

RICHARD CARSON\* and PETER NAVARRO\*\*

## Fundamental Issues in Natural Resource Damage Assessment\*\*\*

### ABSTRACT

*This paper examines the legal and economic implications of adopting various methods of assessing natural resource damages as required by CERCLA. Within the context of the preferences of two stylized political actors—environmentalists and industrialists—we show that the magnitude of damages assessed is quite sensitive to the method chosen and, by extension, to the choice of valuation criteria underlying a given method. The important legal implication is that the debate over which method or methods are “correct” can only be settled after a consensus is reached on what the appropriate valuation criteria and the appropriate aggregation rule to reflect public preferences are.*

### INTRODUCTION

The Federal government has recently—and uneasily—formally embraced the use of public goods valuation methods to assess natural resource damages.<sup>1</sup> This paper examines the law and economics of adopting a particular method and develops a framework for making a prudent policy decision.

From an economic perspective, we show that the magnitude of the damages assessed is quite sensitive to the set of valuation criteria adopted, for example, willingness to pay versus willingness to accept, and also illustrate the relationship of a given set of criteria to the various methods of assessing damages: travel cost analysis, hedonic pricing, and contingent valuation. From a legal perspective, we demonstrate that the two major interest groups in the debate—industry and environmentalists—have lobbied and fought in the courts for the acceptance of criteria and methods that either minimize assessed damages (industry's goal) or maximize assessed damages (the environmentalist's goal). Finally, we argue that

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\*Department of Economics, University of California, San Diego.

\*\*Graduate School of Management, University of California, Irvine.

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1. We will use the term 'damage' to refer to economic losses and the term 'physical injury' to refer to physical damages.

to develop two sets of rules for determining natural resource damage assessment: one set for determining damages from small incidents which would be largely predetermined and not require extensive field work ("Type A Rules") and another set which described procedures to be used for assessing damages in large incidents ("Type B Rules").<sup>4</sup> Congress gave the states and Federal agencies the power and responsibility of public trustee for the purpose of pursuing natural resource damage claims and gave their arguments the strength of rebuttable presumption in the courts as long as they followed the procedures to be laid out.

In 1981, the Executive Branch formed an interagency task force led by the Department of Interior to write the rules. The expertise of the economists involved in the process was primarily that of benefit-cost analysis for new projects which relies on willingness to pay (WTP) and focuses on use values (since existence values for, say, a new water reservoir are generally considered to be negligible). The proposed rules relied heavily on the existing Water Resources Council guidelines<sup>5</sup> for project assessment and reference it as a source of standards in carrying out a non-market valuation exercise. After receiving extensive comments from both industry and environmental groups, the final rules published in the Federal Register barred willingness to accept (WTA) and put a strong emphasis on use values.<sup>6</sup> Soon after, challenges to this rulemaking were filed in Federal court by several environmental groups led by the National Wildlife Federation<sup>7</sup> as well as by a number of states including New York and California.<sup>8</sup> At present these suits are still unsettled.

### VALUATION CRITERIA

The legal dispute over natural resource damage assessment centers around the choice of four major valuation criteria: (1) WTP versus WTA,

4. Type A regulations were published in 52 Fed. Reg. 9042 (1987) and Type B regulations were published in 51 Fed. Reg. 27,674 (1986).

5. See Water Resources Council. Procedures for Evaluation of Natural Economic Development (NED): Benefits and Costs in Water Resources Planning (Level C). Final Rule, in 44 Fed. Reg. 72,892 (1979); and Water Resources Council. Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Govt. Printing Office) (1983).

6. Accompanying the Type A regulations is a computer program which requires inputs such as the substance spilled, the quantity of material spilled, and the type of spill location (e.g., public beach) and produces as the output the magnitude of the economic damages which should be assessed. Type A regulations forbid the inclusion of existence values in a natural resource damage assessment completely while Type B regulations forbid the inclusion of existence values in a natural resource damage assessment unless there are no use values for the resource in question. The Department of Interior's rationale for this decision appears to be that existence values are highly speculative and procedures for measuring them not sufficiently refined to justify rebuttable presumption.

7. See National Wildlife Federation (petition filed by plaintiff in response to Natural Resource Damage Assessment Rulemaking, Federal Court, Washington, D.C.) (1987).

8. See Johnson, Assessing Natural Resource Damages: Flawed Regulations May Limit Recoveries, Natl. Envtl. Enforcement J. (July 1987).

many economists who have been called upon to implement the damage assessment procedure have been drawn into a contentious interest group debate over the relative merits of the different valuation methods and have ignored the more fundamental and antecedent question of "what is the appropriate set of valuation criteria for society to adopt?"

The Institutional Framework provides a brief account of the institutional genesis of the demand for, and legal dispute over, damage assessment methods. The next section, Valuation Criteria, discusses the relationship of various valuation criteria to the goals of industry and environmentalists. The Economist's Perspective section critiques widely held views among economists regarding the valuation criteria. While the Methodologies section examines the "match" between the set of valuation criteria and the various methods and discusses the relative magnitudes of the estimates each of the three methods is likely to yield. Finally, the Choice of Valuation Criteria provides policymakers with a guide to the choice of valuation criteria and examines the collateral question of an aggregation rule for calculating public losses. The paper concludes with a summary and several closing remarks.

### INSTITUTIONAL FRAMEWORK

The demand for natural resource damage assessment procedures arose from three related sources.<sup>2</sup> The first was dissatisfaction of all parties—particularly industry and Federal bureaucracies—with the *ad hoc* and highly unpredictable nature of court decisions on natural resource damages during the 1960s and 1970s; it was believed that the courts (particularly juries) are unable, at least without strong guidance, to cope adequately with cases requiring an understanding of technical issues relating to the physical and biological sciences as well as economics. The second impetus came from a desire by Congress to streamline the procedures in the assessment of damages in cases involving the large number of hazardous waste disposal cases foreseen under the "Superfund" legislation, that is, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Finally, Congress saw that damages for natural resource injuries were infrequently assessed under current laws and that the guidelines for doing so varied under different enabling legislation and different agencies. These differences made prosecution difficult and added to the courts' confusion.<sup>3</sup>

In the CERCLA legislation, Congress directed the Executive Branch

2. For a general overview see Yang, Dower, & Menefee. The Use of Economic Analysis in Valuing Natural Resource Damages (U.S. Department of Commerce, National Oceanic and Atmospheric Administration) (1984).

3. For a comprehensive overview of the state of the law with respect to toxic waste and CERCLA in particular see, Developments in the Law: Toxic Waste Litigation, 99 Harv. L. Rev. 1458 (1986).

(2) inclusion of existence values, (3) inclusion of potential use, and (4) the treatment of uncertainty in the physical injury assessment.<sup>9</sup> In this section, we describe the preferences for the various valuation criteria of two stylized—and polarized—actors in the legal arena: utility-maximizing environmentalists and profit-maximizing industrialists.<sup>10</sup>

In the typical case of natural resource damage, industry seeks to minimize its liability to, and payments that result from, damage assessment. Industry also attempts to reduce the range of uncertainty about that liability, and industry representatives lobby for the acceptance of a set of valuation criteria and an assessment method that will achieve these ends. Environmentalists, on the other hand, seek to maximize assessed damages so as to provide a maximum deterrent to future incidents, enable the full restoration of the environment should an incident occur, and provide moral restitution.

Assume, then, that profit-maximizing industrialists seek to minimize assessed damages,  $D$ , while utility-maximizing environmentalists seek to maximize  $D$ .<sup>11</sup> Our claim is that to achieve its goals, industry will seek to restrict damages to current use, deny the possibility of existence values, assume away the possibility that the injury is much worse than the best point estimate of its magnitude, and embrace a WTP criteria. In contrast, environmentalists will seek to include new potential types of uses as well as current use in damage assessments, stress the importance of existence values, insist that uncertainty be acknowledged in the form of a "worst case" scenario, and favor a WTA property right.

Let there be  $i = 1, \dots, m, \dots, M, \dots, N$  relevant agents (for example, individuals or households), where the  $N$  agents are sorted so that the first  $m$  agents are current users of the resource and the first  $M$  are current or potential users of the resource. Most of the damage assessment rules can then be written in the following form:

$$D = \sum_{i=1}^k [V^i(q_j; C)], \quad (1)$$

where  $A$  is the aggregation rule to be used,  $i = 1$  to  $k$  is the number of agents aggregated over,  $V^i(\bullet)$  is the individual valuation rule used,  $R$  is

the property right assumed,  $q_j$  is the level of physical injuries valued, and  $C$  are the components of value which are use value,  $U$ , and existence value,  $E$ .

Industry wants to set  $k$  equal to  $m$ ,  $R$  equal to WTP,  $q_j$  equal to the point estimate of the physical injury, and  $C$  equal to  $U$ . Environmental groups want to set  $k$  equal to  $N$ ,  $R$  equal to WTA,  $q_j$  equal to a plausible worse case scenario for damages, and  $C$  equal to  $U$  and  $E$ . We know that: (1)  $D$  is increasing in  $k$ , (2)  $WTA \geq WTP$ , (3)  $D$  is increasing in  $q_j$ , and (4)  $V(q_j; U, E)$  is at least as large as  $V(q_j; U)$ .<sup>12</sup> Hence, acceptance of any one of the criteria preferred by industry (holding the other criteria constant) will always lead to an estimate of  $D$  which is less than (or equal to) the estimate of  $D$  based on acceptance of the environmentalists' preferred criterion.<sup>13</sup> Such a rank ordering becomes more difficult if more than one criterion is allowed to vary. Nonetheless, while there has as yet been no systematic analysis of the relative magnitudes of the effects of changing the various indices, our priors, based on extensive experience and results reported in the literature from changing single indices, suggest that changing from  $\bar{q}_j$  to  $MAX(q_j)$  typically results in a larger increase in  $D$  than changing from WTP to WTA. That change in turn yields a larger increase in  $D$  than changing from  $V(q_j; U)$  to  $V(q_j; U, E)$ , which in turn results in a larger increase in  $D$  than changing  $k$  from  $m$  to  $M$ .<sup>14</sup>

Based on this ranking, it is clear that the set of valuation criteria preferred by industry leads to a damage assessment that is less than the assessment which would follow from the environmentalists' preferred set of valuation criteria. The appropriate normative questions that follow from this observation are: what set of valuation criteria should policymakers adopt and which method(s) best reflect those criteria? Before turning to these questions, it is first useful to examine why economists have focused on the relative merits of the different methods rather than upon the choice of valuation criteria.

12. Without limiting the class of allowable aggregation rules,  $A$ , it is hard to make a general statement about changes in the aggregation rule. An important class of aggregation rules is the class of  $k$  times the  $\alpha$ -trimmed mean which includes  $k$  times the ordinary mean and  $k$  times the median as special cases where  $\alpha = 0$  and  $\alpha = .5$  respectively. (To calculate, say, the .1-trimmed mean, discard the lowest 10% of the observations and highest 10% of the observations and calculate the mean using the remaining 80% of the observations.) Within this class of aggregation rules, the result,  $\frac{\partial D}{\partial \alpha} \leq 0$  holds for most injuries likely to be considered.

13. For example, a  $D$  based on summing over  $m$  holding  $A, R, q_j$ , and  $C$  constant will be lower than a  $D$  based on summing over  $N$ .

14. It is difficult to place a change from  $k = m$  to  $k = N$  in this sequence since the effect of this change on  $D$  is highly dependent on whether  $m/N$  was originally close to zero or one and on the effect of going from  $V(q_j; U)$  to  $V(q_j; U, E)$ . Changing  $\alpha$  from 0, the mean, to .5, the median, usually results in about the same size change in  $D$  as including existence values.

9. Another controversial criterion which is less central to the choice of a methodology is choice of an appropriate discount rate. Environmental groups believe that zero is the correct rate while industry favors a high rate.

10. Alternatively, we could have used two government agencies, one with preservation interests and the other with development interests. However, with a few exceptions, the positions of various agencies do not appear to be nearly as far apart.

11. To the extent that environmentalists are "consumers" of a natural resource, for example backpackers, their utility derives from environmental consumption. To the extent that beliefs such as "pollution is morally wrong" motivates environmentalists, their utility derives from more altruistic sources.

### THE ECONOMIST'S PERSPECTIVE

In this section, we examine views widely held by economists on WTP versus WTA, existence values, potential new uses, uncertainty over the extent of actual physical injuries, and the aggregation rule to be used.

#### WTP Versus WTA

WTP represents the amount an agent would be willing to pay for a good while maintaining the same amount of utility the agent had before receiving the good. This criterion implicitly assigns industry a quasi-property right to the resource. That is, under WTP, industry pays to the government what the public would have been willing to pay to industry if industry had owned the resource initially. In contrast, WTA represents the amount an agent would have to be given in exchange for the good, holding the agent's utility constant. This criterion implicitly assigns a quasi-property right to the broader public because it measures how much the public would be willing to accept in exchange for voluntarily giving the resource to industry.

Many economists who have been called upon to implement the natural resource damage assessment rules have assumed that WTA and WTP are approximately equal for natural resource damages; and accordingly, they have regarded the choice between WTP and WTA as unimportant from the standpoint of the magnitude of the damages the government should seek. This impression has stemmed largely from Willig's results<sup>15</sup> that (a) for price changes, the difference between WTA and WTP is a function of the income elasticity, (b) if the income elasticity is zero, WTA and WTP are both equal to the ordinary Marshallian consumer surplus, and (c) for positive income elasticities, WTA and WTP bracket the Marshallian consumer surplus from above and below. The implication economists have drawn from these results is that for price changes and any reasonable income elasticity, WTA and WTP are sufficiently close that for policy purposes, errors in the actual empirical estimates are likely to be more important than the difference between the two criteria.

Randall and Stoll<sup>16</sup> extended Willig's result to imposed quantity changes and found that instead of the income elasticity being the relevant parameter driving the difference between WTP and WTA, there is a "similar" parameter which they term the *price flexibility of income*. If this parameter takes on values similar to those of income elasticities, then WTP and

WTA are also quite close together for imposed quantity changes, and this assumption has likewise permeated much of the applied work on changes in environmental amenities of the last decade.<sup>17</sup>

Note, however, that subsequent theoretical work has shown that WTP and WTA do *not* have to be close together for imposed quantity changes and, in a paper which will have a major influence on welfare economics, Hanemann<sup>18</sup> shows that Randall and Stoll's price flexibility of income parameter is actually the ratio of an income elasticity to a substitution elasticity and that as the substitution elasticity goes to zero, the difference between WTP and WTA goes to infinity for any positive income elasticity. For common goods, the substitution elasticity is likely to be relatively high, but for "unique" goods such as the Grand Canyon, it could be substantially less than one. The environmentalists have taken Hanemann's result to heart because they believe in the uniqueness of most environmental amenities, particularly those that have been destroyed by industry.<sup>19</sup>

#### Existence Values

There is a strong reluctance among economists to base public goods provision decisions on existence values.<sup>20</sup> While there are a number of ways to define existence values, one of the most popular is to separate  $V_i(q_i)$  into two orthogonal components: one which enjoys weak complementary or a technical relationship with a marketed good and one which

17. In contrast to the theoretical results, evidence from CV surveys and economic experiments with real dollars consistently shows WTA and WTP for the same good and same sample to be far apart. One experiment of Coursey, Hovis & Schulze showed that in repeated trials with the same subjects WTA tends to move toward WTP. While the difference between WTA and WTP on their last trial was not significantly different at conventional statistical significance levels, WTA was still approximately 50% larger than WTP. It can also be said that the repeat trials violated the imposed quantity change provision since the quantities determined in one trial can be easily changed in the next so that consumption in one trial can be seen to be a fairly good substitute for consumption in a second trial. Coursey, Hovis & Schulze, *The Disparity Between Willingness to Accept and Willingness to Pay Measures of Value*, 102 Q. J. Econ. 679 (1987).

18. See Hanemann, *Willingness to Pay Versus Willingness to Accept: How Much Can They Differ* (forthcoming in *Amer. Econ. Rev.*). While Hanemann's results do not eliminate the possibility of estimating WTA from WTP they do imply that it is much more difficult than previously assumed by Hausman and others. Not only must one know the income slope but also the slope of the Hicksian composite substitution elasticity. In addition it is fairly straightforward to show in most cases that the estimated difference between WTP and WTA is highly dependent on the particular utility function chosen.

19. See, for example, California Water Resources Control Board Hearings, Exhibit No. 40 (1987) (article submitted by the Bay Institute, entitled *The Value of King Salmon, Harbor Seals, and Wetlands of San Francisco Bay*).

20. Economists who are reluctant to include existence values may be divided into two camps: those who feel existence values to be of trivial importance and those who feel that the current state of the art has not progressed far enough to reliably measure them for public policy purposes. In the earlier economic literature, existence values were sometimes referred to as intangibles or unmeasurables.

15. Willig, *Consumers' Surplus Without Apology*, 66 *Amer. Econ. Rev.* 589 (1976); Hausman, *Exact Consumer's Surplus and Deadweight Loss*, 71 *Amer. Econ. Rev.* 662 (1981) was to show that if the relative parameters of the utility function were known, including the income slope, that the "exact" WTA could be calculated from WTP.

16. Randall & Stoll, *Consumer's Surplus in Commodity Space*, 70 *Amer. Econ. Rev.* 449 (1980).

does not. By this definition, existence value is inherently unobservable in a standard revealed preference sense as it leaves no tracks in the purchase of marketed goods. The usual motives given for someone holding existence values are vicarious consumption, stewardship, and bequest considerations. The actions of public officials, occasional referenda, and the establishment of some lobbying groups (for example, the Alaskan Wilderness Coalition) provide ample evidence of the reality of existence values. The questions are: how important are existence values and why did the economists who helped write the natural resource damage assessment procedures feel that they were either unimportant or too difficult to measure.

The ambivalence of many economists to existence values has grown out of a tradition of determining the benefits for new projects such as water reservoirs which should exhibit little in the way of existence values and the difficulties involved in measuring them reliably. More generally, economists value marginal and reversible changes, and this has important implications for the three standard motives which are said to lie behind existence values, that is, vicarious consumption, stewardship, and bequest considerations. In particular, it is hard to posit a large stewardship value for making a park one acre larger or smaller (although there may be substantial willingness to pay for stewardship reasons for the park as a whole). It is even harder to invoke bequest values related to leaving one's grandchildren a boat dock which could just as easily be built 40 years from now. Unfortunately, a major spill of a long lasting toxic substance such as PCBs in a national park has none of the marginal and easily reversible characteristics of the typical new government project, and most economists have little experience in assessing the relative size of existence values in the types of situations envisioned under CERCLA.<sup>21</sup>

### Potential New Uses

One of the hazards associated with damage to a natural resource is the possible foreclosure of potential new types of uses for that resource.<sup>22</sup> In theory, the value of these new uses can be measured by any one of a number of methods, but *only if* economists are provided with information about what the possible new uses are and how they would be implemented. What should be on this list has been one of the major foci of the damage assessment debate—with economists often caught in the middle. As ex-

pected, environmentalists favor a very long list of uses while industry favors constraining the damage assessment to the current "service flow" from the resource.

Once given such a list, economists generally agree that the theoretically appropriate *ex ante* welfare measure is "option price"<sup>23</sup> where option price equals expected consumer surplus plus "option value." There has been a long theoretical debate over the sign and size of option value in the literature,<sup>24</sup> and the general conclusion today is that, without further specifying the source of the uncertainty, the sign can be either positive or negative and the magnitude should be small. More important for our purposes, Chavas, Bishop, and Segerson<sup>25</sup> have clearly shown that option value, correctly construed, is simply a technical correction which converts an *ex post* welfare measurement into an *ex ante* one.<sup>26</sup>

Unfortunately, there has been some confusion about option values in the legal arena because of misconceptions on the environmentalist side. In particular, current regulations stipulate that only a subset of possible uses called "committed uses" may be considered where "committed uses" are defined as those currently being undertaken and those potential new uses embodied in the trustee's previously existing official planning documents. Environmentalists rightfully object to this truncation of uses and want the list expanded to include other potential uses, but for a variety of reasons environmentalists have mistakenly assumed that these other potential new uses are encompassed in option value. Thus, they use option value in a way other than the narrow technical sense with which the term is used by economists. This confusion was to some degree sown by several early contingent valuation studies which purported to measure option value and found it to be much larger than suggested by theory.<sup>27</sup> The upshot is that environmentalists have been vehemently arguing for option value—which actually could be *negative* and reduce the damages assessed—because they think that it is something else. At the same time, bringing more heat than light to the debate, industry has attacked the use

23. Graham, Cost-Benefit Analysis Under Uncertainty, 71 *Amer. Econ. Rev.* 715 (1981).

24. See, for example, Hartman & Plummer, Option Value Under Income and Price Uncertainty, 14 *J. Envtl. Econ. & Mgmt.* 212 (1987).

25. Chavas, Bishop, & Segerson, *Ex Ante Consumer Welfare Evaluation in Cost-Benefit Analysis*, 13 *J. Envtl. Econ. & Mgmt.* 255 (1986).

26. Smith & Desvousges independently argue the same point with a somewhat different emphasis when they say, "Our analysis implies that option value is not a distinct source of value. Instead, option value is an index of the importance of the perspective—*ex ante* or *ex post*—used to value either changes in a resource, or in the terms of access to it, under conditions of uncertainty." V.K. Smith & W.H. Desvousges, *Measuring Water Quality Benefits* (1986).

27. It later appeared that what was being measured in these studies was different probabilities of the same type of future use, not the actual concept of option value which probably can not be directly measured. See R.C. Mitchell & R.T. Carson, *Using Surveys To Value Public Goods: The Contingent Valuation Method* (1988).

21. What limited evidence there is suggests that existence values may be relatively large. See Fisher & Raucher, *Intrinsic Benefits of Improved Water Quality: Conceptual and Empirical Perspectives*, in *Advances in Applied Economics* (V. K. Smith, ed. 1984).

22. We wish to make it clear that all parties are considering future use in their damage estimates. By a potential new use, we are referring to, for example, making an inaccessible wilderness area into a major national park complete with roads, parking lots, concession stands, and lodges.

of option value as a symbol of what it considers to be the environmentalists' highly speculative position on what uses the now damaged resource might have been put to.

#### Uncertainty Over $q_i$

In numerous legal skirmishes over the magnitude of natural resource damages, economics as a discipline (as opposed to the individual economists testifying as experts) has often been made to look foolish because of large differences in damage estimates. Such differences have strained the notion that "reasonable economists can differ" and have led to both cynicism about, and skepticism of, the precision of economic analysis in general and assessment methods in particular. In this typical case, however, the discrepancy between the relatively low damages estimated by industry economists and the relatively high estimates testified to by environmentalists on the environmentalist side is not an indictment of methods but rather a function of each side's view of uncertainty and collateral preferences for  $q_i$ ; industry seeks to value the "expected physical injuries,"  $E[D|E(q)]$ , while environmentalists seek  $E[D|MAX(q)]$ , that is, a  $D$  conditioned on the maximum possible physical damage,  $MAX(q)$ .

The technically correct measure is, however, the unconditional  $D$  which can be written  $E[D|f(q)]$  where  $f(q)$  is the probability density function of the physical damages. But the drawback with using this measure is that economists have no expertise in determining  $f(q)$ —it is strictly a physical science problem.<sup>28</sup> Moreover, when  $f(q)$  is given, economists have little experience in evaluating  $E[D|f(q)]$ . In part, this is due to computational difficulties, but, to a larger degree, this is due to the great expense of obtaining  $D$  for a large number of  $q_i$ 's, particularly those  $q_i$ 's far outside the range of existing experience. What is clear is that this correct measure will be bracketed on the low end by the industry's preferred  $D$  and on the high end by the environmentalists' preferred  $D$ .

That is, since  $\frac{\partial D}{\partial q_i} > 0$  and  $\frac{\partial^2 D}{\partial q_i^2} > 0$  will almost always be true, then

$$E[D|\bar{q}] \leq E[D|f(q)] \leq E[D|MAX(q)] \quad (2)$$

with the equality holding only if the actual  $q_i$  is known with certainty.

As with attitudes toward WTP versus WTA, these differing attitudes towards uncertainty are rooted in both tradition and economic theory. On the tradition side, we can once again point to the history of assessing benefits for new projects. Such benefits can be seen as a flow,  $S$ , resulting from the project while damages can be viewed as the diminution of that

flow.  $S$  is typically a random variable because of: uncertainty in the estimates (due to sampling), factors related to predicting economic behavior unobserved by the economist, and random errors in utility maximization by agents. For pragmatic reasons, applied benefit-cost analysis have, in the past, typically used  $E(S)$  rather than  $f(S)$  in determining a benefit estimate because of both computational difficulties and philosophical reasons advanced by Arrow and Lind<sup>29</sup> who argued that the government should be risk neutral due to the effective pooling of the large number of projects over a large number of citizens. Arrow and Lind's risk pooling argument, however, has been misinterpreted by many benefit-cost practitioners because it applies to *economic* returns,  $D$ , not physical injuries,  $f(q)$ . Their position logically leads to  $E[D|f(q)]$  not  $E[D|E(q)]$ . Unfortunately, in the case of natural resource damage assessment, the use of  $\bar{q}$  ignores probably the most important source of uncertainty in a damage assessment, namely, uncertainty over the actual  $q_i$ ; and conditioning  $D$  on  $\bar{q}$  will result in too low a payment by industry to the government unless  $D$  is linear in  $q_i$ , which is generally not true.<sup>30</sup>

#### Aggregation Rules

The choice of the aggregation rule involves two components: the choice of the aggregation index  $k$  and the weight to be placed on the damage to each of the  $k$  individuals. The appropriate choice of  $k$  is relatively straightforward if only use values are to be included and the population of users is stable and easily identifiable. The correct choice of  $k$  becomes much more difficult if the inclusion of existence values is desired and current and potential users not easily identified.

Having defined  $k$  and  $V^k(q_i; C)$ , the issue is then how to weight individual losses. There are obviously a large number of possible aggregation schemes. However, we will assume that most of these, such as "consider only racial minorities or homeowners," would not be considered allowable by the court, and we will further rule out entirely arbitrary aggregation rules. Two aggregation rules that are left which have intuitive appeal in terms of fair compensation to a public trustee are both members of the class of  $k$  times an  $\alpha$ -trimmed mean. The first is the mean and corresponds to  $k(A^+_{1-\alpha}(\alpha=0)V(\epsilon))$ . This rule gives equal weight in terms of dollars to the losses of each of the  $k$  agents being aggregated over. The second is

29. See Arrow & Lind, "Uncertainty and the Evaluation of Public Investment Decisions," 60 *Amer. Econ. Rev.* 364 (1970).

30. The linearity assumption is equivalent to  $\frac{\partial D}{\partial q_i} > 0$  and  $\frac{\partial^2 D}{\partial q_i^2} = 0$  rather than the second derivative being greater than zero as is likely to be the case. For the same reason that conditioning on  $\bar{q}$  results in an under estimate, conditioning on  $MAX(q)$  will result in a gross overpayment to the trustee by industry. The magnitude of the actual  $q_i$  may remain unknown for up to 20 years or longer if there are subtle effects of the damage which take a long time to work through the ecosystem.

28. That is, the economists can estimate the dollar value of physical injuries but must first be told what those injuries are by engineers or biological scientists.

the public good using data on activities and expenditures undertaken by the household. The travel cost approach measures WTP because it uses household expenditures (that is travel cost as well as other expenditures on the activity). Since it is based on observed behavior, the travel cost method can only be used to measure the economic value of changes in the levels of activities already being undertaken at that site.

Hedonic pricing<sup>35</sup> is capable of measuring direct plus indirect use (for example, aesthetic) benefits. The HP approach is based on the incorporation or bundling of the non-marketed amenity into the price of some marketed good. Like TC, the HP approach measures WTP because it is based on observed expenditures. It is more inclusive than TC analysis in that prices for a marketed good which bundles in a non-marketed good are likely to reflect potential uses of the bundled non-marketed good as well as current uses. It is, however, somewhat less applicable to natural resource damage cases in that the services of the natural resource of interest are often not found bundled in the price of a marketed good. Both travel cost analysis and hedonic pricing attempt to measure expected consumer surplus because they are based on observed behavior.

Contingent valuation<sup>36</sup> is capable of measuring direct and indirect use values as well as existence values. In contrast to the other two techniques, CV measures option price because it based on (*ex ante*) responses to hypothetical scenarios posed in a survey, and on stated (as opposed to revealed) preferences.<sup>37</sup> These characteristics of CV result in the method's great flexibility to measure different property rights and a wide range of changes in the quality and quantity of the resource in question. The other source of CV's flexibility comes from the potential ability to sample any portion of the index *i*. Note also that at the individual level, CV typically measures existence values and typically measures what people perceive the resource might be used for in the future. What people perceive the future resource use to be, however, is very much influenced by what is described in the valuation scenario. Attempts to separate  $V(q_i; U, E)$

35. See Rosen, Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, 82 J. Pol. Econ. 34 (1974).

36. Randall, Ives & Eastman, Bidding Games for Evaluation of Aesthetic Environmental Improvement, 1 J. Envtl. Econ. & Mgmt. 132 (1974).

37. R. Cummings, D. Brookshire & W. Schulze, Valuing Environmental Goods: An Assessment of the Contingent Valuation Method (1986), set out a number of reference operating conditions under which contingent valuation was believed to work well. One of these conditions was that there should be no uncertainty, and it is uncertainty that drives the difference between expected consumer surplus and option price. Since the conference in which these reference operating conditions were proposed there have been a number of contingent valuation studies which have explicitly incorporated uncertainty. One of the proposers, Schulze, Valuation Methods II: Direct Approaches, presented at Natural Resource Damage Assessment Conference, Resources for the Future, Washington, D.C. (June 1988), has since argued that the reference operating condition concerning uncertainty is no longer necessary to guarantee a valid contingent valuation study.

the median and corresponds to  $\alpha = .5$ . This rule, in essence, gives each of the *k* agents an equal vote as to what the total dollars of compensation required by the public trustee should be. Thus, one rule is based on equal treatment in terms of dollar losses and the other on equal treatment in terms of a vote on the total societal loss. An aggregation rule based on the mean is consistent with the Hicks-Kaldor potential Pareto criterion, while one based on the median is consistent with the median voter criterion. Economists working in the benefit-cost tradition are much more comfortable with the use of the mean while politicians (and economists with more of a public choice orientation) instinctively understand and appreciate voting rules as a way of determining societal decisions.<sup>31</sup>

### METHODOLOGIES

There are three major competing methodologies to assess damages to natural resources: (a) travel cost analysis (TC),<sup>32</sup> (b) hedonic pricing (HP), and (c) contingent valuation (CV). Each of these three techniques is based upon quite strong and different assumptions about an agent's economic behavior. Under certain rather restrictive assumptions and circumstances, each method should yield the same dollar estimate. However, the different methods more typically will yield—and correctly so—quite different estimates under other circumstances. This is particularly true in the natural resource damage case. In this section, we examine the properties of each of these methods with respect to the valuation criteria set out in the following section—Choice of Valuation Criteria.

### The Methods

Travel cost analysis<sup>33</sup> is generally only capable of measuring direct use (for example, recreation) benefits.<sup>34</sup> It is based on the concept of weak complementarity and on the estimation of a derived demand curve for

31. In practical terms, the choice of the mean or median is likely to make much more difference for a resource which was heavily valued by a small group of agents and valued little by most members of society. Letting *k* = *N* for an amenity such as national water quality, means are typically a little over twice the size of medians, while for amenities like a park or a fishing stream, the mean is typically at least four times larger than the median. See Mitchell & Carson (cited in note 27) for a discussion of the means and medians from various valuation studies.

32. Travel cost analysis is the most frequently used member of a class of techniques which are based upon the household production approach. See Becker, A Theory of the Allocation of Time, 75 Econ. J. 493 (1965).

33. See M. Clawson & J. Knetsch, Economics of Outdoor Recreation (1959).

34. Some of the extensions of travel cost analysis such as the hedonic travel cost model, Brown & Mendelison, A Hedonic-travel Cost Model, 66 Rev. Econ. Stat. 427 (1984) and discrete choice models, Caulkins, Bishop & Bouwes, The Travel Cost Model for Lake Recreation: A Comparison of Two Methods for Incorporating Site Quality and Substitution Effects, 68 Am. J. Agric. Econ. 291 (1986) allow the incorporation of site attributes and thus allow one to measure indirect use values such as aesthetic quality.

obtained in a CV survey into  $V_i(q_j; U)$  and  $V_i(q_j; E)$  or to add those two components together when they have been obtained separately to get  $V_i(q_j; U, E)$  have been largely unsuccessful.<sup>38</sup>

### Problems with the Methods

Each of the three techniques suffers from potentially severe problems. For example, TC analysis does not yet have well established procedures for handling congestion, sample selection problems, substitutes, multiple destination trips, and changes in site attributes, although considerable progress has been made on these issues.<sup>39</sup> Similarly, while specification of the standard hedonic pricing equation is straightforward, the implicit demand and supply curves for the characteristics of interest necessary for estimating damages under HP are almost always chronically underidentified.<sup>40</sup> Both TC and HP also suffer from a necessarily *ad hoc* equation specification and availability of less than ideal data sets.<sup>41</sup> It is also not unusual for assessments based on the same data set but different functional forms to result in radically different dollar estimates even when the different functional forms are statistically indistinguishable (in a goodness-of-fit sense).<sup>42</sup>

Contingent valuation also has its problems. While there are few problems with functional form, there typically will be a non-negligible number of outliers (including at least a few "off-the-wall" answers to the key valuation questions) which require "judgement" on the part of the analyst.<sup>43</sup> Respondents are also subject to subtle or not so subtle manipulation by the questionnaire designer. Furthermore, unless adequate numbers of focus groups and pretests are conducted, the survey designer will have no assurance that people understood (or believed) what was intended in the valuation scenario presented. Although well-designed WTP questions do not appear to suffer from strategic behavior (and there are less efficient discrete choice variants which are incentive-compatible), WTA questions

38. See Mitchell & Carson (cited in note 27).

39. For an overview of work on these issues see McConnell, "The Economics of Outdoor Recreation," in *Handbook of Natural Resources and Energy Economics* (A. V. Kneese & J. L. Sweeney, eds., 1985).

40. Again, there has been some progress on this issue; see, for example, Batik, "The Estimation of Demand Parameters in Hedonic Price Models," 95 *J. Pol. Econ.* 81 (1987).

41. Economic theory unfortunately gives little guidance on the specification of travel cost or hedonic pricing equations in terms of what variables should be included or what functional form should be used. Data sets used for estimating these two types of equations have often been collected for other purposes, hence will most often lack some of the major variables needed to correctly estimate the desired statistical relationship. Further, one typically is interested in predicting damages outside the range of the observed data.

42. See, for example, W.J. Vaughan & C.S. Russell, "Freshwater Recreational Fishing: The National Benefits of Water Pollution Control (1982).

43. These include so-called "protest zeros" as well as implausibly high amounts.

almost always appear to provoke a high degree of "aberrant" behavior, including a large fraction of non-responses and infinite compensation demanded responses.<sup>44</sup> Finally, conducting a WTA contingent valuation survey after a widely-publicized natural resource damage episode seems to be an invitation for a gross overestimation of the actual damages, and it may even be difficult to disguise the intent of a WTP question in some *ex post* circumstances.

Because of these methodological flaws with CV, industry can legitimately argue that the WTA criterion in conjunction with the CV method can lead to upwardly biased damage estimates. Industry can also fairly claim in some circumstances that the existence value component of a damage assessment is too easily manipulated and that the ability of the CV method to adequately capture tail behavior likewise leads to biased estimates. Despite these flaws, environmental groups have glimpsed in WTA contingent valuation the possibility of measuring what they think should be measured, and they are happy with the direction of the potential biases. For their part, industry tends to overemphasize the reliability of the methods based on observed behavior, while environmentalists tend to overemphasize the reliability of CV.

From this methodological discussion, two important points emerge: for any given set of valuation criteria the government chooses to adopt, a valuation method exists that can in principle reflect those criteria. No method, however, can produce problem-free estimates, and the obvious imperfections in each of the methods have quite unfortunately become the focal point of the current policy debate, particularly among economists. As argued above, however, proper resolution of this debate requires that policymakers focus first upon the antecedent question of the appropriate valuation criteria. It is to this problem that we now turn.

### CHOICE OF VALUATION CRITERIA

This section provides a guide to policymakers as to the appropriate choice of each of the major valuation criteria, and collaterally, the appropriate assessment method or methods. We consider: (a) WTP versus WTA, (b) existence values, (c) potential new uses, (d) uncertainty over  $q_j$ , and (e) how to aggregate the  $V_i(\cdot)$ .

With respect to the choice between WTA and WTP, if policymakers choose to maximize some global social welfare function, then either WTA or WTP may be correct. This follows because the choice then reduces to the most efficient assignment of property rights rather than to some phil-

44. A number of reasons have been offered for this "aberrant" behavior. Among these are strategic behavior and the rejection of the WTA property right. See Mitchell & Carson for a discussion (cited in note 27).

osophysical determination of who should be assigned the property rights. What we wish to make clear is that the "public" and "industry" are not separate and distinct entities from this perspective and do not exist in isolation. A partial equilibrium analysis is inadequate for determining the effects of choosing a WTA or WTP criterion because such a determination will have a significant impact on the general price vector for society and because, ultimately, the same public suffering the pollution receives wages, rents, dividends, and taxes from the polluters. The choice of WTA or WTP as the liability rule should be seen as a choice over how much pollution society desires to tolerate in exchange for lower prices and a choice of how society wants to compensate its members who are directly harmed by the natural resource damage. We also wish to make clear that, as a property rights question, the choice of WTP versus WTA is a legal and philosophical one beyond the purview of economists. About the only thing economists should say about this choice is that the discipline does not know of any reliable way of measuring WTA. In this regard, it should be openly acknowledged that there is an important divergence between what Congress wanted to be measured—WTA including existence values—and what the Department of Interior regulations eventually mandated should be measured—WTP excluding existence values. This divergence occurred because of the admitted difficulty by economists of measuring WTA and existence values, but it is a divergence which leads to an *underestimate* of damages which is likely to be significant.<sup>45</sup>

With respect to criteria (b) and (c), from any individual utility theoretic approach, there is *no* justification for ruling out *a priori* the possibility of existence values, although it may be possible to develop guidelines for determining the situations where they are likely to be negligible.<sup>46</sup> In this regard, the current CERCLA rule contains an internal contradiction in that it excludes existence values in some cases and allows for their inclusion in others. In particular, the public trustee can include existence values as measured in a contingent valuation survey in a damage assessment but only if there are no use values for the public amenity. However, existence values and use values may be positively correlated, and the magnitude of existence values is most subject to manipulation when the respondents to the survey have had little or no experience with using the public amenity.

45. In a more speculative—and possibly provocative—mode, the fact that damages are typically underestimated under current regulations may justify some additional remedy through the legal system. One possibility would be the awarding of punitive damages when it is determined that an individual or entity deliberately breached the trustee's property rights. One problem, however, with determining the level of punitive damages is that by implication, the courts will not know with any certainty the degree of the underestimate.

46. It is possible, however, to put forth arguments about the measurement of existence values being too easily manipulated by the researcher or being too unreliable, thereby justifying the exclusion of existence values from damage assessments.

Nor is there any justification for not considering potential new future uses. However, these potential new future uses should not, *carte blanc*, become the environmentalist's wish list. Rather, the damage assessment guidelines should spell out clearly which potential new future types of uses should be admitted and at what levels they should be considered.<sup>47</sup> In this regard, economists working in this area have typically been asked to do more than they can (or should). The point we'd like to emphasize is that economists are at least somewhat capable of assessing damages if they are told what the new uses will be, but economists should *not* be thrust into the role of determining what uses should be on the list.<sup>48</sup> This is more properly the domain of other specialists, from park planners and biologists, to fishery and soil experts.

Turning to criterion (d), policymakers should acknowledge the presence of uncertainty about  $q_j$  for the reasons argued in the economist's perspective section, and economists should seek to develop ways to obtain the correct measure of  $D$ ,  $E[D|f(q)]$ , rather than  $E[D|q_j]$  because at present, none of the methods work well for obtaining  $E[D|f(q)]$ . What perhaps can be argued is that if damages are increasing at an increasing rate in terms of  $q_j$ , then there is, *ex ante*, a strong case for using a  $q_j$  which is larger than industry's preferred  $q_j$ , i.e.,  $\bar{q}_j$ , but which is smaller than the environmentalist preferred  $q_j$ ,  $MAX(q_j)$ . If the damages are close to linear in  $q_j$ , then the use of  $\bar{q}_j$  is probably acceptable.<sup>49</sup> This is about all economists can—and probably should—say and ultimately the courts must decide the appropriate  $q_j$ .

With respect to the appropriate  $q_j$ , one means of improving the quality of that decision would be for judges to force both the plaintiffs' and defendants' economists to submit damage valuation functions for the range of the  $q_j$ 's being put forth by either side rather than each side's preferred  $q_j$ . While this valuation function approach is likely to be somewhat more costly, it would provide the courts with very useful additional information and limit the strategic behavior of the litigants. In this regard, the courts as well as the partisans in the debate should recognize that the choice of  $q_j$  is *independent* of the method chosen and that it is a smokescreen to blame large discrepancies in damage estimates solely on the use of dif-

47. At present, CERCLA admits a very small subset of future uses into the assessment. In particular, restoration or replacement cost may be sought for a physical injury to a natural resource if and only if that resource has been set aside and "committed" to a specific future by law prior to the hazardous waste release. See 50 Fed. Reg. 52,150 (1985). While this rules out the environmentalists' "wish list," it may also dispense with many future uses which were being or which would have been considered by the government.

48. To value a new type of use for a natural resource in a CV survey, the respondent must generally be told what that use is, and, if the new type of use is known, a value for it can be inferred using the travel cost or hedonic pricing methods by observing situations where that use is currently being undertaken.

49. A strong argument could be made for using  $\bar{q}_j$  in all cases if the court reserved a right to assess additional penalties *ex post* in the event physical injuries proved to be severely underestimated.

that the magnitude of damages assessed is sensitive to the method chosen and, by extension, to the valuation criteria underlying a given method. We have also argued that the extent of actual damages is "in the eyes of the beholder." That is, the two antagonists have different visions and motives with the result that industry lobbies for criteria and methods which may understate true damages while environmentalists advocate methods and criteria which lead to possibly high and more variable estimates. The important policy implication that follows from these results and observations is that the debate over which method or methods to embrace can only be adequately settled after a consensus is reached on what the appropriate valuation criteria and the appropriate aggregation rule to reflect public preferences are.

In this regard, it appears that there now exists only one set of defensible criteria that can be measured with existing techniques: *median WTP via contingent valuation*. Contingent valuation measures existence value and is the most flexible in incorporating a consideration of any future new uses for the resource in question. In principle, good contingent valuation surveys can measure an individual's WTP (in contrast to WTA), and the use of median WTP rather than mean WTP eliminates the one potentially major problem, justifying the almost necessarily *ad hoc* treatment of respondents giving implausibly large or small dollar amounts. Contingent valuation is, however, no panacea. There are particular kinds of natural resource injuries for which contingent valuation is unlikely to ever work well and injuries for which it is likely to work in a satisfactory manner only after the expense of a great deal of time and money.

If another set of criteria is chosen, then it should be admitted that economists do not yet have a technique that can accurately measure the desired quantity. If another technique is chosen, it should be done so on the basis of an explicit mean-variance tradeoff, and the direction of bias in the technique should be explicitly recognized. There are many situations where the travel cost and hedonic pricing techniques provide quite useful information because existence values can defensibly be argued to be small, and there is good micro-level data on observed choice behavior.<sup>51</sup> At the same time, one of the strongest reasons for using travel cost or hedonic pricing should be the availability of a pre-existing high quality data set suitable for estimating such models. In this case, travel cost analysis or hedonic pricing is likely to be much cheaper and quicker to perform than contingent valuation and, as such, may help facilitate an early settlement.

51. We feel, however, that those who use the travel cost or hedonic pricing techniques should be forced to make the argument that existence values are likely to be small in the given situation. This is in contrast to the current rule which bars the inclusion of existence values if there are positive use values and discourages the use of contingent valuation. Perhaps even two more useful changes would be for the CERCLA rules to provide guidelines on the types of situations where existence values could easily be ignored because they were likely to be negligible, and situations when they could not be ignored.

ferent economic valuation methods when in fact these discrepancies are to a large degree driven by the use of different  $q_i$  by the two sides. Graphing together the valuation functions put forth by the two sides would eliminate much of what now frequently appears, to a judge or jury, to be a technical and often inexplicable disagreement among economists.

As a final, more general observation on criteria (c) and (d), neither the treatment of uncertainty over  $q_i$  nor the treatment of potential new uses should have an impact on the choice of methods *per se*. Rather, these are issues that must be resolved solely within the context of the selection of valuation criteria, and, as argued above, economists should not be forced into participating in this selection process which is properly the domain of the courts, the partisans, and other specialists.

Turning to criteria (e), the government as public trustee must choose the  $k$  agents on whose behalf it is collecting damages and then it must decide the manner in which to weigh each of the  $k$  agents' losses in determining the damages it should seek. If compensation were to be directly paid to those  $k$  agents suffering individual damages and the price vector for products throughout the economy would not be affected by the choice of the aggregation rule, then a strong economic argument in terms of welfare maximization could be made for the public trustee seeking the sum of the individual damages (that is  $k\bar{V}(s)$ ). However, in reality neither of these two conditions are likely to be even approximately met, so the choice of the appropriate aggregation rule is a decision which should be left to the appropriate policymakers rather than to economists.

We should also note that the choice of  $k$  and the choice of  $A(\alpha)$  should not be viewed as independent in many situations. For example, suppose that the individuals living near the site of a toxic waste spill will be the only ones that run the risk of contracting cancer. If  $k$  is set to all individuals in the city and a WTP criteria is used, damages may well be zero under a median voter rule (because most citizens will pay nothing to avoid a spill which does not affect them) while a mean rule will at least reflect the minority position.<sup>50</sup> On the other hand, if  $k$  is defined to be the number of individuals in the "sensitive population," either the mean or the median will tend to yield a high number times a much smaller  $k$  as the damages. Again, economists can only point out the implications (and perhaps estimate damages for different  $k$ 's and aggregation rules), but policymakers must choose the aggregation rule and method of choosing which  $k$  they want economists to use.

## CONCLUSION

This paper has examined the economic and legal implications of adopting various methods of assessing natural resource damage. We have shown

50. A particularly troubling aspect of a median rule is that the damages of any non-global spill can be reduced to zero loss just by choosing a  $k$  at least 50% larger than the impacted population.

In most situations, differences between contingent valuation, travel cost analysis, and hedonic pricing which are not readily explainable and anticipated *a priori* indicate problems in implementing one or more of the techniques. More generally, economists should be more honest with policymakers and the courts and admit that while they have techniques which can reliably measure upper or lower bounds on natural resource damages, the "correct" estimate may remain elusive given the current state-of-the-art in non-market valuation.

We wish to make several closing remarks. First, CERCLA at present embraces the common law approach of taking the *lesser* of restoration cost, replacement cost, or economic damages.<sup>52</sup> While environmentalists have decried this decision rule, there is fairly uniform agreement among economists that it is the right approach. Nonetheless, there is an important substantive issue about which the law is quite nebulous, namely, the option of assessing damages *after* a partial restoration. In this regard, a utility-theoretic approach clearly leads to support for this option, but the law provides little guidance (nor explicitly rules it out). We believe the choice of the optimal combination of the level of partial restoration and damages assessed is a fertile area for clarification both in the economic and legal arenas.

Second, CERCLA also dictates a hierarchy of valuation techniques starting with market prices *if available* to the various non-market valuation techniques—with contingent valuation as a last resort.<sup>53</sup> This hierarchy approach appears to be motivated by a belief that a *market* price is a more accurate measure of damages than a *shadow* price estimated using a non-market valuation technique. However, in addition to the usual myriad of problems in determining "which" market price to use in court for a good which is frequently bought and sold, a new problem arises with regard to public amenities: rarely are public and private goods close substitutes for each other and even rarer in the damage assessment arena are they the perfect substitutes necessary to argue for the greater validity and reliability of using observed prices in private markets to price public goods. All of the economic valuation techniques work well under some conditions, and we believe a more fruitful approach for the CERCLA rules would be to specify those general conditions rather than mandate a hierarchy of preferred techniques based upon misperceived notions of accuracy.

Finally, over the last decade, the economics profession has made major

52. See 50 Fed. Reg. 52,154 (1985). It is easy to put forth scenarios where any other rule leads to nonsensical actions. Consider, for example, a spill of a small amount of a long lasting but not very potent toxic substance on a relatively shallow ledge five miles off the coast of California. Replacement is impossible since the government already owns all of the sea bed. Restoration is technically possible but might run into tens of billions of dollars.

53. See *id.* at 171.

advances in developing methods to measure and value non-marketed goods which benefit-cost textbooks once referred to as unmeasurables, and it is important that this development continue so that natural resource damage assessment becomes fully legitimized. However, the "cost-effective" clause in the CERCLA regulations strongly encourages financially strapped public trustees to minimize the amount spent on having the natural resource damage assessment done. Unfortunately, a correctly done damage assessment often costs substantially more than the government has been willing to allot. This, in turn, has undermined the integrity of the process because when inadequate funds have been appropriated, the resultant product has at times been shoddy, vulnerable to attacks from all sides, and detrimental to the credibility of economists and economic methods.<sup>54</sup> In addition, the CERCLA Type B Rule *ex post* approach, that is, waiting until the damage has been done, severely compromises one of the better methods for damage assessment, namely, contingent valuation.

To address these problems, policymakers should be willing to spend the appropriate sums for a proper job. For some types of incidents the cost of a damage assessment may greatly exceed the actual damages, but an investment in a "generic" assessment for that type of incident may be quite small over repeated applications. For other types of incidents, the cost of a good economic analysis is often small relative to the damages sought, and it is often better not to present an economic analysis to the court than to present one which is easily torn apart and subject to ridicule.<sup>55</sup> In both cases, the government should be willing to invest in *ex ante* analyses with the goal being to bound the range of economic damages for different types of small and large incidents which occur with a fair degree of regularity.<sup>56</sup> What is needed is an *aggressive* research program of strengthening and expanding the CERCLA Type A damage assessment model.<sup>57</sup> Ultimately, such an investment will cut costs by making the

54. This desire to minimize costs is often coupled with the well known tendency of attorneys to wait until the last minute and expect the experts to come up with the "answers" quickly.

55. There are two stages prescribed by the CERCLA regulations in determining damages. First, there is a preliminary assessment of the likely magnitude, and second, if that assessment shows that damages are likely to be substantial, then a Type B damage assessment is called for. Our criticism is directed toward the tendency to minimize cost in the second stage without regard to quality or information gained. We believe the first stage serves a useful screening purpose. How much the government should spend on a damage assessment might, of course, be determined by a benefit-cost analysis to determine such things as the optimal sample size and number of different valuation methods used.

56. Damage study is a good idea of what the baseline conditions were before the injury to the natural resource occurred. Conducting baseline studies may yield a high marginal return for the public's money in situations where there is a high probability of damage to the resource in question.

57. The current CERCLA Type A economic damage assessment model suffers from two primary flaws: it has tried to be too comprehensive and it is based solely on existing economic valuation studies. The first flaw can lead to some ludicrous results which tend to discredit the model. For example, dumping a ton of plutonium off a national seashore permanently destroying the coast

damage assessment procedure both more predictable and less contestable, thus reducing litigation.<sup>58</sup>

It may also be that the legal arena is an inappropriate venue to settle such disputes precisely because the search for the "correct" answer often gets lost in the often polar positions of the two advocates. It thus may be worth exploring the use of institutional alternatives such as a regulatory commission or an administrative law court where the judges involved could receive the training needed to control the abuses of non-market valuation techniques.

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resulted in a damage estimate of approximately \$300,000. The second flaw means that the studies relied upon in building the Type A model are mostly studies done by planning agencies of the benefits of new facilities or improving the quality of existing facilities. While this was a natural place to start in building the Type A model, there are few studies of the types of incidents most likely to be of concern to trustees. The holes in the Type A model are likely to persist because future revisions of the Type A model simply propose to incorporate new studies which have been carried out independently by agencies and universities in the interim. There is no current funding mechanism for carrying out the long-term program of original research necessary to make the Type A model useful and credible.

<sup>58</sup> While economists and policymakers are likely to see this as desirable, environmentalists may not if they view uncertainty over the magnitude of the damages and the cost of the damage assessment as an added deterrent to industrial spills.