Environmental Damage Schedules: Community Judgments of Importance and Assessments of Losses

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ABSTRACT. *Available methods of valuing environmental changes are often limited in their applicability to current issues such as damage assessment and implementing regulatory controls, or may otherwise not provide reliable readings of community preferences. An alternative is to base decisions on predetermined fixed schedules of sanctions, restrictions, damage awards, and other allocative guides and incentives, which are based on community judgments of the relative importance of different environmental resources and particular changes in their availability and quality. Such schedules can offer advantages of cost savings and consistency over current methods, as demonstrated in the case of Thailand coastal resources.* (Jel Q20)

I. INTRODUCTION

While not the whole of the matter, many environmental policy and management issues center on the economic value of changes in environmental resources and amenities and much attention has consequently been focused on monetary assessments of their degradation or changes in their provision. These issues increasingly include assessing environmental damages, weighing of resource degradation with commercial gains, valuing the preservation of environmental assets and maintenance of resource productivity, and generally setting regulatory restraints in accord with community preferences and objectives—issues that largely involve environmental losses and mitigation of losses. However, current methods of estimating monetary values often remain limited and there is little widespread agreement that they provide dependable and consistent valuations (Binger, Copple, and Hoffman 1995; Kahneman, Ritov, and Schkade 1999), particularly in the case of environmental losses, or reductions in losses, for which the compensation measure of value rather than the willingness to pay measure is appropriate (Knetsch 1990, 1997).

An alternative to allocating resources and setting damage awards on the basis of estimates of monetary values, is to base damage assessments and allocative guides on predetermined fixed schedules that reflect community judgments of the relative importance of different environmental assets and particular changes in environmental resources. Such schedules would detail an array of sanctions, restrictions, and monetary damage awards, which would vary depending on the importance of different losses resulting from the impacts of activities or developments on the natural environment. The use of such damage schedules could be far more universally and less expensively employed than current methods, and could provide more consistent deterrence incentives, restitution for harms, resource allocation guidance, and greater fairness of similar treatment of similar losses (Rutherford, Knetsch, and Brown 1998; Kahneman, Ritov, and Schkade 1999).

The efficacy of a damage schedule scheme is to a large extent dependent on the assessment of community preferences with respect to changes in environmental and resource values. The following reports a test of this. The sections, first outline the advantages and limitations of use of damage schedules, especially as compared to current practices; second, examine the use of paired comparison methods as a means of assessing community preferences on which damage schedules

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might be based; and third, report the results of a case study in which scales of the importance of coastal resource losses in Thailand were elicited by this method.

II. COMMUNITY PREFERENCE-BASED DAMAGE SCHEDULES

Damage schedules do not provide, nor are they intended to provide, monetary measures of value. Yet, even based on more limited assessments of community preferences, schedules may provide transparency, ease of implementation, and most, though not all, of the benefits of monetary valuations, without many of the disadvantages such as the often quite arbitrary and variable assessments resulting from use of current non-market valuation methods. Further, the disadvantages of a seeming lack of more precise valuation may be of little importance in actual practice.

While individuals appear to be unable to assign consistent monetary measures to environmental losses, in large part because of the seemingly inherent insensitivity of people's responses to the quantity dimensions of particular losses at issue and to the context dependence of values (Kahneman, Ritov, and Schkade 1999), respondents are able to provide less demanding assessments of relative values with high levels of consistency (Kahneman, Schkade, and Sunstein 1998). Damage schedules require only the latter; they can be based on assessments of community preferences derived from more easily obtained choices of the relative values of various losses without requiring people to assess such impacts in monetary terms. Such empirical support for damage assessments and weighing of environmental trade-offs is likely to be more consistent with community preferences and objectives than most present strategies, including those based on monetary estimates of people's willingness to pay for losses, negotiations between interested parties, and the often arbitrary resolutions imposed by tribunals.

Damage schedules can provide greater predictability by specifying remedies in advance, rather than after, an event or a change such as an oil spill or degradation of wildlife habitat has taken place. This advanced knowledge can provide more effective and efficient deterrence incentives because people responsible for potential losses would be more aware of the consequences of their actions, thus allowing them to undertake appropriate levels of precaution.

Similarly, enforcement of sanctions would likely be easier because once liability is established in any particular case, the consequence is foretold from the predetermined schedule, rather than being the uncertain result of self-serving data collection, attempts to discredit methods, and contentious adjudication. For many of these same reasons, the costs of using damage schedules should be much lower than those encountered with present practices. Once a schedule is implemented, improvements can be made as new information is brought forward, but there is then no need for new assessments and challenges for each incident or activity as it occurs. Also, initial schedules can be based on sanctions for a relatively few harms, and then expanded as more harms are encountered by interpolating and extrapolating from those assigned previously. In this way, similar to other scheduled damages such as those used to define compensation for workers' injuries, increasingly comprehensive schedules could be developed that would assign remedies to each harm that is appropriate to its importance relative to other losses.

Predetermined schedules of sanctions should also better serve horizontal equity goals as greater similarity of treatment of similar losses will likely result (Sunstein, Kahneman, and Schkade 1998). Present after-the-fact valuations often lead to erratic assessments of similar losses, the product of unreliable methods, differences in protocol, and often in the case of contingent valuations, the arbitrary decisions of how many people's loss over what geographic area are to be "counted" in any particular assessment. They also vary as a result of the inherent difficulty people have in assigning monetary sums to particular resources or changes in their quality or availability. This difficulty was recently demonstrated when a large sample of individuals was found to strongly agree on the relative severity of a series of personal and other injuries, but reached very erratic judgments of the punitive damage awards that should be imposed for each—"the consensus breaks down, however, when jurors are asked to express punitive intent in dollars." (Kahneman, Schkade, and Sunstein 1998, 50).

As damage schedules do not yield accurate valuations of environmental losses, the goal of completely optimal allocations and perfectly efficient deterrence cannot be fully met by their use. Although attractive in principle, this level of certain guidance is not usually a realistic alternative as current methods are incapable of providing such estimates. Each approach has limitations of its own that preclude any such expectation, but beyond the shortcomings of each technique, each is at best used to provide willingness-to-pay measures of loss, rather than the more appropriate compensation demanded (or willingness-to-accept) measure (Rutherford, Knetsch, and Brown 1998). Further, monetary estimates are not normally determinate of specific sanctions and resulting incentives even when they are available.[1] Thus the presumed disadvantage of using the more modest guidance of damage schedules rather than monetary valuation may be more illusory than real. And, as Epstein (1995, 39) suggests in discussing the alleged disadvantage of an analogous alternative legal reform, "The relevant comparison between simple and complex rules should be conducted not in the language of aspiration, but in the language of realizable achievement."

Loss assessments and compensation payments serve other important social purposes in addition to directing resources to more efficient uses. And these are by and large even less demanding of accuracy. One such purpose, for example, is to provide some form of social or corrective justice for a loss. For this, it is more important that people see that environmental resources are not taken to be without value and to be disregarded accordingly, but instead have real worth that is recognized by some form of protection and sanctions that attend their degradation—and the more automatic the attendance, the better. Or, parallel to cases of pain and suffering to individuals, it is often important to provide a means of redress. And as suggested by Radin (1993, 60): "Requiring payment is a way both to bring the wrongdoer to recognize that she has done wrong and to make redress to the victim. Redress is not restitution or rectification. Redress instead means showing the victim that her rights are taken seriously." More important, goals of corrective justice and redress, and ones of providing solace to victims, can largely be met by sanctions and damage awards that need only to be widely seen to be roughly correlated to the severity of the transgression; they do not require an accurate assessment of the monetary value of each loss. Damage schedules may well better serve these purposes by providing more predictable, prompt, and consistent assessments than other approaches.

A further perceived disadvantage of the use of guides such as damage schedules is that these are seen to be based on evidence of relationships that are more generic and more relevant to general classes of cases and less applicable to each individual case. Among the reasons for this bias against use of such more general models are an inflated belief in the accuracy of case-by-case decisions, fears of errors being made in the implementation of more general rules, and the difficulty people have in accepting some level of error associated with the application of a general remedy to a specific case (Payne and Bettman 1992). However, numerous studies have shown that judgments are usually better when "formulas" are used rather than reliance on individual determinants of each case (Dawes, Faust, and Meehl 1989; Payne and Bettman 1992). While there is yet little evidence for the case of environmental loss damage schedules, there appears to be little reason to expect more rather than less case by case inconsistency here as well.

Schedules or their equivalent, have of course been used and accepted in other areas in which specific assessments of the value of losses is difficult or expensive. A somewhat analogous case is the widespread use of scheduled awards for injuries used in most workers' compensation schemes. While usually initially designed to compensate for pe-

[1] For example, Exxon apparently agreed to pay less than one billion dollars ($1.15 billion payable over eleven years) for the natural resource damages caused by the Exxon Valdez oil spill, even though a contingent-valuation study indicated lost existence values *alone* were $3 billion (Portney 1994).

cuniary losses, such as lost wages and medical expenses, most have been implicitly or explicitly extended to cover non-pecuniary losses such as pain and suffering as well. And although the specified sums are not taken to reflect the value of such losses to individuals, they do reflect relative values and are therefore widely accepted and achieve many of the efficiency enhancement and other goals of sanctions. Another similar case of an effective and efficient means of getting many of the benefits of accurate valuations when such assessments are impossible or costly to obtain is the use of liquidated damage clauses in contracts. In such cases, the parties voluntarily agree in advance to a pre-established payment in the event of a breach. Damage schedules, or replacement tables, have also been used for environmental losses, but essentially all instances of such use have been limited to minor harms—usually small oil spills—and the sanctions have typically been based on notions of replacement costs or on fairly arbitrary legislative directives rather than on some empirical assessment of community preferences regarding the importance of different losses (Rutherford, Knetsch, and Brown 1998).

III. DERIVING SCALES OF IMPORTANCE

To a considerable degree the efficacy and advantage of widespread use of damage schedules is likely to depend on the extent to which the damage sanctions or incentives incorporated in them clearly reflect changes in social well-being associated with the change in environmental quality. The usefulness of the approach will be greater if consistent judgments of environmental importance can be elicited that provide more accurate signals of community preferences.

Indicators of community preferences might be formulated in several ways. One relatively simple means which at this point seems most promising, and provides a high degree of transparency, is to elicit scales of relative importance of environmental changes by means of paired comparison surveys (Peterson and Brown 1998). Paired comparison is a well-established psychometric method for ordering preferences among objects of interest (Fechner 1860; Kendall and Smith 1940; David 1988). The method involves presenting binary choices for a set of objects—gains, losses, activities, or whatever is being scaled—to each respondent. For example, if three objects, x, y, and z, are being compared, there are three possible paired comparisons: (x vs. y), (x vs. z), and (y vs. z). If the number of objects is not too large, each respondent can be presented with all possible pairs of the objects.[2]

While varying methods may be used to summarize the respondents' choices among the pairs, the most straightforward is to express them as a function of the frequency with which an object is preferred to (or considered more important than) other objects in the choice set. One way to report this frequency, used in the study reported here, is in terms of the proportion of times that an object is chosen relative to the maximum number of times it is possible to be chosen by all individuals in the sample (Dunn-Rankin 1983). If there were, for example, ten people judging three objects, then any one object could be chosen as being most important a possible 20 times (twice for each individual). As all objects are paired an equal number of times, each object has the same probability of being selected. The proportion indicates the collective judgment of the relative importance of the different elements being compared. Multiplying this proportion by 100 eliminates the decimals, yielding a scale from 0 to 100.[3]

The paired comparison procedure provides an indication of the relative importance of the items being compared, to the groups represented by the individuals taking part in the survey.[4] The results of an exploratory

[2] For each individual, the total number of possible pairs of n objects is: $n(n - 1)/2$. It is possible for each judge to be given only a portion of the possible pairs.

[3] Strictly speaking, this scaling procedure yields an ordinal scale of preference, but if the number of respondents is sufficiently large the scale can approximate an interval scale. More sophisticated scaling procedures, such as those proposed by Thurstone (1927) (see also Torgerson 1958), yield a theoretically correct interval scale measure. The two approaches usually produce scales that correlate nearly perfectly with each other (Dunn-Rankin 1983).

[4] Each respondent, unlike contingent-valuation and other valuation methods, provides numerous judgments

study of the effects of oil spills on four different environments illustrate the procedure. Each of 57 respondents—graduates of a resource management program—was asked to select the more important loss from each of the six possible pairs of the four habitat impairments caused by a spill. On the basis of their choices, a 0 to 100 scale was developed indicating the relative importance of the four losses. The scale values were 91 if the spill occurred in a productive marsh area, 57 if in a deep bay, 48 on an ocean beach, and 4 if on an outer continental shelf (Rutherford, Knetsch, and Brown 1998).

A concern with the elicitation of preferences among objects sufficiently different as to prompt differing attitudes or emotions, is that individuals may feel that the objects are incommensurate. This is frequently cited as a problem for people asked to accept monetary sums in exchange for suffering an environmental loss (or even to pay money to avoid such a loss)—some people consider such environmental losses incommensurable with money. However, judgments of the relative importance of even widely different kinds of losses may avoid this incommensurability concern. As Sunstein (1994, 798) concludes:

> We might also believe that goods are comparable without believing that they are commensurable—that is, we might think that choices can be made among incommensurable goods, and that such choices are subject to reasoned evaluation, without believing that the relevant goods can be aligned along a single metric. . . . Both people and societies do make choices among incommensurable goods, and they do so on the basis of reasons.

Consistent with this view, people do seem to make choices over wide ranges of possible changes, not only in their daily lives, but in paired comparison surveys. In one test of this, different groups of respondents were faced with: (1) pairs of disparate environmental losses; (2) pairs of personal injuries; or (3) pairs that included *both* environmental losses and personal injuries. The evidence suggested that respondents in the third group had only slightly more difficulty in choosing between pairs than the other two groups (Gorter 1997).

Individuals are not expected to be perfectly consistent in their choices. Inconsistent choices, which result in circular triads, may occur because of mistakes, systematic intransitive choice, or random choice in cases too close to call. Systematic intransitive choice is more likely when alternatives are multidimensional so that the prominence of different attributes or dimensions may vary depending on the objects being compared (Tversky 1969; Kahneman, Ritov, and Schkade 1999). Close calls occur when two objects are considered of equal or nearly equal importance, such that one may be chosen over the other in some comparisons, and the other chosen at other times. Peterson and Brown (1998) concluded that the great majority of the circular triads in their data were due to close calls.

IV. AN APPLICATION AND TEST

The usefulness of paired comparisons to assess the relative importance of environmental changes is at least in part a function of the ability of individuals representing relevant reference groups to make sufficiently consistent choices to provide a useful scaling on which schedules can be based. A test of such an ability to make meaningful choices among a variety of realistic resource losses was conducted for both formal experts and actual users of natural resources in Phangnga Bay, a coastal area of southern Thailand.

Like other Thai coastal regions, Phangnga Bay is rich in resources but faces problems associated with the rapid increase in population and economic activities that bring about conflicts among resource users. Dominant coastal ecosystems are mangroves, coral reefs, and seagrass beds (Chansang and Poovachiranon 1994). Many rivers flow into the bay and supply it with nutrients and minerals, making the bay an important spawning ground, nursery area, and habitat for many economically important species including marine shrimps, lobsters, crabs, clams, Indian mackerel, and pomfret. Several species of molluscs and crustaceans inhabit the remaining old growth stands of mangroves. Fishing has been an important activity in the area, but catches have declined with over-

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thus adding to the internal consistency of the resulting scale.

fishing and resource degradation. Coastal aquaculture involving black tiger prawns, cockles, oysters, and cage culture of snapper and groupers has become an important activity in the past decade. Developments of residential housing, tourism related facilities and businesses, and a variety of industries along the coast, have become major sources of economic activity and change, and have become increasingly competitive uses of coastal resources.

Paired comparisons can be used to derive two types of scales of importance on which to base damage schedules. The first is to select a series of specific resource losses, such as a specified fish or mangrove loss, and have participants select the loss in each pair that they feel is the most important. The second is to select a series of activities, such as an oil spill or hotel construction, that gives rise to resource losses and ask respondents to select the activity they feel will give rise to the more serious resource losses in the instances described. The first has the advantage that the scale of importance applies directly to the resource loss at issue, and damages or other sanctions could be based on this loss in accord with a pre-existing schedule. This option, however, requires field investigation of the extent of the resource loss (or losses) occurring because of an event or activity. The alternative schedule for events or activities would base damage awards or other sanctions on the particulars of the event, such as the size and location of an oil spill, regardless of the actual losses caused by the spill.

The results of the paired comparison study of specific resource losses in Phangnga Bay are reported here.[5] The eight specific resource losses used in the paired comparison survey were developed from personal visits to the area, interviews of resource users and other residents, discussions with resource managers and government officials in the area, and the results of an extensive pre-test of the survey. The losses include two levels of damage to four important resources in the area and are as follows:

1. partial damage to sandy beaches;
2. severe damage to sandy beaches;
3. severe damage to mangrove forests;
4. clear-cutting of mangrove forests;
5. partial damage to sea grass beds;
6. severe damage to sea grass beds;
7. partial damage to coral reefs; and
8. severe damage to coral reefs.

In each case, detailed information was provided on the nature and productivity of the resource, extent of the human-caused damage at issue, expected changes in the level of productivity due to such losses, and the length of the likely recovery time for the resource loss to be eliminated in those cases for which this was possible. For example, in the case of partial damage to coral reefs, the importance to marine organisms and recreation and natural beauty were outlined before informing respondents that this loss would reduce the resource productivity by half, and that it would take from 6 to 10 years to recover to previous levels.

Two main samples of respondents were used, one of experts and one of resource users or "layexperts." The former included researchers, academics, administrators, and other government officials with experience and knowledge of the area and the resources at issue. The list of formal experts was based on a registry of the National Research Council of Thailand, and suggestions of known experts on the resources of the area. The layexperts included people living in the area and dependent for the most part on the resources. Quota sampling of individuals willing to participate was used to obtain reasonably comparable separate sub-samples of (1) fishers; (2) shrimp farmers; (3) people in tourism-related businesses; and (4) others living in the area whose dependence on coastal resources was less specific. Convenience samples of respondents from these four occupation groups in the immediate Phangnga Bay area were selected.

Each participant was given a set of paired losses with each pair presented on a separate half sheet of paper and presented side-by-side. The half sheets with each of the individ-

[5] The results of a parallel study using a series of events, such as expansion of shrimp farming, housing development, and oil spills, are summarized in Chuenpagdee, Knetsch, and Brown (in process).

TABLE 1
SCALE VALUES OF RESOURCE LOSSES IN PHANGNGA BAY

Resource Loss	Total	Formal Experts	Lay Experts	Fishers	Shrimp Farmers	Tourism	Others
Clear-cutting of mangrove forests	83	85	83	84	81	80	84
Severe damage to coral reefs	78	83	76	73	76	79	76
Severe damage to mangrove forests	66	62	67	72	67	64	65
Partial damage to coral reefs	54	59	53	51	53	56	51
Severe damage to seagrass beds	44	51	42	42	41	45	41
Severe damage to sandy beaches	40	31	43	41	44	41	47
Partial damage to seagrass beds	20	24	19	18	20	23	16
Partial damage to sandy beaches	15	6	17	19	18	12	19
N	221	51	170	45	40	39	46
Kendall u	0.4683	0.5525	0.4523	0.4667	0.4267	0.4644	0.4401
Observed chi-square	2,912.50	801.49	2,168.40	602.93	494.00	522.15	582.52

ual pairs were arranged in random order, and the losses in each pair were randomly ordered to avoid any bias due to sequencing and location of the losses on the sheets. A reference table listing each resource, the magnitude of loss, and recovery time was provided along with a map of the area. For each paired comparison, participants were asked to choose, "the more important loss, not only to yourselves, but also to the environment, to the economic and social values of the community, and to the future of the area." Instead of the 28 possible pairs of the eight losses, the questionnaires excluded the three obvious pairs in which a more severe loss was compared to a less severe loss of the same resource—with the assumed answers included in the results.[6] Participants in the five samples—the experts, and four groups of layexperts—were asked all of the 25 paired comparison questions.

The results of the paired comparisons from the 221 respondents who completed the survey are summarized in Table 1, in which the scale values for all of the eight losses are listed for each sub-sample and for the totals. The most striking finding is the close correspondence of the scale values across the different sub-samples. Not only did resource users generally give similar scale values as did the experts, but the scale values among the sub-groups of users did not vary widely despite the differing self-interests of the different occupational groups. All sub-samples, for example, considered clear-cutting of mangrove forests to be the most important loss, followed by severe damage to coral reefs. There was, furthermore, relatively close agreement among sub-groups of respondents on the differing importance of each of the other losses. This is indicated by the high Kendall u values, which measure the degree of agreement in the preferences among individuals. The null hypothesis, that there is no agreement among the respondents, was rejected in all sub-samples, which generally means that in this case of resource losses in Phangnga Bay, there was significant agreement among respondents, both in the total sample and in all sub-groups.

The close correspondence of the scale values for the eight individual losses among the various subsamples is further evident in the high correlation coefficients (Table 2). These results illustrate a further property of the paired comparisons as their being analogous to providing respondents with a category or bounded scale, which has been found to yield far more consistent judgments—reflecting the apparent wide sharing of norms—than

[6] The comparison between severe damage to mangrove forests and clear-cutting of mangrove forests was left in the questionnaire since it was not certain how respondents would rate the relative importance of these losses.

TABLE 2
PEARSON CORRELATIONS OF SCALE VALUES OF RESOURCE LOSSES IN PHANGNGA BAY

	Formal Experts	All Lay Experts	Lay Experts			
			Fishers	Shrimp Farmers	Tourism	Others
Formal	1.0000	0.9586	0.9409	0.9541	0.9850	0.9349
Fishers	—	—	1.0000	0.9933	0.9738	0.9985
Shrimp farmers	—	—	—	1.0000	0.9886	0.9954
Tourism	—	—	—	—	1.0000	0.9764
Others	—	—	—	—	—	1.0000

elicited responses based on unbounded magnitude scales (Sunstein, Kahneman, and Schkade 1998).

Although the results indicate a significant level of agreement among respondents in the scale values of resource losses and the significant correlation of values of the relative importance among different groups of respondents, Kruskal-Wallis one way analysis of variance on *ranks* was performed to further test if different groups of respondents were from the same population. The results showed that formal experts differed from three groups of resource users only in their rankings of the importance of partial damage to sandy beaches and with two groups of users for severe damage to beaches. The four groups of layexperts generally agreed in the rankings of all resource losses—an indication that they did not act strategically in favoring resources of particular interest to them.

Two further tests were performed on the scale values of the aggregate responses from all groups. The critical range test helps determine if the two choice scenarios come from the same population of stimuli, and the scalability index is used to quantify the ability of different groups of people to distinguish among these scenarios (Dunn-Rankin 1983). If the difference in the aggregated preference scores of any two choice scenarios is greater than the critical range at the accepted level of probability, the two scenarios can be taken to be significantly different. A positive result provided by this test, together with the high scalability index, leads to the conclusion that the scenarios are sufficiently different that respondents should be able to distinguish among them. On the other hand, when the difference between the two choice scenarios is not significant, this suggests they share some common features and thus could be grouped together as having similar overall importance, though it does not imply that they are otherwise equal. The results showed a very high scalability index of 0.858 for Phangnga Bay, and that out of 28 pairs of comparisons, only four pairs fell within the critical range. Although we concluded that most pairs of the resource losses presented to respondents in the study were substantially different from each other and that respondents were able to distinguish between them, it might still be helpful to suggest groupings of these losses to ease the process of mapping different policy responses onto the importance scale. Figure 1 shows three levels of importance on the importance scale, indicating that resource losses within each level were not significantly different from each other and might be treated with similar policy responses.

In sum, each of the groups of layexperts was able to provide consistent scale values for a range of coastal resource changes, and further, their judgments of the relative importance did not differ greatly from those of a group of experts. This high level of agreement lends increased credence to schedules based on these distinctions. Also, this level of agreement made it possible to use the responses from all respondents, expert and layexpert together, as a basis for a single importance scale. As the scale values were already normalized, they could be directly arrayed on a 0 to 100 importance scale, as in Figure 1, representing the different losses and the respondents judgments of their importance.

An illustrative damage schedule was con-

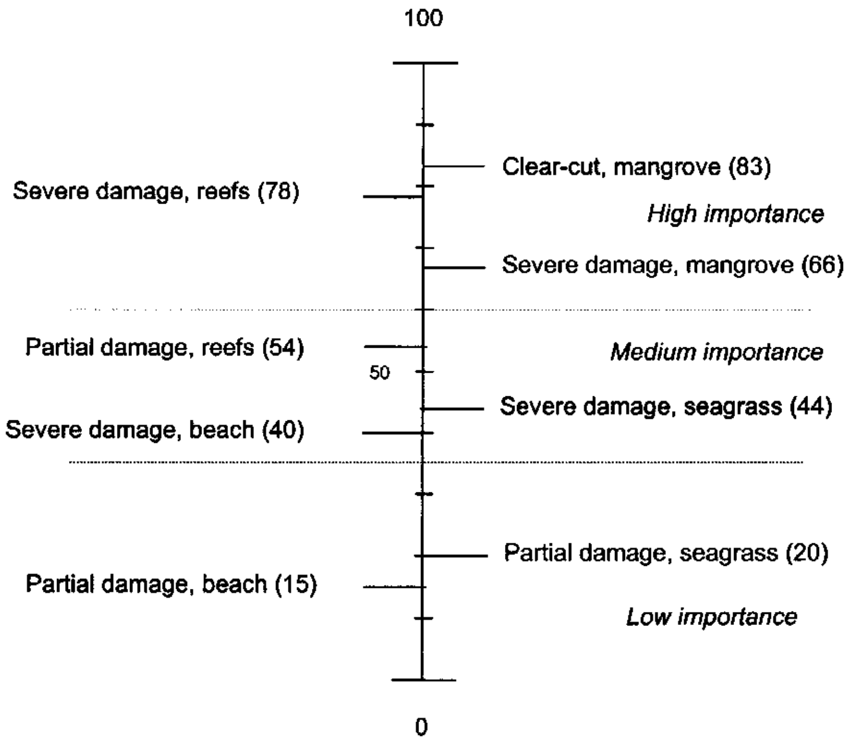

FIGURE 1
SCALE OF IMPORTANCE OF RESOURCE LOSSES IN PHANGNGA BAY

structed based on this importance scale. In general, this process involves assigning different policy responses to these losses according to their level of importance. Figure 2 is an example of a loss damage schedule for Phangnga Bay. If damage payments are to be charged for the damage to these resources, the highest payments would be made for clear-cutting of mangroves, a relatively high damage assessment would be applied to partial damage to coral reefs, a lower payment would be levied for severe damage to seagrass beds, and so forth.

In general, the scale values do not provide an automatic set of sanctions, but they do provide a guide to formulate sanctions, including damage payments, and to design other policies regarding competing uses of these resources which are consistent with an empirical reading of the relative importance of various losses by members of the community. For example, absolute prohibitions or more onerous sanctions might be adopted to severely restrict losses judged to be of the highest importance, such as the clear-cutting of mangrove forests and severe damage to coral reefs. Somewhat less serious losses, such as partial damage to seagrass beds and to sandy beaches, might be subjected to somewhat less stringent restrictions or high damage payments to discourage their loss, but to allow compromise and accommodation in cases of extremely valuable alternative uses. Losses considered by the community as being increasingly less serious might be made subject to notable but successively more lenient restrictions and smaller damage assessments. And in the cases of losses judged to be trivial, an absence or near absence of sanctions could reflect this valuation.

The variable sanctions and damage payments in the design of the damage schedule should make these restrictions more consistent with community judgments of the importance of various losses. This should encour-

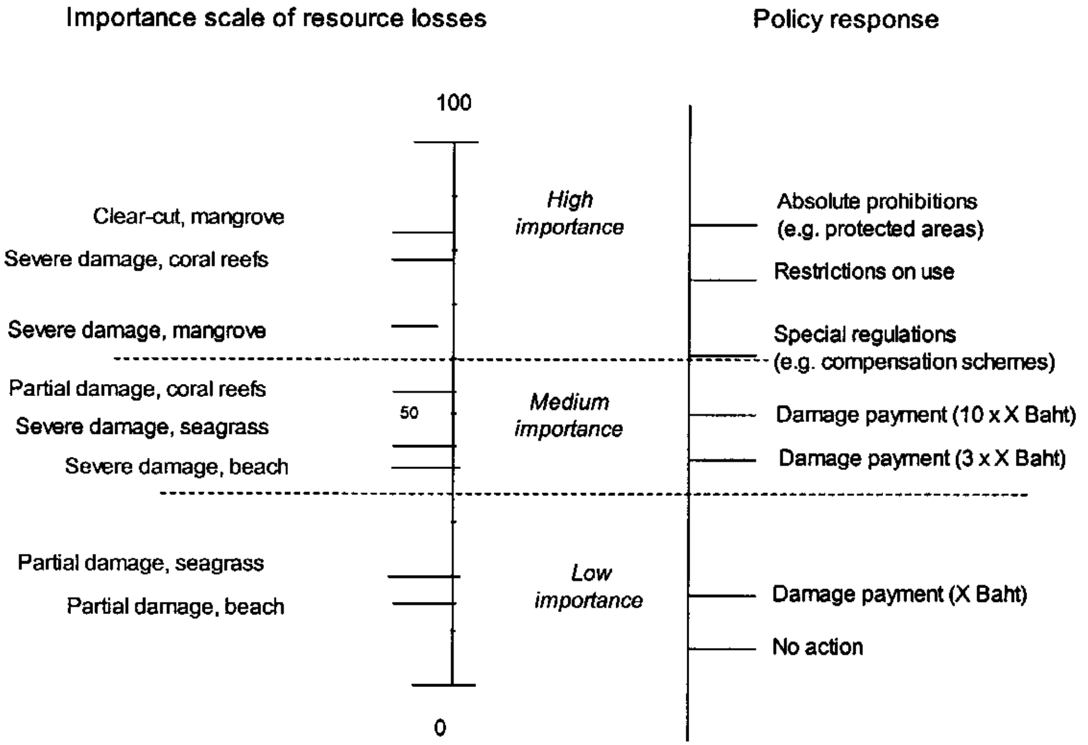

FIGURE 2
ILLUSTRATIVE DAMAGE SCHEDULE FOR PHANGNGA BAY

age more efficient allocations in light of other community goals. As sanctions are set in advance, competing uses of resources would be directed to locations and modes of operation that would take greater account of the full costs of these uses, and restitution would be provided that would be more in keeping with the losses sustained. Further, the sanctions in damage schedules could reflect the disparity in people's valuations of gains and losses and could be adjusted to account for evidence on sums necessary to achieve deterrence and other desired social objectives (Sunstein, Kahneman, and Schkade 1998).

V. CONCLUSION

The mapping of scales of relative importance from, for example, a paired comparison survey, is, like workers' compensation award schedules, with which they have much in common, not an automatic translation nor without the need for somewhat arbitrary assignments. However, in practice, this might well be much less so than the current resolutions. It appears not only possible but likely, based on the results of the Phangnga Bay study, that useful damage schedules can be constructed based on empirically based importance scales so that the damages and sanctions specified by the schedule impose more severe sanctions on what are widely judged to be more serious harms, and lesser sanctions on less important losses.

The schedule represents only approximations of cardinal measures of the social worth of environmental resources, but it does allow policy responses, incentives, and compensation remedies to be tied to internally consistent community judgments of the relative costs or importance of different changes. Further, in much the same way as workers' compensation schedules are developed, more extensive schedules can be developed over time by establishing the relative importance of subsequent changes as they are encountered by interpolation and extrapolation from scale values of those previously assessed.

The use of damage schedules based on people's judgments of relative importance of environmental changes is unlikely to lead to optimal deterrence and maximum efficiency in the allocation of environmental resources. But the alternative is realistically not one that provides this. And for many purposes, including providing socially useful incentives and dependably consistent compensation, this is not a necessity, as long as sanctions and incentives are in accord with the relative importance of changes.

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