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Identifying Appropriate Institutions for Efficient Use of Common Pools

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ABSTRACT

This paper examines institutional solutions to efficient management of common pools. When the variable divisibility of common pools is considered, the argument is advanced that single versus multiple ownership rights is the institutional distinction most important to efficient use patterns. Also discussed are factors affecting a common pool's divisibility including its physical moveability, boundary stability, and reusability.

The emerging view of public goods theory and natural resource economics is that there exist three important generic types of goods in the world: the public good, the private good, and the common pool.[1] The controversy over common pools is whether or not public governmental institutions should manage and regulate their use or whether use patterns should be left to the forces of the market and private ownership arrangements. The argument is advanced in this paper that the private-public or market-government distinction is a red herring and that single versus multiple ownership rights is really the institutional distinction most closely related to the variable characteristics of common pools and to efficiency in use patterns.

Further, Ostrom and Ostrom[2] and Head and Shoup[3] make the argument that the three generic good types each manifest unique properties that are meaningful in telling us what kind of institutional arrangements are efficient for allocating consumption and use. To the contrary, this paper explores the proposition that common pools really do not manifest special properties that present us with distinctive institutional problems. So-called common pools encompass a wide variety of real-world goods whose desirable institutional correlates are determined by whether the goods possess properties that more closely approximate the defining properties

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1. Typical public goods include military defense and the services of a lighthouse. Any item on a grocery store shelf is likely to be a private good. Examples of common pools include lakes, forests, and pastures.

2. E. Ostrom & V. Ostrom, *Public Goods and Public Choices*, in ALTERNATIVES FOR DELIVERING PUBLIC SERVICES: TOWARD IMPROVED PERFORMANCE, (E. Savas ed. 1975).

3. J. Head & C. Shoup, *Public Goods, Private Goods, and Ambiguous Goods*, ECON. J. 567 (Sept. 1969).

of private or public goods rather than some unique combination of properties of common pools themselves. The argument is advanced that a common pool's potential divisibility is most relevant for determining whether it can appropriately be treated as a private good or a public good.

DEFINING COMMON POOLS AND COMMON POOL DILEMMAS

Ostrom and Ostrom[4] have argued that the fundamental differences between public and private goods pertain to their excludability and subtractibility. Public goods are nonexcludable in the sense that once made available to one individual in a population, they are available for the consumption of others. Public goods are also nonsubtractible. One person's consumption of a public good in no way subtracts from the amount of good made available for the consumption of others. Conversely, private goods are excludable and subtractible. Pricing mechanisms or physical barriers can prevent multiperson use of a particular quantity of a private good, while the divisible and nonreplenishable character of a private good implies that one person's consumption eliminates that portion of the good for consumption by others. For example, the loaf of bread I eat cannot feed you, but the missile that provides me with military defense can also provide you with military defense. Indeed, I cannot exclude you from using it in that way.

Common pools such as lakes, pastures, forests, and streams combine the characteristics of nonexcludability and subtractibility. With respect to the excludability dimension, presumbly, they are like public goods. With respect to the subtractibility dimension, they are like private goods. Common pools are distinct from both public and private goods precisely because they combine these two characteristics which in combination cannot be found as aspects of either public or private goods.

An examination of the implications of these two characteristics reveals dilemmas in the use of common pools. Nonexcludability implies that no presumption can be made about constraints on use. In their primitive, pre-legal status, common pools are available for unrestricted use by all who have sufficient desire to use them. Exemplified in Hardin's seminal description of the "tragedy of the commons," the cattlemen destroy the common pasture land through perpetual additions of grazing cattle.[5] In his hypothetical account of ranch life, no mechanism existed for excluding additional cattle.

Subtractibility holds open the prospect of overuse. One person's use reduces the total amount available, perhaps to a point beyond which the integrity of the pool cannot be sustained. If this critical limit is surpassed,

4. Ostrom & Ostrom, *supra* note 2.
5. G. Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243-1248 (Dec. 1968).

then a classic "commons dilemma" is evident in which the aggregate actions of individuals lead to a collective result that is not in their best interests. For example, cattle can graze a pasture land to the point where the land can no longer grow grass. This type of dilemma can occur whenever total demand for use of a commons exceeds its total supply.[6]

The "trap" theorist Platt[7] has extended the definition of commons dilemmas by noting the configuration of positive and negative incentives for action and the temporal arrangement of those incentives. Platt notes that commons dilemmas can be understood as incentive configurations or "temporal traps" in which individuals face short-run benefits from engaging in a particular action (using the commons) that results in net costs for those same individuals in the long-run (depletion or ruination of the commons). Individuals are "trapped" into engaging in the action because the benefits of the action are immediate while the presumbly greater costs are not experienced until a later point in time.

From the ranks of the psychologists, Messick and Brewer[8] and Messick and McClelland[9] acknowledge that the temporal divergence of benefits and costs can create a dilemma in and of itself, but they also point to instances in which simultaneous receipt of benefits and costs produces a dilemma. Such dilemmas develop because the incentives confronting individuals lead them to act in ways that are not in the best interests of the group. In the grazing example, the problem is not simply that the pasture suffers ruination at a point in time subsequent to the fattening of the cattle. Confronted with the immediate effects of his marginal grazing practices, a prudent cattleman may still choose to add more cattle to the pasture. If he fails to do so, other cattlemen may overgraze their cattle, ruin the common pasture, and leave the naive cattleman without even the while-they-last benefits of overgrazing. Thus, the more general dilemma seems to be a "social" one in which each individual sees his own use of the pool as inconsequential to the ultimate outcome. Temporal delays in the receipt of costs are not at the heart of the dilemma though they surely contribute to the overuse of the large class of common pool resources that naturally regenerate over time.

INSTITUTIONAL SOLUTIONS TO COMMONS DILEMMAS

The definition of common pool goods offered by Ostrom and Ostrom appears to describe an empirical universe of goods that are neither public

6. *See* V. Ostrom & E. Ostrom, *A Theory for Institutional Analysis of Common Pool Problems*, in MANAGING THE COMMONS 157 (G. Hardin & J. Baden eds. 1977); J. Edney, *The Commons Problem: Alternative Perspectives*, 35 AM. PSYCHOLOGY 131 (Feb. 1980).

7. J. Platt, *Social Traps*, 28 AMER. PSYCHOLOGY 641 (Aug. 1973).

8. D. Messick & M. Brewer, *Solving Social Dilemmas: A Review*, 4 REV. OF PERS. & SOC. PSYCHOLOGY 11-44 (1983).

nor private. The specified characteristics of these goods generate a compelling explanation of the dilemmas inherent in their use. However, Ostrom and Ostrom do not use this combination of characteristics to develop a logical fit between a particular institutional arrangement and efficient resolution of common pool dilemmas.

For public goods and private goods, arguments that recommend a fit between institutional type and good type are a part of economic tradition. In the most simplistic view, private goods are assumed to be optimally allocated through market arrangements, while public goods are ideally allocated through governmental arrangements. In the former case, markets are viewed as the superior allocating arrangement because pricing of divisible quantities of private goods can be used to steer distribution to those and only those who are willing to pay in excess of the cost of producing those goods.[10] The nonexcludable and nonsubtractible qualities of public goods imply that only a centrally-determined, single quantity of the good can be provided and that market demand signals would distort revelation of the optimal production quantity.[11] Hence, government should oversee the production and allocation of public goods. The coercive powers of government are also needed to ensure collection (through the tax system) of requisite cost contributions from those who might otherwise wish to "free ride" on the nonexcludable good available from those who might have voluntarily contributed to production costs.[12]

Despite recognition that a common pool embodies defining characteristics of both public and private goods, some authors ignore the implications of this combination and simply examine the institutional correlates of public and private goods.[13] Conceivably, common pools require unique institutional solutions. Others focus solely on the nonexclusion property of the common pool and assume that monopoly ownership or governmental regulation is the preferred institutional arrangement just as with public goods.[14] Again, other institutional solutions may be possible, if not preferable.

9. D. Messick & C. McClelland, *Social Traps and Temporal Traps*, 9 PERS. & SOC. PSYCHOLOGY 105 (Mar. 1983).

10. *See* A. SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS (1937); and M. FRIEDMAN, CAPITALISM AND FREEDOM (1962).

11. *See* W. BAUMOL, WELFARE ECONOMICS AND THE THEORY OF THE STATE (1952).

12. *See* M. OLSON, THE LOGIC OF COLLECTIVE ACTION (1965). Olson points to labor unions as another instance where coercion was employed to prevent people from free riding at the cost of others. In the early organizational days of the country's major unions anyone who did not join and pay membership dues to the union stood a good chance of being beaten up. In this way, nonmembers were discouraged from taking advantage of higher wage rates (an indivisible good) negotiated by the union without a contribution to the union itelf.

13. *See for example*, Ostrom & Ostrom, *supra*, note 2.

14. *See* J. Baden, *A Primer for the Management of Common Pool Resources* in MANAGING THE COMMONS (1977), and Hardin, *supra*, note 5.

Bish[15] notes the importance of examining the precise characteristics of "environmental resources" but concludes that for most such resources, private monopoly ownership has informational and incentive advantages over public management. He argues that private owners have rent-motivated incentives to seek information about the high-valued uses of their resource, while public managers are inclined to respond to claims of politically-organized interests who are not necessarily representative of all resource users and whose aggregate claims can easily lead to overuse of the resource. Bish and Ostrom argue that specific institutional arrangements available in the public sector for allocating use of common pools are many and complex, but they fail to indicate the connections between characteristics of goods and optimal or even preferable institutional designs.

The social and temporal trap theorists have analyzed the types of restructurings of incentives or circumstances they see as needed in order for commons dilemmas to be resolved. Circumstances can be restructured so that the temporal delay in the receipt of costs is eliminated. The future consequences of overusing an aquifer are taken into account in plans for current use of the aquifer. Or, the reward structure of actions that produce undesirable outcomes can be altered so that these actions are no longer dominant strategies for individual actors. Heavy fines are levied on anyone whose grazing livestock jeopardize the regeneration capacity of a pastureland. Such analyses demonstrate how incentive structures or circumstances must look if we are to have solutions to commons dilemmas. They do not tell us, however, what types of institutions or assignment of property rights could yield optimal incentive arrangements for common pool goods.

DIVISIBILITY AND SINGLE VERSUS MULTIPLE OWNERSHIP

Traditional analysis of institutional alternatives begins with the basic distinction between public and private ownership of a common pool or between public and private assignment of property rights.[16] However, a more important and fundamental distinction is whether property rights to portions of the common pool should be assigned to *multiple* users or whether property rights to the entire good should be assigned to a *single* user be it public or private.

A variety of alternative institutional arrangements are subsumed into

15. R. Bish, *Environmental Resource Management Public or Private?* in MANAGING THE COMMONS, *supra*, note 6 at 217. Bish is a political scientist who has spent much of his career studying western water resources. *See* R. BISH, R. WARREN, L. WESCHLER, J. CRUTCHFIELD, & P. HARRISON, COASTAL RESOURCE USE (1975).

16. A classic in this field is THE ECONOMICS OF LEGAL RELATIONSHIPS (H. Manne ed. 1975).

the category that assigns property rights to a single user. For example, property rights can be assigned to a single private individual who, thereafter, is able to capture all the economic rents obtainable from use of the common pool. Property rights can also be assigned to a governmental agency with use of the common pool being determined by the multiple group and legislative pressures placed on the agency. Or, groups of users who previously enjoyed common use rights to the good may arrive at a collective decision to transfer their individual rights over to a new administrative body created by those very same users.[17] These institutional alternatives surely have important consequences for the relevant population of users, but the desirability of one or the other alternative seems unrelated or barely related to the *characteristics* of common pool goods. There is nothing inherent in the nonexcludability and subtractibility characteristics that gives us a logical basis for predicting whether a private or public solution is preferable.

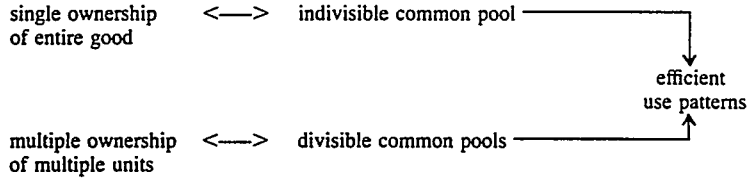
Conversely, the distinction between assignment of one property right to a single user and assignment of multiple rights to multiple users does seem to have consequences that are contingent on at least the variable characteristics of common pool goods. This conclusion is derivable from consideration of the traditional market versus government argument as well as from the nonexcludable and subtractible characteristics of common pool goods.

The advantages of markets dealing with private goods derive from the fact that portions of goods can be allocated to many different users according to their particular values and their ability to pay. Private goods can be "unitized" and "packaged." Public goods by definition cannot be unitized and packaged. A single unit of public good made available to one person is equally available to others. On the other hand, common pools have at least a conceptual basis for being unitized. Because common pools are subtractible, we can imagine that they can be divided up or unitized. We can observe discrete portions of common pools that were it not for technical considerations could be allocated as private goods. Technical obstacles such as unstable unit boundaries (portions of a lake) and physically immoveable units (portions of a park) create the basis for the nonexclusion characteristic of common pools. If you cannot easily divide up and separate units of the common pool, you cannot easily exclude individuals from using any particular portion thereof.

17. The development of the California "doctrine of correlative rights" is an interesting example. Over time, multiple private owners of groundwater resources have ceded their rights to unconstrained use through transfer of allocative powers to centralized (effectively single-owner) court authority. Under the correlative rights doctrine, the evolved powers of the court are especially pronounced when the recharge capability of aquifers are threatened. *See* T. Veeman, Water Policy and Water Institutions in Northern India: The Case of Groundwater Rights, 18 NAT. RES. J. 571 (July 1978) for an explanation of the correlative rights doctrine and an assessment of its applicability to Indian groundwater allocation problems.

Exclusion requires boundaries of some sort. Inability to exclude individuals from using a *portion* of the good implies that any effort to avoid overuse or depletion of a positively valued good must come at the *outer* boundaries of the good. One person or entity cannot decide to exclude individuals from using portions of a good for which he lacks exclusionary authority. Multiple ownership is conceivable but it must result in a single decision about how the exclusion is to be exercised at the outer boundary. Even if the boundary were itself divided up among multiple users, each person's use or exclusion decision would affect the amount of the pool available to others since no internal boundaries could be established. A centralized decision would, therefore, be required that incorporated all interdependencies and multiple owners would need to delegate their decision-making power to a single authority. Thus, single ownership or a unified right to exclude is necessary when divisible units of the good are unimaginable.

The relationship posited so far involving ownership rights and divisibility of a common pool are summarized below:



CHARACTERISTICS OF COMMON POOLS THAT AFFECT THIER DIVISIBILITY

If the divisibility of common pools is crucial in the choice of appropriate institutional arrangements, characteristics of common pools that affect their divisibility are also important. Divisibility is affected by a common pool's physical moveability, its boundary stability, and its reusability.

Moveability

Market arrangements are thought to be efficient if the goods they allocate can be divided up, unitized and distributed to particular individuals according to their willingness to pay for units. Distribution is hampered if a unit or portion of a good cannot be moved. Movement implies that one unit of a good can be placed at a physical distance from another unit. Some goods are simply too ponderous to imagine such a separation. A portion of a park or national forest[18] cannot be picked up and moved (although trees dedicated to particular uses can be). Bulldozers and trucks

18. For the sake of illustration, we are ignoring the purely public good components of parks and forests such as scenic vistas.

can move dirt and animals, but the full integrity of what the good was in its initial state cannot be preserved through such a process. Markets do not completely fail in these circumstances, but mobility on the part of users must be assumed to compensate for the immobility of units of the good.

Boundary Stability

Unitizing portions of the common pool are hindered if unit boundaries are unstable. Whether boundaries are stable depends, in part, on the nature of the use to which the good is to be put. Irrigation water is often diverted from a stream and is easily identified as a distinct portion of that stream increasing in quantity only as more water is diverted. An in-stream use such as trout fishing is difficult to delineate, inasmuch as water characteristics that attract fish and that affect their "biting" behavior are constantly changing.

Reusability

We begin by defining common pools as subtractible goods. However, many goods normally thought of as common pools are not purely subtractible. A unit of a good once having been used may, to some degree, be used again. An individual who crosses a bridge to ford a river in no way diminishes another individual's ability to cross the bridge in exactly the same way at some other time. Reuse implies at least a sequence of use, but it can also involve a more significant temporal element: regeneration. Some goods and many common pools regenerate over time. Water can be diverted from a stream for irrigation purposes but, typically, the next spring the full flow of the stream will return irrespective of summertime diversions. The stream regenerates.

Often, a common pool's regenerative capacity is preserved only if total usage at a given point in time does not exceed some limit.[19] Beyond that limit, the pool's ability to regenerate is dissipated and total depletion is possible. In these cases, the marginal user who confronts placing the good beyond its regenerative capacity is really providing a public good if he foregoes the critical act of consumption. For example, an underground aquifer's ability to regenerate year after year could be threatened by a single individual's decision to pump out an extra one hundred acre feet of water from his well. The aquifer is preserved if he decides not to pump the extra water. The future water supply for everyone is affected by this pumping decision, not just the unit of the aquifer the individual is contemplating consuming. In other words, none of the users of the

19. Every common pool that fits this category will likely possess a different empirical limit. No two aquifers will possess the same limit on use beyond which regeneration is impossible.

aquifer can be *excluded* from the consequences of a particular user using a particular portion of the aquifer when total use has entered a range critical to the aquifer's regeneration. The loss of the future water supply is a public bad (a negatively valued public good) embodying the non-exclusion characteristic in the sense that no one is able to avoid consuming the bad (experiencing the loss). Just as the loss of the future water supply is a public bad, the maintenance of that supply is a public good. Assigning ownership rights to portions of a public good is not feasible since portions cannot be defined. We can hardly expect such efforts to result in optimal use.

QUALIFICATIONS ABOUT THE IMPLICATIONS OF DIVISIBILITY

The presence of indivisible characteristics of common pools does not automatically imply that single ownership is desirable and that markets will fail. A particular category of public goods called "step goods" may have incentive properties different from those usually thought to produce overuse of common pools. Also, small groups of users may be able to exert beneficial influence on each others' use patterns. Finally, some division of a common pool may be feasible and desirable despite the presence of some reusable features.

Step Goods

The future supply of many regenerating common pools resemble "step goods." Step goods are public goods that can be produced or provided only in discrete quantities.[20] Many step goods, for example, a musical concert, can only be provided in a single quantity. If sufficient cost contributions are received, the concert is performed. If fewer contributions are received then the concert may not be provided at all. Future supplies of regenerating common pools are available if total use remains below the pool's critical limit. If total use exceeds that limit, future supplies may disappear altogether.

If an individual has knowledge that his particular contribution to the cost of providing a public good is necessary and sufficient for provision of a discrete level of that good, he may confront a positive incentive to make that contribution. The contribution required to preserve future supplies of a common pool is the foregoing of a use of the pool that would otherwise place the supply of the pool below its critical regeneration limit. A contribution to the preservation of an underground water supply is to refrain from pumping a marginal quantity of water that would leave the aquifer incapable of regenerating a community water supply after the next rainfall or after the next rainy season.

20. *See* R. HARDIN, COLLECTIVE ACTION, ch. 4 (1982).

Future Supply as a Bad

A self-interested individual has an incentive to sacrifice a present use critical to preservation of the commons only if the benefit he expects to receive from his own future use exceeds his expectation of the benefit he would have received from using or consuming in the present the critical portion of the common pool. For example, a farmer who irrigates out of a groundwater basin will presumably value the capacity to irrigate in future years more highly than he would an increment to this year's supply of irrigation water if that increment created an unreplenishable overdraft of the basin. However, if the value of all future uses does not exceed the value of present use for an individual then future supply is not really a "good" at all for this individual, but rather a bad if he foregoes present use to preserve it. The future supply is a bad because the individual suffers a total net loss as a result of his sacrificial action no matter what actions others may take. If all users prefer present uses that would deplete the commons to all future uses then the commons dilemma has no meaningful temporal component. The problem for the group is the simpler task of allocating uses that deplete the common pool. If the pool is relatively divisible, then an assignment of property rights to the multiple users will likely result in the maximization of the use value of the pool. Once rights are established they can be sold to those who place the highest value on the uses of the pool. If the pool is indivisible, use patterns associated with multiple ownership may be chaotic and generate less than optimal value. Nevertheless, worse scenarios are possible. If authority is invested in a single owner who places constraints on use calculated to preserve future supplies (bad in this case) then total use value will be diminished, not enhanced. Single owners in the private sector seldom err in this fashion, but accusations of governmental overprotection are common.[21]

Belief in the Critical Character of Use

In instances where total future uses are valued more than present ones a self-interested individual has an incentive to forego critical use of the pool only if he believes that his marginal use is, indeed, critical. If an individual has information about the choices others have or will make then he can readily determine whether his own decision to use or forego further use of the common pool is critical to preservation of the pool. Ordinarily, the objective probability of his decision being critical will be low assuming there exists even a modest number of like-minded users of the common pool. The choices that others have made could lead to

21. The U.S. Forest Service sometimes holds "old growth" timber off the market while its value as a lumber resource, its highest value, declines. *See* R. Stroup & J. Baden, Bureaucratic Myths and Environmental Management, NATURAL RESOURCES 116.

aggregate use levels that range from no use at all of the common pool to use levels that far exceed the limit ensuring regeneration of the pool. Only a relatively small range of total possible outcomes would make a single individual's marginal use critical to the preservation of future uses.

In real-world circumstances, individuals will seldom possess complete knowledge of the use decisions that others have or will make. Individuals usually will have to make guesses about what actions others will take. Those guesses will certainly be sensitive to whatever information is available in a given situation, but there is no reason to believe that, as a general rule, individuals will have unrealistically high expectations about how critical curtailment of their own use is to preservation of the pool.[22]

On occasion, the perception of marginal use being critical to maintenance of a pool is present.[23] Combined with other factors that counterbalance predictions of market failure in providing public goods, this presence may be important. Experimental studies of public good provision suggest that significant numbers of individuals cooperate, that is, contribute to the cost of providing public goods even though their self-interest dictates that no contribution is the best response regardless of what others may do.[24] The repeated observation of behavior inconsistent with self-interested motives suggest that many individuals act out of altruism. More specifically, they derive positive utility from benefits accruing to others. With step goods, altruism-induced contributions to the public good (curtailments of use with respect to future supplies of common pools) can be added to whatever contributions can be attributed to self-interested motives stemming from the presence of a critical range of contribution. In an experimental study examining contributions to step level goods; van de Kragt, Orbell, & Dawes[25] reported very high levels of contributions to the provision of step goods. Sixty-one percent of subjects contributed to the provision of a step good in instances where subjects were not allowed to discuss among themselves their circumstances nor their strategies before making their contribution decisions. Contributions to step goods were not directly compared to contributions to public goods available in continuous quantities, but the sixty-one percent figure is much

22. The importance some people seem to attach to their own vote in public elections might suggest otherwise.

23. Users will likely see their use as being critical the smaller the total number of users.

24. *See* R. Dawes, J. Orbell, R. Simmons, & A. van de Kragt, *Organizing Groups for Collective Action*, forthcoming, AM. POL. SCI. REV. (Dec. 1986); M. Isaac, J. Walker, & S. Thomas, *Divergent Evidence on Free Riding: An Experimental Examination of Possible Explanations*, 43 PUBLIC CHOICE 113 (No. 2, 1984); A. van de Kragt, J. Orbell, & R. Dawes, *The Minimal Contribution Set as a Solution to Public Goods*, 77 AM. POL. SCI. REV. 112 (Mar. 1983); J. Sweeney *An Experimental Investigation of the Free-Rider Problem*, 2 SOC. SCI. RES. 277 (1973); and P. Bohm, *Estimating Demand for Public Goods: An Experiment*, 3 EUR. ECON. REV. 111 (No. 2, 1972).

25. A. van de Kragt, J. Orbell & R. Dawes, *The Minimal Contributing Set as a Solution to Public Goods Problems*, 77 AM. POL. SCI. REV. 112 (Mar. 1983).

higher than levels of contributions usually reported in experimental studies involving continuous public goods.[26]

Small Groups

Higher contributions to the provision of public goods can also be expected where the group of potential contributors or users is small rather than large. At some, perhaps variable, number of members, a group is sufficiently small when users will know each other, can monitor each other's behavior, and can be expected to exert social pressure on one another to contribute to costs of providing the public good. Where a critical range of use is present, those social pressures are likely to be intense—directed against anyone who might spoil things for everyone else. Groups of users of common pools often are small enough for users to know each other and to be able to monitor each other's relevant behaviors. Users of local aquifers may all live in the same neighborhood. The use of lakes of at least modest proportions should be subject to monitoring.

Altruism and augmented social pressures may combine with the critical range factor to produce limits on the use of regenerating common pools sufficient to avoid aggregate use that threatens the pool's regenerative capacity. Resolution of the commons dilemma is at least conceivable in a market of multiple users and owners.

Reusability Over Time

The indivisible character of public goods implies that they can be reused—one person's use does not reduce the amount available to all by the full extent of that use. But the reusability characteristic need not involve anyone other than the original user. An owner of a section of forest may curtail his cutting of trees so erosion does not hinder the growth rate of new trees. If he overcuts his section, he may be the only individual to suffer the loss of future timber.

In this case, reusability does not apply across the space of potential users but only across time for one user. Because the particular user's action has no effect on other users, a division of the pool and assignment of multiple rights is appropriate—even though an individual's present use could threaten the regeneration of his own portion of the common pool. Division and assignment of a unified property right ought to be possible for units no larger than necessary for the incorporation of all interdependent spatial reuses. If timber cutting in one forest tract affects erosion in an adjoining tract then the unified property right should, at least according

26. *See* M. Isaac, J. Walker, & S. Thomas *Divergent Evidence on Free Riding: An Experimental Examination of Possible Explanations*, 43 PUBLIC CHOICE 113 (No. 2, 1984).

to the interdependence criterion, incorporate both tracts. The future supply of timber created by one individual's choice not to overcut can, in effect, be reused by his neighbor.

SUMMARY

Ironically, the efficiency of assigning single or multiple ownership rights to common pools defined by the characteristics of nonexcludability and subtractibility seems to depend on the extent to which nonexcludability can be violated or on the extent to which subtractibility is, in fact, violated. If a way can be found to divide up the commons then the various parts of the commons can be treated as private goods with each part or good allocated to a separate owner. Owner-users would then have legal backing to exclude others from using their portion of the pool.

If however, those parts or goods are not perfectly subtractible over the space of potential users, then a division of the pool has no conceptual basis. If the same unit of a good can be reused by different individuals then its division among all users makes no sense. The integrity of the unit could be destroyed. There is no feasible way to divide up the warning services of a lighthouse. Nonsubtractible pools must be treated as public goods with single ownership a reasonable alternative to the market failures predicted for multiple ownership.

Only the possibilities for market provision of public goods disturb the neat correspondence between divisible common pools and multiple property right assignments and between imperfectly divisible pools and a single property right assignment. Small groups of users may find themselves able to maintain agreements about appropriate use of common pools with indivisible characteristics. Altruistic motives may also enhance the prospects for market provision of the indivisible goods. Further study of such goods is needed, especially in controlled experimental settings, to determine whether such common pools can be preserved for beneficial future use where multiple owners exist and open markets are operative.