Most economists advocate full compensation for natural resource use and for personal injury. The intent of these positions is to assure proper resource allocation and equity. However, this advocacy often neglects non-market resources and perspectives of future generations. This neglect is compounded by the separation of legal process and economic analysis. As a consequence, many economists fail to understand how incomplete compensation is and lawyers frequently find economic analysis too naive and obscure to be useful. In this report economic and legal theories are described, contrasted, and integrated in a pragmatic conceptual framework. Causes of inadequate compensation are defined using a case-study methodology. Two types of case studies are presented. The first summarizes the published record of compensation for privately induced damage to natural environments; the second presents the results of an original survey on mitigation to environmental impacts of contested water projects. Compensation in both cases is inadequate, in terms of equity and eliminating externalities, because of biased institutional factors. To make compensation more adequate, changes in property rights, liability rules, and insurance are suggested in combination with enhanced public trust doctrine.
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ABSTRACT

Most economists advocate full compensation for natural resource use and for personal injury. The intent of these positions is to assure proper resource allocation and equity. However, this advocacy often neglects non-market resources and perspectives of future generations. This neglect is compounded by the separation of legal process and economic analysis. As a consequence, many economists fail to understand how incomplete compensation is and lawyers frequently find economic analysis too naive and obscure to be useful. In this report economic and legal theories are described, contrasted, and integrated in a pragmatic conceptual framework. Causes of inadequate compensation are defined using a case-study methodology. Two types of case studies are presented. The first summarizes the published record of compensation for privately induced damage to natural environments; the second presents the results of an original survey on mitigation to environmental impacts of contested water projects. Compensation in both cases is inadequate, in terms of equity and eliminating externalities, because of biased institutional factors. To make compensation more adequate, changes in property rights, liability rules, and insurance are suggested in combination with enhanced public trust doctrine.
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INTRODUCTION

Compensation to victims of environmental degradation and personal injury is a necessary tool in the proper management of natural resources as well as a desirable mechanism for obtaining equity. It is also a positive stimulus for institutional change.

If compensation were properly applied, the legitimate functions of correcting externalities and guiding social reform would be accomplished. Proper application of compensation criteria would require a more detailed specification of the privileges and responsibilities of property and liability for the state with regard to the individual, relaxing the barriers to compensatory relief, and insuring against an uncertain future.

The utility of compensation as a management mechanism lies in the fact-finding process required for reasoned compensation. Fact-finding clarifies biological, physical, economic, and social relationships; it highlights alternatives to the status quo. Economic factors must be described, identified, and evaluated. Legal inquiry uncovers the historical roots of a current dilemma and, as conflicts are resolved, provides a rational framework for incorporating new social values.

While ostensibly acting as a mechanism of equitable distribution of costs and benefits, the payment of compensatory and punitive damages is also a powerful incentive to use or develop more benign processes and procedures and as a price signal to consumers. That compensation for known damages is unavailable is a powerful message that informs victims to change their activity or location as a means of mitigation or avoidance.

Compensation is the outcome of a sequence of fact-finding, decision making, and implementation that, in turn, becomes a precedent for the resolution of subsequent conflicts. This interactive sequence includes the following legal steps:

1. Establish ownership
2. Identify cause of confiscation, infringement, damage or destruction
3. Establish liability
4. Estimate damages and punitive relief
5. Select a combination of award, mitigation, and injunctive relief
6. Collect and distribute cash awards and otherwise enforce the settlement.

These steps are taken as emerging rights are captured, inactive rights are reasserted, certified, abandoned, or claimed by others; and as political and judicial entities reapportion rights. For compensation to work, these necessary legal steps also require economic understanding and analysis. The natural coalescence of legal and economic theory and the close cooperation of lawyers and economists have not been fully achieved.

Economists often view litigation as a costly process of income redistribution that has implications for equity but not for efficiency. They do
not acknowledge the roles of compensation in controlling and modifying behavior or in providing a bridge between short-run decision making and long-term achievement of social goals. Despite the indifference of economists toward compensatory outcomes, they trust the legal process to correct failures of the free market system. Lawyers, in turn, presume that liability and property rules are determinants of justice but not of economic efficiency.

Recent attempts at integrating property and tort law, especially the work of Calabresi and Melamed (1972) and Rogers (1982), have demonstrated the utility of a more unified approach to current problems of resources management. Other economists and lawyers have contributed toward bringing economics to bear on law. Much of this effort follows the approach by Posner (1972a, 1972b, 1973) and Hirsch (1979) of applying microeconomic theory to legal rule design. This literature tests existing law against efficiency criteria and suggests whether proposed laws are compatible with the free enterprise paradigm. A second theme uses microeconomic theory and econometrics to test the effect of law.

This report builds on those themes by suggesting the institutions and procedures that are most effective in providing compensation and complementing the desirable aspects of the free enterprise system. In this context, the act and the process of compensation are both important. The act of compensation is interpreted broadly as making amends, including: (1) return of "taken" property, (2) replacement of "taken" property with equivalent property, and (3) replacement of the value of "taken" property.

A successful process of compensation redresses the wrong to the rightful owner(s) of the property and deters further taking from that owner or from others by eliminating the prospect of profits.

This compensation inquiry has important applications inside and outside the neoclassical equilibrium analysis. It explores whether neoclassical theory is an adequate tool for explaining environmental and resource conservation issues, and it tests whether the current level of compensation is adequate to control externalities. It goes beyond traditional principles of profit maximization by accepting legal outcome as a valid reflection of social reform and by making a best effort at merging legal and economic principles.

The Ciriacy-Wantrup three-layer hierarchy of decision making is especially suited to this evaluation because economic analysis can be integrated with legal issues. Fundamental to the thesis are the three interconnected layers of decision making posited by Ciriacy-Wantrup and Bishop (1975):

On the first or lowest level, decision making relates to the determination of inputs, outputs, and the host of similar decisions made by the public operating sectors of the economy, individuals, firms, industries and agencies such as water projects and irrigation districts. This level of decision systems may be called the "operating level." The decisions system on the next higher level comprise the institutional regulation of decision making on the first level. One may call this level of decision systems the "institutional level." On the third level changes in institutions
on the second level are the subject of decision making. This level of decision systems may be called the "policy level."

Certain features of the Ciriacy-Wantrup theory make it especially informative in the coordination of legal and economic policy. The free enterprise paradigm is accepted, but unlike common economic analysis, that paradigm is not the be-all or end-all. Instead, free enterprise is an element of an economic system that is controllable by public decision making. The expanded approach presented here not only recognizes the value of revealed preference by the individual in the marketplace of products, but it also recognizes the value of revealed preference in the marketplace of politics.

Decisions on each of Ciriacy-Wantrup's three decision making levels can be analyzed with respect to structure, function, and performance. In fact, for each layer to contribute to the overall efficiency of decision making, it must maintain its identifiable structure, its fairly independent function, and its particular performance criteria.

Measures of economic efficiency—a fundamental issue at the operating level—are predicted on the institutions and policies of the higher levels. The common idea of property has as much to do with the institutions that dictate the permanence and responsibility of property use as it does the notion of tangible physical objects. Performance at the operating level in terms of profit and utility maximization is a judgment of internal consistency with tacit acceptance of the second-level institutional rules, including property rights and liability rules. The fundamental question of operating level analysis is whether the society is making the best of resource use under the institutional circumstances. Conditions that are efficient under one set of institutions may be inefficient under another.

In this analytical framework, it would be improper to judge second-level institutions on only first-level criteria. Institutions serve more than efficiency goals and cannot be expected to function perfectly or instantaneously when the economy is in flux. During periods when producers and consumers adjust to new institutions and policies, it is important to select new measures that correctly track the shift to the new equilibrium. This transition in criteria is necessary because the economy may have been efficient under the old institutions but unsatisfactory on another basis. The new institutions invalidate the old equilibrium and require changes in resource allocation to establish the new order.

This does not mean that economic analysis is deterministic. Choices of institutions determine the extent and incidence of externalities generated at the consumer and producer operating level. Property arrangements determine which costs are borne by the initiator. With permissive institutions, economic analysis must extend the calculation to extra-market values to be comprehensive. Under conditions of protective institution, however, analysis can be less involved in extra-market values because part of the externalities will have been "internalized". The intent of such institutions is to force the initiator to consider more of the costs.

All economic systems require institutions to enforce and guide operating level decisions. Property and liability rules are the result of initial choices of entitlement. But the initial choices of entitlement might have
been made without an understanding of their consequences. New technology or circumstance may change the consequences; for example, large nuclear power plants may create substantial concern over potential danger to human life and make customers dependent on the reliability of a single machine. Societal values may change in other cases. Often, the institutional arrangements created to judge what the entitlements were and to decide whether steps should be taken to redress any subsequent imbalance are legal in character. Compensation is part of the institutional process of enforcing, reinforcing, or altering operating decisions.

On the operating level, questions of business and consumer efficiency are left to personal and managerial choice, thus preserving diversity of initiative in the private sector. Managers of public enterprise are also expected to apply a similar economic rationale to achieve their goals. Decisions that are presumed to be based on self-interest are made within the existing legal structure, but on economic terms. Self-interest is expected and is not immediately controlled so long as it is legal. This does not mean that all behavior that is legal is condoned. Folkways and social norms are taught and enforced through social sanctions not requiring the force of law.

Decisions made at the operating level can have general and pervasive antisocial external effects until the institutional level responds and re-establishes social preference. Microeconomic efficiency criteria are restricted to the first level, thus permitting problems that confound operating level analysis to be handled at the institutional and policy levels. Wildavsky (1976) explains that conservationists may have a different rationality that regards the utilitarian demands advocated by economists as irrational.

At the institutional level, the most important measure of performance is whether the institutional actors maintain and increase welfare by continuously influencing decision making on the lower level as conditions there change due to the normal dynamics of a market economy (Ciriacy-Wantrup 1967, 1968, 1971). The task of institutional-level science is to understand how changes in the structure and performance of institutions lead to observed results of the first level. Criteria at this level can include equity consideration of politically identified disadvantaged groups, not just the welfare of the aggregate or advantaged minorities. Adjustments are made at the second level when economic behavior does not produce individual and social goals or when third-level policies have reordered social priorities.

At the second or institutional level, law dominates in articulating judicial mandates and in constructing decision rules that evoke desirable behavior at the first level. Economics advises that institutional design that assures the desirable response by independent decision-making producers and consumers at the operating level.

Another measure of performance at the institutional level of the hierarchy is whether the set of institutional arrangements gives the "best" allocation of a particular good consistent with other performance criteria for that level, balanced against other goods affected by those institutions (Strotz 1958). For example, tax incentives for energy conservation can be
judged on a basis of cost effectiveness and can be balanced against concern for equity among income classes. One criterion of acceptability might be a tax design that did not worsen income distribution and that encouraged improvements in building energy performance.

Thus the logic of the economic system expects decisions driven by individually economic purposes to be "connected" at the institutional level that functions to weigh the societal effects on the basis of the values articulated at the policy level. Institutional choices, then, are made to reflect those standards obtainable from policy decisions that recognize improvements in actual conditions rather than attainment of a hypothetical optimum. Thus we should expect that performance criteria at the second level will be from outside the economic literature. The beauty of the Ciriacy-Wantrup theory is that, by recognizing different strengths and limits, law and economics can work together to solve problems according to political preference.

The three-level approach avoids the problem of diluting the neutrality of economic "science", clearly exposes the basis of evaluating the performance of the economy, and allows evaluation of proposed changes in institutions on the basis of previously identified deficiencies. The extension of economic analysis remains objective, and its recommendations are best characterized as prescriptive: rooted in economic science, based on uninterrupted policy motive, and designed as a corrective measure. The more conservative view is that economic analysis be conducted without attention to the framework in which it will be used (Mishan 1982).

On the policy level, institutions designed to support efficiency and distributional equity are necessarily checked for conformity with expressions of our national will as contained in documents such as the Constitution and subsequent judicial interpretations.

Adjustments at this policy level correct or establish institutions that will cause operating decisions to tend toward reform. Examples include constitutional amendments; national legislation, such as the Voter Rights Act and the National Environmental Policy Act; and administrative changes, such as enforcement of civil rights or increased punishment of crimes against women.

Fundamental policy-level decisions ripple down through the institutional level to individual decision making at the operating level. Policy-level decisions are subject to the least economic analysis because they are recognized as the basis of political organization, democracy, and social evolution; therefore, they are more important than temporary inconvenience or inefficiency.

Compensation fits into this three-layer decision framework as an incentive mechanism of feedback and control. The desire to avoid liability controls undesirable activity. The access to relief from harm provided at the institutional level increases the incentive to expose the social costs attendant to production and consumption decisions. When pervasive new conflicts emerge revealing the inadequacy of prevailing institutional arrangements, it is evidence that the second-level institutions need reform.
This report is divided into seven major sections. In section I the economic justification for compensation as a tool of natural resource policy is developed.

Section II reexamines the history of economic thought with an emphasis on the legal origins of property. It shows that important property rights that have adversely influenced natural resource use are the result of judicial decisions that did not anticipate the consequences. Economists have accepted these judicial choices as though they were natural outcomes of social evolution that are now unchangeable.

Section III reviews social economics and the concept of externalities. The conventional view is broadened by acknowledging weaknesses in economic theory and by identifying major misapplications of theory to practical problems.

Section IV presents legal theories of compensation and merges them with the economic perspective.

In section V, current limits to adequate compensation are defined as an organizing basis for the case studies. Numerous barriers to this important mechanism of market control are identified.

In section VI, two case studies are presented. The first case study organizes published reports of compensation by private business for damage to the environment. Only selected damage was concluded to be eligible for compensation and most compensation payments to be based on underestimated costs. The second case study presents the results of an original survey of mitigation and compensation measures taken to prevent environmental damage in major water projects that were contested legally by environmentalists. Here too we find that compensation was considered for only a selected portion of total damage and that actual correction was minimal.

Section VII completes the institutional analysis and makes recommendations for reform.
I. ECONOMIC JUSTIFICATION FOR COMPENSATION

COMPENSATION AS A RESOURCE POLICY TOOL

Compensation is an economically justified measure to correct profit-oriented or consumption activities that are harmful. Compensation functions differently at operating and at institutional levels. In both applications, however, the private market gains support in the form of more accurate price signals, competitive equalization, assurance of long-term resources to exploit, and greater economic efficiency.

Recovery of damages has two important functions. First, recovery is legally justified whenever one person wrongfully destroys or injures the property of another. Second, recovery is justified to insure economic efficiency and democratic control of the economy. For example, when the damaged party is the state, the recovery is necessary to restore the common wealth of the public and to avoid harm to taxpayers who otherwise must pay for remedial actions. For example, a toxic spill may result in the public cost of permanent abandonment of a site plus the public cost of necessary cleanup. In some cases governments have compensated victims or have provided financial assistance resembling disaster relief loans. Social welfare is enhanced because activities with benefits that do not exceed costs when external damages are included are either not attempted or are modified to provide positive net benefit. The flow of money from perpetrator to victim maintains the feedback loop and provides a continuing incentive to mitigate or eliminate harmful activity. This is an element of democratic control.

Damages are awarded in two forms: compensatory and punitive. Compensatory damages are intended to repay the victim for injuries. Punitive damages are awarded to demonstrate social outrage at the perpetrators' conduct. Punitive damages deter similar conduct, just as criminal sanction is a deterrent. The social measure of desirability is enforced by establishing rules that cause private decision makers to further the public purpose while pursuing their own best—though constrained—interest.

When compensation is paid, the victims have their economic well-being restored to the previous level while the perpetrators' well-being is reduced. Because individuals and groups have different values, risk aversions, and decision rules, the resource allocation will reinforce democracy.

In those operating-level relationships between producers and laborers, the question of compensation is whether or not payments must be made for loss of health or life from dangerous job conditions. In the operating-level decisions between producers that cause damage, the questions of compensation includes breach of contract and externalities in production and marketing.

At the institutional interface, the question of compensation is whether private decisions are tending toward irreversible destruction of sustainable resources and whether stock resources are consumed at regrettable rates. The institutional analysis is directed at determining whether one allocation or entitlements over another results in improved operating level efficiency and whether a change in institutions would better allocate resources between
current and future use (Ciriacy-Wantrup 1968, p. 51).

Rules that have been established to reflect social goals and guide private decisions are called public policy. Property is an important element of public policy resulting in decentralized control because ownership allows individuals to seek out their own interest.

Compensation is corrective because rights are restored, but it is also guiding because anticipation of compensating obligations changes behavior and encourages the purchase of insurance. Similar to any other cost, these price signals guide decisions.

Without compensation, free enterprise would be at a serious disadvantage. Private profit-maximizing rules would encourage production that avoided costs. The cumulative effect of the numerous producer and consumer externalities would be to reduce the general standard of living. The ultimate choice of the products from economic enterprise is correctly made only when customers face the price that reflect all the costs of production, including externalities. Compensation can be viewed as part of the incentive process that is consistent with preservation of competition and consumer sovereignty. Institutional incentives, compulsions, arrangements and penalties play a similar role to "the invisible hand" of competition. Anderson et al. (1977) and Randall (1972) provide excellent general views of economic incentives for environmental improvement.

Compensation bridges the gap between short accounting and planning periods and long-term productivity. In a market economy, prices reflect the economic situation as it is and not as it will be. These prices are more accurate in coordinating production decisions that are immediately implemented than they are for coordinating investment, resource use and worker health and safety decisions, which have consequences that will not be realized until much later.

This intertemporal control is accomplished through mechanisms of insurance, bonds, capital accumulation, and by voluntary and involuntary controls on decisions. These institutional controls support private economic planning.

Compensation is thus critical in the economic control system to (1) avoid conversion of natural resources into less valuable products and wastes, (2) avoid productivity-reducing actions that are not offset by economic advantage, (3) enforce consideration of health and life, (4) control natural resources for sustainable yield, and (5) direct investment toward best advantage.

WHY OWNERSHIP AND CONTROL OF RESOURCES AFFECT USE

The initial decision to use resources and the ability to secure compensation are important to the quality and character of life. It is therefore important to determine what effect resource ownership and control has on resource decisions.
In general, economists have simplified their analyses of natural resource allocation by assuming that all people have the same goals and therefore make the same decisions in similar circumstances. It is often assumed, for example, that whoever has the rights to productive resources will use them to maximize profits and that there is one best way to accomplish that goal. Because use is the same under any ownership, it is argued, efficiency is the same.

When actual resource conflicts are studied, however, we find that many conflicts are over aspects other than who gets the profits. Moral, ethical, religious, and cultural differences are all important, such as the following examples.

Many environmental disputes are over use rather than user. For example, should a river be dammed for electricity production or left in recreational use? There may be little profit to be made from use as a free flowing river compared to the profits of construction and electricity sale. Individuals and groups who share the rights to the river disagree.

Other disputes are over users. For example, should a recreation area have controlled access to preserve solitude or should uncontrolled access permit more crowded experiences, but for more people and perhaps at greater private profit?

Still other disputes involve preservation. For example, the effort to prohibit whaling is not due to questions of who should get the profit, rather it is over the morality of killing whales and, consequently, the extinction of a species. The more general controversy over wilderness and ecosystem preservation is not always a conflict over two financially profitable uses. Frequently the choice is between using those resources for profit or allowing them to continue to provide their value in the natural state.

In cases of public health and safety the issue is often over whether the profit to the owners and the workers is justified in light of the "cost" of medical expenditures and the "cost" of lost comfort and life.

Major conflicts also occur when the most profitable activity of one firm decreases the profitability of other enterprises.

When goals are not the same, resource use depends primarily on who owns or controls property. When goals are similar, however, there is still substantial divergence in how the resources are used. Religious, cultural, ethical, and philosophical tenets may dictate certain practices while prohibiting others. Even among the most like-minded decision makers, the choices will depend on preference, risk aversion, and whim. Differences in information alone can result in drastically different resource use.

BEHAVIORAL THEORY OF DECISION MAKERS

Even within private business enterprises and their public counterparts who provide similar products and services, the quest for profit is not pure.
Special interests and dominant philosophies detract from the profit goal, perhaps with desirable results—certainly with different results than profit maximizing alone.

When decision makers do not maximize profit, the institutions that are designed to complement financial self-interest are ineffective. This is important to resource allocation and therefore to negotiation; mitigation, strict prohibition, and compensation are more than questions of equity.

Agencies such as the U.S. Army Corps of Engineers and the U.S. Department of the Interior Bureau of Reclamation are not profit maximizers; however, they have a vested organizational interest in constructing water projects. Ostrom (1975) discusses how the structure of property rights and the organization of water resource agencies has led to over-investment and disregard for certain resources. These agencies reluctantly embrace benefit/cost analysis and defend practices, such as low discount rates, that distort the real national advantage of projects. In some cases they advocate construction even when their own analyses acknowledge the economic folly of doing so.¹ The judicial evolution of economic accountability for water projects is well chronicled by Liroff (1976, 1980, 1982), Anderson (1973), Rogers (1977), Rosen (1977), and Randolph and Ortolano (1975, 1976). The role of private litigation in environmental quality is discussed by the Council for Environmental Quality (1970), Krier (1971), and Lutz and McCaffrey (1971).

Preference for approval of construction projects is a powerful incentive to limiting the costs of mitigating environmental damage and compensation paid to individuals and groups whose interests are harmed by the project because increased expenditures make the lack of economic advantage obvious. Until the late 1930s, federal construction projects were analyzed only casually. In 1936 the U.S. Flood Control Act required financial benefit/cost comparisons for water resources projects. This was codified in a report from the Federal Interagency River Basin Committee that became known as the "Green Book" (U.S. Interagency Committee on Water Resources 1958). The initial acceptance of standard financial evaluation procedures in project planning eliminated the most wasteful projects, but embodied substantial bias that favored construction.

The influence of economics in project planning after 1950 spread first to other construction projects, such as highways, and then to purchasing and spending decisions in military and civilian branches. From there it influenced nonconstruction spending; and beginning the late 1960s, it was extended to pollution control. Until the 1960s, federal analysis used interest rates too low to reflect the value of alternate investment and excluded estimates of opportunity cost, environmental effects, and social impacts. The National Environmental Policy Act of 1969 and associated litigation by environmental public groups vastly expanded the scope of the analysis and established a format for incorporating evaluation of social impacts.

Finally, it is important to remember that existing property and liability rules benefit particular interests. Even if these groups did not inappropriately influence the initial assignment of those rights, they may now understand their advantage and be powerful advocates of the status quo. Direct distributional motives to preserve or increase wealth at the expense of others may lie behind arguments for the right to pollute, the right to mineral discovered on federal and state lands, the right to use water at only the cost of subsidized delivery and the countless other issues that set the stage for environmental disputes. The selection and advocacy of concepts, such as the Pareto optimality, narrow benefit/cost analysis, low discount rates, statutes of limitation, and burden of proof, should be closely scrutinized.
II. PROPERTY RIGHTS

Property rights evoke a potpourri of human emotions, from abstract concepts of liberty and freedom to beliefs about specific actions. Property is important because the rules that specify how persons may conduct their lives to the harm or benefit of others also specify who must pay whom to modify or take exception to the system of rights. These rights are often the crux of important disputes. Advocates tend to view them as unilateral imperatives, while the sociopolitical system uses property rights to serve a multiple purpose by (1) protecting the status quo of wealth and social stability; (2) specifying the conditions under which one's property might be used; and (3) protecting against resource uses that would result in unacceptable externalities.

This unique juxtaposition of economic, legal, and political concerns is a natural starting point for our analysis. Economic and legal concepts of the origin of property are merged in this section. The concept of private property in the United States is the result of independent decisions, international politics, war, legal decisions, and many other small historical incidents. At several junctures single judicial decisions had a critical influence on property relationships that we now take for granted.

Values have changed with time and the economic system has not always been able to adapt markets to make them consistent with new values. In the nineteenth century, it was accepted that resource development was to be facilitated because it supported the common good. Today, externalities may, in many cases, equal or exceed benefits of development. This is partly because more is known about the effects of development and economic activity, but also because recreation, solitude, and beauty are now valued more than they were in the past.

SOCIAL ORIGINS OF PROPERTY

Private property was originally an extension of a person's quest for survival. Food, shelter, and fuel were maintained only for immediate use. Possession of the products of human toil preceded ownership of the means of production. The life of the peasant was sedentary, and his few possessions were so critical to survival that they were considered as productive heirlooms never to be sold. For example, the Middle English word, heir lome, referred to utensils and tools.

Land and capital served as the basis of civil administration but were not for sale. Elaborate civilizations (e.g., Egypt) developed without major markets or economic surpluses, the controlling forces being tradition and religion.

Before the nineteenth century in Western culture, feudalism, manorialism, the stationary-field-grass system, certain forms of the three-field systems and other social institutions restricted the freedom of the private property use for community advantage (Ciriacy-Wantrup 1938). Under circumstances of subsistence and expensive transportation, land control such as
the grazing commons developed.

Private property in common law was the exclusive holding of physical objects for one's own use. Without land ownership, labor exploitation, and industrial technology, property did not add much to the owner's commands, persuasions, or coercions. These strengths were primarily dependent on the relative strength of the manual, mental, and managerial faculties of individuals. Inequities did not spring from the ownership of property but from the difference in personal faculties or from privileges granted by a sovereign. Rogers (1982, p. 211) believes that this rights-oriented, biologically justified property theory is the basis of a comprehensive taking theory.

In the nineteenth century, trade, slavery, industrialization, new patented technology, and unequal access to information created an opportunity to achieve wealth beyond that earned by personal faculty—even in the absence of sovereign (state) grant. Organizers of monopoly enterprise do not need state authority to capture a surplus when the monopoly owes its existence to production efficiency or dominance of input or product markets. Excess profits are also made by shunning family, community, ethnic, religious, cultural, and other belief systems that otherwise have the effect of constraining individual actions for the benefit of the group. For a variety of reasons and with passive agreement, institutional restrictions on private land use were rapidly relaxed.

Farm communities that were once self-sufficient gradually yielded to the developing technology of transportation, which allowed farmers to serve distant markets. Resource utilization that had been closely regulated by social institutions and customs was incompatible with the new dependence on price fluctuations, tax, credit, and immigration. Early agricultural tenants were entrusted not to deplete soil productivity. As this social norm deteriorated, landlords first demanded payment for damages and later expected deterioration in the absence of positive incentives for good management.

Land came to be viewed as a capital investment that could be used, depreciated, or maintained in any way the owner found profitable. Businesses chose their own future and caused social institutions, including the courts, to accommodate their structure. The changes relied on functionaries who were sympathetic or devoted to progress and who cooperated in prescribed ways at certain junctures. A coordinated effort was not necessary. The prevailing belief in progress furnished the means for bringing law and society in line with the new business order. These critical changes in law and policy preceded any general knowledge of their consequences. The public accepted the accommodating institutions as they lost track of the advantage of the initial institutional protection (Winner 1977).

In the American colonies and contested territories, the European institutions protecting natural resources had never been implemented. Capitalistic exploitation of land and labor was subject to few institutional restrictions. There was occasional pressure to devise proper agricultural resource management institutions, but there was also overwhelming pressure from the population to accommodate progress. Private property was important to the settlers, and there seemed to be plenty of opportunity for everyone. Government regulation was often not welcome.
Thorstine Veblen first suggested that law and economic principles are derived from evolutionary responses to habits and customs of social life. This evolutionary process can proceed in a stepwise fashion when the consequences of resource use are immediate. With quick feedback, minor adjustments can be made to perfect the operating rules that influence private behavior. However, when the consequences are not realized until long after the resource-use decision, the legal evolution is characterized by more drastic redefinition and, therefore, more controversial changes in wealth expectations. For example, the Clean Air and Water Acts of the early 1970s were much stronger than earlier regulations.

In the United States, the government serves as an instrumental means through which individuals and businesses attempt to carry out activities; in fact, the government is itself an important property owner and developer. Investors move quickly to capture the immediate profits of a new endeavor and to get out of the investment as it sours. It is a social trap when the projected advantages of change lure business into an aggregate course of action that is possibly irreversible and ultimately harmful to society. This is why surges in political and legal reform have characterized natural resource policy.

Demsetz (1967) describes the intervening adjustment in property rights as a gradual and not necessarily conscious endeavor to cope with new externality problems. The status quo is maintained to secure the expectations necessary to encourage the proper level of investment. These changes are noticed in social mores and common law precedents developed in response to a particular contested issue.

An important but subtle distinction exists between the constructive interpretation of property rights adjustment and the defensive interpretation of "taking away rights." The constructive view was articulated seven decades ago in the Stettler v. O'Hara decision:

When new conditions arise which injuriously affect the health or morals or welfare of the public, we no longer say that we will expand the police power to reach and remedy the evil. Instead we say that a new evil has arisen which an old principle of government--the police power--will correct.

This perspective recognizes the principle of government as national manager and implicitly recognizes property as a bundle of shared rights. Property is acknowledged to include the expected restraint or compulsion placed on owners to act in the behalf of others.

2. This section follows the approach of Commons in examining court decisions to trace the evolution of economic concepts. The exceptional scholarship of William Rogers is used to describe the current state of the law of property.
3. 69 Ore. 519, 532 (1914).
When individuals and firms accept the preexisting social norms, they are unaware of how much their behavior is modified. When a social norm is violated, sanctions are imposed on the violator who is being controlled and regulated. When the conflict is between private and public property rights owners, the private party that refuses to acknowledge the public ownership may think that a regulation is preventing a property use instead of understanding that the constraint is enforcing and existing use by other rights owners.

LEGAL FOUNDATIONS OF PROPERTY

The common-law meaning of "property" referred only to the value of physical things held exclusively for one's own use (Black 1979, p. 1095). Under this definition, property was exchanged at a price equal to the present value of the net advantage for individual use. This use value did not include any value based on excluding other users or on any value resulting from trade. It did not include value based on unpaid factors or uncompensated damage to humans or to the natural world.

Although for decades this historic view prevailed, in the late 1800s the Supreme Court began to develop important interpretations of the meanings of "property" and "liberty". The Supreme Court deliberations resulted from the 1865 Thirteenth Amendment prohibiting slavery and involuntary servitude except as punishment for crime; and from the 1868 Fourteenth Amendment prohibiting a state from depriving any person of life, liberty, or property without due process of law.

During this period, some difficult cases reached the Supreme Court. The Slaughterhouse Cases of 1872 questioned Louisiana's right to grant monopoly franchise to a slaughtering corporation in New Orleans. Butchers who paid regulated prices contended that the state statute deprived them of property and liberty without due process because slaughterhouses without a franchise could not operate and because the butchers could not seek out lower cost services. The Fourteenth Amendment privileges-and-immunities clause did not protect against state infringement of these rights.

5. The question of whether government could regulate business in the interest of public welfare was finally settled in 1934 when the Supreme Court acknowledged broad government powers:

[The Fifth and Fourteenth Amendments]...merely condition the exertion of the admitted power, by securing that the end shall be accomplished by methods consistent with due process...demands only that the law shall not be unreasonable, arbitrary, or capricious, and that the means selected shall have a real and substantial relation to the object sought to be attained. Roberts, for the majority. Nebbia v. New York, 291 U.S. 502, 525 (1934).
The critical legal issue was whether property meant only use-value of physical things or whether it included exchange-value. The common law concept of use-value meant physical things held exclusively for one's own use. If this were the interpretation, then the state did not violate the amendment. If, however, the amendment shifted the bundle of rights in favor of the nominal owner by recognizing property/liberty as everything that had exchangeable value, including "occupation" and "labor", the butchers would prevail. In a split decision the Court rejected the expanded interpretation in favor of the state.

A second slaughtering franchise was granted twelve years later, and the original monopolist sued, claiming his "property" had been diminished in value by competition. The Supreme Court again upheld the use-value interpretation, ruling again that Louisiana was within its authority.

Then, in the first Minnesota Rate Case (1890) the Supreme Court reversed its earlier decisions, changing the definition of property from physical things having only use-value to the exchange-value basis. This decision was partially based on Adam Smith's proclamation in Wealth of Nations:

"The property which every man has in his own labor, as it is the original foundation of all other property, so it is the most sacred and inviolable."

The majority in the Minnesota Rate Case held...

"...[T]hat not merely physical things are objects of property, but the expected earning power of those things is property; and property is taken from the owner, not merely under the power of eminent domain which takes title and possession, but also under the police power which takes its exchange-value. To deprive the owners of the exchange-value of their property is equivalent to depriving them of their property (emphasis added)."

Commons (1968, pp. 16-17) summarizes the effect of the Minnesota Rate Case (1890) decision:

"Thus the transition in the definition of property from physical objects to exchange-value was completed. Title and possession of physical property could be taken from its owner for public purposes under the power of eminent domain, but only on condition that equivalent value should be paid, such that the owners' assets should not be reduced; and this equivalent value, or just compensation, is a judicial question. Now it is enlarged to read: the exchange value of property may be taken from its owners under the police power, but only to the extent that they retain sufficient bargaining power to maintain the same exchange-value that they...

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6. Butchers' Union Co. v. Crescent City Co., 111 U.S. 746, 751 (1884). Earlier in Munn v. Illinois, 94 U.S. 113 (1876), the court ruled that a state-imposed price cut in warehouse rates resulting in a reduction in exchange-value of the business was not deprivation of property since title and possession were not taken.

had, and this also is a judicial question. The definition of property is changed from physical things to the exchange-value of anything, and the federal courts now take jurisdiction.

When the Supreme Court rejected the common-law meaning of property, new elements of property value were legitimized, including rents from monopoly, and advantage from government subsidy or the absence of government protection of public rights. Endorsement of exchange-value would legitimize wealth based on externalities and any other value that was capitalized by annual profits or speculation. By accepting market price regardless of its reason, the need to scrutinize these origins of wealth was lessened.

This important change in the meaning of property was an incidental result of a court challenge of the right of a state to grant exclusive franchise. The legal issue was whether the well-known purpose of the Thirteenth and Fourteenth Amendments to prohibit slavery had given new meaning to property and liberty and thus preempted state's rights. Because of this technical distraction, the Court never discussed the overall implications of its actions.

The acceptance of exchange-value legitimized speculative values and the capitalized value of avoiding public costs of private production, such as labor exploitation and pollution. When a company saves, for example, a million dollars a year by disposing of toxic substances in streams, the company is one million dollars more profitable, and the stock price reflects those extra dividends.

Acceptance of exchange-value set the stage for major distortions of the economy. Private interests took advantage of government acquiescence and mismanagement. They effectively transferred title or control of physical public resources (e.g., minerals, timber and water) and environmental resources (e.g., airspace and watersheds) into private hands. Once these resources were captured, their wealth is capitalized into stock value, even though actual ownership of important aspects of the property rights were still vested in the public ownership and could be recovered by legal action. This is the origin of the notion that private interests own the right to pollute or despoil because its profits and stock value would be reduced if such action were prohibited.

In sum, these relatively recent and inadvertent judicial events have taken on a character of conscious economic policy and permanent property entitlements that have important implications for resource use and for this investigation of compensation. It should be appreciated that property rights are not constant and inviolable but a dynamic phenomenon subject to historic consequence, judicial interpretation, political climate, and human experience.

By the twentieth century, property was no longer considered an exclusive tangible good held for individual benefit. Instead property refers to a dynamic bundle of rights in use, exclusion, and transfer of natural resources and other tangible goods. Property rights include the right to exclude other uses and users and the right not to exploit a resource for its highest immediate profit. These rights are shared by individual and collective interests including nominal "owners", factor users, creditors, labor-
ers, managers, governments, consumers, and even the public in its role as trustee. Specific actions by holders of these rights are allowed, prohibited, or required.

Social customs, economic influence, legal systems and regulatory agents enforce the relationships among the different holders of property rights. There is considerable give-and-take as these forces exert influence to protect, restore, and pursue their vested rights against challengers, and as society changes the rules or reassigns a right. Some institutions, such as taxation, credit, and tenancy, are derived from property; together they form an important complement that provides decision rules for adjusting and accommodating, over time, conflicting demands from different interest groups in society.¹⁸

PROPERTY RIGHTS VOCABULARY

To further discuss the various connotations of property rights and to clarify the technical economic literature, several distinctions must be made. Certain characteristics of ownership, accessibility to capture, control over the consumption of others, and limitation of property use are not commonly articulated. This vocabulary is unfortunately confusing because economists have created specific but obscure definitions for common words. The words "public" and "private" are particularly muddled. To avoid compounding this confusion by creating our own definitions at the expense of a somewhat awkward reconstruction of the existing vocabulary, the reader is cautioned to be aware of subtle distinctions and to read the literature with caution.

Ownership Characteristics

"PRIVATE" AND "PUBLIC" PROPERTY. Public property can be so strictly held that there are virtually no private rights. Private property other than personal property, however, is almost never a close and secure ownership that is free from the intrusion of others and the regulation of government. In common use, these terms refer principally to the nominal right of exchange.

"FUGITIVE" PROPERTY. Certain property, such as wild game and fish, is called "fugitive" property because it is continuously captured for private benefit without the capturer gaining a permanent right to control the resource. Most fugitive resources are now subject to some government controls in recognition of the rights of other harvesters and future generations. Resource economists have been particularly concerned with fugitive resources because they have been frequently depleted or exhausted by harvesters in the absence of public diligence.

¹⁸ This framework was developed by Ciriacy-Wantrup in the early 1950s; for a contemporary restatement, see Ciriacy-Wantrup (1969).
Consumption Characteristics

In the following definition, it should be noted that private/public in context does not imply particular ownership.

"PRIVATE (DESTRUCTIBLE) GOODS". Private goods are those properties that are physically appropriated or consumed by users as a necessary condition of their use. Private goods, such as food and clothes, are not shared.

"COLLECTIVE GOODS". These goods include those whose use does not diminish the quantity or quality available for subsequent use. Examples are street lighting, flood control, and habitat necessary to sustain wildlife.

The distinction between private and collective goods was popularized by Samuelson (1950, 1955, 1958) who originally believed that pure "public" (collective) goods could best be supplied by publicly owned businesses while "private" goods could primarily be left to privately owned enterprise. Some economists insist on calling goods and services "public goods" when they should not be entrusted to the decision-making mechanism of the market. This is more a tautological definition than a criterion based on measurable characteristics. After much debate, economists agreed that this definition cast little light on whether public or private supply was necessary.

In practice, almost all types of "collective goods" (such as television and radio signals, roads and bridges; military and police) are provided by private and public enterprise; "private goods" (such as air, train and bus travel, electricity, and water) are often privately provided, but there are important public exceptions. Collective goods are not necessarily costless to supply.

Control over Supply Characteristics

Building on the work of others, Schmid (1978) has made a convincing argument for keeping Samuelson's distinction between private and collective goods (Coase 1959; Buchanan 1965). Schmid contends that the high cost of excluding non-paying "free riders" is justification for supply by government.

Schmid's definition explains why television stations that cannot advertise must be supported by taxes if they cannot exclude viewers in a cost effective way or secure adequate voluntary contributions. The control over supply can change if a new technology can exclude use. For example, scrambler technology such as movie channels or controlled cable TV can compete with the earlier broadcast TV programs. A new exclusion technology can make it profitable to charge users for goods that were privately provided free. For example, subscription TV may make transmitted signals uneconomical.

Control over Consumption Characteristics

Schmid also emphasizes the situation where there is a cost to the consumer for avoiding a good. Unavoidable goods exist precisely because it is prohibitively expensive to avoid them. Unavoidable goods refer to such un-
wanted risks as those associated with nuclear waste, the exposure to radiation from bomb testing, and countless other toxic substances that are now ubiquitous. Goods that can be avoided at a cost include crime, poverty, noise, and localized toxic substances. Some collective goods, such as TV and radio signals, can be avoided at no cost.

Common property refers to the case in which a number of owners are coequal in their rights to use—but not to transfer—the resource. These rights are not lost through nonuse, and the coequal owners are necessarily equal with respect to the quantities (or other specification) of the resource each uses over a period of time. Potential resource users who are not members of the group of coequal members are excluded. These differences are discussed thoroughly by Ciriacy-Wantrup and Bishop (1975). This age-old meaning is substantially different from the popularized notion of unowned resources that are fugitive until captured by an unrestricted class of would-be exploiters.

Despite decades of serious inquiry within the framework of welfare economics, no one has clearly determined which natural resources should be publicly or privately owned (and under what combination of rights therein).

**NEUTRAL PERSPECTIVES ON PROPERTY RIGHTS**

An examination of contemporary social systems from a value-neutral perspective reveals that many relationships we take for granted are merely extended property rights. Some of the obvious ones are subject to intense debate, particularly when, like private property, they are a crucial distinction between capitalistic and socialistic management.

Building on the thinking of Honore (1961), Schmid (1978) masterfully identifies the following rights as important to compensation.

- The right to use, exchange, and deny use to others in compatible-use goods. These rights are often split among private "owners" and between private and public "owners".
- The right of free entry to markets and to choose among many buyers and sellers. Free entry is controlled by license and franchise, and laws prohibiting discrimination.
- The right to property security. The issue here is the security of ownership during the prescribed term. Ownership need not be in perpetuity. Security is maintained by civil courts and by careful procedures for eminent domain and police power.
- The right to collect and consume economic rents for goods with differential surpluses.
- The right to capitalize future rents. This right allows owners to capture the future value of profits including the profits resulting from externalities.
- The right to injunctive relief, rather than to receive damages, in the case of goods with high contractual costs.
The right to utilize class action suits in the case of goods with high contractual costs.

The right to avoid product liability in the case of goods with high information and collection costs. Rules of law often make recovery of damages uneconomic because the cost of recovery is greater than the individual award.

Rights that are not mentioned by Schmid but that are important to this essay include the rights to (1) use private resources in ways that yield less than maximum profit, (2) avoid tax, (3) decide resource consumption without political participation, and (4) engage in activities whose possible consequences exceed technical or financial ability to correct.

SOCIAL TIME HORIZONS

Time has important implications for property in law and in economics. In economics, most calculations follow accounting conventions of annual summation by using discounting. For purposes of planning future operations, the "short run" is usually less than two years and the "long run" rarely extends beyond a decade. Economists often define the long run as the earliest time when all contracts and capital ownership are changeable. Businesses are normally allowed to distribute profits as frequently as they like, often on a quarterly basis and rarely on a cycle longer than one year.

Legal time horizons are longer. Precedents and their legal philosophy frequently extend for several centuries, and disputes over property can be resolved many years after the fact. Statutes of limitation are legislative enactments that prescribe the time within which lawsuits may be brought upon certain claims or to enforce certain rights. Such statutes exist more as a formal recognition of implied consent or inadequacy of old evidence, not as a principle allowing uncontested wrongdoing to prevail.

A long time-horizon is important to compensation and its resource implications in two ways. First, security of property rights encourages sustainable use of renewable resources and reasoned exploitation of nonrenewable resources. Second, responsibility for property use must extend for a long enough time period to fully determine unacceptable damages and correct resource abuse.
III. SOCIAL ECONOMICS AND THE CONCEPT OF EXTERNALITIES

The economic concept of externalities has become well-known to the other social sciences and to the informed public. In this section some of the original concepts of social economics will be broadly examined, thus avoiding unnecessarily narrowing the investigation. This presentation is particularly designed to allow testing, and rejecting, two popular economic axioms: (1) that property ownership does not affect resource use, and (2) that resource-use conflicts are best solved by giving private interests a larger share of rights.

SOCIAL COST ACCOUNTING

The analysis of social costs began with Marshall's (1927) limited concept of one firm's influence on another firm's production, and it was soon expanded to explain a great variety of interdependencies under dynamic conditions. Marshall's definition of external economics concerned "How far the full economics of division of labor can be obtained by the concentration of large numbers of small business of a similar kind in the same locality." In social cost accounting, separate roles are recognized for special interests including consumers, producers, suppliers, laborers, investors, public individuals, taxpayers, and the public community.

An action may affect any or all of these interests in one or more ways. For example, a decision to pollute while producing a product may increase returns from plant investment; lower product prices to customers; increase purchase from suppliers of the plant; and harm the health of consumers, the non-consuming public, other producers, and laborers.

The accounting boundary can be drawn at the level of the individual, interest group, or political subdivision (city, county, state, region, nation). A net social cost occurs whenever an individual or group is harmed more than helped by the initiating action. A net social benefit is realized whenever benefits exceed costs. The choice of accounting boundary and the weight that is placed on particular effects will determine whether the action is desirable or not. This political element cannot be separated from the economic analysis.

In a hypothetical economy with no future and a population of one person acting as both producer and consumer, or in the case of a culture with strong common values, the consequences of all actions are "internal" to the single decision maker. This is obvious because every benefit and cost accrues to the individual. In communities, each person's productive and consumptive actions affect the welfare of others, but the individual may not always act in a purely public way.

"Externalities" are defined as the desirable or undesirable spillover of effects to third parties who are not directly involved in the effect-causing transaction. Desirable effects are called "external economies"; undesirable effects are called "external diseconomies". It is usually pre-
sumed that an action will be taken whenever the total benefits of the initiator exceed whatever portion of the total costs that initiator must bear. External diseconomies have received more policy attention because the purpose of public policy is to protect the public by managing activities that have an overall adverse effect. This is based on the fundamental premise that individuals can do what they like so long as it is not prohibited by law. The increasing complexity of society, resource scarcity, and other diseconomies reveals the public nature of "private" actions that would have been benign at other times or in other circumstances. In a few circumstances courts enforce payment for unbargained or accidental benefits (Corbin 1963). The emerging problems of technology and increasing population are important causes of these effects. Total social costs are the sum of private costs and external costs.

External costs and benefits are outside the market system and are not reflected in relative market prices. Because relative market prices are incomplete indicators of social benefits and costs, the private market economy produces too much of some commodities and too little of others. Private decision makers avoid certain costs of their activity and are unpaid for certain benefits or potential benefits of their activity.

In the strict economic presentation, externalities are value-neutral; thus, there is little consideration of criminal punishment. The "malfunctioning"—death of workers—of the "private market"—not the decisions of individual people—is considered a natural result of the (desirable) monetary reward and property rights structure of the private market system. Theoretically, the manager of a firm simply makes the identical rational economic calculations required to minimize costs of production that firm managers in all other industries also make. Because the free market paradigm assumes perfect competition, and therefore no long-term profits, any firm that did consider allowable external effects would be at a competitive disadvantage and could go out of business.

Viner (1931–1932) divided externality influences into "pecuniary" and "technological" effects, the distinction having to do with how the effect is felt by a particular entity. Pecuniary effects result from price or cost changes as a consequence of shifts in demand or supply curves. Technological effects (better called extra-market) have come to represent the familiar "spill-over" cases of pollution and noise that are physically experienced. The designation "technological" externality had its origin in "technological coefficients of production" and referred primarily to reductions in physical inputs per unit output made possible by a larger scale operation (Viner 1931–1932, p. 213).

To understand compensation, two more categories of externalities not used by economists are necessary: psychological and sociopolitical. Psychological costs (e.g., frustration, despair, alienation, and futility) and psychological benefits (e.g., confidence, trust, and optimism) are extra-market conditions that are important to economic analysis; however, they are usually ignored for analytical convenience. Sociopolitical externalities affect human rights, democracy, employment opportunity, traditional values, and the prospect of war or peace.

Psychological externalities are realized through a change in psyche.
Sociopolitical externalities are realized through the full range of private and public activity. Social well-being and community vitality are very dependent on these factors and the externalities that modify them, but there is little formal consideration of these topics in economics.

Externalities result from the interdependency of the consequence of individual economic decisions. By definition no compensation is paid: for external diseconomies, the one who creates costs is not obliged to pay; for external economies the one who provides benefits is not rewarded. If compensation is paid, the externality no longer exists.

These effects can be desirable (positive) or undesirable (negative). A positive externality is a collective good precisely because users cannot be excluded at a reasonable cost to the supplier. An undesirable externality is possibly avoided at cost, or it is completely unavoidable and is produced at either zero cost or at a cost saving as a consequence of deliberate production.

The initiating action of the externality might be physical, market, or psychological. The character of the externality changes as individuals and businesses respond, and subsequent victims and benefactors will experience the externality in different ways. The externality might be internalized if the initiator pays for the harm in the case of diseconomies, or if the initiator captures the benefits in the case of economies.

When externalities are not corrected, consumers and producers respond to make the best of the situation. The dynamic interactions change the character and incidence of the externalities. Consider the case of the externality caused by a manufacturing plant that reduces costs by stream disposal of toxic substances. Stockholders, suppliers, and customers of the polluter may gain through the market, experiencing a pecuniary advantage. Other producers will lose because their products are not competitive. Downstream residents must pay higher taxes to purify drinking water. Health may be adversely affected. Some personal health effects can be corrected or managed at a cost. Mitigation costs are pecuniary diseconomies. Farmers using a stream for irrigation will lose productivity as they experience a

9. The issue of psychological stress as an externality was addressed by the Supreme Court in Metropolitan Edison Company v. PANE, decided on 19 April 1983. The court ruled that the Nuclear Regulatory Commission did not have to consider psychological stress associated with restart at Three Mile Island because there is a difference between "actual" risk and public perception of risk. They concluded that this distinction "lengthens the causal chain beyond the reach" of NEPA.

10. If the analysis is limited to the neoclassical-classical efficiency criteria, some more specific classifications are useful. If external diseconomies accruing to a production function affect only fixed costs, the externalities are called "separable". If the diseconomies affect marginal costs or revenue, they are "non-separable". This is important because one-time-only changes in fixed costs do not cause output or product price to change. These costs are paid from profits or owner equity. This classification is cleverly used in Kneese (1965) and Marchand and Russell (1975). Because of special assumptions, it may be of very limited application.
technological externality that might later be realized as loss of income and decrease in property value—pecuniary diseconomies.

Table 1 gives examples of initial externality impacts. The first two rows are economies and diseconomies initiated by consumers. The third and fourth rows are economies and diseconomies initiated by producers. The columns list examples of psychological, technological, and pecuniary externalities for consumer, producer, and worker recipients.

Externalities have far-reaching consequences often extending physically, socially, politically, and economically beyond the primary actors. For example, the national policy to subsidize synthetic fuels from oil shale increases taxes; boosts profit and employment in some industries while reducing it in others; triggers and exacerbates health problems; increases medical expense and health insurance costs; and physically and ecologically destroys vast tracts of land. Only a careful broad-spectrum analysis can tell whether a particular individual is harmed or benefited in balance by the combination of changes that result from the action or whether alternatives to the proposed action are more or less harmful.

PECUNIARY EXTERNALITIES ELABORATED

Pecuniary externalities are the result of induced changes in demand and/or supply that result in changes in equilibrium price. They result from the interdependence among and between producers and consumers. Many familiar social issues are related to the fairness of markets.\[11\]

For example, long-time residents of boom towns often believe that outsiders bid the price of land to levels that local people cannot afford. The sense that locals are economic victims is heightened by their perception that speculators from the outside recognize local opportunities and capture gain while migratory labor and imported materials capture the jobs and profits of the construction activity. These pecuniary effects are relayed to those who are made worse off solely because of the prices they face in the market. The consequence to the individual may be very serious, but from most economic perspectives it is either unavoidable or desirable overall.

There are several reasons for the neglect of pecuniary externalities. First, economic analysis usually treats income distribution before and after transactions as a "given" value-neutral condition. Some economists argue that if people do not like the income distribution, they should correct it,

\[11\] This construct follows the suggestions of Kapp (1969), building on Scitovsky (1954) and Viner (1931-1932). The concept of pecuniary externalities may help explain a number of economic policies that are universally accepted but are incompatible with simple economic theory. For example, usury laws are justified by debtor protection laws but may also prevent investment that is too risky for society even if private interests would risk the money. For discussions of externality policy and the national economy see Peskin, Portney, and Kneese (1981) and Peskin and Peskin (1978).
<table>
<thead>
<tr>
<th>TABLE 1. EXAMPLES OF PSYCHOLOGICAL, TECHNOLOGICAL, AND PECUNIARY EXTERNALITIES FOR CONSUMER, PRODUCER, AND WORKER</th>
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<tbody>
<tr>
<td><strong>Initiators</strong></td>
</tr>
<tr>
<td>Psychological</td>
</tr>
<tr>
<td>Good neighbors (well kept property, friendly children, helpful and generous)</td>
</tr>
<tr>
<td>Envy of others' situations; dismay over others' misfortune</td>
</tr>
<tr>
<td>Pollution control that cleans plant discharge to better quality than intake</td>
</tr>
<tr>
<td>Pollution damages health, reduces pleasure and deteriorates property</td>
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</tbody>
</table>

**NOTE:** Consumer quadrant often described as "direct interdependence of consumer satisfaction."  
Producer quadrant often described as "direct interdependence among producers."  
Worker quadrant often described as "producers direct influence on personal satisfaction."

**NOTE:** '?' designates very limited interrelationships.
but not within the market. Other economists argue that within the general equilibrium model, increased real estate prices in one location are made at the expense of decreased prices elsewhere. The price effects in this view are offsetting and are pure transfer effects.

An important realization is that neither of these explanations denies that individuals are harmed by the pecuniary externality. The income distribution argument casts the issue into another economic topic area, while the transfer argument claims that the harm is offset by gain elsewhere.

Perhaps the strongest argument for ignoring these pecuniary social costs is that they may be so pervasive that they are beyond solution.

Despite the neglect of pecuniary social costs from most economic analysis, at least two major public issues in resource policy depend on the concept for existing public policy. The two cases are farmland preservation and forest management.

**Farmland Preservation**

Each year farmland is converted to other uses. In many cases the conversion is merely a response to market forces, including alternate uses and speculation. Many people have concluded that something may be seriously wrong with the economic signals when these irreversible changes are encouraged even as inputs, such as fertilizer and mechanization which are designed to overcome poor land quality, are becoming very costly and the world food situation is worsening. Farmland conversion to other uses is a major pecuniary social cost.

After Maryland reduced the farm property tax in 1956, every state has enacted some combination of laws that favor agricultural land-use. These extraordinary efforts include comprehensive planning, agricultural zoning and districting, purchase of development rights, differential tax assessment right to farm legislation, and inheritance tax savings for keeping farmland in farming.

**Forest Management**

The problem of pecuniary social cost in forestry is quite different: the highest profit is often made by site destructive harvest practices and minimal restoration and replanting. Even minimal soil erosion control or reseeding is often uneconomic for forest crop rotations of twenty to over one hundred years. The land may remain in forestry after destructive harvest, but often at a considerable loss in physical productivity. Some of the effects are the familiar technological externalities of visual amenity, streambed destruction (including loss of fish habitat), watershed destruction, and flooding. The pecuniary part of this social cost includes future high costs of forest products, unemployment, and associated foregone economic activity that would occur with a faster regeneration and less costly side effects.

Federal, state, and local efforts to correct this problem include sub-
sidies for reforestation, tax relief, free management assistance, and timber harvest laws to prevent certain outcomes of profit maximizing behavior.

ROLE OF INTENT AND POLITICAL CONCERN LITERATURE IN EXTERNALITY

Mishan (1969) and others have excluded "intentional" effects of otherwise legitimate activity from the externality designation. This exclusion may be based on an unstated presumption that these cases are fairly settled within the legal process and therefore require no additional economic attention. Buchanan and Stubblebine (1962) agree with the Mishan concept, but they go further in restricting the categories of externality that are relevant to public policy analysis; externalities are classified on a basis of public concern. Externalities are "potentially relevant" when they have not been subjected to a political or legal evaluation. If known externalities are consciously ignored, the externality becomes "irrelevant". Externalities that raise significant concerns in the political and legal system are "relevant". "Relevant externalities" are then subject to correction. This economic definition does not distinguish the cause of the irrelevance. Thus, if legal hurdles prevent a politically powerless victim from gaining from a claim, or if property rights favor the initiator, the externality is irrelevant.

Law makes slightly different distinction on the basis of care. Even after proving ownership, harm, and cause of harm, a plaintiff seeking relief must sometimes show that a "standard of care" was violated. For simplicity, we can divide these legal distinctions into three categories of shared responsibility between initiator and receptor (perpetrator and victim):

1. "Reasonable risks" voluntarily entered into by the victim under circumstances of "reasonable care" by the initiator, that is, the victim is not entitled to compensation.
2. "Reasonable risks" voluntarily and semi-voluntarily entered into by the victim, but harm results from negligence by the initiator, that is, the victim is entitled to compensation after proving harm, cause of harm, and negligence.
3. "Unreasonable risks" from legal activity voluntarily or involuntarily entered into by the victim with harm resulting, that is, there is a prior determination on the basis of the hazard that the initiator takes full responsibility regardless of care for any harm that might occur. The victim need only prove harm and cause of harm to be eligible for compensation, and the initiator is held strictly liable.

Buchanan (1973) emphasizes that voluntary agreements are made prior to transfer of rights or infliction of harm while judgments are made after the fact and must be based on assessments of harm rather than on acceptance of seller's offer. In the first case the agreement is acceptable because it is voluntary and because the risk is judged reasonable; in the second case, the compensation and/or mitigation cannot rely on the proclaimed value of the loss because the victim may exaggerate the intangible values. Third-party estimates are based on social average values that may understate the loss if
the victim truly gained more personal satisfaction from the particular lost resource than its value to the general population, as reflected in market price.

It is difficult in practice to separate conscious political decisions to not compensate victims from judicial and institutional neglect or unintentional barriers that hamper remedy. It is particularly difficult when pragmatic regulators and courts limit their decisions within strict economic constraints to protect enterprise. For example, even when a firm employs "best available control technology," a process may be more harmful than alternatives that supply the same final good; the process may possibly be more harmful than no production at all. The private judgment to produce a good with an undesirable external consequence is often influenced by financial considerations. The measure of "available control technology" is affordability, not availability. Control technologies that cost more than net profit are opposed by business interests even if the damage of the activities to society exceeds the value to producers and consumers of the offending activity.

Even if some sort of distinction can be made between malicious intent and benign intent, it is clear that for our inquiry into compensation even malice aforethought may need attention.

OPTIMAL EXTERNALITIES AND DESIRABILITY OF REGULATION LITERATURE

Most economists accept the notion of an "optimal externality", the condition that exists after an external economy or diseconomy has been properly priced to insure "optimal output". Optimal output is the production level that would have been produced if private costs and benefits had been equal to public costs and benefits (externalities internalized). An optimal solution has a correct output, but it need not charge the parties responsible for external diseconomies nor reward those responsible for external economies. Furthermore, the victims of others' activities need not be compensated (see Ciriacy-Wantrup 1967 for another view of optimizing).

In general, economists accept externalities as optimal when the benefits of an activity exceed the costs to whomever these costs and benefits accrue. This perspective is based on the concept of "Pareto optimality", named after the engineer-economist Vilfredo Pareto. The idea is that society is making the most efficient use of its resources when no individual can move into a better position without causing someone else to move to a less desirable position. When progress toward Pareto optimality is made by voluntary exchange of property entitlements, the concept is valid (Sandler and Smith 1976, 1977).

But, because this simple idea requires full voluntary compensation to those harmed by a change, it is difficult to apply to policy making. A relaxed version of the principle—called "Pareto preferred" or "potential Pareto"—merely requires that the victims of the change could be compensated from the gains, not that they are actually paid. Most Pareto-based analysis considers only the operating-level efficiency.
Economists have successfully defended the Pareto criterion for localized conflict, but they wisely relax their theory when political circumstances make the concept wholly unacceptable. Arguments that damage be tolerated as a necessary social cost lose their appeal when the initiating enterprise is not in the same political, geographical, or cultural jurisdiction as the victims. Excuses that the damages result from inadvertent, unanticipated, or uninformed actions are equally unconvincing.

The introduction of social accounting to economic analysis prompted a nearly unanimous conclusion: external effects are important because economic actors consider their own well-being but not the well-being of others who are affected by their choices. When individual and public (social) costs thus diverge, resources are misallocated. To the extent they can be measured economically, these unpriced external effects should be internalized.

Most policymakers initially concluded that, for external diseconomies involving the natural environment or natural resources, this internalization should be accomplished by stopping or controlling the offending practice, or by forcing the perpetrator to compensate the victims. It might be generalized that while attorneys favored regulatory schemes, economists favored monetary schemes.

ECONOMIC SURPLUS AS A MEASURE OF UTILITY

The most extensive economic inquiry into just compensation involves the concept of economic surplus. Consumer surplus is the difference between the price that consumers pay for goods or services and the value of the goods and services to them. It is that extra margin of willingness-to-pay that makes something a good buy.

Economic rent incorporates the surpluses that accrue to producers of final goods and suppliers of inputs, such as land, entrepreneurial ability, labor, and capital. Most economists ignore or explicitly exclude any non-pecuniary rewards factor owners may receive from their work.

12. Economic surplus includes the conceptually symmetrical consumer surplus and economic rent (or producer surplus) defined solely on the basis of the entity to which they accrue. Alfred Marshall defined consumer surplus as the advantage from being able to buy a commodity at a particular price, that is, the excess of the total utility from that purchase over (minus) the utility foregone on other commodities by the expenditure. J.R. Hicks redefined the concept as the amount of income variation that would leave the consumer on his ordinal indifference curve following the introduction of the commodity at the particular price. This seemingly simple concept is the subject of a continuing debate among economists. A discussion would take us beyond the scope of this essay into economic obscurity. Interested readers are urged to review Currie, Murphy, and Schmitz (1971) and the accompanying bibliography.
Economists have shown that two of the four surplus measures of change in one's welfare are economically relevant. These definitions are

For Consumers:

1. "Compensating variation" is the amount of compensation, paid or received, that will leave the consumer in his/her initial welfare position following the change in price if he/she is free to buy any quantity of the commodity at the new price. Compensating variation is easily recognizable as the legal notion of complete damages. Complete compensation restores victims to their initial situation and secures the future that would have been experienced in the absence of the damage.

2. "Equivalent variation" is the amount of compensation, paid or received, that will leave the consumer in his/her subsequent welfare position in the absence of the price change if he/she is free to buy any quantity of the commodity at the old price.

For Producers and Factor Owners:

1. "Compensating variation" is the amount of compensation, paid or received, that will leave the factor owner/producer in his/her initial welfare position following the change in price if the producer/owner is free to supply any quantity after compensation.

2. "Equivalent variation" is the amount of compensation, paid or received, that will leave the factor owners in his/her subsequent welfare position in the absence of the price change if he is free to supply any quantity after compensation.

Economists like to use willingness-to-pay estimates of the value of unpriced goods for two principal reasons. First, economists believe that people are more honest in surveys when they are asked how much they would pay for something than when they are asked how much they would accept to give up something. Second, economists generally mistrust surveys and have found indirect market measures of willingness-to-pay, but they have been unable to find market measures of willingness-to-accept.

Recent applications of economic surplus using willingness-to-pay have failed to emphasize the inherent underestimation of welfare loss from proposed actions or for estimating just compensation for wrongful action.

13. Mishan (1947-1948) first argued that these were the most useful measures. Hammack and Brown (1974) and Maler and Wyzga (1976) follow the framework and definitions developed in Currie, Murphy, and Schmitz (1971), as stated by Hicks (1956, p. 99).

14. This perception is based on a mistrust of people, rather than research evidence that victims are unreasonable. It ignores the substantial evidence that consumer behavior in markets is less than rational and is non-neutral with respect to influence like advertising.
ACADEMIC ARGUMENTS AGAINST REGULATION AND COMPENSATION: THE COASE AXIOMS

Political conditions in the early 1960s began to favor new government initiatives for resource conservation. The public was concerned with overpopulation, air and water pollution, natural resource waste, litter, wilderness destruction, and careless management of public lands. These controversies followed closely on the heels of civil rights reform.

At this critical reform juncture, Coase (1960) published an argument that has drastically influenced economic and legal thinking for two decades. Coase's well-reasoned paper questioned whether legal evaluation had properly considered the economic influence of property-rights ownership and the pervasiveness of market solution to all sorts of conflicts. Coase suggested that negotiation between individuals could resolve conflict and achieve economic efficiency by using imaginative solutions that would not be possible through adjudication. A broader selection of possible solutions might ultimately benefit society by avoiding cases where a mandated judgment without negotiation forces the conflicting parties into an economically unsound solution. The opportunity to improve an uneconomic condition is characterized by the ability of one conflicting party to pay the other to modify the solution and improve his/her own wealth. Voluntary agreements are thought to benefit both parties.

Coase's ideas found constructive application among lawyers, who were alerted to the advantages of an economic approach to settlement, and his arguments form part of the basis of the recently emerging mediation approach to conflict resolution, including environmental conflict. Environmental negotiation seeks efficient solutions in a less adversarial context than the courts. Lee (1982) presents the most sophisticated interpretation of these processes and their relationship to legal, political, and economic systems. The experimental economics literature on bargaining efficiency is summarized in Hoffman and Spitzer (1982).

The Coase thesis found a more pessimistic application in some of the literature of economic theory. His broad analysis and constructive suggestions for negotiation were largely reduced to the three arguments most amenable to testing within the free market philosophy. To summarize these three points:

1. The avoidance of harm to a victim harms the perpetrator; all actions are economically bilateral

2. The allocation of resources is unaffected by the allocation of legal rights.15

3. Because any allocation of legal rights is efficient, externalities are not a problem for resource conservation but a tax on externalities will eliminate the efficiency.

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15. Coase qualifies this outcome only by requiring costless negotiation and well-specified rights, and by noting that the redistribution of wealth does not affect marginal value.
These thought-provoking arguments have stimulated a lively theoretical debate among economists and lawyers as they explore the theoretical consequence of relaxing or adding to the model's assumptions.\textsuperscript{16} Despite the fact that economists have shown that the arguments have little if any validity for policy analysis, the arguments still enjoy substantial credibility.\textsuperscript{17}

In a principal example Coase described a conflict between two adjacent land uses, cattle grazing and vegetable production, when unfenced cattle damaged an adjacent vegetable garden. Coase argued that there is only one solution—assuming that both owners who are in business want to maximize profits, they both know the alternatives and adjustments, and they are willing to negotiate.\textsuperscript{18} If a fence restores more profit than its cost, it should be built. If a fence is not profitable, the neighbors should accept the livestock damage or eliminate the cattle.

In the Coase construct, liability determines who must pay whom, but the land use is the same. Joint profit is maximized by merger or by payment from the party without rights to the rights owner for acceptance of the optimal loss.

Coase's interesting argument is generally cited in the legal literature as having proven that whichever form of liability rule is adopted, the allocation of resources remains unaffected. If this were true, the legal profession could dismiss natural resource concerns from their deliberations and concentrate solely on equity.

The Coase model is a useful elaboration of the economic fictions of

\textsuperscript{16} For a well-constructed bibliography organized according to the assumptions, see Hoffman and Spitzer (1982) and the references cited in note 10 supra.

\textsuperscript{17} Coase's detractors shifted attention from general analysis of technological and pecuniary external effects to a simplified examination of externalities among producers. Elaborations of externalities of production functions have been presented by Davis and Whinston (1962), Wellisz (1964), Kneese (1964), Kamien, Schwartz, and Dolbear (1966). For similar analysis using consumption functions, see Dolbear (1967) and Buchanan and Stubblebine (1962); and for a thorough discussion of tort law, see Gregory and Kalven (1969).

\textsuperscript{18} The profit-maximizing goal means that gain and loss is measured as the amount of money each would pay to indulge in the damage-causing practice or would accept to endure the consequences.
The equilibrium theory, in its general and partial forms, is a static theory, concerned with describing the characteristics of the economic system when it is in a hypothetical equilibrium. It is based on assumptions of perfect competition on both sides of every market, no costs of negotiation and enforcement, no effect of income, and perfect divisibility of all resources and products. Individuals and groups are presumed to share the single vision of profit maximizing and the political system as simply a market function because a ban on an activity can only be considered as an infinite price. This theory is constructed to identify the circumstances that are necessary for the free market to operate correctly. It is not based on a description of an existing market situation. Few, if any, examples of this "ideal" economy have been found.

Economists have refined Coase's argument within its limited framework. For example, Plott (1966) proved that the Coase analysis was valid only for products with particular production functions. Buchanan (1969) identified exceptions among even those special cases and further limited its validity by showing that when consumers are parties to the conflict, the payments must be small relative to their incomes, and the marginal utility of money must be constant and equal among parties. For example, $10,000 paid to an unemployable asbestos victim must be no more valuable than $10,000 paid to an asbestos company officer earning $500,000 a year and more valuable than any other possible use of the money by the company. Norgaard and Hall (1974) showed that additional assumptions including direction of technological change, relative level and response of transaction costs, and the elasticity of substitution in consumption and production were necessary to identify preferred liability.

Other economists have narrowed its valid theoretical application to obscure cases characterized by small numbers of actors, full knowledge of everyone's potential gain and loss, equivalent bargaining skills, complete knowledge of consequence and possible mitigation for every possible outcome, low cost of negotiation and efficient enforcement of agreements (Calabresi and Melamed, 1972; Frech 1979; Polinsky 1980; Barkley and Cory 1982-1983).

Coase's contention that the allocation of resources remains unaffected regardless of liability assignment is also only valid for conflict among producers who share the same solitary goals of profit and who subscribe to

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19. A scientific fiction is a deliberate, conscious deviation from reality as a tool of inquiry, conceptually useful in its expediency in understanding, explaining, and predicting reality. A scientific fiction becomes mere dogma and therefore unscientific if the consciousness of its fictional nature and its conceptual usefulness are obliterated (Ciriacy-Wantrup 1971, p. 39). The general equilibrium theory is the mathematical version of classical economics. Economists proceed from pure and applied mathematics to deductive reasoning using unverified statistics and little observation or fact finding. Leontief (1982) credits this distraction with the research that followed Coase's model: "Page after page of professional economic journals are filled with mathematical formulas leading the reader from sets of more or less plausible but entirely arbitrary assumptions to precisely stated but irrelevant theoretical conclusions."
the same social standards of what sort of deal is ethical and moral (Mishan 1967a, 1967b, 1971). If producers have derived satisfaction from their work or other unpriced advantage, the allocation is affected.

In all other cases of externality—between producers and consumers, among consumers or in cases of future generations, or ethics or morals—the Coase contention is invalid.

In summary, Coase's admonition that voluntary, bargained solutions to conflict may be preferable to dictated, inflexible solutions remains a valid possibility. The notion that bargained solutions are "efficient" for resource allocation is true so long as income and transaction costs are ignored and other special assumptions are valid. The contention that resource allocation is invariant to the specification of rights is proven invalid except for special hypothetical circumstances that rarely occur in real cases of conflict.

Despite persuasive cautions from Mishan and others that the Coase theorem should not be applied to policy making, it remains a powerful argument in favor of the status quo as a philosophy of nonintervention. Coase claimed that taxes and regulation only reduce efficiency because they interfere with negotiation. The presumption is that negotiation is conducted without intimidation, without cost, and that the tax is not used to redress the harm. Michelman (1967, p. 1214) goes further in warning against overcompensation.
IV. LEGAL THEORIES OF COMPENSATION

PROPERTY RIGHTS CLASSIFICATIONS

Voluntary human behavior may be classified along a continuum which suggests categories of punishment for undesirable behavior and reward for desirable behavior (Table 2). At the interface of categories, there are vague distinctions reflecting the uncertainty over evidence, guilt, consequence, and relevant punishment.

Behavior is judged by legal and social criteria. The distinction between a tort and a crime is vague in law and virtually untreated in economics. Criminal law is distinguished more by its focus on punishment than on the seriousness of the offense.

Criminal law, unlike civil law, does not limit punishment to the value of taken property even when that property concerns things we allow to be sold. This is because the penalty is at least partly intended as a deter­rence. The economic effect of calculating compensation on a basis of direct market-measured damage is to justify a sort of inverse condemnation in cases where the property itself cannot be recovered. Because market price is always available to a seller, a forced "sale" through property destruction is the lower limit of its value to the owner. Actual property value to the owner can exceed market price by a substantial amount.

Legal and economic perspectives are generally compatible on the important issues of protecting human life against risk and the recognition of collective goods and amenities. Lawyers more easily accept injunctive relief and punitive damages, while economists are more concerned about efficiency and techniques for evaluating human life (Rogers 1977).

The perspectives differ substantially on the issue of protection against environmental risks caused by human interaction with nature. The "rights" of people and their collective social goals are paramount to law, while economics is increasingly insistent on efficiency and anxious to avoid over regulation or other market interference. Some economists even warn against overcompensation.

Law stands apart from economics in its concern for long-term impact and in the preservation of natural areas and exploitable natural resources for future generations. In these cases, economics virtually rejects any measure of value that is not based on the demands of the current population. Economists often presume that the value of resources to distant future generations is reflected correctly in our conservation and preservation decisions or is incorporated in business planning by the opportunity to earn a profit.

20. A tort is any wrongful act, damage, or injury done willfully, negligent­ly, or in circumstances involving strict liability, but not involving breach of contract, for which a civil suit can be brought. A crime is an act com­mitted or omitted in violation of a law forbidding or commanding it, and for which punishment is imposed upon conviction. Should the penalty for a crime be greater than the objective evaluation of the damages?
TABLE 2. BEHAVIORAL CONTINUUM: CATEGORIES FOR REWARD AND PUNISHMENT

<table>
<thead>
<tr>
<th>CONTROL SYSTEM</th>
<th>INTOLERABLE</th>
<th>UNDESIRABLE/DESIRABLE</th>
<th>LAUDABLE</th>
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<tbody>
<tr>
<td>Judicial</td>
<td>&quot;Guilt&quot;</td>
<td>Suspect</td>
<td>&quot;Not guilty&quot;</td>
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<tr>
<td>Criminal</td>
<td>Death/life in prison</td>
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<td>NO JUDICIAL REWARD FOR LAWFULNESS</td>
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<td></td>
<td>Temporary imprisonment</td>
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<td>Parole</td>
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<td>Probation</td>
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<td></td>
<td>Castigation</td>
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<tr>
<td></td>
<td>Ostracism</td>
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<td></td>
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<tr>
<td>Civil</td>
<td>Punitive damages</td>
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<tr>
<td></td>
<td>Compensatory damages</td>
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</tr>
<tr>
<td>Social</td>
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<tr>
<td>Regulatory Fines</td>
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<td>Taxes</td>
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<td></td>
<td>Charges</td>
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<td>Informal</td>
<td>Ostracism, castigation</td>
<td>Mistrust</td>
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in these future years.

Rogers (1982) separates property into three conceptual categories that clarify legal theory and allow economic interpretation (see also Calabresi and Melamed (1972). These categories are (1) human property rights, (2) private property or entitlements, and (3) provisional rights to the commons.

Human property rights are subject to the most absolute protection of the law. These inalienable rights cannot be taken except upon terms of the holder. In certain circumstances, sale is prohibited or the preconditions of a valid sale are prescribed. For example, Americans are not allowed to sell themselves into slavery or to sell their vital body parts. Inalienable rights are protected by the Constitution and by substantive due process limits on legislative power.

In nuisance cases, injunctive relief is granted the holder of these human rights because compensation or other involuntary compromise is not an acceptable substitute for restitution.

21. Buchanan (1973) presents an economic interpretation of "freely negotiated voluntary exchange" that is compatible with this class of rights in the case of the individual.
These core human property rights, including health, bodily integrity, abode, and other essential elements of life and liberty, are the concerns of the policy level of the decision-making hierarchy discussed at length in the introduction. Calabresi and Melamed (1972) identify three justifications for inalienable rights: moralisms, self paternalism, and true paternalism. Moralisms include the full range of religious or ethically motivated group concerns. Self paternalisms include group decisions to limit or prohibit individuals from yielding to temporary gain at the expense of long-term productivity (selling your soul for a mess of pottage). True paternalism includes protection of minors and others from their own desires and reflects the group confidence that they can in fact better determine what is good for someone. True paternalism is overtly inconsistent with Pareto optimality.

Private property or entitlements are protected by a property rule that requires someone who wants to remove or transfer the entitlement to buy it in a voluntary transaction with the seller agreeing to the price. In the case of this property, the state normally intervenes to determine ownership but does not try to decide its value unless the market is uncompetitive or discriminatory. Courts enforce contracts without consideration of whether resource allocation or economic efficiency could be improved by breach. Private property may be taken by government to improve public wealth, but only with compensation. The property losers are accorded process protection against efforts to diminish or redefine these rights and government must show explicit official public advantage from the taking. Inadvertent destruction of this property class invokes a liability rule. The initial owner is allowed to recover the value that the entitlement would have sold for prior to the damage as determined by the state.

Provisional rights to the common stock of natural resources are far less protected. Legislators can reallocate this property without compensation if they so desire, but they frequently choose compensation as a matter of public policy. Compensation is not a constitutional necessity because some common property resources cannot be divested from the public.

The concept of inalienable rights also has an application to the provisional rights to the commons. The concept of "inalienable rights" is an important boundary between law and economics. When Congress declares that an area is forever a wilderness, this can be viewed as attaching an infinite price. Alternatively, it can be viewed as a declaration that this resource is outside market pricing. If something is an absolute right, such as to justify injunctive relief, then no infringement should be permitted and therefore compensation does not justify infringement on those rights.

In the case of irreversible, catastrophic harm (e.g., destruction of the ozone layer), the resource management scheme must install incentives and penalties that are so powerful that the resource is not threatened. No amount of compensation could begin to correct the harm.

22. Calabresi and Melamed (1972, p. 1089) say that the most common reason for a liability rule rather than a property rule to protect an entitlement is that market valuation is unavailable or too expensive compared to collective valuation.
Rogers' definitions help explain part of the conflict between legal and economic theory. Law accepts the evolved social order as legitimate institutional structure, while economics tends to evaluate each decision on the basis of narrow operating-level efficiency, sidestepping equity and long-term welfare. Society must continuously face the unavoidable choice of initial entitlement to new property, the transfer of rights to existing entitlements, and the balance of property, liability, and inalienability rules.

An individual or group may possess all three types of property. For strategic legal and political purposes, defenders of particular rights may try to cast their own claims within the strongest category of human property rights. If the conflict is clearly outside this absolute protection, the legal process attempts to resolve the matter in a way that preserves the identified rights at the least cost.

Sax (1971) presents a convincing argument for separating the government role as conflict resolver (in the continuous shifting of values necessitated by private property) from its role as economic developer. If the property owner is prohibited from making use of the property in a way that has no spillover effects, it is a "taking" of property with compensation warranted (Sax 1971, p. 164; Stoebuck 1980, pp. 1083-1089). If the government prohibits a use that has spillover, it is a resolution without taking and no compensation is warranted.

The Sax no-spillover test works poorly if the Coase symmetrical harm definition is used. Sax argues that technological externalities are often physically asymmetrical. Homeowner activities in residential neighborhoods impose no cost to aircraft operators but airplane noise diminishes residential enjoyment. Homeowners impose no technological externalities on smelter space. Rogers (1980), however, applies a physical test (developed by Horwitz (1980) plus his own rationality criteria) to technological externalities to reveal with little difficulty who is imposing servitude on whom.

PROPERTY RIGHTS, LIABILITY RULES, AND EXTERNALITIES

Legal scholars prescribe several alternative rules of environmental protection:

1. Pollution, despoilment, and depletion are only allowed by permission (Michelman 1971). (Violators may be enjoined.) Entitlement is to a clean, unspoiled, renewable society protected by a property rule.

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23. In water projects, the government is entrepreneur (electric generation and sale), economic developer (flood control, navigation), regulator (watershed and water table conservation), and resolver (water rights). The government as developer is a separate property-owning entity. Intervention in the private market in these terms might best be done in a business-like manner.
2. Pollution, despoilment, and depletion are allowed, but damages must be compensated (Michelman 1971). (Nuisance is found but remedy is limited to damages.) Entitlement is to a clean, unspoiled, renewable society, but it is protected only by a liability rule.

3. Pollution, despoilment, and depletion are authorized (Michelman 1971). They can be stopped only by paying off the initiator at his/her price. Entitlement is to protection from those harmed by the actions.

4. Pollution, despoilment, and depletion are authorized but can be stopped by eminent domain (Calabresi and Melamed 1972). The initiator is paid the court-determined value of the taking of the entitlement to initiate harm.

These four rules can be evaluated for transaction (negotiation, litigation, and enforcement) expense and on a basis of their effectiveness in correcting the wrong and deterring further property rights violations.

These rules are usually applied to environmental conflicts with effects that are limited to national geography. This usually means that distributional and equity questions are presumed to balance out.

d'Arge and Kneese (1980) and Meyer (1979) examined international pollution disputes and found that the question of which citizenry won and lost was more important. Using international court cases, resolutions, and declarations, d'Arge and Kneese (1980) identified the following four rules that are substantially different than the domestic rules cited above.

1. Economic efficiency without compensation. In this scheme, the polluter must pay for economically "best" control technology within and without the country, calculated on the basis of mitigation cost effectiveness; however, the polluter is not liable for damages from residual (economically uncontrollable) releases.

2. Economic efficiency with compensation. Like the first rule (above), it includes responsibility for compensation. This is a "full costing" principle.

3. The victim pays. Like the first rule (above), but the victim is responsible for payment. This rule is based on the Coase reciprocity concept. None of the examples cited by d'Arge and Kneese (1980) advocate this rule.

4. Multinational control by autonomous agency. This is not a rule at all, but merely a suggested organizational structure.

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24. State responsibility for damages resulting from pollution originating in their country need not imply that control be paid from tax revenue. Each state would choose its own form of assessment.
SPECIFIC APPLICATIONS OF LEGAL DOCTRINES TO NATURAL RESOURCE CONFLICT

Five legal doctrines apply to these three classes of property: nuisance, taking, public trust, reserved rights, and law of waste. Because the bundle of property rights is shared among private and public interests, they are necessarily overlapping, abstract, interrelated, and subject to continuous conflict.

Nuisance

When the nuisance law is applied to human and private property rights, the court restores an equilibrium through injunction or settlement. Rogers (1982, p. 112) describes the event sequence (see also, Dobbs 1973, p. 332; Atwood 1969; Calabresi 1970; Bromley 1978):

The original appropriator, after all, has been obliged to relinquish (1) something of value—call it a property right, (2) that the appropriator has put to actual use, (3) often with long-standing acquiescence or approval of the state, and the loss is (4) uniquely felt by a single party, and (5) brings disappointment and frustration of investment-backed expectations, perhaps (6) to the full extent of the anticipated value.

The repudiation of temporary "ownership" is the impetus for the Coase article discussed in section III. The presumed misconduct of the loser requires corrective justice. Where possible, the gains from temporary infringement are surrendered to the owner, and the property is restored to its original productivity. When this is not possible, as in cases of human life and health and other irreversible changes, the loser pays cash compensation judged equivalent to the loss.

It is critical that institutions protect against a one-way unintentional transfer of public rights to private interests or to narrow public interests. The encroachment of public rights occurs because private interests can afford to appropriate rights constantly if the public is not diligent. Institutional rules determine the incentive and penalties for encroachment, and they specify the procedures for recovering rights.

Earlier, an explanation was given of how the profitability of temporarily captured public property is capitalized in the value of the private stock. Encouraging this are legal concepts, such as adverse possession, which is the legal mechanism originally intended to legitimize property ownership when abandoned or neglected property is put to good use for a specified number of years by a nonowner. Possession turns to ownership if the original owner does not care enough about the property to notice and protest the trespass.

Because the public owns so much property and so many property rights, it cannot afford to guard against every would-be trespasser or infringer. In the case of pollution, the public may not realize—in fact, has not realized—the consequence of the insult until it has prevailed for many years.
Just Recovery of Rights to the Commons

Two arguments support restoration of public rights without compensation. The first is that permanent entitlement was never intended, and the gains from temporary entitlement are all that can be extracted. In this view, society has reserved the right to preempt the exploitation of certain resources at anytime or to redecide the next temporary entitlement when the resource is no longer beneficially used by the current entitlement holder. The second argument is that the increasing scarcity of these resources requires changing management to allow other citizens the chance to share the advantage. Divestiture is not taking of property rights; it is reinstatement of the original understanding of ownership.

Rogers thus recasts the nuisance theory of corrective justice as a public trust theory of contributive justice. Public trust is discussed later in detail in this section.

It is difficult in practice to separate a recovery of commons rights from a reallocation favoring public ownership, but important exceptions include court prohibition of "spite fences" and the emerging rights to solar access. For example, the Wisconsin Supreme Court has recognized that interference with a solar collector could be a nuisance and New Mexico has adopted similar rules through legislation. Courts generally accept the legislature as the proper forum for striking the balance between private and collective rights and therefore limit their review to whether the record reflects a reasonable basis of decision by authorities.

The court reconsiders

1. Whether the regulation is reasonably related to a permissible police power goal, including new jurisdiction occasioned by increasing population, environmental externalities, and resource scarcity.
2. Whether similarly situated property owners are similarly treated.
3. The impact of the regulation on the value of the property, i.e., the regulation must not render the property totally valueless.
4. Whether the regulation confers a benefit to the community for which it would "ordinarily" have to pay (modified from Sax 1964; Heyman 1968a, b).

A universal nuisance is virtually the same as the economic concept of technological externality. The universal designation implies the variety of resource conflicts with many users and pervasive effects, such as air, water, noise pollution, and resource depletion effects on groundwater or fisheries. Users are numerous; effects are indeterminate and diffuse; appropriation is incomplete, with an increment of the natural wealth remaining economically or technologically out of reach; and private property rights in the resource commons are poorly defined, which often leads to excessive entry and high environmental costs in mutual spillovers.

Rogers found that legislatures are granted broad latitude in accommodating opposing interests free from legal restrictions on taking. Constitutional objections are ineffective and courts frequently revert to the pre-
1800 rationale that if property is not rendered completely useless due to rulings that allow some use, a "taking" does not occur (Stoebuck 1980). Buchanan (1959) argues that compensation is required only in respect to changes in law or changes in structural rules under which individuals make choices, but not with respect to changes within the structure of existing law. Given that there are few legal restrictions on public policy to recover property rights the problem is to decide when such policy is desirable.

Michelman (1967, p. 1184) has identified the following additional inquiries that guide judges in determining whether or not compensation is necessary for government actions: (1) whether or not the public or its agents have physically used or occupied something belonging to the claimant; (2) the size of the harm sustained by the claimant or the degree to which his [sic] affected property has been devaluated; (3) whether the claimant's loss is or is not outweighed by the public's concomitant gain; and (4) whether the claimant has sustained any loss apart from restriction of his liberty to conduct some activity considered harmful to other people.

In cases of physical takeover of uncontested property, the government frequently acknowledges their responsibility to pay compensation and the subsequent process focuses on determining the amount of "just compensation". When there is no physical taking, the court determines whether any loss occurred resulting from restrictions of activities—other than activities that harm other people. If the victim were not merely being constrained from harming others, the court tests whether an unjust "magnitude of harm" worthy of compensation occurred (Michelman 1967, p. 1191):

Thus, the "magnitude" test holds sway only in cases involving neither a physical takeover nor a restriction on activity favoring a "nuisance". Its main targets are regulations directed against "innocent" property uses and nontrespassory devaluations consequent on public development.

These decision rules were developed before sophisticated economic analysis could trace the indirect effects of economic activity. This explains why crude measures are used by courts to determine the magnitude of harm. Often these tests rely on whether a major portion of a specific element of property was taken. By using a proportional measure of an arguable element of property no firm decision-rule is found.

With modern economic techniques court practices can be improved by setting the absolute magnitude of loss that qualifies a victim to seek compensation. The level could be set to reflect the maximum amount that an individual or interest should be expected to bear in the public interest for any one action or for several related actions. This is analogous to absolute thresholds that shift a theft into the category and consequence of grand larceny. Even without a specified minimum claim, there are indirect incentives as a result of legal fees that effectively eliminate many frivolous claims.

The notion that social gain is "balanced" against private losses to determine if compensation should be paid is completely without merit within the context of modern economic theory. If the balancing shows an overall improvement, including the cost of full compensation, the project is econom-
ically justified. The balancing test, however, might be a legal expenditure that allows unstated consideration of more fundamental social conflicts—namely the origin and justification of the gain that is being taken.

Recall from the discussion of property in section II that much of market value may result from the capitalized value of negative externalities or from government subsidy and market protection. Other values may accrue from uses that were not originally predicted (new technology) and are judged unacceptable after that value is capitalized. In such cases, value is taken and economic change (harm to "owners") results. This may be justified if it reflects a deliberate political decision to not acknowledge the harmed parties interests.

In a broad interpretation, compensation need not be paid in the following cases:
1. When the imposition restrains conduct which is harmful to others
2. When compensation is unwarranted within the structure of existing law
3. When the origin of the contested property right is itself unjustified or temporary, including:
   - Illegal, corrupt, or coercive acquisition
   - Value based on capitalized externalities, subsidies or market protection
   - Temporary entitlement to common property
4. When confiscation without compensation is a deliberate social policy
5. When the amount of harm is less than the socially accepted maximum amount of private loss that should be accepted in the interests of public gain and legal efficiency.

This leaves two clearly compensable cases:
1. Taking to benefit the public or private economic development interests
2. Unintentional and substantial harm to individuals or interests as a direct or indirect result of government or business action.

Because no test alone is perfectly discriminating and reliable, the role of judgment is not diminished by the listing of criteria, but at least the basis of decisions is formalized.

Law of Waste and Temporal Nuisance

Law and economics share a strong interest in finding solutions to conflict that further economic growth and wealth. The joint aim is to get the most out of conflicting uses. Rogers calls this a "utilitarian social functional theory" and attributes its origin to philosophers John Locke, David Hume, Jeremy Bentham, and economist Irving Fisher.

In this view private property is the right to claim future profits from
current investment. It is the reward of these future profits that causes property owners to organize human and natural resources for production. Thus, property is a necessary element of the free-enterprise system of encouraging risk taking, research, experimentation, exchange, and growth. By legitimizing private property as a necessary incentive to desirable private action, externalities become serious barriers to efficiency. Because government owns natural resources and businesses, such as power plants, water systems, and navigation systems, it has interest as an entrepreneur. Because government is funded by taxes from enterprise, it has interest as a business partner. Because government represents its citizens, it has interest as an agent and guardian.

Legal theories of temporal nuisance and the law of waste address such issues as stock resource-use efficiency and the sustaining of productivity and natural amenities for future generations (Rogers 1982, p. 145; Powell 1968, subsec. 637–50; Thompson 1924, subsec. 1852; Smith and Boyer 1956, p. 237).

**LAW OF WASTE.** The law-of-waste doctrine imposes an obligation on resource owners not to impair future productivity. For renewable resources, protection is required against irreversible destruction. For stock resources, possible requirements may include strict conservation practices, recycling and avoidance of unrecoverable disposal if private incentives and government management do not properly allocate these depletable resources over time.

Most economists agree that renewable resources should be managed for sustainable yield, but they disagree on the necessity to conserve stock resources beyond that accomplished by the free market. Ciriacy-Wantrup (1968, chap. 18) develops the necessary theory, definitions, and functional tests to accomplish this management. The traditional economic argument is that market mechanisms adjust to scarcity by price-induced conservation and profit-induced technology and innovation.\(^{25}\)

Analysts judge the adequacy of resource supply on several bases:

1. Physical scarcity and wealth preservation
   a. Intergenerational resource budgeting\(^{26}\)

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\(^{25}\) See Hotelling (1931), Barnett and Morse (1963), Gordon (1967), Cummings (1969), National Academy of Sciences/National Resource Council (1969), Nordhaus and Tobin (1972), Schultz (1974), Weinstein and Zeckhauser (1974), Norgaard (1975), Beckerman (1975), Dasgupta and Heal (1979), Smith (1979, 1980), and Simon (1980). These authors generally show that problems of resource depletion are not serious because of the substitution principle in the price mechanism. Their analyses are strictly limited to operating-level efficiency criteria. Careful examination of nonrenewable resource supply frequently confound the use of the simple economic constructs, such as the excellent paper by Bohi and Toman (1983) for one such study. They show that neither short-run nor long-run response to price allocated resources as the general equilibrium theory would suggest.

\(^{26}\) Daly (1980), Georgescu-Roegen (1976), Heilbroner (1980).
b. Generational transfer goals

2. Economic conservation criteria
   a. Market scarcity
   b. Extended economic scarcity

Commonly presented data supporting these indicators include consumption per capita, employment per unit output, energy per unit output, minerals per unit output, relative costs and prices, net imports (vulnerability and self-sufficiency), reserves, and potential for meeting requirements.

TEMPORAL NUISANCE AND PUBLIC TRUST DOCTRINES.* One of the most controversial and perplexing elements of economic theory is the treatment of time. Resource economists have generally followed the procedures of investment analysis and discounted future values. The wealth of future generations is only considered insofar as the current population considers the future as part of its own satisfaction. At current interest rates, this effectively precludes consideration of the future. For example, consider how insignificant future values are at accepted discount rates. The present value of $1 million of that future satisfaction for combinations of time and interest rate is shown below.

<table>
<thead>
<tr>
<th>Interest Rate (%)</th>
<th>Time (yr) 25</th>
<th>Time (yr) 75</th>
<th>Time (yr) 100</th>
<th>Time (yr) 150</th>
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<tbody>
<tr>
<td>5</td>
<td>295,303.77</td>
<td>25,751.03</td>
<td>7,604.49</td>
<td>663.14</td>
</tr>
<tr>
<td>10</td>
<td>92,296.00</td>
<td>786.23</td>
<td>72.56</td>
<td>0.62</td>
</tr>
<tr>
<td>15</td>
<td>30,377.63</td>
<td>28.00</td>
<td>0.85</td>
<td>0.01</td>
</tr>
<tr>
<td>20</td>
<td>10,482.60</td>
<td>1.15</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

The calculation shows, for example, that is is worth no more than $1.15 to assure $1 million of benefits to a person 75 years from now at a 20% discount rate.

Economic defenses of this procedure take two different approaches. On the one hand, it is argued that there is no effective demand by decision-making citizens for the mid and distant future. The calculation is thus a

*This section was coauthored with Timothy Such of Morrison & Foerster (plaintiffs' attorneys in the Mono Lake litigation), San Francisco, California.

27. Rawls (1971) recommends that each generation pass on enough developed resources (wealth) plus natural resources to make the next generation as well or better off in prospect than the departing generation. Page (1977) defines a minimal requirement of keeping the resource base essentially intact over time.

28. In this view, market scarcity is based on relative market price (see Schultz 1951; also references in note 25 supra).

true reflection of public preference and there is no problem. On the other hand, it is argued that resource scarcity is solved by new technology and by free market mechanisms. Thus, the problem is solved. Tampering can only defeat the desirable automatic solution.

The conventional economic perspective—that market forces protect future generations—is not accepted by all economists and it is generally rejected by conservationists. Since the origin of law, special efforts have been made to supplement market protection of important natural resources. This body of law and custom is called the public trust doctrine. It is an institutional level control that applies to property rights of rivers, oceans, seashores, and common lands to protect public interests, such as access, navigation, fishing, and grazing. Bishop and Ciriacy-Wantrup (1975) and Sax (1970, note 30) describe and cite successful commons management of water resources; agricultural and forest lands; shorelands; parklands, fish and game; and other natural resources.

Elements of public trust law are evident as far back as the Code of Hammurabi, but the first well-documented recognition of trust principles appears in Roman law (Sax 1970, 1980). Roman trust law recognized property rights of citizens in common property resources, particularly waters and associated resources, such as fish and game. Furthermore, Roman trust law established the principle that certain common property resources were to be guarded in perpetuity against infringement. Roman law termed such resource res communis or res nullius. While Roman law provided a detailed inventory of those resources that were subject to public trust protection, the historic record does not explain the mechanisms that were available to enforce these rights nor does the record provide a philosophical and ethical justification to rationalize this legal framework (MacGrady 1975; Althus 1978; Sax 1980; see note 30 supra).

After the fall of the Roman Empire, elements of public trust doctrine reappeared and evolved independently within English, French, and Spanish common law. English common law contributes the most toward clarification and expansion of public trust rights as they apply to the United States. In England, Parliament was the sovereign and guardian of society's trust resources under a set of guidelines that limited their authority by mandating


31. "Fugitive" resources are those that are "reduced to possession" before they are owned. Fugitive resources include three categories according to the system of institutional control; an uncontrolled fugitive resource is called res nullius. Fugitive resources in private, but joint, control (e.g., oil and gas reserves underlying several landowners) are part of private property. Fugitive resources under strict institutional control in which a number of owners are coequal in their rights to use—not transfer—the resource are res communes. Thus, the term commons correctly refers only to res communes (Ciriacy-Wantrup 1971, pp. 43-45; 1968, pp. 141-45). Heirs of a common owner become co-owners through their membership in the group (Bishop and Ciriacy-Wantrup 1975, note 4 and text). Common property subject to public trust limits the group choice to uses that sustain the resource integrity in perpetuity.
conservation and prohibiting permanent transfer to private interests. Ex­
clusive or substantial modification of public trust resources within these
limits required the explicit consent of Parliament. English law primarily
focused application of trust law on disputes involving seashores or tidal
waterways because these were England's most critical threatened commons.

American public trust law is based on this English common law heritage.
Recognition of trust principles can be traced to colonial decisions, and the
doctrine was part of America's early law after independence.\textsuperscript{32} American
courts have continued to expand the applications of trust principles.

To assure growth and protection of commerce between states and for
military purposes, the new American government asserted a right to protect
navigation on major waterways.\textsuperscript{33} This application of the commerce "power"
came to be known as the "navigation servitude". Courts have consistently
recognized the right of the federal government to remove impediments to
navigation based upon this concept. State navigation servitude is judi­
cially recognized when not in conflict with federal servitude. Navigation
is a mechanism of public trust enforcement. This servitude imposed a supe­
rior governmental easement on the beds and shores of navigable waters up to
the high water mark, without claiming nominal title. This allowed abutting
landowners to use the public property so long as there was no interference
with navigation.

Along with judicial acceptance of navigation servitude came the paral­
lel development of a broader public trust doctrine, based on the concept of
state sovereignty in coastal and noninterstate navigable waters, the beds
and shores of such bodies, and in living resources inherent to such lands
and waters. Actual ownership resides in the citizens of each state and is
held in trust for the people by each state's legislature (Dunning 1980,
pp. 364-365; Sax 1970, p. 478). This responsibility results from state
acceptance of English common law, or subsequent U.S. common law, as a con­
dition for entry into the union. It can be complemented by pre-colonial or
pre-statehood laws and customs, including those of Native Americans and
Hawaiians. Courts have termed this assertion of state sovereignty as an
"easement" which is variously protected up to mean high tide, high tide, or
high-water mark. From this premise, courts have consistently recognized the
supremacy of trust easements over competing private property rights.

It is under public trust doctrine that common properties are dedicated
to the public in perpetuity (Sax 1970). Sax suggests that public trusts
impose three restrictions on government authority: (1) the property must be
used for public purpose and held available for general public use; (2) the
property must not be sold, even for cash equivalent; and (3) the property
must be maintained for particular types of use (Sax 1970, p. 477).\textsuperscript{34} Excep­

\textsuperscript{32} See cases collected in Arnold v. Mundy 6 N.J.L 1, 1 Halsted 7 (N.J. Sup.
Ct. 1821) and Martin v. Waddell 41 U.S. (Pet.) 367 (1842).

\textsuperscript{33} Gibbons v. Ogden 22 U.S. (9 Wheat.) 1 (1824).

\textsuperscript{34} For a chronological sampling of recent public trust literature see Sax
tions to this basic rule are allowable if the modifications under considera-
tion have been explicitly approved by a state legislative body, and if the
nature of the modification furthers public uses of some aspect of the
trust. Finally, trust law provides that courts are empowered to compel
reexamination of the legitimacy of historic trust resource allocations, and
can, if necessary, invalidate old agreements and reallocate those rights to
trust resources.

The requirement of perpetual public ownership and control is critical,
for it assures that future generations will have access to these important
resources. The public trust doctrine establishes the public rights to a
healthy environment and emphasizes the fact that private interests cannot
gain property rights to pollute or despoil by even prolonged trespass or
emission. Public trust protects some public wealth from private confisca-
tion, just as some private wealth is immune from public confiscation.
Public trust resources, including water, must remain under public control
by actual administration, close oversight, or other means (Rogers 1982,
pp. 239-40).

An even stronger interpretation is that private ownership or narrow
state management of some types of resources is incompatible with protection
of the property rights for future generations and the avoidance of intoler-
able spillovers within the immediate generation. In presenting this inter-
pretation Rogers (1982, p. 241) cites Alexander (1967), Fried (1977), and
Hubin (1976).

Public trust doctrine differs in detail from state to state, but it is
generally based on the protection and perpetuation of certain natural re-
sources held in trust by government. The public trust doctrines require
fair procedures, carefully justified judgments, less partial bias with re-
spect to current versus future users, and provides the state with procedural
and substantive mechanisms to reconsider the allocations of certain natural
resources.

Legal scholars have fashioned varying interpretations of trust theory.
Wilkinson (1980) states:

It imposes limits and obligations on governments...and this has
evolved recently into the prevention or significant deterioration
of a broad range of public rights in public resources.

Sax (1970, p. 509) suggests that the trust doctrine

[I]s not so much a substantive set of standards for dealing with
the public domain as it is a technique by which courts may mend
perceived imperfections in the legislative and administrative
process.

Another interpreter suggests that much of public trust theory consists of

[A] problem in cost-benefit analysis, but...(in cases where the
courts)...have felt themselves unable to make their decisions on
 overtly normative and economic grounds (see note 30 supra, p. 763).

35. See Marks v. Whitney (491 P.2d 374, 1971); People v. California Fish Co.
(138 p. 79, 1913); and City of Berkeley v. Superior Court of Alameda County
(606 P.2d 362, 1980).
Sax (1980) and Rogers (1977) believe that the broader purpose of the trust doctrine is to protect the state against exploitation of common property resources in a manner that is "uneconomical" or threatens to destabilize society's expectations of uses commonly made of these resources (Sax 1980, pp. 192-93). This broad definition of "economical" goes beyond efficiency criteria and beyond concern for current equity to encompass sustainable yield, future generations, and basic environmental integrity.

The public trust doctrine is not confined to the resource categories that have been historically protected. Contemporary trust doctrine comprises a fundamental yet highly adaptable principle of law governing common property resources that can evolve in response to changing values and of threats to trust resources. As society develops a more comprehensive understanding of the ecological, cultural, and economic values of trust assets, the trust doctrine serves as a mechanism to incorporate this new knowledge within the existing framework of property law. Sax cites the democratizing function of the trust doctrine and its ability to accommodate and express changing social priorities (Sax 1980, pp. 192-93).

When the public trust doctrine is applied to common property resources, other than navigation, there remain some ambiguities over state public trust authority. Is state sovereignty predicated on police power? on common law? or perhaps on a broad and evolving theory of property rights? (Dunning 1983, p. 10147; 1980, p. 364). These conceptual distinctions determine whether the state must pay compensation due to "taking for a public purpose" when restrictions are placed on the use of private property involving trust resources. This judicial interpretation has enabled courts to protect trust resources without having to pay compensation.

In the face of these dilemmas, the courts have a record of decisions that can be organized according to the following categories based on the comprehensive analysis of Johnson (1980, pp. 258-60):

36. Most commentators agree that the state's power stems from the unique and "common heritage" aspect of the protected property, rather than from a need to protect public health and safety, though there exist trust takings based upon police powers. Bosselman, Callies, and Banta (1973, pp. 218-19) emphasize this distinction by reference to Just v. Marinette County (201 N.W.2d 761 (1972):

The Court noted that the lakes and rivers were originally clean and said that the State of Wisconsin has an obligation in the nature of a public trust to "eradicate the present pollution and to prevent further pollution." It found that the regulation sought to prevent harm to "the natural status quo of the environment," and was not designed to produce a public benefit for which compensation would be required.

Recall the discussion earlier in this section regarding the justification for uncompensated taking as a result of a conscious political preference in contrast to uncompensated recovery of rights that were temporarily entrusted to other interests.
1. Court determination of public trust resources
   a. Affirmation of public trust easements
   b. Certification of new public trust applications

2. Court oversight of public trust administrative procedures
   a. Requiring comprehensive resource planning
   b. Requiring broad-participation in decision-making
   c. Requiring express legislative review and approval

3. Court challenge to administrative decisions
   a. Tests for excessive delegation of trust authority
   b. Tests of whether allocation is in the general public interest

4. Court review of public trust recovery
   a. Affirmation or Rejection of legislative judgments of whether
      previous legislative actions were in conflict with trust obligations
   b. Invalidating legislation which authorized private usurpation of
      public trust resources

5. Court review of mitigation and compensation decisions.

The conspicuously missing inquiry is whether—within the authorized
authority of the public trust administration—the combination of charges,
fees, and regulations result in the best use of the resources. In this re-
spect the court relies primarily on the belief that comprehensive procedures
with broad participation will result in proper decisions. This, in turn,
depends on the skill of the administrators, the equity of effective repre-
sentation, and on the alternatives that are available to the decision
makers.

From an economic perspective the tendency to not charge users for the
value of public trust resource—distinguished from the cost of delivering

37. People v. California Fish Co. (138, p. 79, 1913), and Marks v. Whitney
   (491 P.2d 374, 1971).
38. National Audubon Society v. Superior Court (33 Cal. 3d 419, 658 P.2d
   709, 1983).
40. Meunsch v. Public Service Commission (53 N.W.2d 514, 55 N.W.2d 40,
    1962).
    v. Dept. of Public Works (244 N.E.2d 577, 1969), and City of Berkeley v.
    Superior Court of Alameda County (606 P.2d 362, 1980).
44. Priewe v. Wisconsin State Land and Improvement Co. (67 N.W. 918, 1896).
45. City of Madison v. State (83 N.W.2d 674, 1957), State v. Public Service
    commission (81 N.W.2d 71, 1957), and City of Milwaukee v. State (214 N.W.
    820, 1927).
suit to limit diversions by Los Angeles from tributary streams of Mono Lake, based upon the public trust doctrine. Plaintiffs asserted that the rate of diversion caused a reduction in lake volume, resulting in concentration of lake salinity, which threatened the lake food chain, and exposure of peninsulas—allowing predator access to former islands that harbored nesting birds.

The lake had a history of navigation, largely related to tourism and lumber transport. The Audubon Society contended that this major inland waterway was subject to public trust protection which may prohibit destruction altogether, but at a minimum, required explicit legislative evaluation and approval of lake-threatening diversions. Plaintiffs contended that absence of explicit legislative approval allowed courts to independently review evidence of trust impairment, and, if necessary, to modify the terms of an appropriation license, even if the water diversion had continued for 40 or more years.

The CWRCB opposed the Audubon position, arguing that the plaintiffs had failed to exhaust administrative remedies and that there would be destabilizing economic consequences to coordinated water planning if courts evaluated water rights. The agency also asserted that it had incorporated review of water diversion impacts on trust resources in recent decisions despite negligence when they thought they lacked authority to do so (Guy 1982, p. 681).

Los Angeles claimed that their water rights were vested and superior to competing claims, including public trust, because the consumptive use was for urban use (highest value), investments had been made in good faith to exploit this resource, and because they had exercised their right for a substantial period of time. On these bases, Los Angeles claimed that any diminution of their water rights required compensation from the State (Guy 1982, pp. 678-79).

The California Supreme Court decision validated the application of trust principles to inland navigable waters, and recognized the state's inherent public trust authority to modify existing water rights, without compensation, if trust resources are seriously threatened. The court reiterated the state's right to enjoin allocations of resources affecting trust resources even though this practice met with state sanction for decades. However, the court qualified this principle by acknowledging the necessity of providing water for distant urban needs, with the inevitable resulting impact upon trust resources (Dunning 1983, p. 10147).

The court reasserted the state's sovereignty in trust resources, extending this authority to non-navigable tributaries feeding navigable waters even though the state may have previously granted conflicting appropriation rights. It recognized the state's authority to reexamine the necessity of rights to water when their exercise threatens trust resources even though

49. The Audubon Society contended that alternate water was available at comparable costs and that demand management options within Los Angeles might eliminate the need for Mono tributary water. The court decision noted this point but did not review its validity (Stavins 1983).
urban and agricultural uses retain technical supremacy. The court also em­powered and directed the responsible state water agency to henceforth accom­modate public trust requirements when acting upon water application (Dunning 1983, p. 10146).

The Audubon opinion clearly asserts state authority to reallocate major uses of trust resources, in spite of competing claims and without compensa­tion. The decision follows the appealing logic of protecting resources that have a special character and value to the public. It is compatible with the economic concept of reducing externalities and it clearly places the con­tested property under the control of the sovereign. It explicitly considers the interests of future generations. It is an important first step in ex­tending public trust doctrine to cases of indirect physical effects (pro­tecting navigable waters from destruction by tributary diversion) that may now be extended to other indirect threats to public trust resources, such as economic effects experienced through the market.
V. EXISTING LIMIT TO COMPENSATION

The need for compensation beyond that dictated by the free market results from externalities. The overall effectiveness of compensation depends on the comprehensiveness and accuracy of each step in the legal process.

Compensation may be limited by practical constraints such as lack of knowledge about the harm or insufficient funds to press the case; by legal constraints, such as inaccessibility of courts or impractical burdens of proof; by analytical inadequacies, such as underestimates of physical damages or economic consequence; and by social limits, such as cultural ambivalence or discrimination. Incomplete compensation can also result from pervasive damages that are cumulatively significant but are not serious enough for individuals to seek relief. In this section, these limits are organized to establish a diagnostic measure for examining the case studies.

The first sections of this report outlined the organizing principles of the compensation process: establish ownership and type of attendant rights and responsibilities; identify cause of confiscation, infringement, damage, or destruction; establish liability; estimate damages and punitive relief; select a combination of award, mitigation, and injunctive relief; collect and distribute awards; and otherwise enforce the settlement.

Table 3 presents categories that explain why compensation tends to be inadequate. The table is divided into three columns. The center column lists the categories according to the cause of their exclusion from compensation, and the right column lists one or more examples. The left column suggests that dollar values of each uncompensated category might be estimated. Errors in categories and calculation can be cumulative or offsetting. It is important to avoid a systematic bias that over- or undercompensates victims because this would mean that resources are misused and that the economy is less than just.

The limits and barriers to compensation can also be organized according to the scientific uncertainties and institutional inadequacies that prohibit resolution.

Each of the barriers to compensation can be relaxed by changes in institutions and policies that must also balance legal proof of liability and maintenance of property rights. The balance necessarily involves a tradeoff among four classical judgment outcomes for which this aspect of decision theory was formalized for statistical tests of hypothesis. The designation of type I and II errors in the following presentation of judgment outcomes presumes that the null hypothesis of the status quo is correct. Judicial and regulatory procedures evolve to avoid the two types of error while favoring correct judgment. Compensation is intended to minimize the sum of these errors. If there is a bias in either direction it can be corrected by changes in the institutional level rules, such as property rights, liability rules, legal procedures, and insurance requirements.
<table>
<thead>
<tr>
<th>Amount</th>
<th>Category</th>
<th>Example</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Nonhuman values</td>
<td>Value of ocean to sea turtles Value of earth to God</td>
</tr>
<tr>
<td></td>
<td>Undecided consequence</td>
<td>Ozone in atmosphere</td>
</tr>
<tr>
<td></td>
<td>Undetected damage</td>
<td>No examples by definition</td>
</tr>
<tr>
<td></td>
<td>Unknown/unproven cause</td>
<td>Acid rain</td>
</tr>
<tr>
<td></td>
<td>Unknown perpetrator</td>
<td>Illegal toxic disposal</td>
</tr>
<tr>
<td></td>
<td>Not liable</td>
<td>Standard of care</td>
</tr>
<tr>
<td></td>
<td>Preempted/avoided</td>
<td>No standing to sue</td>
</tr>
<tr>
<td></td>
<td>Not legally accepted value</td>
<td>Aesthetics and option value Non-game species</td>
</tr>
<tr>
<td></td>
<td>Economic underestimate</td>
<td>Limited economic theory Uncalculated values Neglect of future generations</td>
</tr>
<tr>
<td></td>
<td>Unawarded damages</td>
<td>Unrepresented victims Judicial error Political &amp; economic coercion</td>
</tr>
<tr>
<td></td>
<td>Uncollectable</td>
<td>Disbursed profits Strategic bankruptcy No real ability to pay</td>
</tr>
<tr>
<td></td>
<td>Settlement cost</td>
<td>Legal fees and court cost Research &amp; expert witnesses Opportunity value of plaintiffs' time</td>
</tr>
<tr>
<td></td>
<td>Payment to victim</td>
<td></td>
</tr>
</tbody>
</table>
FOUR JUDGMENT OUTCOMES

<table>
<thead>
<tr>
<th>Proper Ownership</th>
<th>Reject Status quo</th>
<th>Accept Status quo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE I ERROR*</td>
<td></td>
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<tr>
<td></td>
<td>take rights</td>
<td>correctly pre-</td>
</tr>
<tr>
<td></td>
<td>from owners</td>
<td>serve rights</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Wrongful Ownership</th>
<th>Accept Status quo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE II ERROR†</td>
</tr>
<tr>
<td></td>
<td>do not return</td>
</tr>
<tr>
<td></td>
<td>rights to owners</td>
</tr>
</tbody>
</table>

*Overcompensation—reduces desirable projects and thus lowers living standards.
†Undercompensation—increases uneconomic projects and thus lowers living standards.

PUBLIC AMBIVALENCE TOWARD COMPENSATION

Individuals and groups may be ambivalent about compensation because of the following cultural, financial, and psychological reasons.

• Lack of financial resources to support investigation and litigation
• Fear that complete compensation would be so expensive to business that the economy would collapse or that other undesirable social outcomes prohibit complete compensation
• Belief that certain risk is an inherent and accepted part of living and working, or the belief that individuals make informed voluntary choices to accept risk in exchange for personal advantage
• Resentment that liability awards give others large cash awards that are unearned or "windfall", i.e., an appraisal of awards without an offsetting appreciation of the damage
• A money veil that makes awards seem exorbitant because the one-time settlement seems so much larger than monthly salaries or other familiar quantities of money
• A lack of sympathy for victims because of racial, national, anthropogenic or social perspectives
• Fear that strict rules of compensation may backfire, e.g., strict liability for manslaughter and injury by drinking drivers has little overall support among drinking majorities; those guilty of taking the rights of others are an interest group

50. Rogers (1982, p. 231) cites the failure to compensate Japanese-Americans for relocation and property confiscation in World War II as an example of how lack of public sympathy affects compensation. See also Burke (1969).
• Mistrust of the legal system's ability to award real compensation
• Belief that the high cost of settlements are undesirable waste, particularly when lawyers get a large part of the money
• Failure to receive compensation, thus preferring that other victims also remain uncompensated.

Still, in the United States, the amount of public interest in compensation influences actual awards by (1) influencing legislation that defines property rights, establishes procedural rules, and clarifies public values; (2) directing law enforcement, data collection, and other public efforts necessary for legal action; (3) supporting research to reduce uncertainty over cause and effect and damage estimation; (4) encouraging protection of public values; and (5) acknowledging the legitimacy of compensation when serving on juries and by controlling judicial pragmatism.

LIMITS TO LEGAL ACCESS FOR RELIEF

Victims do not always have the right to seek recovery in court. Primary and secondary victims of an action must have "standing" or a right to sue, must not be preempted by other authorities, and must fulfill the statute of limitations requirements.

Burden of Proof

The burden of proof issue may be the most important barrier to legal relief, partly because current scientific techniques are insufficient to establish causal links between exposure and disease. The excellent correlation between disease incidence in laboratory animals and humans exposed to toxic substances has not yet led to useful rules for weighing evidence. Causation is difficult to prove because some disease results years after exposure; because of questions of whether data from relatively high levels of exposure in animals can be extrapolated to the lower exposure levels experienced by humans; because laboratory animals and humans exhibit variations in sensitivity to specific substances; because humans may be less healthy (or already sick) than uniformly healthy and well-fed laboratory animals; and because random complicating events, such as exposure to promoting agents and synergistic effects, cannot be evaluated.

Science does not offer the means to clarify proportional liability. This problem is evident in the acid rain debate, where the problem is recognized but the percent contribution of different sources and the remedy are not clear. In this situation, no change in legal standards may be sufficient to address the problem because proof of cause and effect is beyond scientific understanding (Doniger 1978; Latin 1982).

Standing to Sue

Standing refers to the legal concept that parties in a case must have a
direct stake in the outcome of a decision. Where the public in general is involved, the right of standing to sue is not always available to public interest groups. It was liberalized by the 1965 Scenic Hudson decision \(^{51}\) on the basis of statutory authority, but in 1981 the Supreme Court substantially reduced private rights to sue for environmental quality under the Rivers and Harbors Act of 1899 on a constitutionality basis. The Supreme Court reversed a lower court decision that had allowed the Sierra Club to question the merit of a large California water diversion (Ford 1982). \(^{52}\) The Sierra Club alleged that the diversion would alter navigation and destroy fishing and farmland, while exacerbating pollution and salt water intrusion in the Delta and San Francisco Bay. "Standing to sue" may be denied when a government agency is assigned to protect the rights, even when the agency chooses not to exercise its duty.

The Supreme Court ruled that congressional silence on the subject of private rights of action demonstrates that they are not to be allowed. Lower courts had found implied private rights of action when a statute does not expressly provide such relief; the Supreme Court had previously authorized this interpretation. \(^{53}\)

This substantial reduction in private rights of action could severely reduce enforcement of environmental legislation, particularly during unsympathetic or anti-environmental administrations. Citizen-suit provisions in legislation help prevent these problems.

Preemption

When the government acts through policy or projects, it is in its organizational interest to avoid paying compensation for damages. By avoiding full compensation, more projects are deemed economic and the appropriation process is simpler because less money is involved. These special circumstances can be divided for conceptual convenience into two categories: (1) cases where government has authority to act without compensation and (2) cases where the government refuses to let itself be sued.

There is a vague distinction in law between cases where the government can "take" property through "police power" without compensation and cases where eminent domain with compensation is exercised. The distinction is made on a basis of whether the legislature or courts are justified in contravening the literal meaning of constitutional protection against taking under the Fifth Amendment.

Separating cases of taking is substantially complicated by the difficulty of distinguishing cases where "taking" of otherwise legitimate property rights is justified for public purpose and cases where the rights are properly in the hands of the public and the action is one of restoring those rights that private interests have illegitimately infringed. For example,

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does a company have the right to pollute and sell that right? Or have they merely been infringing on the public right to clean air and must somehow secure public permission to continue? Bosselman, Callies, and Banta (1973) describe these distinctions in the context of zoning. 54

Refusal to Be Sued

In some cases a sovereign government can refuse to let itself be sued. The government, for example, still will not entertain suits by members of the military damaged by atomic testing. 55 In 1946, the Federal Tort Claims Act considerably broadened private litigation against the U.S. government by granting blanket permission for suits against the government where the wrong would have made an ordinary citizen liable except for "misrepresentation" and other certain kinds of suits.

This reform conforms to a principle of making the government equal to private entities when it engages in business-like development activities, while preserving immunity from litigation contesting regulation, taxes, and other governing activities under the police power.

When the government is charged with the responsibility of protecting the public but does not exercise that responsibility to the satisfaction of victims, private litigation may be preempted. In 1983 the Supreme Court will decide whether federal preemption of nuclear regulation prevents victims from suing private companies for punitive damages.

LIMITS TO COMPENSATION FROM ERRORS AND OMISSIONS IN DAMAGE ESTIMATION

Most economists would make a distinction between compensation that restores the property and compensation that restores the value of the property. In the first case, the property is returned to the owner in the condition prior to the damage, including the value of lost utility during restoration and the complete cost of settlement. In the second case, sufficient money or alternate property to restore its prior "satisfaction" is given to the owner who does not, however, recover the original property.

The second form of compensation is necessary whenever property cannot be physically restored and is desirable on economic grounds whenever the original owner can be satisfied at less cost than restoring the property.

Estimates of loss are most accurate for commonly traded objects. Estimates are less accurate (thus seldom recognized) for non-market, unique, or irreplaceable property or when health and life is destroyed.

To assure economic efficiency and equity, compensation values must be as accurate as is practical and should be distributed equally around the true mean. Any systematic bias in estimation or any class of property owners who are somehow excluded from compensation can adversely affect economic efficiency.

An individual assessment of the value of property may exceed the market price that is established by supply and demand. It is generally the case that a person buys a product only when it is more valuable to them than its price and, therefore, more valuable than other consumption available at the same price. This advantage of ownership is called "consumer surplus".

In many cases the consumer surplus can be restored by another purchase from the market. In other cases, property is less valuable to the individual than its cost in the market. Satisfactory substitutes in kind or cash make compensation complete in these cases.

In cases where there are no market substitutes or where a particular object has personal, sentimental, or collective value, the amount of compensation must necessarily be greater than market price; and even very large payments may be insufficient to restore the original consumer satisfaction. Estimates of willingness-to-sell exceed estimates of the willingness-to-pay by three- to twenty-fold because people are not limited by their income when they offer a possession for sale (Bishop and Heberlein 1979; Meyer 1979; Brookshire et al. 1982). Cases of irreplaceable values include loss of health, life, liberty, and religious or ethical values, genetic diversity and abundance, wilderness, original art, and cultural treasures.56

Substantial problems exist of valuation beyond those of estimation technique. Most techniques use changes in market value or quasi-market values as a measure of effect. This is deficient because changes are ignored at the institutional and policy levels and because changes are tacitly legitimized in price that does not reflect changes in value.

This change in price without a change in value can be understood with three examples. First, consider the economics of natural-hazards information. When the government reveals a hazard that will cause damage (an actual example is the emerging volcano in northeast California), the property price will decline because the probable safe use-interval of property is shortened. But the government has not changed the ability to use property; it has merely provided information that the price is higher than the value. The effect of the information is a saving because futile investment is discouraged and salvage is commenced. Second, consider the problem of controlling toxic waste. If a company is causing more damage in destruction of health or increases in costs to others than the value they provide in goods and services, it is not a loss to close the operation even though the

stock value may collapse. Third, consider the problem of unknown risk. If a company is not allowed to expose the public to uninsured risk (or cannot afford adequate bonding and insurance), it is not a loss to prohibit their activity because their profits must be sufficient to pay all costs.

There are particularly perplexing problems of conducting water-project analysis as though the status quo were based on sound financial decisions. Uneconomic projects from the past can drastically color the sense of legitimacy, particularly when projects are devoted to agricultural support that would otherwise be provided privately. When government acts as developer, the standards of private enterprise are appropriate.

Consider the magnitude of the private gains from the California's Central Valley Project (CVP). Water is sold at an average price of about $5/acre-ft by the U.S. Bureau of Reclamation. Levy (1982) calculated the cost of water delivery (no imputed value of in-stream or alternate uses) at $24/acre-ft on an historical accounting basis to recover imputed property taxes, amortization, and interest. Using replacement cost of the CVP capital plant, the price would be $48/acre-ft. At long-run incremental cost—the cost of delivering additional water from new capacity (again using "free" water)—the price would be $324/acre-ft. Using a slightly different analysis, LeVeen and Goldman (1978) estimated a per-farm present value subsidy of over $352,000 from new water ($25,800 subsidy/farm/yr).

The historic failure to manage water for the general public and instead to deliver the profits to select groups does not mean that changes in existing entitlements are "costs".

In these cases, the assessment of the full cost of resource damage, including costs beyond the operating level, is important to the proper functioning of the economy. Otherwise, the resource values will be compromised to less valuable consumer and profit gains.

The controversy over the economic valuation of human life and other non-market resources has not been resolved in economic theory or law. Courts have trouble apportioning responsibility between risk-knowledgeable, semi-voluntary, or careless victims and the initiator or benefactor of the activity causing the harm. The calculation of damage expressed in terms of monetary compensation is well reviewed in the literature.57 The broader

57. Estimates of the cost of specific environmental damage from pollution are found in Barrett and Waddell (1973), Heintz, Hershhaft, and Horak (1976), Ridker (1976), Maler and Wyzga (1976), and Hodge (1976). The benefits of environmental improvement are reported in Bohm (1972), Dornbusch (1975), Binkley and Hanemann (1975), Bell and Canterbury (1976), Blank et al. (1977), Coughlin (1976), Freeman (1979) and Gramlich (1977).

aspect of designing regulations on a basis of these monetary estimates is presented in Lane (1981).

INABILITY TO COLLECT

The last step in the compensation sequence is to collect for damages. This is a mere formality under the best of circumstances, but with alarming frequency collection is limited by institutional rules, and the lack of insurance or financial resources.

In disputes among individuals, defendants are often "judgment proof" because their income and assets are insufficient to pay for the damage they have done. Defendants can declare bankruptcy to avoid responsibility and may even keep a major part of their assets. In other cases they can evade court orders and collection agents by other legal mechanisms. The inability to enforce collection fits a pattern favoring perpetrators over victims.

Corporations enjoy similar limits to financial responsibility as a result of a nineteenth century decision to increase the ability of business to raise capital from a large number of investors. The implications of this simple institutional fact are astounding, and new implications for liability and compensation are still emerging. Corporations are separate legal entities that allow investors to purchase stock without concern for their own wealth beyond the stock value because creditors, including victims of business activity, will not have access to stockholders' uninvested wealth. It also shifts control from owners to central decision making by the board of directors.

The corporation structure was primarily created to assemble the vast sums necessary to finance industrialization. At that time investors were primarily concerned about liability for the debts of the company should it become insolvent from business losses, not the liability for damage awards, should it become insolvent from liability suits. Industrialization, hazardous technology, and toxic substances have added new dimensions to the risk from business activity. In normal business transactions, creditors voluntarily enter agreements in full knowledge of the corporate limits and frequently monitor solvency to assure payment. There is no similar private control of business liability from toxic pollution or injury. The victims of toxic injury do not voluntarily enter into an agreement and do not discover the harm until damage is done.

When a corporation consents to a liability claim, there are several sources of compensation. In the order of probable depletion these are return of the property, insurance, corporate reserves and retained earnings, borrowing, including time-payment of liability awards, partial property liquidation, and bankruptcy (complete liquidation).

The corporate structure allows speculators to place the public at risk far beyond the value of corporate assets and mandatory insurance. Corporations are sometimes organized around a single risky venture as a matter of liability strategy. Wholly owned subsidiaries can lose their assets without
threatening the capital value of their parent corporation. Because dividends are periodically issued, the stockholders can earn substantial amounts of money while unnoticed or unlitigated damages accumulate. The paid-out dividends cannot be recalled to satisfy the claims of the victims.

In a few cases, the presumption of public advantage from risky large-scale technology has resulted in even more corporate privilege. With regard to nuclear power plants, the federal government has taken the unusual step of providing accident insurance at taxpayers' expense. Corporate liability is completely limited to the insured value even though the expected damage could exceed insurance by hundreds of millions of dollars. In effect, such a limit of liability presumes that it is preferable to have victims, rather than stockholders and taxpayers, bear the costs.

The toxicological character of modern industry allows a corporation to engage in activities with potential consequences for harm that are far greater than the value of assets. The frequent distribution of profits allows investors to profit even when the enterprise cannot pay its ultimate obligations because these externalities take so long to surface. The latency of disease and the statute of limitations further reduces corporate financial concern.

Lessons from the Manville Bankruptcy

Consider the recent experience of the Manville Corporation liability strategy. Manville and its predecessor Johns-Manville were major producers of asbestos and asbestos products, products found to cause lung cancer, mesothelioma (cancer of the lung lining), and asbestosis (an emphysema-like malady).

Asbestos was suspected of causing serious lung damage as early as 1900. In 1933, Johns-Manville settled its first asbestos liability suit for $33,000 and a promise by the plaintiffs' attorney not to represent any other such employees. The major uses of asbestos, however, occurred after 1933.

A study by doctors at Mount Sinai Hospital in New York estimated that 235,000 people will die of asbestos exposure between 1982 and 2027. Peak annual deaths will occur around 1990, approximately 50 years after peak exposure at World War II shipyards where asbestos was heavily used (Kelly 1982). A study commissioned by Manville predicted 52,000 ultimate claims with average awards of $40,000 ($16,600 average award plus $23,400 Manville legal fees) for an ultimate estimated liability of $2 billion (Maxwell 1982). Victims' legal fees probably average 30 to 35% for a net settle


59. See radical tactic: Manville's big concern as it files in chapter 11 is litigation, Not Debt, Wall Street J. 27:1 (August 1982).
ment of $10,800 to 11,600.

In mid-1982 Manville had 16,500 pending claims with 500 new claims per month. Their net worth was $1.1 billion with an annual income of $60.3 million in 1981 and $15.1 million in 1982.

Manville surprised the business and legal worlds by filing for bankruptcy for legal and political reasons, not current cash-flow problems as permitted in Chapter 11 of the federal bankruptcy code. This action affects the distribution of damage awards, although not necessarily to the advantage of Manville.

Filing under Chapter 11 has several effects: (1) all current lawsuits are suspended and new ones prevented from being filed; (2) Manville cannot be forced to disclose corporate records in non-bankruptcy courts; (3) distributors or appliers of Manville asbestos may be assessed damages from asbestos liability but will not be able to countersue Manville for its share of the liability; (4) in cases where Manville is listed as a co-defendant along with other asbestos firms, the court may suspend the case until the Manville filing is complete; and (5) the bankruptcy judge will decide the disposition of pending and future cases, and the court may award an overall settlement to be prorated among claimants, or it may consolidate the lawsuits and have a panel evaluate the individual claims.

Also at issue is whether the companies that insured Manville at the time of worker exposure are now liable for the disease that often did not show up for 20 or even 40 years. Insurance companies argue that they should only pay on policies now in effect and that Manville's failure to inform them of the asbestos danger voids the insurance. Manville had recently been assessed substantial punitive damages reflecting court determination that

60. Other asbestos firms have additional 13,500 pending claims (note 59 supra). The total U.S. corporate liability might easily exceed $40 billion.

61. The asbestos firm credited with originating this tactic is UNR Industries but, unlike Manville, this firm was experiencing financial deficits (note 59 supra). Farm Bureau Services Co. was the third major Chapter 11 filing of 1982 for its responsibility for the polybrominated biphenyl (PPB) contamination of cattle in Michigan. Prior to bankruptcy they had paid $40 million in damages (note 62 infra).


63. Forty-Eight Insulations Inc. faced a similar liability from over 13,000 asbestos suits. They chose to spin-off their remaining non-asbestos business and to remain solely in business to pay insurance claims and to defend themselves in court. They pay the claims from the net revenue of the claims from the net revenue of their business spin-offs and from insurance companies. Claims will be paid on a first-come basis until their money is depleted. Forty-Eight Industries has settled 1000 cases for $9 million. Of that amount victims received $3 million and attorneys $6 million (Sorenson 1982).
they had fraudulently concealed their knowledge of asbestos hazards from workers.\textsuperscript{64}

The bankruptcy move may or may not protect stockholders. Stock price is based on expected earnings. Increases in expected liability decrease stock price while decreases in expected liability increase price. Before the seriousness of asbestos liability was known in 1981, the stock sold for a high of $26.80. With knowledge of likely liability, it sold for $7.88 prior to bankruptcy filing, for a market value of $186 million. After bankruptcy (February 1983) it sold for $13.00. Investors apparently believe that Manville has gained from bankruptcy.

Manville's current assets and expected earnings may not be sufficient to pay for the liabilities of their past operations.\textsuperscript{65} There is no mechanism to recover the Manville profits that have been issued as dividends. Two issues have not been resolved so far. First, should the victims and creditors get all of what is left with the current stockholders getting nothing? Or should the stockholders retain wealth at the expense of the victims? Second, how should the limited assets available for damage settlements be distributed among the victims?

The question of which victims receive compensation and whether it was adequate was being decided on a first-settled first-paid basis. As in all discovery processes, the first litigants bear a larger proportion of legal research and fact-finding expense needed to prove issues that would later be uncontested by the defendants.

The earliest victims died without compensation, the path-breakers had higher litigation costs and lower awards, and the second-wave consolidated their claims and gained the highest net compensatory and punitive damages. The bankruptcy filing stopped this process and will probably split the remaining assets equally among the victims. If Chapter 11 bankruptcy proves to be an effective corporate tactic to avoid liability, it will reduce the incentive for law firms to invest large sums of money on research and case preparation that can only be recovered from the fees from a series of successful suits.

\textsuperscript{64} Punitive damages are awarded to deter malicious wanton acts that are outrageous enough to merit punishment and deterrence in the form of damages to the victim. During the first half of 1982, five cases were awarded a total of $3,080,000 punitive damages. In 1981, five other cases were awarded a total of $2 million in punitive damages. Previous recovery was limited to workers' compensation for Manville employees and compensatory damages for plaintiffs not employed by Manville. Punitive damages are not generally paid by insurance.

\textsuperscript{65} Like all business catastrophes, Manville may face increased losses as purchasers lose confidence in their ability to supply products. Efforts to bolster confidence, however, can further weaken public confidence in their corporate ethics. Ads have proclaimed: "Manville's new world is full of promise" after bankruptcy. Asbestos victims are angered by descriptions of Manville as a lean, tough competitor, wealthy in assets: a "combination that promises steady cash flow and good earnings growth."
Bankruptcy procedures classify creditors as secured, general, or unsecured. Secured creditors are paid in full before other creditors get anything. All people in the same class get the same portion of their validated claims. It is not clear how Manville's creditors, victims with pending claims, and future claimants will be classified.

Under Chapter 11, Manville will transfer its profitable assets to its existing claimants by giving them securities of the reorganized entity or possibly cash. Rules and guidelines structure the negotiations among the classes.

Bulow, Jackson, and Mnookin (1982) predict the following effects on the various parties to the conflict:

<table>
<thead>
<tr>
<th>LOSERS</th>
<th>WINNERS</th>
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</thead>
<tbody>
<tr>
<td>Existing claimants</td>
<td>Future claimants</td>
</tr>
<tr>
<td>Victim attorneys</td>
<td>Bankruptcy attorneys</td>
</tr>
<tr>
<td>Manville liability attorneys</td>
<td>Manville stockholders</td>
</tr>
<tr>
<td>Unsecured creditors</td>
<td>Manville managers</td>
</tr>
<tr>
<td>Secured creditors</td>
<td>Manville employees</td>
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</table>

If the savings in legal costs of asbestos litigation are greater than the legal costs of bankruptcy, if other creditors do not prevail in achieving "senior" status, and if stockholders do not get any assets, the total money available to asbestos victims may increase.

Conclusion

The discovery of an externality, the proof of cause, the award of damage, and the collection of compensation is a difficult and uncertain sequence of scientific and legal steps for owners of public and private property rights owners alike. The scientific unknowns and the expense of recovering damages tend to favor the status quo of perpetuating harm.

In the next section two case studies will be used to gauge the adequacy of compensation for particular sorts of externalities.
The definitions and discussion of property rights have emphasized the prominent role of the public as owners and managers of resources. The public enjoys the outright ownership of resources like timber, minerals, and oil, and has property rights to act as trustee and guardian to other valuable resources like wildlife and soil productivity. But when a government assumes a more businesslike stance toward revenue from public resources and toward protecting property, that government insists that compensation be paid when resources are damaged or destroyed.

Generalized environmental damage, such as that resulting from oil spills, harms resources like fish and wildlife that are directly prized by people, and has far-reaching effects on productivity and ecological vitality. It is easiest to collect damages for those losses that would otherwise find their way into commercial trade. For example, when a clam bed is destroyed it is relatively easy to estimate the profits that are lost to commercial clammers. It is more difficult to estimate and recover damages from resources such as beaches and landscapes that directly enhance life without being sold in a market.66

This section looks at two case studies. The first examines the record of compensation for damages to fish and wildlife; the second case study looks into mitigation of environmental damage resulting from large water projects.

CORRECTIVE RELIEF: RECOVERY FOR ENVIRONMENTAL DAMAGE

Recovery of Damages for Fish and Wildlife Losses

STATE VS. PRIVATE INTERESTS. Since the 1960s, state and federal governments have sued private corporations and individuals for wildlife and fish losses from pollution. These claims for hundreds of thousands of dollars in economic damage are based on legal theories of public ownership and are frequently settled out of court.67,68

Recent litigation is a response to the increasing frequency and consequences of ecological destruction and the public's insistence that business pay these costs. The public rights that are being enforced are not

66. For an excellent discussion of aquatic resource damage, see Dubey and Fidell (1979), and Halter and Thomas (1982, p. 9).
67. This section is based primarily on the excellent research of Halter and Thomas (1982), but is extended using the other sources cited. For a 1970 perspective on this legal evolution, see note 68; for a discussion of the Canadian experience, see Todd (1976).
68. See "Oil and Oysters Don't Mix: Private Remedies for Pollution Damage to Shellfish," Alabama L. Rev. 23:100-33.
new. Governments since medieval times have passed laws to protect resident wildlife (Lund 1980; Bean 1977; Hayes and Evans 1977).

When fish and wildlife were the primary food source, laws and customs protected the sustainable yield; nineteenth-century and earlier wildlife law was conceived to preserve food supply for common benefit (Lund 1980). Through the era of industrialization, those concerns were set aside as business prevailed and paid little compensation. Now, perhaps in recognition of wild species as an indicator of ecological integrity and as an element of sport and aesthetic recreation, protection is being reestablished through enforcement of historical property rights.

As of 1982, three-fifths of American states have laws that explicitly direct agencies or attorneys general to recover compensatory damage when fish or wildlife are harmed (Halter and Thomas 1982, p. 9).69

The Supreme Court has left little doubt that states have these rights even in the absence of this special legislation:

We consider the States' interests in conservation and protection of wild animals as legitimate local purposes similar to the States' interests in protecting the health and safety of their citizens.70

The increasingly clear legislative mandate and court directive to protect these public values by seeking complete compensation may ultimately result in much higher awards and thus stronger "price signals" to would-be polluters.

Complete accounting of the loss from environmental damage depends on identifying all impacts and quantifying the dollar value of the damages. This accounting is the sum of the values: values of resources destroyed; loss of future productivity; cost of cleanup and restoration; and cost of investigation, litigation, and management.

The record to date reflects a conservative approach to identifying and valuing damages. Many impacts are ignored and the values are underestimated for those impacts that are considered. For example, in California v. S.S. Bournemouth, the award for damage to the marine ecosystem from an oil spill was described as only the cost of "cleanup".71 In Maryland v. Amerada Hess

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The courts recognized the rights of states to seek monetary damages for wildlife injury, but economists sought only the value to the hunters of those animals killed immediately by the oil. This calculation is far short of the long-term damage to all wildlife values and the cost of cleanup.

Economic calculations of the loss of even sport wildlife from pollution are underestimated due to several analytical mistakes that result from unique biological relationships. First, the calculation neglects the loss of future sport wildlife due to damage of the lower food chain. Second, the neglect of the timing of the kill underestimates the net reproductive effect. It is interesting that sport seasons, but not economic calculations, implicitly recognize the "cost" differences of kills before and after reproduction. Third, pollution kills each sex of sport wildlife in proportion to its incidence in the population, but the value of the sexes is not the same. In the case of many sport animals, proper management maintains more female because a single male can impregnate several females. Several states value differentially each sex by establishing a bag limit based on a point system. For example, a female duck may count 50 points toward a 100-point daily limit while a male duck counts 20 points. In this example, the female is two-and-one-half times more valuable and will be more prevalent than males because of the effect of the point system on hunters choice. In some cases one or the other sex is so valuable that it is excluded from the hunt. The use of averages miscalculates the value of the kill whenever the male/female ratio is not one to one. In our example of more valuable and plentiful female ducks, the value is underestimated by the averaging technique.

Full calculation would include vicarious, gene pool, and option values for game and non-game species in accordance with accepted economic theory (Bishop 1978). A more general discussion of evaluation techniques is debated in Meyer (1979, 1981) and Russell (1981).

In State v. Jersey Central Power and Light Co., the trial court made the important declaration that "[t]he state has not only the right but also the affirmative fiduciary obligation to ensure the rights of the public to a viable marine environment are protected and to seek compensation for any diminution in that trust corpus" (emphasis added).

74. 69 N.J. 102, 351 A. 2d 337 (1976).
75. 125 N.J. Super. 103, 308 A.2d 671, 674 Super Ct., N.J. Ocean County, 1973. For an earlier review of this evolving legal protection see note 76 infra. For a discussion of the government's obligation to take affirmative action to protect wildlife under a prospective injunction see Nelson (1982).
An example of this litigation is *Commonwealth of Puerto Rico v. S.S. Zoe Colocotroni*.\(^77\) One and one-half million gallons of oil spilled in a mangrove swamp in 1973. In 1978 the court awarded $75,000 in cleanup costs plus $500,000 for mangrove damage. But the court awarded the largest share of the damages for damage to marine organisms:

There was a decline of approximately 4,605,486 organisms per acre as a direct result of the oil spill. This means that 92,109,720 marine animals were killed by the *COLOCOTRONI* oil. The uncontradicted evidence establishes that there is a ready market with reference to biological supply laboratories, thus allowing a reliable calculation of the cost of replacing these organisms. The lowest possible replacement cost figure is $.06 per animal, with many species selling from $1.00 to $4.50 per individual. Accepting the lowest replacement cost, and attaching damages to the lost marine animals in the West Mangrove area, we find the damages caused by Defendants to amount to $5,526,583.20.\(^8\)

The calculation resulted in a large damage award, but it reflects many of the issues we have discussed. Only commercial species were included, value estimates were for the least valuable individuals (rather than the actual value for each species multiplied by the quantity of that species lost), and the court did not award interest on the damage to reflect the six-year delay in settlement. (Interest would have doubled the award.)

**PRIVATE VS. PRIVATE INTERESTS.** Individuals and companies often rely on publicly owned resources for their livelihood. There is a possibility in these cases that a private party or business can adversely affect another individual or business by destroying publicly controlled fish and wildlife.

The courts have a mixed record in these conflicts. In *Burgess v. M/V Tamano*\(^79\) the court granted standing to private fishers who suffered financial loss from fish species damage. In *Middlesex County Sewerage Authority v. National Sea Clammers Association*,\(^80\) however, the Supreme Court overruled the Circuit Court by ruling that the Federal Water Pollution Control Act (FWPCA) and the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) precluded implied private remedies for their violation.

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\(^77\) 456 F. Supp. 1327 (D.P.R. 1978), aff'd, No. 78-1542 (1st Cir. June 29, 1979). The Supreme Court has been asked to grant certiorari on *Commonwealth of Puerto Rico v. S.S. Zoe Colocotroni*.

\(^78\) Id. at 1344-45.


\(^80\) 101 S. Ct. 2615 (1981). This case is reported in Smith (1982). See also note 68 supra.
The fishers alleged that sewage discharge caused algae bloom that depleted oxygen when the dead algae settled on the ocean floor. Fishing, clamming, and lobstering industries subsequently collapsed. By failing to award the damages, injunctive relief, and legal fees, the court preempted private remedy in favor of regulatory remedy alone. They reverted to City of Milwaukee v. Illinois, 81 in which the Supreme Court held that even the common law of nuisance from water pollution is entirely preempted by the FWPCA.

Although this ruling apparently does not preclude public suit to recover damage to fish and wildlife and although the financial loss to fishers would be part of the economic loss calculation, one agency of government is unlikely to sue another with the same vengeance as would private business victims. 82 Even if the government prevails, it might not be able to transfer the court awards to the fishers.

Curiously, public agencies have been reluctant to act in a business-like manner in extracting full value for the resources they sell (timber, minerals, leases) and in protecting public resources against damage. This failure provides serious barriers to economic efficiency and is justification for the private attorney general doctrines.

Recovery of Non-Zoological Resources

STATE VS. PRIVATE INTERESTS. Many of the precedents that support fish and wildlife law may be extended to non-animal resources. In the Tamano and Amerada Hess cases, for example, defendants sought dismissals on the grounds that the state did not have a "property interest" in such waters or aquatic life. Both courts rejected the contention on the basis that the state's public trust responsibilities gave them "technical ownership". If the state is the trustee of non-animal resources, they are empowered to protect the corpus of the trust on behalf of the public beneficiaries of the trust. 83

PRIVATE VS. PRIVATE INTERESTS. Non-animal resources or non-living elements of ecosystems, such as plants, trees, soil, viewscapes, and recreational aspects of lakes and rivers, can be seriously damaged by private action. The sale or lease of these resources at less than economic market value of the failure to incorporate non-market values in public management also result in serious distortions to economic efficiency. Changes in resource use frequently benefit one special interest at the expense of another. There is little evidence that private citizens, as beneficiaries of the public trust, have succeeded in gaining writs of mandamus (court

82. When no private citizen has standing the state can seek injunctive relief as parens patriae. See Hawaii v. Standard Oil Co., 405 U.S. 251, 258-59 (1971).
83. See Nelson (1982) for an excellent discussion of the responsibility to take management action to protect public trust wildlife even when the threat comes from natural causes.
orders) to compel state protection of living and non-living resources. The Mono Lake decision, discussed in section IV, may be a turning point.

Compensation for Loss to Future Generations
and for Loss of Nonhuman Values

Decompensation for fish and wildlife used for sport and food is well established in legal theory and is being reasserted in the courts. Compensation for nongame species and for non-consumptive uses (aesthetic, observation, vicarious, and option values) is gaining legal acceptance as special interest groups articulate their concerns and economists estimate their values. This tends to correct market imperfections but does not incorporate loss to future generations. Some economists argue that our concern for future generations—in contrast to their expected concern for themselves—is part of our decision process. No one has calculated how this concern is implemented or how much it affects our behavior. It is not a major concern of new welfare economics.

The issue of nonhuman "values" has been raised eloquently by Justice William O. Douglas in Sierra Club v. Morton:84

So it should be as respects valleys, alpine meadows, rivers, lakes, estuaries, beaches, ridges, groves of trees, swampland, or even air that feels the destructive pressures of modern technology and modern life. The river, for example, is the living symbol of all the life it sustains or nourishes—fish, aquatic insects, water ouzels, otter, fisher, deer, elk, bear, and all other animals, including man, who are dependent on it or who enjoy it for its sight, its sound, or its life. The river as plaintiff speaks for the ecological unit of life that is part of it. Those people who have a meaningful relation to that body of water—whether it be a fisherman, a canoeist, a zoologist, or a logger—must be able to speak for the values which the river represents and which are threatened with destruction.

The thesis is that certain natural objects and living things should have legally cognizable rights that would be defended by human agents as guardians. This notion is outside the focus and method of economic analysis.

EVIDENCE OF WATER PROJECT CONCESSIONS TO ENVIRONMENTAL QUALITY

Disputes over natural resource use are settled in a variety of ways. Evidence of the joint control over property rights to natural resources includes prohibitory, mandatory, and advisory regulations, lease and fee

systems, and the defense or expansion of rights through litigation. When the bundle of rights to property is formally shared, the individual interests negotiate for protection of their positions. Compromise is evidence of the balance of power.

This section presents the results of a survey of water-project spending for environmental protection.* Cases are documented where federal water developers were compelled to spend significant amounts of money to reduce the environmental damage caused by the projects.85

This evidence is strategically useful to proponents of environmental protection who may argue for similar mitigation measures at other projects. It is presented here to portray the financial measure of the public's enforcement of natural resource rights.

This presentation is necessarily descriptive and must be considered with some caution but the selected cases encompass the full range of mitigation attempts. They provide ample evidence that mitigation is limited to a narrow range of environmental effects and that compensation is infrequently paid.

To understand the narrow limits of this common mitigation, recall that water projects have on-site and off-site effects including riverbed destruction, visual intrusion, downstream habitat modification, and the effects of related development such as roads. Each change affects a different element

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*The case study material for this section was collected by Johannah R. Bernstein as a student project at College of the Atlantic, Bar Harbor, Maine, and was partially funded by the law firm of Hutchins and Soroka, Montreal, Canada.

85. Each case involves a unique project on a particular river system under varying economic and social circumstances. The political and legal strength of environmentalists and the role of the project in national legal strategy influences the outcome. Environmental damage is not strictly correlated with project cost so gross or relative spending for mitigation is not a pure indicator of whether pre-project values were fully restored or possibly enhanced. The cost effectiveness of mitigation using engineered structures depends upon whether they are part of the original design and construction or are remedial retrofits (Ortolano et al. 1978). Retrofits cost more than original construction and can diminish project benefits if their installation interferes with normal operation of the facility. Substantial construction-cost inflation may occur between the time of original construction and retrofit, making unadjusted values difficult to compare.

Finally, there are problems inherent in original data collection that could not be overcome in this case. There was often no specific accounting of costs for environmental mitigation and no consistent procedures for allocating costs of integrated or multiple-use elements. Expenses for picnic areas, boat ramps, or shoreline revegetation may have been considered as mitigation even when offset by project benefit accounts or when they were a necessary element of project completion.
of society. Consider these broad project design and mitigation alternatives.\textsuperscript{66, 67}

1. Change in project location

2. Alteration of project structures (dam height, spillway configuration, turbine size, intake and outlet structures)

3. Additions to project structures (fish passageways, flip lips on spillways, intake and exhaust screens)

4. Modified and added construction procedures (debris removal from reservoir, caulking reservoir basin to protect groundwater)

5. Project operating procedures (stream flow rates, storage area, minimum pool maintenance, rate of change in stream and reservoir levels)

6. Impact monitoring and project reevaluation (environmental performance monitoring, ecosystem recovery tracking, new problem identification)

7. Off-site replacement of destroyed resources (alternate recreation sites, purchase of fish hatcheries, preservation and management of alternate resources not affected by the project but subject to development in the absence of the replacement effort)

8. Compensation (cash transfer among private and public groups and individuals—one-time-only or continuous basis—may be used to restore lost resources or similar substitute resources or may be expended to restore utility through other product ownership)

What, then, can be learned about undesirable project effects and attempts to reduce or eliminate them through mitigation? Table 4 reports the findings. The strongest concessions to environmental quality in water projects are for fish and wildlife. This reflects a combination of factors including the extensive case law protecting game animals, the easy discovery of fishery destruction, and the political and financial strength of recreational users and conservationists.\textsuperscript{68}

\textsuperscript{66} This outline does not include the more fundamental alternatives to the final demands of project outputs, for example, zoning as a substitute for structural flood control, or conservation as a substitute for intensive water application. Complementary analysis is found in U.S. Army Corps of Engineers (1979), Hill and Ortolano (1976, 1978), Liroff (1980), and Glitzenstein (1982).


\textsuperscript{68} This mitigation is facilitated by the Fish and Wildlife Coordination Act (16 U.S.C., §661-667e (1970)). This act prescribes formal interagency consolidation and consideration of engineering modifications and mitigation measures. Although ecological protection is not mandated, U.S. Fish and Wildlife Service recommendations are frequently accepted.
### TABLE 4. SUMMARY OF FISH AND WILDLIFE PROTECTION EFFORTS AT CONTROVERSIAL FEDERAL WATER PROJECTS

<table>
<thead>
<tr>
<th>Water Projects</th>
<th>Location</th>
<th>Conservation Cost as % of Total Proj. Cost</th>
<th>Protection Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaming Gorge</td>
<td>Utah</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Dworshak Dam</td>
<td>Idaho</td>
<td>n.a.</td>
<td>Habitat replacement for elk; improvement in fish productivity</td>
</tr>
<tr>
<td>Teton Dam (Prior to failure)</td>
<td>Idaho</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Ice Harbor, Little Goose, Little Monumental and lower Granite Dams</td>
<td>Washington</td>
<td>184,000</td>
<td>Fish passageways, trap and haul systems; flip lips on spillways</td>
</tr>
<tr>
<td>Synoochee Dam</td>
<td>Washington</td>
<td>2,646</td>
<td>Downstream pipes, trap and haul systems; fish hatchery</td>
</tr>
<tr>
<td>Chief Joseph Dam</td>
<td>Washington</td>
<td>3,000</td>
<td>Shoreline purchase and restoration; corrective dam structures</td>
</tr>
<tr>
<td>Foster Power Dam</td>
<td>Oregon</td>
<td>2,898</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>Fall Creek</td>
<td>Oregon</td>
<td>1,220</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>McNary Lock and Dam</td>
<td>Oregon</td>
<td>23,700</td>
<td>Fish and wildlife protection; levee beautification; visitor center</td>
</tr>
<tr>
<td>Gray Reef Dam</td>
<td>Wyoming</td>
<td>n.a.</td>
<td>Flow control</td>
</tr>
<tr>
<td>Boysen Dam</td>
<td>Wyoming</td>
<td>n.a.</td>
<td>Wildlife habitat improvement, including grazing control; flow fluctuation management and special intake structures</td>
</tr>
<tr>
<td>Fontenelle Dam</td>
<td>Wyoming</td>
<td>n.a.</td>
<td>Fish habitat improvement</td>
</tr>
<tr>
<td>Clark Canyon Dam</td>
<td>Montana</td>
<td>n.a.</td>
<td>Fish habitat improvement, fish screens, flow fluctuation control structures</td>
</tr>
</tbody>
</table>

**NOTE:** n.a. = not applicable.
<table>
<thead>
<tr>
<th>Water Projects</th>
<th>Location</th>
<th>Conservation Cost ($1000)</th>
<th>Protec’n as % of Total Proj. Cost</th>
<th>Protection Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon Ferry Dam</td>
<td>Montana</td>
<td>13,000</td>
<td>30</td>
<td>Fish habitat improvement</td>
</tr>
<tr>
<td>Yellow Tail Dam</td>
<td>Montana</td>
<td>55</td>
<td>1</td>
<td>Fish habitat improvement, fish screens, flow fluctuation control structures</td>
</tr>
<tr>
<td>Flying Pan Arkansas Trans-Mt. Diversion (Pueblo, Sugar Loaf, Ruedi and Lemon Dams)</td>
<td>Colorado</td>
<td>n.a.</td>
<td>4</td>
<td>Fish habitat improvement, fish screens, flow fluctuation control structures</td>
</tr>
<tr>
<td>Gilham Dam</td>
<td>Arkansas</td>
<td>125,000</td>
<td>n.a.</td>
<td>Fish protecting spillway gates</td>
</tr>
<tr>
<td>Missouri Okatibee Project</td>
<td>Missouri</td>
<td>n.a.</td>
<td>n.a.</td>
<td>Reservoir management to limit minimum pool size, releases for in-stream pollution dilution, corrective structures and purchase of 10,953 acres of land</td>
</tr>
<tr>
<td>Garrison Diversion</td>
<td>North Dakota</td>
<td>n.a.</td>
<td>1-2</td>
<td>n.a.</td>
</tr>
<tr>
<td>Kindred Reservoir</td>
<td>North Dakota</td>
<td>2,400</td>
<td>14</td>
<td>Fish and wildlife protection and recreation facilities</td>
</tr>
<tr>
<td>Laurence Hydro-Electric</td>
<td>Massachusetts</td>
<td>1,300</td>
<td>5</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>Turner’s Falls Hydro-Electric</td>
<td>Massachusetts</td>
<td>15,000</td>
<td>8-10</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>Bellows Fall, Vernon, Wilder Falls</td>
<td>Massachusetts</td>
<td>10,000</td>
<td>5-10</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>Hoyoke</td>
<td>Massachusetts</td>
<td>2,000</td>
<td>6</td>
<td>Fish passageways</td>
</tr>
<tr>
<td>Carbons Falls</td>
<td>New Hampshire</td>
<td>10,000</td>
<td>41</td>
<td>Retrofit fish passageway</td>
</tr>
<tr>
<td>Hudson River Power Plants, Indian Point 2, Indian Point 3, Bowline Point, Roseton</td>
<td>New York</td>
<td>90,000</td>
<td>5</td>
<td>Angled fish screens on intake structures, dual-speed pumps, research endowment, biological monitoring</td>
</tr>
</tbody>
</table>
There is a consistent tendency for structural mitigation to cost no more than 5 to 10% of the total project cost. The survey was unable to reveal estimates of annual post-construction costs of mitigation, such as maintenance, monitoring, remedial structures, or the forgone revenues from water releases that must be scheduled to protect in-stream values. These after-construction efforts may ultimately be more costly than initial mitigation.

Most economists agree that mitigation should only be financed when it is cost effective, that is, each dollar spent on mitigation should restore or preserve at least a dollar's worth of benefits. The theoretical philosophy is to include the expense of cost-effective mitigation and uncompensated loss in benefits or increases in costs as part of the benefit/cost calculation. If the benefits fail to exceed costs by a sufficient margin, the project would be rejected on economic grounds.

In practice, Congress frequently authorizes the construction part of large water projects while putting off consideration of the mitigation elements. In some cases the mitigation plan is not even formulated at the time of initial application.

Consider a simple example. Suppose that the cost of constructing a $1 million dam accrued in a present value benefit of $2 million, but destroyed existing benefits valued at $1.5 million. Further suppose that half of the destroyed benefits could be restored by an expenditure of $250,000 as shown below.

<table>
<thead>
<tr>
<th></th>
<th>WITHOUT MITIGATION</th>
<th>MITIGATED, RESIDUAL LOSS</th>
<th>RESIDUAL LOSSES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Project benefits</td>
<td>$2,000,000</td>
<td>$2,000,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Construction costs</td>
<td>-1,000,000</td>
<td>-1,000,000</td>
<td>-1,000,000</td>
</tr>
<tr>
<td>Net direct benefits</td>
<td>1,000,000</td>
<td>$1,000,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Destroyed existing benefits</td>
<td>-1,500,000</td>
<td>Ignored</td>
<td>-750,000</td>
</tr>
<tr>
<td>Mitigation costs</td>
<td></td>
<td>-250,000</td>
<td>-250,000</td>
</tr>
<tr>
<td>Net social benefits (loss)</td>
<td>($500,000)</td>
<td>$750,000</td>
<td>None</td>
</tr>
</tbody>
</table>

If the residual $750,000 worth of lost benefits cannot be mitigated cost effectively, project planners have a tendency to ignore lost benefits (col. 2). If improper analysis allows project proponents to ignore these residual costs, the project appears economic despite the actual economics shown in column 3.

There is also a political consideration. Costs for a federal project must come from appropriations. States may share a portion of the costs, and project users may be required to repay part or all of the costs. When costs are estimated but not paid, there is no accountability for cost overruns in those cost categories. Agency and project proponents may prefer to leave some costs unaccounted so that projects look more economic.

The general reluctance of some economists and policymakers to pay compensation beyond mitigation is discussed elsewhere in this report. For
whatever reason, the federal construction agencies are operating within a framework that favors construction by using public funds under circumstances that may not be economic.
VII. SUMMARY AND POLICY IMPLICATIONS

The case has been made that compensation is a desirable and necessary control mechanism in a free market economy. Compensation for wrongful taking of private property (including life and health) and public property (encompassing natural resources) is accomplished through restoration, replacement, or cash retribution. Compensation also provides an appropriate perspective for balancing the advantages of property between generations.

If compensation were properly applied, externalities would be directly reduced, and the process of resolution would stimulate institutional redesign to manage future resource conflict. The formal process of deciding compensation and redesigning property institutions is occasion to reexamine the circumstances that lead to the current distribution of economic wealth and power. Social welfare is enhanced by eliminating those activities that are privately profitable when external damages are not the responsibility of the initiator but are socially unprofitable when all the costs and benefits are accounted.

The major principle is that operating decisions should be made within an institutional environment that properly encourages desirable transactions while discouraging those decisions that would ultimately result in an overall loss to society. This thesis was developed by first identifying the historic origins of property rights that determine liability and thus compensation. These historic aspects were then considered in the context of legal and economic theory by using a three-layer decision hierarchy that separates conventional economic efficiency criteria from questions of property institutions and policy decisions.

With theory and a decision framework in mind, an outline was developed to organize the existing limits to the desirable process of compensation. An overall pattern of scientific, legal, and economic circumstance and practices was discovered that favors perpetrators over victims. The hypothesis that compensation was biased to favor perpetrators over victims was tested using two case studies. The first case study examined the record of recovery of ecological damages that result from private business activity. Despite long-standing public rights and strong legislative environmental property statutes that clearly mandate recovery, only certain categories of damages were found to be recoverable. Estimates of damages for even these losses underestimate the value.

The second case study examined the extent of mitigation and compensation for existing public values that are destroyed by water projects. Again it was found that only certain categories of loss are considered and that compensation for the unmitigated values is rarely paid. The effect is that calculated project costs understate the cost to society. In turn, the products of the dam projects are sold at less than the total social costs, resulting in unintentional subsidy and resource waste.

The two case studies confirmed the inadequacy of compensation and the bias favoring inadequate public return on public resources and encouraging pollution, despoilment, and resource waste.
The externalities that give rise to the damages needing compensation can be characterized in a way that lends itself to solution. First, consider the ways that jeopardized resources affect individual and group welfare. Personal satisfaction stems from the quantity and quality of publicly provided natural systems, the revenue from sales or lease of public property, and individually earned income. Offsetting these satisfactions are the taxes used to correct private externalities plus the residual effect of the uncorrected damage that must be endured and that may imply major expenses for mitigation, such as medical treatment.

Second, consider the character of the externality insult. Damage may result from delayed response to activities that are no longer practiced, from the residual long-term effect of historic activity, from current activity that may or may not continue, and from future activities.

Third, consider the corrective alternatives. The perpetrator can be assessed damages as a source of compensation and as a price signal to everyone who would engage in similar activity. The perpetrator can also be criminally or professionally charged as a deterrent and punishment. When it is hard to link the actions of particular firms to the consequence for particular victims, the class of businesses initiating the causal agent or action could be charged for damages. When even this pooling of perpetrators cannot be accomplished, tax revenues can be the source of compensation as a way to spread the unintended consequence among the population. When the government is the perpetrator of harm, tax revenues are also the source of compensation funds.

Fourth, consider the preventive alternatives. In addition to the effects of compensation as a deterrent, other controls may be desirable. Would-be perpetrators can be notified that they will be responsible for their actions and can be forced to insure and bond their activities so that the consequences of their actions can be compensated. Regulations are appropriate whenever activities are too risky to people, when productivity is threatened, or when there is substantial uncertainty about potential harm that may be irreversible.

Many of these solutions are inherently complementary or can be designed to work synergistically. For example, if industrial users of particular toxic substances knew that their joint insurance pool would pay for all the damages from that chemical's subsequent misuse, these companies would favor regulations that cost-effectively reduced damage by all firms. Regulation and compensation compel perpetrators to consider the full costs of their activity.

The bias favoring businesses over individuals and private enterprise over public rights is a result of several factors.

1. **Burden of Proof and Business Claims of Harmlessness.** A tremendous advantage favoring perpetrators is the willingness to allow hazardous activities until harm is proven beyond doubt, rather than to prohibit questionable activities unless proven safe or bonded against maximum credible consequence.
2. **Barriers to Relief.** Restricted standing to sue, lack of public sympathy, high costs of litigation, limits on class action suits, and uncollectible awards all favor perpetrator over victim. The structured adversarial format of judicial proceedings is often not amenable to solving complex conflicts, particularly when more than two interests are concerned.

3. **Underestimation of Damages.** Economic damages are currently calculated only for a restricted portion of jeopardized public and private values. Estimates of damage to those few values are frequently biased downward by neglecting non-market values and politically revealed public preference.

4. **Complacency and Impotence of Public Agents.** Overt influence by special interests and functional limits on diligence and enforcement from inadequate funding places private and public victims at a disadvantage, even when property rights are clear and negotiation or litigation could succeed.

5. **Neglect of Future Generations.** The limited ability of legal and economic systems to act paternally on behalf of future generations favors depletion over conservation. Economic analysis often places mistaken trust in the free market to allocate resources over time as though this could occur without proper institutions. These institutions are necessary to correct externalities that will affect later generations and to consider the dependence of future generations on the stock resources that are conserved by current generations.

These substantial problems for resource allocation and equity are the proper concern of the policy level of the decision hierarchy. That every step of the compensation process—ownership establishment, harm identification, liability determination, damage estimation, verdict and collection—has biases favoring perpetrators over victims is central to reform. This bias means that this is not a problem of fine-tuning the economy. Instead, existing institutions can be modified and new institutions created to strengthen victims' positions and to favor public resource conservation. Compensation is thus strengthened to support a closer balance of property rights. Subsequent analysis can suggest changes that might be necessary to readjust the balance of rights. Once major deficiencies are taken care of, the system can be monitored for compliance with goals of stability, flexibility, and equity.

**INSTITUTIONAL SOLUTIONS TO INADEQUATE COMPENSATION**

Institutions affect the distribution of rights, the responsibility for socially constructive behavior, the penalty for adverse behavior, and the process of changing society. Next, institutional alternatives can be divided into categories that would correct compensation inadequacy. These institutional mechanisms reduce the uncertainty of who is responsible and what the consequences of damages will be. They are complementary to self inter-
Facilitate Informed Voluntary Agreement

A strong agreement prevails between legal and economic perspectives that well-informed voluntary resolution of conflict is desirable. Negotiation, however, requires new initiatives and professional skills. Environmental mediation works when the costs of negotiation are low and when both parties can gain from nonjudicial and nonpolitical resolution. The process of environmental mediation seeks to bring people together, clarify their positions, identify alternative solutions, and strike an enforceable agreement.

The financial aspect of self interest is described by economists in the following way. If the expected value of the settlement is sufficiently large to cover time and money costs of the transaction and if the money and time necessary for negotiation are available, the expected victor will pursue the effort. Voluntary resolution of conflict is accomplished by trade, persuasion and agreement, compromise, convention, and collective action. Involuntary resolution is accomplished by regulation, in court or outside the law.

For a change to occur, the transaction costs of the initiator must be less than the value he will gain. For the grantor to stop an unwanted change, the value of the status quo relative to the circumstance after change must be more than the costs of stopping the action. For a mutually acceptable change to occur, the benefits for each party to the transaction must be a positive net of transaction costs.

Considerable progress has been made outside the discipline of economics, but so far little economic analysis has been specifically directed to this effort. Voluntary resolution of conflict is accomplished by trade, persuasion and agreement, compromise, convention, and collective action. Involuntary resolution is accomplished by court or outside the law. Lee (1982) provides an excellent discussion of the necessary and sufficient condition for conflict resolution outside the judicial system. There is a particular need to specify the rights of public participants and to estimate the full range of externalities so that bargaining is correctly based on a balancing of rights.

Reduce Damage Recovery Cost

The "transaction costs" of mediating an environmental dispute are costs of making and closing a deal. Both parties to negotiation gain from low

89. Victims of injustice and damage have strong personal and social reasons to support criminal penalties and civil remedy. Personal motives may incorporate self-interest, such as revenge, the need for money, and protection from further damage. Public motives include the support of justice, equity and the general social good, and, often the strong desire that others avoid experiencing the same consequences.
bargaining costs. The transaction costs of resolving a quest for compensation, however, are a deterrent to the victim and a shield to the perpetrator. High litigation costs reduce the profitability of suing, which provides substantial advantages to perpetrators to keep court access and evidence costs high.

It is strongly recommended that barriers and costs of private litigation be more favorable to victims. Specifically, statutes of limitation should be lengthened to reflect the delay of discovery of health and property effects from industrial activity. The time limits should only be based on the validity of the evidence as determined in court, not as a strict condition of gaining judicial access. Statutes of limitation could be more properly based on prudent and timely action after discovery of harm instead of an arbitrary time limit after the activity that initiated the concealed or latent harm. Class-action procedures and other consolidated discovery and settlement procedures are recommended when there are a multitude of common plaintiffs. Procedures could separate awards of individual damages from the determination of which industries are responsible and how they should share liability.

Require Insurance and Bonding

A private corporation does not always have an adequate incentive to insure against liability because damage responsibility is limited to corporate assets. Corporate assets may be small compared to insurance costs. This can be corrected by mandatory bonding and insuring commensurate to risk.

Insurance and bonding requirements can be based on upper-limit estimates of potential consequence. Insurance rates would correctly evaluate the risk (probability times consequence) such that "excess" liability will be inexpensive. Firms that believe that insurance rates are too high (risk overestimated by actuaries) can self-insure by placing sufficient corporate assets at risk or by creating their own insurance pools among similar risk companies.

To provide the proper economic incentives, insurance premiums must be collected from the perpetrator group and the rates scheduled to reflect each company's relative, not average, contribution to risk. Insurance pools do not offer proper incentives if they are funded by taxpayers or if the insurance pool is so large and rates so unresponsive that companies are not regarded for risk reductions.90, 91, 92, 93, 94

90. The Business Roundtable and the National Association of Manufacturers, among others, are reported to favor public (taxpayer) compensation for victims affected by toxic substances, while several congressional proposals favor compensation from a general tax on industry (see notes 91 and 92 infra). Current efforts to charge 48 states an equal tax on all electric generation (regardless of source—even wind and hydroelectric) to pay for acid rain mitigation, does not offer a proper incentive because 31 states produce most of the pollution by burning coal (see notes 93, 94 infra).
Require Post-Action Insurance

A new concept of insurance to protect against currently undiscovered liability for past activities is advocated. Like all other insurance rates, this coverage would be based on the probability and expected size of awards. Insurance firms would investigate the history and practice of a company and carefully delineate those activities that were potentially harmful and would contractually specify the precise limits of the policy. This inquiry would root out problems, such as hazardous waste dumping, and recommend correction before the consequences of further negligence led to higher damage. The rates charged would be based on the historic record of liability producing behavior. Rates would be reduced by current business efforts to decrease risk. This is analogous to the role of insurance companies in preventing other losses. Insurance rates provide incentives for risk reduction by rewarding safety with lower rates. For example, health insurance is less costly for nonsmokers, fire insurance is less costly for buildings with noncombustible roofs or sprinkler systems, and work liability insurance is less costly with special safety systems.

The relationship between the insurance company and the insured client takes full advantage of each party's business self-interest.

Improve Strict Liability by Statute and Contract

A legislature can pass statutes that anticipate environmental damage and directly specify who will be responsible. This is a clarification of property rights and responsibility, and it reduces uncertainty that would otherwise lead to undesirable activity by initiators who thought they could avoid accountability.

A similar mechanism can be used when state or federal permits and leases are issued or renewed (Fidell and DuBey 1978). In these cases the government merely acts as a publicly interested property owner and explicitly specifies the conditions that make the contract acceptable. Like any agreement, it is the sharing of potential gains from trade relative to alternatives and the assignment of liability to the party with control over damages that makes it worthwhile.

91. See "Business interest in toxic victim compensation is growing with BRT and NAM," Inside E.P.A., pp. 10 (15 April).
92. See "NAM will seek to block toxic victim law, seeing threat to justice system," Inside E.P.A., pp. 2-3 (6 May).
94. See "CRS study says 8-million ton 48-state acid rain plan possible with 1 mill fee." Inside E.P.A., pp. 9-10 (6 May).
Make Resource Value Prior Estimation

Private contracts frequently specify a penalty for breach of contract. By agreeing to the penalty, each party knows in advance how much effort should be devoted to fulfilling its obligation. This is particularly important because the party causing the damage is in the best position to evaluate the cost of preventing the damage relative to the cost of paying to continue the activity. An analogous process whereby the public determined the value of at-risk resources would similarly provide the right "price signal" to businesses who jeopardize public property and rights.

Prior estimates of resource value can be implemented in several ways that include published expert estimates, legislatively or administratively coded values, and published estimating procedures (Fidell and DuBey 1978).

The simplest method is to create an expert source book of value estimates. For example, the American Fisheries Society (1977) periodically publishes a summary of live-fish prices from commercial hatcheries. These replacement costs are often accepted by courts as estimates of fish-killer liability. A second approach is to set the value by legislative or regulatory code. For example, Florida uses a published value established by the state as an estimate of wildlife damage. This resembles an ordinary seller's offer in anticipation of an involuntary transfer. A third approach is to specify the procedures and categories of value that will be used to estimate damages (Washington State Department of Ecology 1972). Damage estimates could use standard procedures based on units of discharge, affected area, and likely damage rates.

Reduce Information Costs

When compensation depends on research and evidence that is characterized by economies of scale, the government should assist in funding, collecting, and disseminating this information. For example, the public could indicate that full relief from business would be sought for environmental damage from pollution. Full relief would include the costs of monitoring and regulating potentially hazardous activity, damage determination and collection, cleanup, damaged and destroyed property at replacement cost, restoration and rehabilitation, and the reasonable cost of acquiring resources to offset irreplaceable losses. The government could act as a clearinghouse for information that supports compensation.

95. Florida Admin. Code, ch. 17-11. This code was challenged but sustained in Department of Pollution Control v. International Paper Company, 329 So. 2d 5 (Fla. 1976). Codified values have the disadvantage of cumbersome updating for inflation.

Represent Unidentifiable Victims

When damage is pervasive and cumulatively significant but no individual or organized group of victims finds it in its interest to sue, the government should seek recovery. Damages could be based on probabilistic analysis rather than on actual harm to identified individuals. Awards could be kept for the national treasury or transferred to efforts that would benefit the victims. For example, if a toxic chemical known to cause stomach cancer contaminated ten million people with an average harm of one dollar, the government could collect $10 million from the polluter and allocate the money to victims of stomach cancer. This calculation is based on an exposure of 10 million people with a probability of one cancer per 100,000 exposed people, yielding approximately 100 cancer victims. One hundred cancer cases at $100,000 harm per cancer victim is a total cost of $10 million.

The Outer Continental Shelf Land Act Amendments provide a model of returning publicly collected awards to those who are harmed by the damage. The act mandates that the damage awards from water pollution be spend on restoration, rehabilitation, and replacement. Michelman (1967, p. 1252) cites several cases where the courts were unable, within the judges' reading of the law, to grant compensation. In these special cases the court notified the legislature that they could provide the requested compensation. The legislature can recover these expenses from new taxes on the harmful activity.

Eliminate Corporate Liability Limits

As an added incentive to adequate insurance, corporate law could be modified to give damage victims easier access to stockholding companies. If a parent company were fully accountable for the liability of subsidiaries, it would have added incentive to pay closer attention to the firm's activities that could result in liability.

Insist on Business-Like Public Resources Management

In a properly functioning free enterprise economy, no valuable resources are offered without a charge. The provision of a resource at less than its marginal value results in either resource waste because the price is too low, or windfall gains to intermediary businesses who capitalize the subsidy by selling their products at market prices that are not reduced by the subsidy. For example, when water is provided to farms at only the cost of delivery, it is used as though it were worth nothing in alternate uses, including conservation of natural systems. The value of net marginal farm product from irrigation can be less than the public cost of alternate use and the taxes that support the subsidy. The savings by the farmer of not having to pay for the value of water in alternate use distorts the economy.

Augment Efforts of Reluctant or Impotent Government

Until government can directly control externalities, the liberalization of rules for class action suits, including litigation for profit, should be encouraged. The Michigan Environmental Protection Act is the classic example of this approach (Sax and DiMento 1974; Yannacone and Cohen 1972). When government fails to enforce a public right, private attorneys should be able to risk their own funds in speculatively seeking compensation. Legal fees for successful litigation would be based on standard market rates or court determined award. Private litigation for environmental protection resolves conflict and has the effect of assigning and coordinating agency responsibility.

Disallow Uninsured or Uninsurable Risks

When a proposed activity cannot be insured because flows of resources that are important to future societies may be irreversibly destroyed, that activity should be prohibited. Concern for certain values explicitly goes beyond economic calculation. The Endangered Species Act of 197399 and the Marine Mammal Protection Act of 1972100 are examples of legislation that specify an overriding ecological importance to species protection, whose sacrifice to any temporary governmental objective without serious deliberation is prevented. Federal highway legislation with similar concern prohibits roads in wildlife refuges unless there is "no feasible or prudent alternative."101

Policy Level Solutions to Inadequate Compensation

At the institutional and operating levels, law and economics use market forces and compensation to restore and rebalance property rights. When these efforts are not enough, more drastic reform may be initiated at the policy level.

Policy-level changes are necessarily more complicated because repercussions can influence many activities other than the ones needing correction. Planners have recently tested innovative changes in property rights that do not violate constitutional limits but have powerful effects on resource use and equity. These strategic laws are worth noting. See Ellickson 1973; Ervin et al. (1977); Hagman and Misczynsky (1974); Hochman and Peterson (1974); Baker and Andersen (1981).

Labor Entitlements

White- and blue-collar workers have long enjoyed severance pay as a recognition of worker entitlement to the profits of a firm. This concept, which has been recently extended to offer cash bonuses for early retirement, could be considered as a sale of the employee's right to remain at the existing wage.

In other cases, laborers have been able to extract cash payments as a condition of plant closures or adoption of labor-saving technology. Schmitz and Seckler (1970) provide economic descriptions of the principle of sharing the benefits of mechanization with farm and industrial workers. For example, sugar workers will receive five acres each when Puna Sugar Co. closes in Hawai'i. Some states now require advance notice of plant closing to allow time for bargaining between the workers and the state over the fees and concessions the company will make for permission to go out of business.

Economic Rent Recovery

The distribution of profits (value added) and external costs from an enterprise depends on the structure of the economy and the distribution of rights. For example, the profits of a site-dependent geothermal development will accrue to landowners, developers, equipment suppliers, the state (via taxes), laborers, and consumers. The distribution of profit among these interests depends on competitiveness, bargaining power, and institution environment. The external costs will accrue to neighboring landowners, consumers of wilderness, and others who are directly or indirectly harmed.

PUBLIC CAPITAL RECOVERY IN BOOMTOWNS. When a government must invest large amounts of money in infrastructure (streets, water and sewer systems, town services), the town may not initially or ultimately recover that public investment. It is a pecuniary externality when tax revenues do not exceed enterprise costs to the public.

Energy and mining boomtowns are notorious for these external effects (Bender and Shwiff 1982):

A boomtown is characterized by a rapid growth of population and employment associated with a high rate of capital investment all of which are unanticipated and which usually continue for several years. As the rate of investment slows down, population and employment decline and finally settle at levels above the initial (pre-boom) levels. Often the high rates of population and employment growth are caused by an unexpected increase in the rate of investment in a particular activity (e.g., coal mining) in the area surrounding the town and subside when the development phase of the activity is replaced by the operational phase (e.g., completion of the development of the coal mine and the construction of any power plants designed to use the coal are succeeded by the actual mining of the coal and operation of the power plants).

Boomtowns have used several techniques to appropriate boom profits to quickly finance necessary (and risky) public capital investments. These techniques can be used in other circumstances to recover and protect public
rights. Governments recover these capital investment costs by requiring new development to finance subdivision infrastructure like on-site roads, sewer lines, and utilities, and by charging the developer a substantial fee for building permits or hookups (Bender and Shwiff 1982). Other techniques include public sale of development permission; transfer and land gains taxes on sales, such as Vermont's tax on short-term land speculation for up to 60% of gross profit (Baker and Andersen 1981); negotiated donation of land or in-lieu payments by developers for parks, schools, and other public buildings; and special assessments for capital dedicated to the new development.102 Developers are more and more frequently required to place their own money at risk for public investment that is necessitated by the new activity and that would be a serious financial burden should the developer abandon the project before the bonds are paid off. Bagman and Miszczynski (1978) focus an intriguing look at the more general problem of windfalls and wipeouts. The former is any increase in the value of real estate, other than that caused by the owner or by general inflation; the latter is a decrease in the value of real estate not caused by the owner or general inflation.

**TAXING RESOURCE EXTRACTION.** One reason that externalities persist is that the victims are not in the same political jurisdiction as the perpetrators. This may not be so in the case of mineral extraction. State and local taxing powers allow an area to capture part of the profits from mining. The revenue can be thought of as a compensation to offset externalities or as a charge to allow the ultimate depletion and subsequent economic deterioration of the region (Page 1977; Gulley 1982). Public finance literature also recognizes the appeal of extra revenue from "outside" sources (Hogan and Shelton 1973).

Two taxes have received particular notoriety as mechanisms of recapture: severance and property.103 Severance taxes are imposed on a basis of how much resource is extracted; property taxes are based on the assessed market value. The final incidence of these taxes depends on market structure. In a competitive market, they are absorbed by the producers, suppliers, laborers, and other tax units. In monopolistic cases or when the taxes affect all suppliers (shifting supply schedules), part of the cost is pushed onto customers. This economic structure is itself the product of historic and existing institutions (Shelton and Vogt 1982). Most economic analyses of taxes ignore the possibility that the tax is a charge for relinquished public property rights, concentrating instead on allocative efficiency (Pareto optimality) and on determining who ultimately bears the tax burden. The tendency to neglect the public's right to the resource itself—including the rights of future generations—results from the presumption that nominal "owners" have unlimited property rights.

Severance taxes are more direct than property taxes because they can be levied on the specific industry while property taxes are collected at a


103. There are numerous possible taxes and combinations of taxes. A good tax designer can craft a tax law to meet multiple objectives.
fixed rate on all property. Severance taxes, however, only work for extractive industries, thus neglecting industries that cause externalities as a result of other activities.

States probably have almost unlimited rights to levy severance and property taxes, as long as they are not so arbitrary as to constitute a taking (Hellerstein 1982). Coal severance taxes of up to 30% of "contract sales price" (price net of taxes and certain charges) have been held valid in state and federal supreme courts (DuMars 1982).  

Another example of this exercise of public tax authority concerns the Native Americans' rights to tax. One year after the Supreme Court upheld the state's right to levy high severance taxes, it upheld the Jicarilla Apache Tribe's right to enact severance taxes on reservation lands (Ragadale 1982; Redhorse and Smith 1982).

The obvious issue is whether taxing authorities will limit their actions to reasonable tax levels. But the definition of reasonableness is perplexing. At the extreme, the ability to tax, like the ability of private enterprise to price goods is limited by economic feasibility. There is only so much surplus to extract. Should the taxing authority assume normal profit-maximizing business behavior, taxes will be set to maximize revenue net of costs, including externalities that accrue to the residents of their jurisdiction. States and tribes can calculate environmental damage, impact on jobs, state service costs, and so on, as part of their deliberation. Overall, their decision is probably more public spirited than other property owners that vie for a piece of the profit.

The economically proper tax would recover three categories of property prevent environmental deterioration, and support other public goals.

104. Severance tax limits have been proposed for some cases. For example Congress proposed to limit coal severance taxes imposed by states to 12 1/2% of f.o.b. mine price. (S. 178, 97th Cong., 1st Sess. (1981); H.R. 1313, 97th Cong., 1st Sess. (1981)). Any limit on the public's ability to pay may be expected to increase the frequency of conflict between business and people because any proposed enterprise that costs more than the tax limit would be undesirable. The absence of tax limits allows the full advantage of the negotiation envisioned by Coase (1960).


107. In Commonwealth Edison v. Montana (101 S. Ct. 2946 (1981) at 2958) the Supreme Court restated the previous rule that had required taxes to be "fairly related to services provided by the state" (Complete Auto Transit v. Brady, 430 U.S. 274, 1977), to mean that the "measure of the tax must be reasonably related to the extent of the contract." This means that the tax must merely be proportional to extraction. This allows recovery of pre-existing public investment and environmental damage. The court's logic is partly based on the notion that a state offers a substantial amount of pre-existing capital to new enterprises in addition to the cost of services necessitated by the project (DuMars 1982). This is completely compatible with the economic notion of recovering fixed costs.
Recover Property

1. The value of services provided by the taxing authority in support of the extractive industry, including a share of preexisting public investment

2. The value of publicly owned resources not otherwise paid for by lease rates or fees

3. The cost of environmental damage

Complement Public Goals

1. The amount of revenue to properly conserve resources for future use

2. Income transfer for equity reasons including property recovery from those guilty of historic injustice.

CONCLUSIONS

This investigation has shown that the public has strong property rights and that many of the private rights we take for granted are overstated or are the result of relatively recent decisions that are reversible. Even if private interests have nominal resource ownership, the public's rights to control resource use are impressive.

Private ownership does not always include the right to change property use, particularly when the proposed new use requires public investment, use of public property, and accommodation of externalities.

In addition to direct regulation, the public can employ institutional mechanisms, such as fees and taxes, to prevent externalities and to pay the public for the resources that are spent on the private investment and as compensation for externalities.

Insurance and bonding rules can be strengthened to assure that victims can recover damages, and rules of liability, court access, evidence and damage calculation can be streamlined to eliminate the bias that favors perpetrators over victims. By making the initiators of externalities responsible for their actions, they will have a self-interest in reducing damages and in purchasing adequate insurance.

These institutional changes allow the full advantage of individual choice at the operating level of the economy while incorporating equity concerns and changes in public policy and public goals.
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