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier," *The Journal of Law, Economics and Organization* 12 (1): 25-61.
- Alston, Lee J., Gary D. Libecap, and Bernardo Mueller, 1999, *Titles, Conflict, and Land Use: The Development of Property Rights and Land Reform on the Brazilian Amazon Frontier*, Ann Arbor: University of Michigan Press.
- _____, 2000, Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon. *Journal of Environmental Economics and Management* 39: 162-88.
- Anderson, Terry L. and P.J. Hill, 1975, "The Evolution of Property Rights: A Study of the American West," *Journal of Law and Economics* 18(1): 163-79.
- Anderson, Terry L., and Don R. Leal, 1993, "Fishing for Property Rights to Fish," in Roger E. Meiners and Bruce Yandle eds., *Taking the Environment Seriously*, Lanham, MD.: Rowman & Littlefield, pp.161-83.
- Arnason, Ragnar, Rognvaldur Hannesson and William E. Schrank, 2000, "Management Costs in Fisheries," *Marine Policy*, 24: 233-43.
- Arnason, Ragnar and Hannes H. Gissurarson, eds., 1999, *Individual Transferable Quotas in Theory and Practice*, Reykjavik: University of Iceland Press.
- Asada, Y., Y. Hirasawa and F. Nagasaki, 1983, "Fishery Management in Japan." *FAO Fisheries Technical Paper* 238, Rome: FAO.
- Barzel, Yoram, 1989, *Economic Analysis of Property Rights*. New York: Cambridge University Press.
- Brooks, Robin, Michael Murray, Stephen Salant, Jill C. Weise, "When is the Standard Analysis of Common Property Extraction Under Free Access Correct? A Game-

- Theoretic Justification for Non-Game Theoretic Analyses,” *Journal of Political Economy*, 107 (4): 843-58.
- Brown, Gardner M., 2000, “Renewable Natural Resource Management and Use without Markets,” *Journal of Economic Literature*, 38 (4): 875-915.
- Berkes, Fikret, 1986, “Local-Level Management and the Commons Problem: A Comparative Study of Turkish Coastal Fisheries,” *Marine Policy*. 10: 215-229.
- Bial, Joseph J., 1989, *Theoretical and Empirical Examination of Decentralized Environmental Regulation*, Ph.D. dissertation, Tucson: Department of Economics, University of Arizona.
- Bial, Joseph J., Daniel Houser, and Gary D. Libecap, 2002, “Public Choice Issues in International Collective Action: Global Warming Regulation, *Working Paper*, Karl Eller Center, University of Arizona, Tucson.
- Bohn, Henning and Robert T. Deacon, 2000, “Ownership Risk, Investment, and the Use of Natural Resources,” *American Economic Review*, 90(3): 526-49.
- Buchanan, James M., 1972, “Politics, Property, and the Law: An Alternative Interpretation of Miller *et al.* V. Schoene,” *Journal of Law and Economics* XV (2): 439-52.
- Buchanan, James M. and Yong J. Yoon, 2000, “Symmetric Tragedies: Commons and Anticommons,” *Journal of Law and Economics*, 43, 1-13.
- Burger, Joanna, Elinor, Richard B. Norgaard, David Policansky, and Bernard D. Goldstein, 2001, *Protecting the Commons: A Framework for Resource Management in the Americas*, Washington D.C.: Island Press.
- Cheung, Steven N.S., 1970, “The Structure of a Contract and the Theory of a Non-Exclusive Resource,” *Journal of Law and Economics*, 13 (1): 49-70.
- Clark, Ian N., Phillip J. Major, and Nina Mollett, 1989, “The Development and Implementation of the New Zealand ITQ Management System,” in Phillip Neher, Ragnar Arnason, and Nina Mollett, eds., *Rights Based Fishing*, NATO ASI Series, Series E: Applied Science, Vol. 169, Dordrecht: Kluwer Academic, pp. 117-51.
- Coase, Ronald H., 1960, “The Problem of Social Cost,” *Journal of Law and Economics*, 3: 1-44.
- Deacon, Robert T, 1999, “Deforestation and Ownership: Evidence from Historical accounts and Contemporary Data,” *Land Economics* 75 (3): 341-59.
- De Alessi, Michael, 1998, *Fishing for Solutions*, IEA Studies on the Environment No. 11, London.

- Demsetz, Harold, 1967, "Towards a Theory of Property Rights," *American Economic Review*, 57 (2): 347-59.
- Eggertsson, Thrainn, 1990, *Economic Behavior and Institutions*, New York: Cambridge University Press.
- Ellerman, A. Denny, Paul L. Joskow, Richard Schmalensee, Elizabeth Bailey, Juan-Pablo Montero, 2000, *Markets for Clean Air: The U.S. Acid Rain Program*, New York: Cambridge University Press.
- Ellickson, Robert C., 1991, *Order Without Law: How Neighbors Settle Disputes*, Cambridge: Harvard University Press.
- Furubotn, Eirik G. and Rudolf Richter, 1997, *Institutions and Economic Theory: The Contribution of the New Institutional Economics*, Ann Arbor: University of Michigan Press.
- Gaudet, Gerard, Michel Moreaux and Stephen W. Salant, 2002, "Private Storage of Common Property," *Journal of Environmental Economics and Management*, 43: 280-302.
- Gissurason, Hannes H., 2000, *Overfishing: The Icelandic Solution*, London: IEA Studies on the Environment No. 17.
- Gordon, H. Scott, 1954, "The Economic Theory of a Common Property Resource: The Fishery," *Journal of Political Economy* 62 (2): 124-42.
- Grafton, R. Quentin, Dale Squires, and Kevin J. Fox, 2000, "Private Property and Economic Efficiency: A Study of a Common-Pool Resource," *Journal of Law and Economics*, 43: 679-713.
- Hahn, Robert W., 1984, "Market Power and Transferable Property Rights," *Quarterly Journal of Economics*, 99(4): 753-65.
- Hahn, Robert W. and John A. Hird, 1990, "The Costs and Benefits of Regulation: Review and Synthesis," *Yale Journal on Regulation*, 8: 233-78.
- Hannesson, Rognvaldur, 1985, "Inefficiency Through Government Regulation: The Case of Norway's Fishery Policy," *Marine Resource Economics*, 2: 115-41.
- _____, 2002, "The Privatization of the Oceans," in Donald R. Leal, ed., *Evolving Property Rights in Marine Fisheries*, Political Economy Research Center, Bozeman, Montana, pp. 1-44.
- Hardin, Garrett, 1968, "The Tragedy of the Commons," *Science*, 162: 1243-8.
- Heller, Michael, 1998, "The Tragedy of the Anti-Commons: Property in the Transition from Marx to Markets," *Harvard Law Review* 111: 621.

- Hess, Charlotte, 1996, *Common Pool Resources and Collective Action: A Bibliography*. Vol. 3. Bloomington: Workshop in Political Theory and Policy Analysis, Indiana University.
- Higgs, Robert, 1982, "Legally Induced Technical Regress in the Washington Salmon Fishery," *Research in Economic History*. 7: 55-86.
- Hollick, Ann L. and Richard N. Cooper, 1997, "Global Commons: Can They Be Managed?" in Partha Dasgupta, Karl-Göran Mäler, and Alessandro Vercelli, eds. *The Economics of Transnational Commons*, Oxford: Clarendon Press, 141-71.
- Homans, Frances R. and James E. Wilen, 1997, "A Model of Regulated Open Access Resource Use," *Journal of Environmental Economics and Management*, 32(1): 1-21.
- Hopkins, Thomas D., 1996, "Regulatory Costs in Profile," *Policy Study No. 132*, St. Louis: Center for the Study of American Business, Washington University, St. Louis.
- Johnson, Ronald N., 1995, "Implications of Taxing Quota Value in an Individual Transferable Quota Fishery," *Marine Resource Economics*, 10: 327-340.
- Johnson, Ronald N. and Gary D. Libecap, 1982, "Contracting Problems and Regulation: The Case of the Fishery," *American Economic Review*, 72 (5): 1005-22.
- _____, 1994, *The Federal Civil Service System and the problem of Bureaucracy: The Economics and Politics of Institutional Change*, Chicago: University of Chicago Press.
- _____, 2001, "Information Distortion and Competitive Remedies in Government Transfer Programs: The Case of Ethanol," *Economics of Governance*, 2: 101-34.
- Joskow, Paul L. and Richard Schmalensee, 1998, "The Political Economy of Market-Based Environmental Policy: The U.S. Acid Rain Program," *Journal of Law and Economics*, 41(1): 37-84.
- Joskow, Paul L., Richard Schmalensee, and Elizabeth M. Bailey, 1998, "The Market for Sulfur Dioxide Emissions," *American Economic Review*, 88(4): 669-85.
- Karpoff, John M., 1987, "Suboptimal Controls in Common Resource Management: The Case of the Fishery," *Journal of Political Economy* 95:179-194.
- Knight, Frank H., 1924, "Some Fallacies in the Interpretation of Social Costs," *Quarterly Journal of Economics*, 38: 582-606.
- Kolstad, Charles D., 1999, *Environmental Economics*, New York: Oxford University Press.

Libecap, Gary D., 1978, "Economic Variables and The Development of the Law: The Case of Western Mineral Rights," *Journal of Economic History*, 38 (2): 338-62.

_____, 1989, *Contracting for Property Rights*, New York: Cambridge University Press.

_____, 1998a, Common Property, *The New Palgrave Dictionary of Economics and The Law*. Peter Newman, ed. New York: Macmillan, Vol. 1: 317-24.

_____, 1998b, Unitization, *The New Palgrave Dictionary of Economics and The Law*. Peter Newman, ed. New York: Macmillan, Vol. 3: 641-43.

Libecap, Gary D. and James L. Smith, 1999, "The Self-Enforcing Provisions of Oil and Gas Unit Operating Agreements: Theory and Evidence," *Journal of Law, Economics, and Organization*, 15 (2): 526-48.

_____, 2001, "Regulatory Remedies to the Common Pool: The Limits to Oil Field Unitization," *Energy Journal* 22 (1): 1-26.

_____, forthcoming, "The Economic Evolution of Petroleum Property Rights in the United States," *Journal of Legal Studies*, 2003.

Libecap, Gary D. and Steven N. Wiggins, 1984, "Contractual Responses to the Common Pool: Prorating of Crude Oil Production," *American Economic Review*, 74 (1): 87-98.

_____, 1985, "The Influence of Private Contractual Failure on Regulation: The Case of Oil Field Unitization," *Journal of Political Economy*, 93: 690-714.

Lueck, Dean, 1989, "The Economic Nature of Wildlife Law" *Journal of Legal Studies*, 18 (2): 291-324.

_____, 1991, "Ownership and the Regulation of Wildlife." *Economic Inquiry*, 29 (2): 249-260.

_____, 1995, "The Rule of First Possession and the Design of the Law," *Journal of Law and Economics*, 38: 393-436.

Lund, Thomas Alan, 1980, *American Wildlife Law*, Berkeley: University of California Press.

McCay, Bonnie J. and James M. Acheson, eds., 1987, *The Question of the Commons: Culture and Ecology of Communal Resources*, Tucson: University of Arizona Press.

Melville, Herman, 1922, *Moby Dick or the White Whale*, New York: Dodd, Mead and Company.

- Myers, Ransom and Boris Worm, 2003, "Rapid Worldwide Depletion of Predatory Fish Communities," *Nature*, 423: 280-83.
- North, Douglass C., 1990, *Institutions, Institutional Change and Economic Performance*, New York: Cambridge University Press.
- Olson, Mancur, 1965, *The Logic of Collective Action*, Cambridge: Harvard University Press.
- Ostrom, Elinor, 1990, *Governing the Commons: The Evolution of Institutions for Collective Action*, New York: Cambridge University Press.
- Ostrom, Elinor, Roy Gardner and James Walker, 1994, *Rules, Games, and Common-Pool Resources*, Ann Arbor: University of Michigan Press.
- Ostrom, Elinor, Thomas Dietz, Nives Dolsak, Paul C. Stern, Susan Stonich, and Elke U. Weber, eds., 2002, *The Drama of the Commons*, Washington D.C.: National Academy Press.
- Pashigian, B. Peter, 1985, "Environmental Regulation: Whose Self-Interests are Being Protected," *Economic Inquiry*, 23(4): 551-84.
- Rose, Carol M., 2002, "Common Property, Regulatory Property, and Environmental Protection: Comparing Community-Based Management to Tradable Environmental Allowances," in Elinor Ostrom, Thomas Dietz, Nives Dolsak, Paul C. Stern, Susan Stonich, and Elke U. Weber, eds., *The Drama of the Commons*, Washington D.C.: National Academy Press.
- Schmalensee, Richard, 1987, Competitive Advantage and Collusive Optima. *International Journal of Industrial Organization* 5: 351-67.
- Scott, Anthony, D., 1955, "The Fishery: The Objectives of Sole Ownership," *Journal of Political Economy*, 63: 116-124.
- Sebenius, James K., 1984, *Negotiating the Law of the Sea*, Cambridge: Harvard University Press.
- Sharp, Basil, 2002, "New Zealand Fisheries Management," in Donald R. Leal, ed., *Evolving Property Rights in Marine Fisheries*, Political Economy Research Center, Bozeman, Montana, pp. 143-78.
- Shotton, Ross, ed. 1999, *Use of Property Rights in Fisheries Management*, Proceedings of the FishRights99 Conference, Fremantle, Western Australia, 11-19 November, Rome: FAO Fisheries Technical Paper, 404/1&2.
- Smith, James L., 1987, "The Common Pool, Bargaining, and the Rule of Capture," *Economic Inquiry* 25 (4): 631-44.

- Wiggins, Steven N. and Gary D. Libecap, 1985, "Oil Field Unitization: Contractual Failure in the Presence of Imperfect Information," *American Economic Review*, 75 (3): 368-85.
- Wilens, James E., 1985, "Towards a Theory of the Regulated Fishery," *Marine Resources Economics* 1:369-388.
- _____, 1988, Limited Entry Licensing: A Retrospective Assessment, *Journal of Marine Resource Economics*, 5(4): 313-24.
- _____, 2002, "Property Rights and the Texture of Rents in the Fishery," in Donald R. Leal, ed., *Evolving Property Rights in Marine Fisheries*, Political Economy Research Center, Bozeman, Montana, pp. 45-75.
- Wilens, James E. and Frances R. Homans, 1998, "What Do Regulators Do? Dynamic Behavior of Resource Managers in the North Pacific Halibut Fishery 1935-1978," *Ecological Economics*, 24 (2-3): 289-98.
- Williamson, Oliver, E., 1975, *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press.
- _____, 1979, "Transaction-Cost Economics: The Governance of Contractual Relations," *Journal of Law and Economics* 22 (2): 233-61.
- Yamamoto, Tadashi, 1995, "Development of a Community-Based Fishery Management System in Japan," *Marine Resource Economics*, 10 (1): 21-34.