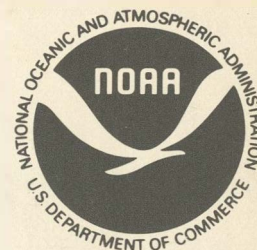


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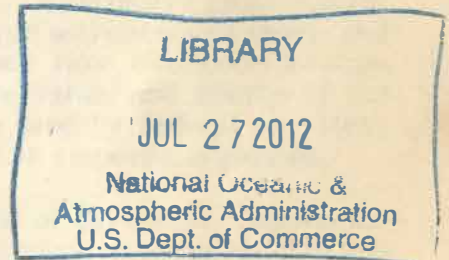
The Use of Economic Analysis in Valuing Natural Resource Damages



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June 1984

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NOTICE

This report has been reviewed by the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) and approved for publication. Such approval does not signify that the contents of this report necessarily represent the official position of the Government of the United States or of the Environmental Law Institute.

FOREWORD

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (P.L. 96-510) established a "Superfund" to provide compensation for cleanup and certain other categories of damages, including those to natural resources, from spills of hazardous materials. On August 14, 1981, the President signed Executive Order 12316 giving the Department of Commerce (DOC) the responsibility of "public trustee" for certain natural resources in the coastal and marine environment. The DOC then delegated that responsibility to the National Oceanic and Atmospheric Administration (NOAA).

Section 301(c)(1) of CERCLA requires the federal government to promulgate regulations for the assessment of damages for injury to, destruction of, or loss of natural resources resulting from a release of oil or a hazardous substance. These regulations, whose development was assigned to the U.S. Department of the Interior by Executive Order 12316, are to specify: "(A) standard procedures for simplified assessments requiring minimal field observation, including establishing measures of damages based on units of discharge or release or units of affected area, and (B) alternative protocols for conducting assessments in individual cases to determine the type and extent of short- and long-term injury, destruction, or loss. Such regulations shall take into consideration factors including, but not limited to, replacement value, use value, and ability of the ecosystem or resource to recover." The regulations will be used by federal and state public trustees to seek monetary compensation for damages from responsible parties.

In July 1983 NOAA published "Assessing the Social Costs of Oil Spills: The Amoco Cadiz Case Study," the first of a series of special, background reports on damage assessment. That report documented the most comprehensive economic damage assessment of a major pollution event ever undertaken. It demonstrated the application of many of the available methods for assessing economic damages to coastal and marine resources, while showing the current limitations of measures of damages. The results of that report should be particularly useful in formulating "Type B" protocols required under Section 301(c)(1).

This report, "The Use of Economic Analysis in Valuing Natural Resource Damages," prepared by economists, lawyers, and policy analysts of the Environmental Law Institute, surveys the field of natural resource economic damage valuation from its conceptual basis to its practice. It discusses for the non-economist the economic theory of damage valuation, the methods developed to estimate those damages, and the legal framework within which those methods have operated and are likely to operate in the future. Particular attention is paid to the requirements imposed by CERCLA and other recently enacted federal and state compensation schemes for conducting economic damage assessments.

Economic damage assessment produces dollar estimates of the change in the flow of goods and services provided by affected resources. Since goods and services traded in organized, commercial markets have established prices associated with them, they are relatively easier to assess than those which are not traded in the marketplace. Much of the current controversy in economic damage assessment centers on the problems associated with attempts to estimate the value of non-market goods and services.

The report highlights the advantages and disadvantages of the many methods of resource damage valuation to enhance understanding of the basic concepts and implications, both economic and legal, of choosing among the potential damage assessment methods. Specific concepts and methods reviewed in the report include: property value changes; lost business opportunity; replacement cost, energy analysis; travel cost; contingent valuation; and the hedonic function approach and its variants. State applications of simplified damage assessment approaches (Type A) in Florida, Virginia, Washington, California, and Alaska are also reviewed.

This report continues efforts by NOAA to help lay the groundwork necessary for lawyers, economists, scientists, and decisionmakers to deal effectively with the timely, but exceptionally complex, national policy issue of hazardous materials in the environment.

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ABSTRACT

Discharges of oil and hazardous materials can reduce the provision of goods and services of publicly owned natural resources, causing a reduction in societal welfare. Legal remedies that do not rely on the theoretical constructs of standard neo-classical welfare economics can hamper the provision of appropriate compensation for natural resource damages. This report attempts to bridge the gap between the legal and economic professions on the application of natural resource damage assessment as required under recently enacted federal and state environmental legislation. The report is divided into three components: (1) a presentation of economic concepts underlying most valuation methods; (2) a description and examination of the methods; and (3) an examination of the legal and regulatory environment within which the methods would be applied. Criteria used for a critical evaluation of alternative methods for estimating economic damages to natural resources are adherence to the principles of welfare economic theory, legal acceptability and feasibility when principles are actually implemented. The methods examined include replacement cost, energy value, travel cost, contingent value, and hedonic functions. The legal component discusses damage assessment in light of the forthcoming regulations pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The report concludes with observations on the likely performance of the economic methods for damage assessment and suggestions for the CERCLA assessment regulations.

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Of course, the authors accept sole responsibility for the content of the report. The conclusions represent the authors' views and are not necessarily those of the National Atmospheric and Oceanic Administration or of the Environmental Law Institute.

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Chapter I

INTRODUCTION

The natural resources of the coastal regions of the United States offer a vast array of commercial, recreational, aesthetic, and ecological services. Although the coastal areas can often accommodate the competitive demands for these services, the direct and indirect effects of one use frequently preclude another. A particularly graphic and timely example of such a conflict involves commercial uses which result in accidental spills and releases of hazardous materials into coastal waters. During the period from 1978 to 1979, the U.S. Environmental Protection Agency received reports on 3076 incidents of hazardous material spills, ranging in degree of toxicity from alcohol to polychlorinated biphenyls (PCB's).¹ Many of these spills occurred on surface water close to the nation's coastlines and some permanently altered the ability of our coastlines to provide a wide range of uses.

When such damage occurs the users are often required to compensate the owners of the resource, private or public, so that the cost of subjecting the resources to spills and releases is fully incorporated into the cost of the commercial use. Only under a compensation scheme which requires internalization of such costs can society attain the best use of the coastal resources.² In the case of hazardous material spills, the courts play a particularly important role. By establishing liability and compensation formulas for determining resource damages, as well as other costs (e.g., cleanup), an after-the-fact incentive is created to encourage industry's attention to greater safety precautions. Unfortunately, this system historically has broken down in the case of two intersecting classes of resources, namely those for which no economic market exists and those that are held by public trustees instead of private parties. First, courts generally have acknowledged damages only to the limited extent they can be quantified in monetary terms. Second, courts have only rarely awarded damages to the governments acting as "public trustees" for environmental damages.³

In recent years much progress has been made in addressing both of these problems. An improved understanding of the vulnerability of natural ecosystems and an increasing awareness of resources owned by the public at large have strengthened the position of the public trustee (Sax, 1970). Further, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, commonly known as

Superfund, gives explicit recognition to the role of the public trustee and its right to be compensated for damages to natural resources.⁴ Equally important, economists and others have focused significant amounts of energy on devising procedures and methodologies for placing values on natural resources, with particular attention to non-market resources for which no readily available price exists.

Advances in valuing non-market resources, however, have been mostly in research and development, with little direct application to court cases or governmental decision making. Moreover, many of the new methodologies are still controversial even among economists, and many questions remain. For example, how does one account for natural resources that are irreversibly damaged and permanently lost? If endangered species are priceless, can that loss ever be valued? In addition, the gap between the theory of economic valuation of natural resources and its application in compensation proceedings must be closed if the proper incentives are to be established for the safe handling of hazardous materials. CERCLA provides an added weight to these problems by requiring the President to promulgate regulations outlining procedures for valuing damages to natural resources held in public trust.

This report does not contain complete answers to all these questions. Its purpose is to begin the process of building a bridge between the methodologies for natural resource damage valuation and their application. It provides a synthesis of the state-of-the-art in valuing resource damages and reviews the legal climate in which these assessments have been and will be used. This information can be used to establish the groundwork for a constructive dialogue among the major participants in damage assessment procedures: economists, lawyers and scientists. Because of the rather broad audience to which this report is directed, an effort has been made to present the economic and legal concepts, terminology and methodology in as elementary a manner as possible. Some technical language, though, is unavoidable. At the same time, some readers may feel that the report is not rigorous enough in technical discussions. For those who decide to probe the topics in depth, references are supplied throughout the presentation.

The remainder of the report is divided into five chapters. Chapter II sets the scope of the report and defines some general terms and expressions that will be used throughout the study. The discussion in Chapter III covers the economic theory and concepts that underlie the valuation of natural resource damages. This chapter places special emphasis on the assumptions that are typically associated with economic theories. Chapter IV presents the various methodologies that have been developed and

used to estimate the dollar value of different natural resource types and notes potential problems in the application of these approaches and possible solutions. Chapter V examines the legal framework in which the economic tools have been used and will be used in the future. This chapter highlights the important relationships between the economists' ideas on damage valuation and requirements of the courts and administrative proceedings. Finally Chapter VI sums up the report and presents findings.

Two particular perspectives have been taken in this report. First, most of the discussion is in terms of damage to coastal zone natural resources that result from spills and releases of hazardous materials and oil. Some inland resources, notably ground water, are not specifically addressed. The tack provides a practical focus, and the economic techniques are, of course, generally applicable to all types of natural resource damages. Second, economic valuation of natural resource damage is just one step, generally the last one, in a damage assessment. It is important to bear in mind the distinction between a valuation of damage (placing a dollar figure on physical damage) and an assessment of damage, which typically constitutes a broader analysis.

Footnotes—Chapter I

- ¹ U.S. Environmental Protection Agency, Hazardous Materials Incidents Reported to U.S. EPA from October, 1977 through September, 1979, Oil and Special Materials Control Division, Washington, D.C., January 1980.
- ² For detailed discussion on externalities and optimal uses of resources, see Coase (1960), Turvey (1963) and Mishan (1971).
- ³ Some recent court cases where the doctrine of public trust has been recognized are In re Steuart Transportation Co., 435 F. Supp. 798 (E.D. Va. 1977), aff'd sub nom. Steuart Transportation Co. v. Allied Towing Corp., 596 F.2d 609, defendant's motion for summary judgment denied sub nom. In re Steuart Transportation Co., 495 F. Supp. 38 (E.D. Va. 1980); Maine v. M/V Tamano, 357 F. Supp. 1097 (D. Me. 1973).
- ⁴ Public Law 96-510.

Chapter II

DEFINITIONS AND SCOPE

Natural Resources

In the past many studies of natural resource issues considered only primary materials extracted for use in the manufacturing process. For example, Barnett and Morse's (1963) examination of resource scarcity in Scarcity and Growth focused solely on minerals, agricultural, and forest products. Environmental quality was considered only an element of quality of life rather than a resource. This view has changed drastically as ecologists, economists, and others have begun to recognize the important role that the environment plays in our economic activities (e.g., in the disposal of waste). The relationship between environment and economic activities is established more fully in materials balance models that show the numerical relationship between economic-technical activities and ecological services. Daly (1973) extended this quantitative interaction between human and ecological sectors by developing a model that traces out the economic impact of using environmental considerations as inputs in industrial activities. For example, when clean water serves as a disposal medium for organic waste, free oxygen may reduce the waste into inorganic substances; the result may be inferior water, less capable of producing harvestable fish. Thus the environment, more than simply an aesthetic factor in the quality of life, is an inherent part of natural resources that face competing uses.

This report adopts this broad view and defines natural resources as natural endowments that provide a flow of services to human life. Resources under this definition would include, for example, wetlands, clean water, clean air, fisheries, and bird and wildlife populations. The types of services offered by these resources are correspondingly diverse involving wastewater treatment, bird watching and wildlife preservation, and recreational fishing and boating. Once this concept is accepted, one can first determine whether a (use) value is associated with environmental resources and, second, apply long-established economic methods for analyzing conventional natural resources to the valuation of environmental resources.

In illustrating the use of these methods, this report usually refers to those natural resources associated with coastal zone areas. The purpose of this focus is not so much to narrow the exposition, for the range of coastal zone resources is huge. Rather, coastal zones represent particularly interesting areas in terms of their significant contribution to total ecological productivity and their sensitivity to environmental disruption. Resources found in coastal zones are numerous and complex; in many ways their valuation presents a difficult challenge to the existing research. Further, much of the economic work on natural resource damage has involved coastal resources, yet most of the methodologies presented here can be used to value damage to inland and other natural resources with little, if any, modification.

Open-Access Coastal Resources

Among the coastal resources, this report focuses on the "open-access" resources which can be considered as owned by the public-at-large. The uses of these resources are open to the public either with no charge or a nominal one such as an entrance fee to a state park. Management of such resources is usually in the hands of governments, acting as the public trustees of the resources. Unlike placing values on privately owned natural resources, valuing open-access resources is difficult because they are not traded in the marketplace and, therefore, have no observable prices.¹ There are two reasons why open-access resources are not normal goods that can be traded in the marketplace. First, by their very definition they are cases of ownership externalities in which no person(s) can claim ownership and exclude others from their uses or charge for their uses. Therefore, no one has the incentive to produce them and trade them as a market good. Second, such resources are generally public goods which, in an extreme case, are defined by economists as a goods whose consumption "leads to no subtractions from any other individual's consumption of that good" (Samuelson, 1954, p. 387). This means that users cannot trade their shares of uses among each other. In fact, such resources are often indivisible. Consequently their values are derived by summing across the individual values of all the users.

It should be noted that since open-access resources do support interests that are private (e.g., properties adjacent to the resources) and commercial (e.g., fish stocks), the scope here extends to the values of the resources involved in non-public interests such as tourism, commercial fishing, and recreational facilities. These interests are often

severely affected by the damages to the open-access resources which serve as inputs to their activities. Although such losses are claimed by private parties instead of the public trustees, they are included in the scope because (1) such losses are an integral part of the damage to a resource, (2) some of the valuation methods can be used in both private and public cases, and (3) all of the methods are interrelated on a conceptual level.

Damage Valuation

This report defines damages to coastal resources as reductions in the flow of services from these resources to human activities. Valuation of damages simply means transforming such reductions into a common unit of value. Although in theory this could be any measured unit, this report usually uses dollars. In very general terms the procedure involves two steps. One is the determination of unit values. For example, what is the dollar value of a duck of a particular species or a visit to a park lost as a result of a spill. The other is the aggregation of all of the unit values to a single number. However, as will be discussed later, a simple multiplication of the unit values by the number of damaged units is seldom adequate.

Damage valuation is then only one step in assessing damages. A common scenario of damage assessment includes field investigation of the consequences of the spill, choice of the baseline condition, assessment of indirect and future damages, and valuation of the lost services (see Figure II-1). However, it is beyond the scope of this report to address all of these. Each step in this process involves a variety of professional disciplines. Therefore, although the focus of this report is on the last step of damage assessment it should be recognized that damage valuation is merely a subset of the entire assessment process and its steps, which certainly have their share of difficulties and problems.

Valuation of damage translates the physical (including aesthetic) damage into dollar terms. Such an accounting provides the basis for compensating the public so that it is as well off after the spill as it was before.² Placing dollar values on natural resource losses explicitly weights the types of resources in terms of their importance to society and is controversial by its very nature. Economists attempt to avoid these concerns by identifying those values that reflect society's preferences instead of their own.

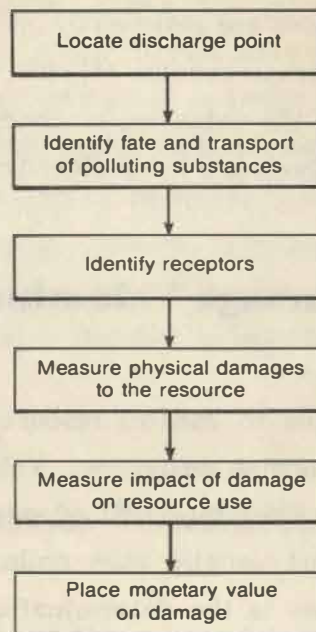


Figure II-1. Stages of damage assessment.

The key to establishing the dollar loss caused by a resource damage incident is to estimate the relationship between the price of a resource and the quantities of the resource consumed or used at that price. In economics, this relationship between price and consumption is captured by a demand curve. The problem with constructing demand curves or functions for open-access resources is that prices are rarely paid. A sport fisherman using the Chesapeake Bay does not have to pay to drop his hook in the water. Nor does a birdwatcher pay to observe an osprey in flight over a wetland area. Although there are several theoretical reasons for this situation (such as the fact that there is no cost of permitting an additional fisherman on the Bay, at least until it becomes overcrowded), the net effect is the same. No readily apparent price- and quantity-demanded relationship exists. The damage valuation methodologies discussed in Chapter IV share the common theme of establishing a surrogate marketplace where prices,

demand functions, or the willingness of the users to pay for the services of these resources can be estimated.

At this time, it is important to point out that cleanup cost is not considered in our definition of damage, although theoretically costs incurred in alleviating or stopping an ongoing destruction of resources are legitimately part of the social loss caused by a spill. This report draws a line between the cost of damage to natural resource and the cost of protecting the resource (even after a spill). Cleanup cost is not included here simply because it is usually straightforward and can be added onto the losses to the resource, once the latter is valued, to arrive at a total social loss. Of course, assessing the existing and future damages to the natural resource is an important consideration in deciding how and how much to clean up a spill. Conceptually, the optimal time to stop the cleanup response is when the marginal cost of an additional cleanup effort equals the cost of damage avoided by the effort. This report assumes that the damage is the result of such an optimal response. Therefore, in practice, the damage valuation discussed in this report should occur after the cleanup response is concluded. Otherwise, the value of the damage will fluctuate depending on the cleanup effort and its success. The distinction here does bring in an important caveat to damage valuation: accurate valuation of damage does not automatically lead to socially optimal compensation.

Having briefly introduced what is meant by economic valuation, we find it useful to make some general observations on the application of economic analysis in damage assessments. One can calculate dollar losses from damage to natural resources without the use of economic tools. Courts can determine the appropriate amount based on a "reasonable" demand of the trustee or simply on restoration of the damaged resources. Or determination of dollar figures can be left to bargaining between the trustee and the responsible party once the court establishes liability. Alternatively, in the case of damage recovery under statutory authority, an agency can choose any valuation procedure that is simple enough to be administered. These approaches, however, leave the determination of compensation to the forces of educated guess, political interest, bargaining power of the liable party, and bureaucratic mechanisms.

Economic analysis introduces an objective element in the controversial world of compensation, but not without its own set of assumptions and biases. One must keep these assumptions in mind when using economic analysis in valuing damages. As Eugene Odum (1978) pointed out when defending the ecologists' use of energy analysis against the criticisms of economists: "It is important for all disciplines to review their articles of faith periodically to determine if they have become biased or have been extended beyond

the limits of credibility." The first major assumption is that open-access natural resources, as in all environmental resources, are valued only in terms of their contribution to human welfare as perceived by individuals. This suggests that the value of the resource can be completely defined in terms of the wants and desires of present generations even though effects may be felt in the future. However, the lack of participation of future generations in determining values of irreversible damages introduces a bias of unknown direction into the analysis: natural resources may be valued differently by different generations. The second assumption is that individual preferences are characterized by substitutability. In other words, if an individual experiences a decrease in some environmental service, there is a monetary payment (that represents command over other goods and services) that will compensate the individual for the loss of the environmental service. This assumption leads economists to search for implicit prices placed by individuals on the unpriced services they consume.

Finally, economic analysis is silent on the question of income distribution. Damage valuations are based on a given income distribution pattern, usually assumed to be the existing one. The net effect of this assumption is that the valuation explicitly excludes losses that represent simple transfers of income. For example, when a local tourist industry loses business because of an oil spill, the lost business volume is not considered an economic damage even though it is a loss to the locality at a given time. In a national context, this business will be transferred to other economic activities, say, in a neighboring state, where the tourist industry was not harmed by the oil spill. Whether the transfer of income from the first state to the second one is a desirable occurrence is a question that economic analysis does not address.³

Footnotes—Chapter II

- ¹ Placing dollar values on privately owned natural resources is a reasonably straightforward process because the loss can often be estimated in terms of the existing market prices and changes in equilibrium quantities. For example, the value of a lake, enclosed by private land, may be imbedded in the sales or rental value of the surrounding land. If the lake becomes polluted and can no longer provide some of its services, such as swimming and fishing, the owner can sue to seek compensation for an amount equal to the difference between the pre-spill and post-spill sales price of the land. (It should be noted, of course, that the aggregate effect on land values of the event described above need not be negative. Price decreases of one or more locations could be offset by increases elsewhere.)
- ² Distribution of income is obviously also involved. But since this report addresses damage valuation from a social perspective the focus will not be on the distributional effects. See Chapter III for more details on this point.
- ³ This subject will be discussed in more detail in Chapter III.

Chapter III

CONCEPTS OF DAMAGE VALUATION

Introduction

This chapter establishes the conceptual economic framework that guides the dollar valuation of damage to open-access coastal resources. The material presented here is important for two reasons. First, in order to evaluate the strengths and weaknesses of the alternative valuation methods discussed in Chapter IV, one must understand the basic economic concepts and theory underlying these methods. These include, for example, willingness to pay, demand curves, consumer surplus, economic rent, intertemporal valuation, option value, and irreversibility. Most of these concepts are well developed in the fields of welfare and resource economics and, therefore, are presented here in a simplified manner. References are provided for those seeking more detail.

Second, economic theory offers guidance on more general issues associated with damage assessment. For example, those who are familiar with damage recovery in court will appreciate the importance of recognizing the types of damages, the extent of social losses, the appropriate assessment focus and level of aggregating losses, and who is entitled to compensation. Although many of these issues are dictated by legal considerations (e.g., limits of liability and allocation of users' rights), which will be discussed in Chapter V, and scientific evidence (extent of damage), economic theory can provide helpful perspectives.

The economic valuation of natural resource damage begins with the demand for the services of the resources. The most obvious services fall generally into the following categories:

- o consumptive recreation (sportfishing and hunting)
- o nonconsumptive recreation (bird watching, boating, etc.)
- o preservation
- o commercial fishing
- o waste treatment

- o commercial development
- o transportation
- o extractive activities (e.g., minerals, oil)

These various services result in multiple demands on the coastal zone resources — some of which are competing and others complementary. For the purpose of this report, only services which will be affected by a spill or release of hazardous materials are relevant. Therefore, transportation, industrial development, and extractive activities will not be discussed here.¹ For the purpose of illustrating the appropriate theoretical framework to value the reduction of these services, the above categories can be divided into two groups.² The first group includes public uses such as recreation and preservation. In these activities the public directly consumes or demands the service as a final product. The second group includes commercial uses such as commercial fishing, facilities, and development. This latter group uses resources as inputs to a final product: fish in commercial fishing, recreation sites in recreational facilities, and waste assimilative capacity for waste treatment. The demand for such "indirect" resource services is referred to as a derived demand, in that it is dependent on demand for the final goods.

Estimating the value of public use resources is more difficult than estimating that of commercial uses since public uses are generally not traded or priced in a marketplace. However, implicit or indirect prices for these services may exist. Meanwhile, one must estimate values of commercial resource uses through a different type of analysis that reflects the fact that the demand for these resources results from the production of the final goods.

Model for Public Use Resources

Public use resource services such as sportfishing, aesthetic enjoyment, bird watching, hunting, photography, and preservation share the characteristic of directly flowing from the natural resource in its original form. A loss of these services as a result of a hazardous material spill directly reduces the welfare or well-being of the public (the consumers): the public is no longer able to enjoy the service and is worse off than before. The economic basis for valuing the loss in well-being is defined by

economists in terms of willingness to pay (i.e., the dollar amount the public is willing to pay for the service rather than be without it). Although seemingly complicated, the concept is easily illustrated. Suppose, for example, data are available on the willingness of a sport fisherman to pay for the opportunity to go fishing. Table III-1 shows a hypothetical relationship between a fisherman's willingness to pay for an additional fishing trip and the corresponding number of fishing trips to a particular site.

Table III-1. Observed consumption points

Willingness to pay for an additional fishing trip (dollars)	No. of fishing trips per year
20	20
40	10
60	0

These points can be plotted on a graph as in Figure III-1 and connected by a straight line. The vertical axis represents the cost the fisherman is willing to pay (including expenditures on travel, food, and equipment) to take a fishing trip. The horizontal axis represents the number of trips the fisherman makes per year. The relationship is a negative one.³ Figure III-1 shows that as the fisherman takes more and more trips he is not willing to pay as much money for the next trip. For example, when the fisherman is making 9 trips a year, he is willing to pay \$40 for the 10th trip; but when he makes 19 trips a year, he is willing to pay only \$20 for the 20th trip. To economists these values are synonymous with the price of the goods and they are called "marginal willingness to pay" (MWTP). The fact that MWTP usually declines is easily understood; for most types of goods, the more one consumes, the less one desires each additional unit. Alternatively, as the costs rise, a person consumes less.

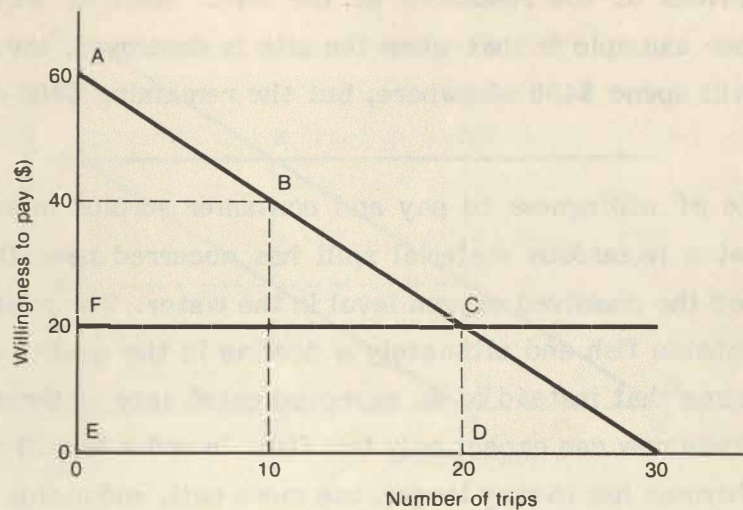


Figure III-1. Hypothetical demand for sportfishing trips.

In order to determine the value of a resource, one must understand the concept of "total willingness to pay" (TWTP). Put simply, TWTP is all of the MWTP's added together. When the fisherman in Table III-1 was making 20 trips a year, he was willing to pay much more than just \$20 for the first 19 trips. For example, on the first trip he would have paid approximately \$56, for the second trip he was willing to pay \$54, and for the third trip \$52. For the 20 trips together, his TWTP is the summation of all the MWTP's or \$800, equivalent to the area shown by ACDE in Figure III-1.⁴

If it did not cost anything to go fishing, the value of the site at 20 trips per year to the fisherman would still be the \$800 per year. However, the trips are not free. Figure III-1 shows that if the fisherman makes 20 trips each year, each trip would cost \$20 for a total cost of \$400.⁵ The net value of the site to him is his TWTP of \$800 minus the \$400 or a net willingness to pay (NWTP) of \$400.⁶ This is called consumer surplus or the amount that the fisherman would have been willing to pay above what he actually did have to pay. In understanding consumer surplus one must remember that it is only at the 20th visit that the fisherman was paying exactly what he was willing to pay, \$20. The diminishing surpluses, less and less as he makes more trips, add up to \$400. To economists, this consumer surplus is the value of a resource. It represents the willingness to pay that is attributable to the use of the resource, not to the cost of using

the resource. In sum, out of the TWTP of \$800, \$400 was for the cost of the trips, and \$400 was for the services of the resources at the site. Another way of looking at consumer surplus in our example is that when the site is destroyed, let's say, by an oil spill, the fisherman will spend \$400 elsewhere, but the remaining \$400 disappears with the loss of the site.

To see the role of willingness to pay and consumer surplus in valuing resource damages, imagine that a hazardous material spill has occurred near the hypothetical fishing site and reduced the dissolved oxygen level in the water. The result is a decrease in the number of catchable fish and ultimately a decline in the quality of sportfishing. More specifically, assume that instead of an expected catch rate of three fish for every eight hours, the fisherman now can expect only two fish. In order to still catch three fish after the spill, the fisherman has to stay longer, use more bait, and motor around more to find a good spot. All of these consequences result in increased fishing costs. This cost increase is shown in Figure III-2. For a trip of equivalent quality (three fish per hour), the fisherman now has to pay \$40, or point D, instead of \$20: the supply curve FC in Figure III-1 has now risen to CD. But the fisherman's demand curve shows that if the cost per trip rises to \$40 he will make only 10 trips per year. The decline in the water quality has increased the cost of trips (for three fish per hour) so that the fisherman will make fewer trips. Another way to present the result of the spill is to hold the cost constant but allow the demand for the site to decrease because of the lower probability of catching fish. The fisherman is simply less attracted to the site and, thus, less willing to pay for going to the site. In other words, for the same cost (price) per trip, he will make fewer trips. In our example, the fisherman paying \$20 per trip before the spill will visit the site only 10 times for the same price. In essence the entire demand curve has shifted from AG to CH. Of course the net result for both versions of presenting the consequence of the spill is the same: the fisherman has reduced his visits from 20 to 10 a year.⁷ The key difference between the two presentations is that the former holds the quality of the site constant (at three fish per hour), whereas the latter allows the horizontal axis to reflect the deterioration in the fishing quality of the site.

What is the value of this damage to the fisherman? It is the loss of consumer surplus (NWTP), or the difference between the pre- and post-spill resource values. The post-spill NWTP, using the same method of calculation outlined above, is \$100 (area ABC). The reduction in consumer surplus is, then, \$400 minus \$100, or \$300. Graphically, it is equivalent to the difference between areas AEF and ABC, or CBEF. In other words, the fisherman is \$300 worse off as a result of the spill. This amount

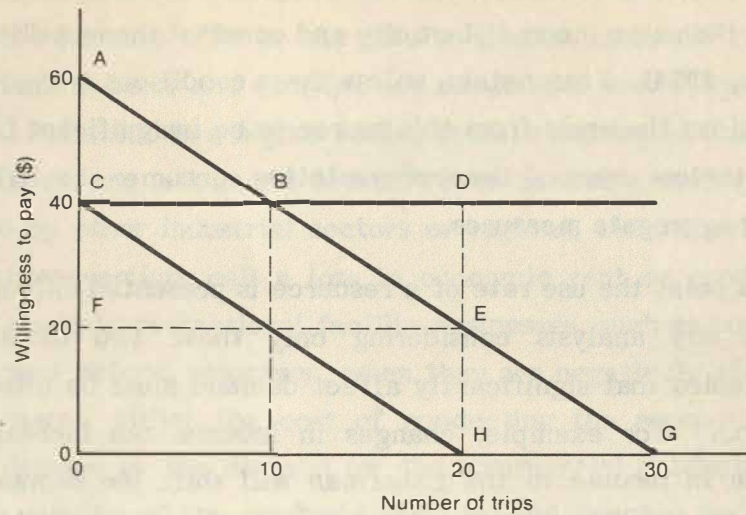


Figure III-2. Reduction in willingness to pay.

represents, under ideal circumstances, the value of the damage to the fishing resource for that specific person.

Up to this point, the presentation has been in terms of one consumer, a fisherman. More realistically, of course, there would be many users of the damaged resource, and one must account for each in the valuation process. Ideally, one would add together the individual consumer surpluses for each user, which would require, of course, a knowledge of the individual demand curves.⁸ As one might imagine this is rarely possible. Usually an analyst must construct an average demand curve. An analyst would collect actual price and quantity (fishing trips taken) data for a sample of the resource users. Using multiple regression analysis, or some other statistical technique, the analyst would group the data into an average relationship from which he could derive a representative estimate of consumer surplus. The question of whether the preference pattern, which underlies any demand function, of a group of users can be accurately reflected through the use of the representative consumer has been raised by practitioners of demand analysis. There seem to be two sources of possible errors. One is that the sample is not representative of the actual group. In this case, the use of the average demand function deriving aggregate values obviously will diverge from the true aggregate value. But this is a sampling problem. More importantly, there is the question that, even if the sample is "true," does adding up individual demand functions arrive at a group demand function which is equivalent to adding up the consumer behavior of the individuals (Hicks, 1956).

It has been shown that the equivalence can occur only under very strict conditions, such as all persons' having the same income elasticity and constant income distribution among the individuals (Phlips, 1974). Fortunately, unless these conditions are seriously violated, most economists consider the error from this source to be insignificant (Houthakker and Taylor, 1970). Nevertheless users of the representative consumer should be aware of the limits of the resulting aggregate measures.

Also up to this point the use rate of a resource is presented only as a function of its cost. Actually, any analysis considering only these two dimensions will be incomplete. All variables that significantly affect demand must be also included (e.g., income, age, and sex). For example, changes in income can increase or decrease demand. An increase in income to the fisherman will shift the demand to the right, producing an increase in the willingness to pay. Similarly, age, sex, and family size can all affect the demand curve to different degrees. The effects of such variables on estimated demand for outdoor recreation have concerned several economists (Seckler, 1966; Stoevener and Brown, 1967). Some have suggested estimating demand curves for separate income groups (Sinden, 1974). In addition, the costs of using competing natural resources will also affect the position of the demand curve. The demand for fishing site A, for example, will be affected by the cost of using a nearby fishing site B. Studies have shown that estimated demand equations will be biased if one leaves out any legitimate variables (McConnell, 1975).

There are two key results in the above discussion. One is that the value of a reduction in the service provided by the damaged resource ultimately is based on the user's demand function. The other one is that, because open-access goods are not traded in the marketplace, their values can be estimated only to the extent the price/quantity relationship can be observed. For most public uses of coastal resource services, price and quantity data will not be available directly. In these situations, analysts have developed indirect techniques for determining resource prices by the use of responses of consumers to given cost structures. The use and applicability of these techniques is the subject of Chapter IV.

Model for Commercial Use Resources

Private losses are the consequence of a reduction in business activities caused by an interruption in the supply of resources used as inputs to these activities. A good

example is a commercial fisherman who relies on a fish stock that has been injured by an oil spill. Several economic effects may result: (1) it is more difficult to catch the fish so more inputs such as labor and gasoline are needed per unit of catch; (2) the increase in harvest cost is reflected in a higher selling price, resulting in fewer sales; (3) laborers are laid off and boats are left at the docks.⁹ Even assuming the inputs to fishing can be quickly absorbed by other industrial sectors or regions, the owner of the business may still suffer what economists call a loss in economic rent or producer surplus.¹⁰ A similar loss can occur in recreational facility businesses, such as boating rentals, hotels, and restaurants near natural resources, when they are negatively affected by a damaged resource. In general, either the cost of conducting the economic activity increases because of the damage or the demand for the commercial products drops because of a reduction in the quality of the products (e.g., dirtied beaches and contaminated fish). The significant difference is that in the former case the supply curve shifts while in the latter case the demand curve shifts. The two cases are analogous to the two scenarios, discussed in the section on public use, of increasing cost of a given fishing trip versus decreasing demand for the fishing trip at the pre-injury price. The end results again should be the same.

The concept of producer surplus is in many ways analogous to consumer surplus. Marshall (1930) thought that producers as well as the consumers receive something extra above the value of the goods they sell. Mishan (1976) defined this surplus as economic rent or the difference between the returns to a resource in its current use and the amount the owner requires to keep the resource in that use.

Figure III-3 illustrates the concept of economic rent for an owner of a hotel of 100 rooms near an open-access beach. The EI curve is the hotel's supply curve or the number of rooms (occupancy rate) provided at a given room rate. It is also the marginal cost of providing an additional one percent of the rooms to guests. Costs increase as more rooms are filled, and the hotel will charge all the guests the marginal cost of the additional occupancy percentage. Thus, in the off-season period the rooms are cheaper than in the peak-season period because of lower marginal cost, but all guests are charged the same price at a given time. Marginal costs rise as the fixed inputs (size of the hotel and limited time of the owner) limit the ability of the hotel to meet the increasing demands even with more variable inputs (staff and materials). Thus, it costs \$20 to provide the room at a 40-percent occupancy rate and \$30 at an 80-percent rate.¹¹ Assuming the demand curve (ABJ) intersects the supply curve at B, resulting in an occupancy rate of 80 percent, the hotel receives a gross revenue of \$2400, shown by the

area ABHF in Figure III-3. But the cost to the hotel is \$1600, represented by the area EBHF. The cost of serving the guests other than the latest ones who boosted the occupancy rate to 80% was less than \$30 per percentage point, but every guest was charged at the \$30 marginal cost resulting in an economic rent of \$800. Graphically, this rent is the difference between areas ABHF and EBHF, or the area ABE. This is the return to the owner for owning the business.

Let us assume that a spill has occurred near a beach. A hotel in the area is adversely affected, and the occupancy rate drops to 40 percent from 80 percent. At 40 percent occupancy the marginal cost for an additional percentage point is \$20 and by charging all the guests this rate the hotel receives the total revenue of \$800. However, the actual cost for providing the rooms is \$600, shown as the area EDGF. The economic rent of operating the hotel has dropped to \$200, compared with a pre-spill economic rent of \$800. The owner has suffered a loss of \$600. This is the area ABDC in Figure III-3.

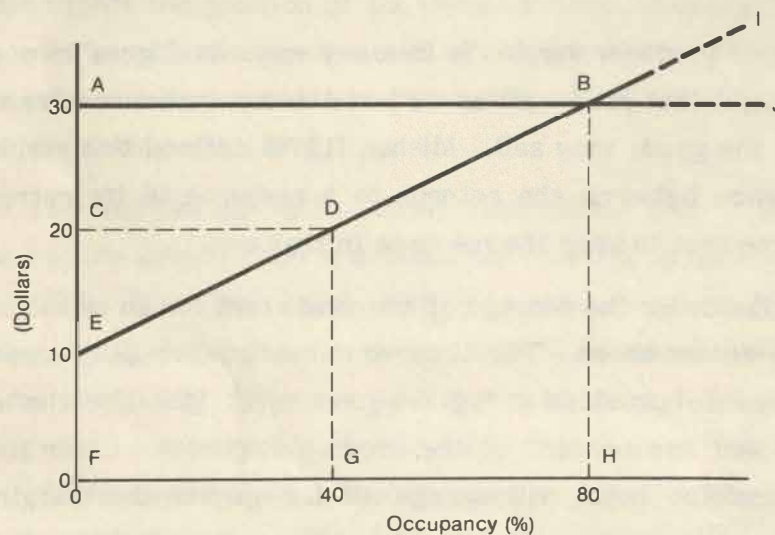


Figure III-3. Economic rent of a hotel owner.

It is possible that the spill also decreased the demand for the hotel (because of less attractive surroundings) thus also producing losses to the consumers. Such losses can be represented as a leftward shift of the demand curve in Figures III-1 and III-2. The loss of consumer's surplus can be calculated according to the new position of the curves. The total social loss due to the spill is the sum of both consumers' and producers' losses.

User Cost of Renewable Resources

Many open-access resources such as fish are under public ownership until used by a commercial or recreational entity. Society places a value on these resources, based on their current and future services. According to economic theory, non-renewable resources such as minerals have a value that is equivalent to their discounted future value.¹² Intuitively, a mining company will leave minerals in the ground if the discounted value from future prices is higher than the value based on present prices. What is not consumed today is available for use in the future. In contrast, renewable resources reproduce themselves; what is not currently used will produce more in the future. In essence, when society refrains from extracting a renewable resource it is investing in future production of the resource. It is clear, then, that the present value of such a resource should include the value of its contribution to future productivity, which economists call the user cost or rent of the resource.¹³ However, neither the public nor the commercial users usually consider this cost since, fish being a fugitive resource, a person is not rewarded later for forgoing a catch now. Furthermore, because fishery is not under any sole ownership management, such as a monopoly, no one is there to charge the user cost. As a consequence the values estimated in the previous two sections do not include the loss of the capital value of renewable resources.

Although the concept is simple, there are several problems in identifying the user cost of a renewable resource. When fishery stocks are managed properly over time, society maximizes its long-run welfare from the stocks. Within this optimal management plan, there are given values of rent in each period that lead to an equilibrium which maximizes the value of the stock. However, if such optimal management does not exist, it is questionable whether the polluter should pay this user cost.

A vast literature (e.g., Gordon, 1954; Gates and Norton, 1974; and Crutchfield and Zellner, 1963) has focused on the hypothesis that harvesting of fish usually dissipates any unpaid user cost in the form of economic rent. For example, in commercial fishing, by

the time the fish are sold on the dock, rent is no longer reflected in the transaction and dissipated across the inputs into the fishing industry. The main reason for this dissipation of rents is the over-exploitation of fishery stocks owing to the "fugitive" character of fishing. Because fishermen do not hold title to any particular type of fish or fishing ground, they have no incentive to maintain the productivity of the fishing ground at an optimal level (Gordon, 1954).¹⁴ Fishing efforts continue until the total cost of harvesting equals the value of total catch. At this level of fishing, too many inputs (or too much cost) are allocated to fishing effort, and the rent that could have been accrued by fishermen in the form of profit (or passed on to consumers) is spent.

There is no reason for polluters to pay user cost if the rent is considered dissipated, as in the above case. However, it is conceivable that the trustee can argue that the damage has deprived the management of the opportunity of managing the resource optimally and realizing the rent in the future. For the same reason, the polluter should pay a user cost if the trustee is already managing the resource by charging its users a fee approximating the rent value of the resource.

Focus of Valuation and Aggregation of Loss

Practitioners of damage assessment at this point may still find the conceptual framework developed in the last two sections inadequate to deal with the real world of damage valuation, where lack of research resources and relevant information is prevalent. Under these conditions the valuation process has to have more of a focus with special concerns for the difficulties in aggregating losses.

In particular, an operational valuation procedure would have to decide on which level of the damages to value, with an eye on how to aggregate the values. The fact is that losses can be valued and aggregated on many levels. For example, the losses due to an oil spill in coastal water where recreational activities exist can be valued by counting the gallons of oil spilled, the deterioration of water quality, the area of shore affected by the oil, the number of dead fish and birds, or the decrease in the number of recreationists. In other words, values can be derived from any of these levels which are simply different manifestations of the same loss, or the chain of impacts from the release to the ultimate reduction in the well-being of the users of the damaged resources. The choice of the level on which to focus the valuation and the recognition of its effects on aggregation of losses is an inherent part of damage valuation.

Generally speaking, there are three levels of damage on which a valuation can focus: (1) user, (2) resource, and (3) discharge. Some general observations can be made about these levels. First, because the value of a resource, in the economic context used here, is derived from the satisfaction of its users, the correct level of estimation and aggregation is at the user level. It is here that differences in tastes and preferences, income, and the availability of substitutes or complements can be taken into account. However, the aggregation of the losses is most difficult at this end of the spectrum, mainly because of the need to identify existing and potential users. Further, the value of losses to one set of users may not be an accurate estimate of value to other users. The second observation is that the situation is substantively similar at the other end of the spectrum: valuing losses at the point of discharge. It will be quite difficult to relate a gallon of oil spilled several miles away to the welfare loss to the fisherman sitting on the beach. Although the problem of aggregating losses is greatly simplified by merely counting the quantity spilled, the damage value per unit of discharge will necessarily vary from one site to another. Valuing the damage on the resource level, being in the middle of the spectrum, may be more clearly balanced in terms of both problems and advantages. Actually, as will be shown later, determining value, especially unit value, at the resource level, such as the value of a fish, a waterfowl, or an acre of beach, has been popular. This level of valuation is especially useful in the context of assessing small but frequent spills which damage a common set of resources.

Finally, it may be that certain types of losses are better estimated at one level than another. For example, losses in non-consumptive activities may be better valued at the user level and losses in consumptive activities at the resource level. To value a partial damage to a state park, particularly if it is unique, one would have to focus on the visitors to the park. Meanwhile, fish or birds killed in a spill can be valued best, for the ease of aggregation, by a fisherman's or hunter's willingness to pay for a fish or bird. The underlying reason for this is that most of the resources used in non-consumptive activities are public goods, in the sense that one's consumption of the resource does not decrease the availability to others. The value of the resource, then, is the sum of all of the users' willingness to pay (Samuelson, 1954). Thus, it is unavoidable to aggregate across the users. However, in consumptive activities such as fishing or hunting, once a deer is killed, its availability to others certainly disappears. Thus, if a representative consumer's willingness to pay can be estimated for a unit of such a resource, aggregation on the resource level will be much more effective.

Since the value of a resource is derived from its service to the users, why doesn't one **always** value the losses at the users' level (i.e., estimate the demand function of the **users** and aggregate their surpluses)? There are generally three reasons. One is that some of the **available** valuation methods **favor** different levels of damages. For example, the **travel cost** method seems to be best applied to the level of a recreational site. Meanwhile, the energy analysis clearly best values damages on the resource level, such as **damage** to wetlands. The contingent valuation approach is versatile enough to value **damages at all levels**.

The second reason for not measuring all damages at the user level consists of the **practical** circumstances surrounding the aggregation of losses. There are times when it is **easier** to count the lost waterfowl than to count the number of waterfowl hunters **affected** by the lost waterfowl. Finally, once a value is established through one level, **future** valuation of similar damages can be conducted on another level. Consider the **case of valuing** a sportfish, such as marlin. The first-time valuation of a marlin killed by **a spill** will have to be conducted on the user level (e.g., have users place a contingent valuation on a marlin). Once this value is established, marlin killed in the future can be **assigned** the same value. Thus, although the first-time valuation is on the user level, subsequent valuations are on the resource level.

In order to choose a focus one has to appreciate that the difficulties surrounding aggregation of losses can occur on all three levels. One of the most prevalent difficulties on the user level is the identification of all users. With the exception of resources under exclusive management, where use frequency is often tallied, it is difficult to ascertain who and how many of them have been using the damaged resource. For example, if there is no record on the uses of the resource prior to its damage, the users who now decided not to use the damaged resource have to be found in order to establish the baseline for measuring the loss. But once the users have found substitutes, it will be difficult to identify them. The most elusive users are the ones who may have never used the resource but are willing to pay for keeping the option of future use. Resources that are unique and not constructable, such as the Alaska wilderness and the Rocky Mountains, must face such hidden demand. An examination of the existence of such demand will be treated in a later section in this chapter, together with the topic of irreversibility. Ultimately, the practitioner of damage valuation has to find the level which gives him the optimal combination of ease of aggregation and accuracy of valuation.

Aggregation of losses to commercial users is also difficult because of possible chain-like effects. For example, in a lawsuit filed against the Allied Chemical Corporation for Kepone pollution of the James River and Chesapeake Bay, plaintiffs included nine business groups ranging from commercial fishermen to restaurant owners.¹⁵ The plaintiffs claimed that because of the Kepone spill their businesses suffered economic losses. The court struggled in drawing a line across the chain of businesses beyond which the defendant is no longer responsible for economic losses. The court wanted to avoid double-counting and yet compensate those who suffered legitimate losses caused by the spill. According to the concepts developed earlier, owners of businesses do earn an economic rent that may be reduced by a spill. This occurs when the owners commit their factors of production, such as a fishing vessel or land or management skill, to a product and receive a gain when they are able to charge more than that amount required by the owner to keep them in that use. The concept of economic rent also entails that losses to commercial interest can extend beyond the primary users. Thus, all the above businesses, if deprived of the opportunity to conduct a substantial portion of their activity as a result of a spill, should be compensated for the reduction of their economic rent.

However, as a practical matter, it is difficult to ascertain the existence and size of the economic rent. First, only businesses that can prove the existence of a pre-spill net profit can claim loss. The absence of a net profit indicates that earnings are barely above the minimum amount that would keep the business in existence and consequently no economic rent exists. Second, in order to claim lost economic rent, the businesses should be able to show that the loss is attributable to the spill. But this will be difficult as some business activities are farther away from the damaged resources than others. In essence, the decrease in net profit must be outside their normal business fluctuation and the businesses must solely or substantially depend on the services of the damaged resource.

Aggregation of values on the resource level can also be complicated when the resource consists of complex components. For example, wetlands provide many services, such as recreation, water supply, pollution control, flood control, food production, aesthetic appreciation, and preservation. If these services are to be valued separately when a wetland is damaged, substantial effort in terms of time and money may be required. One way to minimize such effort is to group the services, as much as the damage incident allows, and measure the damage on a more aggregated level. For example, one can value various types of recreation at a site on a trip to the site basis

(Clawson and Knetsch, 1966). If the selected sample of users is random, the estimated value of the site will reflect a value averaged and weighted across the types of the recreation provided by the site. Another example is to estimate the value of clean water under the assumption that the value reflects all the demands on the water (Gramlich, 1977). Water quality can be measured by whether a section of a river or an estuary is swimmable or is characterized by a certain level of dissolved oxygen. One method of valuing clean water is to question users on their willingness to pay for clean water. The resulting estimates, under certain circumstances, will include the value of all the activities that require "clean water," such as boating, fishing, swimming, camping, and aesthetic enjoyment.

Recently the use of unit resource value tables, such as fish value tables, has been advocated for valuing damage incidents where a case-by-case assessment is considered too expensive. The value table scheme is most useful when the damaged resource can be counted (e.g., number of waterfowl or number of recreational fish killed by a spill). Although the aggregation procedure is simple (multiplying the unit values by the number), it can introduce bias. The unit value is usually assumed to reflect the willingness to pay for a marginal unit of the resource. If the users, because of the spill, lose more than the marginal unit (i.e., more than one unit), each of the nonmarginal units will be worth more than the unit price (see Figure III-1). Because people were willing to pay far more on the nonmarginal unit, the unit value approach may underestimate the total damage value.

There is, of course, little difficulty involved in aggregating losses on the discharge level. Usually, if the source of a spill or release is identified, it is not difficult to discover the identity and quantity of the released material. The Alaska discharge fines are based on such a scheme.¹⁶ However, as the discharge level (which measures the amount discharged) is distant from the users of the damaged resource, the validity of using the predetermined values (per gallon of material) repeatedly for different spills is difficult to justify, unless the incidents are similar. Perhaps more importantly, the unit discharge table assumes a simple linear damage function (the relationship between amount of discharge and extent of damage) which may be unrealistic in many cases. In fact, many damage functions can be nonlinear or noncontinuous. For example, the incremental damage to a resource from a spilled gallon of oil can either increase or decrease. When a unit value is applied to all the gallons, one assumes the incremental damage is constant. This approach can overestimate or underestimate the aggregate value of the damage. A particularly troublesome damage function is the threshold type, in which the ill effects of individual units of discharge are cumulative and only become

actual damage when a threshold is reached. Furthermore, once the threshold is reached, additional units exacerbate the situation only minimally. The application of unit discharge values in such cases may lead to a great deal of controversy.

Impact Versus Losses

It is inevitable that when an open-access resource that provides services to public and commercial uses is damaged impacts will materialize as lost business volume, idle investment, and unemployment. Whether to count these impacts as losses has always been a controversial element in damage valuation. According to the concepts of consumer's surplus and economic rent, expenditures on inputs are not considered part of the losses. Consequently, lost wages, lost sales, and lost payments on past investments are not recognized as economic losses. The underlying reasoning for this position and the circumstances under which one has to moderate this position require some discussion.

The key concept in valuing economic losses of the types discussed here is "opportunity cost." It is, as Mishan (1976) put it, "the worth of the current use of some good in some alternative use." In other words, it is the payment to an input in some alternative use which is sacrificed by keeping it in its present employment. For example, the opportunity cost of investing a dollar in a Treasury Bill is the interest income not received that would have been received had the dollar been placed in the next better account, say, a savings account.

Inputs normally move to the employment that pays the highest opportunity cost. Once employed, this opportunity cost becomes actual payment and its new opportunity cost is the next best price it can command from another employment. The marketplace usually pushes the actual payment toward the opportunity cost through its competitive forces. When the employer perceives a significant difference between what he pays and what the input can charge elsewhere, he will adjust the price downward until it is marginally above the opportunity cost.

Economic theory further postulates that, given the existence of opportunity cost, when existing employment disappears, inputs will move toward new employment opportunities. Then, from a national perspective, a redistribution of expenditure cannot be constructed as loss since the inputs logically will follow the emergence of the demand elsewhere. For example, when beach A is polluted the tourists may move to beach B in a neighboring state, redistributing their expenditures from businesses near beach A to the

ones near beach B. If the now idle inputs at beach A will move to beach B to absorb the rise in demand, there should be no social loss. It is also clear that if the inputs are encouraged to stay in beach A by being compensated for their lost income, society will lose their productivity and prices will rise in both the tourist business in beach B and the goods manufactured by the party paying the idle inputs. In fact, it is seldom the case that an input has no value in some other use. Even in the extreme case of idled labor, if the person uses his time during employment to do something he personally enjoys or something that may be useful in the future, the loss is less than the entire lost payment to the worker. Other inputs, such as equipment and materials, generally have other markets where they can be sold, even if not at the same price.

However, the position of paying no compensation other than consumer surplus and economic rent is equally untenable, given that the assumption of zero transaction cost is seldom realistic. Transaction cost is essentially the cost of relocating inputs. It can be the cost of acquiring information, physical relocation, training for new skills, adapting to a new surrounding, or even the pain of relinquishing a tradition. For example, commercial fishermen, because of family tradition, tend to be reluctant to relocate to other types of jobs, and fishing boats have few non-fishing uses. When inputs are difficult to transfer their opportunity costs are reduced. Moreover, opportunity costs are often lower than the existing payment because the input markets are not perfectly competitive. As a result, even if the input moves effortlessly to a new position, its payment will be less. In all the above cases, partial compensation to the inputs is appropriate so that the transaction costs are not to accrue to the parties affected by the loss of the resource. Of course, it is difficult to determine empirically the extent of the barriers to the mobility of the inputs. In the case of labor, one can search for a "normal" period for an unemployed person to look for alternative employment (e.g., the average unemployment period published in the Bureau of Labor Statistics).

Intertemporal Losses

Welfare losses often take place over time. Spills and releases of hazardous substances can cause long-term, chronic damages as well as short-term, acute effects, depending on the extent and severity of the spill and the assimilative capacity of the resource (Cairns, 1980). For example, the reproductive capability of a fish stock depends on the size of stock at any given time. A sudden reduction of the stock size can affect

the growth of the stock and, consequently, the present and future harvests (Clark, 1973). In some cases, the stock may drop under the "minimum viable population level" and the ultimate extinction of the population becomes unavoidable. Where there are intertemporal effects, it is necessary to calculate the value of future damages as well as more immediate effects. However, projecting future losses can be extremely difficult because of the uncertainty associated with forecasts of the net impact of exogenous variables that influence the dynamics of the recovery ability of the resource and future demand for the damaged resource.

If one can identify future welfare losses due to the spill, they must be discounted to their present value. The following equation translates discrete damages, which are known for blocks of time, over time into present values.

$$(1) \quad PV = \sum_{t=1}^n \frac{L_t}{(1+r)^t}$$

PV is the present value of the loss, t denotes the time period, L_t is the loss at time t , n is the point after which there are no more losses, and r is the discount rate. Suppose, for example, that a \$100 loss is suffered by a recreational fisherman in each year for three years. The present value of his loss in the next three years, using a discount rate of 9 percent, would be \$253.

The choice of the appropriate real discount rate for such analyses has been the subject of much discussion. Theoretically, the discount rate reflects an exchange rate between individual time preferences and the productivity of investments (Fisher, 1930). Some economists have argued that public projects related to natural resource conservation should use a discount rate lower than the market rate determined by the supply and demand for investment funds (Pigou, 1932). Otherwise, resource management decisions would be heavily weighted toward the existing individuals, and too few resources would be left for future generations. Another argument favoring a lower rate for public projects is that government investments (e.g., to let the fish stock grow) are generally less risky compared with private investments (it is unlikely that the government will go under financially). Thus, the risk premium, the portion of the interest rate that compensates for risk, may be smaller in government (social) investments

(Samuelson, 1964). However, it has been found that the use of a two-tier interest rate is awkward (Eckstein, 1954). Further, resource use decisions (e.g., harvesting [consumption] vs. conservation [investment]) are often uncertain and risky enough that a lower risk premium may not be justifiable.¹⁷ Some economists argue that the opportunity cost of the private investment displaced by the government project (e.g., protection of an environmental resource from industrial use risk) should be used in determining the discount rate (Lind, 1982). As a result, the ideal discount rate may ultimately be project specific. In summary, there is no consensus on the appropriate interest rate for discounting purposes. Practical applications usually use a long-run nominal interest rate minus the long-run inflation rate.

Willingness To Pay and Willingness To Sell

In the previous section, net willingness to pay was defined as the amount that would make a person as well off after a damage incident as before. As such, it represents the value of the lost service or consumer surplus to that person. However, this value can vary depending on whether the person is buying the service or selling the service. For example, in trying to establish the value of a sportfish is it more appropriate to ask the fisherman how much he is willing to accept to let the fish go, or how much he is willing to pay to keep the fish? Both questions pertain to the value of the fish, yet one can expect the amounts to differ. In particular, the answer to the former question probably will be larger than the answer to the latter.¹⁸ This issue on the difference between willingness to pay and willingness to sell has been the subject of much debate among economists. Although this chapter will not explore the question fully, it is important enough to discuss at least a portion of the debate that is particularly relevant to valuing natural resource damage. Greater detail can be found in Freeman (1979a), Mishan (1971), Currie et al. (1971), and Bockstael and McConnell (1980).

In a survey of questionnaire studies concerning the value of nonmarket goods, Meyer (1979) found that the answers to "what would I have to pay you" questions were larger than the answers to "what would you pay" questions. Intuitively, this result seems reasonable. In the first question, there is little constraint on the value given by the respondent, while in the second one, the respondent is hypothetically limited by his or her disposable income. Mishan (1971) gives an example of a man who was willing to pay

\$60,000 for a house but is able to buy it later for \$40,000. After the purchase, though, he would not sell the house for less than \$65,000. His net willingness to pay (consumer surplus) for the house was \$20,000, but his net willingness to sell the house was \$25,000.¹⁹ Economists have shown that the difference between willingness to pay and willingness to sell is affected by an "income effect," or the impact of income on the demand for goods (Willig, 1976).

In other words, if the consumption of the goods tends to require a large portion of owner's income, the divergence between the two answers will be large. For example, the ratio of responses to the two questions (willingness to sell vs. willingness to pay) concerning the value of a day's saltwater fishing was 19:1 (Meyer, 1975), compared with a ratio of responses of 3:1 when people were asked about the value of a television program (Bohm, 1972). In the past, economists have generally assumed the income effect to be small in their empirical work, so that the estimated value has been an approximation of both the willingness to pay and the willingness to sell. In fact, the estimated value will lie somewhere between them (Willig, 1976).

However, as Bockstael and McConnell (1980) pointed out, if the service a resource provides is a substantial portion of the consumer's well-being, as in the case when a major portion of his income is spent on the use of the resource, the income effect will be significant, as shown in Meyer's surveys. The implication for empirical work is twofold. First, for methods which depend on questioning the consumers, there is a choice to be made between asking about willingness to pay or willingness to sell. Second, for valuation methods which rely on market data, the boundaries of the estimated value will grow, in essence reducing the accuracy of the estimate. These concerns clearly exist in valuing damage to some of the open-access resources which provide significant services to individual users.

Fortunately, the valuation methods can be used more effectively in dealing with this problem by incorporating legal and ethical considerations. The willingness-to-pay question assumes that the person does not have the right to the resource, while the willingness-to-sell question assumes that the person does have the right since it is his option to sell or enjoy the increased service. When the service of a resource is diminished, asking the user what he should be paid to accept the reduction seems more appropriate. The concept of public good is that the good belongs to no one person but rather the public at large. As the public's representative, the trustee should be considered the rightful owner of the resource and be awarded a compensation equivalent to the willingness to sell on the part of the public. For the same reason, damage value

derived from demand-curve-based market data becomes the lower bound of the true value, with the size of the bias influenced by the magnitude of the income effect.

Option Demand and Irreversibility

The unique characteristics of open-access resources have prompted some economists to question whether standard demand analysis can incorporate all of the resource values. Weisbrod (1964) thought that publicly provided services are associated with a value called "the option value" as well as the consumer surplus from consuming the service. Option value exists when individuals, who are not consuming the services, wish to keep the option of using the services later. This option is important if the resource cannot be purchased whenever an individual wants and he may want to avoid foreclosing the use option. Cicchetti and Freeman (1971) showed that option values can be defined as the difference between the consumer surplus a person expects to obtain from the resource and the amount he is willing to pay for the right to consume the service in the future (option price). If the person dislikes risk (i.e., has to be compensated to undertake an even-odds venture) this option value will be positive.

Considerable controversy has developed over the sign of the option value, beginning with Schmalensee's (1972) argument that the sign can be either positive or negative. Based on the body of the ensuing research (Bohm, 1972; Graham, 1981; Anderson, 1981; and Bishop, 1982), the sign of the option value seems to depend on interpretation of risk aversion, stringency of the assumption underlying the state, and preference function and supply-side uncertainty. Freeman (1983) adds that for a representative situation in which one faces uncertainty from exogenous factors in the use of a natural resource, the option value should be positive. Its magnitude will depend on the ratio of expected consumer surplus to income, on probability of demand, and on the risk aversion of the user. However, if the uncertainty arises from endogenous factors, such as future income, option value can be negative and substantial.

Arrow and Fisher (1974) later demonstrated that in comparing irreversible uses of natural resource preservation, there is a pseudo-option value even if the individuals are neutral toward risk. In essence, the value exists because once the irreversible use is undertaken the misinvestment cannot be corrected, even if future information would have favored preservation over the irreversible use. In order to avoid this, society may be willing to pay an equivalent amount.

Independent of risk preference and the value of future information, some economists promote the concept of existence value (Barkley and Seckler, 1972). One derives this value from a person's willingness to pay for a service which he never expects to use. Bishop (1978) gave the example that many people will be willing to pay to know that blue whales will continue to exist even though they do not expect ever to see the whales.

The empirical evidence on the values discussed above has not been conclusive. However, this may be more of a function of estimation techniques than of the absence of any real value. The presence of non-profit conservation and environmental groups seems to suggest that at least on an aggregate level society is willing to protect its open-access resources from activities that would diminish their availability to the public and future generations. On the national level, the passage of legislation such as the Endangered Species Act seems to indicate that society is also willing to pay for protection through higher price levels which are generated by the cost of complying with such regulations.

If a resource is irreversibly damaged, the value of its future services represents the value of the loss. For services that are now in use, the value can simply be aggregated into the future and discounted back to the present by using equation (1). If the value of an ecosystem in absorbing pollutants is expected to remain constant over many years but the ecosystem is irreversibly damaged by a spill, equation (1) will collapse into L/r , where L is the annual loss value from the lost waste treatment function and r is the discount rate.²⁰

But this may represent only a portion of the future benefits since we do not know of other potential future uses and the effect of the permanent loss on human activities. Thus, the final impact of the loss on human activities is difficult to assess. For example, the value of an endangered species in the long run may be more than that derived from its strict economic use. It may provide unique research subjects and benefit society through enhancement of our understanding of biological processes. A wide variety of life forms may ultimately provide more choices and opportunities to enrich human life.

The above hypotheses all point to the possibility that measuring existing consumer surplus is a lower bound to the value of many open-access resources. Moreover, there are also reasons to believe that relative to the value of manufactured goods, the open-access natural resource values should increase over time. Smith (1974) pointed out that since technological advances usually serve to lower prices for manufactured goods while production of services from open-access resources is likely to remain constant, resource values will rise over time.

It is conceivable that large scale surveys could be conducted to question people's willingness to pay for the option of using a resource in the future or simply to guarantee its existence.²¹ However, such an effort may be impractical. With the exception of services that are observed now and expected to last in the future, long run services of open-access resources are hard to predict, not to mention the difficulty of predicting the value of the resources to future generations. Because of ethical considerations and the uncertainty underlying the determination of these values, economic analysis may have to, at times, give way to some form of institutional or political arrangement to arrive at values for these resources.

Footnotes—Chapter III

- 1 These activities would be relevant if our subject here was management of coastal resources rather than damage valuation.
- 2 There are other divisions illustrating the economic theoretical framework underlying damage assessment. The one chosen here attempts to conform to the cost recovery mechanism established by Superfund. This is considered to be an appropriate compromise between the economic and legal perspectives.
- 3 The inverse demand equation of Figures III-1 and III-2 is $y = 60 - 2x$.
- 4 Total willingness to pay is given by the integral from 0 to the consumption level.
- 5 The supply curve FC assumes constant cost for ease of illustration.
- 6 If the \$20 "price" per trip is an admission fee representing the person's willingness to pay for the resource rather than the real resource cost (e.g., travel, lodging, and equipment), the value of the site to the person will remain \$800. (We thank Myrick Freeman for noting this point.)
- 7 The loss of consumer surplus will also be the same for the two versions if the demand and cost curves are linear and the shifts are parallel.
- 8 Conceptually, this can be done if time series data exist for each user and enough resources are committed to the task.
- 9 It should be noted that the second effect—higher selling price—also incurs losses to consumers. Such losses will materialize as an upward shift in the cost curves (see Figures III-1 and III-2).
- 10 Following Mishan's (1968) suggestion we will use the term economic rent, which includes benefits accrued to all owners of factors of production rather than only to "producers," as suggested by the term producer surplus.
- 11 The equation used to generate the supply curve is $y = 1,000 + 0.4x$.
- 12 This ignores complicating factors such as monopoly and cost effects. See Hotelling (1931), and Burt and Cummings (1970).
- 13 More formally, the rent value of a fish is the change in the value of the fish stock as a capital asset due to the taking of the fish. To this value we need to add another value called stock effect if we consider the fact that harvesting cost increases as the stock size decreases; the rent value of the fish is further increased. (See Anderson, 1977.)

- 14 Gordon stated that fishermen tend to harvest to the point where the average cost of fishing equals the value of average productivity of the fishing ground, instead of only harvesting up to the point where the marginal cost equals the value of marginal productivity. As a result it is difficult to identify the rent by analyzing the difference between dockside prices and fishing cost (Tihansky and Meade, 1975).
- 15 See Pruitt v. Allied Chemical Corp., 523 F. Supp. 975 (E.D. Va. 1981).
- 16 Alaska Stat. Section 46.03.758(a)–(e). The Alaska damage assessment scheme is discussed in more detail in Chapter V.
- 17 We thank Myrick Freeman for pointing this out.
- 18 This divergence exists even if we assume there is no bias in the questionnaire approach and respondents gave serious and accurate answers.
- 19 The net willingness to pay is the total willingness to pay of \$60,000 minus the cost of \$40,000. The net willingness to sell is the total willingness to sell of \$65,000 minus the cost of \$40,000.
- 20 The choice of discount rate was discussed in the section dealing with intertemporal losses.
- 21 In the extreme case the questionnaire will be a national referendum on society's willingness to pay for preserving a resource.

Chapter IV

METHODS OF VALUING DAMAGES

Introduction

In recent years, economists, scientists, and lawyers have made impressive developments in natural resource valuation methodologies. These developments have not lacked variety in terms of types of methods suggested, ranging from the simple replacement cost approach often used in courts to the sophisticated travel cost technique. Some of these methods are beginning to be applied in cases of actual spills where open-access resources were damaged. The replacement cost method was the key to the assessment of the damages to the coastal resources of Puerto Rico when the ship Zoe Colocotroni spilled 1.5 million gallons of oil. The same method also valued the marine organisms killed in the Santa Barbara oil spill. Both the travel cost and the contingent valuation methods were used in valuing the losses to the Brittany coastline incurred by the Amoco Cadiz tanker spill (U.S. Department of Commerce, 1983). Contingent valuation methods enhanced by statistical analysis were used to calculate the value of waterfowl killed by the Kepone spill in the James River, Virginia, (Brown, 1977) and of the waterfowl lost in the Steuart Transportation oil spill in the Chesapeake Bay.¹ If anything is needed in the methodology of resource valuation, it is some form of consensus among practitioners on how to use these methods. Many of these tools could make significant contributions to the efforts by courts and agencies to evaluate the damages caused by spills of oil and hazardous substances. Yet this is not likely to happen if the methods cannot be adapted to the constraints set by legal, theoretical, technical, and institutional factors. Not all the methods discussed in this chapter will satisfy all these constraints equally. However, understanding the methods and discussing their strengths and weaknesses will increase their usefulness under the varying circumstances surrounding damage valuation. Such is the purpose of this chapter. The next chapter will expand on existing and potential applications of these methods within the present legal framework.

This presentation will again strive for ease of understanding in demonstrating how these methods of resource valuation work. This will be especially the case in the discussion of state-of-the-art methods, the application of which is still in the experimental stage. References throughout this presentation will allow interested readers to pursue these techniques further.

In order to establish meaningful relationships between these methods and their application in damage valuation, it is necessary to develop some evaluation criteria. The three criteria chosen for this study are validity, applicability, and acceptability. These will provide a basis for understanding the advantages and disadvantages of the methods and the circumstances in which they will perform best.

Theoretical validity gives a method the credibility that results from performing in an accurate, unarbitrary, and consistent manner. Credibility is indispensable if the method is to purport to lead to fair and equitable compensation.² Mechanically, a theoretically valid method is a framework constructed upon a logical sequence of inductive steps that can be traced to a well-established body of knowledge consisting of facts and reasonable assumptions. Assumptions are necessary complements to facts, for two reasons. First, an analytical framework inevitably simplifies the real world to capture the elements most relevant and essential to the working of the framework. Second, the collection of all facts that are necessary to support an analytical framework without resort to assumptions can be extremely costly and cumbersome. For example, economists assume in demand analysis that individual preference orderings are the same except for variables that can be controlled statistically, such as age, education, and income. Without this assumption, demand analysis would have to establish individual preference functions for all relevant consumers and income, a task requiring tremendous resources. It is thus important to examine the interpretation of facts and assumptions underlying a method when evaluating the validity of the method. Ultimately a theoretically valid method is built on recognizable facts and defensible assumptions.

Applicability can be broadly interpreted as the cost of implementation. The applicability of a method becomes an important consideration when the method is to be subjected to wide uses in solving real world problems. As much as one desires accuracy, any increase in accuracy is usually accompanied by rising implementation costs in terms of data requirements and analytical effort. For example, the advantage of the replacement cost method lies in its low cost. For resources that can be replaced in the marketplace, the necessary information can be obtained easily, for example, by considering cost of fish from a hatchery as the replacement cost for fish killed.

However, use of more sophisticated methods such as travel cost may increase the accuracy of the estimate but involves higher expenditures for surveys and statistical analysis. The consideration of cost is especially crucial when a method is to be applied to a large number of small spills where the benefit of incremental effort to improve accuracy may be small.³ In other words, the cost of applying a method cannot be judged independently from the benefits of the application.

The third criterion is the method's acceptability, not only to the research community, but also to the court system and government agencies. A method is acceptable to the research community if there is consensus that the method is proven valid through peer reviews and an extended period of challenges. Acceptability to the court system and government agencies depends mostly on the credibility the research community attaches to the method and also on the method's being readily understandable and applicable. A method that can be explained unambiguously is much more likely to be effective in communicating its results to non-specialists. However, this sometimes entails understanding and recognition of factors other than ones considered important by researchers.

On the basis of concepts developed in the previous chapter, the valuation methods are divided into two groups: private losses and public losses. Private losses consist of damages suffered by private property owners and commercial interests who use the damaged open-access resources as inputs to their activities. Public losses are the reduction of the flow of services from an open-access resource directly to the public as consumers. These losses relate to the consumption of the resource that takes place outside of the marketplace. The distinction is warranted by the fact that methods dealing with private losses generally are oriented to a diminution of the resource's value based on its marketplace activities (e.g., rent, sales value, profit, and business volume) whereas the methods used in measuring public losses attempt to create a surrogate market where implicit prices or willingness to pay can be derived. Of course the total value of damage resulting from a spill is the sum of both types of losses; an oil spill causes losses to the public use of an open-access beach and losses to the owners of the properties adjacent to the open water where the spill took place. The previous section also discussed user cost or capital value of renewable resources. Although it is not often that a public trustee can make claim for this value, its recognition is important in the context of intertemporal losses.

Methods of Valuing Private Losses

The two methods discussed in this section, changes in property value and lost business opportunity, measure losses sustained by private parties whose property and business depend on the availability of open-access resources. Although there are variations to these two methods, measurements of losses to private interests generally fall into either group. The method using changes in property value assumes that the values of all the activities undertaken on a private property are reflected in its price, including, for example, enjoying a view of public shoreline. Everything else being equal, to the extent that such activity is curtailed the property value will drop. The method using lost business opportunity is less straightforward because the value of the damaged resource is reflected in the marketplace for the product or service provided by the business. In addition, it can be difficult to distinguish economic rent from other types of cost.

Property Value Changes

The price of a property is equal to the discounted present value of the stream of expected rents or services over time, including environmental amenities. Thus, when private property is situated near an open-access resource such as public shoreline, a portion of its market value derives from the accessibility and uses of the natural resource. In a sense, the property uses the resource as an input to its function, which may be residential or commercial. A spill which damages the open-access resource therefore inflicts a loss on the owner of the property. Since the property's value is determined in the marketplace, a comparison between the pre-spill property value and the post-spill value can under certain conditions provide an estimate of the private loss. In reality this comparison can be difficult except in the ideal situation where the property was sold before the spill and again after the spill. When actual transactions cannot be observed for comparison, estimation of the damage would have to come from sales price of similar property, value based on an assessment (e.g., for property tax purposes), or property value study. The validity of using sales prices of similar property of course depends on how similar the two properties are, while value assessed for property tax is often different from actual market price because of its rigid and simple estimation procedure. Recently economists have developed a statistical method to estimate the values of the characteristics (e.g., open shoreline) of a property. This method is referred to as the property value study. Since it belongs to a broader approach

called the hedonic price approach, discussion of its mechanisms will be postponed to later in this chapter. In short, the use of this technique requires a sample of sufficient size that includes properties having different levels of the characteristics in question. For example, the technique can estimate the value of a view of shoreline from private properties in a region. If the property is for rental purposes, the reduction in rent can be summed over the periods when damage is in effect to arrive at the loss. Of course, lost rental value in each of the periods would have to be discounted to present value.

A major assumption underlying the use of changes in property value to evaluate damage is that the land market is competitive so that changes in the characteristics of the land are reflected in its rent or sales value.⁴ More specifically, if a spill deprives a property of its view of a clean beach, will such a loss lead to a drop in the value of the land? Or would the user of the land simply absorb the loss and the value of the land remain constant? For example, the users can be renters and their rent can remain the same because of a long term contract. In the case where the users are also owners and if the residents in the area affected by the spill have low outward mobility (e.g., because of their job situation), the value of the property can remain constant despite the spill. In sum, the change in property value can capture the value of the lost resource only if the land market is competitive and the lost surplus is absorbed by the value of the land. A second assumption, implicit in the foregoing discussion, is that the pre-spill price of the affected parcel does not reflect any expectation of a spill. However, it is possible that buyers' expectations of spill damages are already incorporated into land values through discounting mechanisms. In this case, if a spill occurs and the damages from that spill are consistent with past market expectations, land values will not change at all. This point has a more general interpretation. It is critical to remember that land values reflect streams of costs and benefits and thus a spill will affect values only if it has a direct effect on future service flows and is inconsistent with market expectations concerning those flows.

Another problem of a more mechanical nature may also hamper the use of this property value change technique. It is the task of distinguishing the effect of the spill on the property from numerous other effects which influence the value of the property. Regional economics, the interest rate, and the local school system are but a few of the factors which work in concert to affect property value.

If the above concerns can be addressed, the property value change method is attractive in several ways. First, the method conforms to economic theory since property values are determined in the marketplace. Second, the courts have also

traditionally accepted the market-oriented valuation more than other assessments.⁵ Finally, the changes in property value can be assessed relatively easily when transactions occur.

Lost Business Opportunity

When the private party is a commercial interest and a spill reduces the availability of the resource that is an input to the commercial activity, the party may suffer a business loss. The lost business opportunity can be revenue, profit, and income all forgone because of the spill. For example, commercial fishermen suffer a business loss when a resource stock to be harvested is damaged.

In the previous chapter the concept of economic rent was developed as a legitimate measurement of losses. Economic rent was defined as rewards to the business for holding the appropriate fixed inputs, such as land, capital equipment, and entrepreneurship, to conduct the business. This rent can be approximated generally by profit, excluding the reward for the owner's own labor.

This technique can be difficult to use in awarding damages for expected losses when the business is new or when the profit of a business is subject to large variation, such as commercial fishing; courts are more likely to award lost profits if the damaged business has been operating for some time and has a financial record. An additional legal problem is deciding how closely the business has to be related to the damaged natural resource in order to claim for lost profit. Recently, for example, businessmen such as restaurant owners, wholesalers, distributors, and boat tackle and bait shop owners and their employees have attempted to assert claims for lost business opportunity due to a Kepone spill.⁶ There is, obviously, no definite boundary to the economic impact of the damaged resource. Yet one can speculate that the less a business depends on the availability of the resource the smaller the impact will be. At some point the lost profit will be indistinguishable from the normal profit and loss fluctuation of the business. Payments to inputs such as labor are not generally considered losses since the inputs have opportunity costs and can relocate to other uses. The employee does suffer a loss, though, during relocation or when the new job is not as rewarding as the former one. The key question is how long is the employee to be compensated for that loss. An extreme case would be to compensate, for example, an unemployed fishermen as long as the reduction in harvest caused by the spill exists. In such a case the fishermen would have no incentive to look for other jobs and, in fact, would consider themselves to have zero

opportunity cost. A more reasonable scheme would be to compensate the lost payment for a "normal" period of unemployment that is required to look for another job. Of course, the identification of this transitional period will be difficult since it may differ depending on the occupation and the region.

Courts often use lost business opportunity to award losses. For example, in determining damages to a private oyster bed resulting from an oil spill, a court decided to award the plaintiff the number of lost sacks of oysters by the price per sack, in essence, the revenue, despite the defendant's argument that the plaintiff should not receive more than an expected net profit.⁷ The court based its use of price rather than net profit on the argument that the plaintiff had not only lost his net profit but also the expense of planting and cultivating the oysters. Yet in another oyster case, the court used net profit to award damages by multiplying the estimated forgone yield in bushels by the average price per bushel and subtracting the cost of tonging and marketing.⁸ From an economic point of view both approaches could be correct. In theory, the proper value is net profit if the oysters had yet to be harvested. If, on the other hand, the oysters were harvested and then found to be damaged, market-price is the appropriate value.

In general, valuing damage to commercial interests by lost business opportunity is theoretically simple, although its mechanics can be difficult, for instance, when handling transaction cost for the unemployed labor. Courts seem to be comfortable with the concept but still need to establish some ground rules concerning the composition of lost net profit and the range of businesses which can legitimately claim compensation. Here, economic analysis can be useful in defining "real losses" based on the concepts mentioned in Chapter III. However, converting such definitions into the rules through a judicial, legislative, or administrative process will require more cooperation among the involved parties.

Methods of Valuing Public Losses

Valuing losses to the public when open-access resources are damaged is handicapped by the absence of markets. However, as long as there exists some willingness to pay for the services flowing from the resource, there must be prices implied by the consumption of these services. All the methods discussed below attempt to capture these implicit prices through approximation from prices of a similar resource

in private markets, the cost of replacing the damaged resource, or demand equations directly estimated from the public users. The methods of property value change, replacement cost, and energy analysis are relatively simple to understand and to use. In particular, the change-in-property-value method has already been discussed in the private loss section. However, its discussion here concerns how its results can be converted to public losses. The other techniques that attempt to directly estimate public values such as travel cost, contingent value, and the hedonic approach are more complex and relatively new.⁹

Property Value Changes

Many open-access resources, such as waterfronts, open spaces, and beaches, are similar to private resources. The values of the private resources obviously are reflected in the marketplace, if not singularly, then imbedded in the value of a larger parcel of land. As discussed in the private loss section, damages to such resources can be estimated by examining changes in the private property values. Can one apply these values, when identified, to similar resources in the public domain? For example, when a spill damages a stretch of shoreline containing both public and private beaches, can one use the decrease in the unit value of the private beach as a measure of the loss to the public beach? If such an approximation method is valid, damage to some resources can be valued by examining the private sector. However, the answer is not straightforward and depends on the social mechanism that allocates resources between the public and private sector. Economic theory has justified the provision of public goods such as open-access natural resources by noting that when an individual owner cannot exclude others and charge for their uses, the collective good is best provided by a public agency. If these public goods are not provided by the public sector the private market will fail to satisfy the public's demand for them. Examples of this include historic preservation, protection of the environment, and national defense. However, in providing such public goods the public sector often competes with the private sector for the inputs that are necessary for producing the public goods. The land that is to be used for wilderness preservation could be used for mineral mining; the shorelines that are to be preserved for recreation could be developed for vacation housing. In order for a resource to have the same social value in both uses we must assume that the allocation of the resource between the two sectors is socially optimal.

Fish stock is a good illustration of this allocation scheme and how it relates to values in both sectors.¹⁰ For a given fish stock, there are often two competing demands (Bishop and Samples, 1980). One is from the commercial fishing industry that harvests the fish as a private business, while the other is from sportfishing, which catches the fish as recreation. Fishery management must allocate the fish, through licensing, harvest limitation, and even taxes or fees, so that the two uses maximize total social benefits. This optimal allocation occurs when the marginal values of a fish in both sectors become identical.

The scheme is analogous to the working of the marketplace where the next unit of an input goes to the highest bidder. However, in the case of fish stock, the management (government) takes on the role of the marketplace and must allocate according to perceived marginal values in the two sectors. If management perceives a rise in the demand for sportfishing through an increasing number of sport fisherman, it may construct more boat ramps in recreational areas while limiting commercial catches by area restriction, mesh size, and sales tax on fish as food. Such a reduction of supply in the commercial sector and an increase of supply in the recreational sector will raise the price in the former sector and lower the price in latter, thereby narrowing the divergence of the two prices. Ideally, the process converges toward identical prices. However, does such an omniscient fishery management exist so that one can assume that the marginal values are equal or in the process of converging? The same question applies to other open-access resource activities that compete with the private sector.

The answer to the question obviously depends on how accurately society's institutional mechanisms judge the demand for public goods and how faithfully the mechanisms carry out the optimal allocation. Without getting into the vast literature on public choice, it suffices to say that it will be difficult to show that an existing pattern of distribution of resources between public and private sectors is, indeed, optimal. This is especially so since public choices are not easily adjustable toward changing demands. Thus, there will be few circumstances where it can be shown that the value of lost open-access resources can be approximated by the value of the same type of resources in the private sector.

One could, however, just as in the use of the replacement cost method, assume that recently made public choices do reflect the social or community demand pattern and that the decisions allocating resources, such as leasing of public land or conversion of private land for public uses, do equalize the prices of the resources in both sectors. This

would allow the prices of the resources in the private sector to be used in estimating values of damages to similar open-access resources.

The recent development of the hedonic property value method in estimating values of non-market goods certainly heightens the potential for using private values for valuing open-access resources (Brown and Pollakowski, 1977; Harrison and Rubinfeld, 1978; Polinsky and Shavell, 1976).¹¹ The method, as discussed later in this chapter, in essence identifies the values of non-market goods which were formerly included in a housing package such as air quality, distance to shoreline, open space, access to clean water. These goods also often exist in the public sector as open-access resources. The method breaks up the price of housing into prices of these goods in the private sector. For example, Brown and Pollakowski (1977) estimated the value of open space and proximity to bodies of clean water in private housing. Assuming that public officials optimally allocated land use through zoning and building restrictions, the loss of open space and clean water on public land can be estimated by the changes in the value of private property.

Replacement Cost

Since open-access resources are not being traded in the marketplace, one conceptually simple way to compensate the victim is simply to restore or replace the resources. This concept of replacement cost is widely accepted in law. In particular, replacement cost is called for in federal statutes concerning oil and hazardous substance spills. Both the Clean Water Act and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) authorize the use of replacement cost to compensate victims. CERCLA specifically authorizes the trustee for a damaged natural resource to seek to recover for the cost of replacing, rehabilitating, restoring, or providing the equivalent of the lost resource.

An interesting example of the use of replacement costs to valuing natural resources involves the case of Commonwealth of Puerto Rico v. SS Zoe Colocotroni, where an oil tanker dumped 1.5 million gallons of crude oil in order to free itself after running aground on a reef. A district court awarded the plaintiff, in this case Puerto Rico acting as public trustee, an amount based on the replacement cost for the damaged natural resources.¹² The district court awarded Puerto Rico \$559,500 to restore the destroyed mangroves and \$5,526,580 (in 1978 dollars) to replace dead organisms such as worms in the Bahia Sucia Bay. However, the court of appeals reversed this ruling in part,

holding that the replacement scheme was unreasonable.¹³ The reversal in this case illustrates the problems resulting from several theoretical weaknesses in the method, although it is often considered simple and inexpensive to use.

As an economic tool, the replacement cost method is weak in its use as an approximation of the value of resources. Most people recognize that a replacement value may be simply too costly when it is difficult to restore or reconstruct a damaged natural resource. The Zoe appellate court recognized this difficulty but had no criteria other than the "reasonableness" of the restoration plan underlying the replacement cost. From an economic perspective, the hesitation of the court to award replacement costs is well founded. Theoretically, the costs of restoration seldom appropriately match the lost welfare of the users. Indeed, the only way to determine its validity is to compare the replacement costs with the willingness of the users to pay for the lost services from the damaged resources. In this regard, even "perfect" restoration of the lost resources is often economically inefficient. The users are obviously compensated to their pre-spill welfare position once the resource is restored. However, this may have been done at a cost above the users' willingness to pay. In such a case, the users would have been equally satisfied if given a monetary reward that is less than the cost of restoration. Of course, in the case of open-access natural resources the distribution of the reward and the determination of the total willingness to pay may be impractical. Yet replacement cost precludes the possibility that the public can be compensated to the pre-spill welfare level by an amount lower than the cost of restoring the damaged resource. Recent statutes such as CERCLA and the Outer Continental Shelf Lands Act Amendments of 1978 (OCSLA) allow the compensation to be used to "acquire the equivalent" of natural resources that are injured. For example, instead of replacing some destroyed organisms in a polluted beach, the trustee can enhance the productivity of similar organisms in another area similar to the polluted beach, as long as the trustee believes the users as a whole have gained so that they are as well off as before the spill. A more economically efficient compensation might be achieved by this approach.

As a legal matter, it is crucial first to reduce the confusion stemming from the fact that it is not clear whether the courts and the legislature consider replacement cost in the context of restoration and rehabilitation, or in the context of a measure of compensation to re-establish the users to their pre-spill level of well-being. If the legal validity of replacement cost is dependent on actual restoration or rehabilitation of the damaged resource, the relevant question is whether the restoration plan is feasible.

However, if replacement cost can operate independent of actual restoration, the method deserves the above examination as a tool for valuing natural resource damages.

Replacement cost was mentioned in the liability sections of the Clean Water Act Amendments of 1977 (CWA) and the OCSLA. It seems that the Zoe appellate court correctly determined that Congress intended replacement cost to be a reimbursement to the public trustee who made expenditures restoring the damaged resources. Under the CWA, the trustee is authorized to recover "cost or expenses incurred... in the restoration or replacement of natural resources damages."¹⁴ The OCSLA states that the sum the trustee recovers "shall be available for use to restore, rehabilitate, or acquire the equivalent of such natural resources."¹⁵ On the basis of this perception, the court ruled that using the replacement cost of the dead organisms was erroneous because the new organisms would perish if returned to the oil-soaked sands.¹⁶ The court obviously considered replacement cost a component of an overall plan of restoration.

In contrast, the district court of Puerto Rico, in its earlier decision, apparently considered replacement cost a measure of compensation for the destroyed organisms without necessarily replacing the organisms. The fact that the calculation used the lowest possible cost of the organisms, \$0.06 each, while recognizing that some of the organisms would cost up to \$1.00 to \$4.50 each, implied that actual replacement could not have taken place even if the award was made.

In summary, the problem of using replacement cost as a measure of the lost welfare is that it reflects only the supply side of natural resource uses. Since the value of any commodity is determined by the interaction of demand and supply, the replacement cost method is deficient by definition. It should be used only when there is reason to believe that the replacement cost reflects the willingness to pay for the lost resource. There are generally two circumstances in which this will occur. One exists when a damaged resource, such as sportfish, is consumed in discrete units and provided by commercial suppliers for restocking purposes. The other exists when a resource such as a new public park has been recently constructed. Under this circumstance, the cost of providing the service may reflect what the users, represented by the public trustee, were willing to pay. Since most natural resource services were not "constructed" through a social decision, this circumstance may be rare.

Energy Analysis

There is considerable debate on the issue of whether the method commonly called "energy analysis" should be considered an economic tool in valuing outdoor resources. Many economists feel that the approach is not defensible in terms of standard economic theory. However, its use has been suggested by prominent ecologists such as Eugene Odum (Gosselink et al., 1974) for wetlands valuation as a supplement or replacement to traditional economic analysis. They argue that the method is useful as an alternative to the economist's "component" approach where the value of an ecological system such as wetland is constructed by summing the values of its various functions, such as commercial and sport fishing, waterfowl and recreational water activities. Many ecologists do not agree that the values of all of the wetland functions can be summed (Westman, 1977; Gosselink et al., 1974). It is argued that the component approach is not able to incorporate the "total life-support" value (i.e., the value of supporting the flora and fauna) and invariably underestimates the value of an ecological system. The marketplace then will incorrectly favor commercial uses of such systems instead of preservation, leading to irreversible losses of natural resources.

The basis of the energy analysis approach is the belief that the value of a good is reflected in the amount of energy required for its production (Odum and Odum, 1976; Constanza, 1980). Accordingly, energy is the basic input into all production of goods; labor, capital, and land are only intermediate factors whose values are again based on the energy required to produce them. Given these assumptions, an open-access resource can be valued by its biomass in terms of the biological productivity that supports the resource's services. Once the resource is reduced to units of energy (i.e., calories) its value is simply the product of the units and the unit price. The ratio of the Gross National Product (GNP) to the total amount of energy consumed by the economic activities was the unit price used in at least one study (Gosselink et al., 1974).

An application of energy analysis valuation of open-access resource can be found in Gosselink et al. (1974), where wetlands were valued by assessing the energy content of the salt marshes.¹⁷ The annual net production of salt marshes represented the energy flow of a wetland which carries out its various functions. By using the equivalence of 10^4 kilocalories to a dollar, total life-support value per acre was found to be \$4,100 a year or \$82,000 (in 1974 dollars) income capitalized at an interest rate of 5%. Constanza (1981) later obtained a lower yearly estimate of \$3,120 (in 1981 dollars).

The use of energy analysis in valuing natural resources will continue to be opposed by economists because of its incompatibility with some basic postulates underlying economic theory. Specifically, energy analysis rejects the concept of consumer sovereignty, wherein the market place dictates the allocation of resources and in which the preference pattern of existing consumers is the basis for determining the values of the array of goods in our society. In theory, open-access resource allocation is no exception. There are alternative uses of public resources, and the choice is made on the basis of social preference which reflects individual preferences. Advocates of energy analysis turn this allocation scheme around and propose that values are determined by what goes into the production of a good, namely, the amount of energy, not the demand for the good.

If energy analysis belongs in a social system which ultimately maximizes the individual's utility, the amount of production energy of a good must have a one-to-one relationship to its utility. This is because, as Shabman and Batie (1978) pointed out, energy analysis techniques assume that society's objective is to maximize net energy. This cost-of-supply approach toward valuing goods is incomplete in an economic system where value is determined by the interaction of supply and demand.¹⁸ This defect is especially crucial for open-access resources, which are not produced by man through a social allocation decision. If this relationship does not exist, the energy value of an existing resource may not be equivalent to the resource value based on social utility.

Consequently, any improvement of the energy analysis over the component approach is acquired at the considerable cost of not being accepted by the mainstream of economic analysis. The method is also controversial because it has produced values higher than any other method except replacement cost (Constanza, 1981; and Gosselink et al., 1974). The ecologist could argue that this is due to the comprehensiveness of the approach, while the economist will attribute the high value to the inherent biases of the approach.

Travel Cost

The art of constructing surrogate values for public resources took a substantial step forward with economists' attempts to value outdoor recreation activities. In 1949 H. Hotelling suggested to the U.S. Park Service that the demand for outdoor recreation could be estimated by the user's expenditures during the trip. Hotelling argued that a demand curve for a recreation site could be obtained by plotting the number of trips

against the cost of traveling to those sites. Later, Clawson (1959) and Clawson and Knetsch (1966) empirically applied the concept and firmly established the use of the travel cost method in the field of recreational economics.

Clawson's early travel cost method succeeded in developing the hypothesis that public demand for open-access resources is reflected in expenditures incurred in using the resources. The specific method consisted of two stages. In the first stage, Clawson acquired data on visitation rates and expenditures for a particular park. The purpose of this stage was to construct a relationship between cost per visit and visit rates from residential zones located at different distances around the site. For example, in estimating the recreational demand for Yosemite National Park, Clawson used five counties to trace out the curve between cost per visit and number of visits per 100,000 population from each county. He constructed the cost measure on two main components: (1) an estimate of average daily cost from food, lodging, etc.; and (2) cost from traveling (e.g., 10 cents per mile). The variation in the cost per visit was due mainly to the different distances between regions and the sites. The regions, for example, can be counties, cities, or simply concentric zones about the site. Since the farther distances require higher cost and lessen the number of visits, the relationship will be negative.

In the second stage, Clawson estimated the change in the number of visits when costs are hypothetically increased. The key to this step was to use the relationship between cost per visits and number of visits estimated from the previous stage to project the decrease in visits as cost per trip increased. This was done for each region, and the changes were then summed across the regions. The result of this second stage was an estimated relationship between various costs per trip and total number of visits, in effect, a site demand curve.

Clawson readily admitted that his application of the travel cost method was limited by several assumptions. For example, he assumed that the cost per trip was mostly generated by distance. In actuality, other expenses such as equipment, food, and lodging, when included, may influence the position and shape of the demand curve. It also was obvious that the linkage between the first stage and the second stage required an assumption that (1) recreationists across the regions shared the same preference functions and income elasticity, and (2) recreationists reacted to an increase in entrance fees in the same way as to an increase in travel costs.¹⁹ Finally, Clawson was troubled by the absence of travel time as a factor in estimating the demand for the site. He raised the issues of whether travel time is a cost or benefit and of problems associated with its measurement.

Fortunately, subsequent applications of the travel-cost method have largely addressed the above limitations and improved its usefulness for evaluating outdoor resources. Generally, improvements were made on two fronts. The first is the incorporation of more variables which influence the demand for the site. In particular, substantial research has been accumulated on variables such as income, travel time, congestion, and substitute outdoor activities. A hypothetical travel cost estimation equation expanded along these variables will look like the following:

$$(2) \quad \text{Trip frequency} = a_0 + a_1 \text{ travel cost} + a_2 \text{ income} + a_3 \text{ travel time} \\ + a_4 \text{ use of alternative site} + \text{error term}$$

where the a_0 to a_4 are parameters to be estimated. The second improvement is the relaxation of the assumption that the taste and preference patterns remain constant across regions. These improvements are discussed in turn.

The first step in improving the travel cost method was taken by Brown et al. (1964) by including variables other than the cost of a visit. Their multivariate demand analysis effort was also a pioneering one in applying the travel-cost method to the valuation of sportfishing activity.²⁰ Realizing that the cost of a trip is not the only explanatory variable affecting the number of trips taken, Brown et al. introduced other demand "shifters" such as income and catch rate into the basic regression equation. The study then followed the Clawson method closely. Using five concentric zones, they constructed a schedule between average sportfishing cost per day and fishing days per unit of population. Using the estimated relationship, they constructed a demand equation by tracing the change in fishing days caused by the change in fishing cost per day. They then generated changes in fishing days in each of the zones and summed up all the changes to arrive at the final total demand curve.

The inclusion of the income variable in this work raises two questions about how to measure the influence of income on use of sites. Typically, income is an independent variable in a demand equation. The estimated coefficient of the income variable shows how much the demand curve is shifted by income. Another method is to stratify the sample into several groups by income (e.g., high, medium, and low) and conduct a regression analysis for each of the groups. A more accurate total demand curve could be constructed by adding each of the estimated demand curves. Sinden (1974) has shown that the latter demand curve was less elastic than the computed one, meaning the

computed one may underestimate the consumer surplus. Of course, there is a cost of conducting regressions on stratified samples in that the sample size of each regression becomes smaller, resulting sometimes in less confidence in the statistical results.

The second question on the inclusion of an income variable is whether the increase in demand related to higher income is caused by the decreasing marginal utility of money (a dollar means less to rich people than poor people) or increasing utility of the use (the recreation simply means more, in relation to other goods, to rich people than poor people). If the former is true, Seckler (1966) argued, the estimated demand curve measures the income effect (distribution of income) rather than the willingness to pay of the users. Since the issue of income effect was dealt with in the section on willingness to pay in the previous chapter, it suffices to say here that if the expenditure for the activity is relatively small compared with a person's income, this income effect will be small and the demand curve will accurately reflect his willingness to pay regardless of his income level.

Accounting for the cost of time incurred during the travel and recreation activities in the estimation procedure is a more difficult problem. It has been argued that the cost of such time is its opportunity cost or its value in an alternative use (e.g., going to a movie instead) and its exclusion has been found to underestimate the value of the resource used in recreation activities (Brown and Nawas, 1973; McConnell, 1975). However, other economists have suggested that travel time may be a benefit rather than a cost (Allen et al., 1981; Bishop and Heberlein, 1979; Spaulding, 1976). For a given level of outdoor activity some recreationists consider "getting away" a desirable product. Cesario (1976) and Wilman (1980) have suggested that travel time has two components: the already mentioned opportunity cost, which gives negative value to travel time, and a commodity value, which gives a positive value. The net value of travel time is the difference between the two, which these two authors termed the "value of time saved." Wilman proposed to use this value of time saved to calculate the value of travel time and the opportunity cost of travel time to calculate in turn the net value during recreation activities. The question of how to quantify the cost of time remains difficult. In the past, assuming that the value of time saved is negative (cost), a person's average hourly income was used as a proxy variable. A more accurate measurement of the cost of time would seem to have to come from some sort of questionnaire approach, such as the one suggested by Wilman.²¹ There seems to be no way to construct a measurement based on observed economic behavior.

Congestion is another variable, in the absence of which the travel cost equation

may underestimate the true economic value of an outdoor resource (McConnell and Duff, 1976; Wetzel, 1977; Cesario, 1980). This argument is based mainly on the following scenario: (1) when congestion occurs, users' costs increase; (2) this increase relieves the congestion; and (3) the change in the congestion levels distorts the demand estimation. However, as McConnell (1980) points out, the exact impact of congestion on the travel cost method is often indeterminate without consideration of various components of the estimation such as the assumed preference function, data collected, and estimation method. Anderson (1980) argued that the Clawson method is still meaningful when no admission fee is used and that the congestion-corrected demand curve of Wetzel (1977) merely shows how use will vary with an entrance fee and does not necessarily carry a welfare implication. In addition, Cesario (1980) addressed the effects of congestion across substitute sites. In the context of damage valuation, the argument seems to call for compensation for substitute site users since the loss at one site creates congestions at other sites.

An additional bias results from the absence of variables representing activities that are substitutes to the one whose demand is being estimated. In standard demand analysis, it is a well-established procedure to include prices of substitute goods in the estimation equation, since consumer behavior is dictated by the price of the good in question in relation to the prices of competing and complementary goods. When these prices are not included in the estimation equation the resulting demand curve could be biased in unknown directions. In the case of the travel cost method, the influence of substitute activities becomes increasingly significant as the sample includes more distant zones. For common outdoor resources, such as fishing and camping, the number of alternative sites increases as the user is farther away from the site under study. This problem can be generally addressed by gathering additional data on the alternative activities. Sinden (1974), in his analysis of recreational activities, included the choices of swimming, boating, and fishing. Gum and Martin (1975) and Burt and Brewer (1971) all have considered the demand for an outdoor resource in the context of an outdoor resource market, where different sites and activities compete for the limited recreation budget of the users.²²

Empirical demonstration and quantification of the improvement from the elimination of the biases discussed above have been difficult because of multicollinearity among the independent variables included in the travel cost equation (e.g., travel cost and travel time).²³ This leads to difficulty in determining the accuracy of a particular estimation equation. The net effect is that no particular specification of the estimation equation

can be known as the true one. Researchers can improve the specification only by observing the significance of the variables through iteration, and assuming that as the equation becomes more fully specified, the results will be more accurate. Since the direction and magnitude of the biases caused by less than full specification depend on the correlation of the variables included in the equation to the variables that are omitted and the coefficients of the omitted variables, unless a researcher has this information beforehand, it will be difficult to decide how much he should worry about the biases discussed above.

The second type of improvement in the use of the travel cost method has resulted from substituting individual samples for zone-oriented samples (Brown and Nawas, 1973; Gum and Martin, 1975). Rather than having each zone as an observation on the number of visitors and their travel cost, as in the original Clawson work, some travel cost analyses use each individual who visits the site as an observation. The resulting demand curve is one of a "representative" user rather than an aggregated demand curve that shows the relationship between total number of visits and the cost of reaching the site. The individual observation approach relaxes the restrictive assumption in the Clawson approach of holding tastes constant across the region, since each observation comes with individual information on income, recreation budget, age, education, and other outdoor activities. In addition an immediate effect is the growth in sample size, which reduces much of the statistical bias a researcher encounters in regression analysis, and increases the confidence intervals surrounding the resulting estimates. For example, the long standing multicollinearity problem caused by simultaneous inclusion of travel cost and travel time can be alleviated this way (Gum and Martin, 1975). Gum and Martin employed this approach to estimate demand in terms of total visits and revenue for all types of rural outdoor recreation in Arizona.

However, the improvements in the individual observation approach are gained at the added cost of conducting individual surveys. Gum and Martin used a sample consisting of 2,296 responses (19.9% response rate) at a cost of \$3 per returned mail. Interviews, while more accurate, were estimated to cost about \$30 to \$40 each. The Clawson-Knetsch travel cost method, as Bowes and Loomis (1980) pointed out, needs only visitor registers or visitor permit records as a data base.

The travel cost method, being an early economic tool in valuing outdoor recreation, has gone through extensive development under various researchers. Its use in damage assessment is likely to be acceptable to those who are involved in valuation techniques because of its basic validity and applicability to site-oriented activities. In

comparison with the contingent valuation and hedonic price approaches, the data requirements of the travel cost method under the Clawson version are not severe. However, the individual observation version does require a larger sample size and more information.

Contingent Valuation

In the mainstream of economic valuation of open-access resources, the contingent valuation approach stands as a major competing methodology to indirect market transaction approaches (travel cost and hedonic price). Its attraction lies in its simplicity and directness in questioning or surveying the consumers about their valuation of the resource. The scope of its application is limitless as long as the respondents can imagine hypothetical buying situations for the good in question such as clean air, clean water, endangered species, and ecosystems. This feature is especially helpful in identifying existence and option values which are elusive to other methods. In contrast, the indirect market transaction approach is often limited in the range of nonmarket goods it can value.

The cornerstone of the contingent valuation approach is that, given appropriate assumptions, the consumers can reveal their willingness to pay for nonmarket goods contingent upon a hypothetical market transaction, and answer questions such as "How much are you willing to pay for preserving the Grand Canyon?" The method assumes that persons respond to the contingent market just as in a real market transaction, where the usual conditions in consumer behavior hold, such as utility maximization subject to an income constraint. By questioning or surveying a number of the consumers, the method can produce an aggregate value. Respondents are typically asked to answer a questionnaire on their total or marginal willingness to pay for or sell a good, or a yes or no incremental bidding. A recent addition to the types of questions asked of the respondents is the ranking of alternatives (Rae, 1981; Desvousges et al., 1982). This development is based on the belief that respondents will be more accurate in their answers when asked an order of preference rather than an absolute number. The technique requires sophisticated statistical tools such as logit analysis and so far has been experimentally applied only in the area of water quality.

Naturally the question of whether consumers reveal their true willingness to pay or not has generated a substantial amount of controversy. Critics of the method have pointed out various types of biases inherent in the consumers' answers that diminish the

method's accuracy. Many of the arguments can be found in Freeman (1979a). This section will briefly outline the biases and update Freeman's discussion with recent research results. It will then comment on the application of the method to damage valuation. First, though, a brief summary of past applications of the contingent valuation approach is needed.

Schulze et al. (1981), in their thorough exposition of the contingent valuation approach and summary of its applications, trace the roots of the approach to Davis (1963) and Bohm (1972), who used questionnaires to value recreation opportunities in the Maine woods and public television, respectively. Schulze et al. credit the first application of the approach to Randall et al. (1974), who used a bidding game technique to extract the willingness of recreationists to pay to avoid a visual disturbance of landscape. The same technique was employed in a subsequent air study by Brookshire et al. (1976) to assess people's willingness to pay to avoid the construction of a power plant on Lake Powell in the Glen Canyon National Recreation Area. Four groups of respondents (residents, remote site campers, developed site campers, and motel visitors) were shown the pictures of the power plant standing on the north side of the lake at varying distances from the lake shore and with varying sizes of stack plumes. They were then asked to increase, at increments of one dollar, their willingness to pay for avoiding the scenarios depicted in the photographs. The study estimated the statistical visitor population and converted it into visitor-party-days using the mean length of the stay and the mean size of the visiting family. Using the mean individual bidding from each of the four groups, the study calculated that the recreationists were willing to pay \$727,600 a year to avoid a stack plume that substantially reduced visibility in the area, and \$414,000 a year to prevent a detectable smoke column on the lake which did not impair visibility. When a 5% discount rate and a 35-year lifetime for the power plant were employed, the values of avoiding these two situations were \$21,182,000 and \$12,174,000, respectively.

The value of air quality (in terms of nitrogen dioxide levels) in the Los Angeles region also was estimated by the contingent valuation method (Brookshire et al., 1982) in the course of comparing the method with the hedonic price approach. Brookshire et al. surveyed Los Angeles residents' willingness to pay (on a monthly basis) for an improvement in air quality from either poor to fair or fair to good. Their willingness to pay ranged from \$11.00 to \$22.00 for the former and \$5.55 to \$28.18 for the latter.

The contingent valuation approach has also been applied in the area of recreation opportunity. Meyer (1975) used a community decision version of the approach to estimate the recreational and preservation values associated with the salmon of the

Fraser River in Canada. The community decision approach was developed to avoid the so-called "strategic behavior," which is discussed in more detail later, of the respondents that may distort their true willingness to pay. Meyer believed that the strategic behavior can be reduced by providing the respondents with a grasp of community expenditures. He first provided them with information on actual dollar expenditure per household, in the areas of education, sanitation, fire protection and so on. The respondents were then asked what dollar amount per household they thought would be appropriate for certain recreational opportunities. Their answers led to an aggregate value of \$11,833 for the opportunities. In the same study, for the purpose of comparison, Meyer also employed three other types of contingent valuation techniques: willingness to pay, which resulted in an aggregate value of \$1,099, willingness to sell at \$20,961, and judicial award at \$11,683.

In addition to trying to estimate the value of a specific project such as preserving visibility in a scenic area or preventing an ecosystem from commercial development, economists have also attempted to estimate the value of a partial loss of a wildlife species. If the loss can be translated into a quantitative measurement, for example, the number of waterfowl killed, the contingent valuation method can be adjusted to estimate unit values. Hammack and Brown (1974) estimated the marginal value of waterfowl in hunting by surveying hunters' total net willingness to pay (i.e., "how much would the cost of waterfowl hunting have to rise for you to stop the hunting trip?"). When the net willingness to pay was regressed over the number of waterfowl killed with other independent variables such as income, taste, and seasons hunted, a marginal value for the waterfowl in hunting was derived. This value is equivalent to the price which the hunters would be willing to pay for an extra bagged waterfowl each day. In a survey of hunters in seven western states Hammack and Brown found the marginal value to be between \$2.38 and \$3.35. Another application of contingent valuation to wildlife is a study by Schulze et al. (1981) on values of elk hunting in Wyoming. The study found hunters would have to be paid \$142.00 to reduce their encounters from five per day to one.

The Brown and Hammack study actually was used later to support the case of the state of Virginia against Steuart Transportation Co., where a spill by the defendant killed approximately 15,675 waterfowl. Using the same structural equation and estimated parameters as the ones employed in the earlier study, but with a new set of data on the independent variables, Brown (1977) prepared a statement determining that the marginal value of an Atlantic Flyway waterfowl was \$16.72. It is important to note that the use of marginal value in valuing aggregate damage is justified when each of the hunters is

expected to bag one less bird. If some hunters are affected more, the total net willingness to pay will diverge from the amount acquired by the marginal value times the number of lost bags. Daubert and Young (1981) used a similar approach but estimated demand functions for instream recreation which allowed for a more accurate assessment of use value.

Finally, the contingent valuation method has attempted to estimate existence and option values. According to Desvousges et al. (1982) in their study to compare alternative approaches to estimate water quality benefits, there have been three attempts (Greenley et al., 1981; Mitchell and Carson, 1981; Rae, 1981). Unfortunately it seems these studies were hampered by various problems, including lack of distinction between option values and existence values, incorrect interpretation, and faulty estimation frameworks and assumptions. Desvousges et al., in the same study, attempted to identify the option value and existence value of water quality change in the Monongahela River. The study found the option value for the loss of boating recreation ranging from \$15.00 to \$60.00 per user.

Questions about the validity of the contingent valuation method have existed for some time. Samuelson (1954) was pessimistic about directly questioning the public on the value of public goods and services. Supporters of the contingent valuation method readily recognized that the answers from the respondents are subject to various biases which impede the extraction of the true willingness to pay. It seems that the most worrisome one was what can be called the strategic or gamesmanship behavior of the respondent. Maler (1974) demonstrated that a consumer whose goal is to maximize his own well-being, when asked his willingness to pay, will either overstate or understate it. The former occurs when the consumer understands that he does not have to pay for the supply of the public good in question, while the latter occurs when he has to pay for the good. Freeman (1979a) succinctly described some of the efforts that have been made to reduce the strategic bias by carefully constructing questions to remove the respondents' incentives to overstate or understate. But he correctly pointed out that these maneuvers are costly in terms of the increased sophistication of the questionnaire. Meanwhile, there is little incentive for the respondents to commit the time and effort necessary to comprehend and respond to the questions.

Some researchers using contingent valuation methods have argued that strategic bias is not significant empirically. Bohm (1972) asked five groups about their willingness to pay using for each group a different payment scheme (e.g., pay or not pay for the service). The average answers from the five groups were not significantly different.

Brookshire et al. (1976) in the Lake Powell study, tested the hypothesis that if strategic bias exists the frequency distribution of biased answers will be flatter than that of true answers. This results from the assumption that strategic answers tend to go to extremes: environmentalist respondents will give a very high willingness to pay while more industry-oriented ones will give a low value such as zero. An examination of the actual distribution of the bids in the study failed to show any flattening of the frequency distribution.

There are other biases that may also affect the accuracy of the contingent valuation method. Incomplete information in the hypothetical situation may mislead the respondent. Lack of information on substitute activities, expenditures, and other characteristics of the circumstances within which one makes the actual decision can lead to inconsistent valuations among respondents. Schulze et al. (1981) also pointed out the starting-point bias problem. This occurs when respondents are to answer yes or no to incremental bids (the use of which has been justified on the ground that it is easier to focus on willingness to pay when responding yes or no to a bid). Depending on where the surveyor starts the first bid the method may bring different values. However, most of these biases have been considered by the users of contingent valuation approach. It has been found that in many cases careful construction of the questions and fuller specification of information needed to respond to the bids can reduce the influence of the biases.

Several unsettled questions nevertheless remain, even if the effects of survey biases are resolved. First, as pointed out by Freeman (1979a), it may be difficult for the survey designer to eliminate strategic behavior and yet provide incentives to the respondent to calculate accurately his willingness to pay. Not being able to reap the benefits of a "good" bid which exist in an actual transaction, will the respondent spend the necessary time and effort to make an accurate bid? Second, Bishop and Heberlein (1979) asked the question: will a survey of attitudes reflect actual behavior? They pointed to a survey of social psychological studies that showed there is actually a low correlation between attitude and actual behavior (Schuman and Johnson, 1976). The implication of this finding is that even if all of the above-mentioned biases are eliminated the contingent valuation method still may be able only to extract a hypothetical willingness to pay which may well be different from the one revealed under an actual transaction. Third, why are the willingness to pay and willingness to sell obtained in surveys so different from each other? Is it the income effect, a bias, or simple inaccuracy?

The empirical portion of the Bishop and Heberlein study is a good starting point to address some of these questions. In this study, the value of an early season goose hunting permit was estimated by both the contingent and travel cost methods. Their results were then compared with actual cash transactions (observed willingness to sell). This study consisted of three samples. In the first sample, 237 hunters were mailed checks of \$1.00 to \$200.00 and instructed to mail back the check or the permit. In the second sample, 353 hunters were sent questionnaires and asked to make hypothetical bids on the permits. In the last group, 300 hunters were questioned about their expenditures and distance traveled. The responses from the second and third groups were used to construct willingness to pay through the contingent valuation and travel cost methods. The results are shown in Table IV-1.

Table IV-1. Summary of consumer surplus per hunting permit in the Bishop and Heberlein study

	Surplus per Permit (\$)
Actual cash offers (willingness to sell)	63
Contingent Valuation	
Willingness to sell	101
Willingness to pay	21
Travel Cost Estimates	
Model 1 (time value = 1/4 median income rate)	28
Model 3 (time value = 1/2 median income rate)	45

Source: Bishop and Heberlein (1979)

Several observations on these results are useful. First, the willingness to pay from the contingency method was one third the observed willingness to sell, and the hypothetical willingness to sell was 1.6 times higher than the actual one. Second, the travel cost method that used a time value of 1/2 median income rate resulted in a value that was 28% lower than the value from actual transactions. Third, in the contingent approach, the willingness-to-sell value was 5 times greater than the willingness-to-pay value. One implication of these results is that values estimated by the contingent

valuation method can be significantly different from values revealed through actual transactions. Another is that the vast difference between estimates of willingness to pay and willingness to sell is still troublesome. Similarly, Meyer (1975) found willingness to sell from his study to be 20 times the willingness to pay; Hammack and Brown (1974) found the ratio to be 5 to 1; Bishop and Heberlein (1979) also found a 5-to-1 ratio; and Brookshire and Randall (1978) estimated a 7-to-1 ratio. This difference could have resulted from the survey biases, the differential between attitude and behavior, income effect, or inaccuracy due to lack of effort on part of the respondents. There is no empirical evidence to help to sort out the biases. However, Gordon and Knetsch (1979) examined this divergence and demonstrated that the traditional explanation of an income effect is tenuous at best. Burdening the income effect as the cause of the divergency will imply abnormal indifference patterns in the users. These implications should be qualified by the fact that Bishop and Heberlein obtained the cash value of willingness to sell rather than willingness to pay. Supporters of contingent valuation have generally avoided asking for willingness to sell because it is more difficult for the respondents to be bounded by price ceilings in hypothetical situations. Consequently, the study does not show how the hypothetical willingness to pay compares with actual cash transactions.

A study by Brookshire et al. (1982) empirically compared hedonic price equation estimates with estimates by the contingent valuation method. In their conceptual discussion, Brookshire et al. developed the hypothesis that contingent valuation estimates will be lower than the rent gradient obtained through hedonic analysis of property values in the same market. This hypothesis was supported in the subsequent empirical analysis: rent differential due to differences in air quality was \$15.44 to \$45.92 per month determined by the hedonic approach, compared with \$11.00 to \$22.06 for an improvement from poor to fair air quality. The result is not surprising. In essence, the rent differential in the study is derived from the housing expenditure equation. As in a supply-side equation (housing producing access to clean air) the marginal cost rises as level of clean air consumption increases. Meanwhile, on the demand side, the marginal willingness to pay for clean air decreases as the consumption of clean air increases.

In summary, the contingent valuation method should be used with caution and in recognition of its potential biases. However, the contingent valuation method is the only tool available at this time to estimate option and existence values. In this light the cost of potential biases is sometimes simply outweighed by its benefits. In addition, careful construction of the questionnaire and the survey or interview mechanism undoubtedly will reduce some of the biases. In the context of damage assessment, it probably should

be used only in ex ante estimation. Once the damage has occurred, questioning the users of the lost resource inevitably will elicit strong strategic behavior, producing a substantial upward bias in the responses. There is also a question whether the respondent should be asked about willingness to pay instead of willingness to sell. Chapter III proposed that if one assumes that property rights in the damaged resource lie with the public users, the correct measure should be willingness to sell. Yet the vast difference between the answers to the two questions somewhat undermines the acceptability of a willingness to sell estimated by the contingent valuation method.

The Hedonic Function Approach

The hedonic function approach, recognized sometimes by its many variants such as the characteristics approach, household production approach and property value approach, is based on a relatively simple concept: consumers ultimately derive utility or satisfaction from the characteristics of a good. The consumers will buy goods such as candy or simply sugar to acquire (produce) the taste of sweetness; cars or motorcycles for speed; and clean air, hunting permits, or transportation for recreation. Because many open-access resources can be considered a package of desirable characteristics, such as a state park providing various recreational experiences, the hedonic approach is conceptually appealing for the valuation of damages to the resources. Economists have attempted to use this approach to value the components (characteristics) of a resource by expressing the uses of the resources in an input (e.g., trip, time, or license) and output (e.g., fish caught or waterfowl bagged) framework. It is hoped that the approach will reveal the implicit prices of the components (outputs) and therefore possible measures of welfare changes.

To date, the application of the hedonic technique has been most prolific in the form of the property value study which has already been mentioned in the section on property value change. In these studies the price of a housing unit is assumed to reflect the implicit prices of the characteristics associated with the house, including air quality (King, 1976; Polinsky and Shavell, 1976; Harrison and Rubinfeld, 1978; Deyak and Smith, 1974; Witte et al., 1979; and Brookshire et al., 1982), open shoreline (Brown and Pollakowski, 1977), and wetlands (Shabman and Bertelson, 1979). Less extensive application has occurred in other areas, such as food nutrition (Ladd and Suvannunt, 1976), automobile quality (Ohta and Griliches, 1975), quality index (Griliches, 1977), pediatric care (Goldman and Grossman, 1978), and cornblending (Ladd and Martin, 1976). Recent interest in preservation of wildlife such as waterfowl and sportfish also

has brought the approach to bear on the valuation of these species. Brown et al. (1978) conducted the pioneering study that applied the technique to value various hunting game and sportfish, using the 1975 Department of Interior survey of hunting, fishing, and wildlife-associated recreation. In the first stage, Brown et al. estimated the relationships between expenditure for the hunting or fishing activity and the number of days of the activity and the catch. Hedonic prices were then constructed from the estimated parameters and were used in a second stage for estimating demand equations. The second-stage estimation produced a range of marginal values of \$3.00 to \$34 per day for hunting game and \$12 to \$38 for sportfish. McConnell (1979) has used the household production version to estimate the value of winter flounder fishing in Rhode Island. McConnell's household production approach estimated a fisherman's winter flounder season to be worth \$515. This value was constructed from a simultaneous system of two demand equations: one for the trip and the other for catch rate (quality).

The estimation technique of the hedonic price approach consists of two stages. First, a regression equation is constructed, with the price of the input (e.g., housing) as the dependent variable and the quantities of the different relevant characteristics (e.g., number of rooms and clean air) serving as the independent variables. The estimated parameters become the estimated implicit prices or hedonic prices of the output. Rosen (1974) has shown that these prices theoretically represent the equilibrium points of the supply and demand for the output. The bulk of the recent research in hedonic functions thus has focused on the second stage where economists have attempted to construct a demand function from these prices (Witte et al., 1979; Harrison and Rubinfeld, 1978).

The property value version of the hedonic approach assumes that demands for various attributes such as shelter, surrounding amenities, police and fire protection, education system, distance to work, and so forth are all incorporated in the demand for the house. Therefore, even though only the price of the house is observed during the transaction, implicit prices exist for all of the above attributes. A property value study can theoretically reveal these implicit prices, yet is subject to the theoretical uncertainties noted above.

Freeman (1979a) has an extensive discussion on the use of property value and its relationship to demand. It is sufficient here to say that only under certain conditions will changes in a property's value reflect the values of its attributes. The property value equation is generally not a total willingness-to-pay curve whereby its estimated parameter can be used to calculate consumer surplus. It will reflect consumer surplus only when the selling price, as already mentioned, completely allocates the surplus from

the transaction to the seller, as in the case of perfectly discriminating sellers. However, in the context of valuing damages due to oil spills and hazardous waste releases the property value study may not be particularly relevant since the basis of the property value method is the value of private property. The method can be meaningful only in the framework of the private-to-public approximation where, as discussed in an earlier section, one accepts the values of the resources embedded in private property as an approximation of the values of the same type of resource in an open-access context.

The household production approach, as developed by Becker (1965), emphasizes the consumer's ability to produce the outputs (in contrast to housing where the outputs are given). The only published works emphasizing this approach have been the ones by McConnell (1979), Bockstael and McConnell (1981), and Deyak and Smith (1974). McConnell estimated the benefits of sportfishing by deriving demand equations for fishing trips and quality of fishing in terms of catch rate. In this framework, one uses inputs such as time per trip, miles traveled, and bait to produce the two items in demand. Just as with the property value study, if the household production equations are properly identified the surplus can be revealed. McConnell also pointed out that the travel cost method can be seen as a special case of the hedonic/household production approach, if one assumes that a trip is an output and that other outputs are exogenous. This result is not surprising since the travel cost method is inherently a supply side approach.

There has been strong criticism of applying the hedonic price approach to the measurement of welfare changes. The criticism centers on the argument made by Pollak and Wachter (1975) that preference parameters can be separated from the production technology parameters only under severe constraints, such as the technology function being nonjoint, homogeneous, and characterized by constant returns to scale. They claim that in the absence of these conditions, it will be difficult to attribute the changes in observed consumption points to either the demand or the supply side. This difficulty has been termed the "nonlinear budget constraint" problem. The term is based on the theoretical conclusion that while a linear budget constraint holds in the input space (income or expenditure on bait, tackle, and gasoline), the budget constraint facing the consumption of the outputs changes, depending on the level and combination of outputs. Bockstael and McConnell (1983) argue that under such circumstances, no meaningful measurement of welfare can be derived. There are economists who consider the nonlinear budget issue a special case of the identification problem, which can be addressed

by properly specified estimation techniques (Barnett, 1977). However, at this time, no consensus exists as to what that estimation technique should be.

At least one study has compared the empirical results of the hedonic approach with alternative approaches based on the same data set. The McConnell (1979) study estimated the value of fishing for winter flounder through both the household production approach and the travel cost method. Compared with the \$515 per fisherman per season, estimated through the household production equations, the travel cost method produced an estimate of \$233. It is interesting to note that the main difference between the two methods in this study is the absence of the equation on demand for quality of fishing trips in the travel cost method.²⁴ If the difference between the two estimates comes from the absence of the second equation in the travel cost method, one implication is that a downward bias exists in estimation methods that do not estimate the demand for quality as an endogenous variable.

Without resolution of the problem related to the estimation method in the second stage, use of the hedonic approach as a valuation tool probably will continue to remain in the world of research, rather than practice, in damage valuation. However, the attractive feature of the hedonic approach is that the method depends on market transaction data and provides an alternative tool to the contingent value approach discussed earlier.

Footnotes—Chapter IV

- 1 U.S. Comptroller General, Total Costs Resulting from Two Major Oil Spills, report to the U.S. Senate Subcomm. on Environment, Energy, and Natural Resources, App. III, n.d. (June 1, 1977).
- 2 Fair and equitable is defined here within the context of a marketplace economy and the existing income distribution pattern.
- 3 The benefit of an incremental increase in accuracy is the reduction of social loss (i.e., the misallocation of resources when the loss is not accurately valued, due to the increase in accuracy).
- 4 See Freeman (1979b) for a more detailed discussion on the conditions under which the property value approach can operate.
- 5 See, e.g., Storley v. Armour & Co., 107 F.2d 499 (8th Cir. 1939).
- 6 All such individuals sued Allied Chemical Co. for damage in a Kepone spill in the James River of Virginia. See Pruitt v. Allied Chemical Corp., 523 F. Supp. 975 (E.D. Va. 1981).
- 7 Skansi v. Humble Oil & Refining Company, 176 So. 2d 236 (La. Ct. App. 1965).
- 8 Carr v. United States, 136 F. Supp 527 (D. Va. 1955).
- 9 Another technique used in estimating value of recreational activities is the participation model where the rate of participation, rather than the willingness to pay, is estimated. The estimates are based on past relationships between the use rate and variables influencing the use. The result of the technique, however, is in terms of rate (visit days or trip frequency), instead of value. An additional step of incorporating unit values is necessary before the value of the activity is produced. For this reason the participation model is not discussed here. Interested readers can consult several recent recreational benefit studies, for example, Vaughan and Russell (1982); Hay and McConnell (1979); and Miller and Hay (1981).
- 10 See McConnell and Sutinen (1979) and Bishop and Samples (1980) for a fishery management model for both commercial and sport fishing.
- 11 It should be noted that the hedonic approach analyzes the differentials of a cross-section of properties rather than the change in the value of a specific property.
- 12 The figure was \$5,526,583.20. It was based on a replacement cost derived by referring to the price of certain marine organisms from biological supply laboratories: \$0.06 per animal. In addition, for the damage to the mangrove forest, the court awarded \$559,000 for the purpose of planting new mangroves and restoring the damaged area to its condition before the oil spill.

- 13 456 F. Supp. 1327 (D. P.R. 1978), aff'd in part, rev'd in part and remanded, 628 F.2d 652 (1st Cir. 1980).
- 14 33 U.S.C. Section 1321(f)(4).
- 15 43 U.S.C. Section 1813(b)(3).
- 16 Interestingly, the court of appeals was silent on the replacement cost of the mangroves.
- 17 Energy analysis was one of the four methods used to value the wetlands. The other three were (1) commercial and sports fisheries, (2) aquaculture potential, and (3) waste treatment.
- 18 At this point the criticism is the same as the one we used in the replacement cost section.
- 19 Bowes and Loomis (1980) have argued that if one considers that travel is a complementary input to recreation this assumption is not necessary for the travel cost method to be valid.
- 20 The study was later improved with new methodology and data (Brown et al., 1975). The new version of the study reached an estimate of \$21-\$22 average per fishing day for the value of salmon and steelhead sportfishing in Oregon. Brown et al. then divided the cost by the quantity of fish caught to reach the value of the fish. Admitting this to be a hazardous process, they arrived at \$60 per fish in terms of 1974 dollars. Since fishermen consider traveling time as an input to recreational fishing, they would minimize it.
- 21 The method will be discussed in the contingent valuation section.
- 22 When using multi-site analysis, some observations will have zero visits since the consumer uses only some of the sites. During estimation, a statistical problem results from these zero cells. The logit model can be used to address the problem. (See Feenberg and Mills, 1980, Chapter 7.)
- 23 This occurs when some of the variables explaining visit rates or willingness to pay move in similar patterns (in the worst case they become the same variable); for example, travel cost and travel time generally change concurrently. To understand the problems of multicollinearity, see the standard econometric textbooks such as Kelejian and Oates (1974).
- 24 The catch rate was, however, included as an independent variable in the travel/cost equation.

Chapter V

LEGAL FRAMEWORK FOR DAMAGE ASSESSMENT

Introduction

Natural resource damage valuation is dependent on the legal framework in which it is presented and debated as well as on the underlying economic theory. In most instances, courts will have the final say as to what a resource is worth. Not only does the legal system define the kinds of damages for which compensation can be sought and who is entitled to seek compensation; it also establishes constraints on how the values can be calculated. Moreover, damage valuations must meet certain legal criteria in order to be acceptable. In the past, a patchwork system of federal and state statutes and regulations and common law defined the legal context for natural resource damage valuations, particularly with regard to oil and hazardous substances spills. The passage of the Comprehensive Environmental Response, Compensation and Liability Act in 1980 (CERCLA) introduced a far-reaching set of ground rules for damage assessments and valuations.¹ Regulations under this Act, when finally promulgated, will set the stage for most claims for open-access natural resource damages that result from oil discharges and hazardous substance releases.

The purpose of this chapter, given the tremendous importance of CERCLA, is to provide a working understanding of the legal framework for open-access natural resource damages as defined by that Act. Although some of the relevant sections of CERCLA have not yet been implemented, the statute and its legislative history offer useful insights to the potential roles of economic valuation techniques in damage assessment. The focus on CERCLA is not to ignore state schemes and programs or common law precedents. Samples of the former are described later in the chapter as possible models for the emerging federal framework. A discussion of the latter is presented in the Appendix. CERCLA is by no means the only federal statute that deals with hazardous substance releases and oil discharges or that has implications for open-access natural resource damage assessment. Prior to the passage of CERCLA, several federal statutes addressed different aspects of liability and damage recovery from oil and hazardous substance spills. Table V-1 compares the enforcement provisions of all these acts and identifies the specific sections relating to those provisions.

**Table V-1. Enforcement provisions of major
federal environmental statutes**

Provision for enforcement	Clean Air Act 42 USC	Safe Drinking Water Act 42 USC	Resource Conservation & Recovery Act 42 USC	Federal Water Pollution Control Act 33 USC	Outer Continental Shelf Lands Act 43 USC	Comprehensive Environmental Response, Compensation & Liability Act 42 USC	Trans-Alaska Pipeline Authorization Act 42 USC	Deepwater Port Act of 1974 33 USC
Injunction	\$7413(b)	\$300g-3(b) \$300h-2(b)	\$6928	\$1319(a),-(b)	\$1350(a)	\$9606(a)	\$1652(b)	\$1514(b)(3) \$1514(c)
Adminis- trative compliance order	\$7413(a)	\$300	\$6928	\$1319(a)	\$1348(a)	\$9604(b) \$9606(a)	\$1652(b) \$1653(a)	\$1514(b)
Civil penalty	\$7413(b)	\$300g-3(b) \$300h-2(b) \$300h-3(c) \$300i(b)	\$6928(a)(3) \$6928(g)	\$1319(d) \$1321(b)(6)	\$1350(b)	\$9606(b) \$9609		\$1517(a)(2)
Criminal penalty	\$7413(c)		\$6928(c),-(d)	\$1319(c)	\$1350(c)			\$1514 (a)
Citizens' suits to compel compliance	\$7604	\$300j-8	\$6972	\$1365	\$1349(a)			\$1515
Liability for response costs				\$1321(f)(1), -(4)	\$1814(a)	\$9607(a)(4)(A), -(B)	\$1653(b) \$1653(c)(1)	\$1517(d),-(e)
Liability for damages					\$1814(a)	\$9607(a)(4)(C)	\$1653(a)(1) \$1653(c)(1)	\$1517(d),-(e)
Government claims for response costs				\$1321(f)(5)	\$1813(a)(1) \$1813(b)(1)	\$9611(a)(1) \$9611(c)(1)	\$1653(b) \$1653(c)(1)	\$1517(d), -(e) \$1517(f)(1)
Public trustee claims for natural resource damages					\$1813(a)(2)(C) -(D) \$1813(b)(3)	\$9611(b)	\$1653(a)(1) \$1653(c)(1)	\$1517(i)(3)
Private claims for damages					\$1813(a)(1) \$1813(a)(2)(A), -(B),-(D),-(E) \$1813(b)(1),-(2), -(4),-(6),-(7)		\$1653(a)(1) \$1653(c)(1)	\$1517(d) \$1517(i)(1)

As a final note before introducing CERCLA and the state schemes, it should be mentioned that much of the material in this chapter refers to damage assessment procedures in general, of which resource valuation issues are only one part. This reflects, in large part, the emphasis of the statutes. However, the following discussion highlights, wherever possible, the resource valuation considerations found in the acts or state schemes.

Comprehensive Environmental Response, Compensation and Liability Act of 1980

In a significant departure from the pattern of past federal environmental law, CERCLA established liability for damages resulting from the injury to, destruction of, or loss of natural resources that is caused by the release of hazardous substances. The statutory framework under CERCLA for natural resource damage recovery has three components:

- (1) a public trustee that is authorized to recover for damages;
- (2) a rebuttable presumption in favor of damage assessments that can be relied upon by the public trustee in asserting claims for resource damages; and
- (3) regulations for making resource damage assessments.

Public Trustee Rights and Responsibilities

CERCLA gives the federal or state governments the right to seek to recover damages for the injury to, destruction of, or loss of natural resources that results from the release of hazardous substances. A government must assert its claim in its capacity as public trustee for the natural resources. However, neither the statute nor its legislative history provide many clues about the nature and scope of the public trustee's rights and responsibilities. The following discussion examines the pertinent statutory language and legislative history in an attempt to shed some light on these issues.

Polluter's Liability to the Public Trustee

Section 107, the liability section of CERCLA, specifies the parties who may be liable under the statute, what defenses to liability they may assert, and the statutory limits to their liability. Under section 107 (f), liability for damages resulting from injury to, destruction of, or loss of natural resources "shall be to the United States Government and to any State for natural resources within the State or belonging to, managed by, controlled by, or appertaining to such State...."² Although far reaching, section 107 establishes liability for natural resource damages only to the federal or state governments; liability to private persons, such as property owners or fishermen, is precluded.

Since the management of natural resources such as fish and wildlife is a sensitive and complex area of federal-state relationships, as is the management of natural resources such as surface water and ground water, section 107 might give rise to overlapping or intertwined claims by federal and state governments. Notwithstanding the above-quoted language of section 107(f), another passage in that section authorizes "the President, or the authorized representative of any State" to act as the public trustee. This provision for alternative representation may enable the federal and state governments to apportion the damages for which they will seek compensation.

A confusing feature of CERCLA is that its liability provisions, which establish rights against the party responsible for a release, do not parallel the claims provisions establishing a claimant's rights against the fund. Section 107 (f) can be read to allow a state to seek to recover resource damages on behalf of the federal government, or vice versa, as discussed above. But section 111(b) may imply that state and federal claims against the fund must be pursued separately:

...any such claim may be asserted only by the President, as trustee, for natural resources over which the United States has sovereign rights, or natural resources within the territory or the fishery conservation zone of the United States to the extent they are managed or protected by the United States, or by any State for natural resources within the boundary of that State belonging to, managed by, controlled by, or appertaining to the State.

Because this provision elaborates the types of natural resources for which each governmental entity may assert claims, it might be interpreted as insisting that one government could not assert a claim for resources that are within the responsibility of another government. However, the National Contingency Plan promulgated under section 105 requires multiple trustees to coordinate and cooperate in carrying out their

responsibilities.³ The legislative history indicates that the state can delegate its responsibilities as a trustee to a federal agency. As one authority has observed, "with a reasonable degree of cooperation between federal and state governments on restoration planning and implementation, the task of such an allocation (of claims) might be permanently avoided."⁴

Public Trustee Duties and Responsibilities Under CERCLA

Section 107 goes beyond the mere creation of a governmental right of action; it specifies the legal form that a government must follow to recover damages. Section 107(f) provides that "The President, or the authorized representative of any State, shall act on behalf of the public as trustee of such natural resources to recover for such damages." In both specifying a governmental right of recovery and stipulating the legal vehicle for asserting such a right, section 107 strongly implies that the only way in which a government may seek to recover for natural resource damages is by means of an action "on behalf of the public" as a "trustee of such natural resources." Assuming that Congress intended to link this right of action with the legal form for asserting that right, at least two significant issues emerge. First, what are the trustee's duties and responsibilities to the public? Second, what types of natural resource damages can a public trustee recover?

The CERCLA trustee language originated in S. 1480, as introduced into and reported out of the Senate Committee on Environment and Public Works. The legislative history offers little discussion of it, but both the concept of a public trustee and the statutory language expressing that concept are very similar to those found in other federal pollution statutes (e.g., the Clean Water Act, the Outer Continental Shelf Lands Act⁵, the Trans-Alaska Pipeline Authorization Act⁶, and the Deepwater Port Act⁷). Because few courts have interpreted these statutory expressions, common law antecedents to the federal concept may help answer the above-mentioned questions about what the public trustee can and must do, and what kinds of resource damages can be recovered.

Common Law Duties and Responsibilities of the Public Trustee

Under basic trust law, a trust has three features: (a) the corpus—the legally protected property; (b) the beneficiary—the party for whose benefit the trust is managed and the one who can legally enforce proper management of the trust; and (c) the trustee

—the party who manages the corpus and who has strict obligations to protect the corpus for the benefit of the beneficiary. Legal scholars typically conceive of a public trust for natural resources as having the natural resources as the corpus, the citizenry as the beneficiary, and the government as the trustee. Legal scholars have examined several duties and responsibilities for the public trustee. Generally speaking, the trustee should guard "against unfair dealing and dissipation " and " refrain from reallocating resources to more restrictive uses or subjecting public uses to private self interest."⁸

Case law cites more specific duties: avoiding a substantial impairment of public uses; balancing competing uses; exercising reasonable judgment about reallocation of resources; and ensuring that transactions are undertaken for proper trust purposes.⁹ Although the foregoing duties and responsibilities of a public trustee are somewhat vague, the concept of a public trust has been used by courts to impose strict standards of conduct upon the trustee. As extrapolated from the more precisely defined private trust, the public trust retains many of the seriously regarded responsibilities accorded the private trust relationship.

Two examples illustrate the gravity of a public trustee's responsibility as well as the broad range of duties that accompany a trustee's role. In Illinois Central R.R. v. Illinois,¹⁰ which is considered the foundation of contemporary public trust law,¹¹ the Supreme Court held that Illinois could not convey title to certain lands under Lake Michigan to a private corporation, reasoning that title was "held in trust for the people of the state that they may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing thereon, freed from the obstruction or interference of private parties."¹² A more recent case involved not the conveyance of title to land but the regulation of the use of land in order to protect a nearby park. In Sierra Club v. Dept. of Interior,¹³ the plaintiff brought an action to compel the Secretary of the Interior to exercise his statutory authority to protect the Redwood National Park from damage resulting from timbering done adjacent to the park. The district court noted that the Secretary had general trust responsibilities with respect to public lands as well as specific powers and obligations under the Redwood National Park Act.¹⁴ The court held that the Secretary had a legal duty to use his powers to protect the park and that his administrative discretion regarding the exercise of those powers was subordinate to his general trust obligation and his specific statutory duty.¹⁵ Thus, a public trustee's duties and responsibilities may range from conveyance of legal title to the trust corpus to regulation of timber cutting on lands that adjoin the corpus. Significantly, while in the modern context the trustee's discretion with respect to the corpus is recognized, that

discretion nevertheless is subordinate to his trust obligations; failure to fulfill such obligations probably would constitute an abuse of discretion.

Natural Resource Damages Recoverable by the Public Trustee

The types of natural resource damages that a public trustee may recover range as broadly as the public uses for the resources. The government may protect these uses by removing the source of contamination or taking remedial actions to mitigate damage, or by seeking compensation through claims for damages. CERCLA section 107(f) expressly distinguishes between the measures for damages and replacement costs for natural resources:

Sums recovered (by the public trustee) shall be available for use to restore, rehabilitate, or acquire the equivalent of such natural resources by the appropriate agencies of the Federal Government or the State government, but the measure of such damages shall not be limited by the sums which can be used to restore or replace such resources.

The public trustee may recover for natural resource damages in excess of the cost of restoring or replacing those resources. Such additional recovery appears to constitute compensation to the public for harm suffered as a result of the hazardous substance release.

In distinguishing the issue of damages from the issue of replacement or restoration costs, CERCLA left open the question of what types of natural resource damages are compensable. "Natural resources" is defined broadly in the statute to include

...land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the fishery conservation zone established by the Fishery Conservation and Management Act of 1976), any State or local government, or any foreign government.¹⁶

Notwithstanding the breadth of the above definition of resource types covered by the Act, it is not clear what rules a public trustee should follow in determining the kinds of uses of natural resources for which to assert claims. This is, of course, the relevant issue from an economic point of view.

Common law cases involving public trustee claims suggest some guidelines. The public uses protected in Illinois Central R.R. Co. v. Illinois included navigation,

commerce, and fishing. Many other uses have been protected, such as bathing, swimming, and other recreational activities.¹⁷ Accordingly, it would appear that a public trustee can seek to recover for the values of numerous public uses of the damaged or destroyed natural resources. Two recent cases brought under common law have allowed a government, as public trustee, to recover for resource damages resulting from oil spills. In the case of In re Steuart Transportation Co.,¹⁸ the court held that the federal government and the Commonwealth of Virginia could recover under the public trust doctrine for the value of approximately 30,000 migratory waterfowl killed by an oil spill. The court stated that under the public trust doctrine both governments "have the right and duty to protect and preserve the public's interest in natural wildlife resources. Such right does not derive from ownership of the resources but from a duty owing to the people."¹⁹ Similar reasoning was applied in Maryland v. Amerada Hess,²⁰ which allowed the state to sue for harm to water quality that resulted from an oil spill in Baltimore Harbor. In the latter case the court said that

The conclusion seems inescapable to this Court that if the State is deemed to be the trustee of the waters, then as trustee, the State must be empowered to bring suit to protect the corpus of the trust—i.e., the waters—for the beneficiaries of the trust—i.e., the public.²¹

Common law cases such as these will be useful in helping to define CERCLA's public trust concept. Prior jurisprudence suggests that courts will give broad scope to the responsibilities of the CERCLA public trustee. A public trustee must refrain from dissipating the trust's corpus through conveyances to private parties; protect the corpus by issuing land use regulations when necessary; and recover damages on behalf of the public when the corpus is injured or destroyed. Further, the trustee must protect the public's rights to navigation, commerce, fishing, and recreation. The common law answer to the second question mentioned above, concerning the types of natural resource damages that the public trustee may seek to recover, appears to be that many types of damages can be recovered. Prominent among those types are diminished water quality and loss of wildlife. Of course, the foregoing examples merely illustrate the range of possible duties and types of recoverable damages; they do not exhaust those possibilities.

It is still unclear whether aesthetic or existence values could be protected under the public trust doctrine. Section 301(c) of the Act provides some guidance on this issue. Although this will be discussed in some detail later, this section requires, in part, that regulations be promulgated to measure damages, "including direct and indirect injury, destruction, or loss and shall take into account factors including, but not limited to, replacement value, use value and ability of the ecosystem or resource to recover."

The phrase "use value" could be taken to include consumptive and nonconsumptive uses such as aesthetic enjoyment. However, this is hardly a firm recognition of the economist's sense of aesthetic and existence value and it is likely that the issue will remain unresolved until subjected to court scrutiny.

The public trustee's claim for resource damages is to be based upon damage assessments made by federal officials pursuant to regulations promulgated under CERCLA section 301 (c). Under section 111 (h)(2), such damage assessments will have rebuttable presumptions in their favor in judicial or administrative claims proceedings. The appointment of a public trustee alone was not thought by Congress to be sufficient for effective resolution of damage assessment issues. In creating a rebuttable presumption in favor of damage assessments, Congress sought to ensure that natural resource damage claims would be readily defensible. The relevant portion of the text, subparagraph 111 (h)(2), poses two important issues for damage valuations under CERCLA: (1) the nature and force of the rebuttable presumption that is stipulated for claimants; and (2) the choice between judicial or adjudicatory administrative proceedings for applying rebuttable presumptions to damage assessments.

The Nature of the Rebuttable Presumption

Subparagraph 111 (h) (2) states that any "determination or assessment of damages for injury to, destruction of, or loss of natural resources... shall have the force and effect of a rebuttable presumption on behalf of any claimant" in a judicial or adjudicatory administrative proceeding. Creation of a rebuttable presumption in favor of the claimant who, it is assumed, would rely on the CERCLA damage assessment techniques, bolsters the claimant's efforts to prove its case. Precisely how and to what extent a rebuttable presumption bolsters a claimant's proof of damage is far from clear. Potential problems loom from (a) ambiguities in the quoted statutory language; (b) the relation between the CERCLA presumption and Rule 301 of the Federal Rules of Evidence, which governs presumptions generally in federal courts; and (c) ambiguities within Rule 301 itself. These problems may become important considerations in the claimant's deliberations about whether and where to assert its claim.

CERCLA Language

The assessments or determinations of damages made by the appropriate agency shall have the "force and effect of a rebuttable presumption on behalf of (the)

claimant."²² What does the quoted phrase mean? The legislative history is silent on this point. As understood by legal scholars, a presumption is a rule of evidence: one may take a basic fact, which has been established, and infer from it the existence of the presumed fact.²³ For example, suppose a plaintiff seeks to prove that a defendant received his letter. Plaintiff may produce evidence that the letter was mailed; that it was properly addressed to defendant and included a return address; and that it was never returned. In most jurisdictions such evidence would be held to raise the presumption that defendant received the letter.²⁴

A damage assessment or determination made by an agency under CERCLA represents the agency's conclusion from its own on-site investigation and analysis of various surveys, studies, and tables. Consequently, it would seem that to enjoy the "force and effect" of a presumption, the total damage assessment must be considered to be the presumed, not the basic, fact. Basic facts would consist of the empirical data gathered by the agency. Would the value tables and surveys used by the agency constitute basic facts or presumed facts? If they were considered to be presumed facts, the final agency determination would be a presumption based on another presumption, a situation the validity of which has been disputed by scholars of evidence.²⁵ Probably basic facts would include all the data used to arrive at the total damage determination, which would constitute the presumed fact.

A related problem is that the final agency determination of damage will be a complex composite of many lesser, discrete damage determinations, including perhaps separate assessments for each species, habitat, long-term or short-term effect, direct or indirect effect, and each nonconsumptive, aesthetic, or recreational value. Typically, a presumption applies to a single, reasonably well defined basic fact and derives a single, reasonably well defined presumed fact. For example, a common presumption used in drunken driving cases takes as the basic fact the level of alcohol in a driver's blood and derives the presumed fact that the driver is intoxicated. Both the basic and the presumed fact are well defined. The situation under CERCLA is different. CERCLA's presumption may rest on the following factors: the size of the release; the toxicity, degradability, and dispersability of the substance; and the sensitivity and productivity of the receiving environment. Courts may well respond to the difficult task of assessing resource damages by heavily weighting the rebuttable presumption in favor of the public trustee.

Relation Between CERCLA Presumption and Rule 301 of the FRE

The public trustee may present its claim in either a federal court or an adjudicatory administrative proceeding.²⁶ The application of evidentiary rules differs between these two forums. The Federal Rules of Evidence (FRE), with their detailed jurisprudence on presumptions, apply in federal courts. But the situation with adjudicatory administrative proceedings is not clear; indeed, CERCLA section 112(b)(4)(C) provides that the hearings shall be informal and that "the rules of evidence prevailing in judicial proceedings need not be required." In order to understand the significance of this difference between forums, we shall examine how the FRE give full play to the operation of the rebuttable presumption.

Rule 301 governs presumptions generally in civil actions and proceedings:

In all civil actions and proceedings not otherwise provided for by Act of Congress or by these rules, a presumption imposes on the party against whom it is directed the burden of going forward with evidence to rebut or meet the presumption, but does not shift to such party the burden of proof in the sense of the risk of nonpersuasion, which remains throughout the trial upon the party upon whom it was originally cast.

Of concern here is the phrase "all civil actions and proceedings not otherwise provided for by Act of Congress or by these rules." Does the express provision in CERCLA for a rebuttable presumption take that statute out of Rule 301, leaving its meaning and scope to administrative or judicial discretion? Some statutory presumptions may specify their own effects or may have their effects determined by courts. These presumptions fall within the exception clause of Rule 301. Examples are (1) conclusive presumptions; (2) prima facie evidence; and (3) burden of proof shifts.²⁷ Other statutes may create a presumption without specifying its effect. CERCLA falls within this latter category. One authority notes:

As to those statutory presumptions that do not specify what effect they are to be given and that have not been judicially construed, there seems to be no good reason for exempting them from the operation of Rule 301. Since Congress did not trouble to give them any greater effect when they were enacted, it is unlikely that applying Rule 301 would offend any deeply felt Congressional policy. Applying Rule 301 has the advantage of providing uniformity and certainty with respect to the effect of such presumptions. As to any subsequently adopted presumptions of unspecified effect, it is reasonable to suppose that they are enacted with the expectation that Rule 301 will govern.²⁸

This argument is persuasive. The best interpretation of CERCLA section 111 (h) (2) is that since the "force and effect" of a rebuttable presumption is not explicated in the statute or its legislative history, it should be assumed that Congress intended for Rule 301 to apply.

The Meaning of Rule 301

Having cleared the initial obstacles (how to apply a presumption to a CERCLA damage assessment and whether Rule 301 governs that presumption), the inquiry flounders on the final point, namely, what Rule 301 requires for the presumption. Widely analyzed and criticized, Rule 301 avoids the two traditional theories about presumptions and ends up as neither fish nor fowl. Current legal scholarship does not provide clear guidelines for interpreting the presumption found in CERCLA.

A presumption can relate to either of two types of burdens borne by a litigant with respect to evidence. Although the terminology in this area of law is confusing, generally scholars speak of (1) the burden of producing evidence (or burden of going forward with the evidence); and (2) the burden of proof (or burden of persuasion). These burdens are distinguishable on three points:

First, the burden of proof is in practice largely a question of the proper phrasing of jury instructions; the burden of producing evidence determines whether the case is to be decided by the judge or the jury. Second, the issue of burden of proof arises only at the time of jury instructions, while the burden of producing evidence is at issue any time one or the other of the parties asks for a peremptory ruling from the court; i.e., on motions for nonsuit, directed verdict, or judgment notwithstanding the verdict. Third, the burden of proof can be shifted only as the result of the proof of a presumption, while the burden of producing evidence can switch from one side to the other as the result of the introduction of evidence as well as by operation of a presumption.²⁹

The claimant will attempt to meet the two burdens in order. First, in order to satisfy the burden of producing evidence, he "will seek to introduce enough evidence so that the judge will permit the case to get to the jury...."³⁰ Second, to satisfy the burden of proof, he will seek to introduce "enough evidence to convince the jury to find in his favor."³¹ The weight of these burdens has little practical significance because a party can determine whether they have been met only after the judge has ruled on any motions to take the case from the jury or after the jury has returned its verdict.

Consequently, a party must put on as much evidence as is necessary to support its contentions.³²

The weight of the burdens becomes more significant, however, when the presumption is met by rebutting evidence. With the increased importance of this issue, it is not surprising to find more scholarly controversy than what occurs regarding the distinction between the burdens. Two schools of thought exist regarding this issue. The "Thayer-Wigmore" school follows the "bursting bubble" theory of presumptions. According to this theory, a presumption is merely a procedural convenience that operates only in the absence of any evidence of the presumed fact. The presumption vanishes in the face of rebutting evidence, so that the issue goes to the jury if the proponent can put on further evidence of the presumed fact, but if not, then the opponent is entitled to a directed verdict against the proponent.³³

Another school of thought, the "Morgan-McCormick" view, gives greater effect to presumptions, emphasizing that they are usually created for substantive policy reasons rather than mere procedural convenience. The Morgan-McCormick theory would either treat presumptions as shifting not only the burden of producing evidence, but the burden of proof as well, or at least would require juries to be instructed about the presumption and told that they could find contrary to the rebutting evidence. The Supreme Court's proposed Rule 301 would have followed the Morgan-McCormick line of thought. Congress obscured the issue considerably by expressly rejecting the Morgan-McCormick theory but without clearly adopting the traditional alternative view (i.e., the Thayer-Wigmore bursting bubble).³⁴

Professors Wright and Graham have identified four questions that are pertinent to understanding the meaning of Rule 301 as it relates to rebutted presumptions:

- (1) What is the procedural effect of an unrebutted presumption?
- (2) What is required to rebut the presumption?
- (3) Who decides whether the presumption has been rebutted?
- (4) What is the effect of rebuttal on the operation of the presumption?³⁵

Each question is be discussed briefly in the context of the following hypothetical case.

Suppose polluter "P" releases a hazardous substance into the James River, causing damage. In a subsequent jury trial of the issue of the nature and scope of natural resource damages, federal agency A presents the following evidence as to damages:

- (1) There is a statutory rebuttable presumption in favor of its damage assessment.
- (2) Its survey calculates that 50,000 fish died because of the released substance.
- (3) According to its fish table the value of that species of fish is \$1.00 each.

By using the Wright-Graham questions, the issues can be framed as follows.

- (1) What is the procedural effect of an un rebutted assumption?

Under Rule 301, a proponent's proof that a presumption exists satisfies his burden of producing evidence. But if the opponent produces no rebutting evidence, the proponent is not entitled to a directed verdict in his favor, in contrast to the Thayer-Wigmore theory. Instead, the proponent is entitled only to an instruction that the jury "may presume the existence of the presumed fact; the presumption has no mandatory effect on the jury."³⁶ Assuming that P introduced no evidence to rebut A's final assessment, it is clear that A's proof of the presumption satisfied its burden of producing evidence. But since A is not entitled to a directed verdict in its favor, it may receive only an instruction that the jury may presume the presumed fact. Thus, A's evidence regarding the number of fish killed and the reliability of its fish value table still must satisfy the burden of persuading the jury to find in its favor.

- (2) What is required to rebut the presumption?

Curiously, the legislative history concerning this issue is vague. The Conference Report mentions only "evidence contradicting the presumed fact" and "no evidence."³⁷ Considering the alternatives of allowing any evidence to rebut a presumption, even if that evidence would be insufficient to support a finding of the nonexistence of the presumed fact, or imposing a more circumscribed approach, Professors Wright and Graham opt for the latter. According to them,

The better reading would be that the judge acquires discretion over the presumption instructions only when the evidence would support a jury finding of the nonexistence of the

presumed fact. The Report does not consider the possibility that the opponent's evidence might be so strong as to entitle him to directed verdict on the nonexistence of the presumed fact, but the reference to the fact that the presumption is only sufficient to survive a directed verdict 'at the end of his case-in-chief' presupposes the possibility of a peremptory ruling at a later point.³⁸

Suppose P introduces some rebutting evidence (e.g., that the fish are worth only \$0.25 each, according to a fish farm supply catalogue). Because of the vagueness of the legislative history of Rule 301, it is not clear whether P has rebutted A's evidence. According to Wright and Graham, the judge acquires discretion over the jury's instructions on the presumption only when P's evidence is strong enough to support a finding of the nonexistence of the presumed fact; otherwise, the instructions under question (1), discussed above, are to be used. Thus, if A's foundation evidence for its value table is relatively weak, the judge would have discretion over the jury instructions, but if the foundation evidence is strong, then the instructions under question (1) would be used because the judge would have no discretion over the matter.

(3) Who decides whether the presumption has been rebutted?

This question is decided by the judge under Rule 301.³⁹ The issue is not as significant under Rule 301 as it would be under the Thayer-Wigmore theory because Rule 301 provides a less drastic consequence of rebuttal than the bursting bubble approach. As a result, regardless of the relative weights of the evidence presented by A and P, the decision concerning rebuttal still would lie with the judge.

(4) What is the effect of rebuttal on the operation of the presumption?

Under the Thayer-Wigmore theory, a rebutted presumption has no further effect. Under the Morgan-McCormick theory, rebutting evidence only satisfies the opponent's burden of proof; it doesn't burst the bubble. Thus, the issue still would go to the jury. Under Rule 301, "the jury is no longer instructed that it may presume the existence of the presumed fact, but only that it may infer it. Unlike the Morgan-McCormick viewpoint, the instruction is discretionary with the judge, not mandatory."⁴⁰ Applying this reasoning to the hypothetical case, P's proof of rebutting evidence as to the value of the fish would not dissipate completely the presumption in favor of A. That presumption would still take the issue to the jury unless P's rebutting evidence was so strong that no reasonable jury could disbelieve it. If the issue went to the jury, the jury would be

instructed that it might infer the existence of the presumed fact (i.e., the assessed value of the damage). Such instruction would be discretionary with the judge, not mandatory. The judge's exercise of discretion probably would turn on such factors as the relative strengths of the evidence, the complexity of the fact issues, and the nature and extent of the damage.

While the foregoing discussion only roughly sketches the application of Rule 301 to a hypothetical CERCLA damage assessment proceeding, some tactical implications of the Rule may be noted in advance of actual litigation. Wright and Graham close their discussion of the policy of Rule 301 with an emphasis upon the Rule's allocation of authority between judge and jury.

It is apparent from this summary that Rule 301, while it has some features that would appeal to both schools of thought, creates a presumption that is neither Thayer-Wigmore nor Morgan-McCormick. Since the effect of Rule 301 is to increase the number of cases that are decided by the jury rather than the judge, it leans toward the Morgan-McCormick point of view. On the other hand, the mandatory effect of the Rule 301 presumption is limited to taking the case to the jury; thereafter, it has only such effect as the jury chooses to give it. In this respect, the Rule may be said to resemble the true Thayer-Wigmore theory. Since the Rule contemplates telling the jury about the presumption in most cases, it adopts a policy advanced by Professor McCormick. But in attempting to find a middle ground between the two extremes, Congress has developed a presumption doctrine that is novel only in its sweeping application.... But if the exact details are not clear, the policy is; Rule 301 is designed to increase the power of the jury in deciding factual controversies by reducing the authority of courts to create and enforce presumptions that would take the case from the jury or require that it be decided in a particular way. The Rule 301 presumption operates only against the judge; insofar as the jury is concerned it is simply an authorized inference.⁴¹

The authors believe that a significant feature of Rule 301 is that it increases the power of the jury in deciding fact issues by decreasing the judge's discretion over presumptions. If so, the rule has important implications for the choice of forum for litigation of damage assessment issues under CERCLA.

Choice of Forum

Damage assessment litigation, with its attendant rebuttable presumption, may occur in two forums under CERCLA: judicial proceedings in federal district court or

adjudicatory administrative proceedings. Two factors may favor the choice of one forum over the other: (1) whether a jury trial is desirable; and (2) whether the Federal Rules of Evidence, with their spelled out rules on presumptions, are to be given full force. A public trustee desiring a jury trial or application of the FRE should file its claim in federal court. Factor (1) arises in connection with statutory phrase "adjudicatory administrative proceeding." Assuming that such a proceeding would be tried before an administrative law judge without a jury, a tactical issue arises whether a claim should be presented administratively, without a jury, or judicially, either with or without a jury. Factor (2) concerns two express statutory conditions that CERCLA sections 112(b)(4)(C) and (D) lay down for adjudicatory administrative hearings: that they need not follow judicial rules of evidence, and that claimants must bear the burden of proving their claims. The following discussion examines these forum selection factors in detail.

First, regarding the possibility of a jury trial, it seems that even if Rule 301 applied to adjudicatory administrative proceedings, the Rule would be meaningless. Some writers, who assume that Rule 301 applies to civil nonjury trials, have concluded that its application in those trials is meaningless, no more than a rhetorical device.

What is the effect of a Rule 301 presumption in a non-jury trial? If it is assumed that the rule applies, the answer would seem to be: very little. Since there are no instructions, this aspect of the presumption would be meaningless in a court trial. The notion that the presumption 'takes the case to the jury' would also seem to be without meaning; since in passing on a motion for an involuntary dismissal the judge weighs the evidence, he presumably would have the same freedom as the jury to disregard the presumption.... Perhaps the only possible effect of the presumption in a court trial is to insulate a finding supported by a presumption from appellate reversal on grounds of lack of evidentiary support.⁴²

Because the judge decides the fact issues in a nonjury civil trial, jury instructions cease to be important and the distinction between the burden of producing evidence, which relates to the judge, and the burden of proof, which relates to the jury, is blurred. In other words, the allocation of power between judge and jury becomes irrelevant in a nonjury trial. These consequences would seem to apply with equal force to adjudicatory administrative proceedings. If an administrative law judge followed this strand of legal scholarship suggesting that the importance of a rebuttable presumption declines in a nonjury trial, the value of CERCLA's presumption is reduced in the adjudicatory administrative forum.

Second, regarding the applicability of the FRE to adjudicatory administrative proceedings, two statutory provisions may bear on the choice of forum. Under Section 112(b)(4)(C) of CERCLA, such proceedings shall take place before an arbitrator and "shall be informal, and the rules of evidence prevailing in judicial proceedings need not be required." While this statement does not completely preclude adoption of the FRE, either by administrative rule or by agreement of the parties to the proceeding, neither does it provide guidance on how to apply the rebuttable presumption of section 111 (h) (2).

Section 112, concerning claims procedures under CERCLA, may provide a clue to applying the presumption. Section 112 (4) (D) provides that "the claimant shall bear the burden of proving his claim" in an administrative proceeding. Does this prescription differ from Rule 301? As discussed above, Rule 301 does not alter the claimant's burden of proof, in the sense of the risk of nonpersuasion. Beyond this point, however, the Rule's effect on the claimant's burden of proof is rather unclear. Since the FRE are not barred from adjudicatory administrative proceedings, perhaps the most prudent interpretation of section 112 (4) (D) would be that the reference to the claimant's burden of proof is consistent with the meaning of Rule 301. Otherwise, adjudicatory administrative proceedings would follow a different rule on presumptions than federal courts, resulting in another factor affecting choice of forum. Nonetheless, it should be noted that while the applicability of the FRE may affect the choice of forum, the rebuttable presumption, however it is interpreted, remains available in both types of proceedings.

Damage Assessment Regulations

Subsection 301 (c) of CERCLA requires damage assessment regulations to be promulgated by the Executive Branch. The subsection's organization is straightforward: subparagraph (1) devolves responsibility for promulgating the regulations to officials to be designated under the National Contingency Plan; subparagraph (2) specifies some of the assessment methods to be used; and subparagraph (3) states that regulations shall be reviewed and revised, where appropriate, every two years.⁴³

Subparagraph (1) requires the promulgation of damage assessment regulations not only for releases of hazardous substances but for releases of oil as well. This is the case even though CERCLA's definition of hazardous substances excludes oil and, consequently, no liability is attached under that statute for oil spills. It appears that Congress sought to apply the new damage assessment regime to claims for damages under section 311(f)

(4) and (5) of the FWPCA, which establishes liability for both oil and hazardous substances spills, in order to aid enforcement of the latter statute.⁴⁴ Congress did not bring claims arising under the Outer Continental Shelf Lands Act, which imposes liability for oil spills resulting from Outer Continental Shelf oil and gas activities,⁴⁵ under the CERCLA damage assessment regime. Nevertheless, CERCLA establishes the principal federal regulatory regime for assessing pollution damages, as it covers both land and water pollution and certainly has the broadest application of any federal regime.

The legislative history of subparagraph (1) clarifies congressional intent regarding the damage assessment regime:

Investigations by the Committee on Environment and Public Works revealed the need for an improved, fair and expeditious mechanism for dealing with natural resource damages caused by releases of hazardous materials. The principal hindrance to attaining such a mechanism was the absence of a standardized system for assessing such damage which is efficient as to both time and cost.⁴⁶

Because of this clear congressional intent to create a standardized damage assessment system that is fair and efficient, the implementing regulations must adhere to that intent in order to be legally defensible. The emphasis on fairness suggests the desire for an accurate, noncontroversial data base, while the mandate for efficiency in terms of time and cost suggests the desire for simple, effective damage assessment techniques.

Subparagraph (2) takes this interest one step farther and requires that the regulations specify two types of assessment procedures:

- (A) Standard procedures for simplified assessments requiring minimal field observation, including establishing measures of damages based on units of discharge or release or units of affected area, and
- (B) alternative protocols for conducting assessments in individual cases to determine the type and extent of short- and long-term injury, destruction, or loss. Such regulations shall identify the best available procedures to determine such damages, including both direct and indirect injury, destruction or loss and shall take into consideration factors including, but not limited to, replacement value, use value, and ability of the ecosystem or resource to recover.

Application of one type of procedure rather than another turns on the severity of resource damage resulting from a particular release. Congress intended Type A procedures, which use simplified assessments and minimal field observations, to apply to minor releases of oil or hazardous substances and Type B procedures to apply to major

releases and to require the development of "alternative protocols" for assessing damages. The latter procedures will require more field work than Type A procedures.

The Committee Report suggests several techniques for Type A simplified assessments:

A simplified type of regulation is necessary to effectively deal with damage assessment in most "minor" releases of hazardous materials. Natural resource damage assessments based on this type of regulation should require as little fieldwork as possible, and rely on a combination of habitat values, tables of values for individual species, and previously conducted surveys and laboratory studies, related to units of discharge or units of affected area.⁴⁷

Several observations can be made from a legal standpoint regarding Type A procedures. The legislative goals of efficiency and simplicity probably are readily attained by an assessment that relies on existing surveys and tables, because the investigation period is curtailed substantially. More difficult to defend against, however, would be a challenge based on the issue of fairness. A polluter could argue that its fifth amendment due process rights are violated by a damage assessment system that requires little or no field observation of the release site. This argument could be countered with the point that the relatively little process that is due the polluter for most minor spills must be balanced against the great administrative need for efficiency in dealing with numerous cases.

It may also be argued that the government should not be permitted to use a table of values based on prior, perhaps outdated, research. It is possible, though, that this argument could be countered by pointing out that CERCLA requires the damage assessment regulations to be reviewed and revised, if necessary, every two years.⁴⁸ Consequently, probably the most relief available to the polluter who raises this challenge would be a court order that the government revise its value tables.

A more formidable legal problem may lie in the fact that CERCLA requires the government to use combinations of habitat and species value tables. Defense of tables of habitat and species values will be difficult in situations where more than one species or habitat are damaged. The total cost charged should not include double recoveries for decimated interdependent species. In such situations, value tables can be a double-edged sword: the full ecological cost should be recovered efficiently, but the complexity of an ecosystem may give rise to allegations that the simplified method is unfair.

Probably the most controversial aspect of the Type A procedures concerns the statutory requirement that the value tables be "based on units of discharge or release or units of affected area." Utilization of such units will require the establishment of a base line both for discharges and affected areas. This would require research that was both systematic and comprehensive, studying the characteristics of oil and hazardous substances in terms of toxicity, degradability, and dispersibility, as well as analyzing the effects of those substances on many different ecosystems. Since such a monumental study has yet to be undertaken, the government must use a piecemeal data base for its simplified assessments. In a legal sense, this deficient data base increases the need for a strong presumption in favor of damage assessments, because a defendant may attempt to rebut the presumption with highly competent evidence, such as on-site observations and investigations. As damage assessments become more simplified and less dependent on field work, they require stronger presumptions in their favor to remain effective.

Type B procedures apply to major releases of oil or hazardous substances. These procedures require the government to develop alternative protocols (i.e., procedures) for conducting assessments. Protocols are to be tailored to particular release incidents and, consequently, will require more on-site observation and surveys than Type A procedures. According to the Committee Report, Type B protocols apply to situations where "the extent of natural resource damage is substantial and extensive fieldwork becomes necessary."⁴⁹ In the absence of any quantitative statutory distinction between Type A and B procedures, government agencies will be responsible for specifying the appropriate situations for applying the procedures.

While a quantitative distinction is certainly not precluded from the implementing regulations (such as drawing the line between minor and major spills at 10,000 barrels of oil or hazardous substances),⁵⁰ the Committee Report's statement that Type B protocols apply where natural resource damage is "substantial" and "extensive fieldwork becomes necessary" indicates that qualitative factors must be considered as well. This makes sense because relatively small releases of some hazardous substances, such as dioxin, can wreak substantial damage and trigger large federal or state damage claims. While quantitative criteria for releases are set under the National Contingency Plan, these amounts mark the threshold for reporting requirements under CERCLA⁵¹ and, hence, cannot serve to distinguish between major and minor spills.

Statutory objectives for Type B protocols include determining the "type and extent of short- and long-term injury, destruction or loss." The Committee Report elaborates the congressional intent for these protocols as follows.

The (B) type of regulations would be employed in large or unusually damaging releases and would be used to guide the site-specific damage assessment. Such a regulation would contain protocols for field assessment of the type and extent of short- and long-term damage and methodologies for determining their value.

The protocols for field assessments should provide uniform instructions that will allow for thorough site investigation in a cost effective manner. Sampling and statistical procedures should be clearly defined. The methods for determining the geographical extent of damage should also be enumerated.⁵²

Type B regulations should specify protocols which instruct on-site personnel regarding field assessment methods and techniques. The protocols should contain suggested sampling and statistical techniques, procedures for determining the geographical scope of the damage, and methods for estimating short- and long-term damages. Protocols also should specify methods for determining the values of the various elements of damage.

In addition to guiding on-site damage assessments, protocols also may utilize existing surveys, studies, and classifications where applicable. Nothing in the statute or its legislative history prevents the government from using species tables, habitat tables, or previous studies, which were originally intended for Type A simplified assessments, in its Type B protocols. However, such tables or studies should be used only where clearly applicable to the ecosystems that are being assessed. Congress also intended that the protocols use the classification system of the national wetlands inventory:

It is the intent of the legislation that these protocols be designed to accommodate the majority of potential release sites, including coastal estuaries, open water, fresh water rivers, lakes and woodlands. The classification system of the national wetlands inventory should be of help in accomplishing this task and it should be used to the extent practicable in developing these protocols.⁵³

In addition to the objectives set for each type of regulation, the Committee Report discusses some features common to both types: "The regulations must also contain procedures for assessing the value of direct losses of organisms and their habitat and indirect losses of organisms and habitat through ecological interactions."⁵⁴ Obviously this shared feature will be implemented differently for each type of regulation. Type A simplified assessments could value indirect losses by stipulating assumptions which link various species and habitat tables. For example, an agency could rule that the release of 2,000 gallons of oil into a river will be deemed to cause a direct loss of 15,000 fish of species X and an indirect loss of 10,000 fish of species Y.

Alternative protocols in Type B procedures might treat the issue differently (e.g., specifying that if 30,000 dead species X fish are observed, 50,000 species Y fish are deemed to be destroyed). While the concept of assessing indirect losses (including reduction in reproduction as well as in the food chain) probably would be difficult to administer, the extra effort might be economically feasible if it resulted in larger recoveries for resource damages.

Recognizing the nascent state of the art of damage assessment, the committee also outlined several research goals. S. 1480, as reported by the committee, would have included requirements for directed research to aid the development of assessment techniques. Although these requirements were deleted from the final Act, they nevertheless are useful as guides to agency implementation. The Committee Report stated:

Research efforts should include... development of ways to assess (1) long-term damage to ecosystems, (2) chronic effects such as those affecting behavior, reproduction, or food supply that result in indirect losses, (3) predictive capabilities to determine potential losses through trophic level interactions, and (4) information on minimizing the damage caused by release control, dispersal, and cleanup operations. Research should be carried out both at field sites and in the laboratory.⁵⁵

These indirect research topics underscore the general legislative mandate for the development of agency expertise in this area. As the Committee Report states, the directed research provision was "designed to assure that a continuous and ongoing research effort is made to improve the methods and protocols used in evaluating release damage. The research program will improve the scientific bases for methodologies used in damage evaluation."⁵⁶ An overriding concern of Congress when it enacted the damage assessment provisions was the development of agency expertise. As shown in the legislative history of those provisions, Congress also intended that the newly developed experts would use a variety of assessment techniques and methods in carrying out their mission in a cost-effective manner.

State Approaches

Under Executive Order 12316, the responsibility for promulgating the damage assessment regulations falls upon the Department of the Interior. As of this writing,

little progress has been made toward final rule development even though the two-year period is over. Although CERCLA is clear in its general requirements concerning damage assessment, it provides little specific guidance, especially in terms of economic valuation of damages. It is almost certain that in searching for damage assessment procedures consistent with CERCLA's requirements, various state experiences with assessing damages that result from oil or hazardous substance spills will be examined. However, these past experiences are limited in number and sophistication. The following discussion briefly describes five damage assessment schemes that suggest a range of alternative approaches.

Damage Assessment in Florida

Florida's liability and compensation statute establishes a pollution recovery fund for addressing damages from oil, pesticides, ammonia, chlorine, and certain other chemicals.⁵⁷ The statute imposes strict liability (subject to certain defenses) for damages from pollutant discharges. Damages that are recoverable under this act include the costs of restoring the "air, waters, and property, including the animal, plant and aquatic life of the state, to their former condition." The fund acquires through subrogation the rights of any claimant who receives fund monies.

The statute is unique in that it requires that damages for fish kills be assessed through the use of fish value tables. The tables are to include values for individual categories of fish and are to be promulgated by the Department of Natural Resources and the Fresh Water Fish Commission.⁵⁸ The number of fish that are killed by a spill "may be estimated by standard practices used in estimating fish population." The tables promulgated by the state assign dollar values to a wide variety of freshwater and saltwater fish, turtles, crustaceans, and shellfish. In addition, they include two marine mammals: manatees and porpoises. (A portion of the tables is reproduced in Table V-2).

The actual techniques used to arrive at the values are unclear. Dockside value and replacement costs (hatchery costs) are the most common valuation bases, although others are used as well. An attempt was apparently made to account for the recreational value of trophy fish (such as marlin and bluefish) which are priced above the dockside price: blue and white marlin at \$200 each. However, these values do not appear to have been based on any formal analysis of sportfishing expenditures. Most of the freshwater fish are valued in categories of weight or length, while marine species are given one set price. The value of a manatee was arbitrarily set at \$500. According to a state official,

Table V-2. Florida fish values

Common Name	Scientific Name	Value (\$)
Anchovies	Engraulidae	0.50
Angelfish	Chaetodontidae	20.00
Bluefish	Pomatomus saltatrix	5.00
Bonito	Sarda sarda	3.00
Dolphin	Coryphaena hippurus	7.00
Marlin		
Blue	Makaira nigricans	200.00
White	Tetrapturus albidus	200.00
Silver Perch	Bairdiella chrysura	0.25
Manatee	Trichechus latirostris	500.00
Whiting	Menticirrhus ep	3.00

Source: Department of Air and Water Pollution Control, State of Florida

one basis for this figure was that it cost \$2,000 to capture a manatee for a weed control program being tested by the state. The direct relationship between these figures remains unclear.

The Department of Environmental Regulation has often used the Florida fish value tables in litigation against polluters. Two cases are illustrative. In the case In Re: Florida Power and Light Co.,⁵⁹ a consent order was signed whereby Florida Power and Light (FPL) agreed to pay \$30,000 into the Department of Environmental Regulation's Pollution Recovery Fund. This sum represents the value of fish, as determined from the fish value tables, that were allegedly killed as a consequence of a breach of FPL's reservoir. Settlements of this kind have the advantage of enabling the state to recover some compensation without investing considerable amounts of time and money in

litigation. It is also advantageous to the polluter because it does not by its terms encourage other parties to sue. The Consent Order pertaining to FPL specifically stated that nothing connected therewith would be construed as an admission of liability on the part of the party responsible for the release.⁶⁰

In State Department of Pollution Control v. International Paper Company⁶¹, the Florida Supreme Court found that the tables were "proper and relevant to the question of damages and may be introduced as evidence and rebutted, and the trier of fact is required to accept such values as presumed fact unless credible evidence to the contrary is introduced...." In this case, a total of \$14,113.50 was awarded to the state including investigative costs and expenses and \$12,009.20 for the value of the fish as determined according to the tables. The defendant had challenged the constitutionality of the state's fish value tables and the trial court agreed, stating that the tables denied the defendant due process of law. However, the State Supreme Court reversed the trial court's finding; it held that while the tables were not themselves conclusive evidence, they were admissible and could be introduced as evidence and like any other evidence be rebutted.

It is difficult at this point to draw many firm conclusions from Florida's use of fish value tables. Most cases are settled out of court and there has been no known legal challenge to the process by which the values are assigned. Florida officials generally agree that the fish tables facilitate placing dollar values on fish kills. However, the accurate determination of the extent of a fish kill remains a problem. The fish value tables have been criticized on two counts. First, as noted earlier, the tables use a wide range of valuation techniques; there has been little effort to rationalize the valuation procedures. Second, they are based on 1973 prices and have not been updated, although some effort has been made to determine appropriate adjustment indices.

Damage Assessment in Virginia

Like Florida, Virginia employs fish value tables to assess the value of fish killed by oil spills. Virginia does not mandate the use of a fish table in its statute. Rather, the law directs the State Water Quality Control Board, deemed the owner of the dead fish, to recover the replacement value of the fish that are killed, plus the costs of investigating the kill and the legal costs incurred in connection with any lawsuit for recovering their value.⁶² The State Water Quality Control Board has elected to use a table of fish values published by the Southern Division of the American Fisheries Society.⁶³

This table presents the average purchase price of freshwater fish species at hatcheries. The values are based on a survey of commercial hatcheries in the southeastern United States in 1970 and updated in 1974. Values are expressed in cents, by length in inches, and by pounds over a certain length. For example, the value of a large mouth bass ranges from \$ 0.23 at 1 inch to \$2.85 per pound over 12 inches. One exception to the replacement cost type of estimates involves sturgeons. These are valued, independent of size, at \$51 per pound. A footnote to the table explains this value as accounting for the rare nature of the fish and its need for protection. There is no explanation of the method used to arrive at this figure. According to state officials, the tables have played an important role in the effective enforcement of the state's oil spill law. They estimate that Virginia has about 300 oil spills and 40 hazardous substance spills per year. Of the oil spills, the state identifies possible responsible parties in about 150-160 cases. Usually, the parties charged with responsibility for the spills agree to clean up the spills and pay damages.

A typical damage assessment case in Virginia might follow these lines. First, state authorities are notified of a fish kill. They investigate two issues: (1) who is responsible for the discharge that killed the fish; and (2) what is the extent of the kill (the body count). To measure the extent of the kill, the state examines 100-yard segments of the river every one-half mile downstream from the discharge. Officials note both the species and size (measured in terms of length) of the dead fish. Once the state identifies the discharger, it sends a letter charging that party with responsibility for the kill. A bill accompanies the letter and includes the cost of the investigation as well as costs for replacement of the killed fish, itemized in terms of species and sizes.

Typically, the party that is charged objects primarily to the state's claim that it is responsible for the kill. Once the state proves the party's responsibility, however, strict liability attaches under the Virginia statute and the only issue open to dispute is the measure of damages. This issue is rarely contested by the polluter and only one case has actually gone to litigation. There are at least two reasons why the fish tables have been relatively uncontroversial, according to a state official: (1) the tables are uniform, with standardized measures that appear fair and thus are difficult to challenge; and (2) the total damages charged to the polluter are generally very low.

In a ruling that is consistent with Rule 301 of the Federal Rules of Evidence, which governs presumptions in federal courts (as discussed above), a Virginia state court held in Weaver Mirror that the defendant could rebut the fish values established by the state.⁶⁴ Also consistent with Rule 301, the Virginia judge instructed the jury that it

could base the value of the destroyed fish on the values contained in the fish tables. In that case, the jury rendered its verdict in favor of the state. Since the case was not appealed, this issue has not been presented to the Virginia appellate courts.

The AFS tables deal only with freshwater fish. Saltwater fish kills are valued using commercial market values. The state takes the "dockside market price per pound" for saltwater fish, using a correlation chart for size and weight that was established by the Virginia Institute of Marine Science. Since there is no commercial price for small fish (e.g., a 3-inch bluefish) the state establishes an arbitrary price (10 cents per fish) to compensate for this "environmental niche," on the rationale that such fish could be harvested at a commercial size in the future. One official noted that as the state moves away from its tables to estimations of the value of non-commercial-sized fish, the resistance of the polluters appears to increase.

There are at least three limiting factors in the Virginia valuation scheme. First, the state does not seek to recover for total resource damages, only for the standard replacement cost of a few commercial species of fish. Second, calculated replacement costs are for state fish hatcheries, which have very large economies of scale. Third, the fish tables do not account for endangered or commercially valueless species. In one case, Virginia Electric Power Company (VEPCO) was alleged to have killed an estimated 85,000 12-inch grizzard shad. VEPCO argued that hatcheries stock only 3-inch grizzard shad, and then only for their use as food for bass. Therefore, VEPCO concluded, there was no restocking cost for 12-inch grizzard shad (and hence no liability). The Virginia Fish and Game Commission wanted to refrain from charging VEPCO because the shad were not sportfish. Finally, the Water Control Board, reasoning that young shad must come from parent shad, set 10 cents per fish as their value for the purpose of reproduction. In another case, an endangered darter was nearly made extinct by a large kill on the Roanoke River. The darter was not listed in the AFS table, and the state recovered only an arbitrary value of 10 cents per fish.

Damage Assessment in Washington

A Washington statute establishes fines and damage claims for any discharge that causes "the death of, or injury to, fish, animals, vegetation or other resources of the state, or otherwise causes a reduction in the quality of the state's waters below (its) standards." ⁶⁵ At this time, most of the discharge incidents have involved fines rather than assessed resource damages. In fact, the damage claims have yet to be challenged in

court. This statute permits the state to recover the replacement value of fish killed by hazardous spill. Unlike Virginia and Florida, however, Washington has forgone fish value tables in favor of standardized methods for assessing damages. Contained in the 1982 Guidelines for Evaluating Freshwater Resource Damages and Computing Resource Damage Claims in Washington State (Guidelines), a publication prepared by the State Department of Ecology to standardize its damage evaluation field investigations, the prescribed procedures are neither mandated by statute, as in the case of Florida, nor promulgated pursuant to statutory authority, as in Virginia.⁶⁶ The state may, however, use the Department of Ecology's field investigations in its attempts to recover for resource damages. Damages are recoverable by the attorney general on behalf of the people of the state.

The major portion of the Guidelines is devoted to assessing the actual physical damages. The report provides a five-stage field investigation with methodologies outlined for each stage: (1) documenting evidence; (2) determining the affected area; (3) computing the mortality estimate; (4) compiling supplementary data; and (5) writing the final report.⁶⁷ For example, in the documenting evidence stage, the investigator obtains water samples for pH, dissolved oxygen, conductivity, and turbidity from locations within and above the affected area. As another example, the second stage of the Guidelines requires the use of two methods: direct observation of dead or dying fish and benthic sampling to determine the damaged resources.

Once the Department of Ecology determines the nature and extent of the fish kill by means of these investigative stages, it calculates the economic values of the damage. Economic assessment consists of "essentially two phases: (1) identifying fish values, restocking costs, resource loss costs and repropagation loss costs, and (2) computing the damage claim."⁶⁸ For the resource loss costs the department includes fish values based on production costs at state fish hatcheries, anglers' expenditures, and ex-vessel prices. The second step of computing the damage claim simply adds up the above costs. Several adjustments are normally in this process. They include increased mortality of hatchery fish versus natural fish; the value of roe contained in spawning females that are killed; and the natural mortality and survival rates of the fish. The resource damage costs also are based on actual state efforts in restoring fish populations.⁶⁹

In 1980 the State of Washington, with federal support, developed the Marine Resource Damage Assessment Program to enhance its capability in assessing damages to the Puget Sound and the coastal areas. The economic valuation of the damages again

focused on lost incomes and recreational expenditures, but with the noticable call for including loss of state tax and license revenues.

The Washington scheme shows a well-integrated approach toward damage assessment without depending on value tables. The scheme is clearly still focused on evaluating fish kills, and in that respect, its evaluation and computation protocols are comprehensive and well developed. An interesting question is whether this scheme can be expanded to include other resources which have more nonconsumptive values (e.g., esthetic and preservation values). The economic values mentioned in the guidelines are still essentially replacement and production costs, but seem to be moving toward expenditures for recreational resources. While this is a step in the right direction, some attention is needed on relating the expenditures to the willingness to pay of the recreationists.

Damage Assessment in California

California's oil spill statute establishes liability for "any damage or injury to the natural resources of the state, including, but not limited to, marine and wildlife resources, caused by the discharge or leakage of petroleum, fuel oil, or hazardous substances...."⁷⁰ This language is not significantly different from the other state statutes discussed above. But California courts appear to be more adamant in allowing the state to recover for loss of recreational and aesthetic values. For example, the California Supreme Court, in People ex rel Younger v. Superior Ct., Alameda Cty.,⁷¹ upheld the state's assessment of the maximum penalty of \$6,000 per day against the Port of Oakland for the discharge of 125,000 gallons of oil into the Oakland Estuary. The court reasoned that the maximum penalty was not simply punitive in nature and, therefore, was not invalid against a municipality. Instead, the penalty compensated the people of California in part for natural resource damages because the harm "caused not only to the waters themselves but to the wildlife and marine life dependent on them as well as its pervasive and continued effect defines a general assessment of damages to say nothing of their calculation in terms of money."⁷²

California officials elaborated upon the state's policy on resource damage assessment in federal congressional hearings on various Superfund bills.⁷³ According to one official, the state first determines the extent of the resource losses, then assigns monetary values to fish and wildlife. California has used six methods for establishing the value or compensatory costs of fish and wildlife resource destroyed by pollutants: (a)

replacement cost, (b) commercial value, (c) resource loss value, (d) ecological or environmental damage, (e) costs to fishermen, and (f) liquidated damages.⁷⁴ California's current approach to establishing monetary values for natural resources emphasizes the resource loss value. Resource loss damages have been subdivided into three parts to account for the resource, its uses, and its value to society: (1) replacement value, (2) use value, and (3) existence value.⁷⁵

Replacement Cost

The replacement cost for birds is based on breeding habitat costs. Birds are placed in one of five habitat categories, ranging from birds able to breed in captivity in an artificial habitat to those that require a secluded natural environment for breeding. The implicit assumption is that birds that are more expensive to breed are more vulnerable and, therefore, more valuable. The values range, respectively, from \$5.50 per bird (based on costs of buying pheasants from a game breeder) to \$36,750 for rare or endangered species that require extensive natural conditions (based on one-half the amortized capital expenditure for protecting 60 condors). The values in each category are adjusted to account for number of offspring, length of breeding cycle, habitat availability, and population. (The factors used to account for these adjustments are shown in Table V-3.) Mammal replacement costs are calculated from prices at supply houses and pet stores for small animals (e.g., the average pelt value for a representative species of intermediate-size animals—\$33 for a bobcat and \$5 for an opossum). A habitat evaluation procedure similar to that used with birds is employed for large mammals. Rare and endangered species are valued on an individual basis with no set methodology. Fish replacement costs are based on hatchery production costs.

Use Values

Recreational use values for the resource categories are based on Brown's analysis of the U.S. Fish and Wildlife Service's National Hunting and Fishing Survey.⁷⁶ In that work, Brown calculated the consumer surplus (willingness to pay) for hunting, fishing, and general recreation groups in dollars per user day. Nonconsumptive use values (e.g., bird watching) were calculated by allocating total recreation or bird-watching days over the number of different species of mammals and birds. Each species was then placed in one of five population categories (e.g., 0-100, 100-1000, etc.). This is to account for the fact that the rarer the species, the greater its nonconsumptive value. By dividing the number

**Table V-3. Adjustment factors for California
replacement cost calculations**

Subject of Replacement	Adjustment factor
<u>Habitat Availability</u>	
Plentiful	1/2
Restricted	2
Scarce	4
<u>Number of Offspring</u>	
0-1	4
2-3	2
4 or more	1
<u>Breeding Cycle</u>	
2 per year	1
1 per year	2
1 every other year	4
<u>Population</u>	
1-100	1
100-1,000	2
1,000-10,000	4
10,000-100,000	8
over 100,000	16

Source: Hazardous and Toxic Waste Disposal: Hearings on S. 1480 Before the Subcomms. on Environmental Pollution and Resource Protection of the Sen. Comm. on Environment and Public Works, No. 96-H9, Part 2, 96th Cong., 1st Sess. 186 (1979) (statement of Fred E. Walgenbach).

of use days for each species—100,000 (40 million bird-watching days divided by 400 species) for birds and 170,500 (37.5 million nature walk recreation days divided by 220 species of mammals) for mammals by the midpoint of the population category, the use days per animal by species was calculated. These were multiplied by Brown's value per recreation day to arrive at the nonconsumptive monetary value estimate by animal. A hypothetical calculation is illustrative. Suppose one is interested in the recreational value of a migratory waterfowl of which there are 50,000 in the state. According to Brown, its hunting value is \$40 per hunter day. A total of 100,000 user days (40 million bird-watching days divided by 400 species) divided by 50,000, yields a recreational use figure of the waterfowl of 2 days. This figure multiplied by Brown's estimate of an average consumer surplus for migratory waterfowl of \$47 per user day equals a recreational monetary value per bird of \$94.

Existence Values

The calculation of existence values for birds and other animals is based on estimates of nonconsumptive use values developed by Horvath (\$119 for birds, \$157 for other animals).⁷⁷ They are adjusted by recreational use per animal as described above and values determined by population class. California's justification for using these base figures, which are larger than Brown's, is that they more accurately reflect willingness to sell than willingness to pay. The existence value for fish is calculated from a linear relationship between Brown's nonconsumptive value of \$22 per user day to Horvath's \$132 and related to the human population affected. The final estimate is \$15.42 per individual affected.

Two other categories of damage values are considered under the California program: damage to the environment and habitat use loss. The first is based on restoration cost of a marsh area and is set at a minimum of \$990 (1978 dollars) per acre. Habitat use loss is based on current activity loss not explicitly included in the recreational uses discussed earlier.

A version of this approach was applied in a situation⁷⁸ that arose after leveling and filling activities were conducted in the "Big Hole," a complex of islands, water channels, and land masses along the Colorado River. California argued that the leveling and filling destroyed wildlife habitat, diminished aesthetic value, decreased water quality, and reduced recreation. As estimated by the state, the annual figure for total value of damage was assumed to accrue for 13 years, 3 for the period between the

incident and the beginning of restoration, and 10 for years of restoration. This loss was discounted using a 7 percent interest rate. The relevant calculations are given below.⁷⁹

Big Hole Damage

Bird Damage	\$16,400
Mammal Damage	1,475
Fish Damage	3,550
Habitat Damage	<u>\$ 5,080</u>
Total Annual Damage	\$26,505
Total Present Value of Damage (rounded) (7% discount rate over 13 years)	\$271,300

In a settlement, the state was eventually awarded \$75,000 and a 2-mile easement across the defendant's property to permit public access for recreational fishing. In addition, the defendant was ordered to restore the channel. Total damages were found by summing over the individual components. To the extent that delays occur in damage restoration, an additional item, the present value of annual damages over the period of delay, was included.

Because of the complexity and detail of the California plan, a few general observations are useful. First, the California system is essentially ad hoc. Although there is some attempt to rationalize the procedures in terms of formal economic theory, the linkages are weak and there appears little overall coherence. Second, the California procedures do attempt to provide a more comprehensive analysis of different damage types than the other state schemes. However, a third point is that the approach is applied on a case-by-case basis and may be more difficult to generalize in a routine fashion. Fourth, these valuation techniques have been expressed mainly in penalty notices and settlement positions. Fifth, there appears to be a serious potential for double counting if the single component estimates are simply summed. For example, under the California scheme a duck of a common species that is killed by a spill would be valued for hunting and bird watching even though the former might well preclude the latter. Further, an existence value would also be ascribed to the duck.

Damage Assessment in Alaska

In its statutory provision establishing civil penalties for the discharge of oil, the Alaska legislature made three findings:

- (1) Oil discharges may cause significant short- and long-term damage to the environment.
- (2) While the "exact nature and extent" of oil pollution can neither be documented nor quantified with certainty and precision, substantial civil penalties should be imposed to provide incentives for safe oil handling and to compensate for "subtle, long-term or unquantifiable" losses.
- (3) Penalties for small oil discharges should be assessed on a "case-by-case judicial determination," while large spills should be handled with statutorily set penalties.⁸⁰

Following these findings, the statute requires the Department of Environmental Conservation to establish a schedule of fixed penalties, based on characteristics of the oil and the receiving environment, to be included in implementing regulations.⁸¹ The schedule is required to vary according to the "toxicity, degradability and dispersal characteristics of the oil" and the "sensitivity and productivity of the receiving environment." The promulgated schedule will further subdivide the oil and environmental categories. The schedule will subdivide toxicity, degradability, and dispersibility of oil each into high, moderate, and low classifications.⁸² It also will divide the receiving environment into freshwater, marine, and public land environments and then further divide each group into critical, very sensitive, and sensitive areas.⁸³ The result is a simplified classification system for oil pollution damage, although the intent of the penalties is to provide incentives for safe handling of oil.

Payments to the damages are assessed in the following manner. First, the statute establishes a base civil penalty for each environmental category. Next, the statute assigns numerical factors to each classification of oil. The net civil penalty is determined by multiplying the base penalty by the arithmetic mean of the toxicity, degradability and dispersibility factors of the oil.⁸⁴ This procedure is intended to take into account the ecological significance of the affected area and the polluting characteristics of the oil in an attempt to assess penalties accurately and consistently. The statute contains a schedule of maximum limits for discharges, ranging from \$10 per gallon for oil releases in sensitive freshwater environments, to \$2.50 for estuarine and intertidal environments, to \$1 for open salt water. The regulations establish the following formula for calculating civil penalties for oil discharges based on the legislative directive:

$$P = (G) \cdot (B) \cdot \frac{(T+D+S)}{3}$$

where

- P = Civil Penalty
- G = Number of Gallons Discharged
- B = Base Civil Penalty
- T = Toxicity Factor
- D = Degradability Factor
- S = Dispersibility Factor

The toxicity, degradability, and dispersibility factors each range from 0.15 to 1.0. The amount of the penalty paid per gallon can range from \$10.00 for a spill in a critical freshwater environment, to \$0.055 for one on public land without significant environmental resources.

Alaska's regulations require that all spills be reported, regardless of their amount. According to one official of Alaska's Department of Environmental Conservation, this results in significant paper work for the state and authorities to set priorities for cases and carefully allocate scarce enforcement resources. The official estimated that more than 1,000 spills were reported to the Fairbanks office in 1981, of which 300 were considered to be large. The largest, a spill of 100,000 gallons of oil, occurred in January 1981. Many of the reported spills are mixtures of oil and mud from oil drilling, or spills from oil storage tank overflow pits. Most cases are resolved by settlement. This is probably due in part to the fact that the state, because of scarce administrative resources, must select only the highest priority cases for action. These are usually large spills, for which responsibility is clear.

Plaintiffs in a recently filed case have challenged the damage assessment regulations as unconstitutional.⁸⁵ The case involves a pipeline leak at Atican Pass on the North Slope. The oil reached the Atican River and emptied into the Sagwan River, traveling 150 miles. Cleanup by Aleyska, the pipeline company, was minimal. A disagreement arose when Aleyska reported that it had spilled only 1,500 barrels of oil and the state claimed that the company had in fact spilled 5,000 barrels. The state based its damage assessment on its estimation of the amount spilled and on its classification of the receiving environment as very sensitive because the rivers pass through a wildlife refuge.

The significant innovation of the Alaska system is that it is based on the characteristics of the pollutant and the characteristics of the receiving environment. Penalties are higher for highly toxic discharges into critical environments and lower for

less toxic discharges into environments lacking in significant aquatic resources. An important virtue of Alaska's approach is that it might allow nonconsumptive uses and ecological values to be factored somewhat into the categorization of environments as sensitive, critical, or productive, in a more systematic manner than in the case-by-case approach of California.

One should note, however, that the Alaska system charges penalties rather than cost of damage, although the penalties are somewhat related to the scale of the damage. Calling the charges penalties, the system becomes invulnerable to arguments that the levels of the penalties do not correspond to the amount of harm actually caused by the discharge, since the primary purpose of penalties, from the legal perspective, is to punish an illegal act rather than compensate the harm.⁸⁶

Despite its simplicity, the scheme seems to have been applied only twice.⁸⁷ In addition to the Aleyska pipeline, a Korean ore carrier, the Lee Wang Zin, was assessed penalties after it sank off the coast of Alaska and spilled 100,000 gallons of fuel oil. One of the reasons for such infrequent use of the scheme is that the statute applies only to spills of more than 18,000 gallons. It is unclear, therefore, how a simplified scheme such as the Alaskan one would operate under frequent demands.

Footnotes—Chapter V

- ¹ Comprehensive Environmental Response, Compensation and Liability Act of 1980, Pub. L. 96-510, 94 Stat. 2767 (hereinafter cited as CERCLA or the Act).
- ² CERCLA section 107(f). The subsection then qualifies the quoted language by stipulating that no liability shall be imposed where (1) the party sought to be charged demonstrates that the natural resources in question were specifically identified as an irreversible and irretrievable commitment in an environmental impact statement; (2) the decision to grant a permit or license authorized such a commitment of natural resources; and (3) the facility or project was otherwise operating within the terms of its permit or license.
- ³ 40 C.F.R. Pt. 300, 47 Fed. Reg. 31180 (July 16, 1982), ELR Reg. 47401 (National Oil and Hazardous Substances Contingency Plan). Subpart G discusses state and federal trustees.
- ⁴ S. Bleicher, The Impact of Superfund on Government Claims for Damages to Natural Resources, Environmental Protection Report 5 (August 1981) (National Governor's Ass'n). But see In re Allied Towing Corp., 478 F. Supp. 398,402 (E.D. Va. 1979), discussing liability for oil removal costs under the FWPCA: "The actual costs incurred by the states for the restoration or replacement of their resources, as distinguished from similar costs incurred by the Federal Government on the states' behalf, may be recovered only by the states."
- ⁵ Outer Continental Shelf Lands Act, 43 U.S.C. Section 1331 (1981) (as amended) (hereinafter cited as OCSLA).
- ⁶ Trans-Alaska Pipeline Authorization Act, 43 U.S.C. Section 1651 (1976).
- ⁷ Deepwater Port Act of 1974, 33 U.S.C. Section 1501 (1976).
- ⁸ W. Rodgers, Environmental Law 172 (1977) (hereinafter cited as Rodgers).
- ⁹ J. Sax, The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention, 68 Mich. L. Rev. 471, 490 (1970).
- ¹⁰ 146 U.S. 384 (1892).
- ¹¹ Rodgers, supra note 8, at 175.
- ¹² 146 U.S. at 452.
- ¹³ 376 F. Supp. 90 (N.D. Cal. 1974), further proceedings 398 F. Supp. 284 (N.D. Cal. 1975).
- ¹⁴ Redwood National Park Act, 16 U.S.C. Section 79 a-j (1976).

- 15 376 F. Supp. at 93.
- 16 CERCLA Section 101 (16).
- 17 Rodgers, supra note 8, at 174.
- 18 495 F. Supp. 38 (E.D. Va. 1980).
- 19 495 F. Supp. at 40. Although the case was settled, it is interesting to note the evidence of damages that the United States presented. The U.S. introduced a willingness-to-pay study which estimated lost hunting value that resulted from the oil-induced bird kill. An expert applied the results of the study, which had been done for the Pacific Flyway, to the Virginia area. The study consisted of a questionnaire for hunters that elicited information concerning household income after taxes (I), number of seasons of experience hunting waterfowl (S), hunter's cost per season (C), hunter's seasonal bagged waterfowl harvest (W), and the hunter's estimate of how much his costs would have had to rise above present costs before he would have decided to abstain from waterfowl hunting (V). The expert derived an equation for predicting consumer's surplus, and when mean values for I, S, C, and W were placed into the formula, the expert obtained the marginal value of a bagged waterfowl for a representative hunter.
- 20 350 F. Supp. 1060 (D. Md. 1972).
- 21 350 F. Supp. at 1067.
- 22 CERCLA Section 111 (h)(2).
- 23 See 21 C. Wright and K. Graham, Fed. Practice and Procedure 561 (1977) (hereinafter referred to as Wright and Graham).
- 24 See McCormick's Hornbook on Evidence 820 (E. Cleary, ed.) West Publ. Co. (2nd ed. 1972) (hereinafter referred to as McCormick).
- 25 Id. at 820, n. 32.
- 26 CERCLA Section 112 (b)(4)(c).
- 27 Wright and Graham, supra note 23, at 579-80.
- 28 Id. at 583.
- 29 Id. at 558.
- 30 Id.
- 31 Id.
- 32 Id. at 558-59.
- 33 Id. at 564.

34 Id. at 571.

35 Id. at 571-72. At least one case, U.S. v. Chevron Oil Co. (5th Cir. 1978), has addressed the effect of a rebuttable presumption on the issue of environmental harm under section 1321 (b)(3), the civil penalty provision of the FWPCA. 583 F.2d 1357: The court treated the Coast Guard's oil sheen test of the harmfulness of an oil discharge as a rebuttable presumption. The court allowed the defendant to rebut the presumption with evidence that the discharge was not harmful. The evidence consisted of the testimony of an expert witness. 583 F.2d at 1360-61: The government did not produce any evidence at the administrative hearing. 583 F.2d at 1361: The court of appeals found for the defendant, reasoning that:

Evidence of a sheen thus provides a sufficient basis for the government to assess the section 1321 (b)(6) civil penalty unless a defendant proves that its spill was not harmful under the circumstances. If a defendant introduces such evidence, as Chevron did here through Dr. Mackin, the Government must rebut with evidence that defendant's spill was of a harmful quantity under the circumstances.

583 F.2d at 1364: Although the court did not discuss Rule 301 or the competing legal theories about presumptions, its holding appears closer to the Thayer-Wigmore "bursting bubble" than the Morgan-McCormick view.

36 Wright and Graham, supra note 23, at 571.

37 Id.

38 Id. at 572.

39 Id.

40 Id.

41 Id. at 572-73.

42 Id. at 612-13.

43 See S. 1480, 96th Cong., 2d Sess. (1980) (hereinafter referred to as S. 1480). S. 1480 presented the damage assessment framework in one complete package at section 6(e). Thus, section 6 (e)(1) stated that damage assessment regulations would be promulgated by designated agencies and provided a general outline of the nature of those regulations; section 6(e)(2) stipulated the types of resources for which each agency would be responsible in its regulations; and section 6(e)(3) established a rebuttable presumption in favor of any assessments or determinations of resource damages that are made by the agencies. In its enacted form, CERCLA broke section 6 (e) of S. 1480 apart and scattered the provisions, with section 6 (e)(1) becoming section 301 (c) and section 6 (e)(3) becoming section 111 (h). Subsection 6 (e)(2) was deleted and part of section 6 (e)(1)(A) was modified because Congress

chose to forgo a statutory assignment of damage assessment authority among various agencies in favor of simply allowing the president to allocate such authority in the National Contingency Plan.

A significant fact for interpreting the meaning and intent of CERCLA section 301 (c)(2), which describes the nature of the mandated regulations, is that this subsection adopted verbatim the text of section 6 (e)(1)(B) of S. 1480.

- 44 Because the FWPCA and CERCLA establish liability for different costs, the CERCLA damage assessment regulations might be used differently in proceedings brought under the two statutes. Under the FWPCA, section 1321(f)(1) establishes liability to the U.S. government for the actual costs incurred for removing oil or hazardous substances. The 1977 amendments to the FWPCA added section 1321(f)(4), which provided that the costs of removal shall include any costs or expenses incurred by the federal government in the restoration or replacement of natural resources damaged or destroyed as a result of the discharge of oil or hazardous substances. CERCLA establishes liability for a broader range of damages. Section 107 (a) establishes liability for all costs of removal or remedial actions plus liability for damages "for injury to, destruction of, or loss of natural resources...."

Liability under the FWPCA is for the actual costs of removal, including the costs of restoration or replacement of natural resources. CERCLA establishes liability for removal costs also, but it goes farther than the FWPCA, establishing liability for public harm, such as loss of use, that is caused by injury to, destruction of, or loss of natural resources.

This difference in liability raises the issue of how the CERCLA damage regulations, which essentially are intended to measure the values of uses of natural resources, can be used to measure damages for the purpose of determining the extent of liability under the FWPCA. It would seem that the best way to compute the extent of liability under the FWPCA would be simply to add the actual costs of removal. Perhaps one use of the CERCLA regulations would be to measure the extent and value of damage in order to show that the actual removal actions taken under the FWPCA were reasonable.

- 45 See note 5, supra.
- 46 S. Rep. No. 96-848, 96th Cong., 2d Sess. 85 (1980) (hereinafter referred to as S. Rep. No. 96-848).
- 47 Id. at 86.
- 48 CERCLA Section 301(c)(3).
- 49 S. Rep. No. 96-848, supra note 46, at 85-86.
- 50 B. Rashkow, An Analysis of Alternatives to the Traditional Approach to Damage Assessment, 8 (May 15, 1981) (unpublished paper) (hereinafter referred to as Rashkow).

- 51 CERCLA Section 102(b).
- 52 S. Rep. No. 96-848, supra note 46, at 86.
- 53 Id.
- 54 Id.
- 55 Id. at 87-88.
- 56 Id. at 88.
- 57 Fla. Stat. Section 403.165(2).
- 58 Fla. Stat. Section 403. 141(3).
- 59 In re Florida Power and Light Company, Florida DER Case No. 51-81-80.
- 60 Id.
- 61 329 So. 2d. 5 (1976).
- 62 Va. Code Section 62.1-44.15(11)(a)-(c).
- 63 Rashkow, supra note 50, at 12. See generally American Fisheries Society, Monetary Values of Fish (1975).
- 64 Commonwealth ex rel. St. Water Control Bd. v. Weaver Mirror Co., Law No. 4722 (Franklin Cty., Va. Cir. Ct., June 2, 1977).
- 65 Wash. Rev. Code Section 90.48.144 and 90.48.142.
- 66 R. deBey and E. Fidell, The Assessment of Pollution Damage to Aquatic Resources: Alternatives to the Trial Model, 19 Santa Clara L. Rev. 641, 650 (1979).
- 67 See Rashkow, supra note 50, at 16-20.
- 68 Id. at 16.
- 69 Id. at 17-18.
- 70 Cal. Navig. Code Section 293.
- 71 127 Cal. Rptr. 122, 16 Cal.3d 142 (1976). This case was brought under section 13350(a) of the California Water Code, which establishes a civil penalty for discharge of oil or wastes into California waters. Thus, the issue of liability for resource damages was addressed by the court within the framework for civil penalties.
- 72 127 Cal. Rptr. at 126.

- 73 Hazardous and Toxic Waste Disposal: Hearings on S. 1480 Before the Subcomms. on Environmental Pollution and Resource Protection of the Sen. Comm. on Environment and Public Works, No. 96-H 9, Part 2, 96th Cong., 1st Sess. 186 (1979) (statement of Fred E. Walgenbach).
- 74 Id. at 185 (statement of Michael Martin).
- 75 Id. at 186 (statement of Fred E. Walgenbach).
- 76 G. Brown et al., "Estimating Values of Wildlife: Analysis of 1975 Hunting and Fishing Survey," Working Paper No. 7, U.S. Fish and Wildlife Service, March 1978.
- 77 J. Horvath, Southeastern Economic Survey, March 1978.
- 78 State of California v. Alice B. Copeland Vincilone, No. 15156 (Cal. Sup. Ct., Riverside Cty., filed 1973).
- 79 F.E. Walgenbach, "Economic Report on the Fish and Wildlife Damages Sustained at the Big Hole Area of the Colorado River," California Department of Fish and Game, 1973.
- 80 Alaska Stat. Section 46.03.758(a).
- 81 Alaska Stat. Section 46.03.758(b). These penalties are for the discharge of oil and apparently are intended to provide incentives for the safe handling of oil. Section 46.03.760(a)-(d) creates a distinct set of civil actions for limited damages to compensate the state for environmental damages that result from violations of various environmental statutes, regulations, and permits, including those relating to oil. The civil actions for limited damages parallel the discharge penalties in that both are to be assessed according to the toxicity, degradability, and dispersal characteristics of the oil and the sensitivity of the receiving environment, but the damage provisions are not set according to the regulatory schedule used for discharge penalties. However, Section 46.03.758 (i) provides that a person cannot be liable for both a discharge penalty and a limited damages penalty for the oil discharge.

Section 46.03.760(e), as amended in 1980, states that in addition to liability for a civil action for limited damages, a person who discharges oil in violation of state law can be liable to the state "for the full amount of actual damages caused to the State by the violation, including direct and indirect costs, associated with the abatement, containment or removal of the pollutant, restoration of the environment to its former state, and all incidental administrative costs."

Thus, while it appears that a person cannot be liable for both a discharge penalty and a civil action for limited damages, a person could be liable for one of these plus the actual damages caused to the state.

- 82 Alaska Stat. Section 46.03.758(d).
- 83 18 Alaska Admin. Code 75.510; 75.520; 75.530.

- 84 18 Alaska Admin. Code 75.570.
- 85 State of Alaska v. Aleyska Pipeline Service Company, No. F79-33
(D.Alaska 1979).
- 86 The authors thank Norman Meade and George Kinter of NOAA and Jeffrey Trauberman, senior lawyer at the Environmental Law Institute, for pointing out this implication.
- 87 Information in this paragraph is based on a paper written by the staff of American Petroleum Institute.

Chapter VI

SUMMARY AND CONCLUSION

Recovery for damages to public natural resources is a well-recognized and accepted concept. However, the practice of calculating a compensation that is optimal, in a formal economic sense, is still relatively undeveloped. This report has surveyed natural resource damage valuation from its economic conceptual framework to its practice. The focus of the report has moved through the economic theory of damage valuation, the methods developed to value the damages, and the legal framework within which these methods have operated and are likely to operate in the future. Given this vast scope, the conclusions to be made in this section require some general qualifications.

The general perspective of this report is one of an overview rather than a verification or a test of hypotheses and valuation tools. The emphasis has been on major developments in the theory and practice of damage valuation, generalizing on a level that is consistent with the many disciplines that are involved in natural resource damage assessment. This focus was chosen in an effort to bridge the often wide gaps among the various involved professionals such as scientists, economists, and lawyers. Such gaps are a rather common problem precipitated by the specialization that is called for within each of the professions when dealing with various aspects of damage assessment. The professionals do not always share similar concerns, and yet a useful assessment scheme requires coordinated efforts from all of the contributing professionals. This overview also attempts to highlight the advantages and disadvantages of the numerous methods for damage valuation and assessment since most of them represent trade-offs between various concerns that a practitioner of damage assessment faces. These methods have seldom been examined under a common theme. For these reasons, this report leaves the more rigorous examination of valuation and assessment methods to the relevant professional literature. Instead, it aims to enhance the reader's understanding of the basic concepts and ability to choose appropriate approaches to damage assessment. In order to achieve this goal, the report views damage valuation techniques in a framework that can provide consistency throughout the theory and practice of damage assessment. The observations below comment on the practicality of this framework in the real world and its impact on the practice of damage assessment.

The Use of Economic Theory

Natural resource valuation, either in the context of compensation for damages or in a regulatory framework, is a process of allocating the services of the resources. Various mechanisms for arriving at allocation of natural resources, whether they be legal, economic, or political, all explicitly or implicitly recognize that trade-offs must be made between natural resources and other goods. This report emphasizes economic theory above the alternative approaches for several reasons. First, economic theory offers a logical and testable framework for damage valuation. Second, economic theory is consistent with the principles of consumer welfare maximization and therefore with the way other goods are valued in this society. Third, economic valuation concepts provide a firm and consistent basis for comparing services across resources and other goods. The mainstream of economic theory points to the use of consumer's surplus and producer's surplus in valuing resources, the former being the amount one is willing to pay for services above what he actually pays, and the latter the amount accruing to a business owner that exceeds his cost of running the business. This is not to deny the importance of other non-economic considerations. When warranted, they will inevitably modify any final valuation estimates.

Damage valuation is estimating the dollar change in the surpluses due to a change in the resource service flow. When a service provided by a public resource is interrupted by a damage, the public suffers a loss. The key to measuring this loss is identifying the reduction in the willingness of the users to pay for or sell the amount of the lost service. As long as there is relationship between willingness to pay and the amount of service consumed, the reduction in the surplus, theoretically, can be calculated. For commercial uses it is important to remember that the services of the resource are inputs, like labor and equipment, into the production activities of the commercial interests. The loss to a commercial interest is the producer's surplus, which can be approximated by profit forgone because of the interruption in the flow of the inputs caused by a spill. Whether other inputs, such as labor, also suffer a loss is difficult to determine without a careful examination of their opportunity cost. Some open-access resources (for example, fish) also have user cost value that should be recognized in both public and commercial uses. This value arises from the fact that many living resources reproduce and a unit left unused will bring more units in the future. The situation is analogous to capital investment; loss of living resources deprives the present users not only of their existing services, but also of more services in the future. But unless a renewable resource is

under optimal management this value is dissipated throughout the **present users**. Because it is generally believed that optimal management seldom exists, **there is little** ground to collect the user cost from the polluters.

There are limits to the surplus concept, and disregarding **these limits** will lead to its misuse and misunderstanding. In many ways, these limits serve an important role of keeping economic theory within the boundaries of science and of **objectivity**. One serious limit is the surplus concept's silence on the issue of income distribution. Once the surplus concept determines the compensation to the users of the damaged resource, it pays little attention to the distribution of that compensation. It also ignores those impacts of the damages that merely redistribute the expenditures of the users regionally. A similar limitation comes from the implicit assumption as to the primacy of the present consumers. The valuation of the resource under the surplus concept only recognizes the preference patterns of the present users of the resources and tends to ignore the preferences of future generations unless explicitly considered by the present resource users. This assumption, of course, becomes more crucial if a resource is irreversibly damaged. How much should society be compensated for the destruction of endangered species? No one other than an omniscient resource manager can predict future generations' preferences and use patterns.

Meanwhile, economic theory is beginning to expand the horizon of valuing open-access resources beyond the typical user, with the recognition of concepts such as option demand and existence value. Yet ultimately because economic theory attempts to preserve objectivity and avoid philosophical undertones, it can address only efficiency issues given the existing distribution of wealth and preference pattern. In economic theory then, assessing compensation according to the social value attached to the damaged resource is an efficiency issue.

Valuation Methods

The valuation methods discussed in this report were divided into private uses and public uses. The methods applicable to private uses are essentially changes in property value and lost business opportunity. When the resource service flow is reduced, the property owner, like a commercial interest using the service of the resource as input, suffers a loss. Everything else being equal, the magnitude of the loss can be calculated conceptually by taking the difference between the pre-spill value and post-spill value of

the property. Ideally, sales values just before and after the spill are used for this comparison. Since such information is rarely available, one has to resort either to comparing sales prices of similar properties or using assessed values. Property value study involves a more rigorous statistical analysis of housing prices and attempts to isolate the value of a specific characteristic of the house, such as a view of a shoreline. No matter what technique is used, all of these methods require the assumption that the land market must be competitive enough to allow property values to be affected by a deterioration of the components related to open-access resources (e.g., loss of a clean beach).

When a business operation is adversely affected by damaged natural resources, the lost profit of the firm(s) can be a good approximation of the economic rent forgone. Empirically, though, the quantification of the loss can be difficult unless the business is healthy and stable, and keeps good records of its profits. Methods for valuing losses to private interests are generally well accepted in the courts because the estimates are derived mostly from market transactions.

In public resource uses, property value analysis may offer a convenient and quick way of estimating values where the resources are similar to the ones embedded in private properties. For this approach to provide an appropriate estimate, one has to assume that a resource manager has allocated the resource between the private and public sector in a socially optimal manner. Only then will private sector prices be identical to public sector values.

Valuing natural resource damages in terms of replacement cost has been the most extensively used method, and various statutes enacted to protect the public from oil and hazardous material spills mandate its use. The concept is intuitively attractive because not only is the victim assured to be compensated to the pre-damage position (assuming perfect restoration), but also the method is easy to apply whenever the damaged resource can be replenished or reconstructed. Theoretically, though, the replacement method is difficult to defend, owing to its disregard for the demand side of resource values. Because the replacement cost is often higher than the public's willingness to pay for the damaged resource, the method may contain an upward bias. In such a case, the public would have been better off with a compensation less than the replacement cost but equivalent to its willingness to pay for the damaged resource.

Energy analysis was developed by ecologists who believe the traditional economic approach vastly understates the social value of an ecosystem such as wetlands. Tied to the necessity of valuing only services that can be related to users, economists have

generally stayed away from valuing the comprehensive functions of an ecosystem. As an alternative, energy analysis is procedurally simple and comprehensive—the energy content of an ecosystem is counted and multiplied by the contribution per unit of energy to GNP. The assumption underlying the method is that energy is the ultimate input to all economic activities and the value of a good is the value of the energy required for its production. Instead of depending on both the demand and supply of a good for the determination of its social value, energy analysis prescribes values on the basis of energy content. In the context of traditional economics, the method is valid only if the energy input of a good is directly proportional to the utility the users derive from the good. This linkage is not clearly established. Without this linkage the energy analysis, in effect, imposes an energy oriented value system upon the public. To the extent that one agrees with this philosophical position, the method is valid. Meanwhile the method still suffers from its lack of acceptability in traditional economics.

The travel cost method, developed in the early 1960's, stands as a well-accepted tool for valuing outdoor activities. It is based on actual expenditures and distance traveled by the users of the resource. Since its conception, the method has undergone various improvements to accommodate more and more factors influencing a user's demand for outdoor activities. In terms of data requirements the method does require more information than the ones discussed above, but less than the contingent valuation and the hedonic price approaches. Ideally, the information should consist of visitor records showing the distances traveled. However, because its focus is site oriented, it may be ill-equipped to deal with damages that are not localized. Among the recent applications of the travel cost method is the damage assessment of the Amoco Cadiz oil spill off the coast of France (U.S. Department of Commerce, 1983). Since the travel cost technique is well-developed and accepted by most of the economists, it will probably play an increasing role in the area of natural resource valuation.

The contingent valuation approach depends mainly on answers from resource users about their willingness to pay for the resource services. The method has been used by economists to value a wide range of environmental resources, from clean air to wildlife. The potential of the method is vast since it is not constrained by data on actual transactions. As long as a respondent can simulate his or her decision making in a hypothetical situation, willingness to pay can be directly estimated. It is by far the most versatile tool for valuing non-market goods such as open-access resources, especially for probing their option and existence values. Contingent valuation methods have undergone various refinements to ensure that the respondents equally understand the hypothetical

situation (e.g., an oil spill in wetlands) and its implications (e.g., the long term effects of an oil spill).

Critics of the approach generally point to the various biases that are thought inherent in the method, such as the strategic behavior of the respondents and the lack of incentive for the respondents to work on a "good" decision. Some of these biases have been either disproved or eliminated by further improvements. However, several observations on the weaknesses of the method still stand. First, most of the improvements are acquired at the cost of making the respondent's decisions more complicated. As more effort is required for the answer, the response is less certain. Second, the difference in the existing empirical results between willingness to pay and willingness to sell is so large that the gap implies the possibility of strong bias. Finally, there is the question of whether one's attitude (which drives the respondent's answer) is ever identical to one's behavior (the actual transaction). As these problems are resolved by researchers, the contingent valuation method will take a stronger role in damage assessment.

The hedonic price approach is still in the experimental stage and is in many ways the most complex method. Its usefulness, however, has been clearly demonstrated by its application in the property value area. Because its key concept is that one buys a good ultimately to produce and consume the characteristics of the good, the method is a powerful tool to extract implied component values of a package which has an explicit price. For example, the implicit price of a bedroom is embedded in the price of the house; the hedonic price approach allows one to identify the price of the bedroom. The approach is especially useful in valuing services of open-access resources because the expenditures on outdoor activities are usually observed only on an aggregate level (cost per trip) whereas the resources involved are components of the activities (boating, hunting, and fishing). Finally, being based on actual transaction, it offers an important alternative to the contingent valuation approach.

The hedonic price approach is unable to identify the true demand function from the observed expenditure. Although various attempts have been made to overcome this problem, no consensus exists among economists that any alternative can actually lead to the calculation of willingness to pay. Given this uncertainty, the application of the hedonic price approach beyond the existing property value studies is likely to be limited until the estimation problems are more carefully worked out.

Legal Framework

In the past, the assessment of damages from oil and hazardous material spills has been conducted within a patchwork of federal and state statutes and regulations and common law. The valuation methods used were essentially ad hoc, including lost profit, replacement cost, property value change, and surveys. These values were also used in different assessment forms, such as value tables, guidelines, penalties, and testimonies. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 can stabilize this situation through its framework for damage assessment. However, given the absence of consensus on the use of assessment methods, the assessment regulations to be promulgated under CERCLA are likely to be controversial and subject to challenge in court.

The majority of valuation methods have not been subjected to judicial or administrative proceedings. Although this report has examined these methods in terms of their validity, applicability, and acceptability, one can only speculate on how well they will perform in the court. Nevertheless, a few observations can be made on the probable relationships between the emerging legal framework and the economic methods.

- o To begin to understand the application in court of the damage valuation methods discussed here one should clearly distinguish the use of the methods for damage assessment from their use for resource management. The distinction is warranted because these methods were developed mostly for valuating the resources for allocation purposes. While the methodology is the same for both cases, the focus of a manager of a multiple-use resource is likely to be different from the focus of a judge or jury that struggles with deciding whether to award compensation to a victim and how much an award should be. The manager's task is regulatory whereas the judge's task is compensational. The implication is that for different purposes the methods may be judged by different criteria.
- o Since the valuation methods which courts have most often encountered are the ones using market-oriented values (e.g.,

changes in property value) it is likely that judges and juries will continue to favor values estimated from market transactions. This could handicap the use of contingent valuation methods relative to travel cost and hedonic price approaches, especially in post-spill analysis where the respondents may have strong incentives to inflate their willingness to pay or sell (strategic behavior). Of course this leaning may be reduced as the contingent valuation method becomes more widely applied and accepted.

- o Courts tend to focus on the point of damage and are more likely to understand valuations which are resource oriented rather than user or service oriented. For the same reason, courts are likely to prefer aggregation of the losses that are conducted along the resource level (counting fish killed) rather than on the users' level (counting fishermen). As much as an economist would favor the latter, unless the users can be unambiguously identified, unit values for damaged resources are the form the courts will most probably accept. To the extent that this is the case, it will be best to focus damage valuation on the resource level for consumptive activities (duck hunting and sportfishing) and resort to the user level only when dealing with nonconsumptive activities.

- o Clarity of the assessment mechanism and its underlying assumptions will greatly improve the acceptability of any method in administrative and judicial proceedings. In fact, this could be a reason why courts have accepted estimates based on replacement cost and changes in property value. Although it is inevitable that the valuation method will become more complex since the liability of the polluters now covers open-access goods, methods that can be clearly presented stand a better chance of being accepted. This may mean that a potentially powerful method such as the hedonic price approach should wait until it is more fully developed.

- o Since there are uncertainties surrounding any damage valuation, estimates should be presented in such a way as to reflect the likely range of value. This will allow the administrative body or court to have some flexibility in expressing its degree of confidence in an estimate rather than accepting or rejecting an estimate. The concepts of confidence range and best estimates are well developed in the field of quantitative economics.
- o Because CERCLA does not preempt state imposed liability for hazardous substance releases, many pollution incidents are likely to lead to liability under both state and federal laws. Considerable confusion in the area of damage assessment can be avoided if federal officials would harmonize federal assessment practice and procedure with some exemplary state approaches.

Simplified Assessment

The concern for cost efficiency in assessing numerous small spills is explicit in CERCLA's call for the use of simplified procedures requiring minimal field investigation. The Act specifically recommends that procedures base the assessments on units of discharge or units of affected area. In requiring the use of simplified assessments, the Act also provides those techniques with the force of a rebuttable presumption.

However, the use of the simplified assessment may in the future face challenges from polluters on the basis of fairness. A polluter could argue that his Fifth Amendment due process rights are violated by a damage assessment system that requires little or no field observation of the release site. In this regard, the existing valuation tables and guidelines used by several states and upheld by courts in assessing damages to natural resources can serve as models to the required simplified assessment protocol.

The fish tables used by Florida and Virginia offer an easy and quick approach and appear to have found legal acceptance at least at the state level. Once the extent of

damage is assessed, the unit values are simply read off the table. Compensation is the sum of the unit values multiplied by the unit cost. The weakness from an economic point of view of the existing tables is twofold. First, the table values are generally replacement costs and suffer theoretically. Second, they tend to be limited in scope and rarely account for recreational or other values. Both limits might be solved, at least in the short-run, by surveying the full range of existing credible natural resource valuation studies, using these estimates, and where appropriate, constructing a larger table. To the extent that regional differences in the values are significant, individual tables could be designed to reflect these differences. Gaps and deficiencies in the available data could be filled through additional research or on a replacement cost basis until further information is available (perhaps through the large spill assessments). One drawback of the use of natural resource valuation tables is the propensity of double counting and overlap between the values. This would be particularly significant in cases where multiple use resources are involved.

A more comprehensive value table scheme is used in California. This approach includes replacement cost, use values, and existence values. It employs six methods for assessing the values: replacement cost, commercial value, resources loss value, ecological damage, costs to recreational fishermen, and liquidated damages. In a general sense, California's use of some of the values estimated in past economic research attempts to come closer to the economic concept of willingness to pay. However, because of the complexity of value types and the number of factors to be considered, the calculations tend to lack overall coherence. For example, there appears to be double counting if the single component estimates are simply summed, as in the case of adding the value of duck for both hunting and bird watching.

The scheme applied in Alaska is an example of a unit of discharge approach and is closest to the simple assessment method envisioned in CERCLA for addressing minor spills. For example, both systems are concerned with measuring long- and short-term effects of pollution and both are concerned with indirect losses and the ability of the ecosystem to recover. The scheme places dollar fines according to units of discharged materials and type of environmental receptors. An important virtue here is that the approach may allow nonconsumptive uses and ecological values to be factored into the categorization of environments as sensitive, critical, or productive, resulting in damage assessment that is more systematic than is the case-by-case approach. The fee schedule also incorporates the characteristics of the discharged substances such as toxicity, degradability, and dispersibility.

Again, the difficult part of the Alaska scheme is calculating the fines that adequately represent the value of the damaged resources. Ideally, this might require inventorying samples of different potential receiving environments (using perhaps the classification systems developed by the U.S. Department of the Interior's National Wetlands Inventory as suggested by CERCLA) for resource services; valuing the service flows using a combination of economic methods and existing data; aggregating these values to arrive at dollar value of resource flow per acre; and translating this value into a barrel charge. It is this last step that is most complicated and perplexing. One possible approach is to estimate through field studies the quantity of a given oil type or hazardous material that, if introduced into an acre of a specific receiving environment, would reduce the resource flow from that acre to zero. This quantity divided into the economic estimate of the resource value per acre would be the charge per unit of the discharge that would be likely to affect an acre of resource. This description is an obvious over-simplification but does serve to highlight the difficulty in relating the barrel charge to the appropriate economic value. Even in the approach hypothesized here, the charge is the average damage cost (not marginal) and is not truly appropriate unless the exact quantity of substance it takes to destroy the specific environment is actually released—an improbable occurrence.

Finally, the role of economic valuation aside, a few general observations concerning existing simplified schemes are worth noting. First, the programs that enjoy the status of rebuttable presumption seem to have been effective in shifting the burden of proof to the polluters. The art of assessing damages being complex and uncertain, the ability of the defendant to overturn a state assessment seems to have been weakened. Second, the use of set schemes such as value tables appears to produce a framework which renders a status to the values that they otherwise would not possess. Although the values themselves are generally estimated in an ad hoc manner (for instance, by the replacement cost method, or by arbitrary designation) they are rarely challenged individually on the ground of theoretical validity and accuracy. Rather, the entire tables are questioned. Third, the use of simplified schemes has the appearance of fairness in that all polluters will pay the same compensation per unit of damage. Such perceptions may have reduced the propensity of the polluters to challenge the states' assessments. However, a polluter could argue that his Fifth Amendment due process rights are violated by a damage assessment system that requires little or no field observation of the release site. Fourth, it may be that the state schemes have been successful simply because no polluters have made substantial efforts to rebut the assessments. Such efforts may occur when the inaccuracy of the estimates causes significant losses to the

polluters. Finally, it is important to note the distinction between damage and penalty. CERCLA's damage approach calls for the charges to correspond to the scale of the harm while Alaska's penalty approach does not. The implication is that if CERCLA adopts the Alaskan scheme it will be more vulnerable to legal challenges.

Large Spill Assessment

As a spill becomes more damaging to a resource, the concerns for the accuracy of the assessment method will increase for the simple reason that bias in the estimates will be magnified by the scale. An inappropriate set value in a value table may cause significant underestimation or overestimation in major spills where either the discharge or the area affected is large. Further, value tables often do not include indirect factors such as the ones specified by CERCLA under requirements for large spill assessment procedure. These include short- and long-term loss, direct and indirect injury, use value, and the ability of the ecosystem to recover. Consequently, there will be a point beyond which applying the simplified assessment schemes (i.e., value table or fixed fees) will lead to misallocation of resources caused by "bad" estimates. Although one cannot quantitatively determine the cutoff line, a standard assessment protocol should be developed either to supplement or to replace the simplified assessment scheme when necessary. This calls for a spill-specific approach in which field investigation and sampling of users are necessary.

A few suggestions can be made for the development of a standardized assessment protocol for major spills. First, given the diversity of the types of valuation methods, an in-depth effort must be undertaken to provide a clear documentation of the advantages and disadvantages of these methods and a definition of the circumstances under which they perform best. Part of this effort should be to develop a decision-making guideline for choosing the appropriate method(s). Undoubtedly such a standardization effort will elicit numerous disagreements among proponents and critics of the methods. These can be minimized by careful specification of the trade-offs among the methods and the characteristics of damage which influence the choice. The promise to keep the guideline flexible so that the latest research results can be easily be included will also reduce the number of controversies.

Second, the same diversity may suggest that several valuation methods should be used concurrently. Parallel assessment offers the benefits of having a range of estimates, and of continuously comparing and monitoring the relative performances of the methods. However, the alternative methods should use the same sample if not the data, so that the differences in estimates can be attributed to the the methods. For the same reason, if the methods focus on different levels (fishermen vs. fish), the aggregation process should be explicit.

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Appendix

DAMAGE ASSESSMENTS IN JUDICIAL PROCEEDINGS

To form a more complete picture of the legal environment in which natural resource damages are valued, it is useful to look at some actual court cases involving such damages. This appendix presents sample cases in which damages were assessed by the court, or in which settlements were reached after the plaintiffs had developed a damage assessment methodology and a monetary estimate of natural resource damages. Although only briefly described, each case is analyzed to determine what valuation methodologies were used and how they were received by the courts.

This review includes damages to both public and private goods to show the gradual increases that occur in terms of the difficulty of demonstrating and calculating damages. In addition, the cases involve a mix of federal, state, and common law. The cases are grouped according to whether the damage is to real and personal property, commercial species, non-commercial species, ecology and habitat, or aesthetic and recreational use. These categories are not necessarily exclusive, but they serve to delineate the various services and functions provided by natural resources.

Real and Personal Property

Real and personal property, consisting of "everything that is the subject of ownership" including "land, and generally whatever is erected or growing upon or affixed to land,"¹ presents, of course, the easiest case for assessing damages to natural resources. The economic concept of private goods is directly applied, and generally values can readily be determined by price. Some natural resources, such as land, trees, and oyster beds, can be traded and owned as real and personal property. According to McCormick's Handbook on the Law of Damages, "in assessing damages, market value is the usual standard."² The courts have, whenever possible, relied on this standard for awarding damages to real and personal property.

In earlier cases the court would award a lump sum, the goal of which was to reflect generally the market value without getting involved in a specific assessment technique. In Parsons v. City of Sioux Falls,³ pollution of a river caused a downstream riparian owner discomfort and annoyance and curtailed his use and enjoyment of the

river. The opinion of the court was that when the damages were not susceptible to exact measurement, it was for the court to determine their extent.

A similar approach was taken in Doucet v. Texas Company⁴, where it was first established that lessees of state oyster beds have the right to sue for damages. The court found that "the plaintiff had a valuable property right in these oyster beds, for the loss of which he can recover against the one by whose fault the loss was incurred."⁵ Although it was specified that the damages that were awarded were the value of oysters allegedly killed, there seems to have been little attempt to perform a careful calculation of this value.

More recent cases have tended to be more specific in assessing the market value of damages. Two cases demonstrate possible differences in methods used for measuring damages for the loss of oysters. In Carr v. United States,⁶ compensation for damages to sixteen acres of oyster beds was determined by the value of the crop at the time and place of destruction, but was limited to the net loss sustained by the claimant. This figure was derived by multiplying the estimated forgone yield in bushels by the average price per bushel for that year and subtracting the cost of tonging and marketing. In Skansi v. Humble Oil & Refining Company⁷ (an oil company's drilling operations had damaged oysters through oil contamination) the measure of damages was not limited to the expected net profits. The court held that the plaintiff had lost not only his expected net profit, but also all of the expense of planting and cultivation that goes to make up sales price. Thus, the plaintiff was allowed to recover his sales price. He ordinarily sold oysters for \$3.50 (in 1965 dollars) per sack, but since his pleadings limited him to \$3 per sack, he was awarded only that amount. The method of assessing damages can have a great impact on the amount of compensation awarded. Although in both cases the market value of oysters was established as \$3/sack, in Carr the plaintiff was ultimately awarded an average of \$2.04/bushel (in 1955 dollars) and in Skansi the plaintiff was awarded an average of \$3/bushel (in 1965 dollars). Skansi was also awarded the cost of replanting that was undertaken to save part of his oyster stock.

Other courts have supported the market value plus labor approach of the Skansi case. In Noerr v. Lewiston Smelting & Rfg.,⁸ the discharge of poisonous and corrosive gases, smoke, and lead particulates from a brass smelter caused substantial damage and death to livestock and vegetation on a neighboring farm. The farmer was awarded \$52,623.30 (in 1973 dollars) in damages, an amount determined by the market value of cattle that died, the diminution in value of cattle which had to be sold, the cost of transporting those to be sold, the market value of the silage, grass, and fodder that had

to be destroyed, the cost of removing such vegetation, the cost of veterinary services above the average of \$10 per year per cow, lost use of leased farms, loss of reduced colt production, and loss by reason of reduced milk production. In addition, the plaintiffs were awarded \$2,000 for annoyance, inconvenience, and discomfort from odors, gases, lead, and smoke. These pollutants discolored painted surfaces, soiled clothes on wash lines, and caused human health problems.

Another method of assessing market value used by courts is the diminution in value of lands. This method was used in the case of Storley v. Armour & Co.⁹ This case was an action by 32 owners and residents of farms bordering a river downstream from the Armour & Co. meat packing plant who suffered damages when the river was polluted by the disposal of the plant's waste directly into the river. The court supported a diminution in value theory of assessment, claiming that it would incorporate other damages sustained by plaintiffs.

It would seem that the difference between the fair rental or use value of a farm upon the river with the defendant making only such use of the river as it might lawfully make and its fair rental value in the condition resulting from the defendant's unlawful use during the period in question, should constitute a fair and proper measure of the general damages suffered by the owners or occupants of all of these farms. Such a measure would naturally embrace all such items of damages as persons negotiating a lease might reasonably take into consideration in arriving at a fair rental value for any particular farm, which would necessarily include interference with comfortable living due to odors, inability to use the river for a water supply or for swimming, fishing, boating or for ice, increase in the number of flies, and everything else which would obviously affect the value of a farm for the highest and best use for which it would normally be available."¹⁰

In terms of damage to anticipated profits from decreased milk production, the court held that where the evidence shows the extent of the losses as a matter of just and reasonable inference, they may be recovered.

A more recent case challenged the market-value method of damage assessment in an attempt to recover the cost of restoring damaged property to the previous undamaged natural condition. In Ewell v. Petro Processors of Louisiana, Inc.,¹¹ the plaintiff, Dave Ewell, had a one-eighth interest in a 550-acre swamp which became polluted by chlorinated hydrocarbons when Petro Processors, owners of adjacent property, disposed of industrial waste in an improperly constructed pit adjacent to the plaintiff's property. Although Ewell sought \$170 million (in 1968 dollars) as the amount needed to remove and replace the polluted soil, the trial judge held that not more than the value of the

damaged property could be recovered, and so instructed the jury. However, the judge admitted that no hard and fast rules exist in Louisiana as to the measure of damages in such cases.

In some cases involving immovable property our courts have used the cost of restoration as the measure.... In other cases, the difference between the value of the property before and after the damage has been the measure.... In one case a combination of the two methods was used.¹²

As a consequence, despite the court's refusal to award damages in excess of the value of the property in this case, the decision did not have the purpose of setting precedent. Rather, the judge stated that the proper measure of damages in regard to a chemical spill which pollutes property should be decided on a case-by-case basis. In determining damages for each case, consideration should be given to such factors as "extent of damage; use to which property may be put; extent of economic loss, both as to value and income, and cost of and practicability of restoration."¹³

The market value of the property was set at \$375 (in 1968 dollars) per acre by a local realtor, the only expert witness who testified to the point. This amount was determined by a survey of the sale value of comparable property. However, the realtor did note that demand for swamp land was not high.¹⁴ Although timber had been damaged, counsel rejected the idea of including the value of the timber in the claim, believing that it would be too difficult for the court to accept.

Another important factor is the concern of the court for certainty in assessing damages. In Carr, the judge stated that a "claim for the value of the crop at the time and place of destruction if not entirely speculative, was recoverable"¹⁵. Similarly, compensation for damages to the oyster ground was found not to be recoverable on the basis that "the proof thereon was largely speculative."¹⁶ Although the judge in the Carr case was very strict about this, the court in Skansi dismissed arguments by the defense that the plaintiff failed to show sufficient damage to sustain recovery and asserted that the plaintiff "proved it by the only method available to him."¹⁷

Commercial Species

Commercial species, particularly those of fish, are unlike real and personal property in that the producers do not own part of the factors of production when the resource in question is at large. Commercial fisherman, for example, invest in boats and

gear, but do not contribute toward the breeding and raising of the fish. Since capture of free swimming commercial fish cannot be excluded from some persons by another, the rights to fish are not traded on the market.

Commercial fisherman are the most common plaintiffs in cases where damages are sought for the value of commercial species. Their eligibility for recovery for damages to fish and shellfish has long been supported. The judge in Burgess v. Tamano¹⁸ stated:

Indeed, in substantially all of those cases in which commercial fisherman using public waters have sought damages for the pollution or other tortious invasion of those waters, they have been permitted to recover.¹⁹

Nonetheless, difficulties in recovering adequate compensation do occur for commercial fishermen. Most of these stem from the problems of supporting an assessment of damages to the satisfaction of the court.

Union Oil Company v. Oppen²⁰ was one of many cases arising from the Santa Barbara oil spill of 1969. The plaintiffs were commercial fishermen seeking to recover damages for aquatic life that had been damaged when, on January 28, 1969, a large volume of crude oil escaped from the ocean floor underneath an oil drilling platform maintained by Union Oil Company of California. The oil floated to the surface of the ocean and permeated the waters of the Santa Barbara Channel and Harbor.

The court decided that commercial fishermen could recover damages. However, in spite of its willingness to compensate, the court appeared to place a strict burden of proof for establishing damages on the plaintiffs:

...it must be shown that the oil spill did in fact diminish aquatic life, and that this diminution reduced the profits the plaintiffs would have realized from their commercial fishing in the absence of the spill. This reduction of profits must be established with certainty and must not be remote, speculative or conjectural."²¹

Although this case ultimately was settled out of court, its preparation by the counsel for the plaintiff offers insight into difficulties encountered in assessing damages to commercial fish. The plaintiff sought to establish a base figure of the average yield of commercial fish from the Santa Barbara Channel by using catch figures from the California Department of Fish and Game for the years before the spill. These would be compared with the catch figures for the years after the spill. The fundamental difficulty with this theoretically simple plan is that catch figures change radically from year to year. In this instance, the use of catch figures to establish damages was further

discredited by flooding that occurred in the same year causing silt build-up and possibly contributing to the diminution in the fish catch.

Another problem encountered was that the commercial fishermen in the Santa Barbara area tended to keep very sparse records of yearly catches. Counsel for the plaintiff had planned that the fishermen would testify that, while they previously caught fish in the Santa Barbara Channel, they did not do so at present. The court considered this sort of statement as being "remote, speculative or conjectural."

Statutory relief for damages to commercial species is allowed occasionally. For example, in National Sea Clammers Association v. City of New York, the court of appeals reversed a district court decision that had dismissed the claims of commercial fishermen seeking damages and injunctive relief for harm to fish under the Federal Water Pollution Control Act and the Marine Protection, Research and Sanctuaries Act. The court of appeals held that an implied cause of action under these statutes could be maintained by injured fishermen.²² However, the Supreme Court reversed on this issue, holding that these statutes, rather than implying a private cause of action, preempted the underlying legal basis for such claims.²³

Non-Commercial Species

Non-commercial species for which no direct prices exist have offered courts the greatest challenge in their attempt to provide adequate compensation for damages to natural resources. As recently as 1980, courts have been perplexed about where to turn for assessment methodologies. The court of appeals in Commonwealth of Puerto Rico v. SS Zoe Colocotroni²⁴ commented on the absence of precedent in rejecting the assessment methodology presented by the plaintiff.

To say that the law on this question (of assessment methodology) is unsettled is vastly to understate the situation. The parties in this lawsuit, and we ourselves, have ventured far into uncharted waters.²⁵

Methods used to value damage to non-commercial species have varied widely. Some jurisdictions have established values for fish by statute. Florida, for example, uses fish value tables that were created by statute²⁶ to assign dollar figures to individual species of fish. Although all values attempt to reflect an amount greater than the market value, the assessment methodologies vary from species to species. An example

of assessment methodology is that which is employed for so-called trophy fish. These are fish which are caught for sport in Florida (e.g., bluefish, tarpon, marlin). The values placed on these are based on willingness-to-pay theories and incorporate the prices people pay to go sportfishing. The average price for many of these trophy fish is \$20.00.

Florida's fish value tables have been upheld in court. In State Department of Pollution Control v. International Paper Company,²⁷ the Florida Supreme Court found that the tables were "proper and relevant to the question of damages and may be introduced as evidence and rebutted, and trier of fact is required to accept such values as presumed fact unless credible evidence to contrary is introduced." A total of \$14,113.50 (in 1976 dollars) was awarded to the state and included investigative costs and expenses as well as \$12,009.20 for the value of the fish as determined by the tables.

Fish value tables have the benefit of being powerful as well as expedient. Unlike many cases where the burden of proof is on the plaintiff to show that the assessment of damages is not remote, speculative, or conjectural, the fish value tables shift the burden of proof to the defendant. In International Paper the defendant challenged the constitutionality of the fish value tables used by the state. The trial court had agreed, stating that the tables denied the defendant due process of law "because of the conclusive nature of the tables." The Florida Supreme Court reversed; it denied the conclusive nature of the tables, stating that they were admissible and could be introduced as evidence and rebutted like any other evidence.

These fish value tables have been used primarily by the Department of Pollution Control to settle with polluters outside of court. In the case In Re: Florida Power and Light Company,²⁸ a consent order was established between the two parties whereby Florida Power and Light (FPL) agreed to pay \$30,000 (in 1980 dollars) into the Department of Environmental Regulation's Pollution Recovery Fund. This sum represents the value of fish, as given in the fish value tables, "which allegedly perished as a consequence of the breach of FPL's reservoir." Settlements of this kind have the advantage of enabling the state to recover adequate compensation without investing considerable time and money in lengthy court cases. It is also advantageous to the alleged polluter in that it helps the defendant avoid possible liability to other possible parties; the consent order pertaining to Florida Power and Light specifically states that "nothing connected herewith shall be construed as an admission of liability on the part of the party released."

A recent case, In the Matter of the Complaint of Steuart Transportation Company,²⁹ found that the Commonwealth of Virginia and the United States both could

recover for the value of migratory waterfowl killed by an oil spill. Had the case gone to court, the plaintiffs planned to present expert testimony concerning the value of waterfowl. The methodology planned by plaintiff's expert witnesses would have assigned monetary values on the basis of willingness to pay.

Although we may not speak directly of a market price, we may speak directly of the value of the birds in terms of use, both consumptive —harvesting by hunters—and non-consumptive such as through viewing, photography and knowing that the fowl are unharmed by the actions of man in his transport of petroleum.³⁰

Techniques were developed for valuing consumptive and non-consumptive uses of waterfowl. To establish a consumptive value, 4,900 waterfowl hunters from seven states were asked to respond to questionnaires about their income, years of experience in waterfowl hunting, amount of money spent on hunting, and number of waterfowl killed and retrieved. A non-consumptive value was derived from information about the number of birdwatchers in the United States, the number of visitors to a National Wildlife Refuge located near the oil spill, and estimated variations in monthly visitation due to variations in waterfowl population. Application of these valuation techniques to the Chesapeake Bay spill assigned \$15 for non-consumptive uses of a non-game bird and an additional \$15 for its hunting value, totaling \$30 for the bird (all in 1980 dollars). Other witnesses, whose testimonies would have been used to put this economic theory in context, included people whose various interests expressed the value of birds in economic terms. For example, a bird rehabilitator would have testified on how much money is spent to clean an oiled bird and aviculturists on what zoos pay for various birds.

As in cases using fish value tables, one of the biggest problems encountered in preparing the Steuart case was counting the ducks. Oiled birds will head for cover or go out to sea and also tend to avoid humans. For these reasons, wildlife experts from the National Audubon Society and the U.S. Fish and Wildlife Service estimated that birds killed by the spill would be three times the actual count.

For every bird counted, two birds would (1) die or not be washed ashore, (2) be eaten by predators before they could be counted, or (3) wash or crawl into inaccessible areas.³¹

Although the final estimated value of the waterfowl was \$572,038, the case was settled out of court for \$115,000 (in 1981 dollars).³² This amount averages to between \$4 and \$10 per bird, depending on the accepted number of birds killed.

Replacement cost methods frequently have been used by courts in evaluating damage to non-commercial species. For example, in State of Tennessee ex rel. Goodrich v. Riggan,³³ the State of Tennessee was awarded \$1,119 (in 1974 dollars) as the value of the deer killed as a result of negligent application of an herbicide. This figure was based on the replacement cost of the deer in question. The state appealed this decision claiming that, since buying or selling deer in Tennessee was illegal, the normal measure of damages, market value, was inapplicable. Rather, the state sought to recover damages which would fully compensate the "aesthetic, ecological, and recreational worth" of the deer.

The state presented a number of expert witnesses who assessed damages based on willingness to pay theories. One of these theories attempted to value the deer by dividing dollars spent on hunting deer in Tennessee by the number of deer in the area. Another method involved expert witness conservationists who gave their personal opinion as to the value of the deer. The state's ultimate assessment of damages was \$2,500 (in 1973 dollars) per deer killed.³⁴ The defendant presented a number of methodologies for valuing replacement costs. These included the cost of catching and transporting a deer, and the cost of shooting a deer at a Texas operation which allows hunters to shoot a doe for \$25-\$50 and a buck for \$75-\$100.

The court rejected the state's assessments and instructed the jury to consider

the average cost per deer, cost affected by the survival ratio, restocking cost, the fact that deer reproduce themselves, transportation costs for the deer and economic benefits, including that from deer hunters; to reach an amount which would fairly compensate the State of Tennessee for its alleged loss of deer and unborn fawns....³⁵

The jury based its assessment of damages on testimony which asserted that it would cost \$100 (in 1973 dollars) to catch and move a deer from an area of abundance of deer to the place the deer were killed.

The replacement cost method was used to award damages in Commonwealth of Puerto Rico v. SS Zoe Colocotroni. The SS Zoe Colocotroni, a Panamanian oil tanker, was carrying 187,670 barrels of crude oil from Venezuela to Puerto Rico when it ran aground on a reef 3.5 miles south of Puerto Rico. After 10 minutes of trying to free the vessel, the captain ordered the dumping of more than 5,000 tons of crude oil to lighten the ship. By the time the vessel refloated, 1.5 million gallons of crude oil had been dumped in the sea, forming an oil slick 4 miles long and one-tenth mile wide. This oil

came ashore in Bahia Sucia on Puerto Rico and penetrated beaches and the mangrove forests, killing over 92 million organisms.

The United States and the Commonwealth of Puerto Rico brought suit to recover for damages to the bay and its related resources. They conducted surveys of the area and determined that there was a decline of approximately 4,605,486 organisms per acre (unquestionably the majority of these were non-commercial). Since 20 acres were proven to be affected, it was estimated that 92,109,720 organisms had been killed. The plaintiffs presented a theory of assessing damages based on replacement cost using prices from biological supply laboratories. The district court accepted this, stating:

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 \$0.06 per animal with many species selling from \$1.00 to \$4.50 per individual. Accepting the lowest replacement cost, and attaching damage only to the lost marine animals in the West Mangrove area, we find damages caused by defendants to amount to \$5,526,583.20 [in 1978 dollars].³⁶

The defendants had many objections to this assessment methodology, challenging both the approach and the data used to assess damages.

The appellate court agreed with the district court that damage assessment should be performed on the basis of restorative and rehabilitative costs.

We think the appropriate primary standard for determining damages in a case such as this is the cost reasonably to be incurred by the sovereign or its designated agency to restore or rehabilitate the environment in the affected area to its pre-existing condition, or as close thereto as is feasible without grossly disproportionate expenditures.³⁷

However, the court disallowed the estimated value of damage, in part because the plaintiffs "did not represent that they proposed to purchase 92 million invertebrate animals for actual introduction into the sediments."³⁸ Moreover, the court held that plans to restore the environment should give attention to such factors as "technical feasibility, harmful side effects, compatibility with or duplication of such regeneration as is naturally to be expected, and the extent to which efforts beyond a certain point would become either redundant or disproportionately expensive."³⁹ For these reasons the court held that it was error to award \$5,526,583.20 for the replacement value of the destroyed organisms, and the case was remanded to the district court.

Ecological and Habitat Destruction

The difficulty of assessing damages to ecosystems and habitats stems from their provision of services and functions which cannot be owned exclusively. As a result, assessments for ecological and habitat destruction has rarely been addressed by the courts. However, the right of states to recover for damages to their waters has been established in the case of State of California v. SS Bournemouth.⁴⁰ Although a number of suits have been brought by states against oil polluters, the majority have been settled out of court after preliminary decisions by judges that states do have a right to recover for the costs of replacing or restoring natural resources. Nevertheless, many of these settlements have involved only minimal or spurious assessments of damage.

In the case of Maine v. M.V. Tamano,⁴¹ the state assessed the damages at \$100 million (in 1973 dollars) in a claim filed while the oil tanker was still in the jurisdiction of the Maine court. After the initial complaint, the State of Maine surveyed thousands of miles of Maine coastal areas to assess the impact of the oil on clams. Its findings were compared with state records of annual clam harvests in each area. Although the clamdiggers recovered under a separate claim for loss of profits, the state sought compensation for the value of the clams before any value was added by the clamdiggers' labor. Factors taken into consideration in this assessment were the effects of the oil on future reproduction of the clams as well as the present value of the clams outside that added by the labor of the clamdiggers. The case was settled for \$1 million (in 1973 dollars).

In the case of Commonwealth of Puerto Rico v. SS Zoe Colocotroni (see discussion above), the question of proper assessment of damages to a mangrove lagoon was raised. The damages were to a flourishing natural environment which became seriously damaged by oil, "to the point where some of the underlying sediments were no longer capable of supporting anything but the most primitive forms of organic life, such as worms."⁴² The district court found the proper measure of damages to be the cost of restoring the site to its original condition. Restoration was to be performed by intensive planting of mangroves in the 23 acres that were most affected by the spill. The plaintiffs presented evidence that it would cost \$16,500 per acre to plant mangroves and an additional \$36,000 per year for a five-year monitoring and fertilizing program. The total cost for restoring the mangrove area was calculated at \$559,500 (in 1978 dollars).

On appeal, the defendants argued that damages should be measured as the diminution in value of the property and, therefore, in this case could not be assessed at more than \$5,000 (in 1980 dollars) per acre, which was the market value of comparable property in the vicinity of Bahia Sucia. The diminution-in-value methodology was rejected by the court of appeals:

A strict application of the diminution in value rule would deny the state any right to recover meaningful damages for harm to such areas, and would frustrate appropriate measures to restore or rehabilitate the environment.⁴³

However, defendants' objection to the district court's assessment was upheld. The appeals court stated that the restoration plan presented by the plaintiff was unreasonable:

In light of the district court's finding that there was no significant damage in East Mangrove, it is not clear why replanting of mangroves on that site was necessary at all. Furthermore, plaintiff's experts also testified that the mangrove trees in the West Mangrove were dead or dying because of the presence of oil in the sediments. Replanting new trees in this same oil-soaked environment seems pointless if no attempt is to be made to counteract the effects of the oil. As we are remanding the case in any event, we think this award should be vacated pending a redetermination of the extent of the damage in West Mangrove and a further submission by the plaintiffs integrating this proposal into a more reasonable plan, or set of alternative plans, for restoring the area.⁴⁴

One possible plan for the restoration suggested by the court of appeals was for alternative site restoration. Although this plan was originally rejected by the district court, the appellate court suggested that the plaintiffs might wish to reopen the question of alternative site restoration as a means of awarding damages.

Another case concerned with assessing damages to ecological systems (again, mangrove stands) is State of Florida v. Bruce.⁴⁵ Unlike Zoe Colocotroni, where the assessment was based on restoration costs, in Bruce the court assessed the value of mangrove trees which had been cut down. To demonstrate the value of these trees, the state presented the works of several experts who placed the value of an acre of mangrove trees between \$4,000 and \$100,000 (in 1977 dollars) per year. It then selected \$4,000 per acre per year and from this calculated the value of the damaged mangroves. The court accepted the state's contention that detrital value, the accumulated leaves, branches, and seeds which serve as an essential element in the estuarine food chain, should be the basis for calculating damages. Detrital value, it was argued, should be

derived from the size of the lost canopy cover, and this size could be found by aggregating the measure of the cut mangrove tree diameters. In this instance, 2000 square feet of canopy was lost. The value for the 2000 square feet which was assumed to be a \$4,000 per acre per year value was then multiplied by 15, the number of years required for a mangrove seedling to reach maturity. No effort was made to translate the \$4,000, which came from a 1977 article, into then-current dollars.

In addition to showing that the lost detrital production was the factor to be considered in calculating the value of the damages, the state also argued that mangroves served many other functions. However, compensation was not asked for the latter values. The uncompensated lost functions include water cleansing, pollution control, nutrient uptake and assimilation, shoreline stabilization flood prevention, water conservation, oxygen production, and sequestration of heavy metals and other toxic substances.

The state used the lowest estimate of the value of mangrove lagoons out of a desire that the court consider its request reasonable; it believed that if its request was not considered reasonable it might lose the case. In addition, since the damaged mangroves were located in already disturbed wetlands, the state felt uneasy attributing a high value to them. Nevertheless, some state officials now believe that the \$4,000 per acre per year estimate of the value of mangrove trees was probably too low.

Aesthetic and Recreational Use

Damages for loss of aesthetic and recreational use are often sought by private parties and by governments acting as trustees of public goods. In evaluating these losses, the courts have used methods which assess this type of damage both separately and as a component of other damages (i.e., loss of land, loss of commercial and non-commercial species). The most common response of the courts to loss of aesthetic or recreational use for private parties is illustrated in Parsons v. City of Sioux Falls⁴⁶ (see discussion on Real and Personal Property). The court held that when the "plaintiff's use and enjoyment of the river was substantially curtailed, and he and his family suffered discomfort and annoyance,"⁴⁷ adequate compensation was to be determined by the court.

From their very nature, such damages are not susceptible of exact measurement, nevertheless it was for the court to determine their extent.⁴⁸

The appellate court in Storley v. Armour & Co. (see discussion on Real and Personal Property) directly addressed the question of proper methodology for assessing loss of aesthetic and recreational use in a case brought by private owners. The district court had assessed damages on the theory that "the measure of damages where the riparian lands were leased was diminution of rental value, and where they were occupied the damages were actual damages proximately caused by the pollution."⁴⁹ In assessing damages to occupied farms, aesthetic and recreational uses were considered actual damages proximately caused by the pollution. Although loss of aesthetic use (interference with comfortable living) and loss of recreational use are valued separately, the methodology is fundamentally the same: lacking any actual loss of money, reasonable compensation for the loss of these privileges was for the court to decide. Thus, any objections that the compensation of \$150 for each year of interference with comfortable living and \$25 for each year for the deprivation of swimming, boating, and fishing privileges was not sufficient, were not supportable in court. However, the appellate court held that, for the farmer who was granted a rehearing, damages should be awarded as would fairly represent the diminution in the rental or use value of his farm. The reason stated for this change in assessment methodology was that the diminution in value measure would encompass all actual damages caused by pollution.

Compensation for loss of aesthetic use and recreational use often may be awarded in a disguised manner. The case of Ewell v. Petro Processors of Louisiana, Inc. (see discussion on Real and Personal Property) is an example of this. Here, the court decided that the plaintiff could not recover damages in excess of the value of the property. However, in addition to the diminished value of the property, the jury awarded the plaintiff \$5,000 (in 1968 dollars) for mental anguish. An attorney involved in the case as counsel for the plaintiff speculated that this sum was in part compensation for loss of recreational and aesthetic use of the property.⁵⁰

The case of Oppen v. Aetna Insurance Co.⁵¹ suggests that if the damages suffered by the plaintiffs are not different in kind from those suffered by the public generally, an individual may not recover damages for loss of recreation. In this case, owners of pleasure boats were denied compensation for loss of navigational rights due to an oil spill in the Santa Barbara Channel.

Plaintiffs in the case of State of Tennessee ex rel. Goodrich v. Riggan (see discussion on Non-Commercial Species) attempted to use willingness-to-pay theories to assess the loss of aesthetic, ecological, and recreational uses of deer negligently killed. However, the court held that this testimony was not valid because the deer were

replaceable and therefore all testimony that did not pertain to replacement cost was not allowed. The argument that deer were replaceable was forcefully supported by the fact that there was such an overabundance of deer in Central Tennessee that some would starve if not otherwise eliminated.⁵²

Footnotes—Appendix

- 1 Black's Law Dictionary 1382-83 (4th ed. 1951).
- 2 C. McCormick, Handbook on the Law of Damages 165, West Publ. Co. (1935).
- 3 272 N.W. 288 (D. S.D. 1937).
- 4 17 So.2d 340 (D.La. 1944).
- 5 Id. at 341.
- 6 136 F. Supp. 527 (D. Va. 1955).
- 7 176 So.2d 236 (La. Ct. App. 1965).
- 8 60 D. & C. 406 (1973).
- 9 107 F.2d 499 (8th Cir. 1939).
- 10 Id. at 504.
- 11 364 So.2d 604 (La. Ct. App. 1968).
- 12 Id. at 608.
- 13 Id. at 609.
- 14 Personal communication with C.J. Brown, May 22, 1981.
- 15 136 F. Supp. at 535.
- 16 136 F. Supp. at 536.
- 17 176 So.2d at 239.
- 18 370 F. Supp. 247 (D. Me. 1973).
- 19 Id. at 250.
- 20 501 F.2d 558 (9th Cir. 1974).
- 21 Id. at 570.
- 22 616 F.2d 1222, at 1232 (3d Cir. 1980), vacated and remanded, 453 U.S. 1 (1981).
- 23 453 U.S. at 11.
- 24 456 F. Supp. 1327 (D. P.R. 1978).
- 25 628 F.2d 652, at 678 (1st Cir. 1980).

- 26 Fla. Stat. Section 403.141(3) (1973).
- 27 329 So.2d 5 (1976).
- 28 Fla. DER Case No. OT-81-82.
- 29 495 F. Supp. 38 (E.D. Va. 1980).
- 30 G. Brown, Jr. and J. Hammack, *Economic Valuation of Waterfowl* (1980) (report prepared for litigation).
- 31 U.S. Comptroller General, Total Costs Resulting from Two Major Oil Spills, report to the Senate Subcomm. on Environment, Energy, and Natural Resources, App. III, n.d. (June 1, 1977).
- 32 \$115,000 Awarded in Oil Spill Suit, 3 Chesapeake Citizen Report, No.2 at n. 2 (March - April 1981).
- 33 Shelby Law. No. 3 (1974).
- 34 Assignments of Error and Brief of Appellant, at 19. See M. Bean, Law and Wildlife: An Emerging Body of Wildlife Law, 7 Environmental Law Reporter 50020 (1977).
- 35 Assignments of Error and Brief of Appellant, at 8.
- 36 456 F. Supp. at 1344.
- 37 628 F.2d at 675.
- 38 628 F.2d at 676.
- 39 Id. at 677.
- 40 307 F. Supp. 922 (C.D. Cal. 1969).
- 41 357 F. Supp. 1097 (D. Me. 1973).
- 42 628 F.2d at 673.
- 43 Id. at 673.
- 44 Id. at 677.
- 45 Fla. DER Case No. 80-1481.
- 46 272 N.W. at 288.
- 47 Id. at 292.
- 48 Id. at 293.
- 49 107 F.2d at 504.

- 50 Personal communication with Bryant Conway, Counsel for Plaintiff,
May 5, 1981.
- 51 485 F.2d 252 (9th Cir. 1978).
- 52 Personal communication with John J. Tomanson, Counsel for Appellant,
May 1981.