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Title: DECISION GUIDES FOR FOREST PRACTICE LAWS IN OREGON

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Spawned by the current interest in revising Oregon's Forest Conservation Act, this study defines the forestry regulation problem and outlines theoretical approaches to its solution.

Unregulated private forestry is found to present opportunities for government intervention, the gains from which could exceed the losses. Proposed is a public goal of maximizing net satisfactions from Oregon's private forest lands, subject to specified constraints and assumptions. This goal is derived in a chapter on welfare economics.

Following an evaluation of past regulation goals and approaches, the study discusses guidelines for regeneration and logging regulations consistent with the assumed regulatory objective. In a full employment economy it appears that public regulation of private forestry is unlikely to increase net benefit from wood output alone above that

which the unregulated market would attain (ignoring non-wood benefits). However, government leasing of private land for wood production does provide a possibility of increased satisfactions from wood output. Upon considering non-market forest benefits and undesirable side-effects of logging, welfare-increases from intervention are shown to be possible.

After reviewing the concept of optimal levels of spill-over effects, the study points out the possibility that optimal levels of non-market damages could depend on whether the liability for damage reduction is placed on the victims or the damager. Considering both liability viewpoints, a scheme for determining optimal regeneration regulations is outlined for cases where non-market values are at stake. Approaches to optimizing levels of external non-market damages from logging are then examined under each liability scheme, considering actions causing changes in single or joint benefits. The importance of distinguishing between mutually exclusive and additive management practices is illustrated.

Forestry-caused environmental changes discussed under non-market benefits include variations in water siltation and temperature, fish and big game populations, and scenic beauty.

The study aims to assist economists advising planners of forest practices legislation and administrative regulations. Much of the information presented would be useful in designing such intervention

today to approach the study's assumed regulatory goal. Other more detailed decision guides are proposed for research to determine optimal regulations on study areas. Broad application of such research results could increase welfare by a greater amount than could preliminary regulations designed immediately.

Throughout the study, emphasis is placed upon the need for, and possibility of, making incremental analyses comparing marginal benefits and costs even when these marginal quantities are in different units. Evaluation of regulatory alternatives is left to decision makers; the study simply illustrates ways of arraying and comparing alternatives and points out implications of various approaches to forest practices regulation.

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DECISION GUIDES FOR FOREST PRACTICE LAWS IN OREGON

I. INTRODUCTION

A rising concern over possible future timber famine as well as the threat of federal forestry regulation stimulated the Oregon State Legislature to pass the Forest Conservation Act[1] in 1941. This law defines for private forest landowners certain forest management practices to assure a future timber supply.

The present Act requires leaving either specific numbers or areas of seed-bearing trees per unit area of timber harvested in order to assure a seed source for regeneration. Requirements vary for six different timber types. After a given period, removal of seed sources is allowed upon attaining adequate levels of stocking defined in the Act. On some timber types, minimum tree diameter limits for harvesting are specified.

Equivalent or more effective regeneration practices can be substituted for those required in the Act, if approved by the State Forestry Department prior to harvesting.

Should inadequate stocking result from failure to comply with the Act, the State Forestry Department shall make a reforestation effort

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[1] The Oregon Forest Conservation Act is reproduced in Appendix A.

costing no more than $25 per acre. The delinquent landowner must bear this cost.

Recently some of the following factors have prompted forestry leaders in Oregon to consider revising the current Act:

1. A desire for a more flexible law which, while still protecting the public interest, allows a wider range of land management activities.
2. Rising public interest in environmental quality and an increasing concern about the effects of logging upon water, fish, wildlife and scenic values.
3. Augmenting demand for outdoor recreation resources.
4. Greater confidence in our forests' timber producing capacity as well as in technology's ability to find wood substitutes and to adapt to changing species, sizes and qualities of timber.

In 1968 the Oregon State Board of Forestry appointed a Forest Conservation Act Study Committee to prepare a proposed revision of the Act for consideration by the Board, for review by certain state agencies and by forest industry representatives, and for eventual presentation to the 1971 Legislature. The Committee conducted a series of meetings in 1969 and early 1970, and by March 1970 had drafted a proposed revision of the Forest Conservation Act with the assistance of State Department of Forestry staff. Committee members

included N. B. Giustina (Giustina Brothers Lumber Company), Clarence Richen (Crown Zellerbach), Frank Gilchrist (Gilchrist Timber Company), Donald Barker (Barker Timber Company), and Carl Stoltenberg (Oregon State University School of Forestry).

This study was proposed by Dean Stoltenberg as a possible source of economic guidelines which might assist public officials and legislators in evaluating proposed revisions of the Act and in suggesting other changes. Indirectly, the decision makers in formulating a new Forest Conservation Act are the people of Oregon. More directly, and for the purposes of this study, they are legislators in the case of state laws, and they are regulatory groups in the case of administrative regulations. Legislators will review suggested revisions of the Act and eventually draft and vote on a new law, while regulatory agencies would design administrative rules for specific situations.

Forestry legislation would affect about 10,300,000 acres of private forest land in Oregon (U.S.F.S., 1965a). In any given year, however, most of the laws to be considered would concern only the private areas harvested. These comprised between 330,000 and 480,000 acres yearly between 1963 and 1967 (O.S.F.D., 1963-67).

If 400,000 acres were affected annually by legislation which resulted in present discounted net benefits worth, say, $10 per acre, annual benefits would be valued at four million dollars. Poorly designed laws could similarly result in significant losses.

The State Department of Environmental Quality has indicated that they expect the new conservation act to outline forest practices to meet the state water quality standards. The D. E. Q. would then be willing to accept the Act's requirements instead of developing its own enforcement program for forest lands. Since state and federal land management agencies are required to meet any water quality standards adopted by the D. E. Q., portions of the new Act could directly affect practices on all Oregon forest lands--private, state and federal.

Objectives

In August 1968 a conference of industry and government leaders in forestry revealed a lack of agreement on basic goals of forestry regulation (O. S. F. D., 1968). There is still much debate over which regulation measures to impose, and a wide range of government intervention alternatives has not yet been considered.

So far, both in Oregon and elsewhere, the literature reveals no serious economic approach to evaluating forest regulation alternatives and their goals. This study makes such an analysis of forest practices legislation (both in general and with specific reference to Oregon) as a means for improving social welfare.

The study assumes that professional economists would serve as advisors to legislative decision makers and is directed to such analysts. It presents three types of information:

1. Theoretical information helping to explain the rationale behind certain forms of intervention.
2. Information of use in designing forest practice legislation today.
3. Detailed decision guides for research to determine optimum regulations on study areas. Results of such research could provide guidelines for developing regulations to increase welfare by a greater amount than could today's regulatory efforts.

In general, the study aims to provide information helpful in making forest regulation decisions with a clear view of objectives, alternatives and consequences. More specifically, the study aims:

1. To examine theoretical problems inherent in the forest regulation goal assumed in this study, viz., to maximize net satisfactions to Oregon's citizens from her private forests (see pages 54-56).
2. To identify inabilities of an unregulated market to meet the above goal.
3. To evaluate past forestry regulation goals and approaches.
4. To examine the welfare implications of regulating private wood output.
5. To illustrate how the bargaining solution to external diseconomies might differ depending on whether the law

requires the damager to bargain with the victim to accept damages, or whether it requires the victim to bargain with the damager to reduce damages.

6. To develop decision guides for approaching optimal types and levels of intervention in reforestation and logging on individual areas, taking into account joint production of multiple benefits.

Value Judgments

Many economists make a fetish of the need for scientific objectivity and for the avoidance of value judgements in economics. I must at the outset make clear my disagreement with such views and outline what value judgments underlie this study. That economics, as suggested by Boulding (1969) is a moral science seems to me a valid claim. The moment one deals with questions of social welfare, ethical neutrality becomes impossible. This is not to give the economist license to make normative prescriptions but simply to point out the ethical content of many issues with which he deals. Nutter (1968, p. 167) writes, "Economics can escape moralizing, but it cannot escape morals."

One basic value judgment underlies the study: While individual freedom is valued highly, it is proper for government to intervene in private enterprise to improve welfare of society as a whole. This

implies Lerner's (1944, p. 1) view that economic activity exists to meet the needs of an entire society and is not purely for entrepreneurial gain.

The whole issue of government regulation of forest practices, or for that matter government intervention in general, has been emotionally loaded. Among economists, we have on the one hand Stigler and Friedland (1962, p. 1) maintaining that "the innumerable regulatory actions are conclusive proof, not of effective regulation, but of the desire to regulate." On the other, there is Galbraith (1954) asserting that underlying the objectivity so firmly espoused by most economists is a predilection for market allocation of goods and services.

Outside the field of economics, the battle rages more fiercely, with opposed factions in the forestry issue calling one another names such as "dickey-bird watchers" and "rapacious timber barons".

Assuming that some forms of intervention in private forestry can improve net social benefits, the problem might be seen as a trade-off between entrepreneurial freedom and other public benefits. Within a certain range of intervention measures, as we attempt to increase social welfare, we reduce individual freedom. However, trying to maximize individual freedom will subject us to the pains of unplanned development, many forms of pollution and other undesirable side-effects. This trade-off is difficult to make, but it cannot be avoided.

For the outputs to be dealt with in this study, I feel that a weighing of positive and negative consumer preferences in terms of dollars or other measures is a useful guide for resource allocation. As we shall see, many problems in natural resource use arise from weakness in or lack of such preference signals. However, this should not dampen our interest in searching for the signals rather than having a policy elite dictate what ought to be.[2] The latter course may at times be unavoidable, but I consider it a last resort.

Procedure

A basic hypothesis of this study is that in private forestry the free market system fails to achieve a welfare optimum, and, therefore, net benefits from private forests could be increased by government intervention.

A general review of welfare economics outlines the necessary and sufficient conditions for a welfare maximum and how a free market system might theoretically attain such a state. After noting certain cases in which the market system in reality fails to create this optimum, both in general and in the case of forestry, the study then formulates a goal for forestry legislation.

In considering forms of intervention to secure a given type of benefit on a particular forest area, the elements of analysis to be suggested are as follows:

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[2] This is basically the issue of consumers' sovereignty, an excellent discussion of which is found in Scitovsky (1962) and Baumol (1962).

1. Define an objective.
2. Outline alternatives for meeting the objective.
3. Isolate the costs and benefits and to whom they accrue (in dollars or otherwise) for each alternative.
4. Form a model to trace relationships between inputs and outputs.
5. Develop criteria for ranking alternatives and choosing the best.

Conceptually, the criterion is to choose, on a given area, that forest management plan which yields the greatest excess of benefits over the costs required (including opportunity costs).

The study takes a rather detailed approach of developing guides for regulation decisions on individual forest tracts. From a legislative standpoint, this is unrealistic. Further research would be needed to apply this study's decision guides on pilot areas in order to develop regulations for particular forest zones. There is, however, information in the study of immediate use in designing less sophisticated regulations.

Due to interdependence between areas, long time-horizons, joint production, and measurement difficulties, the allocation problem with which forest practices legislation deals is complex. Let us for a moment digress and illustrate the nature of this complexity.

The Nature of the Problem

Let us examine a model that might be used to find a net-benefit-maximizing combination of inputs and outputs in a given forest region if there were no problems in value measurement, prediction, and data availability. Such problems obviously do exist, and hence the approach below has little practical significance. It should, however, point out the difficulties of the allocation problem we are dealing with and should suggest the need for the incremental approach developed in this study.

Imagine that the state is divided into several independent forest regions such that activities in one region have no effect on costs and returns in any other region. Within each region are interdependent forest and non-forest tracts. Forest management practices on one tract can add to or subtract from net benefits on the same tract or on other tracts in the same region. All of the land on each tract has some common characteristic, either a dominant type and productivity of forest or the fact that costs are imposed from forest practices on another tract.

Forestry on each tract is a joint production process yielding outputs such as wood, water, wildlife, aesthetic values, and recreation opportunities. For the state as a whole we seek forest activities which will maximize the net value of forest outputs in each region.

This becomes the maximization of each region's net benefit function.

For simplicity, consider a region composed of tracts 1 and 2, each of which produces outputs D and E. Prices of D and E, P_d and P_e, are assumed constant. There is interdependence between tracts: On each tract annual private and social costs can be a function of outputs on both tracts. For example, if output D is water quality, water quality on tract 2 can be affected by forest management practices on both tracts 2 and 1 if 2 is downstream from 1. If all outputs and costs occur in the same year then total cost functions would be

$$C_1 = F(D_1, E_1, D_2, E_2)$$

$$C_2 = G(D_1, E_1, D_2, E_2)$$

where subscripts refer to the tract on which the particular benefit or cost occurs.

Net benefits for the region, B, are gross values minus total costs.

$$B = D_1P_d + E_1P_e + D_2P_d + E_2P_e - C_1 - C_2$$

To maximize the function B, first set its partial derivatives equal to zero.

$$\frac{\partial B}{\partial D_1} = P_d - F_{D_1} - G_{D_1} = 0$$

$$\frac{\partial B}{\partial E_1} = P_e - F_{E_1} - G_{E_1} = 0$$

$$\frac{\partial B}{\partial D_2} = P_d - F_{D_2} - G_{D_2} = 0$$

$$\frac{\partial B}{\partial E_2} = P_e - F_{E_2} - G_{E_2} = 0$$

where F_{D_1} is the first partial derivative of F with respect to D_1. Other subscripted forms of F and G have analogous interpretations.

Solving the above system of equations for D_1, E_1, D_2 and E_2 would give the optimum level of outputs on each tract.

Let us now include in the model the fact that outputs occur as flows over time and not simply in one year. Now we are concerned with the present values of discounted costs and benefits, C' and B'. In the notation below, n is the number of years in the planning horizon, r is the discount rate, and, of the double subscripts, the first refers to the tract number on which the variable occurs, while the second is the year in which it takes place.

Present value of social and private costs on tracts 1 and 2 are

$$C_1' = H(D_{11}, D_{12}, \ldots, D_{1n}, E_{11}, E_{12}, \ldots, E_{1n}, D_{21}, D_{22}, \ldots D_{2n}, E_{21}, E_{22}, \ldots, E_{2n})$$

$$C_2' = J(D_{11}, D_{12}, \ldots, D_{1n}, E_{11}, E_{12}, \ldots, E_{1n}, D_{21}, D_{22}, \ldots, D_{2n}, E_{21}, E_{22}, \ldots, E_{2n})$$

Present value of the region's net benefits is

$$B' = \sum_{i=1}^{n} P_d D_{1i}(1+r)^{-i} + \sum_{i=1}^{n} P_d D_{2i}(1+r)^{-i} + \sum_{i=1}^{n} P_e E_{1i}(1+r)^{-i}$$

$$+ \sum_{i=1}^{n} P_e E_{2i}(1+r)^{-i} - C_1' - C_2'$$

Again setting all the partial derivatives of B' equal to zero we could solve for the output variables which now comprise yields of D and E on each tract and in each year. This gives us (t)(m)(n) variables where t = number of tracts, m = number of types of output (e.g., wood, water quality, miles of highway scenic strips, etc.) and n = number of years.

That this model is empirically useless needs little emphasis here. We would be unable to derive functions such as H and J with present levels of information, and problems would become staggering should we add more output types as well as tracts. Added are the problems of inferring prices of non-market goods as well as estimating price-changes over time. Also, while the model includes external costs in each tract's cost function, external benefits are assumed away. Inclusion of these would introduce further complications.

Although the foregoing is just one model for maximizing net regional forest management benefits, all others would have similar shortcomings from a practical standpoint. The problems in

implementing aggregate models provide the incentive for pursuing a simpler course.

The optimal regulation plan--that which maximizes net gains to society in each region--will remain unknown. We will be unable to quantify net regional benefits in common units, but we should be able to rank forest management plans according to preference. One alternative can then be chosen as preferred over others. This study provides a framework whereby decision makers can attempt to maximize net benefits on an area, given the limitations in value measurements, difficulties in predicting physical consequences of given actions, and problems in reflecting people's desires through public officials.

The fact that inputs and outputs of concern in forestry regulation cannot always be quantified in dollars needn't emasculate economics as a useful policy tool. As Hitch and McKean (1966, p. 120) point out in discussing the elusive problems of defense economics, "economic choice is a way of looking at problems and does not necessarily depend upon the use of any analytic aids or computational devices." Asking what Hitch and McKean (1966, p. 107) call the "right questions" is extremely important. For example, what are the alternative means for attaining our goals? For each alternative, what are the costs and benefits? Are the benefits worth the costs? Meaningful answers do not necessarily depend on dollar measures.

To those who suggest that we cannot compare dollar costs with

certain intangibles such as beauty, or that some cannot be financially compensated for a loss of such values, I would reply that similar valuations are constantly being made. We often pay for intangible pleasures such as those from a concert or a park visit, and there are definite limits above which we are not willing to pay. I agree that there are some values to which individuals cannot attach price tags; for example, most parents would not sell their children for any price. Nevertheless, public policy makers must often infer such values. They may, for example know that a given highway project would reduce expected highway deaths by one every two years, yet they could reject the project as too costly, thereby inferring that prospective returns were not worth the costs.

Portions of the study will consider certain forest benefits separately and examine welfare consequences of actions to attain these outputs. Under some conditions benefits from a regulatory action to change one type of output may be well worth the costs. However, when this is not the case, we must examine joint production possibilities.

II. WELFARE ECONOMICS AND FORESTRY LEGISLATION

Welfare Maximization

Conceptually, a state of maximum welfare exists where no reorganization of resources could make anyone better off without making someone else worse off. This is often referred to as the Pareto optimum. Kaldor (1939), recognizing that rarely do we have a welfare gain for one group without harming someone, suggested that one might improve on the Pareto optimum by implementing policies meeting the following compensation test: Gainers from a change must be able to compensate losers and still be better off than before.

The goal which this study assumes for forestry legislation is to maximize the present value of net satisfactions to Oregon's citizens from her private forests. Discussions in this chapter will point out the need for qualifications to this goal; these will be listed in a more formal statement of regulation objectives at the close of the chapter. In addition, the chapter will examine the concept of a welfare maximum, major reasons why an unregulated economy is unlikely to achieve such a maximum, and will point out general areas for public intervention in forestry to improve welfare.

Perfect Competition

Abstracting from reality, the model of perfect competition,

given certain assumptions, theoretically results in a Pareto optimum for a given economy. Due to the model's stress on consumer sovereignty and lack of government interference, perfect competition has in our democratic society been praised by many as the ideal vehicle to welfare maximization. Let us start with a brief review of the model of perfect competition, its underlying assumptions, how in theory it could maximize welfare, and why in reality the free market fails to do so.

The assumptions of perfect competition are as follows:

1. Perfectly competitive markets imply so many buyers and sellers that no single unit can influence price. Hence, there is a set price for each factor and product.
2. Consumers and producers have perfect knowledge.
3. There is perfect mobility for all factors of production.
4. Firms and consumers have free entry to and exit from the market.
5. Commodities within a given class are homogeneous.

Assuming that consumers and producers act in a manner consistent with utility and profit maximization, the following would result under perfect competition:

Consumers would organize expenditures so that the last dollar spent in every area would yield the same satisfaction. The price of any product would be the same for all consumers. Firms would adjust

production to equate marginal cost with product price or marginal revenue. The price of any productive factor would be the same for all producers and would equal the value of its marginal product. Interest rates would be the same everywhere in the economy.

Additional assumptions, as follows, are needed for perfect competition to lead to welfare maximization:

1. Independence of individual consumer preferences (no un-priced side effects in consumption).
2. Independence of production functions (no un-priced side effects in production).
3. No public goods of the type where more for one person does not mean less for others, or where there is no opportunity to charge a price to individual users.
4. Absence of decreasing cost industries.

Perfect Competition and Pareto Optimal Conditions

Underlined in each of the seven sections below are the marginal conditions necessary for Pareto optimality. Each section also shows how a perfectly competitive economy could assure these conditions. The analysis is adapted from Reder (1947, p. 21-46) and Sosnick (1969).

1. To maximize satisfaction from two commodities, a consumer purchases the combination which places him on his

highest indifference curve, given a budget contraint. This is the familiar tangency between the price line and an indifference curve, implying that the marginal rate of substitution between the pair of goods equals their price ratio. Since with perfect competition all consumers would face the same set of prices for any two commodities, the price ratios are the same for all. Thus we meet one necessary condition for welfare maximization--that the marginal rate of substitution between any pair of products must be the same for all people consuming both. In the two-person case this assures that both will be on the contract curve in the familiar Edgeworth box. Neither can be made better off without making the other worse off.

2. Given a transformation function for the production of two products, a profit-maximizing producer reaches the highest iso-revenue line, i.e., where the marginal rate of transformation between the two products equals their price ratio. With perfect competition all firms face the same product prices and, hence, the same price ratios. Therefore, a second condition is met: the marginal rate of transformation between any two products must be the same for all firms producing both. For the two-firm, two-output case this assures that output occurs where the production

possibility frontiers are tangent when one firm's axes are rotated 180 degrees. Should production occur at some point where frontiers cross (i.e., where marginal rates of transformation are not equal), then outputs could be increased without changing inputs.

3. To maximize output for a given cost, a firm using two factors to produce a product will reach the highest convex iso-product curve tangent to a constraining iso-cost line. That is, the firm equates the marginal technical rate of substitution between the pair of factors with their price ratio. Perfect competition assumes all firms face the same factor prices and price ratios. Thus the marginal technical rate of substitution between two factors will be the same for all firms using both to produce the same product. Analogous to condition 1, except on the production side, this assures that output of one firm cannot be increased without decreasing another's production (given a fixed amount of inputs).

4. If we consider a factor as a negative product, the following necessary condition for welfare maximization falls out of 2 and 3 above. The marginal rate of transformation between a factor and a product must be the same for all firms using the factor and producing the product.

5. From 2 we can infer that the firm's marginal rate of transformation between two products equals the economy's marginal rate of transformation between the pair. This rate equals the product price ratio (as in 2), and this same price ratio also equals the consumer's marginal rate of substitution between the two products (from 1). Therefore, any consumer's marginal rate of substitution between any two products must equal the economy's marginal rate of transformation between the same pair.

6. Consider something (like man-hours) that is used both in production (as labor) of a product X and in consumption (as leisure). Assuming constant prices, let money be a numeraire for the product X. A, The marginal rate of transformation between man-hours of labor and money output for a firm (taking man-hours as a negative product as in 4.) must equal B, The marginal rate of substitution between money and man-hours (of leisure) for the consumer.

Under perfect competition, each profit-maximizing firm hires labor until the value of its marginal physical product equals the wage, which is the same as A above. The consumer maximizes his satisfaction if he supplies an amount of labor such that his pleasure-loss in sacrificing one more hour of leisure just equals the wage. That is, his marginal

rate of substitution between leisure and money (B above) equals the wage. Since in perfect competition the wage (for a given type of labor) is everywhere the same, the market assures that A equals B.

A similar argument would follow for anything that is both an object of consumption and a factor of production.

7. One last condition assures optimal allocation of resources over time. Let the community's capital stock be expressed in dollars. The interest rate that lenders demand must equal that which borrowers are willing to pay.

Suppose party A is willing to give up $1 now to receive $1.05 next year, and party B would willingly pay $1.06 next year to receive $1 now. If A loans $1 to B for $1.06 next year, then A is better off while B is not made worse off. Only when the interest rate demanded equals that willingly paid is there no longer the opportunity for increased welfare at no ones expense.

Equilibrium in a perfectly competitive capital market gives one interest rate at the intersection of the aggregate investment demand and savings supply functions, hence guaranteeing condition 7.

A simultaneous meeting of conditions 1 through 7 (often called the Pareto or Paretian conditions) would be necessary but not sufficient

for a Pareto optimum. Only if all indifference curves are convex to the origin and all transformation functions are concave to it do we meet the sufficient conditions. Not meeting the sufficient conditions raises the possibility of having the necessary conditions define a welfare minimum. However, perfect competition again saves the day through its assumption of profit and utility maximizers who would automatically avoid the position of a welfare minimum. Hence, perfect competition in theory assures that both first and second order conditions for a welfare maximum will be met.

Note that nothing has been said about income distribution and its welfare implications. We could be anywhere on the contract curve (or its analog in production) and still be at a Pareto optimum. Thus, there is an infinite number of Pareto optimal points. More will be said about distribution problems shortly.

While the foregoing review of Pareto optimality made use of only two and three-dimensional examples, the analysis can be expanded mathematically to n dimensions--for example, see Samuelson (1967, p. 229-249).

I do not display the model of perfect competition as a Good Thing that we must assiduously emulate. I simply use it to trace through the standard arguments which help us to see how the Pareto conditions could theoretically be met without government interference, given the fulfillment of certain assumptions. But these assumptions are not met.

The question thus becomes: Can government intervention in private forestry bring about net increases in welfare (i.e., move us closer to a Pareto optimum)?

The road to social bliss does not necessarily lie in forcing the economy into a mold of pure atomistic competition in the classical sense. The needs of our complex technology could never be met by many small competitive firms in all sectors. A certain degree of bigness is a prerequisite for the price and demand stability, capital reserves, and long-term planning required for today's massive investments in production and technological development. (See, for example, Galbraith (1962, Chapter 7) and Galbraith's (1967) The New Industrial State.) This should not be taken as a plea for laissez faire but rather for a controlled economy in which we seek the Pareto conditions, however, not necessarily through the vehicle of the purest competition.

The following section will examine cases of the unregulated market's failure to achieve the Pareto optimum. In examining first the problems of an unregulated market, this chapter presents a defense for certain forms of intervention. The discussion forms a background for later analyses to determine whether or not existing and proposed forms of regulation in private forestry are likely to improve welfare.

Market Failures

In general the free market will fail to create the necessary conditions for welfare maximization as long as one or more of the two sets of assumptions on pages 17 and 18 are not met. The following classification of market failures draws heavily on Bator (1958) and Herber (1967, p. 17-37). Each alone is sufficient to cause deviation from maximum welfare.

a) Public goods that are not readily priced in the market will generally not be supplied by private enterprise.

b) Institutional barriers can prevent the capture of prices on certain outputs and thus inhibit private production.

c) Failure of firms to maximize profits may result from imperfect knowledge or overriding goals.

d) Undesirable or desirable unpriced side-effects (externalities) from man's activities leave an opportunity for welfare improvement.

e) Unforeseen aggregate effects of incremental decisions may be undesirable ("The Tyranny of Small Decisions" (Kahn, 1966).

f) Monopoly elements cause price to be above marginal cost; a greater net social product would result with larger output at a lower price.

g) Decreasing average costs in certain productive processes will invite monopoly problems by causing concentration of output in a few large units. In addition, forcing price to equal marginal cost will result in private losses.

I do not consider the last two failures to be significant in private forest management and will thus ignore them in this study. The others are treated in more detail below.

Public Goods

Outputs that are not readily distributed and priced in separate units to consumers are known as public goods and are not likely to be supplied by private enterprise. The public good phenomenon is seen by Samuelson (1954) as a case of indivisibility of output where a good cannot be parcelled so that more for one person must mean less for another. Benefits from such goods are widely available, and those not paying for the output cannot be excluded from consuming it (Musgrave, 1959, p. 9).

Certain forest outputs such as scenic beauty and water quality and quantity have a public good nature in that they are not easily priced and sold to individual consumers. Thus, their production is likely to fall short of the optimum point where marginal social benefit equals marginal social cost. (See pages 32-34 for an explanation of this marginal condition.) In general, the output of unpriced

collective goods by private forest landowners will merely be what is coincidentally produced. Welfare could be increased through public production or intervention to stimulate private output of such goods if producing additional units would cost less than their value to consumers.

There are examples of small groups voluntarily organizing to provide collective goods if individual benefits are great enough to at least one member to cover his costs of providing some quantity of the good (Olson, 1965, p. 33-36). However, Olson (1965, p. 35) remarks, "The larger the group, the farther it will fall short of providing an optimal amount of a collective good."

Perhaps an example will clarify the above assertion. Consider a small sub-group of preservationists such as the Save the Redwoods League, which has enough support to purchase a redwood area for public recreation use. A much larger number of people who do not support the League will also benefit from its activities. While active supporters expend effort to purchase the public good to the point where their marginal gains and losses are equal, the marginal gains (and hence potential efforts) of non-supporters are not included in the calculus. Hence the sub-optimal purchase effort.

The larger the group which can gain from a public good and the more evenly the benefits are distributed among its members, the harder it becomes for the group to take any decisive action (Freeman,

1969). In a large group, potential gains for a single member may be small, and thus he has little incentive to act. But collective benefits for the entire group could be significant.

To draw another example from forestry, most individual advocates of improved scenic beauty along highways may not have enough at stake to stimulate organization and action to gain these benefits. The collective benefits, however, could be great. (Similar arguments could be made in cases of water quality, wildlife or fish benefits from changes in forest management.)

On the other hand, for each large forest landowner, the potential gain from not considering scenic values is relatively large. Due to the fairly small numbers of major forest land holders and the great individual benefits they have at stake, effective political power against government intervention (for public goods production) is easier to attain than support for such interference. Witness, for example, the past strength of the forest industry lobby in the Oregon legislature compared with the lobby for conservation groups.

The power of a group to gain objectives does not necessarily vary in proportion to the total benefits it seeks. This is due in part to differences in the size of groups and the value of benefits to individual members. Thus, we cannot assume that welfare will be maximized by letting interest groups battle in the political arena without any intervention on behalf of unorganized groups.

The discussion of public goods suggests that government intervention might be needed to fulfill certain group needs which are not readily met by the free market. If such intervention can result in benefits worth more to recipients than their cost, welfare will be improved--a step will be taken toward the goal of maximizing benefits.

Institutional Barriers

Certain institutions inhibit the pricing of given outputs so that such goods, while not being inherently pure public goods, become publicly supplied.[3] In forestry, the tradition of not charging a price for individual game animals harvested reduces the incentive to increase production of these on private land. The institution of pricing outdoor recreation below cost or at zero cost similarly inhibits private recreation output. (It also places public managers in the position of not knowing how much a given recreation development is actually worth to recreationists.)

Whether the barriers to pricing a commodity are institutional or technical (as in the case of national defense or clean air), some form

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[3] The distinction between public and private goods is not always sharp. Outputs such as education and recreation can be and are privately produced--yet they have diffuse and widespread beneficial side-effects of greater national productivity, better mental health, etc. Such quasi-public goods--or private goods with certain public good characteristics--are common in forestry.

of intervention is neeed to approach an optimal supply of the good. However, with public action to increase output of an unpriced good, unless some effort is made to gauge values and costs involved, an optimum output--where marginal social cost equals marginal social revenue--would be purely accidental.

Failure to Maximize Profits

If, through imperfect knowledge, incorrect assessment of risk factors, or overriding goals,[4] firms fail to maximize profits, total welfare is less than it could be (assuming no other market failures exist). The misallocation might take place in the failure to produce certain potentially profitable goods or producing so that the marginal cost of the last output units is more or less than their price.

Several questions must be asked before we can determine when this is a significant failure in forestry in the absence of externalities, and what improvement intervention could promise. For example, if a firm fails to reforest a given area because it does not expect

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[4] Goals overriding profit maximization may be sales maximization to gain size and influence, or the desire to weaken a rival. Determining to what degree such overriding goals are reducing potential welfare would be extremely difficult, if not impossible. Intervention to deal with such problems (if they are problems) would be in the realm of price and output regulation. The major concern in this study, however, is land management practices.

sufficient future returns, can the government estimate these returns with sufficiently greater accuracy to justify requiring reforestation? Might the state prohibit reforestation if it feels private enterprise has overestimated returns?

Another problem: Most woodland owners never expect to receive final harvest returns from reforestation efforts. Should the state force investment here? Attached to this question are considerations involving interest rates, pay-back periods, ethics, alternative investments and economic growth. Problems from the failure to maximize profits will be discussed in Chapter IV.

Externalities

Costs or benefits which do not accrue to the firm causing them are another case of the market's failure to achieve Pareto optimality in the forestry sector. Examples of positive side-effects (external economies) in forestry would be increased yields of big game and water following certain logging operations, or improvement in scenic beauty and water quality from reforestation after natural damage to timber. Instances of negative side-effects (external diseconomies) include decreased water quality or reduced aesthetic values following some logging activities.

Abstracting from forest management for the moment, let us consider the problems and possible solutions of side-effects or

externalities. (For reviews of literature on externalities see Mishan (1964, p. 98-154) and Margolis and Vincent (1966).) The assumption of profit maximization implies that firms adjust production so that marginal cost equals the price of output. Now assume that, due to the firm's output, there are negative side effects (such as water pollution) upon individuals external to the firm.

Let us consider the private and public costs of output collectively as social costs and (assuming momentarily there are no external unpriced benefits) consider the product price as social revenue. (In this example social revenue equals private revenue but with external benefits, social revenue could exceed private revenue per unit of output.) Now, with external costs, if the firm has equated its private marginal cost with private marginal revenue, the marginal social cost must exceed marginal social revenue. In other words, the last units of output have cost society more than they are worth--reducing output would increase net social product.

If external benefits exist and the firm equates its marginal cost and marginal revenue, the last units of output are worth more to society than their cost--increased output would raise net social benefit. In general, with the presence of external benefits and/or costs, the optimum output which maximizes net social revenues is where marginal social cost equals marginal social revenue.

This principle can be viewed in Figure 1 which shows marginal

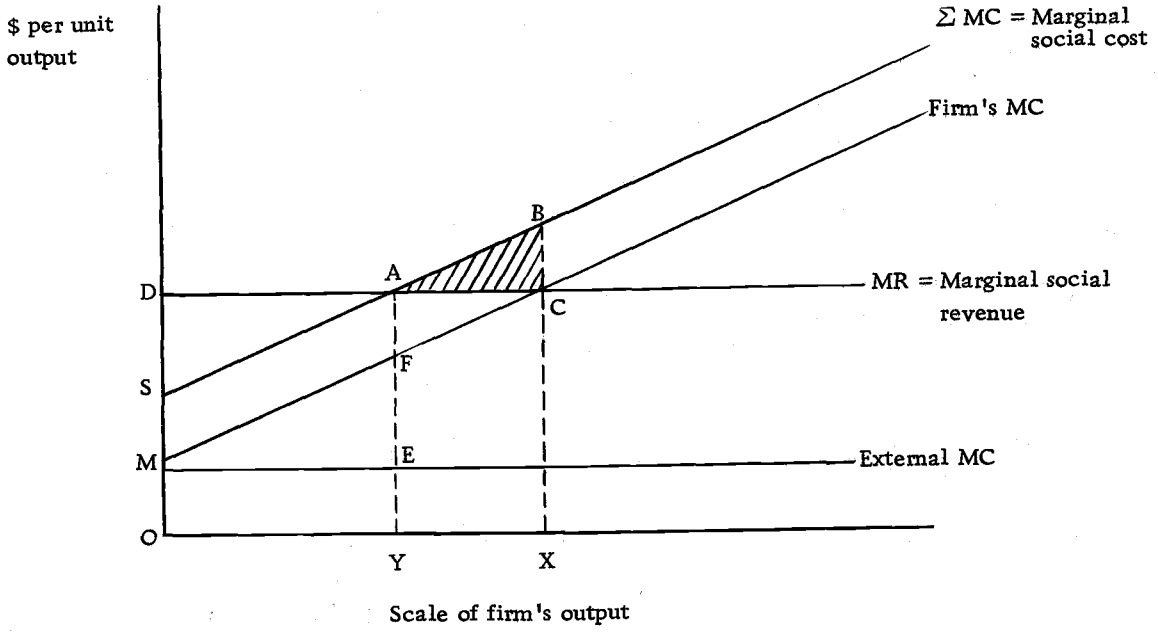

Figure 1. Marginal revenues and costs with external damages.

cost (MC) and marginal revenue (MR) curves for a firm creating an undesirable side effect (for example, a pulp mill causing water pollution which imposes costs on downstream water users). For simplicity, the diagram assumes that the only way to reduce pollution is to diminish output, that external damage per unit of output is constant, and that output price is constant. More realistic models will be explored in Chapter V.

Added external costs per unit of the firm's output are shown by the curve labeled external MC. The marginal social cost curve is a vertical summation of the firm's MC and the external MC curves. Undisturbed, the firm will seek output X where its MC equals MR. However, we note that in moving from output Y to X, the added social cost YABX exceeds the added social revenue YACX. Only at Y, where marginal social cost equals marginal social revenue do we have the maximum possible net social gain, SDA.

Note the extremely important point that at our optimum output Y, the externality still exists. The presence of negative side-effects alone is not in itself proof of resource misallocation, although it might arouse our suspicions. Problems, however, result from failure to make the proper adjustments when externalities are present (Kneese and Bower, 1968, p. 83-84).

A resource misallocation problem exists when there is the opportunity for a reorganization such that gainers can more than

compensate losers. Hence in Figure 1, X is a non-optimal point because moving to Y reduces external costs by FABC while diminishing A's profits by a lesser amount, FAC. The external cost reduction (or gain) is more than enough to cover A's loss. Output Y is optimal since no reorganization would enable gainers to over-compensate losers. The process of moving to optimal points such as Y in the presence of side-effects can be thought of as optimizing externalities.

Our model can be made more realistic so that side-effects could be reduced at a given cost without necessarily reducing output (for example, see Figure 5, page 119), but the above conclusion still holds. The optimum is not necessarily where all external costs are eliminated.

It should be clear at this point that arbitrarily imposing certain standards, say of water quality or aesthetics, would not necessarily improve welfare. And it would only by chance result in an optimum such as Y in Figure 1. If a given firm operates at a point such as X in Figure 1 and regulation moves it far enough to the left of Y, net social product could actually be lower than before intervention. Thus, to avoid such problems, some efforts should be made to gauge costs and returns of regulations so as to at least approach an optimum level of side-effects. Methods of seeking such optima in forestry will be discussed in Chapters VI and VII.

Some writers such as Bator (1958) have made a more detailed

classification of externalities than shall be used here. Bator discusses (1) Technical externalities (the same as failure "g" in this study, decreasing costs). (2) Public good externalities (discussed here under public goods) and (3) ownership externalities (resulting from the fact that the affected party does not own or control the firm causing side-effects). This category, often called technological externalities, is the only one which shall be referred to as an externality in this study.

A fourth type of side-effect is the pecuniary externality which refers to positive or negative price changes caused by one firm but affecting others. I will follow those such as McKean (1958, p. 137-143) and Davis and Kamien (1969) who feel that such external effects are simply part of the price system's operation and needn't concern us.

The Tyranny of Small Decisions

The "tyranny of small decisions" is a name given by Kahn (1966) to a situation where the total effect of many small decisions willingly made is so unpleasant that one can assume people wouldn't have undertaken the decisions had they known the collective consequences beforehand. This is a form of imperfect knowledge--not necessarily about individual decisions, but about collective results.

Consider, for example, the effects of logging patterns on fish

populations through increased stream temperatures. While individual cases of temperature-increases may not seem significant, a series of these effects on enough streams could change temperatures beyond a critical point and cause excessive fish damage. Guides to determine whether this and similar forms of "tyranny" in forestry are apt to be important in terms of costs and returns will be examined later.

There is generally insufficient opportunity in the free market to consider probable total effects of many individual decisions. Relying solely on such decisions raises the possibility of an eventual net social welfare lower than that which would have resulted from some other actions. Thus, public intervention may be able to increase social welfare when the tyranny of small decisions threatens.

Problems of Income Distribution and Compensation

In public policy we are concerned with income redistributive effects of intervention schemes. There is an infinite number of Pareto optimal points, each associated with a different income distribution. To those who suggest that we strive for equal income distribution, Robbins (1938) has pointed out the not unreasonable assertion that people's capacities for enjoyment probably vary widely. That, on the assumption we wish to maximize total utility, defends some degree of income inequality.

Nevertheless, problems remain. Suppose we had a device for

measuring cardinal utility, and distributed income so as to equate the marginal utility of the last dollar to each person. We would have maximum total utility, but as Mishan (1964, p. 1017) has suggested, we would then probably allow huge incomes for those "lively spirits" with large capacities for joy and meager incomes for those with lesser capacities ("the starvelings"). This is also a distasteful result for many.

The solution to such a dilemma may be to let voters decide on the "best" income distribution. This implies the existence of a social welfare function about which, as we shall see, there has been some argument. Assume momentarily that there is such a function composed of society's indifference curves in utility space. In the two-person case, these could be shown by the W contours in Figure 2. We then have a theoretical welfare maximum (the "bliss point" P in Figure 2) where the utility possibility frontier composed of Pareto-optimal points (FF) touches the highest contour on the welfare function (see Bator (1957) for a derivation of this framework). With a given amount of resources and exhausting all production and distribution possibilities, FF represents the maximum possible utility combinations for both individuals. Inside FF it is always possible to make one better off without making the other worse off.

It is important to note with such a framework that if we are not at the bliss point, certain non-Pareto-optimal points (inside FF in

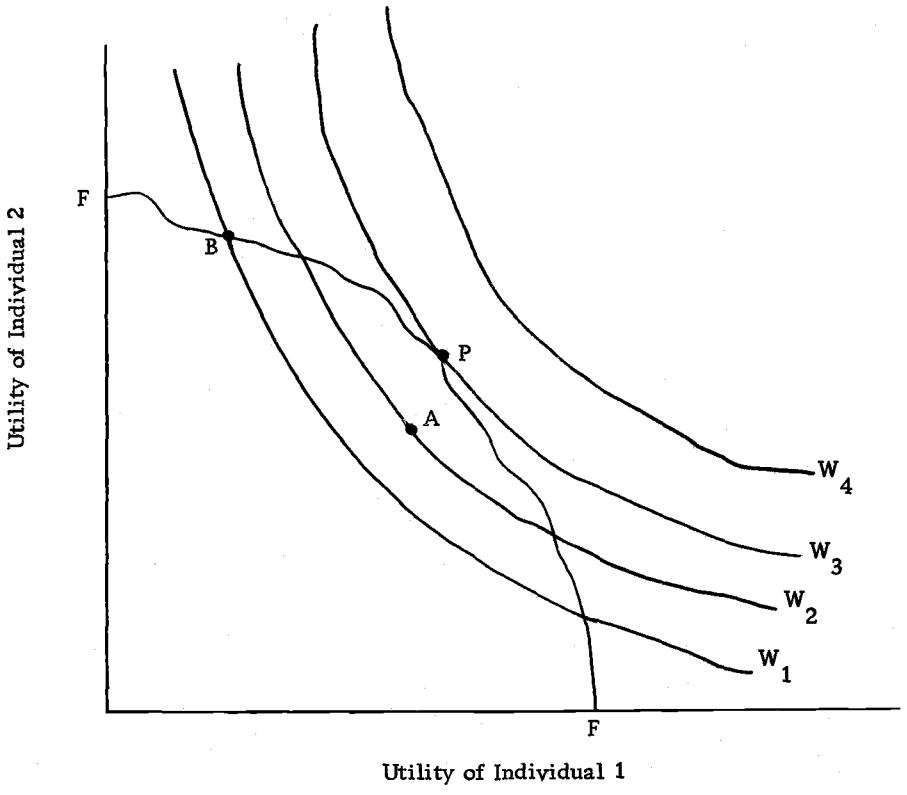

Figure 2. Two-person social welfare function and bliss point.

Figure 2) could be preferred to some Pareto-optimal points. For example, society would prefer point A to B in Figure 2, for A is higher on the welfare function.

In order to treat the problem of income distribution, we must make the precarious step from utility to income. Legislators can deliberate and vote on their preferences about income distribution but certainly not on the apportioning of utility. Hence, we might model the preferences of legislators regarding income distribution (between two groups) by Figure 2 with the axes labeled money instead of utility. The concept of utility, however, is not lost, for implicit in any legislator's decision on income distribution must be some subjective judgment about the utility of this income to the people involved. Collective value judgments about income distribution must be considered before we can say whether society is more satisfied as a result of moving to a Pareto-better point (i.e., moving from a point inside FF to a point closer to FF in Figure 2).

All this is related to the compensation principle which states that welfare is improved if gainers can compensate losers and still be better off than before. Kaldor (1939) stressed that it was not so important to see that compensation did take place, only that it could. In fact, Ruggles (1949-50) pointed out that failure to compensate might leave the community more satisfied than if compensation actually took place. For example, consider a policy under which the wealthiest

have lost income while the poor have gained more than enough to compensate the losers. Legislators in such a case might feel that failing to compensate would yield a better income distribution than if compensation took place.

If we do not compensate the losers from the gains of those made better off (even though we know we could), we must make some interpersonal utility comparisons to "prove" increased welfare. At this, economists will balk, and rightfully so. With any policy there is no way of knowing whether the losers' utility-loss is less than, equal to, or greater than the gainers' utility gain. We can only make statements about estimated dollar measures of losses and gains. If gainers financially compensate losers (to the extent the latter are as satisfied as they were before the policy) and gainers are still happier than before, only then can we prove increased welfare.

Stigler (1943) calls attention to certain problems with the compensation principle. In some cases we wouldn't wish to compensate the injured party--for example, most would frown upon compensating thieves who were harmed by a crime prevention program. Stigler also mentions the difficulty of determining who is injured and to what extent. Similar objections to compensation are raised by Hines (1955).

In addition, Stigler (1943) worries about policies which may change people's indifference maps--an occurrence which blurs any judgment about groups being better or worse off. For this study, I

will make the admittedly off-hand judgment that the reallocations resulting from forestry laws will be small enough, relative to the total forest output, that preference structures will not be significantly changed.

Spengler (1934) divides public policies into four types:

1. Policies which would injure their proponents as well as all others.
2. Proposals which would benefit one group but injure others.
3. Proposals which would benefit one group and be neutral in their effects on others.
4. Proposals which would benefit all groups.

Allen (1952) feels that welfare economics can only say something about types one, three and four above but not two. Since most policies probably fall in group two, such a view severely cripples the powers of welfare economics as a guide to public policy. Compensating the losers, however, provides a way out of the dilemma.

Although much has been written about the welfare implications of compensation, I feel that in our case, we needn't be greatly concerned about them. While it is true that the utility change from an additional dollar more or less will vary from one person to another, one can only guess at the degree of difference. There is no way a priori of knowing whether welfare will be more, less or unchanged when shifting a given amount of income from forest landowners to the

public or vice versa. In addition, the total utility differences between regulation with and without compensation may be so small relative to the gross income changes wrought that they may simply be trivial.

One might be more willing to make the judgment that a shift of one dollar from a millionaire to a pauper would increase welfare. But in the case of forest regulation, the incidences of income-shifts are so general that we can only speak of broad groups such as the public or forest landowners, industries, highway travelers, fishermen, water users, etc. Any guess about the total welfare effects of an income shift between any of these groups would at best be hazardous.

The upshot is, then, that the question of whether or not to compensate forest landowners for income losses due to regulations must be answered in the political arena. And this is by no means a simple task. There would doubtless be little desire to compensate the regulated for every inconvenience caused by legislation. At the other extreme, non-compensated costs could be so severe as to antagonize landowners into non-compliance problems.

But the problems continue. What about requiring practices that some landowners willingly undertake while others would not? If compensation is recommended here, then we would pay some landowners for things they would willingly do anyway. We might recommend never compensating, on the rationale that increased costs would

simply be reflected in reduced land values, thereby not changing the long run private profit situation. That, however, is meager consolation for the current landowners. On the other hand, certain landowners whose property values have increased dramatically would probably be in little need of consolation.

The following section reviews writings which have raised doubts about our abilities to improve welfare through certain types of public intervention--following which are arguments defending these abilities.

Attacks on Welfare Theory

The Hassle Over Second Besting

Because of the utter impracticality of trying to attain all the conditions necessary for a welfare maximum, Little (1957, p. 138) suggested searching for conditions sufficient for an improvement in welfare. Although this seemed much more practical than striving for the "bliss point" (see page 38), Lipsey and Lancaster (1956-57) with their theory of the second best delivered a shattering blow to concepts of either maximizing or improving welfare through public policy. Their main thesis is as follows (Lipsey and Lancaster, 1956-57, p. 11):

> The general theorem for the second best optimum states that if there is introduced into a general equilibrium system a constraint which prevents the attainment of one of the Paretian conditions, the other Paretian conditions, although

> still attainable, are, in general, no longer desirable. In other words, given that one of the Paretian optimum conditions cannot be fulfilled, then an optimum situation can be achieved only by departing from all the other Paretian conditions.

They go on to state:

> It follows, therefore, that in a situation in which there exist many constraints which prevent the fulfillment of the Paretian optimum conditions, the removal of any one constraint may affect welfare or efficiency either by raising it, by lowering it, or by leaving it unchanged (Lipsey and Lancaster, 1956-57, p. 12).

Mathematically, Lipsey and Lancaster (1956-57) prove their conclusion by first maximizing a function of n variables subject to a constraint. Considering this maximum the Pareto optimum and calling the first order conditions the Paretian conditions, they proceed to maximize the original function subject to an added constraint in the form of an inequality of one of the Pareto conditions. Such a maximum would be a second best solution. The resulting new first order conditions become rather complex and no longer resemble the original Paretian conditions. Further, it is shown that it may not even be possible to satisfy the new first order conditions to attain a second best solution.

Needless to say, the Lipsey-Lancaster conclusions were frustrating to the practitioners of piecemeal welfare economics. The stern warning was that "to apply to only a small part of an economy welfare rules which would lead to a Paretian optimum if they were

applied everywhere, may move the economy away from, not toward, a second best optimum position" (Lipsey and Lancaster, 1956-57, p. 17).

Intuitively feeling that welfare economics must have something constructive to say about public policy, economists began to rebel against the implicit nihilism in the theory of the second best. Krutilla (1961) agreed that, in general, public intervention guided by marginal equalities would keep the economy from the constrained maximum, but he pointed out that abstaining from intervention would not necessarily permit the economy to be closer to that maximum.

In the same vein, Mishan (1962, p. 216) decries

> ...the rather paralyzing conclusion that unless all optimal rules are everywhere met nothing at all may be said, a conclusion that is too often eagerly embraced as an anodyne against further thought. If second-best theory has a positive contribution to make, it is that of serving notice that, in the presence of constraints, slap-dash optimizing, wherever one can, may not improve matters; one has, in that case, to proceed cautiously--which is rather different to not proceeding at all.

Mishan (1962) also maintains that even though at times we may be mathematically unable to derive all the necessary conditions for utility maximization due to the failure to meet one or more Pareto optimum conditions, they are implicitly realized. The individual <u>does</u> make a choice which must be considered the best possible under the conditions he faces. For example, it is still possible to conceive of the consumer equating the marginal utility per dollar expenditure in all

available fields, even if certain Pareto conditions are not met.

Davis and Whinston (1965) note that the Lipsey-Lancaster approach does not tell us when the Pareto conditions should or should not be satisfied. They show that not meeting one of the Pareto conditions does not necessarily mean we must abandon all the others to achieve a constrained maximum.

While the concept of unconstrained welfare maximization through meeting all the Pareto conditions is useful for understanding welfare theory, it is not a realistic goal in practice. As Davis and Whinston (1967, p. 324) suggest, "In any real economy there will always be imperfections somewhere."

Furthermore, any optimum, constrained or not, is always changing as wants, technology and resources change over time. In addition, the very act of resource reallocation to improve welfare will move the optimum itself (Nutter, 1968). Such frustrations have prompted Nutter (1968, p. 168) to label the welfare optimum as an "unattainable inconsistent goal".

The above thoughts lead many economists to attempt second best solutions through a piecemeal approach of reducing market imperfections in one sector (say, forestry, or one segment of forestry) while recognizing that imperfections exist elsewhere. Nutter (1968, p. 169) comments on this stepwise approach as follows:

> Perfectionists may wish to argue that piecemeal improvements in welfare, however defined, are likely to lead to less total improvement than a policy that takes all interactions into account; but they must face the fact that the course they advocate is simply impossible.

The Davis-Whinston (1965, 1967) efforts give support for Pareto conditions as a guide in piecemeal policy. They state:

> We have analyzed second best problems by attaching as constraint(s) the given explicit or implicit form of the behavioral rule(s) of the deviant to a model from which the Pareto conditions were derived. When the additional constraint(s) contained only variables subject to the choice of the deviant, then, except for the deviant, all Pareto conditions and behavioral rules were of the same form as those for the second best problem. When the additional constraint(s) contained variables whose values depended upon the choices of other units, then only for the deviant and those units whose variables entered into the additional constraint(s) did the Pareto conditions and behavioral rules differ from those of the second best problem (Davis and Whinston, 1965, p. 12).

Krutilla (1969, p. 23) quotes Davis and Whinston to give still another defense for policy aiming at incremental welfare improvement:

> ...since additional constraints cannot increase the value of the solution, the removal of a specified behavioral constraint will never worsen welfare, but can leave it (either) unchanged or improve it.

The Social Welfare Function

In our society we require some form of democratic agreement on the ranking of different income distributions (in other words, a social welfare function) in order to rank Pareto optimal points as well

as non-optimal ones (see Figure 2).

Arrow's (1963, p. 46-60) "possibility theorem" shook the foundations of welfare economics by asserting the non-existence of a social welfare function that could meet the following five conditions (Arrow, 1963, p. 24-30):

1. Society's ranking of alternative states should be unique and independent of the order in which the states are considered by voters.
2. The social welfare function should not respond in a direction opposite to changes in individual preferences.
3. Elimination of an irrelevant alternative should not change the original social ranking.
4. The social welfare function should not be imposed. (Individuals should be free to choose among all alternatives.)
5. No individual should dictate the choices for society.

Demonstrating the voting paradox, Arrow (1963, p. 3) shows that in voting on several policies by successive comparisons of pairs, the final outcome will sometimes change with the order in which policies are voted on. Hence condition 1 is violated.[5]

Mathematically, Arrow (1963, p. 51-59) further proves that in developing rules for social choice it is, in general, impossible to avoid violating the non-dictatorship or non-imposition conditions in satisfying his first two axioms.

Following Arrow's unpalatable conclusions for welfare

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[5]This paradox occurs only in the special case where some individual preferences are not "single-peaked" (Musgrave, 1959, p. 120).

economics, several writers have rushed in to rescue the social welfare function.

Baier (1967) for example suggests considering Arrow's five conditions as being desirable criteria but not necessarily inviolable axioms. In many cases they are not violated in the process of making collective rankings of states of the economy.

Tullock (1967), while he cannot mathematically disprove Arrow's possibility theorem, contends that the problems it raises are inconsequential in a practical setting. Part of the voting paradox arises from the assumption that issues are voted on separately without simultaneous consideration of other alternatives. In reality, Tullock points out, many alternatives in the form of amendments as well as other bills are usually considered at the same time by a legislature. The problem of imposition does, however, arise, but insignificantly, in that small gradations between alternatives will always exist when voting takes place. Thus, certain minor changes, if they had been considered before voting, would have been approved. Tullock, then, agrees with Arrow that a minority can theoretically impose its wishes on the majority, but feels such impositions are relatively minor.

In summary, Tullock (1967, p. 270) writes:

> That the majority voting process normally leads to a determinate outcome and that this outcome is apt to be reasonably satisfactory will surprise no practical man. Clearly this is

> what does happen. One of the real problems raised by Arrow's book was why the real world democracies seemed to function fairly well in spite of the logical impossibility of rationally aggregating preferences. The solution I have offered, that no decision process will meet Arrow's criteria perfectly, but that a very common decision process meets them to a very high degree of approximation, permits us to reconcile the theoretical impossibility with the practical success of democracy.

Coleman (1966) not only recognizes, like Tullock above, that the possibility theorem's results rest on the assumption of considering only one issue at a time, but also on the condition that voters have no information about one another's preferences. He maintains that Arrow's voting paradox largely disappears if voters act so as to maximize expected utility through vote trading (log rolling).

Log-rolling (I'll vote for your program if you vote for mine) provides an opportunity for strength of desire to be registered in the voting process rather than simply adding yes's and no's. Depending on the degree of urgency with which a legislator views a bill, he can trade varying numbers of votes in return for support of the measure he favors.

Since such vote trading does in fact occur in legislatures, we have some accounting (even if imperfect) for preference intensity, and, thus, regardless of the order of voting on alternatives, a unique collective ranking is theoretically possible.

Coleman (1966, p. 1122) concludes:

> Arrow's theorem depends on individual rationality under certainty, which allows no expression of intensity of preference, but only ordering among alternative outcomes. It is clear, however, first, that rational behavior in collective decisions requires rationality under uncertainty or risk, which opens the possibility of expression of intensity of preference; and second, that in actual groups, the existence of a sequence of decisions gives actors the resources that allow the expression of such intensity, even if imperfectly and incompletely.

In the foregoing discussion my major aim has been to show that Arrow's possibility theorem should not lead us to feel that a legislative body cannot form a collective ranking of different income distributions without inconsistencies or dictatorial impositions.

I do not wish to imply that there are no problems with pooling individual preferences to arrive at some collective expression of public wants. A great deal more must be known about ways in which political bodies reach decisions and what the implications are for public welfare. Studies such as those by Olson (1965), Braybrooke and Lindblom (1963), Buchanan and Tullock (1962) and Downs (1957) are useful efforts in this direction. I do, however, seek support for the crucial assumption in this study that consistent social orderings of welfare states <u>can</u> be made without violating the condition that, in Samuelson's (1967, p. 223) words, "Individual preferences are to count."

Let us then agree that a legislature can show some social preferences about various welfare states resulting from given forest

regulations and compensation schemes--and that these judgments would not strongly offend our democratic sensibilities.

Comments on the Welfare Attacks

This chapter has aimed in part to illustrate the usefulness of piecemeal welfare economics, which is essentially what forest practices regulation involves.

Admittedly, highly sophisticated analysis will reveal certain limitations and ambiguities in welfare economics. It is an area which lends itself well to what Baumol (1962, p. 228) has called "assassination by over-analysis". In this vein, Little (1957, p. 279) has written that "economic welfare is a subject in which rigour and refinement are probably worse than useless." A somewhat less harsh view is given by Baumol (1965, p. 137):

> It is all very well to undertake a searching examination of the foundations of welfare economics, and in the long run a great deal that is of considerable value may emerge from such a study. But in the meantime, public policy cannot wait. Decisions must be made...

Baumol (1965) also observes that if a reasonable policy appears ineffective when tested with a simplified model, this raises not only doubt about the policy but also doubt about the model's applicability.

Many have been bothered by the lack of concern for non-market elements in traditional welfare theory, but, as has been mentioned in the introduction, weighing alternatives and even making marginal

analyses without knowing dollar values is perfectly possible. It is not unreasonable to ask, "Is a particular non-market gain (e.g., increased water flow) worth its intangible cost (e.g., the resulting scenic values lost)?" All too frequently, however, such questions are not phrased. The important thing is to spell out alternatives and consequences and to ask relevant questions.

Some, such as Morgan (1961), have recommended not only abandoning efforts at rehabilitating welfare economics but discarding its whole analytical framework in favor of a new approach to understanding the policy-making process through a study of actual cases. Morgan feels that the attempt to gain generality through a theory of welfare economics can impede progress in understanding public policy to improve welfare.

I am in favor of more research on new approaches to understand concepts of welfare improvement in our economic system and others. However, I would not discard the current welfare economics until better tools of analysis have been developed to replace it.

A Welfare Goal for Forestry Legislation

Let the ideal private forest management program from a public viewpoint be one in which no change could yield gainers enough to compensate losers (if any). The analyses of this chapter have shown that such a state is not likely to exist in an unregulated private

forestry sector; therefore, there is a possibility of improving welfare through public intervention. The discussion has also proposed that to maximize total welfare in the entire economy or in one sector is at best an elusive goal for the following reasons:

1. Tastes and technology are changing over time.
2. Certain market imperfections will always exist somewhere in the economy. Removal of imperfections in one sector may change a previously established "optimum" set of conditions to a non-optimal set.
3. Imperfect knowledge of alternatives and their consequences.
4. Problems in determining the welfare-maximizing income distribution.

For decision makers designing forest practice regulations, this study assumes a qualified goal of maximizing the net present value of satisfactions to Oregon citizens from Oregon's private forest land.

The qualifications are:

1. Accept market imperfections in other sectors of the economy as given, realizing that changes in other sectors could affect optimal decision rules in the forestry sector.
2. Work within our limited knowledge of future tastes, technology, and consequences of management practices.
3. Consider the opportunity costs of all resources devoted to forestry, including land. Avoid devoting to forestry a given

resource quantity which could yield greater satisfactions in some other activity.

In attempting to meet the above goal, results of this study suggest determining the amounts (in dollars or other terms) and incidences of gains and losses resulting from possible regulations. The basic guideline is that if gainers could overcompensate losers, the regulation could benefit society. Two basic problems must be dealt with:

1. Who the gainers and losers are depends on the viewpoint. If we accept as given the current rate of environmental damage production, and we impose restrictions on the landowner to reduce these damages, the landowner loses and the rest of society gains. On the other hand, we could assume that society simply forbids uncompensated damages. Then the law might allow increases in management intensity with accompanying external damages as long as resulting profit-increases to landowners (the gainers) would be large enough to compensate the rest of society (the losers) for damages imposed.
2. Mutually exclusive forest management alternatives must be examined to assure that a desirable alternative with net benefits is not enacted if it precludes adoption of a plan with still greater net benefits.

It is important in any regulatory decision to include the administrative costs of intervention together with other negative effects. At any given level of intervention, administrative costs should be minimized. One way to promote this would be to have one agency administer as many of the forest regulations as possible. This would minimize the number of permits, inspections and agencies involved and also provide a better estimate of administrative costs to compare with resulting benefits.

III. INTERVENTION IN PRIVATE FORESTRY--PAST AND PRESENT

Historical Perspective

In Europe, consideration of communal benefit from land use has a long history as compared with the United States. During the Middle Ages under the feudal system, forests were either communal or owned by the lords (Brandt, 1939, p. 60). Although with the downfall of feudalism, private property rights became established, the underlying acceptance of some land use regulation in the public interest was still present.

Over the years, in western Europe private property ownership has remained a cherished ideal; however, rather stringent forest practices legislation has developed and been accepted as being for the public good. For example, in addition to compulsory reforestation requirements in Sweden, Norway and Finland, permission to harvest trees on private land is required from public forestry boards. Public officers decide whether to clear-cut, thin to a given intensity, or to postpone harvesting (Marsh, 1954, p. 16-17; p. 32-33, p. 56-57; Zivnuska, 1959, p. 19-22). Sparing the details, general objectives of the Scandinavian forest laws have been to assure continuing flows of timber and to prevent forest devastation (Marsh, 1954, p. 61, 62, 76).

With no lengthy background of land use controls in the public interest, we in the United States cannot expect anywhere near the

European acceptance of such regulation. Thirty years ago Kelso (1939, p. 73) wrote:

> A great deal of education and "trial by fire" will be needed before a web of land use controls in the public interest will exist in this country in any degree approaching what now exists in Europe.

Although many forest practice laws have been passed in this country since Kelso wrote the above, they are still relatively mild by European standards.

From 1920 through the 1940's occasional bills advocating federal regulation of private forestry were introduced in Congress, but strong forest industry opposition kept these bills from a Congressional vote (Stoddard, 1968). Interest in public regulation of private forestry was spurred in 1933 by the Copeland Report entitled A National Plan for American Forestry (U. S. Congress, 1933). Folweiler (1944) summarizes the recommendations of that document as follows:

> (a) more public ownership, (b) more public aid to private owners, (c) public regulation of private forest land, and (d) federal assumption of that part of the task, if and when other agencies could not or would not perform forest conservation.

As for specific details of federal regulation, the Copeland report (U. S. Congress, 1933, p. 1347-1349) suggested classifying certain private forest areas as "federal protection forests" to be subject to federal control because of assumed threats to public values such as wood supply, water flow control and scenic value. The report suggested

that a Federal Board do the classifying and establish regulations such as the following:

> Maintain forests in such a way as to minimize erosion, floods and drought.
>
> Forest existence must not be jeopardized.
>
> Forbid management methods which would increase risk of damage from fire, disease or insects.
>
> Require harvesting permission from enforcement agency if cutting more than five or ten acres.
>
> Require reforestation within some specified period after cutting if land were not converted to some other use.

It was suggested that the U. S. Forest Service administer the program with cooperation from state agencies in establishing regional regulations.

Much of the pressure for regulation of private forestry stemmed from the 1933 estimates that U. S. annual timber drain was 16-1/3 billion cubic feet while yearly growth was estimated at only 9 billion cubic feet (U. S. Congress, 1933, p. 22-23).

In 1937 F. A. Silcox, then Chief of the U. S. Forest Service, suggested in his annual report that the federal government play a role in regulating private forestry (A.F.A., 1938, p. 2). The possibility of federal legislation became even more evident with the formation, a year later, of a Joint-Congressional Committee on Forestry, part of whose task was to examine the feasibility of federal forest laws (S.A.F., 1956, p. 3).

The pressure for federal forest regulation stimulated much

debate over the pros and cons of forest practice rules and probably motivated the passage of most state forest practice laws existing today. In several states, leading forest industries voluntarily helped draft such laws (Stoddard, 1968). Thirteen state forestry laws were enacted between 1940 and 1950 (S.A.F., 1956, p. 4), but few have been passed since then. Before 1940 only four states had regulatory laws (S.A.F., 1956, p. 4). Most of the laws require leaving a certain concentration of seed trees, and several specify minimum diameter cutting limits (S.A.F., 1956, p. 6-9).

The literature reveals no efforts at formulating economic guidelines to approach an optimum level of government interference in private forestry. Most writing on forest practices legislation has dealt with descriptions of existing laws in the United States and abroad, with pros and cons of forestry regulation, or with a review of possible regulations to attain certain arbitrary reforestation goals: see for example, Buttrick (1941), Goodman (1941), Recknagel (1946), Davis (1946), Kaylor (1945), Silcox (1939), Damtoft (1941), and Swenning (1941).

Evaluation of Past Legislation Goals

The objectives of Oregon's Forest Conservation Act as stated in the Act are as follows (O.S.F.D., 1969, p. 114):

> The preservation of the forest, conservation of forest resources for the equal and guaranteed use of future generations, protection of forest and water resources and the continuous growth of timber on lands suitable therefor are declared to be the public policy of Oregon.

Washington's Forest Practices Act proposes (S.A.F., 1956, p. 26): "To keep timberlands productive by seeking to maintain continuous growth of timber on all lands suitable for such purposes."

In California the Forest Practice Act (S.A.F., 1956, p. 10-11) declares a public interest in the state's forest resources and establishes a policy:

> 1. To encourage and promote management of forest lands to maintain continuous production of forest products.
>
> 2. To encourage and assist private ownership in management and economic development of privately owned forest lands.

The above three states have fairly similar goals for their forest laws. In general, most state forestry regulation have stressed continuation of timber output. Some, however, have made more explicit mention of securing other values in addition.

A major problem with the aim to assure continuous production of timber or any other specific output is that such yields are really means to an end and not goals in themselves. Most legislators would probably agree that broad public goals are on the order of maximizing or improving social welfare, or in land use problems, to maximize the present net value of public and private benefits (both dollar and non-market) flowing from the land. Yet there is no such implication in the

objectives for Oregon's Forest Conservation Act. Nor is there any suggestion to compare the benefits of additional wood supply or other outputs with the required costs.

Terms such as "preservation", "conservation", "protection", and "continuous growth of timber" are subject to widely differing interpretations. Zealous pursual of such goals can well involve, at the margin, incurring additional discounted costs that exceed the resulting discounted benefits. Even if we clarify a term such as "preservation of the forest", we must know how much and what type of forest we wish to preserve. And if we desire continuous growth, it is relevant to ask what level of continuous growth. What are the costs of varying degrees of instability in wood output? (Problems and shortcomings of setting long-term physical wood production goals will be discussed in Chapter IV.) Similar comments would apply if goals were to also mention non-wood outputs in terms of preservation, continuous production,... etc.

Two major approaches to formulating goals would be (1) To aim for particular outputs such as wood, water quality and wildlife or, (2) To seek to improve or maximize social welfare or present net benefits from forest lands. The second approach allows considerably greater freedom in applying the goal to any forest area. That is basically the course taken in this study where we seek policies from which the gainers can over-compensate the losers. In the final analysis it is not

specific forest outputs that we seek, but rather satisfaction to people. It is easy to lose sight of this point when designing objectives of the first type. As a clarifying clause the second type of broad objective can parenthetically include a listing of benefits such as wood, water quality, fish, wildlife, aesthetic values and recreation. The stress, however, is on benefits to people and not on particular outputs per se.

Factors Motivating Change in the Forest Conservation Act

Let us examine the following elements which are all playing a part in the pressure for change in the Forest Conservation Act: 1. silviculture, 2. the wood supply situation, and 3. changes in public goals.

On the silvicultural side we find that regeneration practices required by Oregon's law are usually less intensive than those used voluntarily by major land holders. Use of "equivalent or better forest practices" (see ORS 527.101)[6] such as artificial reforestation or thinning requires submission of a substitute plan for approval by the State Forester at least 30 days before harvesting. This is considered by many an undue inconvenience to individuals who are carrying out more intensive practices than required anyway. Some public officials, however, point out the advantage that the law has stimulated more

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[6] All Oregon Revised Statute numbers refer to those found in the Appendix.

detailed planning by forest managers.

Requirements for Ponderosa pine (ORS 527.091, 2 (a)) forbid cutting trees 16 inches and less in diameter breast high. This would effectively rule out profitable thinning and improvement cuttings and has therefore not been closely followed or enforced.

If, due to violation of the Act, an area fails to become restocked five years after harvesting, the State Forestry Department shall attempt reforestation, the costs of which shall not exceed an average of $25 per acre (ORS 527.170-527.190). On many sites, non-forest vegetation becomes so well established after five years that a 25-dollar-per acre reforestation effort would fail.

At the close of the Ponderosa pine section (ORS 527.091, 3 (d)) is the following statement:

> The provisions of this subsection shall not apply to those areas within this type which are determined by the State Forester to be lands unsuitable for the growing of timber; such determination shall be made at the time of application for the permit required by ORS 527.040 and 527.050.

While such a statement provides the flexibility needed to avoid requiring unproductive investments, it applies only to Ponderosa pine and not to other species. Moreover, clear guidelines for defining what is "unsuitable" are necessary.

Since the enactment of Oregon's Forest Conservation Act, there has been a decreasing concern over timber cut-and-growth relationships in the United States. Originally, as we have noted, much of the

interest in forestry regulation was stimulated by the estimate in 1933 that the U. S. annual timber cut was nearly twice the growth. However, the growth-cut ratio has gradually improved; the U. S. Forest Service estimated in 1962 that annual growth exceeded cut by about 60% on a cubic foot basis (U.S.F.S., 1965b).

While these cubic foot estimates mask a decline in log size, quality and a change to a less desirable species mix, the forest industry has shown an encouraging capacity to adapt to these changes and to be able to process new species, grades, and sizes, previously unutilized. Because there is growing confidence that we can sustain a high level of forest products production, there is probably less pressure for strong legislation aimed strictly at increasing wood output. This, at the same time, strengthens the position of those who propose regulations which would enhance benefits such as water quality, fish, or scenic beauty but would dampen wood output.

There is still another argument which may give growing strength to considerations of amenity as opposed to wood output, where the two conflict. Following Gailbraith's (1958) hypothesis, one might assume that in the United States,unit increases in market goods per capita (e.g., wood products) are yielding diminishing marginal satisfaction and that certain non-market amenities are gaining in relative importance. While such an argument raises many questions and is not likely to be proven right or wrong, there is, nevertheless, concrete

evidence of rising public concern for values such as cleaner air and water, scenic beauty and natural areas. Deterioration of environmental quality rather than product scarcity now appears to be one of the most pressing problems in the eyes of the U. S. public.

It should be emphasized that while negative side-effects of forestry gain much publicity, there are also positive effects. Consider, for example, results of harvesting such as increased big game populations and more open hunting areas, greater access to recreation areas through forest roads, or availability of more scenic variety from clearings and a diversity of timber age classes.

Effectiveness of the Act

In designing new forest practice laws, a logical question is to ask, "How effective was the original Act?" This brings us back to the initial objectives. As Hamilton (1962) points out, to the extent that one goal (although not formally stated) was to forestall federal regulation, the Act was a complete success.

However, considering the aim of assuring timber output--i. e., gaining regeneration after harvest--the Act is extremely difficult to evaluate. Such a task would require more data than is available on reforestation results of complying versus not complying with the Act. Furthermore, evaluating the minimum seed tree requirements is a problem, since most large landowners now choose more intensive

practices. Compounding the evaluation problem is the fact that there is a wide variety of timber types as well as regeneration conditions.

The ideal evaluation would be based on a comparison of today's harvested lands with what their condition would have been without the Act. This, of course, is impossible. The only type of evaluation available is a contrast (on some particular type of area) between cut-over tracts which met the Act's requirements and those not in compliance with the law. One such study was made by Bever (1954) on certain lands in central western Oregon. On unburned areas he found no correlation between amounts of seed source and resultant stocking. Part of the problem was the fact that even on the sample plots in violating areas, some seed source happened to be available. This, however, is not always the case.

On areas with slash burning, Bever (1954) noted improved regeneration with increasing concentration of seed trees. However, whether or not tracts were in compliance with the law he found that 91% to 93% of his plots exhibited new stocking at least as great as that required in the Act (300 or more trees per acre, 100 of which are well distributed over the area; see ORS 527.020(4)). Of the areas observed, 69% were in compliance with the law.

All of Bever's plots which were not adequately stocked were either extreme south or southwest exposures. He felt there was no evidence that additional seed would improve regeneration on such

critical sites. Thus, his results indicated that except on severe southern exposures, the legally required seed source was adequate on Douglas-fir sites in central western Oregon. He did find, however, that the required minimum number of seed trees gave better restocking than the minimum seed block requirements.

The foregoing should not imply that natural regeneration will always be the desired action on non-southern exposures. As already mentioned, artificial regeneration methods are often found more profitable.

The above-mentioned plots were located in regions where adjacent properties supplied some seed source, whether or not legal seed tree requirements were met. Thus, they are of questionable value in evaluating the effectiveness of seed source requisites. In general, within the Douglas-fir region it is not reasonable to assume that 91% to 93% of the harvested areas will have more than 300 trees per acre, whether or not the seed source requirements are met. A recent study shows that only 77% of the 2,358,749 acres of private forest land classed as cutover in Oregon has more than 300 seedlings per acre (O.S.F.D., 1969b, p. 4).

A "Safe Minimum Standard" of Conservation?

Ciriacy-Wantrup (1963, p. 253) has suggested that a "safe minimum standard" of conservation of flow resources such as forests

would be to avoid the "critical zone". The latter is defined as that state, in the process of flow resource use by man, where depletion is economically irreversible (based on realistic expectations of prices and technology). The flow resources referred to here are those that become available in a stream over time, the rate of flow being affected by man's activities.

At first glance the safe minimum standard seems an attractive guide in forest practices legislation. We could regulate so as to assure that commercially valuable forest associations would always be re-established after logging. Our aim would be to avoid conditions (such as heavy brush establishment) which would make regeneration costs greater than the present value of expected future benefits therefrom.

Objections to the goal of maintaining a safe minimum standard of conservation might arise when the costs of meeting the standard exceed the expected benefits. We might ask in the case of certain harvested site V Douglas-fir lands with extreme regeneration problems, whether it is worthwhile incurring the costs needed for regeneration in cases where wood output is the only return. As we shall note in the next chapter, such reforestation efforts can sometimes be losing ventures.

Let us assume that clear-cutting certain forest sites would automatically result in passing the critical zone. On such areas

several alternatives are open: 1. Forbid all cutting. 2. Allow partial cutting with conversion to tolerant species. 3. Allow clear-cutting but require regeneration, regardless of expected losses. 4. Have minimal seed tree regulations, or perhaps no requirements, and not worry if regeneration fails.

Alternative 4. gives rise to an irreversibility which many might suggest we should avoid. However, the avoidance of irreversibilities is subject to the same type of economic analysis as any other enterprise. If society cannot expect an acceptable return from trying to maintain a given resource flow, then why not enter the critical zone? Or, in other words, why should we spend more trying to avoid an irreversibility than its avoidance is worth to us? But in taking this approach we must also analyze alternatives one and two above. It is possible in many cases that the benefits from avoiding clear-cuts will exceed the resulting opportunity costs.

The word "irreversible" has an unpleasant ring--yet we constantly encounter economic irreversibilities in resource use. For example, in building highways or dams we often irreversibly forego certain other land uses. I do not suggest we take irreversibilities lightly but only that they not be feared excessively. Maintaining a safe minimum standard of forest management implies that we avoid irreversibilities of timber flow simply for the sake of doing so. This is scarcely an adequate guide.

The question of uniqueness mentioned before is one that beclouds the irreversibility issue. Obviously, losing a resource as unique as the Grand Canyon would be more serious than forfeiting a given stand of second-growth timber which might be readily available elsewhere. Yet we are aware that a timber stand may be unique in that nothing exactly like it occurs anywhere else.

One might be tempted to decide against exploiting any "truly unique" resource whose loss would be irreversible. But even this gives rise to a possible weakness. To give a strained example: If we should find a unique source of cancer-curing drug in the rocks of the Grand Canyon, we would undoubtedly begin to mine the Canyon. There is no simple rule which enables us to make the often difficult decision on whether or not to incur an irreversible loss. The dictum, "Thou shalt not pass the critical zone," while a beautifully clear policy guide, has its shortcomings.

Another frustration with the safe minimum standard is that it implies we accept the current amount of forest land as being certainly not more than optimum. But have we ever decided on the optimum acreage? And further, we seek not only an optimum forest area but a desired distribution of forest lands. Such questions will be discussed in chapters IV, VI and VII.

The Need for Flexible Laws

Those who drafted the present Forest Conservation Act recognized the need for flexibility in the law and thus designed different regulations for various forest types. However, due to the broad range of desirable practices, varying from acre to acre within one region, many forestry leaders today feel that a law should specify accomplishments rather than practices (O.S.F.D., 1968). For example, one could require a given number of seedlings per acre within a certain time after logging rather than legislating the means of attaining this objective.

While requiring certain accomplishments rather than practices gives us a more flexible law, we are still saddled with certain rigidities inherent in enforcing the same requirements on different areas. For example, requiring specific reforestation standards on all harvested areas, regardless of costs, invites the possible misallocation discussed under the "safe minimum standard". The expected present value of all public and private benefits from reforesting certain areas will sometimes fall considerably short of the regeneration costs. Those who fear such misallocations resulting from regulation may praise the market's alleged ability to selectively stimulate action only where consumers' current or expected (dollar) votes are strong enough to warrant the needed expenditure.

Of course, as we have noted, the market sometimes fails to register all preferences in terms of dollar (or other) votes, and hence the justification for intervention on behalf of the uncounted votes. However, the pitfalls of intervention are in a sense the reverse of certain market failures: While markets may fail to account for certain valid preferences, the government might assume that such preferences exist where indeed they do not. Either mistake leaves the opportunity to rearrange inputs so that those who gain therefrom can overcompensate the losers.

If we should require certain practices to gain benefits such as water quality or aesthetic results, a tremendously flexible law, with requirements varying from one area to another, would be needed to meet our objective. Without such selectivity we run the risk of demanding expenditures on some areas to gain benefits that no one would receive or that would not be worth their cost. Similarly, on other areas we might miss the opportunity to gain significant public benefits by stronger requirements at costs the recipients would gladly pay. These comments essentially restate the problem of finding the optimum level of external diseconomies discussed on pages 31-35. Some knowledge of approximate marginal revenues and costs is needed to approach such an optimum.

Flexibility in the Act is also needed because we are dealing with a dynamic system. The optimal forest management policy on any area

changes with variations in factors such as population, tastes and preferences, and uses of other lands. Our desired policy depends not only on what has been done in the past but what will be done tomorrow and for all time. For example, the optimal management policy for aesthetics and water quality on a fairly inaccessible forest area would undoubtedly change with the construction of new highways into the region accompanied by increased population, more recreation activity and new land uses. Thus, there should be provision for constant evaluation and change of intervention measures when they cease to be optimal.

Enforcing fairly rigorous management standards for all forest lands gives us no assurance that total welfare will be improved; the resulting marginal costs may or may not exceed the expected marginal benefits. Certainly such rigidity leaves the opportunity for welfare improvements through selective changes in management requirements.

The dilemma is, then, that ideally we would like separate intervention decisions on every acre--a need which cannot be met by statutory law. The alternative is administrative law, which, as Hardin (1968, p. 1245) reminds us, is feared for the reason: Quis custodiet ipsos custodes?--"Who shall watch the watchers themselves?" Are we willing to trust an agency or decision group to develop, enforce, and revise administrative rules which would apply to specific areas? This study develops economic guidelines for designing such rules, in

case that course is taken. However, these decision criteria would also be of use should the somewhat less ambitious aim of maintaining some minimum management standards be adopted.

The Regulated Write Their Own Regulations

In an effort to win the cooperation of regulated landowners, forest industry representatives have often been consulted in the writing or at least approving of state forest practice laws. A major benefit of such landowner involvement is the probable increased interest among the regulated in following the requirements. Failure to consult landowners can result in antagonism and non-compliance problems.

However, excessive efforts to attain industry approval might result in overlooking certain complaints of damaged parties or advantage-seeking groups. An example of inviting such bias is the current proposed revision for the Forest Conservation Act being prepared by a committee composed (except for the Chairman) of forest industry representatives. Where are the spokesmen for groups such as sportsmen or those concerned about water quality and scenic beauty?

The above should not be taken as a condemnation of industry for not suggesting stricter laws. It is simply to suggest better representation of major concerned groups in drafting proposed forest regulations. A broader and more objective approach is needed where the

public's wood production and consumption interests are considered together with other non-wood values.

Many students of political science have noted that public efforts to regulate private industry have often evolved into regulatory laws or agencies that are strongly influenced by representatives of the regulated (Edelman, 1964, p. 22-43). Such situations lead to vigorous assurances in statutes that the public interest will be protected while the ultimate actions on behalf of the public are often feeble. Edelman (1964) cites numerous examples of such symbolic assurances in federal legislation. It is this characteristic situation that prompts Crowe (1969) to suggest that the answer to the question of who shall watch over the custodians of resources with common property attributes is, the interests of the regulated. In Oregon's forestry regulation, the custodians have been the State Forestry Department which administers forest laws; forest industry representatives chaperon the custodians, even to the extent that they draft the suggested revisions of the laws.

Crowe (1969) holds a rather dim view of the chances that wishes of large unorganized groups will be adequately considered by government regulation in the traditional manner. He suggests stronger efforts at developing and disseminating information about damage to resources with common property characteristics so as to "sustain a high level of 'symbolic dis-assurance' among the holders of generalized interests in the commons" (Crowe, 1969, p. 1107). Such efforts

are likely to strengthen the influence of currently unorganized groups that have a potentially large collective gain from certain forms of regulation.

What this suggests for forestry is that glaring instances of unpleasant side-effects from forest management on private and public lands be more widely publicized instead of carefully concealed. However, blindly advertising all forms of damage, no matter how small, might swing the pendulum of regulation too far. And failure to explore and widely disseminate information about damage abatement alternatives increases the chance that the public will assume the only solution to be prohibition of logging on many areas. We might improve the chances for reasonable regulation if greater efforts were made to spread accurate information about the damage and abatement issues. The optimum intervention scheme which meets our objectives will lie between the two extremes of (1) laws which contain little more than a token mention of concern for public values and (2) those which regulate so severely as to cripple the forest industry and thereby lower total state welfare far below that which an optimum regulatory scheme could yield. The present course has produced the first type of law; disseminating incomplete or erroneous information could stimulate the second.

Secondary Benefits

Should timber output benefits include the secondary gains from income generated by wood processing and by activities servicing or otherwise related to the processing sector?

Marglin (1957) has suggested that only if a given economic activity taps unemployed resources (land, labor or capital) with a zero opportunity cost can we legitimately count their full productivity as a benefit. If we simply have attracted resources from another activity, only the difference between their productivity in the previous use and that in the new use is the real secondary benefit.

During periods of full employment of labor and capital one must assume some opportunity cost of resources shifted to the processing of any increased wood supplies that might result from legislation. What unemployed labor currently does exist seems mainly due to educational, social and mobility problems and would not likely be utilized simply through greater wood output. Unless otherwise noted, this study will assume full employment.

With full employment, the only secondary benefit one could attribute to increased timber output would be the added productivity and income linkage effects of factors attracted to forest industries beyond such benefits in their previous employment. Unless planners have knowledge about any significant advantage in returns to productive

factors in forest industries above returns in other activities, they should ignore secondary benefits. This is not to suggest that such advantages do not exist in certain industries. Obviously some activities generate greater secondary benefits than others. Current and future research using tools such as input-output analysis will yield much useful information to help decide what areas of development to stimulate to achieve the greatest net secondary benefits in Oregon. However, until such information is available, any estimates of secondary benefits from stumpage output would amount to rather uneducated guesses (given this study's full employment assumptions). Where secondary benefits are not considered, the net social return from a given wood output will be its stumpage value.

We must reckon with the possibility of reduced wood production resulting from the use of decision guides proposed in this study. For some areas in the state we could assume that factors released through a contraction of forest industry output could find employment in other activities in Oregon with equal linkage effects. Such a view allows considering the stumpage value in this type of region as the only benefit lost through a decrease in timber output.

In light of our economy's dynamic nature, it seems reasonable to assume that in the above type of region, resources could be readily shifted from timber processing to other activities. This assumes that changes are gradual and also ignores the time lag needed to shift inputs elsewhere. That a certain period of unemployment would exist when shifting resources, cannot be denied. And therein lies a

weakness in assuming away secondary benefit losses even if re-employment does take place. Adequate planning, however, could minimize readjustment problems. In addition, the wood output-changes to be considered in this study would be relatively small compared with the state's entire timber production. Thus, the study is not concerned with massive dumping of unemployed resources on the market.

In a state as heavily dependent upon wood processing as Oregon there are, however, many regions where we could not assume immediate re-employment of factors made idle by reduced wood output. This raises some questions of a long-term planning nature regarding Oregon's economy. Should more effort be made by the state government to stimulate a greater diversity of economic development in certain timber dominated regions?

In some areas, greater wood output rates or even maintenance of current levels, could only be achieved at an opportunity cost of requiring wood production investments with rates of return lower than those available elsewhere. Would this course be the lowest cost method of maintaining or enhancing local income levels? What other alternatives are available? These questions can obviously not be answered here and must be considered separately for given regions. However, they are important and ought to be faced squarely when we consider forcing private landowners to produce more wood. The

following chapter treats in more detail the economic implications of laws to maintain or increase wood output.

IV. REGULATING REFORESTATION FOR WOOD OUTPUT

This chapter deals with the decision of whether or not to require reforestation, considering only wood values and ignoring all other benefits as well as negative side-effects. Non-market outputs and damages will be included later to see if conclusions are altered (see Chapter VI). This approach allows us to handle more simply the wide variations in site productivity and in the level of desirable and undesirable side-effects. Such effects may be significant on some areas and trivial on others.

As has already been noted, the desire for continued wood output was one of the forces motivating forest laws in Oregon and elsewhere. But we are also aware that pursuing such a physical output goal runs the risk of conflicting with the aim of maximizing the net present value of satisfactions flowing from the land. The costs of meeting a particular wood output level at the margin may exceed its value. Even if for some reason a given wood output were desired, we would not necessarily attain this at least cost by reforesting every acre. A lower cost alternative might be to not reforest certain low-return acres and require more intensive practices such as thinning on other areas.

Most reforestation laws have been based on the assumption that regenerating harvested timber is always desirable.[7] It is this rigid

[7] In actual administration of Oregon's Forest Conservation Act, the

assumption with which this study takes issue. Admittedly, it sometimes makes sense to require by law that certain practices always be carried out. For example, our society will not allow parents to starve children. Given our value system, we can always assume that the present value of a human life will invariable be far greater than the present value of food needed to sustain it. We make analogous assumptions in requiring minimum levels of educational investment for our citizens. That reforestation should automatically be one of these required investments is to me a highly suspect assertion.

Before discussing actual issues of costs and returns, let us examine other implications of requiring reforestation strictly for wood output on all harvested areas that are not shifted to other uses. The moment we legislate reforestation standards, we implicitly approve of forced investment in a given sector. It would seem logical that if we believe in improving welfare by forcing investment, it ought to first be forced in the most profitable directions. There are many wood growing investment alternatives--some attractive and others highly questionable from the standpoint of rate of return, risk, and pay-back period. Any law requiring reforestation for wood output on

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reforestation requirements have not been strictly enforced on some areas where sincere reforestation efforts have failed due to extreme regeneration problems. A law could provide for alternatives of requiring reforestation, allowing regeneration failure or restricting clearcutting, depending on the circumstances. This study develops guides for evaluating such alternatives.

all harvested areas is a shotgun approach to investment which makes no effort at ranking opportunities according to criteria of desirability.

A critical look at the policy of decreeing investment in reforestation rather than in other areas raises a thorny issue. There are many non-forestry investment opportunities that could yield greater rates of return than certain reforestation expenditures. If we accept the policy of forcing individuals to invest in wood production, why not extend the doctrine and require investment in any number of other enterprises which public officials favored?

Ideally we might wish to regulate private investment so as to equate marginal rates of return in all projects. This is analogous to the seventh necessary condition for welfare maximization (page 22). In any enterprise the best investments are generally exploited first, and eventually added investments yield a decreasing rate of return. With a disparity in earning rates, usually investors will willingly shift funds from projects with lower rates of return to those with higher rates, thereby increasing total earnings. Removing funds from the first type of project will raise its marginal rate of return while adding investment to the second will lower its marginal earning rate. Such shifts in investment could eventually equate rates of return so that further changes could not increase total earnings.

As Baumol (1969) outlines, unequal investment earning rates prevail for several reasons. For one, a varying degree of taxation

between enterprises dictates that before-tax earning rates be unequal if after-tax rates are to be the same. Monopoly elements can cause barriers to entry of capital into certain activities, thus driving up earning rates in these sectors. Risk differentials cause similar discrepancies. And presence of beneficial or undesirable side-effects will cause a divergence between the social and private evaluation of an enterprise's earning rate.

Because of externalities, public goods and the other market failures discussed in Chapter II, I have attempted to justify public intervention in investment activities, and these points will be discussed in more detail later. However, where these problems are not present, what reason is there to believe that widespread government regulation could come any closer to equating marginal rates of return than the free market can? I shall continue on the assumption that in the absence of market failures previously outlined, the large majority of Americans would be satisfied with the way the free market allocated investment funds.

Now, considering only wood output, what attributes of the free market might cause a failure to invest in wood production activities which are more profitable than other investments being undertaken? I shall assume that the problem of different taxation rates is unavoidable for the present and that monopoly elements in forestry are insignificant. However, some may raise the question of a failure to

maximize profits either through underestimating potential returns or being discouraged by the long production period in forestry. (Recall that externalities and public goods are being temporarily ignored in this chapter.)

Regarding the practice of forcing an individual to make long-term forestry investments, we needn't feel too guilty about the possibility that he may never receive the final return. Reforested land should bring higher prices than bare land, and thus there is the opportunity through land sale to gain receipts at any time from the reforestation investment. (Of course, this is of little comfort to the individual not wishing to sell his land. But there is sometimes the opportunity to sell timber cutting rights long before the harvest date.)

The following section will examine the notion of a failure to maximize forestry profits as a possible rationale for government intervention in private forestry, strictly from a wood production standpoint.

Seeking Optimum Timber Yields

Demanding that all harvested areas be reforested implies that we seek a forest land area at least as great as that resulting from such a course. Yet it has never been defined what Oregon's forest land area goal is or what distribution of forest areas is desired. Nor, for reasons already outlined, do I think definition of area or volume

goals is a fruitful direction in which to move. If we can define reforestation investment criteria, the use of which will meet our welfare goal, then applying the criteria will result in a wood output and forest area which could be considered optimal. Such an area or volume is not determined for posterity by planners; it is the result of continuously applying management criteria, and it changes with time as price expectations and other parameters vary.

It is basically the above kind of reasoning which underlies Gregory's (1958) suggestion of a regional timber output goal which maximizes the present net worth of forest land. Suppose we accept this type of timber growth goal; i.e., we attempt to maximize the present value of reforestation investments, leaving idle those acres promising negative present values in timber and transferring acres to other uses if the latter promise greater returns than forestry.[8] Where would be the justification for intervention? Would the free market give us this pattern of timber output?

Continuing, temporarily, to consider wood value as the only forest benefit, we might wish to justify public intervention if the

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[8] Recall, we are still ignoring non-timber values. In reality I would include all output values and then recommend no reforestation requirement on lands where such investment would yield a negative present value. On this point I have elaborated elsewhere (Klemperer, 1969). While such a criterion may seem impractical when many values cannot be quantified in dollars, the basic framework, as we shall see in Chapter VI, can be adapted to provide useful decision guides.

market failed to maximize the present value of wood output. As was just mentioned, a possible reason for such an occurrence could be the failure to maximize profits. If a private forest land holder, through ignorance of costs and returns, failed to maximize the net present value of all his forest management opportunities, some might suggest that the government require practices to achieve this maximum.

However, it is scarcely realistic to expect that regulation could effectively maximize the present value of all the state's private forest investments, even if discount rates could be agreed upon. Such intervention implies government research and formulation of requirements for regeneration, cultural practices, cutting regimes, etc. on every private forest property. This degree of regulation would undoubtedly not be accepted in the United States, and administrative and information costs could probably not be justified.

Regulation to prevent premature harvest of timber is sometimes suggested and is actually enforced in some European countries. There are a number of difficulties with this idea. Timber maturity is a slippery concept; if we mean financial maturity where the timber's value growth rate equals the alternative rate of return, the point of maturity depends on the alternative rate inferred. Undoubtedly, regulating the harvest age would mean requiring some landowners to hold timber longer than they wished--in essence a form of forced savings. If such saving were a public policy goal, there would be simpler and

more effective ways of achieving it; for example, through heavier taxation.

There might be some concern about clear-cutting timber while its value growth rate is still considerably above alternative rates of return. Major forest landowners are financially too astute to follow such a practice,[9] and while it does occur among some of the small woodland owners, educational efforts at explaining timber value growth rates might be the best solution.

The costs of regulating all private forest management practices would be high, both in terms of dollars and ethical resistance, and the returns (considering wood alone and ignoring secondary benefits) are not social, but accrue to the private landowners. Since we are content to allow the individual to make his own income decisions in other areas, I see no reason to force his hand in the forestry case.

We may wish to consider increasing the present value of Oregon's private wood growing activities (rather than maximizing) by concentrating on reforestation requirements alone and ignoring all other cultural practices. But even here, the arguments in the previous

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[9] In some cases firms may cut timber whose apparent value growth rate exceeds the alternative rate of return if failure to harvest would cause opportunity costs such as under-capacity in the mill or special markets lost. Such harvests would be made if the above opportunity costs exceeded the present value of the wood growth which would have occurred had the timber been held to the end of the financial rotation.

paragraph apply.

Thus there is no justification for the state to require private investment (strictly for wood income reasons) in management practices such as regeneration, maintaining stocking density, thinning and other silvicultural practices. However, educational activities to make known and evaluate available alternatives can be of value to landowners.

Later chapters will build a defense for regulations where certain non-market values are concerned. But here we are dealing with only wood.

Related to the question of optimum forest management intensity is the problem of insect and disease control. Legal requirements in this area are covered in another portion of Oregon's forest laws but not under the Forest Conservation Act (see O.S.F.D. (1969a), pp. 120-122). While such considerations are beyond the scope of this study, the question of what degree of disease and insect control to require also lends itself to economic analysis. Obviously, a goal of complete eradication at any cost is unsuitable. Somewhere there must exist an optimum control intensity which maximizes the difference between control costs and values conserved per unit of time.

On occasion some will suggest legislation to reduce unnecessary logging damage to residual stands. Perhaps one of the simplest means of handling such problems would be to require written timber

sale contracts since some of the worst logging damage cases occur when contract logging is done with a verbal agreement or under a loosely written contract.

Many readers may rebel against the suggestion that private wood income alone provides no justification for forcing private expenditure on certain forest practices. Therefore, let us examine in greater detail possible net benefits from requiring wood investment and from government forestry expenditures on private lands.

Net Benefits from Forcing Wood Investment

Note the following symbols to be used shortly:

P.O.R.: Private opportunity rate (the compound interest rate of return to the individual in the best alternative use of reforestation funds).

R.F.: The internal rate of return on a reforestation investment (that interest rate which equates discounted costs and revenues, i.e., which yields a zero present value).

S.T.P.: Social time preference rate (the interest rate at which society discounts future returns to the present).

G.O.R.: Government opportunity rate (the weighted opportunity cost of tax money, in terms of an interest earning

> rate). Baumol (1969, p. 495) has suggested that the correct discount rate for public projects is the "weighted average of the opportunity cost rate for various sectors from which the project would draw its resources, and the weight for each sector in this average is the proportion of the total resources that would come from that sector." I find this a more acceptable guide in evaluating public expenditures than any other in the literature.

There is no guarantee that simply because we force investment in reforestation that total investment in the economy will rise. Assuming that each individual or firm has a given desired investment level, a required increase in forestry investment is very likely to be offset by decreases in investments elsewhere. If we follow this line of reasoning and assume that the rates of return in required reforestation projects are equal to the rates in displaced investments, then social welfare is unchanged. If rates of return on required reforestation are lower than private opportunity rates, we would be shifting investment from higher to lower return projects--certainly not a welfare improvement.

At this point a note of protest might be raised. What if the social time preference rate (S.T.P.) is lower than the private opportunity rate (P.O.R.)? If the internal rate of return on a reforestation

investment (R.F.) is greater than or equal to the S.T.P., would not society be better off by requiring the landowner to make the investment, regardless of his alternative rate of return? However, such action implies that it is acceptable to force private individuals to invest in any and all projects whose internal rates of return exceed the S.T.P. In the first place, it is doubtful that such a proposal would receive much support. Secondly, the approach assumes that there is enough capital to keep investing in all activities with rates of return at least as great as the S.T.P. But in reality capital may be more limited. Hence, the guideline is to first invest in the highest rate of return projects, regardless of the S.T.P. (if such a thing can even be meaningfully measured).

Milliman (1961) raises an interesting point about time preference rates, social or otherwise. He suggests that a divergence between the time preference rate and existing opportunity rates of return indicates a state of disequilibrium. If the time preference rate of any decision maker (individual, public official or firm) were lower than the marginal productivity of available investment opportunities, he could increase satisfactions by reducing consumption and increasing investment until the two rates were equal at the margin. This leads me to suspect that large and persistent differences between an alleged S.T.P. rate and rates of return in available investment opportunities are a sign that the inferred S.T.P. rate is too low.

The difficulty in proving increased welfare from forcing private individuals to invest at an alleged social discount rate stems largely from the position of ignoring secondary benefits of wood output. Hence, under that assumption, when an individual makes a forestation investment and receives the returns from wood, he gains while there is no net gain to the rest of society.[10] In asking whether gainers can over-compensate losers as a result of requiring an individual to invest at a rate of return lower than his alternative rate, we find the landowner loses, and the rest of society's net gains are zero. Welfare decreases.

This analysis does not suggest that all existing forest investment does not influence welfare. It only implies that additional forced private forest investment above voluntary levels will not increase net satisfactions to Oregon citizens if we assume full employment.

It may be difficult to accept this reasoning if a landowner's time preference rate is, say, 25%, and he refuses to reforest a tract with a potential R. F. of 24%. Would not society be better off if such a high-return investment were made? Not really; with the exclusion of

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[10] Although consumers' purchases of additional wood must yield a utility-gain, expenditures on other goods must decline correspondingly, resulting in a utility loss. One might argue that utility-gains from added wood purchases must have exceeded utility-losses from decreased consumption of other goods, otherwise the wood would not have been bought. However, such gains are apt to be small and will be ignored in this study.

secondary benefits, the returns accrue to the individual landowner and are of no concern to the rest of society. However, if this is a rate of return someone else wishes to make, then they have the opportunity to do so either through a lease arrangement or an outright land purchase. And this is precisely what does happen: private firms and public agencies buy forest land, and private companies also make land leases for timber growing purposes. It would be possible for the state to make similar leases.

A Lease Plan

Consider a harvested private forest tract which the owner does not plan to reforest because the expected rate of return is too low for him. One could envision a social gain from reforestation of the tract if the state itself financed the regeneration and retained the resulting timber earnings and if the following would hold: The R.F. would have to exceed the G.O.R. by enough to provide a present value at least as great as the present value of lease payments (if any) required by the landowners. Such an arrangement is similar to lease agreements between woodland owners and large timber companies in the South. If the state is truly interested in stimulating wood output on private lands, the above appears to be a defensible course of action.

Although a defense is made here for not forcing landowners to reforest when only wood output is at stake, it behooves the public to

always require harvesting permits. As will be discussed in Chapters VI and VII, the state may wish to impose certain reforestation and logging regulations for non-market benefits.

If an owner intends not to reforest, he should declare so before harvesting, thus allowing the state to include in any lease offer the possibility of leaving seed trees. Of the requests for harvesting permits on areas where no regulation for public benefits is deemed necessary, the state could analyze cases of declarations not to reforest. Among the latter, if R.F. should exceed G.O.R., increasing lease payment offers could be made up to the point where either the owner accepted a lease agreement or where present value became exhausted. If, at this latter lease payment level, the owner still refused to accept a lease contract, the case would be dropped with reforestation not undertaken. Likewise there would be no regeneration if R.F. were found less than G.O.R. Examples of such calculations will be given shortly.

A lease scheme frees the State from examining every private reforestation opportunity, yet it provides a means for exposing and exempting unprofitable reforestation ventures. It also eliminates the possibility of a requirement which could shift private investment from higher to lower rate of return projects. In addition, lease agreements give much greater assurance that the reforestation investment will reach maturity. When forcing an unwilling landowner to reforest,

there is a greater likelihood than under the state lease that the land will shift to another use before fruitation of timber values. Leasing-landowners could pay property taxes based on the capitalized value of lease payments.

Another advantage of the lease plan is the absence of problems resulting from a divergence between private and government predictions of stumpage prices. The state would never be demanding that landowners accept its price predictions. If the state's predictions, on which lease payments are based, should turn out to have been too high, the state incurs the loss, not the landowners.

To avoid the possible administrative problems and bureaucracy involved in government lease arrangements, some might suggest simply subsidizing the reforestation if R.F. > G.O.R. However, such a policy might induce nearly all landowners to request the subsidy, although many would willingly finance the reforestation themselves were the subsidy not available.[11]

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[11] Note that a similar argument might be made against the lease plan. An owner on whose land R.F. > P.O.R. might tell the state he did not plan to reforest in hopes of driving up the state's lease offer (if any) to a present value exceeding that which he estimated for the reforestation investment. Should the landowner not succeed in gaining a sufficiently high lease offer, he would reforest on his own. However, should the state's lease offer be high enough, he would accept it even though he would have reforested without the offer.

In general, however, as long as R.F. > P.O.R. most large industrial forest owners would probably prefer reforesting on their own rather than losing control of the wood output.

Below is an outline of the situations just discussed.

I. Landowner reforests voluntarily. (This implies R.F. > P.O.R.): No government action.

II. Landowner does not wish to reforest. (This implies R.F. < P.O.R.)

a) R.F. < G.O.R. : No reforestation.

b) R.F. > G.O.R. : State makes lease offers

A scheme for treating cases where public goods and external costs are important will be discussed in Chapter VI.

There is a major drawback of the lease plan: Although we find some landowners entering into binding long-term land lease agreements (as long as a rotation) with large industries, we could well find a resistance on the part of industry to enter into similar agreements with the state. Two ways to weaken this resistance would be to make the agreements as flexible as possible by:

1) Allowing the landowner to sell the land without selling the timber.

2) Permitting new land uses involving timber removal as long as the landowner would purchase the timber from the state at the state's originally estimated timber harvest value[12] discounted at the G.O.R.

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[12] If at this time the state's original estimate appeared too high, it could be brought in line with realistic expectations.

The second point would assure that any land use replacing the timber would have a present value at least as great as that of the state's wood growing investment and that the state (having been compensated) would be no worse off than before the timber was cut.

If the standing timber purchased by the landowner from the state (under (2) above) were merchantable and could sell for an amount greater than the purchase price, the landowner could make a windfall gain. However, if the state realized that the impending sale price to the landowner would be less than the market price, the state would undoubtedly harvest and sell the timber itself.

A State Take-Over Plan

Another approach whereby the state could undertake unutilized reforestation opportunities promising to earn at rates greater than G.O.R. would be to force the non-reforesting landowner to accept state use of his land for timber growing. All regeneration and management costs would be borne by the state which would also own the timber. Let this be called the "take-over plan".

Such a forced lease with no payment would occur only if the landowner refused to reforest and did not use the land for any other purpose. State timber-growing on private land would not occur if:

1. R.F. were less than G.O.R.
2. The landowner reforested voluntarily.

3. The landowner shifted the land to some other use. (Such a voluntary shift implies the new use returns at least P.O.R.--in that case, foregoing the lower-return forestry investment is justified.)

The same flexibility as suggested for the lease plan could also be offered under the state take-over (see points 1 and 2, page 99).

The above plan offers less freedom of choice to the landowner than the lease plan; however, both are considerably more flexible than the current system. Another problem with the state take-over plan: Even without intentional reforestation, a landowner will often have some regeneration and timber returns; under the take-over, he loses the opportunity to receive this. Also, the private owner may have viable plans to convert the area to a new use in, say, 15 to 20 years and may thus have a justification for keeping the state from reforesting. Under the take-over plan as outlined, transition to a new use must be immediate in order to avoid the take-over. Although one could build into the plan some allowances for proposed future land use changes, it is often extremely difficult to judge how realistic or serious an individual's long-term land development plans are.

Both the lease and take-over plans have the following advantages over the present system of requiring privately financed reforestation on all harvested areas:

1. One never runs the risk of shifting private funds to

reforestation projects with a lower rate of return than the funds earned in their previous use.

2. One does not require reforestation if the expected rate of return is below the opportunity earning rate of government funds.

Increasing Long-Term Investment

Let us now drop the assumption that required forestry investments are offset by equal decreases in investment elsewhere. Now we say that requiring certain reforestation investments not voluntarily undertaken will increase the aggregate level of long-term investment. There are those who would favor the resulting increase in distribution of income toward future generations. But is there really a strong justification for such a redistribution?

Our per capita incomes have risen steadily over time and there is little reason to doubt that this trend will continue. Reforestation investment by edict, then, is a public policy transferring resources from the poor to the rich. Viewed in this light, the compulsion to provide more for future generations loses some of its urgency. (This argument is made by Milliman (1962), Tullock (1964) and Baumol (1968).)

If indeed policy makers wish to increase or at least shift levels of investment, they would probably improve welfare more per dollar

invested by emphasizing short term projects rather than activities with long pay-back periods, given that rates of return are the same (Baumol, 1968). From this standpoint, planners might justifiably be more interested in increasing investment in projects such as urban redevelopment, job retraining, and mental health clinics rather than in activities such as reforestation.

Lack of enthusiasm for aggressive public policy to stimulate wood output for the sake of wood alone might be understood as a callous disregard for possible timber famine. But such a famine does not seem a major concern. Greater demand for wood will increase stumpage prices which in turn will stimulate greater wood output, both through more reforestation and by more intensive utilization of trees. Higher prices would also lead to greater substitution of materials such as concrete, glass, metals and plastics for wood. Consumers could still be satisfied. There is no immutable law stating that houses must be made of wood. To assume that whatever wood we produce will ultimately be consumed may not be too risky, but the assumption that consumers will be willing to pay the full costs of its production, no matter how much is produced, is indeed tenuous.

The Goal of Stabilizing Wood Output

Following the reforestation investment guides outlined in this chapter could, through leaving certain harvested areas unforested,

have an adverse effect on stability of timber output. The desire for such stability has been the underlying rationale for policies of sustained yield and has been a major stimulus for most reforestation laws.

In recent years, however, the dogma of sustained yield has been criticized by many economists (Thompson, 1966; Waggener, 1969; Smith, 1969). The dissatisfaction with stability of wood output as a goal (and, implicitly, stability of communities and forest products industries) falls in five general areas:

(1) Attempting to stabilize wood output in the face of fluctuating demand can cause marked instability of wood prices.

(2) Seeking stability of communities through stabilizing wood output means maintaining the status quo. This stifles flexibility and change and can conflict with goals of economic growth. Economic efficiency demands that resources be continuously shifted to their most productive uses; arbitrarily holding certain resources in wood investments can conflict with this efficiency.

I do not wish to imply that economic growth is a "good" goal while stability is a "bad" one. They are simply conflicting. For consistency we must follow either one or the other and not embrace both, as is so commonly done. (One might suggest a goal of stable growth rates, but that is a

form of stability not included in (2) above.)

(3) The opportunity costs of maintaining a given degree of stability can exceed what the stability is worth.

(4) Although high and stable employment levels are important national and regional goals, it is possible within this framework to have changes in output of given industries. Rather than seeking wood output stability by requiring certain inefficient reforestation investments, perhaps public policy could help the economy to adjust to instabilities in sector output due to changes in timber availability. Such guidance could be in the form of job retraining, research and development in the use of substitutes for present wood products, and stimulating the development of non-forest industries.

(5) Because of increasing labor productivity in wood processing activities, it would actually require an increasing flow of timber simply to maintain current levels of employment in timber-dependent industries. Schallau, Maki and Beuter (1969) have estimated that in the Douglas-fir region a 7% increase in annual log output between 1963 and 1980 would be accompanied by a 13% employment decline in timber-dependent industries. They conclude that "what the economic impact study of alternative levels of log production

illustrates most clearly is the difficulty of rationalizing a sustained-yield forest management policy in terms of local-community stability" (Schallau et al., 1969, p. 104).

The above study also predicts that certain areas in Oregon, if they remain heavily timber-dependent, will experience economic and population declines even if annual log output could be increased by 20% between 1960 and 1980. Thus, there is little reason to expect that forest practices legislation could hold out any promise of economic security for such regions. The solution lies in aggressive public policy to broaden the economic base of certain areas and to facilitate the transition.

The above points should illustrate that the goal of stabilizing wood output can often conflict with other desired objectives. There is some optimum but unknown degree of instability in wood output, and this study assumes that attempting to increase the present net worth of reforestation investments would bring us closer to this optimum than arbitrarily seeking stability.

I will be the first to admit that this chapter's approach will not necessarily maximize total satisfactions from wood output. It could well be that certain depressed areas may find it worthwhile to incur some net losses in wood growing activities in order to reap benefits generated in wood processing when other employment alternatives are

severely limited.

The above considerations involve relaxing the assumption of no secondary benefits. While such benefits may have to be included in isolated cases, any detailed analysis for doing so is beyond the scope of this study.

There is one crude method of considering regional secondary benefits to possibly foster regeneration of barren areas not required by law to be reforested. Some timber-dependent regions with apparently incurable long-term unemployment problems could benefit from greater timber output. Governments in such areas might be willing to use local tax money to subsidize landowners by enough to stimulate more reforestation. Such an approach assures that at least some effort is made to see if expected local secondary benefits are large enough to warrant the added expenditure needed to increase wood output. This scheme, however, raises a problem mentioned earlier: As soon as landowners realize that subsidies are available, they might be demanded by all.

If potential recipients of secondary benefits are able and willing to bribe an individual to produce more of something (e.g., trees) then he would on his own (with full realization of all economic development or relocation alternatives), then let that be. But otherwise let us not be rashly influenced by impressive secondary benefit estimates and income multipliers. Being swayed by such estimates alone without

considering alternatives could lead to some disturbing conclusions. For example, why not force certain people to work longer hours or require given firms to produce more output only on the basis that secondary benefits are thereby generated? Such suggestions would be distasteful to most in our society, yet forcing private timber growing investments for secondary benefits of wood growth is essentially the same type of action. Aside from emotional objections to such a pursuit of secondary benefits, there are the economic criticisms raised earlier.

Evaluating Reforestation Opportunities

When a landowner does not wish to reforest, I have suggested that the state use the expected internal rate of return (R.F.) on the reforestation opportunity as a partial basis for its course of action. Although yield tables roughly indicate the expected wood volumes for certain sites, species and ages, the problems in estimating stumpage prices several decades in the future make the gauging of R.F. a difficult task. Simply using current stumpage prices as the future values is an inadequate guide; at least some assumed price increase is bound to yield a more reasonable answer.

Let us first consider the lease plan. In trying to decide whether to lease a given unreforested area, the state might use the following approach to avoid making a definite future stumpage price estimate.

Assume that the landowner has stated a minimum annual payment per acre he will require before leasing his land to the state for reforestation. Then the state could determine what future stumpage price would be needed to make the present value of expected yields exactly equal to the sum of the regeneration cost and discounted values of lease payments and management costs (using a discount rate of G.O.R.). This stumpage price needed to yield a zero present value (i.e., necessary to assure that R.F. = G.O.R.) could be judged for realism. If planners felt it to be unreasonably high, no lease would be made; if it seemed within reason, the state could make the reforestation lease.

Another approach would be to make a stumpage price prediction of, say, $X per MBF at rotation age. A present value without lease payments, P.V., could be found by discounting (at G.O.R.) the product of $X and expected harvest volume and subtracting the regeneration costs and discounted management costs. The maximum annual lease payment, P', would be the P which made

$$P.V. - P \left[\frac{(1 + i)^n - 1}{i(1 + i)^n} \right]$$

equal to zero, where n = rotation age and i = G.O.R. The second expression is the present value of n annual lease payments.

Thus, the maximum annual lease payment would be

$$P' = \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] \quad P.V.$$

Increasing lease offers beginning at some point less than $P' could be made until either the landowner accepted or until the offer exceeded $P'. At the latter point, reforestation would be abandoned (unless non-market values were of concern).

Let us take a closer look at the kinds of calculations needed for public decisions regarding private areas not voluntarily reforested. Suppose that 20% of the state's tax funds comes from individual consumers whose dollars have a 5% opportunity cost rate while 80% are from the corporate sector which has a 10% opportunity cost yield. (These figures are simply examples and are taken from Baumol (1969).) G.O.R. would then equal the weighted average:

$$.20(5\%) + .80(10\%) = 9\%$$

Now, imagine that a private landowner informs the state that he does not wish to reforest a Douglas-fir site (site index 170) which has just been harvested. The owner, however, is willing to lease the land to the state for 60 years at $4 for acre per year. Using an international rule yield table (1/8 inch kerf, 5 inch minimum top, trees over 12 inches d.b.h.) to reflect future utilization improvements, the state estimates a yield of 64, 200 board feet per acre in 60 years

(McArdle, 1961, p. 27). Regeneration costs plus the present value of all management costs are estimated at $40 per acre. The present value of lease payments for 60 years at 9% is $44.20.

The state then asks, "What future harvest value is needed to assure a 9% R.F.?" This would be the value which yielded a zero present value using G.O.R. = 9%. The discount factor which gives the present value of a sum 60 years from now at 9% interest is .0057. We ask that

$$(.0057)X - 44.20 - 40.00 = 0$$

where X = the harvest value in 60 years. Solving, X = 84.20/.0057 = $14,772.

Such a future value requires an expected stumpage price of

$$\frac{\$14,772}{64.2 \text{ MBF}} = \$230/\text{MBF}$$

If the state feels it can expect $230/MBF on the area in question in 60 years, it makes the lease and reforests. If not, the tract is left alone. Note that the above and all subsequent calculations are in constant dollars.

The foregoing simply illustrates a decision framework; actual values of the interest rate, yields and costs are left up to the decision maker to choose. Expected yields from thinnings could be easily built

into the analysis.

Greater sophistication could be introduced by considering the probabilities of natural and artificial regeneration success to find the expected extra yields attributable to a particular means of artificial regeneration. Teeguarden (1969, p. 9) has suggested the following:

$$Y^* = Y(P^*) - Y(P_n) = Y(P^* - P_n)$$

where:

Y^* = expected extra yields attributable to planting or seeding for a given treatment-site class

Y = anticipated yields from an established plantation

P^* = probability of regeneration success, with planting or seeding for a given treatment-site class

P_n = probability of natural regeneration success.

Teeguarden's (1969) probabilities were based on a sampling of "expert opinion" of experienced foresters. The Y^* value could replace the final harvest volume used in the previous calculations.

On low quality sites with high regeneration costs it is questionable whether expected wood values alone could justify any government action. Consider a non-reforested Douglas-fir acre of site index 100. Assume $P^* = 1$, $P_n = 0$, and, to be conservative, G.O.R. = 6%. The stand is expected to maintain a 6% value growth percent until age

70; therefore, consider the final yield as 14,500 B.F. after 70 years (again using the same international table as before). Assume that regeneration costs and discounted management expenses are $80. The discount factor for the present value of a payment, X, 70 years hence at 6% is .0169. To assure a 6% R.F., without any least payments, we require that

$$.0169(X) - 80 = 0$$

$$X = 80/.0169 = \$4734$$

Stumpage price needed for a 6% R.F.:

$$\frac{\$4734}{14.5 \text{ MBF}} = \$326/\text{MBF}$$

With lease payments the required stumpage price would be still higher. A lease payment as low as $1 per acre yearly would raise the needed stumpage price to $398/MBF. Had we used the G.O.R. of 9%, rotation of 60 years and the $4 annual lease, the necessary stumpage price would have been $2,793/MBF.

The above examples simply illustrate the point made several times before: Separate analyses are needed on given reforestation opportunities in order to choose an optimal government plan of action.

In evaluating reforestation opportunities under the take-over plan, the state could make analyses similar to those above, simply

assuming P_n equals zero.

Uneven-Aged Stands

So far we have dealt only with the case of clear-cutting and reforesting. In uneven-aged stands (e.g., ponderosa pine) clear-cutting may never occur. Beyond a certain stocking level, greater density implies a lower rate of return on the timber investment. Due to discrepancies between private and public opportunity earning rates, the state may be willing to accept a higher level of stocking than the landowner.

The same objections as outlined on pages 93-96 could be raised against a policy of forcing the landowner to maintain higher stocking levels. Again, a lease plan could provide an escape from those objections. If a firm chooses a given stocking level and the state feels it could afford more, let the state make lease offers to take over the whole property for one rotation, promising to leave the original volume on the area at the contract termination.

Chapter VI will adapt the framework of this chapter to include consideration of non-market benefits.

V. SEEKING OPTIMUM EXTERNALITY LEVELS

This chapter will examine theoretical aspects of reaching optimal levels of external diseconomies (such as point Y in Figure 1, page 33) and will discuss possible means for dealing with problems of forestry-caused external damages.

Damagers, Victims, Gainers and Losers

I shall refer to the recipients of external damages as the victims while those causing these damages will be termed the damagers. In a sense the roles of damager and victim are reversible. For example, if a forest landowner kills fish through logging-caused siltation, the fishermen are victims while the landowner is the damager. Should the fishermen force the landowner to reduce siltation and thereby lose profits, the landowner could be seen as a victim. This study will consider that the party first imposing damages will be the damager; the one receiving these initial damages will be the victim.

These definitions can even apply to the case of a damager--say, an air or water polluter--who began discharging his effluent long before many people lived in the area. If people then migrated into his pollution zone and required that he install pollution control equipment, he might consider himself a victim. Nevertheless by the above definition, he would still be the damager, for his damage would have to fall

on victims first before they would demand damage abatement. As long as a firm extends negative side-effects onto areas beyond its immediate ownership, it runs the risk of becoming a damager.

There is, however, the case where society may suddenly change its definition of what constitutes damage. Then a firm might be required to begin controlling something which was not originally considered damage when the firm's initial investments were made. Here the newly-defined damager might be considered a victim. This problem is discussed on page 141.

The terms gainers and losers must not be confused with victims and damagers. The latter refer to parties existing as a result of unregulated activities which produce external diseconomies. Gainers and losers refer to those affected by government actions creating changes in the above activities.

Voluntary Bargaining

Following an analysis similar to Turvey's (1963), we can note how bargaining or bribing could optimize external diseconomies. Assume that firm A imposes costs upon firm B. Figure 3 shows A's marginal net gain curve (MR minus MC) and B's marginal loss curve (marginal losses imposed by A). Assume for the moment that any damage actually reduces the victim's money income so that he is really able to make bribe payments to reduce damages.

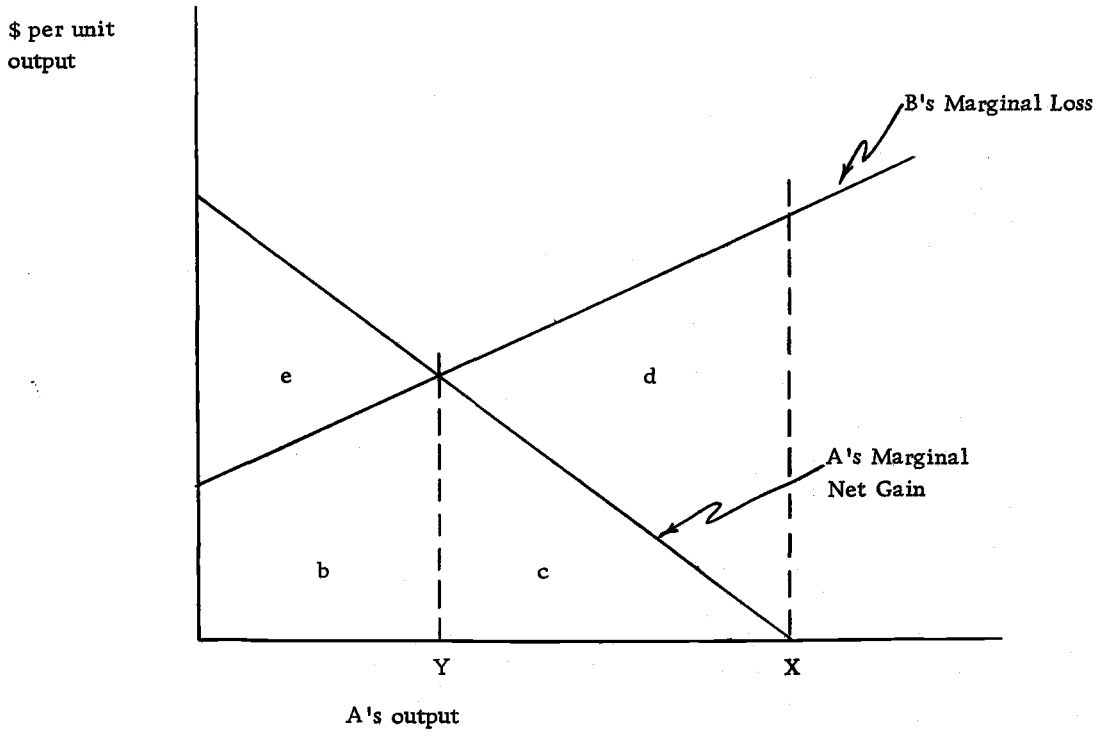

Figure 3. Marginal private gains and marginal external losses.

Without negotiation or impediment, A will seek output X which maximizes its net gain. However, maximum net social gain, e, is at output Y. With the possibility of B bribing A to reduce output, we see that B would be willing to pay up to c + d to move A to Y, whereas A would need at least c to accept moving there.

Imagining that B makes a series of bribes to reduce A's output by small steps, we see that to the left of Y in Figure 3, B could no longer pay what A would require for further reduction in output. Thus, in theory, bargaining could result in near-optimum levels of dis-economies. Note that an analogous argument can be made in the case of external economies. The recipient of external benefits then bribes the firm to increase output.

The model of Figure 3 applies only to cases where output reduction is the sole means of lessening damages. While this may occur in some cases, usually there are many externality-reducing alternatives involving different production technologies on the part of the damage causer.

The more general cases can be illustrated by Figures 4 and 5, the latter of which is adapted fromKneese and Bower (1968, p. 100). The horizontal axes of "units of damage caused by firm" could be items such as units of waste or sediment discharged into a river, or miles of highway scenery damaged by a firm. Curve OT in Figure 4 shows total damage cost to parties external to the firm, and O'C, the

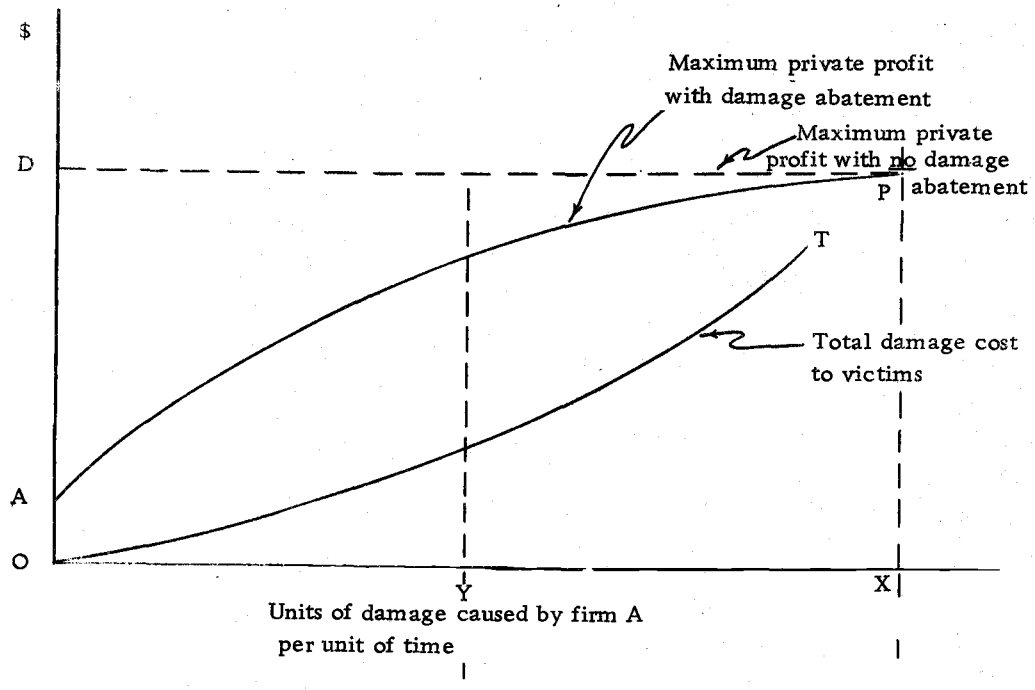

Figure 4. Net revenue and total damage costs per unit of time.

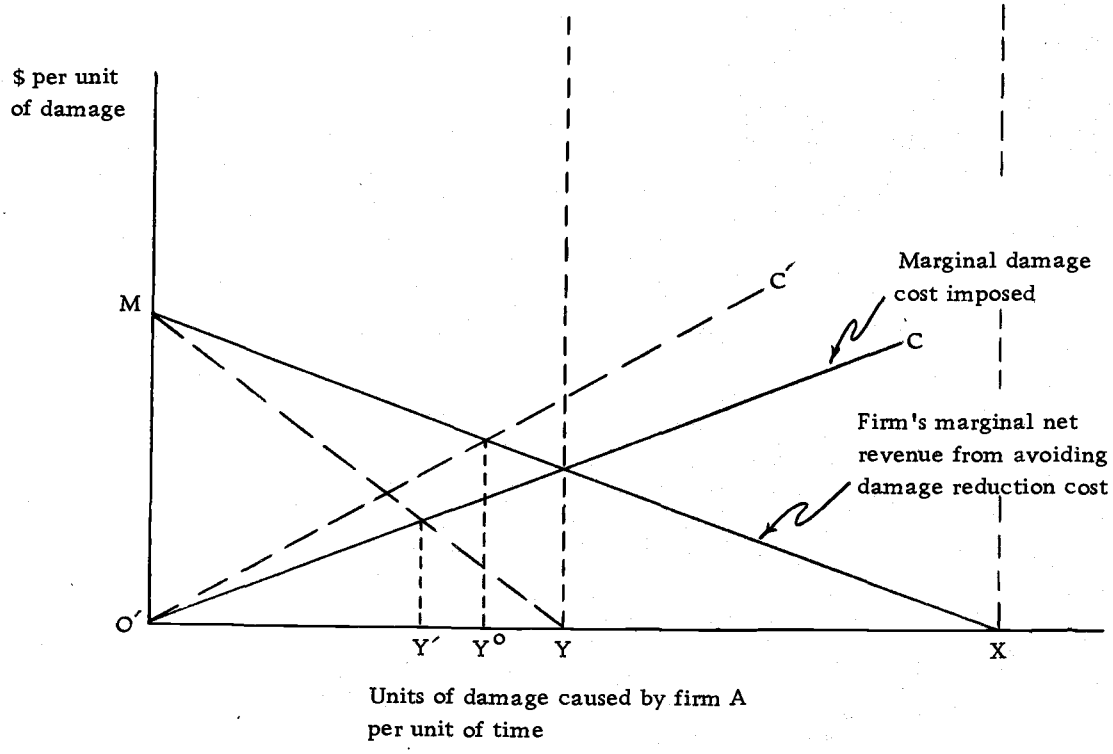

Figure 5. Marginal costs and revenues per unit of damage.

marginal damage cost in Figure 5, is derived from OT. The dashed line DP in Figure 4 represents the firm's maximum profit OD (net revenue) without damage abatement. Actually DP should not be drawn over an axis of damage levels but is shown here to compare the firms potential profit with AP, the maximum profit with damage abatement. The vertical distance between AP and DP represents total damage abatement costs; least-cost abatement methods are assumed.

In Figure 5, MX shows the firm's increase in net revenue per unit of damage abatement avoided--the slope of AP in Figure 4. Reading backwards from right to left, MX is the firm's marginal damage abatement cost, i.e., the net revenue loss per unit of abatement.

The optimum damage level from society's viewpoint occurs at Y where marginal damage cost equals the firm's marginal net gain per unit of damage avoided or at the point of maximum vertical difference between AP and OT in Figure 4.

The time dimension may be introduced into the models on page 119 by considering the total net revenue and damage cost functions AP and OT as capitalized values if they occur as flows over time. The horizontal axes could be units of damage in one particular period, say a year, or could represent a steady flow over time. One could even conceive of units of physical damage occurring in one year only (e.g., stream siltation) with damage costs occurring as a flow over

time (e.g., the resulting reduced fish kill for several years). Adaptation of this model for specific situations will be discussed later.

As described for Figure 3, effective barter could bring us to the optimal point Y in Figure 5. The bargaining solution exists in theory when the number of parties involved is small and there are no impediments to organization. But this is not the case with most side-effects in forest management. Damaged parties are generally large, diverse groups and not readily organized, e.g., fishermen, travelers and recreationists. In addition, damages are often caused by several parties. The probability of reaching an optimum level of forestry side-effects by letting affected parties bargain on their own is virtually nil.

There are isolated cases of bargaining which probably improve the forestry externality problem. For example, organizations such as Nature Conservancy bargain with timber companies to purchase forest areas of unique scenic value. The timber company accepts a price at least as great as the value of forest management income foregone, and the buyers apparently receive satisfactions that more than offset the purchase cost. Nevertheless, these bargains are not common. Not only are there organizational problems inhibiting such arrangements, but the public-good nature of the benefits makes voluntary contributions unlikely. In general, the person not contributing something to bribe the damager, will gain just as much from a

successful bribe as the contributor. Hence there is little incentive to act. Also we would have sub-optimal purchase efforts for reasons outlined on page 27.

Wellisz (1964) brings out a possible ethical objection to bargaining in that it compensates the threat maker whereas the judicial process generally indemnifies the victim. The latter arrangement might seem ethically more acceptable to most.

Any plan of payment to prevent damages raises the unpleasant possibility of present or potential firms collecting payments by threatening to create external costs (Kneese and Bower, 1968, p. 105). One would have to carefully guard against such potential forms of extortion.

A Note of Warning

An important point should be noted: Seeking optimal points as just outlined with the use of models such as Figure 5 (or Figure 3) alone without considering the total values in Figure 4 can sometimes lead to a mis-allocation of resources. It is imperative in Figure 4 that the AP curve lie above OT at least in some range.

Consider Figure 6, analogous to Figure 4 except that AP lies below OT. The negative portion of AP indicates that at high levels of damage abatement the firm incurs losses.

Figure 6 generates Figure 7, which, viewed by itself, indicates

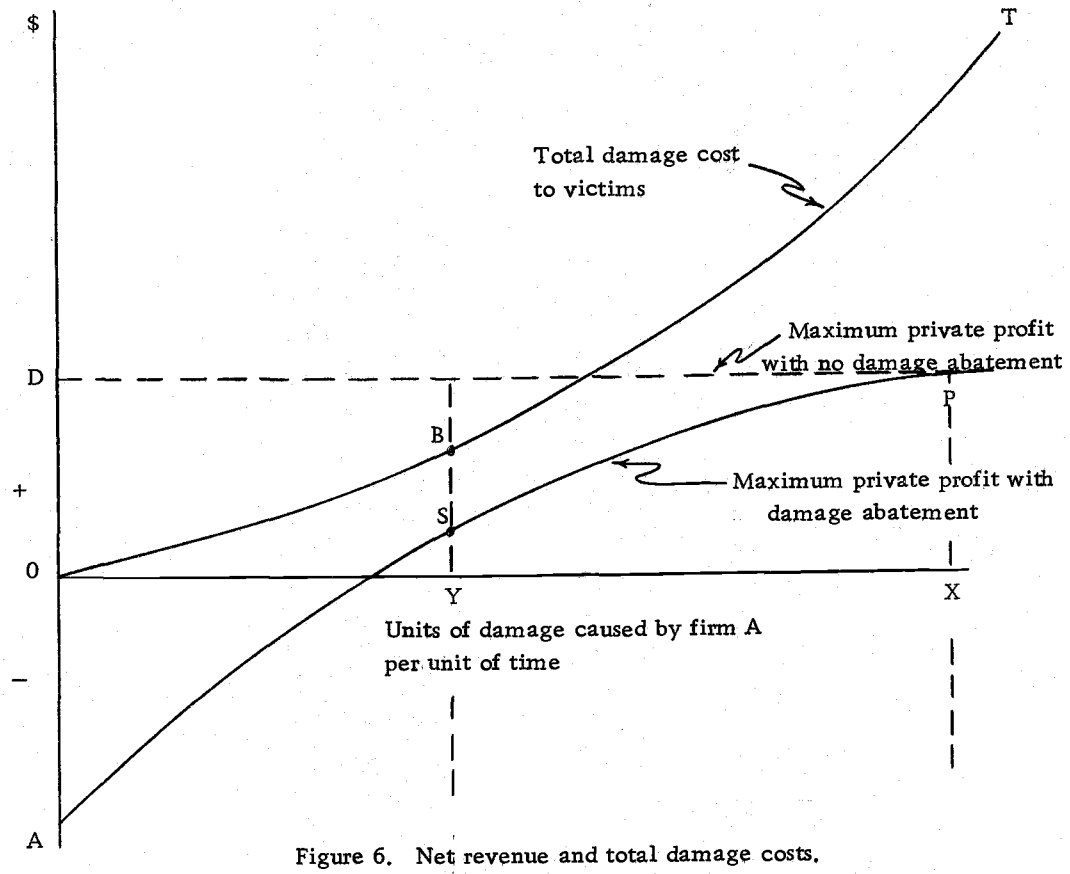

Figure 6. Net revenue and total damage costs.

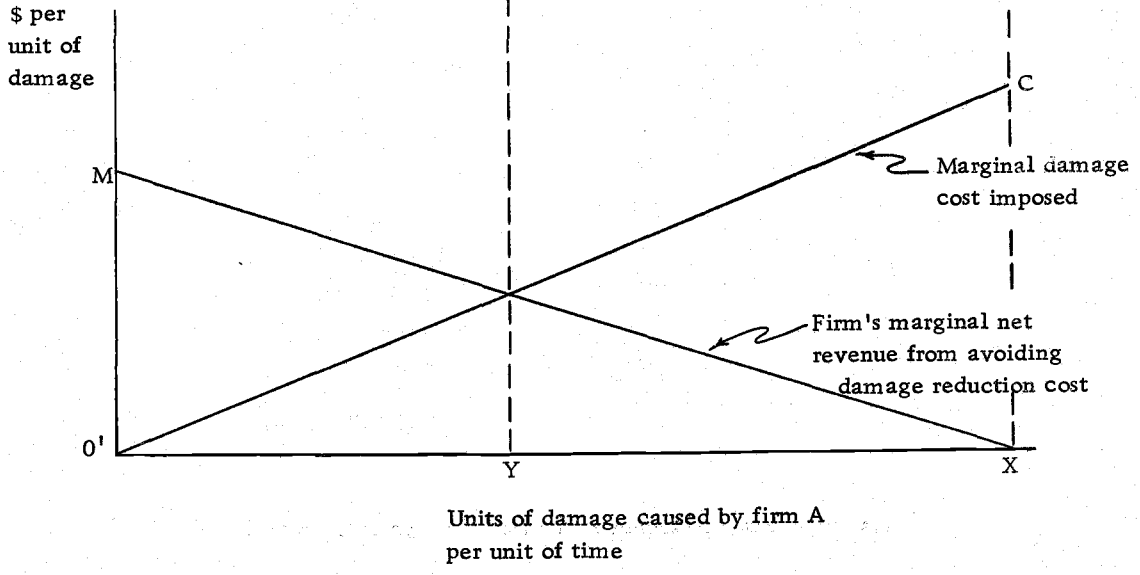

Figure 7. Marginal costs and revenues per unit of damage.

a possibility of an optimal solution at Y through bargaining or some other means. While Y is a least-social-cost operating level for the firm, it is nevertheless creating a negative social value SB in Figure 6. In such a case, society would be better off if the firm ceased to operate. There is the distinct possibility of such relationships occurring with wood production activities in certain areas.

Equating marginal damage costs and marginal-net-revenues-from-avoiding-abatement is a necessary but not sufficient condition for the existence of an optimal damage level. Total social returns must be positive.

Under situations, as depicted in Figure 6, where it is best not to practice forestry, a payment needed to compensate the forest owner for foregoing forest income could sometimes be the land purchase price if no alternative land use existed. In Figure 6 if OD were the present value of the future net income stream without damage abatement, OD would essentially be the land value. In such cases, recommending compensation of damagers is tantamount to suggesting public purchase of the land in question.

Merger

Some writers have raised the idea of "internalizing" an externality through merger of firms and thus attaining an optimum level of side-effects (Kneese and Bower, 1968, p. 89). For example,

consider O'C in Figure 5 as the marginal damage cost of a firm B, the only one harmed by A. Then if A and B merged, MX and O'C would be the marginal revenue and marginal cost curves (with respect to damage) for one firm, AB, which would seek its optimum damage level at Y without interference.

The merger solution is only feasible when the externalities involve small numbers of firms which could be merged. In the forestry case, external economies and diseconomies affect the general public, so the type of merger discussed above is precluded. The only feasible kind of "merger" is for the public to purchase the lands from which the side-effects arise. In such a case, one management (the public) could consider all the relevant costs and returns, and theoretically, arrive at an optimum externality combination.

Charges and Payments

As reviewed by Turvey (1963), economists have often suggested charging the firm causing a diseconomy and subsidizing the victim. For example, in Figure 5 (page 119), if each unit of damage output starting at 0', is taxed by an amount equal to the marginal external cost imposed, A will face the dashed marginal net gain curve MY and automatically seek output Y. Such a scheme places the liability for damage reduction upon the damager. The profit-maximizing damager would continue to create units of damage, compensating

victims by the required amount, until the compensation payment (the charge) for a unit of damage exceeded the cost savings from avoiding abatement. Turvey (1963) points out that if A is taxed for each unit of damage created, but the damaged party is not compensated and can bargain with A, then he might pay A to reduce damage output to Y' in Figure 5, a non-optimal point.[13] This possibility is avoided only by compensating the damaged party to offset the imposed costs at damage level Y.

In the case of external costs falling on large groups where parties will not bargain (as in forestry) an optimum could be reached by taxing the damager and not compensating those adversely affected. It is this type of situation that Kneese and Bower (1968, p. 97-129) examine in the case of water pollution.

Another system places the liability for damage reduction on the victim. Analogous to the case of bargaining, the government can offer the damager payments per unit of damage reduction. An optimum could result if payments equalled the value to victims of damage abatement. The profit-maximizing damager would examine expected

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[13] In Figure 5, with damage charges, A faces the marginal net gain curve MY, while the uncompensated victim still faces the marginal damage cost function O'C. Analogous to the explanation of bargaining solutions on page 118, the victim could bribe A to reduce damages to the point where these curves cross, i.e., at Y' in Figure 5.

costs per unit of damage abatement and, starting at X in Figure 5, would continue to reduce damage, accepting damage reduction payments, until he reached the point, Y, where the cost of reducing one more unit of damage exceeded the bribe payment for that unit. Note that to the right of Y in Figure 5, payments or charges would not need to be as high as the maxima defined by OC; they would only have to be higher than levels shown by MX.

While people might object ethically to paying the damager, the result in terms of damage reduction should in theory be the same as under the charges system, according to Kneese and Bower (1968, p. 101) and Coase (1961).[14] This is logical as long as a given damage value is the same in the charges or payments scheme. Such would be the case when damages actually decrease money income of victims by, say, X dollars per unit of damage. An example would be a water pollution-induced yearly income loss of $X per unit of pollution to a commercial fisherman, with no other losses assumed. (For simplicity, a horizontal, linear marginal damage function is assumed.) The $X exactly defines the minimum compensation the victim would require to willingly endure one additional unit of pollution for a year. If annual fishing income would rise by $X with certainty after

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[14] Note that with payments we encounter the possible extortion problem mentioned before.

removing one pollution unit, $X is also the maximum payment the fisherman would make to eliminate that unit for one year. It is important to note that the victim could actually afford to make this payment without reducing commitments elsewhere as long as the pollution unit were actually removed. Either way, whether the victim bribes the damager to abate pollution or whether the damager bribes the victim to accept damages, they will reach the same abatement solution if they deal with dollar damages.

In contrast to the case of damages which reduce income, the charges and payments schemes may lead to different damage abatement optima when we deal with non-market costs such as damages to scenic beauty or water quality (Mishan, 1967, p. 55-73). Since it is primarily these damages which occur in forestry, it behooves us to examine this problem.

The Effect of Liability on the Optimum Externality Solution

Consider as an example a case of non-market damages to residents along a river due to logging-caused siltation and turbidity in the river. While the victims' incomes are not lowered, the pollution decreases their satisfactions because of aesthetic damages and poorer fishing. Without market values, a schedule of marginal damage per unit of siltation is not readily available.

There are two bargaining cases from which two different

marginal damage functions might be derived.

Case 1: Place the liability for damage reduction on the victims and determine what they would be willing to pay damagers for incremental reductions in damage. A solution would be achieved as described under the payments scheme.

Case 2: Place the liability for damage reduction on the damagers and state that they have no right to inflict social costs unless they fully compensate the victims. This means deriving a marginal damage function by asking the victims what payment they would require as compensation for each incremental increase in sedimentation, starting from undisturbed water purity. An equilibrium damage level as described under the charges scheme could be reached.

Cases 1 and 2 can be seen as representing two different degrees of property rights. Allowing damage at the start and placing liability for its removal on the victims (Case 1) implies a greater emphasis on property rights than does placing liability on the damager (Case 2) where non-compensated damages are simply not allowed.

The possibility of two different bargaining solutions, depending on the liability scheme, arises for the following reason: If we assume declining marginal utility of money, the sum demanded by victims as compensation for a given unit of damage (Case 2) will exceed the money victims would be willing to pay damagers to reduce

the same damage (Case 1) (Mishan, 1967, p. 62). This can be shown with the aid of Figure 8 which plots an individual's total utility (T.U.) from increasing amounts of money, assuming diminishing marginal utility.[15]

Assume the victim's money assets place him at M' and that some pollution exists. Consider a possible pollution reduction of P which is worth U' utiles. If the liability is placed on the victim, (Case 1) he will be willing to pay up to M_1 to eliminate P. A greater payment would not be made for it would bring a utility loss greater than the utility gain from damage reduction.

Now, placing the liability on the damager (Case 2), what sum would the victim require from the damager as compensation to willingly endure the existing P? To receive a money-induced utility gain of U' to cancel the pollution-induced disutility of U', the victim needs an addition of at least M_2 to his money supply (again assuming he started at M'). M_2 is greater than M_1.[16]

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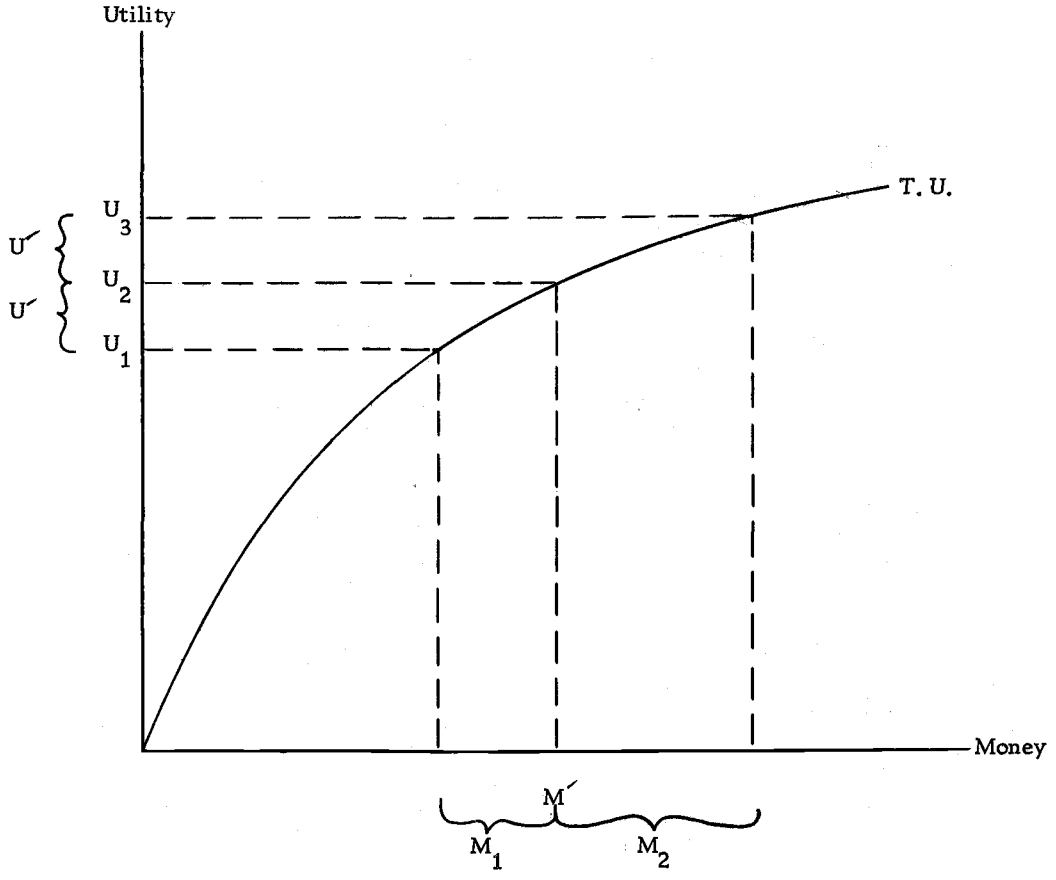
[15] This analysis assumes that an individuals' utility curve for money is independent of the damage level. If this were not the case, a family of utility curves would be needed, one curve for each damage level. While this would complicate the analysis, conclusions would be unchanged.

[16] The same reasoning could be used to support the assertion that the maximum sum offered by the victim to prevent one unit of threatened pollution-increase would be less than the minimum amount demanded as compensation for enduring the same threatened unit.



$U_1\ U_2 = U_2\ U_3 = U'$

Figure 8. Declining marginal utility of money.

Under the above assumptions, a Case 2 marginal damage function--derived by plotting the compensation sums required for each unit of damage--will lie above a Case 1 damage function derived from the payments victims would be willing to make to avoid each unit of damage. A hypothetical marginal damage function derived from Case 2 is shown by O'C' in Figure 5 (page 119) while that for Case 1 is shown by O'C. Thus in Figure 5, the optimum damage level of Y under victim liability is higher than the optimum damage level Y^{o} under damager liability.

Another way to illustrate the effect of the liability scheme upon the bargaining solution of externality problems is to imagine that victims are relatively poor. If liability for damage reduction is placed upon them, they will be willing to pay little or nothing for damage abatement. However, under Case 2, the same low-income residents would probably require much larger sums as compensation for enduring the same damage level (even if we assume no lying). Note that these results still depend on a declining marginal utility of money. Only by assuming that the victim's utility curve for money becomes flatter above his current income position can we surmise that the money he demands to endure a given disutility will exceed that which he will pay to eliminate it.

Hence, with declining marginal utility of money, we are left with the conclusion that under a bargaining scheme, greater amounts

of non-market damage will exist if the victim bears the liability than if the damager must compensate victims.

An assumption of constant marginal utility of money allows us to assert that the externality reduction would be the same whether the liability were placed on the victim or the damager. Although such an assumption may be risky, it at least eliminates conflicting solutions depending upon where the liability for damages is placed.

Some of the work in decision theory under uncertainty suggests the possibility of increasing marginal utility in portions of some people's utility functions for money (see, for example, reviews of these studies in Raiffa, 1968, p. 94-95); however, the evidence is not conclusive. Such empirically derived utility functions for money are based on an individual's valuation of alternative probabilities of winning given sums of money. These derivations can be influenced by a person's bias for or against gambling, by lack of familiarity with probability concepts, and by preference for certain probabilities (Halter and Dean, 1969, p. III-A-22). The functions do not isolate relative utility-changes felt by an individual as a result of actual changes in his money wealth.

There has not yet been a method devised to conclusively prove whether the marginal utility from added income declines, is constant, or increases for a given individual or group. Therefore, decision makers must arrive at a subjective judgment on the matter, realizing

fully the following effects of their choice:

1. Assume declining marginal utility of money: The optimal non-market damage level will be higher if liability for damage reduction is placed on the victims than if it is placed on the damagers.
2. Assume increasing marginal utility of money: The optimal non-market damage level will be lower if liability is placed on the victim than if it is placed on the damager.
3. Constant marginal utility of money: Placing liability on the victim or damager will yield the same damage optimum.

Also resting on the assumption of diminishing marginal utility of money is the possibility that within the same liability scheme we could achieve different non-market damage optima (through bargaining) depending on the income levels of victims, as pointed out by Mishan (1967, p. 61-62).

Consider the victim-liability case. Poor victims, as opposed to wealthier ones, suffer a greater utility-loss (starvation in the extreme case) when parting with a given sum of money. The same group (or another) with a much higher income could conceivably be willing to pay more to reduce the same damage. If we assume the utility-gain from the damage reduction is the same in either case, this implies a declining utility-loss per dollar spent as income rises, at least at low incomes. In the foregoing case, the wealthier the

victims are, the greater will be their effectiveness in bribing the damager to reduce damages.

Now consider the damager-liability scheme. If we assume diminishing marginal utility of money, the sum demanded by a wealthy man as compensation for a given unit of damage will probably exceed that demanded by a poor man as compensation for the same amount of damage. Here, the wealthier the victims are, the less likely it is that damagers could bargain with them to accept any given damage level.

While variations in income levels may affect certain externality solutions, groups to be considered in this study will probably be large and homogeneous enough so that the above problem will be of little concern.

Where To Place the Liability for Damage Reduction?

If decision makers are not willing to assume a constant marginal utility of money, the question of where to place liability for damage becomes vital since it affects the optimal level of damage.

There are those who would rally to the cry of "Property Rights!" and would suggest that costs incurred by forest landowners to prevent damage to public values should be reimbursed by the public. Others would stress the judgment that all social costs imposed must be compensated for or stopped.

At this point two separate questions should be clarified.

1) Where should we place the liability for damage reduction?

2) Should compensation payments actually be made? (i.e., compensate the forest owner in the victim-liability case or compensate the victims under damager-liability).

The second question is independent of the first and must be answered on a subjective basis (see pages 37-44). It is perfectly possible to regulate for optimal damage levels using a framework of liability on the damager or the victim without actually compensating either one. In dealing with a given damage on an area, public officials could estimate a damage abatement cost schedule such as MX in Figure 5 (page 119) and, depending on the liability decision, somehow arrive at OC or OC'. The setting of an optimal damage level where marginal abatement cost equals marginal damage cost is independent of whether or not compensation is paid.

Below are general comments on the two liability schemes; possible frameworks for actual forest practice regulation under each liability assumption will be discussed in Chapters VI and VII.

Placing Liability for Damage Reduction on Victims

The victim-liability scheme involves starting with unregulated damages from forest management. In dealing with any negative side-effect, the damager could estimate a schedule of costs (out-of-pocket

costs plus opportunity costs) for various levels of damage reduction. Decision makers could then ask if the rest of the public would be willing to pay the increased costs of attaining various degrees of damage abatement. Making incremental decisions, a given improvement in environmental quality could be decreed if the public felt it was worth the added cost.[17] The public's willingness to pay might be gauged by voting for increased taxes to cover the costs of damage reduction or by simply considering the likelihood of such a vote. Note that if it were decided that compensation needn't actually be paid, the public might say, "Sure it's worth it" when indeed it may not be.

With liability for damage reduction upon the victims, when we improve environmental quality at the expense of timber profits, the victims gain while damagers lose. As in the decision guide on page 56, we ask whether gainers can over-compensate losers.

A basic rebellion against the victim-liability approach is that it implies starting with the private profit maximizing damage level and asking the public to pay for--or somehow testing its willingness to pay for--damage reductions. Placing liability on the damagers,

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[17] If, in addition to direct damage abatement costs, one also expects decreased output and higher prices of the damager's product, the public must also include these costs in the decision. Likewise, one should recognize that sufficient increases in certain outputs could lower their unit values to society (see page 197).

while eliminating this problem, raises others.

Placing Liability for Damage Reduction on Damagers

Under damager-liability we start with forest management which imposes no costs upon others. Then marginal increases in private income due to steps in forest management intensification would be estimated. Society would have to gauge the compensation payments it would need to willingly endure each rise in environmental damage caused by successive increases in forest management intensity. Any increase in wood production intensity could be allowed as long as the resulting private income gain exceeded society's required compensation payment for the resulting damage.

With damager-liability, when we increase timber output together with damages, the damagers gain while the victims lose. As before, we ask whether gainers can overcompensate losers; however, here gainers and losers are reversed from the case of liability on the victim.

This illustrates an important point: who the gainers and losers are from a government action depends on where the law places the liability for damage reduction. Under victim-liability, the starting point is unregulated damages, and the government actions are damage abatement requirements (damagers lose; victims gain). With damager-liability, we start with no damages allowed, and the

government actions are the issuing of permits allowing given levels of damage (victims lose; damagers gain).

The approach of asking public decision makers what compensation society would require to tolerate given levels of damage is fraught with problems. In the first place, it is not a question commonly asked; thus there would be little precedent and few guidelines. Furthermore, if compensation to the public were not actually expected, unrealistically high compensatory sums might be stated as a bluff to seek abatement of all undesirable side-effects. The notion of actual mass indemnity payments to all individual damaged parties is so foreign to us that it is not likely to receive much serious thought. Even if we assume away lying, how would such a scheme be enacted? Questioning each individual? Making higher payment to more sensitive souls and lower compensation to those who care less?

There is yet another interesting facet of compensating the victims: It may be that, among some groups, only very high payments could serve as compensation for accepting certain levels of environmental damage. To use an extreme and exaggerated analogy, consider a parent confronted with a threatened kidnapping. The amount he would or could pay to prevent the kidnapping is finite. Yet the sum he would demand as compensation for the loss of his child could well be infinite.

While environmental damage is not like stealing children, the

point is that it is extremely difficult for some people to name a compensating payment for the loss of certain environmental qualities. This would be especially true of wealthier individuals to whom additional amounts of money may mean less than they do to the poor. Given our increasing affluence, we may find a growing trend in some areas toward treating and protecting environmental quality in the manner that children are protected.

Although estimating victims' probable compensation requirements is a difficult procedure, efforts in this direction should be made because of the significant influence that such data may have on what is deemed an optimum damage level.

One approach would be to impose regulations upon the forest owner (the strictness thereof depending upon the damage hazard) and let him bargain with the public to allow relaxation of these restrictions. Public hearings could give the forest owner an opportunity to offer payments for incremental relaxations in the proposed environmental quality standards.

It may well be that the damager-liability scheme is rife with income distribution problems. Wealthy groups could conceivably drive up compensation requirements high enough to result in heavy cutting restrictions. This might be seen as providing playgrounds for the rich while creating high housing costs for the poor. In the final analysis, problems of the damager-liability approach can only

be assessed after actually trying the scheme on study areas.

Imposition of Unplanned Costs

Until very recently it has been accepted practice that logging operations could impose certain "inevitable" costs upon society as long as they were not "excessive" and no "negligence" was involved.

Thus society, with little complaint, has allowed certain degrees of water quality degradation, fish kill, and scenic damage, feeling these were necessary evils connected with private wood harvesting which they were not willing to lessen.

Let us assume the above has been an accepted mode of operation, and under these assumptions private forest managers have invested extensively in wood growing activities. Now, if the public suddenly decides that it is no longer willing to bear the previously accepted costs, an argument could be made for compensating the forest landowners for the sudden and unplanned increase in their expected costs due to regulation. One could argue that they had no reason to expect the reduced harvesting profits to occur.

Note that nothing in the above argument provides a defense for continuing the policy of damager-compensation indefinitely. It could logically apply only to those who had already invested in wood growing under the accepted institution of "allowable damage" and who would be injured by a post-investment change to a public policy which would

not allow uncompensated external costs. Hence, while we might be willing to compensate forest owners for legislation-caused costs if they have already made their investments, anyone making a wood-growing investment after the new institution cannot demand compensation for unexpected costs imposed. Under any new legislation, investors can make their decisions considering the capitalized increase in expected harvesting costs caused by regulation.

This then, is an argument for placing damage-reduction liability on the victims in the case of currently existing forests and placing liability on damagers where the forest is established after new legislation. However, the issues of compensation and liability are ethical ones and can not be resolved here. I seek only to raise implications of the alternatives and possible arguments.

Land Trades

Logging on certain areas is bound to create more undesirable side-effects than on others. For example, consider fragile watersheds or areas along heavily used highways and rivers. On such lands, the optimal degree of regulation may be rather stringent and complicated. To minimize costly policing and complaints about regulation it may be well to offer owners of such problem areas a choice of strict regulations or a chance to trade the property for some publicly owned land with fewer externality problems and hence less

regulation.

Such trades would lead to public ownership of problem areas, less regulation of private forestry and no reduction in the amount of privately owned land. All public landowners--federal, state, county and municipal--could become involved in trading with private owners.[18] Note, however, that governmental units might be unwilling to forego timber income as a result of a trade if the private land regulation were of primary benefit to those outside of its jurisdiction. For example, if a county owned a forest from which it received annual timber revenues it could be reluctant to trade this tract for an equal area of private roadside forest to be managed for scenic beauty which

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[18] The possibility of land trades raises an interesting question: What if a private landowner, on whose land stringent restrictions have been imposed, can find no public agency willing to trade a tract of equal private value but with fewer management restrictions (assuming such public tracts are available)? Suppose the reason behind such a refusal was that the public was unwilling to forego the difference in timber income between the highly regulated private tract offered and the less-regulated public land it would have to relinquish. (Assume that both tracts would lie in the jurisdiction of the governmental unit in question and that its citizens were the only benefactors from the original private land regulations.) From the victim-liability standpoint, such a refusal to trade would suggest that the public were asking a private landowner to forego income to prevent social damages, the prevention of which the public itself would be unwilling to pay. This could raise the charge that regulations were too restrictive.

However, from the standpoint of damager-liability, the view is that the landowner has no right to impose uncompensated social costs. Under such a philosophy, the public's refusal to trade properties does not weaken the argument for harvesting restrictions unless, of course, the landowner can bribe the public to accept the damages.

would accrue primarily to out-of-county tourists.

Obviously, the spill-over problem does not disappear with public land-ownership; the same externality optima must be sought. Nevertheless, under public ownership the process of finding an optimum would be simplified by the fact that the damager and victim are the same party (see "Merger", p. 124). Also there is a greater probability that a given management plan will be followed without costs of policing. While there are many instances of parties being damaged by public forest management practices, it is also true that on public lands there is in general more concern for non-market outputs than on private areas (for example, note the landscape management areas and studies of water quality and yield on certain federal forests).

Implicit in the notion that the public may be interested in trading a less visible public forest tract for certain private highway border areas, is a concept that the disutility of any environmental damage depends on the number of people affected. Temporary turbidity of a given stretch of stream or loss of replacable scenic forest cover ought to be of little public concern on areas rarely used. To deal only with reducing certain physical changes without considering how many are damaged is to ignore the fact that our ultimate concern is not with damage to the environment per se but with damage to people. Hence the level of present and expected use of given forest areas will to some extent dictate the degree of regulation thereon--simply another

argument for flexibility in designing forest practice requirements.

Costs of Intervention

Because certain public programs to optimize externalities could be very costly, some effort should be made to estimate costs of alternative intervention schemes. Coase (1960) and Castle (1965) have pointed out that public intervention should only occur if the resulting increase in net benefits exceeds the cost of the program.

VI. REGULATING REFORESTATION FOR NON-MARKET BENEFITS

Here the discussion of Chapter IV will be extended to include non-market public benefits from reforestation of private lands.

Before considering reforestation, however, there is the larger question of whether or not to allow harvesting on a particular area in the first place when harvesting could entail the temporary or permanent loss of certain social benefits such as scenic beauty, water quality or soil values. For the moment let us consider only the question of whether to allow clearcutting of a mature stand, or forbid all logging. The decision on various degrees of harvesting--from clearcutting to preservation--will be discussed in Chapter VII.

Liability on the Victims

With the framework of liability for damage prevention on the victims, public decision makers could ask whether the present value of public benefits, if any, from forbidding timber harvest were worth the present value of private opportunity costs of no harvesting. The question raises three possibilities.

(1) Public benefits from retaining the forest could be deemed worth the private income foregone, regardless of whether or not the area were reforested. Then the decision would be to forbid clearcutting. Whether to compensate the

landowner for the resulting income-loss is another question. If we assume no partial cutting alternatives, lack of compensation is akin to confiscation if no other land use is possible. The case of highly restrictive regulations, particularly without compensation to the landowner, may elicit suggestions to trade the regulated land for some public land with fewer externality problems (see pages 142-144).

(2) Public benefits from retaining the forest might be greater than private opportunity costs if the land were not reforested but less than private opportunity costs if the area were reforested. Then the state would tell the landowner, "You may clearcut if you regenerate, otherwise, no harvesting is allowed."

Let us consider (2) above, assuming that no compensation would be paid to the landowner if harvesting were forbidden. Then the landowner would generally choose to reforest (unless there were the perverse case where regeneration costs exceeded the current value of the mature stand).

Now assume that under (2) the state would compensate the landowner for harvest income foregone if clearcutting were forbidden. If the private rate of return on the reforestation investment (R.F.) were less than the owner's private opportunity rate (P.O.R.), he would not plan to reforest, and the state would forbid harvesting.

If R.F. > P.O.R., the owner would willingly promise to reforest, and the state would allow clearcutting.

The third possibility is:

(3) Public benefits of forest preservation would not be worth the private opportunity cost of foregoing the harvest. In this case clearcutting would be allowed, whether or not reforestation occurred.

Now, under (3), if R.F. > P.O.R., the landowner reforests but if R.F. < P.O.R. he states his intent not to regenerate. In the later case, the state might consider public action if lack of reforestation would impose certain social costs such as erosion or scenic damage.[19]

Consider a case where the landowner refuses to make a reforestation investment because its private present value is minus $X; assume further that failure to reforest means losing scenic and soil values of public concern. Forcing the landowner to reforest means a private cost of $X. With liability for damage prevention upon the victims, the public would ask whether the expected social benefits from reforestation would have a present value of at least $X. If public benefits were deemed worth $X, reforestation could be required, if not, the landowner could do as he pleased. In the case of requiring

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[19] Each case should be evaluated separately. For example, scenic values may or may not be important, depending on the area's accessibility to people (see page 144). Likewise the contribution of no reforestation to soil losses or water quality degradation depends on factors such as soil type, slope and rainfall.

reforestation, whether or not to compensate the landowner by $X would be a question to answer in the political sphere.

The above framework requires that the state and private owner agree on an expected stumpage price. Also, due to the wide range of private opportunity rates (P.O.R.) used by different individuals, the approach requires that the state infer some realistic P.O.R. for various classes of landowners. Having each landholder suggest his own P.O.R. would be unwieldy.[20] However, one could classify landowners according to size of total landholdings, inferring a higher guiding rate of interest for smaller owners and a lower rate for larger owners with longer planning horizons.

Another problem remains. On the basis of public values I have suggested forcing certain practices on private land (with or without compensation) as long as the present value of public benefits would be worth the capitalized costs. Without the public benefit, no requirement was made. How large must the social benefit be before we consider intervention? Some admittedly arbitrary judgment must be made. The net public benefits, however, ought to at least exceed the administrative costs of the intervention program.

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[20] Moreover, in cases where some government payment is expected, there would be the problem of landowners suggesting an unrealistically high P.O.R. in order to extort an excessive subsidy. Suppose present value < 0. We know that as P.O.R. increases, present value declines. Therefore, the greater P.O.R. is, the greater is the subsidy required to give a zero present value.

In dealing with non-market benefits, public decision makers are asked to decide whether given benefits are worth certain costs. This requires quantifying the expected public benefits in some form, but not necessarily in dollars (see "Evaluating Environmental Benefits", pages 194-197).

Liability on the Damagers

Where liability for damage prevention is placed on the landowners, regulating reforestation is seen in an entirely different light. Starting with a forested area ready for harvesting, the landowner would have to determine if his profits from harvesting would exceed the compensation society would require to willingly endure the damages, if any, associated with cutting. If they did, harvest could proceed, otherwise not.

With harvesting, two alternatives should be examined: harvesting with or without regeneration. Society's compensation requirement would most likely be lower with reforestation (unless a treeless site contained certain public advantages--in which case no compensation would have been required with harvesting in the first place). A landowner's profits might be higher or lower with reforestation, depending on the site.

Suppose the harvest value of a given forest with high public values is $20,000. Society's compensation required to willingly endure

clearcutting on the area is set at $16,000 without regeneration and at $12,000 with regeneration. Assume further that the landowner estimates the present value of a regeneration investment on the area at minus $6,000. If we subtract society's compensation payments from the landowner's profits, his returns are net social values. Under our assumptions, the net social value of clearcutting without regeneration would be $20,000-$16,000 = $4,000 and with reforestation would be $20,000 - $6,000 - $12,000 = $2,000. Everyone would be better off under clearcutting without regeneration. If the landowner's expected present value of a reforestation investment exceeded minus $4,000, net social value would be greatest if regeneration were undertaken.

VII. REGULATION OF LOGGING

This chapter will discuss logging regulation to achieve optimal levels of forestry-induced environmental effects (positive or negative) in areas of water quality, scenic beauty, fish and big game.

When managing land for non-market benefits, Webster and Hagenstein (1963) suggest that decision makers concentrate, as a first step, on objectives of minimizing costs of attaining certain non-market benefits or maximizing benefits for a given cost. Due to difficulties in measuring values such as water quantity and quality, they are reluctant to suggest production goals of increasing or maximizing net social benefits from land management activities through marginal analysis.

However, the decision framework outlined later in the chapter makes use of marginal analysis in comparing (under our two liability schemes) regulation-induced incremental changes in net landowner revenue with resulting changes in net public benefits in an effort to reach optimal regulation of forest practices. Instead of expressing in common units the costs and benefits of maintaining environmental quality, costs will be in terms of dollars with non-market values in physical units. As Fox and Herfindahl (1964) suggest, it seems more sensible to estimate the cost of providing some physical quantity of an extra-market good and then to ask whether it is justified, rather than

to make sophisticated analyses using highly questionable monetary values of non-market outputs.

To use the decision models developed in this chapter, one would need to predict probable environmental consequences and landowner costs of alternative management schemes. Landowner costs of any particular management plan would be the difference in present values (to the landowner) between the profit maximizing scheme and the plan in question. Little will be said here about estimating present values of expected income to the owners of forest areas under different management assumptions. While there may be problems in estimating monetary costs and returns of practices not commonly used, present value calculations are in general fairly straightforward. Examples of such procedures are found in Rickard, et al. (1967) where present values of hypothetical forest stands are simulated under several different landscape management assumptions.

Detailed use of the decision guides for logging regulation in this chapter would become too costly and time-consuming for practical application on every logging area. The more complex guides here and elsewhere in the study are presented as possible approaches for research to determine optimal regulations on study areas within certain characteristic zones of separate regions. Such research could result in suggested regulations for given zones within regions. Regions could be particular forest types while zones within regions would be

related to certain uses such as streamside areas, highway borders, and isolated timber production areas. Zones could be further subdivided according to intensity of use.

The major problems in logging regulation arise in quantifying the probable effects of management alternatives upon factors such as water quality, fish, scenic beauty or big game. In many cases, predictions of environmental changes caused by certain actions would only be crude guesses; however, we can generally predict the direction of changes and at least something about their magnitudes. The next three sections will attempt to point out that sufficient predictive techniques are currently available to utilize--even if imperfectly--the decision frameworks outlined later in the chapter. The intent is not an exhaustive survey of methods for predicting (in specific units) environmental effects of alternative forest management practices. Details on these methods are available in the literature (some of which will be cited) and will not be covered in depth here.

Water Quality

The more important aspects of water quality which are affected by logging in Oregon are levels of suspended and deposited sediment, turbidity, logging debris, and water temperature. While it is known that cutting practices can affect water yields, this study will not consider water supply as a sufficient problem in Oregon to examine

harvesting regulations aimed at increasing water yields from forest lands. Floods, however, are a major problem in Oregon. Although it has been suggested that logging can significantly increase flood peaks in western Oregon (Anderson and Hobba, 1959), relationships between logging intensity and floods are not clearly defined (Krygier, 1969). Hence, regulation for improved water regimen will not be considered here.

Sediment

It has long been recognized that exposure of bare soil due to activities such as agriculture, construction, or logging on watersheds can increase the levels of sediment (soil particles) suspended in, or deposited on beds of watercourses. This sediment causes damage to fish (see pp. 165 through 168),accumulation of silt deposits in lakes and reservoirs, increased purification costs for certain water users and reduced aesthetic qualities of water.

While careless logging can sometimes dramatically increase stream sediment levels, it is not necessarily always the major cause of sedimentation. For example, Anderson (1954) has divided the sediment load in the Willamette River Basin above Salem, Oregon into three sources: (1) 24 percent from forest lands comprising 77 percent of the drainage area, (2) 22 percent from agricultural land comprising 23 percent of the area, and (3) 54 percent from eroding main

channel.

With logging, the major contributor to sediment is road and skid trail construction (Krygier, 1969; Fredricksen, 1969). Mass soil movements, often aggravated by road building, are another cause of sedimentation problems.

A number of studies have indicated that soil scientists and hydrologists can judge the sensitivity of a given forest area to soil erosion and sediment problems. Anderson (1954), for example, has classified western Oregon into 13 zones of different erosion potential based on factors such as soil type, slope, and climate. Brown et al. (1969, p. 172-176) have made predictions of sediment deposition resulting from certain land management alternatives. Water quality variables are being recorded on a study of several forest cutting patterns in Arizona (Worley, 1966).

Other studies indicate the possibility of making crude predictions of probable sedimentation resulting from alternative logging practices on given sites. Leaf (1966) has recorded sediment yields from three similar Colorado watersheds which received different concentrations of clear-cutting with varying amounts of road building. Packer (1967) has had success in predicting the distance of sediment movement downslope from logging roads, given certain soil types, slopes, precipitation volumes, road cross-drain spacing, road cut and fill slopes, and types and widths of protective strips below roads.

Volumes of coarse sediment (cubic feet per acre) and suspended sediment (parts per million) in streams have been recorded before and after logging with different concentrations of roads on similar areas (Fredricksen, 1965, 1969).

Skyline logging with minimal road mileage tends to yield lower sediment levels than tractor logging on similar areas (Fredricksen, 1969). Depth of soil disturbance and percentage of surface area with exposed bare soil have been recorded on skyline and high-lead logging areas by Dyrness (1967) and have been found to be considerably less than under tractor logging.

Work has been done in Oregon by Dyrness (1967b) relating sediment-causing mass soil movements to site characteristics such as soil type, elevation, soil parent material, aspect, slope, road mileage, and road drainage. Swanston (1969) has done similar studies in coastal Alaska.

On some soils, compaction of skid roads has increased surface run-off and sediment problems. Steinbrenner (1966) has found that scarification of such skid roads by deeply loosening abandoned road surfaces with a three-toothed rock ripper has reduced surface run-off and has actually increased the quality of adjoining sites.

Many of these studies have recorded the rate of decrease in stream sedimentation levels with regrowth of vegetation on exposed areas. Hence it should be possible to estimate the probable duration

of increased sediment levels due to various logging practices, as well as the sediment levels themselves. Based on past experiences, such as those of the studies cited, educated guesses of expected sediment levels following given management plans could be made in parts per million of suspended sediment and in terms of coarse sediment deposition rates in beds of streams or other bodies of water.

Timber harvesting alternatives to be evaluated from the sediment standpoint in the decision framework on page 181 could include practices such as no harvesting; high-lead and skyline logging at various intensities; caterpillar and rubber-tired tractor logging with different sizes and spacing of patch cuts; different road standards regarding road area per acre, drainage requirements, slope, seeding old roads and trails, scattering slash on road cuts and fills; selective cutting and shelterwood schemes.

Water Temperature

Stream temperature has been found to increase after removing stream-shading vegetation (Brown and Krygier, 1969). Given sufficient water temperature-increases, populations of certain fish species decline (see section on fish damage). Also, increased water temperature sometimes gives rise to algal blooms which cause problems of taste, color and odor of water.

Timber harvesting near streams has little affect on water

temperature as long as stream-shading vegetation is undisturbed. If streams are small enough, shrubs and small unmerchantable trees can supply enough shade to stabilize stream temperature. Temperatures are directly related to the percentage of stream surface exposed to sunlight. Thus the suggested means for minimizing stream heating due to logging is to leave stream-side strips of vegetation, the size of these strips depending on the amount of shade needed.

Brown (1969a) has developed an equation for predicting stream temperature-changes resulting from logging-induced increases in sunlight reaching the stream, given information such as: type of stream bottom material; stream depth, width and flow rate; and percentage and length of stream exposed to sunlight before and after logging.

Bauer and Franklin (1969) and Hughes (1969) have used Brown's (1969a) method to predict temperature change due to a postulated harvesting pattern after which the logging was actually done.[21] Hughes (1969) notes certain of his temperature-change predictions (using Brown's (1969a) technique) that appear reasonable and others that he deems clearly too high. Predictions by Bauer and Franklin (1969) appear more promising. It is evident that Brown's (1969a)

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[21] These studies are preliminary, unpublished reports and will thus not be directly quoted.

temperature-change prediction formula does not produce consistent results. Nevertheless, it appears from the work of Hughes (1969), Brown (1969b), Brown and Krygier (1969), and Bauer and Franklin (1969) that hydrologists are gaining the experience to make reasonable guesses of expected water temperatures in given streams following certain logging practices.

It seems plausible that results of ongoing research will soon enable hydrologists to suggest rough rules of thumb which field men could apply to estimate expected stream temperatures, given initial temperature and certain logging assumptions.

Attempts at estimating the expected temperature-changes at various points downstream from clearcut areas are becoming more refined. Brown (1969b) notes that increased stream temperatures will cool only very slowly upon flowing through heavily shaded zones.

The optimal amount of increased sunlight (and thus temperature) allowed on any stream would depend on its current temperature, the expected damages from given temperature-increases and the costs of (as well as possible scenic benefits from) maintaining the streamside vegetation. Means for handling these relationships are discussed later in the chapter.

A given harvest might be prohibited for temperature reasons in a particular year; however, due to regrowth of shading vegetation elsewhere, the same harvest might be allowed a few years later.

The degree of shade removal allowed in any particular harvest would depend on the number and distribution of existing and proposed harvests along the stream.

It should be noted that while leaving narrow stream-side strips wide enough to minimize temperature-increases from logging, the strips may not significantly reduce sediment and turbidity problems caused by soil disturbance above them. They can, however, eliminate logging debris in streams.

Scenic Beauty

One of the most difficult forest outputs to evaluate is scenic beauty. It is not measured in units as we may measure certain aspects of water quality or fish populations, but its degree depends on the subjective evaluation of the observer. While there may be some concensus regarding the ugliness of certain clearcut logging operations, there would be less agreement on the scenic effects of alternative partial logging methods as well as on the desired amounts and distributions of different vegetative types.

The discussion of scenic beauty will be confined mainly to areas bordering roads and water which are exposed to public observation. There is some justification for treating certain isolated private forest areas, rarely if ever visited, as wood factories with little concern for temporary scars from logging. In general the public is not

concerned about the internal appearance of industrial plants, hence there seems little reason to stir up agitation about temporary scenic damage in rarely-seen areas.

There may on occasion be private forest areas with recreational development potential where one might consider some harvesting regulation to enhance aesthetic values. However, a careful consideration of alternatives should be made in such cases. For example, suppose that on an area (visually isolated from public traffic), the costs of regulation for recreation use are deemed less than the potential recreation benefits. This in itself is not sufficient justification for enforcing the regulation. There may be the alternative of declaring the area non-recreational and developing the same recreation potential at a lower cost on some other private or public area.

Forest zones along frequently traveled routes, present a different problem. While people may complain about the scars of logging, they would probably not wish all highway borders to be forested. Driving through certain cleared areas with broad vistas is also attractive. In short, a given standard of roadside beauty is simply not available; a certain mix and variety of vegetative cover is desired; long corridors of dense, tall forest borders, uninterrupted open vistas, alternating patches of forest and openings, and selection or shelterwood forests of tolerant species.

Perhaps the difficult thing for most to accept is abrupt change

in the existing roadside vegetation. We should, nevertheless, bear in mind that many scenically attractive areas today are the result of past changes.

One of the more perplexing problems in designing public policy with long-term effects is the fact that tastes change with time. As Boulding (1969) points out, the notion that tastes are simply given is absurd--outside of a few basic needs, most of our preferences are learned. Thus we must be aware of the pitfalls in policies based on the assumption of stable preferences.

The long-term results of policies can themselves have an influence on tastes and public values. For example, public subsidy for producing recreation and scenic areas could stimulate increased demand for these outputs through a "learning by doing" phenomenon (Krutilla, 1968). However, to use such a demand stimulus as a justification for public subsidy is questionable; the same "learning by doing" could accompany public expenditure in many areas, for example, art, music, or sports.

Casual observation of American values in recent decades seems to reveal an increasing acceptance of more rapid value-changes, broad-mindedness, and a gradual softening of clear-cut dichotomies between "good" and "bad" or "right" and "wrong" in areas such as beauty, and the arts. Due to an apparent increasing flexibility of value systems, and the uncertainties in predicting tastes, as well as

the lack of any present absolute criterion of scenic beauty, a suitable guide in scenic area policy may be to offer a variety of vegetative types. The difficult task of determining what this mix should be will fall upon public decision makers.

All this is not to say as Galbraith (1967, p. 409) does that questions of "the beauty, dignity, pleasure and durability of life" are "beyond the reach of economics". Admittedly, in many cases the economist lacks the tools to prescribe an optimum output of certain extra-market goods; however, he needn't feel compelled to make such prescriptions. The economist can play a valuable role in identifying alternatives and the likely outcomes of these--at the same time making no value judgments about these alternatives. Such information, presented objectively, can be of great use to policy makers.

Alternatives in landscape management for scenic values are virtually countless. Examples would be some of the following: clearcutting at various times and in different sized patches, shelterwood systems, conversion to tolerant species with continuous selective cuttings, clearcutting and restocking with anything from brush to dense forest cover, or prohibition of all logging.

Under given price, productivity, and interest rate assumptions, present values of timber income from any of these alternatives could be estimated.

Fish Damage

Closely related to water quality is the fish carrying capacity of streams. Studies have shown that siltation, sediment, reduced dissolved oxygen content of water, temperature-increases, and stream blockage by debris can reduce fish populations (O.F.C., 1968a, 1968b).

Excessive suspended sediment in water can injure and clog fish gills, resulting in increased disease levels and population-declines. Silt deposits on streambeds can reduce aquatic insect and plant life and hence lower fish food supplies. Filling of spaces by sediment in gravel streambeds reduces bottom productivity by destroying sheltered spawning areas and decreasing cover for young fish (Chapman, 1962). Such sediment also decreases permeability of spawning gravel which in turn will reduce salmonoid embryo survival through reduced oxygen and build-up of waste products. In addition, hatched fry are often unabel to emerge from heavily silted spawning beds (Hall and Lantz, 1969).

A total of many upstream siltation problems can also cause deposited sediment in estuaries, resulting in damage to marine life such as oysters. This might be seen as an example of the tyranny of small decisions (page 36). Each individual logging operation causes only negligible damage in estuaries while the cumulative damages can

be far greater.

Often accompanying siltation are turbidity problems harmful to fish. Turbid water reduces sunlight penetration and thus hinders development of young fish and aquatic plants (Cordone and Kelly, 1961). Since plants provide necessary food and shelter, their reduction will lower fish populations.

Increases in water temperature as well as decomposition of logging debris can lower the dissolved oxygen content of water, thus causing increased fish mortality (O.F.C., 1968b). Also accompanying excessive water temperatures are reduced egg survival, and increased occurrence and virulence of certain fish diseases (O.F.C., 1968a).

Presence of debris which blocks fish passage can be a serious threat to fish populations. Chapman (1962) cites an unpublished Oregon Fish Commission report indicating a 75 percent reduction in spawning salmon attributed to logging debris blockage in one Oregon stream.

Essential to our use of decision guides in forestry regulation to reduce fish damage is an ability to predict the probable effects on numbers of fish caught due to alternative timber harvesting plans. We have already established the possibility of roughly estimating the stream sediment, debris, and temperature consequences of various forest management practices. It also appears possible in many

cases to make intelligent guesses about expected fish mortality accompanying given postulated changes in temperature, siltation, and debris in particular streams.

Fisheries biologists have long been estimating numbers of salmon and steelhead returning to spawn in certain index streams in Oregon. Research studies have provided data for estimating the number of fish caught in the commercial and sport fisheries for each adult returning to spawn (Allen, 1969). Thus, given a projected change in spawning adults in a given stream, some estimate can be made of the resulting change in sport and commercial fish caught.

Data on numbers of spawning anadromous fish in streams before and after a given change in water temperature and siltation are meager. Compounding the problem is a wide natural variation in numbers of spawning fish each year in a particular stream even when water quality is unchanged. Nevertheless, biologists are beginning to gain information about fish population-declines in certain streams following increases in temperature and siltation as well as decreases in dissolved oxygen content (see for example Hall and Lantz (1969) and Cordone and Kelley (1961)). With the rising interest in effects of water quality upon fisheries, we can expect further research in this area.

No established technique is yet available to predict fish population-changes with given decreases in water quality, and fisheries

biologists I have spoken to will profess their reluctance to make such predictions as individuals. They have, however, shown interest in the idea of having panels of experts predict expected changes in game fish populations in particular streams, given postulated changes in water quality and given an estimate of the existing populations. As results of current research on fish damage become available, it seems reasonable that rough guidelines for predicting changes in fish caught with postulated forest management activities could be established.

As for the valuation of sport fish, decision makers could either make some subjective comparison between numbers of fish saved and associated opportunity costs, or they could attempt to derive demand curves for certain species (see "Research Needs", page 207 and Brown, Singh and Castle (1965)).

Studies are available which give the net value per pound of salmon to commercial fishermen (Naggiar, 1966).

Big Game

The effect of forest management, upon deer and elk populations differs fundamentally from the other side-effects discussed here, in that it is not a diseconomy. Increased timber cutting, up to a point, generally augments big game populations by stimulating growth of forage plants (Trippensee, 1948, p. 189, 341). Not only is there

more game for hunters, but removing forest cover and building forest roads provides better visibility and mobility for hunting.

Hence the problem is not that damage values may exceed the profits from avoiding damage abatement, but that the private forest owner, not receiving gains from added game output, may not produce enough deer. "Enough" deer would be the point where the value of an additional animal equalled its cost of production. At the private landowner's profit maximizing pattern of timber cutting, the deer population may not be optimized. The cost of producing one more deer (i.e., the wood income-loss through providing more forage) may be less than the value of that deer to the public. Thus, producing more deer could raise welfare.

From a practical standpoint, the question of forest harvesting regulation to attain optimum big game populations is largely academic. We know little about the relationships between big game populations and alternative timber harvesting patterns over long time periods. True, we know that clearcutting stimulates forage and big game development and that eventual forest regrowth will later reduce forage and game. However, what are the effects (on big game harvests) of various partial cutting alternatives or different sized and spaced clearcuts with various rotation lengths? Such questions cannot be answered at present nor are they currently being investigated in Oregon.[22]

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[22] Conversation with William C. Lightfoot, Game Biologist, Research Division, Oregon State Game Commission, Corvallis, Oregon, March 5, 1970.

Another complicating point: While big game production and timber harvesting are complementary over a wide range of output, wood and big game are to some extent competitive products in that big game often destroy tree seedlings (Heacox and Lawrence, 1962). In addition, where forest areas are used for cattle grazing in eastern Oregon, big game can reduce cattle income by consuming forage. The foregoing comments should serve to point out that there is simply not the information available to evaluate harvesting regulation proposals from a big game standpoint.

Perhaps one way to stimulate welfare-improving changes in big game management with a minimum of public intervention would be to encourage more fee hunting on private lands. Suppose that, through interaction of the demand for and supply of hunting privileges, the average fee income per bagged animal would reflect the value of the animal to the hunter. This would encourage the landowner, on his own, to institute big game-increasing practices as long as the resulting rise in game income exceeded the cost of the practice. Such reallocations would improve welfare because the gainers (the hunters) would be over-compensating the losers (the landowners whose timber income would have declined as a result of increasing the game population). While practices to increase big game harvests may not always be known, a fee system could encourage experimentation in this direction.

A number of practical problems may hinder development of fee hunting. There may be a strong feeling that game animals not artificially stocked are public property and ought not to be sold by private landowners. Where hunting fees are charged, users may demand extra services such as road improvements and campgrounds, the costs of which could offset the fee income. Nevertheless, hunters should be made aware through information programs that big game production is not always a costless by-product of timber output, and, likewise, that opening lands to hunters entails costs of road maintenance, increased fire danger and vandalism.

Although there may be resistance to more widespread use of fee hunting, the scheme offers a possibility of welfare improvements with minimal public intervention.

Something-for-Nothing Opportunities

Among possible resource reallocations there are those which yield increased benefits at virtually no cost or at costs so low as to be trivial in comparison to resulting gains. The phrase something-for-nothing, although somewhat misleading, refers to such opportunities.[23]

Every effort should be made to explore low-cost methods of

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[23] The existence of true something-for-nothing opportunities is simply a case of technical inefficiency--i.e., being inside the production possibilities frontier.

reducing environmental damage. In the same manner that a simple costless adoption of contour plowing substantially reduced soil erosion on farms, certain changes in logging practices at little cost might reduce public damages, especially in the area of water quality. While the decision to take advantage of something-for-nothing opportunities is easy to favor, unfortunately, few examples in forestry leap to mind.

In fire prevention (although not really a concern in this study) the imposition of certain smoking safety rules could be deemed a something-for-nothing opportunity. Another would be prohibition of dumping into streams slash and unused logs which could block anadromous fish passage. Prevention of log landings in stream bottoms where other equal-cost alternatives exist and, similarly, prohibiting skid trails and roads from running straight up and down steep slopes in fragile watersheds could often receive ready defense from a water quality standpoint. Jeffrey (1968) notes that some measures such as pre-logging planning might actually increase both private and public returns. For example, pre-logging planning can sometimes reduce total road length and the percentage of steep road grades, both of which could reduce siltation problems.

The more difficult regulatory decisions involve foregoing certain benefits to obtain others. Problems are compounded when the gains and losses are measured in different units. It is to such problems

that we now turn.

Single Benefit Production

Most forest management regulations would have multiple benefits in several areas; for example, restricted harvesting on certain tracts could yield an increase in scenic values, water quality and fish populations. On the other hand, some practices have a major effect on only one type of value. The former will be discussed under "Joint Production" while the latter is examined below.

One of the few practices yielding essentially one type of value is the maintenance of forested strips along public highways for scenic purposes. Unless these borders are extremely wide they will have little effect on water quality or other values. Hence, this practice will provide a useful example with which to illustrate a decision framework for regulating practices with single benefit outputs.

Opportunity costs of several alternative landscape management schemes in hypothetical old growth Douglas-fir stands have been examined by Rickard, Hughes and Newport (1967). For several initial stand types, they calculated net present values from simulating 12 different management schemes. Three of these alternatives were:

A. Clearcut now and regenerate with Douglas-fir.

B. Shelterwood cut now and regenerate with Douglas-fir.

C. Convert to tolerant type with periodic partial cutting.

Alternatives A through C yielded decreasing present values, the opportunity cost of each plan being the difference between its present value and that of A. By observing existing areas (and photographic studies over time) illustrating the three management methods, decision makers could form some subjective judgment of the aesthetic value of each alternative.

Rickard et al. (1967) outline a "simple betterness" technique whereby certain alternatives may be automatically eliminated without actually attaching dollar values to the scenic outputs. Figure 9 illustrates the method. The left-hand scale shows net present values of five mutually exclusive management alternatives while the right side represents utility from the aesthetic output of each alternative. The broken bars indicate the absence of cardinal utility values; only an ordinal ranking is possible. Alternative 1 is dominated by 5 on both the dollar and utility scales; likewise 2 dominates 3 and 4. Thus we are left with a choice between 2 and 5.

In some cases the simple betterness approach may resolve the choice question completely. In others it may or may not narrow the range of choice. However, the simple betterness method will always result in a selection of non-dominated alternatives which can be ranked in order of decreasing private value accompanied by increasing public benefits.

Carrying the framework of Rickard et al. (1967) somewhat

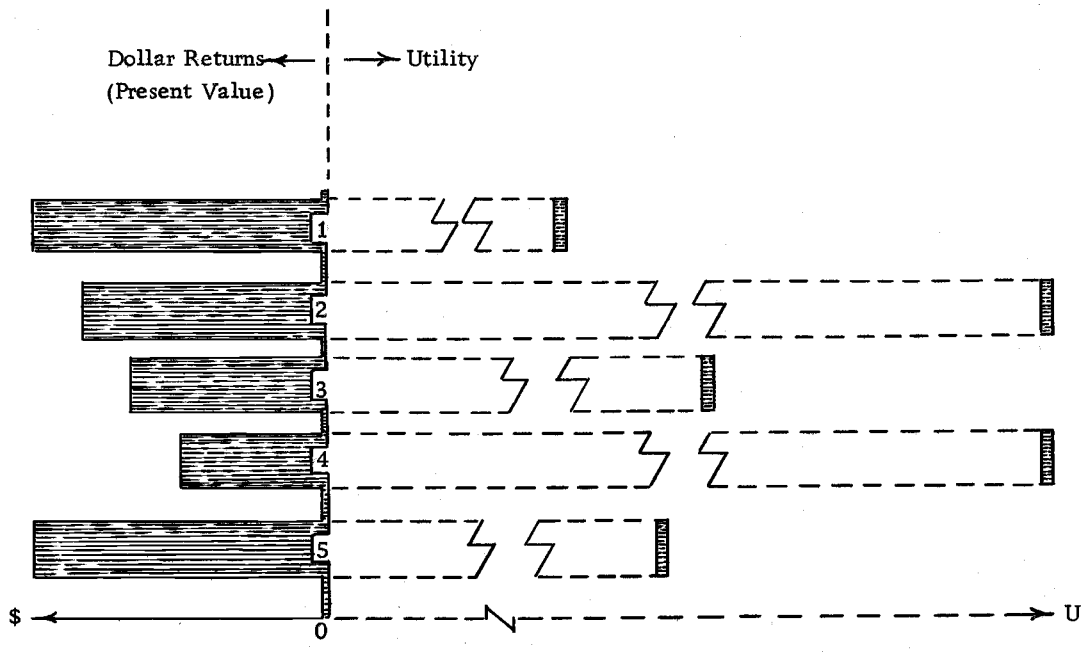

Figure 9. Dollar and non-dollar returns from five hypothetical alternative actions. (Adapted from Rickard, et al (1967, p. 30))

farther, consider a case where applying the simple betterness method has allowed the ranking of three alternatives as shown in Figure 10. Note that actions A through C are mutually exclusive. The decision problem becomes more complex if we include practices which can be applied together on the same area. The latter will be referred to as additive practices--for example seeding old logging roads or providing for streamside shade. Since most additive practices provide multiple benefits, they will be discussed under "Joint Production."

Shifting from alternative A to B in Figure 10 involves a marginal opportunity cost of MC_1 and an increase in aesthetic returns or utility. Again, benefits needn't be measured in dollars; decision makers need only form some subjective evaluation of the aesthetic differences between the plans. An increase in landscape management intensity from B to C brings a further utility-increase at a marginal cost of MC_2.[24]

Liability on the Victims

With liability for scenic damage reduction on the public, we start at A in Figure 10, the private profit maximum, and ask if the public feels that the increase in aesthetic returns from a shift to

[24] Note that a change from B to C is strictly hypothetical. Having actually instituted a shelterwood system one could not readily convert to tolerant species.

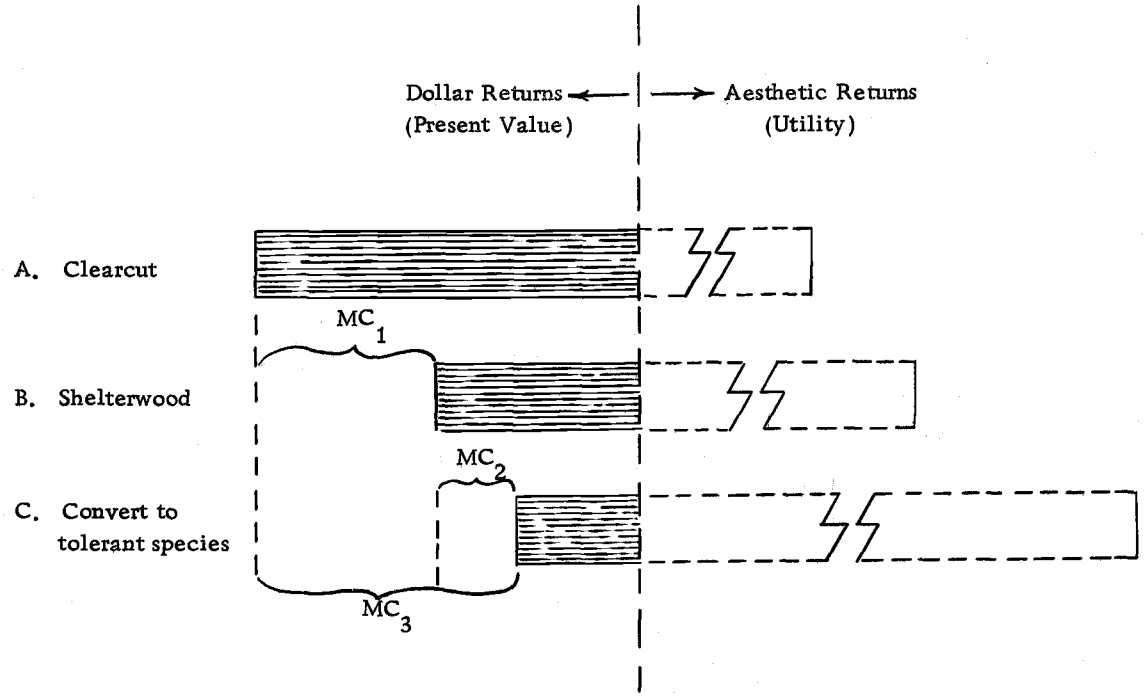

Figure 10. Hypothetical dollar and non-dollar returns from three landscape management alternatives.

shelterwood cutting along a given highway stretch is worth MC_1. If the answer is yes, increasing intensity of scenic management could be required as long as decision makers felt the marginal benefits were worth the marginal costs. If a given plan, say B in an array such as Figure 10, is rejected, all others below it should still be considered, with the appropriate changes in marginal costs and benefits. With B rejected, the question is whether the increase in aesthetic returns as a result of moving from A to C is worth a marginal cost of MC_3.

Liability on the Damager

Under the damager liability framework we start with a situation of no damage to society, i.e., C in Figure 10 (in some cases this could be no timber harvesting). Decision makers would inquire whether the scenic loss from moving to B could be compensated for by a payment of less than MC_2 to the public. Each time such compensation could be made, the next higher plan in the array should be considered in the same way. Increasing relaxation of scenic standards could be allowed as long as the resulting increases in private revenues were large enough to compensate the public for the resulting scenic losses. Again, if one alternative is rejected, all others above it should still be considered. For example rejecting B means asking if the scenic loss in moving from C to A could be compensated for by

a payment of less than MC_3.

Note that the ranking of aesthetic returns need not occur as shown. On an area where clearcutting may open a desired scenic vista, it could yield a greater aesthetic utility than the partial cutting alternative. Again, the need for separate intervention decisions to fit specific areas is evident.

In a situation where plans A through C in Figure 10 would yield decreasing aesthetic satisfactions, the decision problem largely disappears. The simple betterness guide would automatically select alternative A. Thus one can see the importance of first eliminating all dominated alternatives before using the procedure just outlined with Figure 10.

Joint Production

With joint production each alternative management scheme affects several public values. Two major tasks in the decision problem are specifying alternative actions and predicting probable outcomes of each. Extremely complex decision problems can result when a large number of alternatives with fine gradations between each are arrayed. Depending on the benefits at stake, decision makers can consider various sized arrays of management alternatives. A balance must be struck between the need to reduce the problem to a workable number of alternatives and the danger of making a biased analysis by

omitting important alternatives.

Mutually Exclusive Alternatives

Let us first consider the case of joint benefit production from mutually exclusive alternatives on a given forest area as outlined in Table I; additive practices will be included shortly. The management plans in Column 1 could be as follows:

1. Clearcutting with an average of 100 feet of road per acre.
2. Clearcutting with an average of 50 feet of road per acre.
3. Shelterwood harvesting.
4. Convert to tolerant species with partial cutting.
5. No harvesting.

The difference between 1 and 2 might be a heavier use of cable logging with 2.

Physical descriptions of the expected environmental outcomes of each plan in Table 1 are listed in columns 5 through 9 and are summarized in column 10[25]. If the "environmental package" (column 10) is considered as one output, the model is basically the same as Figure 10. Table 1 is shown on the assumption that decision makers have eliminated all dominated alternatives by the simple betterness scheme (working with columns 2 and 10) and that the remaining plans

[25]See "Evaluating Environmental Benefits", pages 194-196.

TABLE 1. DECISION TABLE FOR MUTUALLY EXCLUSIVE MANAGEMENT PLANS

1	2	3	4	5	6	7	8	9	10	11	12	13
Management Plan	Net present value of private forest income	Direct outlays plus opportunity cost (Present value)	Marginal private cost ↓	Stream sediment levels for certain periods, p. p. m.	Stream turbidity for certain periods, J. T. U's*	Average stream temperature for given distance	Expected contribution of area to state fish harvest (#fish/yr.)	Scenic character	Total environ-mental package	Environ-mental change ΔE_{ij}	Compensation demanded to endure damage (K > N)	Marginal compensation
1 (Present mgmt.)	$100,000	$ 0	$25,000	a	f	k	p	u	(a,f,k,p,u) = F	ΔE_{12}	K	K-L
2	75,000	25,000	25,000	b	g	l	q	v	(b,g,l,q,v) = G	ΔE_{23}	L	L-M
3	50,000	50,000	25,000	c	h	m	r	w	(c,h,m,r,w) = H	ΔE_{34}	M	M-N
4	25,000	75,000	30,000	d	i	n	s	x	(d,i,n,s,x) = I	ΔE_{45}	N	N
5 (No timber harvesting)	-5,000	105,000	Marginal private gain ↑	e	j	o	t	y	(e,j,o,t,y) = J			

* Jackson turbidity units.

are arrayed in order of decreasing private returns accompanied by increasing public values. (Note that the increasing public value refers only to the environmental package, but not necessarily to individual environmental columns.)

The environmental changes ΔEij in column 11 of Table 1 represent a description of the change in the environmental package associated with a change from management plan i to plan j.

Liability on the Victims. With victim-liability, decision makers start in row 1 of Table 1 (the unregulated case) and ask, "Is the change in the environmental package from F to G (ΔE_{12} in column 11) worth a present outlay of $25,000 (column 4)?" As in Figure 10, all alternatives in the table should be tested whether or not certain ones are rejected in the process. The plan ultimately chosen from the unrejected alternatives would be the one with the highest net social value.

Whenever a plan is rejected, new marginal costs must be calculated as the difference in private values between the last acceptable alternative and the unrejected one below it. Likewise a new environmental change must be considered. For example, if the environmental change ΔE_{12} in moving from 1 to 2 is not deemed worth the marginal cost of $25,000, the next step is to consider a move from 1 to 3. Marginal costs would then be $50,000 with the environmental change being ΔE_{13}. This stepwise process must be carried through to the

last alternative.

It may be naive to assume that, for any area, accurate predictions could be made to complete a tableau such as Table 1; nevertheless, for informed decision making, some effort must be made in this direction. From the literature reviewed earlier in this chapter it appears that biologists and hydrologists can give rough indications of expected environmental changes from certain management alternatives on given areas. Even crude predictions, if used in the decision frameworks outlined here, can result in regulations which are apt to improve welfare far more than arbitrarily imposed environmental quality standards.

In regions where secondary benefits are expected to be significant (see pages 106-107) column 2 of Table 1 could include the present value of net secondary benefits generated by each plan's expected wood flows. Appropriate changes would then be made in columns 3 and 4.

Liability on the Damager. With damager-liability we start in the last row of Table 1 at the no damage point and work upward. Column 12 shows the compensation society would require to willingly endure the environmental damage associated with each alternative. Note that no compensation is required in row 5 of column 12 since that is assumed to be a no-damage situation. The change in compensation society would require (column 13) to willingly endure each

incremental decrease in environmental quality (column 11) would be compared with marginal private gains in column 4. In moving from row 5 upward (increasing wood revenue), the column 4 costs become marginal gains to the landowner. Increasing wood production intensity (increasing environmental damage) could be allowed as long as marginal gain figures in column 4 exceeded the marginal compensation requirements in column 13.

Rejecting a given increase in wood production intensity does not mean we should fail to consider further changes above the excluded alternative. Analogous to the discussion on page 182, we skip the rejected plan and make new marginal benefit and environmental loss calculations, never stopping until the unregulated state has been considered. Suppose decision makers rejected alternative 3 because the marginal compensation payment needed to accept it, M-N, exceeded the marginal private gain, $25,000. The decision would then be whether to move from 4 to 2, entailing marginal private gains of $50,000 and a marginal compensation requirement of L-N. Decision makers would eventually choose the alternative above which all others were rejected.

Additive Alternatives

With the inclusion of practices which can be achieved simultaneously on one area, we need separate decision tables which array

additive practices under each mutually exclusive alternative. After determining some optimum combination of practices to add to each mutually exclusive alternative, one can array the mutually exclusive optima and select one of these in the manner outlined for Table 1.

Suppose that on a given area we wish to consider the five mutually exclusive alternatives on page 180. Under each action there are several possible additive practices (except in the no-cutting case). Consider the array of three such activities and their environmental consequences with alternative 1 on a given tract as shown in Table 2. The additive practices are shown in rows b, c and d.

Note that in Table 2, the environmental packages represent the cumulative results of a given practice and all the accepted ones above it. In Table 1, environmental packages represent only the effects of the given practice in question since the alternatives are mutually exclusive. Similar differences exist between the cost columns (3) in the two tables. The column 3 figures in Table 2 are cumulative costs of a given action and all the others above it. In Table 1, column 3 gives only the costs of each mutually exclusive alternative. Otherwise, the interpretation of columns is the same for both tables.

Liability on the Victims. Starting in row a of Table 2, the procedure for deciding whether to accept or reject a given practice under victim-liability is the same as that outlined for Table 1. However, once a practice is rejected as not being worth its cost, the procedure

TABLE II. DECISION TABLE FOR ADDITIVE PRACTICES WITH A MUTUALLY EXCLUSIVE ALTERNATIVE, CLEARCUTTING AND AN AVERAGE OF 100 FT. OF ROAD PER ACRE. LIABILITY FOR DAMAGE REDUCTION UPON THE VICTIM.

1	2	3	4	5	6	7	8	9
Additive practices	Net present value of private forest income	Total outlays plus opportunity cost (Present value)	Marginal private cost	Stream sediment characteristics	Expected contribution of area to state fish harvest	Scenic character	Environmental package	Environmental change ΔE_{ij}
(a) Private profit maximizing method	$100,000	$ 0		m	n	p	(m,n,p) = Q	
			$1,000					ΔE_{ab}
(b) Seed old roads and trails	99,000	1,000		d	e	f	(d,e,f) = R	
			2,000					ΔE_{bc}
(c) Scatter slash on road cuts	97,000	3,000		g	h	k	(g,h,k) = S	
			7,000					ΔE_{cd}
(d) Leave streamside strips	90,000	10,000		l	m	n	(l,m,n) = T	

for evaluating the next alternative differs from that in Table 1.

Table 2 has been completed on the assumption that all the practices in rows b through d would be accepted. If one or more are rejected, the remaining alternatives should still be considered; however, with the following recalculation of environmental changes. When a practice is rejected, the environmental descriptions must be changed to reflect the loss of environmental quality due to the rejected practice since the columns contain cumulative descriptions. For example, assume practice c (scatter slash on road cuts to reduce erosion and sedimentation) is rejected because the environmental gain, ΔE_{bc} is not deemed worth $2,000. The environmental package for row d must then be revised, and the environmental change from adding d to b is the difference between the column 8 description found in row b, and a new description entered in row d. In general, if one practice is rejected, a new environmental change must be figured for all following practices except those whose effects are independent of the rejected practice.

One might be tempted to eliminate the need for recalculating environmental changes (when rejecting a practice) in the following way: Simply omit the cumulative accounting of environmental quality-results in Table 2 and list the expected environmental change with the adoption of each practice. However, this would invite problems, for the environmental effect of a practice often depends on the

other practices already present. For example, if one starts with no regulation and institutes slash scattering on road cuts, one may reduce sedimentation by, say 50 ppm. However, if one has already required road bed seeding, culvert installation, and reduced road grades, the addition of slash scattering may reduce sedimentation by considerably less than 50 ppm. Hence the decision regarding any practice can depend on the order in which it is considered.[26]

Marginal costs in Table 2 are not affected by rejecting an alternative. For example, eliminating row c reduces total costs by $2,000, hence making the present value of row d $92,000; however, marginal costs of adding row d will still be $7,000. In general, eliminating an alternative requires reductions in the total cost column (no. 3) below the rejected practices but no change in the marginal cost for each row.

In constructing tables of additive alternatives, analysts should attempt to list first the practice which would contribute (to the unregulated situation) the greatest environmental quality gain per dollar of private cost. Progressing down the table, practices should be added in an order of decreasing environmental gain per dollar cost. A problem is that the decision maker's evaluation of environmental

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[26] This illustrates why the non-mutually exclusive practices have been called additive instead of independent. They are not truly independent.

changes may differ from that of the analyst who constructs the table.

If the decision maker himself constructs the table by listing practices in order of decreasing gains per dollar spent, he may simply stop at the alternative he decides to reject. All others below it he knows will be less desirable. However, if decision makers have the analyst array the alternatives they should consider practices which occur below rejected ones, since there is no assurance that decision makers will also feel the practices occur in an order of decreasing gain per unit cost.

After having analyzed Table 2 and eliminated any undesirable additive practices, the decision maker has determined an optimum combination of practices to apply with the mutually exclusive alternative 1 (clearcutting with 100 feet of road per acre). Suppose he has rejected action c; we can then designate his optimal 1-plan as $1_{b,d}$. The same decision process can be used to find optimal additive action combinations for each mutually exclusive alternative. The decision maker might arrive at the following alternatives: $1_{b,d}$; $2_{b,d}$; $3_{b,c}$; 4_{b}; 5 . These could be arrayed and one selected in the manner outlined for Table 1 under "Liability on the Victims" (page 182).

Liability on the Damager. In placing damage reduction liability on the damager, finding an optimal combination of additive practices with a mutually exclusive alternative becomes more complex than in previous examples. No longer can we simply compare the

environmental package of one row in a decision table with that in the adjacent row.

For this situation, let us use Table 3--a revised version of Table 2. Column 2 shows marginal private costs from Table 2. If we start with all practices, column 2 costs become marginal private gains as practices are deleted. Let environmental packages in column 3 be as follows:

E = Environmental package resulting from the profit maximizing method (row a) of meeting the mutually exclusive alternative (here, clearcutting and an average of 100 feet of road per acre).

E_b = Environmental package resulting from adding practice b to a.

E_{bc} = Environmental package resulting from a, b and c.

E_{bcd} = Environmental package resulting from a, b, c and d.

Each package in column 3 is a combination of certain environmental characteristics such as those in rows 5, 6 and 7 of Table 2. For simplicity, these are omitted from Table 3.

Under damager liability we start by imagining a minimum damage situation with all practices instituted, i.e., with environmental package E_{bcd}. An environmental change from deleting a given practice would be the difference between 1) The environmental package resulting from all accepted practices applied together and 2) The

TABLE III. DECISION TABLE FOR ADDITIVE PRACTICES WITH A MUTUALLY EXCLUSIVE ALTERNATIVE, CLEARCUTTING AND AN AVERAGE OF 100 FT. OF ROAD PER ACRE. LIABILITY FOR DAMAGE REDUCTION UPON THE DAMAGER.

1	2	3	4	5
Additive practices	Marginal private gain, $ (reading upward)	Environmental package	Environmental change from deleting a practice	Compensation required to endure damage caused by deleting a practice
(a) Profit maximizing method		E		
(b) Seed old roads and trails	$1000	E_b	$E_{bcd}-E_{cd}$	J
(c) Scatter slash on road cuts	2000	E_{bc}	$E_{bcd}-E_{bd}$	K
(d) Leave streamside strips	7000	E_{bcd}	$E_{bcd}-E_{bc}$	L

environmental package resulting from all these practices minus the practice being considered.

Column 5 of Table 3 shows the public compensation needed to endure damage caused by deleting a given practice.

Starting in row d, the column 4 environmental change from deleting practice d is noted as $E_{bcd} - E_{bc}$. The minus sign does not denote subtraction in the mathematical sense but implies a description of the loss in environmental quality due to a shift from package E_{bcd} to E_{bc}. If the compensation, L, required by the public to willingly endure this loss is greater than the marginal private gain of $7000 (column 2), practice d is retained. Otherwise it is rejected.

Once a practice is rejected, new environmental changes and compensation payments must be calculated for columns 4 and 5. For example, if d were accepted and c rejected, the environmental change from deleting practice b would be $E_{bd} - E_{d}$. Practice c is no longer included.

The decision whether to retain or reject a given practice may depend on the order in which it is considered. This problem could be minimized by entering practices from top to bottom in Table 3 in order of decreasing environmental gain per dollar of private cost.

An optimal combination of additive practices for any mutually exclusive alternative would be reached after eliminating all practices whose marginal compensation requirements in column 5 were less

than their marginal gains in column 2. The Table 3 procedure just outlined would be applied to mutually exclusive alternatives 1 through 4 to determine the optimal combination of additive practices for each case. From these four (as well as no. five, no cutting), one could be selected by the method discussed under "Liability on the Damager" in the case of Table 1 (page 183).

Some Extensions

So far, the approach has been to consider the same additive practices several times under different mutually exclusive cutting alternatives. The reason for this is that a given practice can yield a different environmental effect depending on the cutting scheme with which it is used. For example, leaving streamside strips under a clearcutting plan might prevent a larger temperature-increase than under a partial cutting scheme where streams would be fairly well shaded without a streamside strip policy.

However, there are some additive practices, the environmental consequences of which are independent of the mutually exclusive cutting alternative with which they are combined. Such practices can simply be judged separately by a comparison between their private costs and social returns. An example would be the requirement of building simple bridges for moving equipment across streams.

An added decision is to determine the optimum degree of certain

practices such as leaving streamside strips. There is an opportunity for marginal analysis in deciding on an optimum strip width by weighing the opportunity costs of incremental width-increases against resulting increases in social gains. Research studies might be made on these problems, but the inclusion of such analyses in each regulatory decision would over-complicate an already cumbersome framework. Limitations on time, personnel and finances justify emphasizing simplicity in regulatory decisions.

Evaluating Environmental Benefits

In evaluating single environmental conditions as well as packages, decision makers must be aware of the timing and physical amounts of outputs, the number of people affected, and the expected future changes in numbers of people involved.

For many cases of siltation, scenic damage, fish kill and other spill-overs, the effects last for a specific period and are not permanent. Knowing the timing and duration of damages, as well as the rate of recovery therefrom, is essential to meaningful damage evaluation. And for the same reasons, estimates are needed of the numbers of people affected at different points in time.

The information represented by letters in the environmental description columns of Tables 1, 2 and 3 would often require explanations in some detail. For example, stream sediment levels expected

from a given management alternative could include the following types of information:

I. Mean suspended sediment levels November through March, ppm, and Sediment bedload, ft.^{3}/acre.

A_1. At the logging area. A_2. Number and type of users per month.

a) Year of logging; deviation from undisturbed state

b) One year later; deviation from undisturbed.

c) Two years later; deviation from undisturbed.

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B_1. Two miles downstream. B_2 No. & type of users per month.

a) Year of logging; deviation from undisturbed.

b) One year later; deviation from undisturbed.

c) Two years later; deviation from undisturbed.

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C_1. Five miles downstream. C_2 No. & type of users/mo.

a)

b)

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II. Mean suspended sediment levels April through October, ppm.

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Same sub-heading as under I.

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III. Probability of mud-flows and earth slides and consequences thereof; deviation from undisturbed state.

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Various dates.

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Appropriate changes would be made in any other column affected by the practice in question. Under fish, for example, the expected changes in populations of commercial and sport fish catches and species composition could be recorded for various time periods and stream locations. The expected number of anglers at various points in time would also be relevant information.

Descriptions of scenic characteristics should likewise be associated with information on expected vegetative changes as well as use pressures over time.

The Need for State-Wide Planning

The analysis until now has been to make regulatory decisions on separate areas while ignoring the aggregate effects of all regulatory decisions over time. It is important, however, that decision makers be aware of state-wide regulatory trends which might change prices of marketed goods or evaluations of non-market outputs. Consider, for example, many separate decisions to reduce timber output in favor of scenic benefits. This reduction, if large enough, could raise timber prices above those assumed if each decision were treated under ceteris paribus assumptions. Likewise, substantial aggregate increases in outputs such as scenic areas might eventually lower the public's evaluation per scenic acre below that expected from one acre without increased scenic areas elsewhere.

This suggests that some members of local regulatory decision groups have a broad state-wide view of forest output trends. If regions are regulated by strictly local decision groups which assume no changes elsewhere in the state, evaluations of outputs might well be unrealistic. In addition to a state-wide outlook, regulatory boards should also represent major groups affected by management of the areas in question--for example, industries, water users and various recreation interests.

Problems of Administrative Feasibility

The idealistic approach of separate regulatory decisions for each logging area raises the problem that administrative costs will be excessive. However, reducing such costs by setting regulations for broad regions will cause the misallocation costs discussed under "The Need for Flexible Laws".

The trade-off as we move away from separate decisions on each acre is one between reduced administrative costs and increased costs of resource misallocation. Future studies might examine the extent to which this trade-off could be profitably made by society. For example, one might divide the state into several forest regions with common characteristics, and within each, delineate separate zones such as scenic areas bordering highways with given travel intensities, streamside zones, and isolated timber production areas.

In each zone within separate regions, trial study areas could be established to design optimal regulations following this study's decision framework. Research would be needed to refine the approach and to evaluate results of using decision groups of different compositions. Information costs would in part dictate the intensity of regulation and number of regulatory zones. Should it be possible to develop fairly consistent optimal regulations on separate study plots within zones, regulations could then be established for entire zones within each region. In the absence of administration and information costs, each acre would be a separate zone. Future research could yield information useful in determining the optimal number of regulatory zones within each region.

Let it be stressed that the decision guides developed in Chapters VI and VII are not immediately applicable in drafting forest practice laws. They are only useful as a framework for determining optimal regulations on research areas; the results of such studies could provide valuable inputs for future forest regulation efforts. There is, however, much general information throughout the study which could assist policy advisors in formulating forest regulation objectives and in making broad-brush attempts at attaining them today.

VIII. SUMMARY AND RESEARCH NEEDS

One of this study's aims was to present information which would help public decision makers agree upon forest regulation goals and design laws to approach these goals today. A secondary aim of the study was to present a decision framework for designing pilot regulations on study areas. Such research could eventually lead to more refined regulations which could more closely approach public goals than could today's regulation efforts. The objective assumed for lawmakers was to improve as much as possible the net satisfactions to Oregon's citizens from her private forests.

Early in the study, required conditions for the unfettered market to achieve a welfare maximum were reviewed. Following this came an analysis indicating that unregulated forestry practices will leave opportunities for public action to increase net satisfactions, thus suggesting government intervention.

The major obstacles to welfare maximization in forestry without public regulation are externalities and the public good nature of certain forest outputs. If private wood production causes uncompensated damages or fails to produce certain social benefits (the gains from which exceed their production costs), then public action might increase net satisfactions.

Assuming no non-wood forest benefits and no increases in net

secondary benefits from added wood output, the study found no reason to compel private forest owners to increase wood output beyond the level supplied by the free market. Under certain conditions, however, government leasing of private land for wood production could increase net benefits from wood output. Where non-market benefits and undesirable side-effects of logging were important, public intervention appeared to provide a means for increasing net satisfactions.

In attempting to achieve optimal levels of damages, the following guideline was used: If gainers from a regulation could overcompensate losers, its institution would increase welfare. However, who the gainers and losers are was found to depend on whether the liability for damage reduction was placed on the damager or victim. Assuming a non-linear utility function for money, it was noted that the optimal level of non-market damages in a given case will depend on which of the above liability frameworks is chosen. Considering both liability viewpoints, a scheme for trying to determine optimal regeneration requirements was outlined for cases where non-market values are at stake (pages 146-151). Approaches to optimizing levels of external non-market damages from logging were then examined under both liability schemes, considering actions causing changes in single or joint benefits (pages 173-193). The importance of distinguishing between mutually exclusive and additive management practices was illustrated.

If forest practice laws are to be revised and applied in the near future, economic guides for their establishment must be usable now. Thus, highly sophisticated models for which data are not yet available were not considered. When dealing with non-market goods where production functions and values are not well defined, there is little sense in suggesting mathematical models requiring precise quantitative data.

Unfortunately, techniques are not yet available for accurately estimating effects of alternative forest practices on outputs such as water quality, fish, and game. However, intelligent guesses about environmental effects of different actions are possible. The decision guides developed in this study cannot promise a welfare maximum from the private forest resource, but they are the best means available for improving net satisfactions, given current limitations in information.

The study's tabular approach for regulating extra-market forest outputs is rather flexible. Results of using such a scheme on the same area by two different decision makers will most likely differ (even under a given liability assumption). To a large extent the welfare improvement from any given regulatory action depends on the degree to which the public's desires are reflected in the decision makers' actions.

Measurement and prediction problems aside, there would still be difficulties in applying the suggested decision frameworks for regulating

logging and reforestation. To assure flexibility, each proposed harvesting area should be considered separately rather than establishing broad regulations for an entire region. On some areas, such as fragile watersheds or tracts with high scenic value, tentative regulations could be established immediately. But to make the required regulatory analyses on all the state's private forest lands in the near future would be a herculean task. Moreover, the need to adjust regulations to changing circumstances dictates against setting requirements today on an area where harvesting may not be considered for fifty years.

The need for flexibility over time and the lack of funds and personnel to set all regulations immediately, suggest delaying regulatory analyses on many areas until the owner applies for a cutting permit. This, however, raises a problem in that requests for many permits in a short period could cause long delays in determining optimal regulations on some tracts--certainly a costly imposition in cases where timing of harvests may sharply affect profits to a landowner.

The above problem may lead to a scheme whereby landowners would request a tentative set of regulations on areas which they may be harvesting in the next five years or so. With regulations already set on such areas, harvesting permits could be issued on fairly short notice, since changes, if any, in the established regulations would generally be minor.

The problem of uncertainty about the ultimate regulation on

many areas still remains for landowners, however. That may be one of the more difficult things to accept in the flexible approach to regulation adopted here.

Research in applying decision guides for logging regulation could suggest optimal regulation schemes for different types of forest areas. It would be impractical to conduct highly detailed analyses for setting separate regulations on every forest acre.

This study has not aimed at providing one specific decision rule for arriving at a precise answer to any forest regulation problem. It has attempted to point out different approaches to the problem, the implications of each, and has presented frameworks for choosing among alternatives.

Research Needs

One of the immediate needs in determining the workability of decision guides proposed here is to actually apply the approach on several study areas. Analysts for gathering and preparing physical and economic data could be drawn from organizations such as the State Forestry Department, State Universities, and the Game Commission. If several different groups of decision makers independently used the data to arrive at an optimal set of regulations for each study area, the results would probably vary widely. Important questions to answer are: What type of decision making group would best represent the

interests of society? What are various means for registering individual differences in intensity of preference regarding outcomes of resource use alternatives? What would be the costs of determining optimal intervention schemes with the guidelines proposed here and using them at various levels of intensity (i.e., different numbers of practices and outputs considered, sophistication of predictions, etc.)?

If research studies on areas of similar characteristics would tend to suggest the same optimum set of regulations, then forest practice rules could be established for certain types of forest zones without separate analyses for every harvesting area.

The question of the two different approaches to liability for non-market damages and the implications of each should be actively debated among lawyers, legislators, and the public in general. For the case of liability on the damagers, efforts should be made to determine the feasibility of estimating compensation payments victims would require to willingly endure given damages. In many of the issues dealing with environmental quality there may be topics for fruitful cooperative research efforts among economists, sociologists, political scientists and psychologists.

The current study has been concerned only with incidences of costs and benefits within Oregon. How might optimal regulations differ if consideration of these incidences were extended to include the entire United States? To what extent could out-of-state demands

influence Oregon's decisions? How important are logging-induced water quality-changes in rivers flowing from Oregon to other areas? If such a broadening of scope would affect regulatory decisions significantly, what legal and political institutions could be utilized (and in what manner) to extend the decision framework beyond state boundaries?

Zivnuska (1966) has raised the point that considering land use externalities arising from private forestry alone without considering other activities is to ignore the major portion of land management problems. What are the possibilities of, and justifications for, coordinated statewide regulation of all land use, public and private, in Oregon? Market failures due to externalities and public good outputs can result from many forms of land use such as agriculture, and all types of construction.

A great deal more research is needed to improve techniques of predicting changes in water temperature, sedimentation, fish populations and fish catches as a result of various forest management practices. Instituting the forest regulation approach outlined here could provide some of the data useful for solving the above problems, given a detailed recording of treatments and variables before and after treatment on certain study areas. In addition, we should explore more fully the range of mutually exclusive management alternatives and additive practices.

While strictly physical data on environmental variables can be

used in regulation decision models, having dollar values of non-market outputs would greatly simplify decision making and would allow the use of more sophisticated models. Although much work has been done in developing techniques for deriving shadow prices for unmarketed goods, there are still many problems.

Several studies have estimated demand functions for a non-market good by tracing the relationship between the quantity of the good consumed and the indirect expenditures of consumers to gain use of the good (Cicchetti, Seneca and Davidson, 1969, p. 294-304). While such expenditures are related to the good in question there may often be only a weak link between 1) expenditures on travel and equipment needed to consume a given non-market good such as a park visit and 2) the actual utility gained from the good itself. From the indirect expenditures there could be gained many satisfactions not directly related to consuming the extra-market good.

Because of the debate over methods of valuing non-market outputs, and the varying results of different approaches, this study has stated environmental outcomes in physical terms and left decision makers with the evaluation choice. This, however, is not to suggest that monetary valuations of non-market goods ought not be made. Improving techniques for estimating demand functions for such goods is an important need. It is equally important to explore more fully various methods of using such functions to set shadow prices.

Should we choose the monopolists' profit maximizing price or some simulated perfect competition price? To what degree should consumers' surplus be considered--both in valuing non-market goods as well as outputs foregone as a result of supplying non-market goods?

While this study has discussed only a few externality problems in forestry, there are others which deserve study also. For example, consider the effects of forest pesticides and fertilization upon water quality, or effects of cutting practices upon water regimen and game production. There are also problems from unchecked disease and insect infestations as well as from inadequate fire prevention and control. How might one design regulations to achieve optimal levels of damage in the above areas?

Since forestry regulation deals largely with issues of uncertainty, much could be done with stochastic decision models. Although, implicitly, the outcomes of alternative actions entered in this study's models are expected values, more detailed analyses could be developed using probabilities of various outcomes and actually calculating expected values (see, for example, Sadler (1970)).

Although research needs are large, it should be emphasized that much can be done to improve welfare through forest practices regulation even with the imperfect knowledge available today. To postpone greater intervention in forestry while we await more perfect prediction and valuation techniques may be to invite a needless decrease in net satisfactions to Oregon's citizens from her forest lands.

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APPENDIX

APPENDIX

FOREST CONSERVATION ACT (OSFD, 1969a, p. 114-119)

527.010 Oregon Forest Conservation Act. ORS 527.010 to 527.240 and subsection (1) of 527.990 are known as the Oregon Forest Conservation Act.

527.020 Definitions for ORS 527.010 to 527.240 When used in ORS 527.010 to 527.240:

(1) "State Forester" includes the State Forester or his appointed and designated representative.

(2) "Operator" means any person who harvests timber or other forest tree products for commercial purposes, or who causes timber or other forest tree products to be harvested for such purposes.

(3) "Seed tree" unless otherwise used or defined in the context, means a live, healthy, windfirm tree of commercial species and of seed-bearing size, possessing a relatively full crown.

(4) "Adequately restocked", unless otherwise used or defined in the context, means not less than 300 live seedlings or trees per acre established by natural or artificial means sufficiently spaced for individual normal growth and development, and 100 of which are well distributed over the area.

(5) "Douglas fir type" means an area which predominates in Douglas fir.

(6) "Spruce-hemlock type" means an area which predominates in Sitka spruce or western hemlock, or a combination of the two species.

(7) "Ponderosa pine type" means an area which predominates in ponderosa pine, sugar pine or Jeffrey pine, or all of them in combination.

(8) "Lodgepole pine type" means an area which predominates in lodgepole pine.

(9) "Mixed species type" means an area which contains any

combination of two or more of western larch, white fir, alpine fir, grand fir, Douglas fir, Engelmann spruce, lodgepole pine, western white pine, ponderosa pine, sugar pine and occasionally other tree species.

(10) "Hardwood type" means an area which predominates in hardwood species.

(11) "Other forest type" means any area which predominates in a forest species not designated in subsections (5) to (10) of this section.

527.030 Declaration of policy. (1) The preservation of the forest, conservation of forest resources for the equal and guaranteed use of future generations, protection of forest and water resources and the continuous growth of timber on lands suitable therefor are declared to be the public policy of Oregon.

(2) It is recognized that several forest types exist within Oregon and that forest practices may vary according to each forest type. Therefore, in order to accomplish the foregoing purposes, acceptable forest practices are set forth for each forest type in ORS 527.091.

527.040 Harvesting timber for commercial purposes without a permit, or refusing to discontinue such operation after notification, prohibited. No person shall fail or refuse to obtain a permit for the harvesting for commercial purposes of timber or other forest tree products, or continue to conduct a harvesting operation after having received notification from the State Forester to discontinue such operation, as provided by ORS 527.160.

527.050 Cutting timber for commercial use; issuance of harvesting permit. (1) The State Forester may issue permits for the harvesting for commercial purposes of timber or other forest tree products. On and after January 1 of any year, or during any part of the year, it shall be unlawful for any person to harvest or cause to be harvested any timber or other forest tree products for commercial purposes from lands within Oregon without first having obtained a written permit for that year from the State Forester.

(2) No permit shall be issued by the State Forester when he has been notified by the Department of Revenue or county tax collector of the delinquency in the payment of any taxes or assessments on the timber to be harvested, or the delinquency of the operator or timber owner for yield taxes due and owing under ORS 321.315 or timber

severance taxes due and owing from either the operator or owner to the State of Oregon, or the harvesting of forest crops by the operator or owner without the permit required by ORS 321.310; provided that the State Forester may issue such permit after a proper receipt evidencing the payment of all such taxes has been filed with him, and where applicable, evidence also is filed with him of the issuance to the operator or owner of the permit required by ORS 321.310.

527.060 Provisions of harvesting permit. Any permit issued pursuant to ORS 527.050 shall require the operator and landowner to:

(1) Comply with the requirements of ORS 527.010 to 527.240 applicable to the area described in the permit.

(2) Comply with the rules and regulations pertaining to ORS 527.010 to 527.240 as such may be promulgated by the State Forester and approved by the State Board of Forestry.

(3) Take reasonable precautions and action necessary to protect the residual stands of trees and seed source, both prior to and during harvesting operations and the disposal of slashings.

527.070 Harvesting permit to be issued in conjunction with power-driven machinery permit. The harvesting permit referred to in ORS 527.050 shall be issued in conjunction with the permit to operate power-driven machinery required by ORS 477.625, wherever and whenever that section applies.

527.091 Forest practices for each forest type. The harvesting for commercial purposes of timber or other forest tree products of timber or other forest tree products on lands within Oregon shall comply with the following forest practices for each forest type, unless such harvesting is done pursuant to ORS 527.101:

(1) On Douglas fir type areas within a legal quarter section involving one ownership, or each ownership within a legal quarter section:

(a) Trees shall be reserved and left uncut on not less than five percent of the area, such area to be well stocked with commercial coniferous tree species of seed-bearing size; such may be accomplished by reserving and leaving uncut marginal long corners of timber between logged areas, strips of timber along creeks, across valleys, along ridges or natural fire breaks, and staggered settings of timber.

(b) Alternatively to paragraph (a) of this subsection, coniferous seed trees shall be reserved and left uncut, well distributed over the area, in a ratio of not less than two trees per acre; such trees shall be at least 18 inches in diameter breast high outside the bark.

(c) The requirements of paragraph (a) or (b) of this subsection shall be complied with until the area involved is adequately restocked.

(2) On spruce-hemlock type areas within a legal quarter section involving one ownership, or each ownership within a legal quarter section:

(a) Trees shall be reserved and left uncut on not less than five percent of the area, such area to be well stocked with commercial coniferous tree species of seed-bearing size; such may be accomplished by reserving and leaving uncut marginal long corners of timber between logged areas, strips of timber along creeks, across valleys, along ridges or natural fire breaks, and staggered settings of timber.

(b) The requirements of paragraph (a) of this subsection shall be complied with until the area involved is adequately restocked.

(3) On ponderosa pine type areas within a legal 40-acre subdivision involving a single ownership, or each ownership within a legal 40-acre subdivision:

(a) All thrifty, immature ponderosa pine trees 16 inches and less in diameter breast high outside the bark shall be reserved and left uncut.

(b) Where compliance with paragraph (a) of this subsection would not result in leaving at least four ponderosa pine seed trees per acre 16 inches in diameter breast high outside the bark, there shall be reserved and left uncut additional ponderosa pine seed trees larger than 16 inches in diameter breast high outside the bark, in a quantity sufficient to aggregate four seed trees per acre well distributed over the area.

(c) The requirements of paragraphs (a) and (b) shall be complied with at all times; provided, however, that ponderosa pine seed trees, over 16 inches in diameter breast high outside the bark, may be harvested if the area involved is adequately restocked as defined in this paragraph. "Adequately restocked" for the purposes of this paragraph means not less than 300 live ponderosa pine seedlings per acre at least six inches in height, established by natural or artificial means, sufficiently spaced for individual normal growth and development, 100 of

which are well distributed over the area; or means not less than 100 live ponderosa pine seedlings or trees per acre between one and sixteen inches in diameter, established by natural or artificial means, well distributed over the area; or means any combination thereof.

(d) The provisions of this subsection shall not apply to those areas within this type which are determined by the State Forester to be lands unsuitable for the growing of timber; such determination shall be made at the time of application for the permit required by ORS 527.040 and 527.050.

(4) On lodgepole pine type areas within a legal 40-acre subdivision involving a single ownership, or each ownership within a legal 40-acre subdivision, trees shall be reserved and left uncut on not less than five percent of the area; such area shall be well stocked with trees of seed-bearing size.

(5) On mixed species type areas within a legal 40-acre subdivision involving a single ownership, or each ownership within a legal 40-acre subdivision:

(a) All thrifty, immature trees representative of the type, 14 inches and less in diameter breast high outside the bark, shall be reserved and left uncut.

(b) Where compliance with paragraph (a) of this subsection would not result in leaving at least four of such trees per acre, there shall be reserved and left uncut additional seed trees representative of the type, larger than 14 inches in diameter breast high outside the bark, in a quantity sufficient to aggregate four seed trees per acre well distributed over the area.

(6) On hardwood type areas, and other forest type areas, the seed source requirements for such types shall be those determined by the State Forester to be the equivalent of the seed source requirements set forth in subsections (1) to (5) of this section.

527.101 Equivalent or better forest practices. As an alternative to the respective requirements of forest types set forth in ORS 527.091, should an operator or landowner desire to use other equivalent or better forest practices which will accomplish the purposes of ORS 527.010 to 527.240, including but not limited to artificial restocking of the area, and partial or selective cutting of the stand to promote regeneration or to benefit the general health and increase the annual growth per acre of residual stands, such practices may be

used, provided:

(1) That not less than 30 days prior to the commencement of harvesting operations the operator and landowner submit in writing to the State Forester a substitute plan detailing the forest practices desired to be used; and

(2) That prior to the commencement of the harvesting operations such plan has not been disapproved by the State Forester.

527.110 Compliance with ORS 527.091 not required when trees are removed for excepted purposes. ORS 527.091 shall not apply to any lands from which trees are removed for the following purposes:

(1) To clear land for bona fide agricultural, mining, business or residential purposes.

(2) To clear rights of way, landings, camp sites or fire breaks.

527.120 Proceedings to determine whether removal of trees is subject to Oregon Forest Conservation Act. (1) Whenever the State Forester finds that any lands from which trees have been removed are not being used for any excepted purposes, as specified in ORS 527.110, he shall notify the landowner of such findings by serving him personally with written notice or by mailing to him written notice.

(2) The notice shall specify in either case the lands involved and shall state that unless written objections are filed with the State Forester within 30 days the lands shall be reclassified and thereafter be deemed forest lands within the meaning of ORS 527.010 to 527.240 and subject to the provisions thereof.

(3) Should the landowner file objections within this time, the State Forester may, at his discretion, bring a suit in the circuit court of the county where such lands are situated, and the court shall judicially determine whether the lands are within any of the excepted classes or are subject to the provisions of ORS 527.010 to 527.240.

527.140 Examination by State Forester following harvesting operations and issurance of release; subsequent harvesting in released areas to be examined. (1) At least once each year the State Forester shall examine all forest areas upon which timber harvesting operations for commercial purposes have been conducted, or timber cut in accordance with ORS 527.110 and 527.120, in order to determine

whether the operations have been conducted in compliance with the terms and conditions or ORS 527.010 to 527.240. Upon completion of the examination the State Forester shall issue to the operation or landowner found to have conducted the operations in compliance with the terms of ORS 527.010 to 527.240, a release from any penalties and obligations provided for in ORS 527.150 to 527.240.

(2) However, if at any time after the release is issued, additional forest products are harvested for sale from the area released, such harvesting shall again be subject to the privisions of ORS 527.010 to 527.240.

527.150 Notice of violation; contents. Immediately upon the detection of any violation of the provisions of ORS 527.050 to 527.140, the State Forester shall notify the operator and landowner, or their agents, in writing, of his finding that the harvesting operations have not been or are not being conducted in accordance with such provisions, specifying in which respects the operator has been delinquent and directing such steps as he deems necessary to assure future compliance with such provisions with respect to the entire operation.

527.160 When operation to be discontinued; bond to insure restocking; suspension or revocation of permits. (1) If the operator notified as provided in ORS 527.150 fails, neglects or refuses to conform to the practices directed in the notice, or if no appeal has been taken as provided in ORS 527.240 within 30 days after notification, the forester shall order the operation discontinued until the operator or landowner has given satisfactory assurance that he will resume operations in compliance with the provisions of ORS 527.050 to 527.140 and furnish cash deposit or surety bond approved by the forester, in an amount set by him, which shall not exceed $25 per acre for that portion of the area which through failure to carry out such sections does not have sufficient source of seed to restock the area. Such cash deposit or surety bond shall be furnished to insure that the owner or operator will artificially restock the area for which the money was collected within five years of the date of completion of the harvesting operations, which operations include the disposition of slashing as required by law. Moneys furnished under this section shall be paid into the State Treasury and credited to the State Forestry Department Account for the purposes of ORS 527.170 and 527.180.

(2) Upon ordering an operation discontinued, as required by this section, the forester may suspend all permits required by ORS 527.010 to 527.240 and any permit issued to the operator under ORS 477.625 to 477.640 and 477.670; thereafter, if the operator fails to comply with

ORS 527.050 to 527.140, as such compliance is directed by the notice required by ORS 527.150, the forester may revoke any and all permits referred to in this subsection. After revocation of such permits, no further harvesting operation shall be permitted until the area in violation is brought into compliance with ORS 527.010 to 527.240.

527.170 State Forester to restock area, when; maximum expenditure. In the event that at the end of the five-year period specified in ORS 527.160 the operator or landowner has not adequately artificially restocked the area and if it has not become adequately restocked through natural means, the State Forester shall enter upon the lands and take such steps as are necessary to correct the conditions caused by the violation of ORS 527.050 to 527.140. He shall keep full records of the costs incurred. The maximum amount to be expended by him for such purposes is determined at a rate not to exceed an average of $25 per acre for each quarter section or fractional part thereof upon which such correction is necessary.

527.180 Notification of cost of restocking area; forfeit of cash deposit or bond. Upon completion of all steps necessary to repair the damage caused by the violation of ORS 527.050 to 527.140, the State Forester shall notify the delinquent operator or landowner, or his agent, in writing, of the costs incurred. Thereupon the cash deposit shall be forfeited, or so much thereof as the forester has found necessary to correct the conditions caused in the area by the delinquency; or, if a bond has been posted in lieu of a cash deposit, the sureties on the bond shall be liable for all costs incurred hereunder, provided that the operator or landowner has failed, within 30 days under notification in writing by the State Forester, to pay the amount of money for which he has posted bond, or so much thereof as the forester has found necessary to correct the conditions caused in the area by the violation.

527.190 Action by State Forester upon failure of operator to furnish cash deposit or bond after notification of violation. (1) In the event that any operator or landowner, upon notification by the State Forester of a violation of ORS 527.050 to 527.140, fails, neglects or refuses to furnish cash deposit, or bonds in lieu thereof, the State Forester shall, within 90 days after said event, file a certified copy of the notice of violation as of record with the county clerk or other recorder of deeds in every county in which any part of the premises lies. Such notice shall contain the names of the parties, the nature of the violation, a description of the real property in the county involved, affected or brought into question thereby, and the amount of the lien which may be claimed. From the time of filing such notice,

and such time only, the violation shall be notice to purchasers and encumbrancers of the rights and equities of the State of Oregon in and to the premises. Such notice shall be recorded in the same book and in the same manner in which mortgages are recorded and shall be discharged by the forester in a like manner as mortgages are discharged.

(2) As soon as is practicable, and in no event later than five years after the date of filing the notice of violation, the forester shall enter upon the lands and take such steps as are necessary to correct the conditions caused by the violation of such sections. The maximum amount to be expended by him for such purposes is determined at a rate not to exceed an average of $25 per acre for each quarter section or fractional part thereof upon which such correction is necessary.

527.200 Costs incurred pursuant to ORS 527.190 to be a lien on the land and a debt of the operator. Upon the completion of all steps taken pursuant to ORS 527.190 which were necessary to repair the damage caused by the violation, the forester shall notify the delinquent operator or landowner in writing of the costs incurred. Thereupon the total of the amount shall become a lien against the lands upon which the costs were incurred and a debt or obligation of the operator or landowner due the State of Oregon. The debt or obligation shall be collectible in any action brought for that purpose by the Attorney General in the name of the state. A written statement and notice of such lien, describing the land and stating the itemized amount of said cost shall be certified under oath by the forester and filed in the offices of the county clerk of the county in which the land is situated within 90 days following the completion of the repair of damage. Such lien shall be recorded in the same book and in the same manner in which mortgages are recorded, and shall be discharged by the forester in a like manner as mortgages are discharged. No lien provided for in this section shall bind the land for a longer period than one year after the same shall have been filed, unless suit be brought in a proper court within that time to enforce the same. Suits to enforce the liens created by this section shall be brought in the circuit court, and the pleadings, process, practice and other proceedings shall be, as nearly as possible, made to conform to the proceedings of a foreclosure of a mortgage lien upon real property. In all suits under this section, the court shall, upon entering the judgment for the plaintiff, allow as part of the costs all moneys paid for the filing and recording of the lien, and also a reasonable amount as attorney's fees. The remedies herein prescribed are not exclusive, and the state, in its own name, may have any other civil remedies provided by law to insure compliance with ORS 527.010 to 527.240, except that no injunctive relief shall be granted against any operator unless he has been notified by the State

Forester, in writing, of a delinquency at least 30 days immediately prior to the date of application therefor.

527.215 Operation to be discontinued when certain taxes are not paid. Immediately upon becoming informed of the delinquency in the payment of any taxes on timber being harvested pursuant to ORS 527.010 to 527.240, or the delinquency of the operator or timber owner for timber severance taxes due to the State of Oregon or yield taxes due under ORS 321.315, or of the harvesting of forest crops by the operator or owner without the permit required by ORS 321.310, the Department of Revenue shall notify the operator and timber owner or their agents in writing of such delinquency or absence of such permit. If such taxes are not paid in full within 10 days after such notification, and a receipt therefor filed with the Department of Revenue, or if such permit is not obtained within such 10-day period, the Department of Revenue shall notify the State Forester, who shall order the operation discontinued until such taxes have been paid in full and receipt, therefor filed with him and, where applicable, until evidence also is filed with him of the issuance of the permit to the operator or owner.

527.220 Administration and enforcement of Oregon Forest Conservation Act; duty and powers of State Forester. The forester, acting under the authority and direction of the board, is charged with the administration and enforcement of ORS 527.010 to 527.240 and may exercise all powers necessary or convenient. He may perform all duties imposed upon him by such sections and employ sufficient personnel to assure compliance with them, including assistance to applicants in formulating necessary harvesting plans. The foregoing powers are in addition to all others conferred upon him by statute.

527.230 Findings or oders of State Forester; appeal. Any findings or orders made by the State Forester pursuant to the duties imposed upon him by ORS 527.010 to 527.240 are final unless modified or vacated in an appeal taken within 30 days after the issuance of such finding or order in the manner provided in ORS 527.240.

527.240 Appeal from findings or orders of forester. Any person affected by any finding or order of the State Forester under the terms and provisions of ORS 527.010 to 527.240 may appeal to the State Board of Forestry under such rules as it may prescribe. An appeal from any decision of the board under such sections may be taken by any person affected by such decision. The appeal shall be taken to the circuit court of the county in which the land or any part thereof affected by the decision is located and must be taken within 30

days from the date of the decision by the State Board of Forestry.

527.260 Injuring forest tree of another or extracting pitch without, or in violation of, a permit prohibited; permit to extract pitch. (1) No person shall willfully and unlawfully:

(a) Bore or cut any forest tree belonging to another for the purpose of extracting pitch;

(b) Cut, injure or deface any such tree for the purpose of taking any part of it; or

(c) Injure or destroy any such tree.

(2) The State Forester, with the consent of the owner of the land, shall issue permits for the extraction of pitch from forest trees. The terms of the permits shall clearly describe the area to which the extraction shall be confined and state the precautions necessary, in the judgment of the State Forester, to be taken by the permittee, so that the extraction will not result in an increased fire hazard to life and adjoining property.

(3) No person shall:

(a) Bore or cut any forest tree for the purpose of extracting pitch without having first obtained a permit to do so; or

(b) Wilfully or negligently fail to comply with the terms of the permit.