A Manual for Conducting Natural Resource Damage Assessment: The Role of Economics

Prepared for:

Division of Economics
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PREFACE

This manual is intended as a training tool for U.S. Fish and Wildlife Service field personnel in the application of economics to assess damages resulting from the release of oil or other hazardous materials to the environment. The purpose of the manual is not to provide a step-by-step guide for the conduct of primary economic analysis, but to provide an understanding of how economics fits within the overall damage assessment process. With this understanding, Service personnel can work as members of the damage assessment team to assure that investigations which are performed are of maximum benefit to the overall damage assessment process.

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This manual reflects the final guidelines on natural resource damage assessment published by the U.S. Department of the Interior and the proposed guidelines on natural resource damage assessment published by the National Oceanic and Atmospheric Administration as of April 1995.

This manual does not represent official Department of Interior or Fish and Wildlife Service guidance or policy. The opinions and assertions expressed in this manual are solely those of the authors.

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This manual is intended as a training tool and information resource for U.S. Department of the Interior (DOI) Fish and Wildlife Service field personnel in the application of economics to assess damages resulting from the release of oil or other hazardous materials to the environment. The purpose of the manual is not to provide a step-by-step guide for the conduct of primary economic analyses, but to provide a better understanding of how economics fits within the overall damage assessment process. With this understanding, Service personnel can work to assure that injury studies which are performed are of maximum benefit to the overall damage assessment process. In particular, this manual provides field personnel with:

- An understanding of the techniques that are often applied to generate economic damage claims for use in settlement negotiations;
- A basic understanding of the types of economic tools that may be applied in more complex and large-scale cases; and,
- A general understanding of the types of information required to support an economic damage claim.

This manual does **not** represent official DOI or Fish and Wildlife Service guidance or policy. The opinions and assertions expressed in this manual are solely those of the authors. In addition, this manual assumes a basic understanding of natural resource damage assessment. While an overview of the natural resource damage assessment process is included, this manual addresses only economic damage assessment in detail.

The purpose of this Executive Summary is to provide an overview of the issues and questions addressed in this manual.

ES.2 An Overview of Natural Resource Damage Assessment

Chapters 1 and 2 provide a general overview of the role of economics in damage assessment. Chapter 1 defines important concepts within damage assessment, and notes that:

- Natural resource damages are separate, distinct from, and residual to remedial activities and spill response actions;
- The principal goal of the damage assessment process is timely restoration of all injured resources;
- The secondary goal of the damage assessment process is to recover compensable values and assessment costs;
- The "value" of a natural resource is the economic value of the services provided by the resource;
- The "services" provided by a resource include all services provided to humans or other resources, including nonconsumptive and passive use services;
- The categories of economic loss that are compensable include changes in consumer surplus or economic rent and reductions in fees or payments for use of a resource;
- The categories of economic damage that <u>are not</u> compensable include taxes foregone, lost wages or other personal income, and losses associated with speculative uses of a resource;
- A relationship exists between restoration costs and compensable values within a damage claim (i.e., trustees should find a balance between these two components of economic damage); and,
- The Department of Interior is a trustee for a wide-range of natural resources over a broad geographic area.

Chapter 2 outlines the steps for conducting natural resource damage assessments under DOI's final rule and NOAA's proposed rule, focusing on the role of economics in the damage assessment process. This chapter presents readers with two general guidelines. First, a preliminary damage estimate, including both restoration costs and compensable values, should be established early in the damage assessment process. This estimate should be updated on a regular basis as additional information is obtained. These estimates need not be made public, but can be used simply to support management of the damage assessment process, and to assure that the costs incurred in conducting the assessment are reasonable. Second, economics has an important role in the restoration alternative selection and costing process. Specifically, the selection of an appropriate restoration option may require the balancing of restoration costs with compensable losses, consideration of the cost-effectiveness of available options, and consideration of the relationship between expected costs

and benefits of proposed restoration options. In addition, economic tools are used to assure that sufficient funds are recovered to allow for completion of selected restoration options.

Chapter 2 also provides guidance on the selection of a damage assessment approach, including descriptions of each of the assessment procedures available under DOI's and NOAA's rules. In addition, brief reviews of issues encountered in data gathering to support compensable value determination, including the need for focused studies and the challenges in dealing with perishable data, are addressed in this chapter.

ES.3 Restoration Costing for Purposes of Natural Resource Damage Assessment

The primary goal of any damage assessment is the full restoration of all injured resources and the services those resources provide. A common problem encountered by trustees in natural resource damage assessment is understating the likely costs of restoration actions, leading to under-recovery of economic damages (i.e., funds recovered are insufficient to support the restoration actions envisioned by the trustees). In addition, responsible parties often reject trustee restoration cost claims as inaccurate, incomplete or poorly documented. Such concerns on the part of the responsible party can slow the settlement negotiation process and delay restoration of injured resources. Thus, Chapter 3 provides a framework for the generation of accurate and complete restoration cost estimates within a CERCLA, CWA or OPA damage claim. Specifically, this chapter describes:

- DOI's and NOAA's rules for restoration costing for purposes of damage assessment under CERCLA, CWA and OPA, including the role of cost in restoration alternative selection, the categories of cost that can be included in a claim, and cost estimating methodologies;

- The potential for pooling recoveries from several releases or sites to fund regional restoration actions;

- The application of a phased approach to restoration planning;

- Typical restoration cost components (e.g., planning costs, implementation costs, program evaluation and monitoring costs);

- The importance of accounting for time in estimating restoration costs (e.g., expected changes in the cost of the project over time, the expected lifespan of capital equipment, the timing of recurrent expenses, and the need to estimate the rate of return (i.e., interest) on recovered funds); and

- Various factors that may introduce uncertainty into the restoration costing process. While it is impossible to account for all sources of uncertainty in a restoration cost estimate, all efforts should be made to account for obvious sources of uncertainty and to make the assumptions used in accounting for these factors explicit in the restoration cost claim. In addition, in some cases, it may be advantageous to allow

the responsible party to undertake the restoration action directly, in order to reduce the exposure of the trustee to this source of uncertainty.

ES.4 Primary and Secondary Methods for Compensable Value Determination

The second component of a claim for natural resource damages is compensation of the public for the interim loss of the injured resources' services. The monetized value of the interim lost services is known as "compensable value." Compensable values can be estimated in a number of ways, depending on the specific characteristics of the damage assessment. In certain cases, the results of existing research can be applied. This technique, referred to as "benefits transfer," is the subject of Chapter 5. In other instances, primary research may be required. Primary research involves collection of original data, and/or development of a model or valuation function specific to the case at hand. The range of primary research techniques that can be applied to estimate compensable values, as identified in the DOI and NOAA rules, is the subject of Chapter 4.

The purpose of Chapter 4 is not to provide step-by-step instructions for the conduct of primary economic research. Rather, this chapter provides field staff who have little or no formal training in economics with a basic understanding of economic tools that may be applied in damage assessment. More specifically, this chapter:

- Provides guidance for conducting primary research in simple assessments;
- Provides a general understanding of more complex valuation methods to allow field staff to conduct assessment planning and management activities for more complex cases; and
- Allows field staff to recognize the potential for claims based on various valuation approaches.

In addition, a better understanding of these techniques will help Service staff in drawing on the results of these types of studies in the context of benefits transfer.

Chapter 4 first provides an overview of the concept of consumer surplus, the proper measure of economic loss in damage assessment. This chapter then provides descriptions of six classes of valuation techniques. These include market-based approaches (e.g., market demand and supply models, fee losses, and the appraisal methodology); added or averted cost approaches; revealed preference techniques (e.g., travel cost and property valuation models); the factor income approach; contingent valuation; and habitat equivalency. Each of these sections include a non-technical explanation of the technique, including the data requirements, examples of the ways in which the technique can be applied, and the technique's advantages and disadvantages. Two examples of the application of the habitat equivalency approach are provided. Since no one method will typically capture call categories of damage resulting from a release event, multiple methods are commonly applied. Thus, this chapter also describes how to identify and account for double counting.

Chapter 5 describes the "benefits transfer" method for assessing economic damages resulting from injury to natural resources, and provides detailed guidance for the application of this technique. Benefits transfer involves the application of value estimates, functions, data and/or models developed in one context to address a similar resource valuation question in an alternative context. In natural resource damage assessment, benefits transfer is often employed:

- When there is insufficient time or financial resources to gather primary data to support a full damage assessment;
- To generate preliminary, or "back-of-the-envelope," compensable loss estimates for purposes of damage assessment planning and budgeting; and/or
- When the expected magnitude of the damage claim does not justify the cost of primary research.

Chapter 5 provides discussion of (1) steps for conducting benefits transfer; (2) uses and types of benefits transfer; (3) limitations of benefits transfer; (4) commonly referenced sources of valuation studies; and (5) the use of public and private expenditures and activities data as a means to infer resource values.

ES.5 The Role of Time in Natural Resource Damage Assessment

In many cases natural resource damages will occur over an extended period of time. For example, the release of hazardous contaminants from an uncontrolled waste disposal site may have resulted in the loss of natural resource services in the past. In addition, these losses may be expected to continue into the future, pending full restoration of the resource. Similarly, trustees may have incurred natural resource damage assessment costs in the past, and may expect to incur costs associated with resource restoration in the future. Under DOI's final rule and NOAA's proposed rule, trustees are expected to present a single, "present value" damage claim to the responsible party. Thus, in many cases, it will be necessary for trustees to apply the concept of "discounting" to a damage claim. The application of appropriate discounting rules is necessary to assure that the public is appropriately compensated for compensable losses, made whole for the cost of conducting the damage assessment, and provided with sufficient funds for the completion of necessary restoration actions.

Chapter 6 provides a general introduction to discounting and capital budgeting for purposes of natural resource damage assessment. Addressed are:

- The need to discount past and future compensable losses in developing a present value damage claim;
- The need to put damage assessment costs in present value terms; and,
- The capitalization of future restoration costs.

Specifically, this chapter provides a brief introduction to the key concepts in discounting; reviews DOI's and NOAA's guidance on discounting in the context of natural resource damage assessments; recommends an approach for discounting past and future compensable losses; recommends an approach for calculating the present value of past and expected future damage assessment and response costs; and provides guidance on capital budgeting for purposes of generating a present value restoration cost claim.

ES.6 Uncertainty in Damage Assessment

Uncertainties exist in any damage claim. For example, it may be difficult to establish the exact number of birds or fish killed as a result of an oil spill, to estimate the time period required for full recovery of a resource, or to measure the public's willingness to pay for an environmental improvement. Uncertainty in the context of damage assessment often extends beyond standard measures of statistical confidence to cases in which little or no primary data are available to support development of a claim. This is especially true for preliminary damage estimates developed for purposes of assessment planning or settlement negotiations.

Chapter 6 outlines the various factors that introduce uncertainty into an economic damage estimate. It also proposes a value of information approach for determining whether to undertake additional research to reduce such uncertainties. The value of information framework allows analysts to consider whether the cost of additional research is warranted given the likely improvement in the accuracy or precision of the final estimate. This approach can be applied to any phase of the damage assessment process as a means to establish priorities for potential data gathering and analytic tasks.

1

INTRODUCTION

1.1 THE PURPOSE OF THIS DOCUMENT

This manual is intended as a training tool and information resource for U.S. Department of the Interior (DOI) Fish and Wildlife Service field personnel in the application of economics to assess damages resulting from the release of oil or other hazardous materials to the environment. The purpose of the manual is not to provide a step-by-step guide for the conduct of primary economic analysis, but to provide a better understanding of how economics fits within the overall damage assessment process. With this understanding, Service personnel can work to assure that injury studies which are performed are of maximum benefit to the overall damage assessment process. In particular:

- Since most cases involve small damages and are settled out of court, this manual provides field personnel with an understanding of the techniques that are often applied to generate economic damage claims for use in settlement negotiations.

- This manual also provides field personnel with a basic understanding of the types of economic tools that may be proposed or applied in more complex and large-scale cases.

- Finally, this manual provides field personnel with a general understanding of the types of information required to support an economic damage claim, allowing these personnel to focus limited assessment funds on those studies required to support the damage claim.

The damage assessment process generally requires the coordinated efforts of scientific, legal, economic and policy specialists. Given an understanding of the role of economics in the damage assessment process, field personnel will be able to work effectively as members of the damage assessment team.

This manual assumes a basic understanding of natural resource damage assessment. While an overview of the natural resource damage assessment process is included in Chapter 2, this manual addresses only economic damage assessment in detail. For guidance on such related topics as injury assessment, restoration planning, and DOI policy on damage assessment, readers should refer to other guidance and training materials available from DOI and the National Oceanic and Atmospheric

Administration (NOAA). In addition, Service field personnel should consult with the solicitor assigned to each case to assure that agency policy and legal requirements are met.[1]

This manual does **not** represent official DOI or Fish and Wildlife Service guidance or policy. The opinions and assertions expressed in this manual are solely those of the authors.

1.2 Relationship of Natural Resource Damage Claims to CERCLA Site Remediation and Oil Spill Response Activities

Natural resource damages are separate, distinct from and residual to remedial activities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or cleanup activities in response to an oil spill. That is, natural resource damages reflect injuries and lost services from the time of the release through completion of remedial activities or spill response actions, as well as any injuries or lost services remaining after these activities are completed. For example, a remedy selected for a site might address the human health risks posed by a site, but not more wide-scale ecological effects. Similarly, oil spill response activities are generally limited to removal of gross oil contamination, while effects such as reductions in fish populations or loss of wetland are not generally addressed. Thus, the purpose of a natural resource damage assessment is to identify activities that will fully restore injured resources to baseline (i.e., pre-release) conditions, and to compensate the public for services lost or diminished from the time of the release through full restoration of the resource.

1.3 An Overview of Natural Resource Damage Assessment

The purpose of this section is to define: the components of a damage claim; the meaning of the term "value" to natural resource economists; the categories of economic damages that are and are not compensable; and the relationship between restoration costs and compensable values. A discussion of the steps generally followed in conducting a damage assessment is provided in Chapter 2.

1.3.1 Components of a Natural Resource Damage Claim

A natural resource damage claim is made up of three components:

Restoration Costs + Compensable Value + Cost of the Assessment

Timely restoration of all injured resources is the primary goal of the damage assessment process. Restoration costs include all of the costs associated with the selected restoration alterative, as discussed in Chapter 3. In addition to recovering restoration costs, a trustee may decide to pursue

[1] In addition, this manual does not provide detailed guidance on the application of the Type A damage assessment model or damage compensation schedules. Detailed guidance for these approaches to damage assessment is available from NOAA's Damage Assessment Center in Silver Spring, Maryland.

a compensable value claim. "Compensable value" is the amount of money required to compensate the public for the reduction in natural resource services from the time of the release until the injured resources and the services those resources provide are returned to their baseline conditions (also referred to as "interim losses"). Compensable values represent the value of lost public use of the services provided by the injured resources plus passive use values [43 CFR 11.83(c)].[2] Assessment costs include all of the reasonable costs of assessing damages at a site.

While all damage claims involve an assessment cost component, not all cases will involve recovery of both restoration costs and compensable losses. For example, an oil spill may result in interim lost use (e.g., a fishing closure), but the trustees may choose a no-action alternative for restoration to allow natural recovery. In such cases, the trustee may act to recover compensable values, which will then be used for restoration projects at other sites. Alternatively, trustees may wish to recover restoration costs following a release event, but may not attempt to recover for compensable losses. For example, interim lost use of the site might be limited (such as an oil spill that effects a bathing beach during the winter), or the cost of assessing the interim losses might exceed the expected damages. In these cases a trustee might simply present a restoration-based claim with no associated compensable damage component. A relationship will often exist between compensable values and selected restoration activities, as discussed in Section 1.3.5.

1.3.2 The Meaning of Services and Value in Natural Resource Economics

For damage assessment purposes, value can be defined in terms of the economic value of services provided by natural resources. For example, one of the services provided by a freshwater lake might be the provision of a recreational fishing and boating site. As discussed in Chapter 2, one of the first steps in a damage assessment involves development of an inventory of the services provided by the injured resource and the identification of services that have been affected by the release event. Once these affected service flows have been identified, the damage assessment team will work to identify methods that can be used to monetize the economic value of the loss. These methods are described in detail in Chapters 3, 4 and 5 of this manual.

Exhibit 1-1

EXAMPLES OF NATURAL RESOURCE SERVICES IN DAMAGE ASSESSMENT

Clean Water

-- Fish Populations
- Recreation, subsistence, passive use

Clean Sediments

-- Benthic Organisms
- Commercial shellfishing, marine transportation, archaeological preservation

Healthy Ecosystems

-- Diverse Wildlife Populations
- Passive use, cultural/spiritual

Not all services provided by natural resources accrue directly to humans, and not all involve consumptive activities. As shown in Exhibit 1-1, the services provided by a natural resource may accrue to other resources (e.g., clean surface water can support

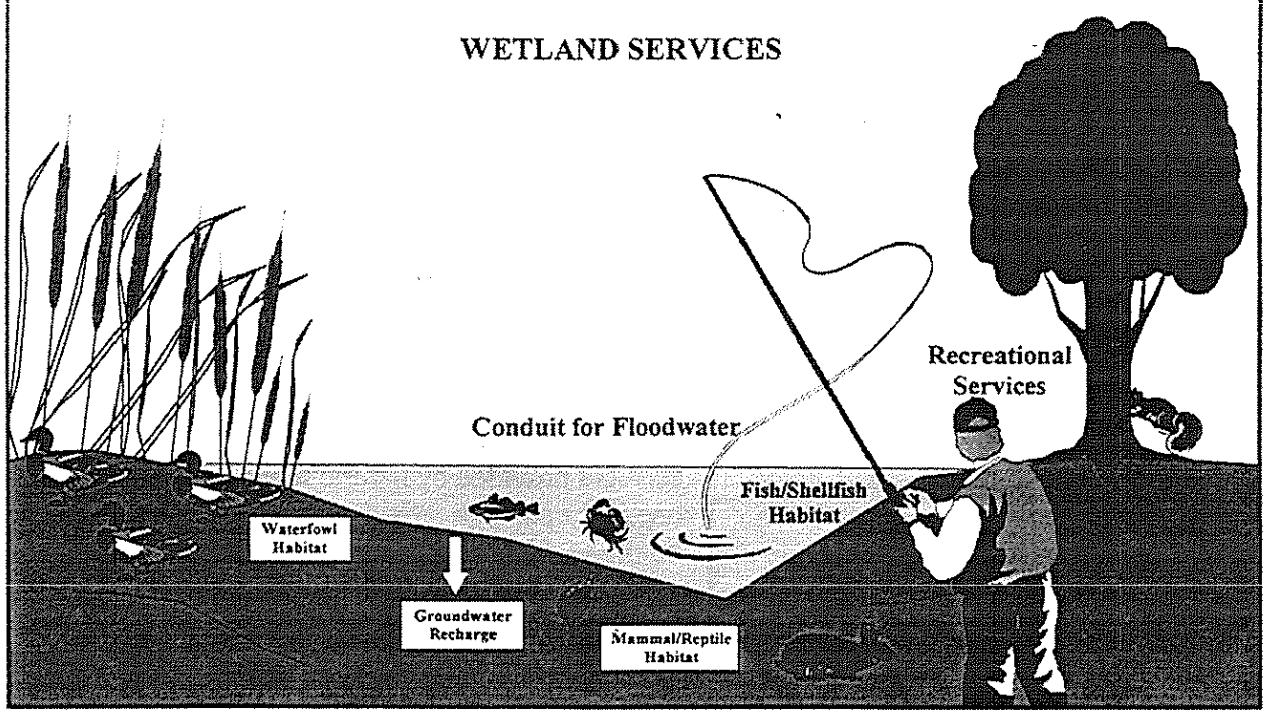
[2] Throughout this document, the term "passive use value" is used to refer to all values not based on the *in situ* consumption or utilization of a resource (e.g., the values individuals place on a resource to simply know that it exists). These values are referred to in the DOI rule for damage assessment as "nonuse values."

fish populations), or to humans (healthy fish populations can support a sport fishery). As described in Chapter 4, methods exist to monetize services accruing to humans and to other resources. In addition, these services need not be consumptive -- many individuals derive passive use values from natural resources (e.g., the value of simply knowing that natural resources exist). Exhibit 1-2 presents a stylized graphic demonstrating some of the services provided by a freshwater wetland.

Exhibit 1-2

NATURAL RESOURCE SERVICES IN DAMAGE ASSESSMENT

WETLAND SERVICES



In addition to their use as a means to monetize economic losses, measures of natural resource services can be used to evaluate the extent to which injured natural resources have been restored (i.e., the actual or expected effectiveness of a restoration activity). These services, however, should not be viewed as a separate commodity to be restored independently of the resource. Specifically,

> [DOI] does not believe that Congress intended to allow trustee agencies to simply restore the abstract services provided by a resource, which could conceivably be done through an artificial mechanism. For example, nothing in the language or legislative history of CERCLA suggests that replacement of a spring with a water pipeline would constitute 'restoration, replacement, and/or acquisition of equivalent resources.' CERCLA requires that natural resources damages be based on the cost of restoration, rehabilitation, replacement, and/or acquisition of an actual natural resource [58 Fed. Reg. 39340, July 22, 1993].

1.3.3 WHAT CATEGORIES OF ECONOMIC DAMAGE ARE COMPENSABLE?

A variety of measures of economic damage are applied within damage assessments conducted under CERCLA and the Oil Pollution Act (OPA). Specifically, the following categories of economic loss are compensable within these statutes:[3]

- Changes in consumer surplus associated with the injured resource. or example, recreational anglers may place a lower value on a stream if the quality of the stream is degraded by releases from an upstream hazardous waste site.

- Changes in economic "rent" associated with the injured resource, including economic benefit accruing to private parties because a federal or state agency or Indian tribe does not charge a fee or price for use of the resource. For example, economic rents are generally not collected on marine fisheries; however, in the event of an oil spill the rent accruing to the commercial fishing operations that utilize these resources might decline. This reduction in rent is claimable by trustees as a compensable value.[4]

- Fees or payments that would have been collected by a federal or state agency or an Indian tribe for a private party's use of the injured resource. For example, a state agency might lease a lake to a concessionaire. In the event of a contaminant release, the concessionaire might fail to make a payment, representing a compensable loss.

In some cases natural resource damages may result from site remediation or oil spill response activities. Damages associated with these activities are recoverable under DOI's and NOAA's rules. For example, the selected remedy for an uncontrolled hazardous waste disposal site might include installation of an impermeable cap, whose construction results in the destruction of wetland. Similarly, intensive cleanup activities following an oil spill can result in collateral damages (e.g., loss of shoreline vegetation). Consideration of the potential effects of such activities should be given at the time of the action (e.g., during oil spill response planning activities or in the form of comments on the proposed remedy for a site), in order to minimize this category of economic damage.

A detailed discussion of economic surplus and a review of the methodologies that can be used to address these categories of compensable values is provided in Chapter 4.

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[3] Many of the terms used in this section, including "consumer surplus" and "economic rent" are defined later in this manual.

[4] Economic rents can be associated with a wide-range of natural resources. For example, a waterway that is used for commercial shipping provides economic rent in the form of transportation services. The economic rents may or may not be collected by a sovereign authority (e.g., a regional transportation authority may impose a fee for use of a canal). If the authority does not collect a fee for use of the resource the economic rent associated with that resource will accrue to the users; if the authority does collect a fee for use of the resource, all or part of the rent will be captured by the authority. In either case, a reduction in the magnitude of the rent due to a release can be claimed as a compensable value.

1.3.4 What Categories of Economic Damage are Not Compensable?

Several categories of economic impact are not compensable under CERCLA or OPA. These include:

- Taxes foregone. For example, if a spill event results in a reduction in wages for individuals working in tourism-related businesses, the loss in income taxes paid by these individuals is not a compensable damage. Reductions in taxes paid do not represent net economic losses, but simply transfer payments not made from individuals or businesses to the government. Taxes differ from fees in that fees are generally assessed in exchange for access or services, while taxes are generally assessed as a percentage of income, sales receipts or real property value.

- Wages and other income lost by private individuals, except that portion of income that represents uncollected economic rent. Following on the example above, reductions in the incomes of individuals working in a tourism-related business following a spill are not recoverable as damages. Economic losses to private parties may be recoverable by affected individuals or private organizations through other legal means.

- Economic damages associated with a speculative use of a resource ("speculative losses"). In practice, speculative use of a resource is defined as any use for which no significant consideration was given prior to the release. For example, a release might result in contamination of an aquifer. If a regional water authority had purchased land above the aquifer prior to the release, with intentions of using the aquifer as a water source at some time in the future, the use in question would not be speculative. However, if no documented consideration had been given to the use of the resource prior to the release, any compensable losses associated with that resource might be considered speculative. The concept of speculative loss is closely tied to the term "committed use" as defined in DOI's final rule.[5]

Private versus Public Losses

The issue of "private" versus "public" losses commonly arises in damage assessment cases. As described in this manual, the compensable loss resulting from a release event represents the reduced value of the resource, as measured by changes in consumer surplus, economic rent, and fees and other payments to trustees. In some cases the claims of individuals may overlap with those of the trustees (e.g., a class action suit by homeowners in response to reduced property values following a groundwater contamination event). Service field personnel should work closely with the regional solicitor assigned to the case to address such issues.

[5] Committed use is defined as either a current public use or a planned public use of a natural resource for which there is a documented legal, administrative, budgetary or financial commitment established before the discharge of oil or the

- For cases under CERCLA, economic damages which occurred wholly before December 11, 1980, and which were associated with pre-December 11, 1980 releases may not be recoverable.[6]

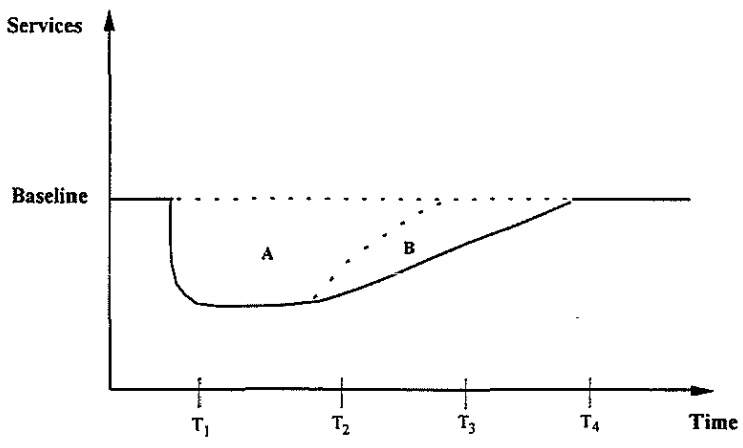
This is a partial list of economic damages that are not recoverable under CERCLA and OPA. Service employees should discuss the categories of damage they hope to pursue with the DOI solicitor assigned to each case early in the damage assessment process in order to identify potential legal obstacles.

1.3.5 THE RELATIONSHIP BETWEEN RESTORATION COSTS AND COMPENSABLE VALUES

Compensable values are often a function of the restoration option chosen for a site. For example, consider the graphic presented in Exhibit 1-3. In this case some event has occurred at time T_1 which reduces services from the baseline (i.e., pre-spill) level to a lower level. This example assumes that, if no restoration activity is undertaken, the resource will recover to the baseline level by time T_4. In this case economic damages would be represented by the area A+B. Now assume that some restoration activity begins at time T_2, which allows the resource to recover more quickly (by time T_3). In this case damages would be represented by area A. In other words, the benefits of the restoration action (in the form of avoided losses) are represented by area B.

Exhibit 1-3

RELATIONSHIP BETWEEN RESTORATION COSTS AND COMPENSABLE VALUES



T_1 = Injury begins
T_2 = Restoration results begin
T_3 = Restoration achieves baseline
T_4 = Baseline achieved through natural recovery
A = Interim compensable values, given restoration
B = Compensable values avoided through restoration

This relationship is also considered in Exhibit 1-4. In this case three alternative restoration options are available, which vary in terms of the number of years to full recovery of the injured resource. For these options, as restoration effort increases, compensable values decrease. For example, releases from an uncontrolled hazardous waste site may have resulted in contamination of a riverine environment. A less intensive restoration action (e.g., source control

release of a hazardous substance is detected [43 CFR 11.14(h)].

[6] While there have been several interpretations of this "wholly before" limitation, this interpretation is the most common.

Exhibit 1-4

RESTORATION COSTS AND COMPENSABLE LOSSES ASSOCIATED WITH DIFFERENT RESTORATION ALTERNATIVES

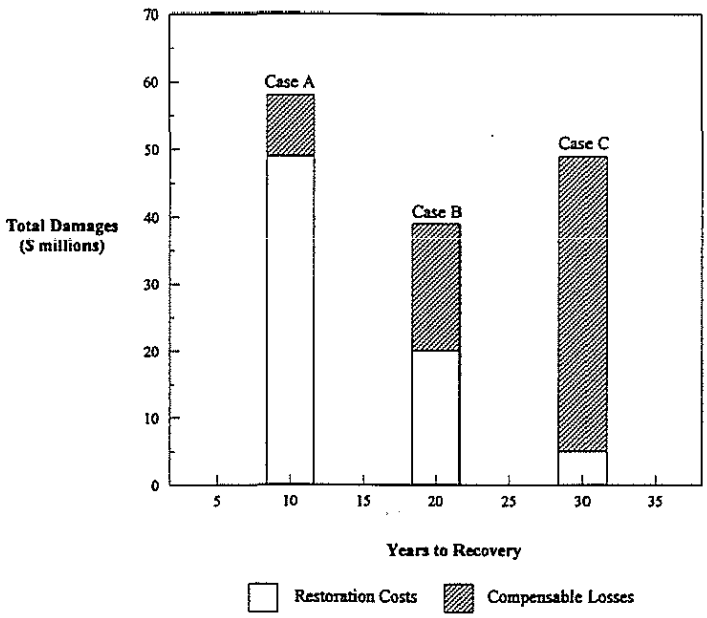
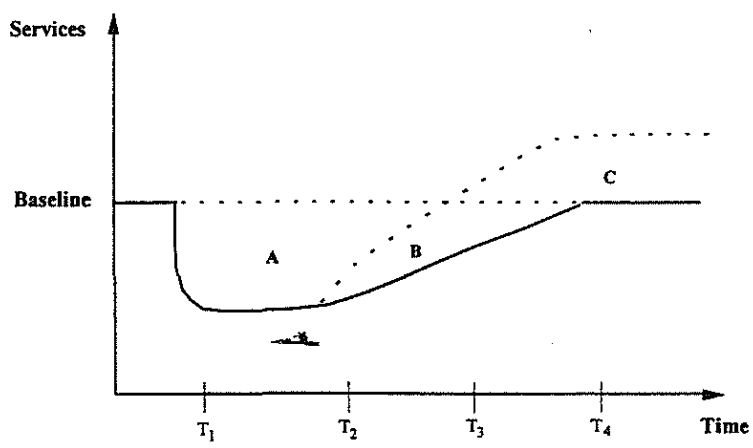


Exhibit 1-5

RELATIONSHIP BETWEEN RESTORATION COSTS AND COMPENSABLE VALUES



T_1 = Injury begins
T_2 = Restoration results begin
T_3 = Restoration achieves baseline
T_4 = Baseline achieved through natural recovery
A = Interim compensable values, given restoration
B = Compensable values avoided through restoration
C = Compensatory services

with no treatment of contaminated sediments) might cost relatively little, but leave significant compensable value losses (as illustrated in Exhibit 1-4 as Case C). Alternatively, a more intensive restoration program (e.g., treatment of contaminated sediment combined with restoration of injured biota) might be relatively expensive, but allow for a large reduction in compensable losses (Case A). In the single example shown in Exhibit 1-4, the economically optimal restoration action would be Case B, which represents the option with the lowest total restoration cost plus compensable losses (i.e., the minimum of total damages). Of course, in many cases it will not be feasible to monetize all compensable losses, or to generate such a complete set of restoration options. The general concept that restoration costs and compensable losses should be balanced, however, should be considered in all cases.

Recall that all funds recovered as part of a damage claim must be used only to compensate the trustees for assessment costs and to restore the resource. Thus, in some cases the pattern of services at the site of a release will look more like the graphic presented in Exhibit 1-5. That is, activities will be undertaken to restore services at time T_2, which will continue past time T_3. These additional services, which are sometimes referred to as compensatory services, are represented by area C.

1.4 Tracking Assessment Costs

A complete damage claim will include all "reasonable" costs incurred in completing the assessment. Damage assessment costs are reasonable when the various phases of the assessment have a well defined relationship to one another and are coordinated, when the anticipated incremental benefit obtained by using a more costly injury or damage assessment technique is greater than the anticipated cost of the technique, and when the expected cost of the assessment is expected to be less than the expected damages. This manual does not provide detailed guidance on assessment cost accounting; however, several general statements can be made:

- Guidelines are available for cost accounting and documentation for purposes of damage assessment (e.g., Superfund cost recovery guidance, Coast Guard spill response cost recovery guidance). Service employees should consult these sources early in the damage assessment process to assure that appropriate procedures are being followed to allow for full recovery of all costs properly allocable to the assessment.

- Costs incurred in all phases of the damage assessment that are properly allocated to the assessment should be recovered. These include the costs of developing a preassessment screen, conducting assessment planning activities, completing the assessment, and conducting post-assessment activities (e.g., restoration planning).

- All costs, both direct and indirect, that are properly allocated to the assessment should be recovered. For example, costs incurred in identifying and contracting with outside experts is a category of costs recoverable within an assessment. Similarly, indirect costs associated with Service employees (e.g., fringe benefits) are also recoverable.

- In some cases pre-judgement interest may be collected on assessment costs incurred prior to a judgement against (or settlement with) the responsible party. In addition, post-judgment interest may accrue on damage awards. Readers should refer to Chapter 6 for further discussion of this topic.

Many of the issues raised in accounting for assessment costs are the same as those in accounting for restoration costs. Readers should refer to Chapter 3 for further review of these issues.

1.5 Interior's Trust Resources

States, Indian tribes and various federal agencies serve as natural resource trustees under CERCLA and OPA, among other statutes. Within the federal government, the Secretary of the Interior shares trustee responsibilities with the Secretaries of Commerce (delegated to the National Oceanic and Atmospheric Administration), Agriculture, Energy and Defense. The Secretary of the

Interior speaks for all DOI agencies, including the Fish and Wildlife Service. Many, if not most damage assessment cases involve multiple state, federal and sometimes tribal trustee agencies.

DOI regulations define trust resources to include:

> ...land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States..., any state or local government, any foreign government, any Indian tribe, or, if such resources are subject to a trust restriction on alienation, any member of an Indian tribe [43 CFR 11.14(z)].

The definition of trust resources promulgated by NOAA under OPA is substantively the same as this definition.

The Secretary of the Interior acts as trustee for natural resources managed or controlled by DOI. Examples of the Secretary's trusteeship include, but are by no means limited to, the following natural resources and their supporting ecosystems: migratory birds; anadromous fish; endangered species and marine mammals; federally-owned minerals; and certain federally managed water resources. The Secretary is also trustee for those natural resources for which an Indian tribe would otherwise act as trustee, in cases where the United States acts on behalf of the Indian tribe. In addition, the Secretary is trustee for natural resources located in, over, or under land administered by DOI. Examples of these land resources include units of the Natural Park Service, the Natural Wildlife Refuge System, and public lands managed by the Bureau of Land Management (Title 40, Subpart G, Part 300.600, "Trustees for Natural Resources," The National Oil and Hazardous Substances Pollution Contingency Plan under CERCLA).

Given the mobility of many fish and wildlife species, the Fish and Wildlife Service plays a broad role in a wide-range of damage cases. For example, Service employees' concerns are not limited to releases that result in acute injury to migratory bird species, but can more broadly encompass the loss of clean habitat for these species. That is, since all habitat has the potential to support DOI trust resources, such habitat may itself be a trust resource.

While the principal responsibility of Service employees is to those resources for which the Fish and Wildlife Service has explicit responsibility (e.g., endangered species or their supporting habitat), in many cases Service employees will need to be aware of other Interior trust responsibilities (e.g., National Park Service lands, off-reservation fishery rights held by Indian tribes), and the trust responsibilities of other state or federal agencies (e.g., groundwater) who may be involved in a damage assessment. Consideration of these resources will facilitate development of a comprehensive damage claim that meets the goals of all trust agencies involved.

DOI's trust responsibilities do not appear to extend to "non-natural" resources, such as cultural and historically important resources (e.g., archeological or historic objects, human remains). However, the services provided by natural resources may include support and preservation of these non-natural resources. For example, a service provided by shoreline sediments might include

The "Grossly Disproportionate Test"

Responsible parties have argued that a "grossly disproportionate" test should be applied to selected restoration activities. That is, the cost of a selected restoration activity should not be "grossly disproportionate" to the benefits of the action, with benefits measured in terms of the increase in resource value or services provided. The term "grossly disproportionate" does not appear in the CERCLA or OPA statutes, nor does it appear in DOI's or NOAA's NRDA rules. Its use was first proposed by the court in a footnote to the Ohio v. Interior decision. In this footnote, the court stated:

> Scholars agree that recovery of full restoration cost in every case, no matter how large the sum is, is not required by CERCLA. DOI obviosly has some latitude in deciding which measure applies in a given case: the rule might for instance hedge on the relationship between restoration cost and use value (e.g., damages are limited to three-times the amount of use value)" [880 F.2d at 443-44 n. 7].

Instead of relying on this test in the selection of an appropriate restoration program, Service employees should follow the DOI and NOAA guidelines for restoration alternative selection. These guidelines include consideration of the cost-effectiveness of available options and the relationship between expected costs and benefits (not all of which can be monetized), as well as a range of other factors.

serving as a "vessel" for historical artifacts. An oil spill might result in the inability to carbon date these artifacts, or shoreline erosion resulting from the loss of vegetation might lead to a loss of archaeological remains. In this case, the value of the natural resource is partly the value of preserving or maintaining historically or culturally significant resources. Similarly, other natural resources might provide the context for cultural resources (e.g., the cultural value of an historic lighthouse may, in part, be related to the beauty of the natural setting in which it is found). In some cases, other statutes (e.g., the Archaeological Resource Protection Act) might serve as a legal means for recovering damages to these resources. Further discussion of the various services provided by natural resources is provided in Chapter 2.

1.6 Overview of Manual

The remainder of this manual is presented in six chapters. Chapter 2 provides an overview of the damage assessment process, with a focus on the role of economics in this process. Chapter 3 addresses the issue of restoration costing for purposes of natural resource damage assessment, with the goal of assuring that restoration cost estimates are complete and accurate. Chapters 4 and 5 address direct and indirect methods for assessing compensable losses. Chapter 6 describes the role of time in the natural resource damage assessment process, including the calculation of present value

restoration costs, compensable values and damage assessment costs. Finally, Chapter 7 contains a general discussion of the role of uncertainty in the damage assessment process.

Several appendices are also provided. Appendix A contains a glossary of terms and definitions of abbreviations commonly encountered in economic damage assessment. Appendix B presents an annotated bibliography of selected documents that provide additional discussion of the issues and topics raised in this manual. Appendix C proposes a standard format for reports of economic damage assessments.

Readers should note two conventions used in this manual. First, citations to DOI's final rules and NOAA's proposed rules for damage assessment are given in an abbreviated format (43 CFR 11.xx and 15 CFR 990.xx, respectively). Since NOAA's rules were proposed rather than final at the time this manual was developed, they had not yet been published in the Code of Federal Regulations. Until they are, these rules can be found at 59 Federal Register 1167-1189 (January 7, 1994). In addition, the term "restoration" is used throughout this manual to refer to any actions to restore, replace, rehabilitate, and/or acquire the equivalent of injured natural resources.

2

THE DAMAGE ASSESSMENT PROCESS

2.1 INTRODUCTION

This chapter outlines the steps for conducting natural resource damage assessments under DOI's final rule and NOAA's proposed rule, with a focus on the role of economics within the natural resource injury and damage assessment process. While the most visible role of economics is in the estimation of compensable losses, economic tools can and should be applied throughout each assessment. Specifically:

- A preliminary estimate of economic damage (including both restoration costs and compensable values) should be established early in the assessment process. Trustees should update this estimate throughout the assessment process as additional information is obtained. Note that these estimates need not be made public, but can be used simply to support management of the damage assessment process.

- The preliminary damage estimate should be used to focus the injury assessment process, as reflected in the definition of "reasonable cost" contained in DOI's final rule [43 CFR 11.14(ee)]. Specifically, DOI defines costs as reasonable when:

  - the various phases of the assessment are coordinated;

  - the benefits of the studies undertaken (measured in terms of their contribution to precision or accuracy of the final damage estimate) exceed the costs of the studies; and

  - the cost of the assessment is less than the anticipated damages.

  NOAA defines reasonable costs to mean those costs associated with performing an assessment in accordance with its proposed rule. NOAA's proposed rule, in turn, gives guidance for each phase of the assessment as to the reasonableness of assessment activities. The proposed rule requires that

any studies or procedures be directly related to the purpose of the assessment and are conducted in a cost-effective manner. This approach does not require the trustee(s) in the early stages of a release event to devise a preliminary estimate of total damages likely to result from the release. However, the proposed rule does require that the assessment be conducted in such a manner to avoid unnecessary and excessive costs.

- Economics has an important role in the restoration alternative selection and costing process. As described in Chapter 1, the selection of an appropriate restoration option may require a balancing of restoration costs with compensable losses, consideration of the cost-effectiveness of available options, and consideration of the relationship between expected costs and benefits of proposed restoration options. In addition, as described in Chapters 3 and 6, economic tools are used to assure that sufficient funds are recovered to allow for completion of selected restoration option(s).

The DOI and NOAA rules provide standardized procedures for estimating economic damages based on the cost of restoring injured natural resources plus the compensable losses incurred between the time of the release and full restoration of the resource. Trustees are not required to follow these procedures; however, trustees who follow these rules will obtain a rebuttable presumption under CERCLA (section 107(f)(2)(C)) or OPA (section 1006(e)(2)). Exhibit 2-1 compares the DOI and NOAA procedures for damage assessment. In general, the two rules are similar, with the most significant differences occurring in the defined assessment procedures.[1]

Whether or not trustees follow these rules, the following phases should nearly always be included in a natural resource damage assessment:

- **Preassessment** -- notification of the responsible party and other trustee agencies, establishment of the protocol for coordination of damage assessment activities among trustees, collection and sampling of ephemeral data, and emergency response actions.

- **Assessment Planning** -- screening of available information, formal determination of whether to proceed with the damage assessment, selection of the damage assessment procedure, identification of scientific and economic methodologies to be applied within the assessment, and development of a preliminary estimate of economic damages.

- **Assessment** -- injury determination, injury quantification, and damage determination.

- **Post Assessment** -- completion of injury and economic damage reports, restoration accounting and restoration planning.

[1] For example, NOAA's rules include provisions for the application of compensation tables for determining damages due to oil or other hazardous material releases; compensation tables are not provided in the DOI rule.

Exhibit 2-1

COMPARISON BETWEEN DOI AND NOAA DAMAGE ASSESSMENT PROCESSES

DOI	NOAA
	I. Prespill A. Prespill Planning B. Trustee Coordination
I. Preassessment Phase A. Preassessment Screen B. Data Collection & Sampling C. Preassessment Screen Determination	II. Preassessment Phase A. Preassessment Determination B. Data Collection and Sampling C. Damage Assessment Determination D. Emergency Actions
II. Assessment Phase A. Coordination B. Notification C. Planning D. Decision on Type of Assessment 1. Type A or Type B E. Assessment 1. Injury Determination 2. Injury Quantification 3. Damage Determination	III. Assessment Phase A. Plan Development B. Assessment (Comp Formula/TypeA/EDA/CDA) 1. Injury Determination 2. Injury Quantification 3. Restoration 4. Compensable Values Determination
III. Post Assessment Phase A. Report of Assessment B. Demand C. Restoration Account D. Restoration Plan	IV. Post Assessment Phase A. Report of Assessment B. Demand C. Restoration Account D. Restoration Plan

Source: National Oceanic and Atmospheric Administration, Proposed Rules for Natural Resource Damage Assessment, 59 FR 1070, January 7, 1994.

As described below, the activities performed under each of these phases can overlap; for example, trustees will often select an assessment procedure and establish a preliminary estimate of damages within the preassessment. In addition, the damage assessment process is often iterative, with progressively more detailed analyses and data gathering activities undertaken as the assessment progresses. The purpose of this chapter is to provide summary descriptions of each phase of a damage assessment, general guidance on the selection of an assessment approach, and a review of the advantages and disadvantages of each approach.

2.2 PREASSESSMENT

This first phase of a damage assessment involves activities required to initiate the assessment, such as: notification of the responsible party and other trustee agencies; establishment of protocols for coordination of damage assessment activities among trustee agencies; collection of ephemeral data (i.e., data that might be lost if not collected soon after a release, such as the number of boaters or bathers turned away from a spill area); and emergency response actions. In some cases limited sampling and primary data gathering and analysis is conducted in the preassessment stage of the assessment (e.g., to support the decision to move forward with an assessment).

In addition, under DOI's and NOAA's rules trustees are required to complete a preassessment screen, referred to as a "preassessment determination" in NOAA's proposed rule. The preassessment screen addresses such administrative issues as: is the release covered under CERCLA, CWA or OPA?; do the trustee(s) have authority to claim damages?; is there reasonable cause to proceed with the claim?; and is there a reasonable probability that the claim will succeed? [see 43 CFR 11.23 and 15 CFR 990.20-25]. As part of the preassessment screen, trustees also identify natural resources potentially at risk, exposure pathways to these resources, and the services that have been lost. These determinations will generally be based on existing information. For example, the release of oil to a mid-Atlantic river might result in the loss of freshwater wetland habitat, the death of several hundred birds and marine mammals, the temporary closure of a recreational fishery, and the temporary closure of a municipal drinking water intake. As part of the preassessment the trustees would consider these categories of injury, as well as the associated services that have been lost or diminished as a result of the spill. These services might include: the provision of clean wetland habitat; shoreline erosion prevention afforded by the wetland; recreational services provided by the wetland and associated wildlife (e.g., local bird viewing trips); recreational angling opportunities; and the provision of clean and inexpensive water for municipal water users.

Exhibit 2-2 lists common categories of injured resources and details some of the services provided by these resources. For example, as a natural habitat, coastal wetland provides services to other natural resources (e.g., a breeding and rearing environment for shorebirds), and to humans (e.g., passive use values). Such wetland also provides flood control and shoreline erosion prevention.

In practice, trustees often develop a preliminary estimate of economic damages as part of the preassessment. This estimate is nearly always based on readily available existing data, and should incorporate the cost of potential restoration actions, as well as any categories of compensable loss that might be included in the claim. General guidance on the development of a preliminary estimate of damages is provided in Section 2.3.1. This initial estimate will rarely be released to the responsible party, and be used simply to support the administrative decision to proceed with the assessment. Preliminary damage estimates can be highly uncertain; in fact, in some cases there will be insufficient information to generate a defensible estimate at this phase of the assessment. This activity will, however, provide the trustees with an indication of the types of studies required to complete the damage claim.

Exhibit 2-2

CATEGORIES OF INJURED RESOURCES AND LOST SERVICES

Example Categories of Injured Resources*	Example Lost Services **
Habitat (e.g., wetland, forested upland, grassland, riverine systems, coastal systems, sediments, coral reef)	Services provided to other resources, such as: clean water, sediments, soils, and food. Passive use
Fish and Wildlife	Recreation Education Cultural Commercial Passive use
National Parks, National Wildlife Refuges, National Monuments, other public lands	Habitat Recreation Education Preservation Cultural Passive use
Beaches, Rivers, Surface Water Bodies, Marine Corridors, Wetlands	Water quality Commercial use (e.g., municipal/ industrial/agricultural water supply; marine transport; economic development) Recreational use (e.g., swimming, fishing, hunting, wildlife viewing) Subsistence use Flood control/erosion prevention Education Research Passive use
Groundwater	Municipal/commercial/industrial/ agricultural use Discharge of clean groundwater to surface water Passive use
Archaeological and Cultural	Historical Cultural Education Research Passive use

* The categories listed in this exhibit are not mutually exclusive (i.e., a release may result in injury to multiple resource categories, as well as a range of lost services).

** The services provided by a natural resource can accrue to humans and to other natural resources, and need not be consumptive.

2.2.1 Assessment Procedures Available Under DOI and NOAA Rules

One of the most significant decisions made by trustees in the preassessment will be the selection of an assessment approach.[2] DOI defines two options for conducting damage assessments: Type A (or "simplified") and Type B ("comprehensive") damage assessment procedures. NOAA's proposed rule defines four options: (1) application of compensation formulas, (2) application of the Type A model, (3) expedited damage assessment, and (4) comprehensive damage assessment. The Type A (i.e., computer model-based) procedures available under DOI's final rule and NOAA's proposed rule are the same. Application of NOAA's proposed compensation formulas is limited to cases involving discharges of ten to 50,000 gallons of oil, and where the trustees have determined that there has not been a significant loss in passive use values. There are no equivalent compensation formulas in DOI's rule. The expedited damage assessment guidelines provided by NOAA reflect a standardization of the simplified Type B assessments that are commonly conducted by natural resource trustees under CERCLA.

This section of the manual describes the available approaches for conducting natural resource damage assessment under DOI's and NOAA's rules. It also provides guidance for selecting from these approaches. In practice, there are a spectrum of approaches and procedures used to estimate economic damages. These range from simple application of the Type A model, to the formal application of benefits transfer techniques (as described in Chapter 5), to full-scale primary investigations. The selection of any one damage assessment approach does not preclude later selection of a different approach. In fact, many assessments are conducted as a series of progressively more detailed analyses. For example, a trustee may apply the Type A model to an oil spill, while initiating a more comprehensive assessment of damages. The initial results of the Type A model may provide insights into the likely magnitude of damages from the spill, or might be used in early settlement negotiations with the responsible party. As noted above, additional analyses and data gathering should be undertaken only if the benefits of the analysis or data exceed their cost. This approach allows the trustee to assess the value of additional effort at each stage of the assessment, and to identify the most promising avenues of analysis to follow.

Selection of an appropriate damage assessment procedure will depend on the characteristics of the case at hand, the level of funding and time available for the assessment, and the purpose of the assessment (e.g., to establish a preliminary estimate of damages as part of the decision to proceed with a full assessment, or for use in settlement negotiations with the responsible party). Specific questions to consider include, but are not limited to:

- Are simplified methods or models available to address the damage category of concern?
- Are there case-specific or site-specific factors that preclude the use of a simplified approach, or an approach based on benefits transfer (e.g., the discharge resulted in substantial injury to a unique or highly valued resource)?

[2] Under DOI's final rule, selection of an assessment approach is considered to be part of the "Assessment" phase (see Exhibit 2-1). In most cases, however, trustees will select an assessment approach during the preassessment.

- Are more detailed methods available for damage estimation, and are these methods likely to be applicable to the case at hand?

- Will a more detailed or case-specific analysis provide a significantly more accurate or defensible damage estimate?

- Is the expected improvement in accuracy or defensibility resulting from the application of a more detailed approach justified in light of the added cost?

- Is sufficient funding available to cover the cost of the assessment?

- Is sufficient time available to undertake more detailed or case-specific analysis?

- Is recovery of damages from the responsible party likely, including the cost of the assessment (i.e., does the responsible party have sufficient financial services)?

- What is the status of the relationship and communications between the responsible party and the trustees (i.e., is the responsible party likely to litigate or is a negotiated settlement likely)?

- Do the advantages of increased accuracy and completeness in the damage estimate outweigh the potential disadvantages of delays in resource restoration?

The type of damage assessment approach selected will often be dictated by the litigation calendar. For example, a responsible party may declare bankruptcy. Once this action is taken, the courts will dictate the schedule under which all creditors, including natural resource trustees, must present their claims. Thus, trustees may need to develop a reasonable remediation and restoration scenario (if one has not been selected for the site) as well as an estimate of compensable value within the time constraints of the bankruptcy proceeding. Similarly, statute of limitations issues or other legal constraints may force trustees to estimate damages prior to selection of a final remedy for a site. In these cases trustees will need to project such factors as the expected timing of resource recovery and the expected effectiveness of site remediation activities in order to estimate damages.

The cost of conducting a damage assessment will vary depending on several factors, including the types of natural resource services affected, the amount and quality of available data, and the nature of the natural resource injury. For example, detailed data on recreational behavior (e.g., number of recreational anglers who traditionally visit a site) are often collected by resource management agencies. While the quality of these data vary, in some cases these estimates may be sufficient to meet the needs of the damage assessment (e.g., a case in which a negotiated settlement is likely). Similarly, existing estimates of the cost of restoring injured wetland may be available for use in establishing a restoration cost estimate. In other cases, existing data may not be available, prompting the need for primary data gathering or analysis.

Below are brief reviews of the various general techniques available for damage assessment.

2.2.1.1 COMPENSATION FORMULAS

Under OPA, the simplest option for estimating economic damages involves the application of compensation formulas [see 15 CFR 990.40]. These formulas may be used for spills between 10 gallons and 50,000 gallons, as long as trustees determine that the loss in passive use values resulting from the release is not significant. These formulas estimate economic damages based on predicted average restoration costs and average lost use values. Natural resource injury is predicted based on several factors, including the season, type and quantity of oil released, and region and type of habitat affected. Separate formulas have been developed for spills in estuarine and marine environments, and inland waters.

If trustees decide to apply NOAA's compensation formula, damages estimated using the formula are added to any economic losses estimated by the trustees for beach or shoreline closure or lost boating days (for inland waters), and the cost of conducting the assessment. Other categories of damage may be included as long as their inclusion does not result in double counting. A brief discussion about the application of the compensation formulas is provided in NOAA's proposed rule [15 CFR 990.41 and 990.42]. More detailed discussion is contained in the documents "Compensation Formula for Natural Resource Damage Assessments under OPA: Oil Spills into Estuarine and Marine Environments," and "Compensation Formula for Natural Resource Damage Assessment under OPA: Oil Spills into Inland (Freshwater) Waters."

2.2.1.2 TYPE A MODEL PROCEDURES

DOI has developed two simplified models for estimating economic damages from releases of oil or other toxic substances: the Coastal and Marine Environments Model (CME) and the Great Lakes Model (GLE). The CME model was finalized in March 1987 [52 FR 9042] and revisions were proposed in December 1994 [59 FR 63300]. The GLE was proposed in August 1994 [59 FR 40319] and had not been finalized at the time that this manual was written. In its proposed rule, NOAA indicates that trustees may use the CME under OPA and that it is likely to adopt the GLE as well.

These models consist of three main components: (1) a physical fates submodel used to determine injury; (2) a biological effects submodel used to quantify injury; and (3) an economic damages submodel used to determine economic damages. Use of the model requires information on the characteristics of the release (e.g., substance and quantity), parameters related to the release and the resources likely to be affected (e.g., the location of the spill, the type of environment affected, wind speed at the time of the spill) and information regarding lost services (e.g., length of beach closure, area of hunting closure). Readers should refer to the guidance manuals for these models for a complete discussion of their use, and to DOI's and NOAA's rules for guidance on when the use of these models is appropriate.

2.2.1.3 Expedited Damage Assessment/Simplified Type B Assessment

In its proposed rule under OPA, NOAA included a damage assessment procedure usually referred to as "expedited damage assessment." This procedure is intended to offer flexibility to trustees in estimating economic damages, recognizing that the Type A model may not address all the types of resources affected by a hazardous material release event, but at the same time recognizing that a comprehensive damage assessment may not always be warranted. Note that while DOI does not specifically describe this approach in its current rules for damage assessment under CERCLA, numerous assessments conducted by Interior agencies can be classified as "expedited" assessments.

Estimating economic damages using expedited damage assessment procedures essentially requires following the same steps, but in less detail, as those required in a comprehensive damage assessment: injury determination, injury quantification and damage determination. Expedited damage assessment, however, involves the use of simplified valuation methods, such as the habitat equivalency model or benefits transfer techniques, as opposed to more expensive and time consuming primary valuation approaches (as described in Chapter 4). Thus, within an expedited damage assessment the economic valuation step is likely to rely heavily on existing information and, possibly, limited primary data gathering efforts.

2.2.1.4 Comprehensive Damage Assessment/Full Type B Assessment

The final option available to trustees to evaluate economic damages is the comprehensive or Type B damage assessment procedures. This assessment approach is employed in cases involving significant injury to resources resulting in substantial direct use and passive use losses. These types of cases may require detailed, site-specific scientific and economic studies to determine and quantify injury, and to evaluate economic damages. Such assessments will generally involve teams of government and private sector investigators, and may take years to complete.

For example, wide-scale contamination of a marine bay system or inland waterway will likely require primary assessment activities to define the extent of contamination, potential remediation alternatives, the type and scope of lost resource services, and the resulting loss in direct use and passive use values (as defined in Chapter 4). Note, however, that it will generally be appropriate to construct a preliminary estimate of damages, using the same types of data and techniques as might be used in a Type A or expedited assessment, prior to undertaking such primary data gathering or analysis.

2.3 Assessment Planning

The second phase of DOI's damage assessment procedures is the development of a plan for conducting the natural resource damage assessment [see 43 CFR 11.30 through 11.35]. The purpose of this phase of the process is to ensure that the assessment is performed in an organized and systematic manner and at reasonable cost. This phase includes the following:

- Continued coordination among trustees (e.g., designation of a lead trustee).
- Identification and possible involvement of potentially responsible parties.
- Formal selection of the type of assessment procedure to apply (e.g., Type A or Type B).
- Identification and documentation of the scientific and economic methods to be used in developing the damage estimates, including estimates of the costs to perform the studies.
- For Type B assessments, development and documentation of sampling, quality control and quality assurance plans.
- For Type B assessments, development of a preliminary estimate of economic damages.

In section 2.3.1 we review the steps followed in developing a preliminary estimate of damages, and in section 2.3.2 we provide additional guidance on the development of the damage assessment plan.

2.3.1 Development of a Preliminary Estimate of Damages

Under DOI's rule for damage assessment under CERCLA, trustees must "develop a preliminary estimate of: the anticipated costs of restoration, rehabilitation, replacement, and/or acquisition of equivalent resources for the injured natural resources; and the compensable value...of the injured natural resources" [43 CFR 11.35(a)]. The purpose of this estimate is threefold: (1) to provide an order-of-magnitude estimate of economic damage for use in administrative decision making and settlement negotiations with the responsible party; (2) to allow the trustees to identify categories of injury that should be valued as part of a full damage assessment; and (3) to confirm that the costs of conducting the damage assessment using the selected methods are reasonable and justifiable.

In addition to restoration costs, the preliminary estimate of damages may include compensable values (i.e., the economic value of any services that have been lost or diminished as a result of the release event from the point in time when the release occurred through full restoration of the resource). This preliminary estimate will generally be based on existing data and limited primary field study. The preliminary damage estimate can be expressed as a range of values, explicitly reflecting uncertainties in the available information.

In the course of developing the preliminary estimate trustees may find that: (1) methods do not exist to quantify the magnitude of economic damage for a particular resource and/or service; or (2) methods exist, but the data required to complete the analysis using these methods are not available within the scope of this phase of the assessment. At this time, efforts should be made to bound the

potential magnitude of economic damage using reasonable assumptions. Where sufficient information is not available even to allow for an order of magnitude estimate of damage, a qualitative description of the damage category should be developed. If the available information indicates that the magnitude of damages is likely to be significant, a more detailed analysis can be conducted as part of the full damage assessment. Several of the case studies presented in later chapters of this manual represent assessments of the form common to preliminary damage assessments.

The steps typically followed in developing a preliminary damage estimate are:

Step 1: Review available data on the release and the site;

Step 2: Identify categories of natural resource injury;

Step 3: Identify natural resource services potentially affected by the release;

Step 4: Select services for analysis;

Step 5: Identify and describe available restoration options (including the likely cost of such options, and the extent to which, and the time frame in which, these options will restore the injured resource and lost or diminished service flows);

Step 6: Identify methods and data sources to estimate damages, considering the types of data required and available to complete the damage calculation;

Step 7: Estimate the magnitude of lost services (e.g., lost user days);

Step 8: Estimate economic damages by assigning economic values to the lost services; and

Step 9: Define major uncertainties and limitations to the analysis.

Note that these steps will apply for any type of natural resource damage assessment (e.g., preliminary, expedited, comprehensive). The primary difference relates to the level of effort committed to the assessment. Typically, a preliminary damage assessment will rely on readily available data and existing studies. In contrast a full-scale damage assessment will require primary data gathering and other field investigations.

2.3.1.1 Selection of Services for Analysis

Trustees generally will have conducted Steps 1 through 3 as part of the preassessment phase. At this stage, trustees should review any new information obtained since the preassessment determination to identify injury to natural resources and services potentially affected by the release or spill. Based on this review, trustees will develop a list of potentially affected services.

Step 4 entails selecting services for further analysis. In considering compensable losses, an obvious criterion in selecting from the list of disrupted services is the expected magnitude of economic damages. For example, a reduction in recreational fishing opportunities may have resulted from an oil spill event, but the expected magnitude of the this loss may not warrant the effort required to develop a quantitative damage estimate for this category of natural resource service (e.g., the closure may have only extended for a few days). The availability of sufficient information on the nature and magnitude of injury will also be an important determining factor in the selection of services for further analysis.

2.3.1.2 Identification and Costing of Restoration Options

The fifth step in the development of a preliminary damage estimate is to evaluate available restoration options. This step includes gathering information on the expected cost, effectiveness, and timing of each option. Information on the likely timing and effectiveness of potential restoration actions will be required to develop a preliminary estimate of compensable losses, since these losses will continue to accrue during the restoration process. In developing a preliminary estimate of expected restoration costs, trustees should take into account the ability of the injured resources to recover naturally, as well as the anticipated effects of any spill response or hazardous site remediation actions. A further discussion of restoration costing is included in Chapter 3.

2.3.1.3 Estimating Compensable Losses

Steps 6 through 9 in the development of a preliminary estimate of damages involve the estimation of compensable losses (e.g., the monetization of lost services resulting from the time of the release through full recovery of the resource). After selecting those services that merit further analysis, trustees identify the methods and data sources available for estimating economic damages. As described in Chapters 4 and 5, there are an array of valuation methods available for use in evaluating compensable losses. For the purpose of preliminary damage assessment, trustees should focus on simple methods that do not require intensive data collection or primary analysis. These methods may include benefits transfer, the habitat equivalency approach, as well as some market based approaches (such as market price, added or avoided cost, and estimation of lost fees).[3] Note that application of a simplified approach at this phase of the assessment does not limit the use of primary valuation techniques later in the assessment.

In estimating the magnitude of lost services, trustees should compare the baseline level of services provided by the resource (i.e., the level of services that would have been provided by the resource in the absence of the release) to the level of services experienced after the release. Note that the magnitude of lost services may vary over time as the resource recovers from the release event, either naturally or in response to restoration activities undertaken by the trustees. The recovery rate may vary by service category, and thus should be considered separately for each category of service

[3] Readers should note that application of the habitat equivalency approach, while simplified in an economic sense, may require significant scientific assessment.

lost or diminished as a result of the release. For example, the amount of oil present in a wetland following a spill event may decline in a short period of time to a level at which bird watchers are willing to return to view birds. Restoration of the same wetland as a fully functioning nursery for juvenile fish, however, may require a longer period of time.

After the magnitude of lost services has been quantified, trustees next must apply a dollar value to this flow of services. For purposes of the preliminary assessment, these values should be estimated based on existing data and simplified valuation approaches, such as benefits transfer. For example, valuation of the closure of a marine transportation corridor would probably rely on readily available site-specific data, while valuation of lost or diminished recreational opportunities might rely on benefits transfer. In some cases existing data will not be sufficient to allow for the development of a preliminary compensable damage estimate. In these cases trustees should develop a qualitative description of the economic effect. For example, trustees may believe that the release of a hazardous substance has resulted in injury to an endangered species population; however, the magnitude of the injury might be unknown at this phase of the assessment. In this case the trustees would note that passive use values for this resource may have been diminished, and might propose studies to better define the magnitude of the loss.

The final step in the preliminary assessment process involves the documentation of significant sources of uncertainty and limitations in the analysis. This step is key to the selection of injury categories and services for further analysis, and in the prioritization of damage assessment studies. In planning the damage assessment, trustees should focus on those studies that: (1) are required to document injury at the site; (2) will support selection and costing of restoration options for the site; and (3) will allow for the development of a defensible and accurate compensable damage claim for direct use and passive use losses at the site. In selecting studies for development of a compensable damage claim, trustees should place the highest priority on those categories of damage that are of the greatest magnitude, and which demonstrate the greatest uncertainty. In reporting the preliminary estimate of restoration costs and compensable losses, it may be appropriate for trustees to generate a range of damage estimates, reflecting alternative injury and valuation assumptions. In this case, the assumptions used to generate these estimates should be clearly stated. In addition, any significant sources of uncertainty that are not explicitly captured in these estimates should be defined and discussed (further discussion of uncertainty in damage assessment is provided in Chapter 7).

Consider the following simple example:

> Ongoing releases of toxic metals from an abandoned mine site have resulted in injury to fish and wildlife populations downstream from the site. Specifically, the trustees have identified two categories of injury for further analysis: (1) reductions in fish populations due to acute mortality at the site (including several species popular with recreational anglers), and (2) reductions in the reproductive success of several endangered bird species in the area of the release. In addition, due to wide-spread public concern over the environmental effects of the site, the trustees believe that passive use losses may exist for the site. Remediation actions planned for the site will halt further releases from the site, but will result in the loss of several acres of freshwater wetland.

Exhibit 2-3 provides a summary of the results of Steps 6 through 9 of the preliminary assessment conducted for this case. As shown, for each impacted service category the trustees have estimated the magnitude of the lost services (e.g., number of fishing trips displaced), as well as the economic loss associated with these service impacts. In those cases for which insufficient information was available to establish a compensable loss estimate the trustees have considered the potential unit value of the loss in services. For example, the loss of clean habitat is believed to have resulted in a reduction in reproductive success for several pairs of bald eagles. This loss is valued in the third column of Exhibit 2-3 based on the cost of providing clean replacement habitat (as described in Chapter 4, the habitat equivalency method can be used to compensate the public for past losses in environmental services through the provision of additional services of the same type in the future). For each category of damage, the trustees note the principal uncertainties associated with the preliminary damage estimate in order to focus any additional studies that are conducted. In addition, the trustees identify primary valuation approaches that could be applied in a full assessment.

2.3.2 Preparation of a Damage Assessment Plan

Once the decision is made to proceed with a full damage assessment, the final task in the preassessment determination is the development of a damage assessment plan. The damage assessment plan represents a formal summary of the results of the preassessment determination and a generalized plan, including descriptions of the types of studies required and cost estimates for these efforts, for the investigations required to complete a full damage assessment. While the degree of detail provided will vary from case to case, damage assessment plans should incorporate that information required to facilitate and focus the damage assessment process. The assessment plan can serve the following purposes:

- Identify the scientific and economic methodologies that the damage assessment team expects to apply during the full damage assessment;
- Identify available restoration and replacement options and outline the selected approach to further investigation of these options;
- Provide information that demonstrates that the damage assessment can be performed at reasonable cost and within a reasonable time frame, and that the identified approach is the most cost effective available;
- Provide formal justification for selection of the proposed assessment methodologies;
- Facilitate coordination among parties involved in the damage assessment; and
- Identify procedures and schedules for conducting the assessment, including schedules and plans for collecting data and sharing it with potentially responsible parties.

Exhibit 2-3

EXAMPLE: PRELIMINARY ESTIMATE OF COMPENSABLE LOSSES

Service Category	Magnitude of Lost Services	Preliminary Economic Damage Estimate	Uncertainties and Limitations	Primary Valuation Approach
Recreational Fishing	10,000-20,000 trips/year displaced, 1980 (year in which fishing restrictions put in place) to 2010 (year in which fishing restrictions are expected to be lifted).	$50,000-$100,000/year.	Value per displaced trip. Number of trips/ year displaced.	Travel cost model.
Clean Habitat for Endangered Bird Species	Several pairs of bald eagles have experienced reduced reproductive success. Injury is believed to have existed since 1965, and is expected to continue until 2020 (year in which full recovery is expected).	Unknown. Cost of replacement breeding habitat is estimated to be $60,000 per nesting pair; additional damages will be estimated for compensation for past losses.	The number of breeding pairs affected; the availability of substitute and compensatory habitat.	Cost of replacement habitat. Habitat equivalency approach.
Productive Wetland	5 acres (following site remediation)	$100,000, based on the cost to replace this lost habitat.	No significant uncertainties.	Replacement cost.
Passive Use Values	Passive use losses for 1.5 million households in the state in which the site is located; from 1980 (year in which site became public) to 2020 (year in which full recovery is expected)	$10/household/year, or $15 million annually.	Willingness to pay per household.	Contingent valuation.

Formats for damage assessment plans will vary depending on the unique conditions of a case, time and funding constraints, and the legal status of the case. For example, negotiations may necessitate the development of a preliminary plan. Similarly, time constraints associated with some release events may require the preparation of preliminary study designs and interim reports. The form and scope of the damage assessment plan should be established to best meet the needs and conditions of the case at hand. However, in all cases the plan should identify the need for further investigations, describe how these additional investigations will address significant uncertainties or unknowns identified in the preassessment determination, establish

an estimate of the cost of conducting these additional investigations, and define the time required to complete such investigations.

2.4 ASSESSMENT

Once the preassessment and assessment plan or preassessment phase report are complete, the trustees will proceed to conduct the damage assessment, assuming settlement has not been reached or a determination to terminate the assessment process made. This section provides a general description of the steps followed in a Type B assessment (whether expedited or comprehensive), which include injury determination, injury quantification and damage determination, with a focus on the data and steps required to support the development of an economic damage claim. This section also provides a review of issues encountered in undertaking primary data gathering to support a damage claim. In addition to outlining the steps followed in completing the assessment, this section also reviews issues associated with gathering primary data to support estimation of compensable losses.

2.4.1 INJURY DETERMINATION

In this first step of the assessment phase, trustees identify categories of natural resource injury resulting from the release of oil or other toxic substance. The focus of these efforts should be on categories of injury that can be documented to support a restoration or compensable value claim. For example, a study to fully define the extent to which a release event may have resulted in a change in the nature of the benthic invertebrate community at a site may yield important scientific findings, but may not provide information to the restoration planning process or economic assessment process. Specifically, trustees need to determine that (1) injury has occurred to trust resources, and (2) the injury resulted from the discharge of oil or toxic substance from the incident or site in question.

The steps to injury determination generally include:

- Identify types of resources potentially affected;
- Conduct sampling and testing of these resources;
- Determine if injury to these resources has occurred; and
- Determine the exposure pathways causing the injury.

DOI's rule provides guidance on determining the exposure pathways and on testing and sampling techniques appropriate to damage assessment [43 CFR 11.63 and 11.64].

2.4.2 Injury Quantification

In the second phase of the assessment process, trustees quantify the extent of injury and consider the reduction in the quality and quantity of services provided by the injured resources. As in the injury determination stage, the focus of this phase of the assessment is on the development of information to support the selection and design of restoration options, and on the documentation of compensable losses.

In the injury quantification phase of the assessment, trustees attempt to place numerical bounds on the extent of the injury, such as the time period over which the injury occurred, the area over which the resource was injured, and the severity of the injury (e.g., concentration of contaminants in groundwater, extent of reproductive failure in a bird or fish species). The time period over which the injury has (and will) occur is important to the ultimate quantification of compensable values. This step may require the development of estimates of the ability of the resource to recover in the absence of any restoration activities, and the extent to which the resource will recover under various proposed restoration options. Note that impacts by other hazardous substances or other anthropogenic effects (e.g., a dam, urban development) may require identification and quantification in order to isolate the effects of the release.

The injury quantification stage of the assessment also involves consideration of lost services. Trustees will typically complete the following steps:

- Identify services affected;
- Quantify baseline service levels prior to the release;
- Quantify post-release service levels; and
- Estimate lost services based on the difference between baseline and post-release service levels.

The results of this process are used in the damage determination stage to support compensable value determination. Therefore, it is important that these estimates are consistent with the data needs of the damage determination methods to be employed. In addition, quantification of lost services should only be conducted for those resources for which damages will be sought, or for which restoration options will be developed.

2.4.3 Damage Determination

In this third step of the assessment process, trustees estimate the monetary damages resulting from the release event. This step involves estimating restoration costs and placing a dollar value on compensable losses. Again, this phase of the assessment should focus on the most substantive damage categories.

A wide-range of primary and secondary methods are available to evaluate compensable losses associated with natural resources, as discussed in Chapters 4 and 5 of this manual. Selection of an appropriate method(s) will depend on the specific service being valued, the type and quality of available data to support the assessment, the ease and cost of collecting additional data, the magnitude of expected damages, and the availability of funding to undertake the assessment. As part of the preassessment or assessment planning phase, trustees will generally have selected methods for use in damage determination. Trustees should review these selections and the results of the injury quantification phase to confirm that selected methods are still appropriate.

Once the damage determination is completed, the trustees will be able to present the final damage claim to the responsible party, and move to develop a formal restoration plan for the site.

2.4.4 Data Gathering to Support Compensable Value Determination

Primary data collection activities for purposes of compensable value determination generally fall into two categories: (1) collection of data to quantify the magnitude of lost resources or services; and (2) collection of data to monetize these losses. Quantification of lost services might include assessing the number of acres of injured wetland, the expected time to full recovery of these acres, and the pattern of services provided by these wetland acres prior to full recovery. Alternatively, trustees might use survey research techniques to define changes in recreational use patterns in response to a release event. Examples of primary data required to monetize a loss include the values individuals place on a day of recreational activity at a site, and individuals' willingness-to-pay to restore a resource to pre-release conditions. In some cases, trustees might develop a survey instrument to address both of these data needs. For example, a survey might ask how often members of a household visit a given site, and if they would be willing to pay for an improvement in the quality of the site (through a higher site access fee, for example). In some cases data collection will involve specific user groups, while in other cases a survey sample might include representatives of the entire United States population.

Two issues are commonly encountered when considering primary data collection for purposes of damage assessment: the need for focused investigations and the collection of perishable data. These issues are discussed below.

2.4.5 The Need for Focused Studies

As noted earlier in this manual, primary analyses and data gathering activities undertaken for purposes of damage assessment should be focused on establishing proof of injury, quantifying the magnitude of economic loss associated with such injury, and selecting an appropriate restoration option(s). As stated in DOI's 1986 preamble to the original Type B rule,

> [g]eneral research studies are not compensable under a damage assessment performed pursuant to this rule, since it is inappropriate that experimental research studies to advance general scientific understanding be included as a part of a specific natural resource damage claim [51 FR 27710].

Thus, adequate consideration should be given to the need for primary analyses to support the damage claim, so that limited assessment funds can be focused on documenting those injury categories and service flow losses that will generate the greatest damages, in terms of restoration costs or compensable values.

2.4.6 Perishable Data

The data required to complete a damage assessment may be ephemeral or perishable. For example, failure to collect data on the number of birds killed as a result of an oil spill at the time of the release may make it difficult to make such determinations at a later date. Similarly, characterization of changes in recreational use of a site years after a release event can be difficult and highly uncertain. Thus, trustees should consider the need for immediate data collection following a release event, especially events of limited duration (e.g., oil spills). For example, a major oil spill might result in the oiling of beaches and other resources associated with a National Wildlife Refuge. In this case a Service employee might be assigned the role of quantifying the effect of the spill on recreational use of the Refuge, in terms of total visitation, the extent of area closed to the public, and the reaction of the public to the event. This effort may involve informal data gathering activities (e.g., simply inventorying, for each day of the event, the portion of the park that is affected), or formal survey methods (e.g., a formal survey of individuals who continued to visit the site, to determine their lost use values). Such efforts will be especially important in cases where other types of data on pre-release conditions are not available (e.g., car counts taken at a park entrance).

2.5 Post Assessment

The post assessment phase generally consists of four components that are necessary to finalize the damage claim. These include:

- **Finalization of the Damage Assessment Report** -- development of a formal written report describing the determinations made in each phase of the assessment.

- **Presentation of Demand** -- presentation of the final damage claim to the potentially responsible party(s), including expected restoration costs, compensable losses, and the cost of the assessment.

- **Establishment of the Restoration Account** -- placement of recovered damages in a financial account.

- **Development of a Restoration Plan** -- preparation of a detailed restoration plan, describing the selected restoration activities to be funded under the claim.

In DOI's rule, the requirements for this stage of the assessment are codified at 43 CFR 11.90 through 11.93. In NOAA's proposed rule under OPA, these requirements are described at 15 CFR 990.80 through 990.84.g17

3

RESTORATION COSTING FOR PURPOSES OF NATURAL RESOURCE DAMAGE ASSESSMENT

3.1 INTRODUCTION

The primary component of a natural resource damage claim is the cost to restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources and the services those resources provide. This chapter provides a framework for the generation of restoration cost estimates within a CERCLA, CWA or OPA based damage claim. This chapter includes a review of the rules for restoration alternative selection and costing provided by DOI and NOAA as well as some general guidance on restoration costing.

A common problem encountered by trustees in natural resource damage assessment involves understating the likely costs of restoration actions, leading to under-recovery of economic damages (i.e., funds recovered are insufficient to support the restoration actions envisioned by the trustees). In addition, responsible parties often reject trustee restoration cost claims as inaccurate, incomplete or poorly documented. Such concerns on the part of responsible parties can slow the settlement negotiation process and delay restoration of injured resources. Thus, development of defensible and complete restoration cost estimates will help to assure that sufficient funds are available to undertake desired restoration actions, and facilitate a more timely settlement with the responsible party. The purpose of this chapter is to provide guidance to Service personnel to allow for the development of defensible and complete restoration cost estimates.

The remainder of this chapter is presented in five sections. Section 3.2 reviews DOI's final and NOAA's proposed guidelines for restoration costing for purposes of damage assessment under CERCLA, CWA and OPA. Section 3.3 discusses cost categories frequently considered in restoration costing for purposes of damage assessment. Section 3.4 reviews the role of time in the development of a restoration cost claim. Section 3.5 describes various sources of uncertainty that may be encountered in restoration costing, and proposes several options for incorporation of such uncertainty into restoration cost assessments. Section 3.6 presents an example restoration costing exercise.

Given the broad range of environmental restoration projects that might be considered within a natural resource damage assessment, this manual does not provide unit costing data or detailed project costing guidelines.

3.2 DOI AND NOAA GUIDANCE ON RESTORATION COSTING[1]

3.2.1 THE ROLE OF COST IN RESTORATION ALTERNATIVE SELECTION

DOI's final rule and NOAA's proposed rule for damage assessment call on natural resource trustees to consider a range of possible restoration actions in both the planning and implementation phases of the damage assessment process. Under both rules trustees are required to identify a range of alternatives, including no-action, and then to compare and select from among these alternatives based on various factors. These factors include:

- Technical feasibility;
- Environmental effectiveness (i.e., the extent to which the alternative accomplishes the trustee's restoration goals and objectives);
- The relationship of the expected costs of the alternative to the expected benefits (including benefits that cannot be easily monetized);
- Cost-effectiveness;
- The level of risk and/or uncertainty associated with the alternative;
- The results of any actual or planned response actions;
- The potential for additional natural resource injury from the proposed alternative;
- The expected natural recovery period;
- The expected extent of natural recovery in the absence of restoration activities;
- The potential effect of the alternative on human health; and
- The extent to which the alternative complies with state, federal and tribal regulations and policies.

[1]The focus of this chapter is on the restoration costing process. Readers should refer to DOI's final rule and NOAA's proposed rule for further guidance on restoration alternative selection and the restoration planning process [43 CFR 11.82 and 15 CFR 990.75].

Application of a strict cost-benefit test to each alternative is not envisioned under either rule (see the preamble to NOAA's proposed rule for a discussion of this issue [59 FR 1134-35, Jan. 7, 1994]). However, cost is a component of several of the selection factors listed above.

3.2.2 Categories of Cost to Include in the Restoration Cost Estimate

DOI's final rule and NOAA's proposed rule describe two general categories of restoration costs that are recoverable within the natural resource damage assessment process: direct costs and indirect costs. Direct costs are those costs that are directly attributable to a selected alternative. Examples include compensation of government employees for the time and effort devoted to the selection and implementation of the selected alternative, and the cost of materials acquired, consumed or expended as part of a restoration action [43 CFR 11.83(b)(1)(i) and 15 CFR 990.74(d)(2)].

Indirect costs include activities or items required to support the selected alternative, but which cannot be directly accounted for. The most common category of recoverable indirect costs is traditional labor overhead, which is generally calculated as a percentage of direct labor costs. For example, government agencies often include the cost of leasing office space in their overhead rate. Many of the non-salary costs associated with trustee employees involved in planning or implementing a restoration alternative may represent claimable indirect costs [43 CFR 11.83(b)(1)(ii) and 15 CFR 990.74(d)(3)]. In some cases state or federal agency budget offices maintain indirect rate estimates that can be applied for purposes of restoration costing. DOI's damage assessment rule explicitly requires full documentation of the assumptions used by trustees to generate any indirect rate [43 CFR 11.83(b)(1)(iii)], and NOAA's proposed rule requires the calculation of any indirect rates "...in accordance with any reasonably sound method" [59 FR 1132, Jan 7, 1994].

3.2.3 Cost Estimating Methodologies

DOI presents several cost estimating methodologies that may be used in restoration costing. Specific methods listed in the DOI rule include:

- Comparison methodology -- consideration of the costs of a similar project, adjusted for factors specific to the proposed project. For example, a trustee agency may have recently completed a wetland restoration project in the assessment area, and thus may have information on the cost of this type of restoration activity.

- Unit methodology -- application of unit cost estimates for each required component of the restoration action (e.g., the cost per adult bird produced by a breeding program).

- Probability methodologies -- use of expected values or range estimates of the cost of a restoration action, or of specific components of the action (e.g., the use of an existing range estimate for the cost of a bird breeding program).

This approach may be more useful than the unit methodology, in that it more accurately reflects uncertainty in the cost estimate.

- Factor methodology -- use of a function (e.g., a proportion) of an existing cost estimate for a restoration action or component of an action (e.g., an existing cost estimate might be scaled up to reflect a larger program being conducted at a site).

- Standard time data methodologies -- use of standard estimates of the time required to complete a task (e.g., the use of standard time estimates in estimating the cost of a fish population monitoring program).

- Cost- and time-estimating relationships -- the use of a regression equation that describes the relationship between cost and/or time and the physical or performance requirements of a restoration action. For example, the cost of restoring a contaminated groundwater resource might be a function of the depth of the aquifer, the size of the contaminated zone, the type of treatment method to be used, and the volume of water to be treated) [43 CFR 11.83(b)(2)].

DOI also permits the use of other methods that "...are based upon standard and accepted cost estimating practices and are cost-effective...." [43 CFR 11.83(b)(3)].

In most cases trustees will apply several of these methods, or variants of these methods, to estimate restoration costs for purposes of damage assessment. Each method has the attribute of requiring documentation of all assumptions and data sources. While NOAA does not propose explicit guidance for restoration costing under OPA, every effort should be made to apply generally acceptable costing methodologies, such as those described by DOI, and to explicitly document all assumptions and data sources.

3.2.4 Pooling of Restoration Funds

NOAA notes the possibility of pooling recoveries from several cases to fund restoration activities [15 CFR 990.74(c)(3)]. While formal rules for this type of restoration arrangement are presented by NOAA (i.e., the development and public review of Regional Response Plans), trustees might use informal variations of this approach. Specifically, this approach may be appropriate in cases that involve resources for which an active and effective restoration program already exists. For example, an oil spill might result in the death of several piping plovers. Since active programs to restore and protect plover populations are underway in several areas of the country, it may be possible (and cost effective) to scale-up these programs as a means to restore the lost birds. When the selected restoration option involves a contribution to an existing fund or program, it will still be necessary to document the basis for the selection and the restoration cost claim.

3.2.5 Phased Approach to Natural Resource Restoration

NOAA also notes the possibility of a phased approach to natural resource restoration, in which alternative actions are tested and reviewed prior to selection of a final alternative(s) [15 CFR 990.74(e); see also the preamble language at 59 FR 1132-33, Jan. 7, 1994]. The goal of this approach is to increase the likelihood of a successful restoration program. A phased approach will be particularly attractive, and possibly necessary, when there is substantial uncertainty regarding the likely feasibility and effectiveness of a restoration action at a given site. This approach also may be valuable when trustees require additional information to select between two or more proposed actions intended to accomplish similar restoration goals.

Development of cost estimates for a phased restoration planning and implementation process can be challenging. In most cases, responsible parties will be unwilling to sign a "blank check" to support restoration planning and implementation actions, prior to the selection of a final alternative. Thus, trustees may need to estimate the likely cost of the entire restoration program, components of which may remain uncertain at the time of settlement or presentation of the claim in court. In these cases trustees should generate a best estimate of the expected value of restoration costs, fully documenting all assumptions made in generating this cost estimate.

3.3 Typical Restoration Cost Components

A wide-range of options have been proposed for the restoration of natural resources following the release of oil and other hazardous materials to the environment. Examples include, but are by no means limited to: contaminant removal (e.g., dredging of contaminated sediment "hot-spots" within a bay system, or biological treatment of an oil-contaminated beach); creation, restoration or protection of various ecosystem types (e.g., mangroves, marine and freshwater wetlands, seagrass beds, upland habitat, riverine environments, coral reef); and enhancement of fish and wildlife populations (e.g., operation of bird breeding facilities and fish stocking programs). In addition, trustees can choose a "no action" alternate (i.e., allow for the natural recovery of a resource). Despite the variety of environmental restoration options, it is possible to provide a general overview of cost components that are typical to many restoration efforts. The goal of this section is to assist trustees in the development of complete restoration cost claims through careful consideration of the various cost components that comprise the restoration action. One possible taxonomy of these cost components is presented in Exhibit 3-1, and is discussed below.

Both direct and indirect costs associated with a restoration program may be recovered as part of the damage claim. The costs associated with planning and development, and program implementation, evaluation and monitoring may include trustee employee salaries and overhead, travel costs, materials and supplies, and equipment purchase or lease costs. In some cases private contractors or other government agencies will perform various activities associated with the restoration process (e.g., sediment sampling activities conducted by the Corps of Engineers as part of the restoration effort). In these cases contract labor, overhead, materials and supplies, equipment and travel requirements should all be considered in developing the restoration cost estimate. In addition, any expected government contracting costs, which include the cost of bidding and

Exhibit 3-1

TYPICAL RESTORATION COST COMPONENTS

Planning Costs

- Restoration Plan Development
- Public Review, Public Meetings, Response to Public Comments, Community Relations
- Human Health and Safety Plan/Quality Assurance Plan
- Chemical/Physical/Biological Surveys
- Feasibility/Pilot Studies
- NEPA/CZMA Compliance, other Permitting and Regulatory Compliance Requirements

Implementation Costs

- Physical/Chemical/Biological Contaminant Removal/Treatment/Containment
- Habitat Reconstruction/Creation/Enhancement
- Wildlife Replacement/Restocking/Protection
- Land/Real Property Acquisition, Water Rights Acquisition
- Cash Contributions to Existing Mitigation/Banking Programs or Regional Response Plans
- Trustee Oversight of Restoration Actions Undertaken by the Responsible Party
- Community Relations/Education, Public Meetings
- Contracting Costs

Program Evaluation and Monitoring Costs

- Monitoring the Progress of Restoration Actions
- Evaluation of Restoration Program Results/Effectiveness
- Follow-up Studies/Actions, as Required
- On-going Management

competing the job, managing contracts, and providing for independent quality assurance and review of project results, should be included in the cost estimate.

3.3.1 Planning Costs

Restoration plan development costs are recoverable under DOI's final rule and NOAA's proposed rule. These include costs associated with: developing a detailed restoration plan; receiving public comments on the proposed plan, and revising the plan in response to these comments; developing human health and safety plans; conducting field sampling and other investigations as required to complete the plan; conducting feasibility and pilot studies to test the viability and effectiveness of possible options; and meeting NEPA, CZMA, and other state, tribal or federal project review, permitting and regulatory compliance requirements.

Note that public education may be required at various stages throughout the restoration process, to gain the cooperation of key groups (e.g., to minimize disturbance of the site being restored), to explain the need for management restrictions (e.g., a fishing closure to allow fish stocks to recover from a spill), or to encourage participation in the program (e.g., encourage farmer participation in co-funded soil conservation or stream protection programs). These types of activities are necessary to assure success of the restoration program, and thus are properly included in the damage claim.

3.3.2 Implementation Costs

Restoration program implementation costs can vary widely in type and magnitude, depending on the restoration option(s) selected. Common categories of these costs are listed in Exhibit 3-1. In some cases a settlement agreement may include a commitment by a responsible party to complete a specific restoration action, or to achieve a specific set of environmental objectives (e.g., to reduce contaminant concentrations to a specific level; to restore a fish population). Trustees may incur costs associated with oversight and review of these actions and should recover these costs as part of the settlement.

3.3.3 Project Evaluation and Monitoring Costs

Part of the restoration process involves monitoring and evaluating the results of the completed restoration program. For example, the trustees may choose to create a freshwater wetland to compensate for the loss of wetland acreage due to remediation activities at a site. In order to assure that full restoration of wetland functions and services has occurred, it may be necessary for trustees to monitor the site for several years, if not decades. If the restoration alternative is not functioning as expected, corrective actions could be undertaken.

It is important to note that evaluation and monitoring costs may occur even in cases in which the "no action" alternative is selected. For example, an affected seabird population may be expected to recover quickly following an oil spill event; thus, restoration actions may be deemed unnecessary.

However, monitoring of the affected wildlife population may be desirable to assure that natural recovery is progressing as expected, and to confirm that unexpected effects (e.g., excess reproductive failure) are not occurring.

3.3.4 Costs of Acquiring Equivalent Resources

DOI's rule for damage assessment restricts federal trustees from choosing acquisition of land (and, presumably, other real property, such as water rights) for federal management, unless restoration, rehabilitation and replacement actions are not possible [43 CFR 11.82(e)]. However, in some cases acquisition of equivalent resources may be deemed appropriate.

Acquisition of an equivalent resource may not be limited to ownership in fee, but can include purchase of easements, covenants and deed restrictions, as well as lease arrangements. Selection of the acquisition option may entail costs beyond the cost of acquiring a right to the property. For example, it may be necessary to compensate the local community for tax (or fee) revenue losses, to provide for management and upkeep of the property, and if the goal is to protect or enhance a species, to take actions to limit access to the property. Thus, trustees should carefully consider and document the expected long-term costs of resource acquisition.

3.4 Time Frame of Restoration Activities

In developing a restoration cost estimate as part of the damage claim or in costing out several restoration options for further consideration, trustees need to consider the time period over which the proposed actions will occur. Specifically, trustees need to incorporate into the analysis:

- Expected changes in the cost of project components over time;
- The expected lifespan of required capital equipment (i.e., to allow for replacement); and,
- The timing of recurrent expenses.

In addition, trustees will need to consider the expected rate of return (i.e., interest to be received) on funds recovered as a result of a damage claim. This issue is addressed in detail in Chapter 6.

3.4.1 Inflation

Prices for labor, overhead, materials, supplies and equipment will generally increase through time, in response to inflation. The rate at which these costs increase may vary. For example, fuel costs might be expected to increase at a rate greater than that of general inflation, while wages might be expected to lag the general rate of inflation. The rates of inflation in these general cost components will vary from year to year, and across geographic areas. Note that prices for some

goods and services might be expected to decrease through time. For example, costs to treat contaminated soils have generally fallen over time, due to the emergence of more cost-effective technologies. To the extent that a decline in the cost of a particular component of a restoration plan is expected, that factor should be taken into account in the costing process.

3.4.2 Recurrent Expenses

Some restoration program requirements will be recurrent. For example, a restoration action might require monitoring and evaluation of effectiveness every other year. Consideration should also be given to the expected lifespan of required capital equipment (e.g., boats or other equipment needed to support the restoration program). Detailed documentation of the recurring expense assumptions used in generating the cost schedule should be provided with the cost estimate. As shown in the example at the end of this chapter, careful accounting for the timing and frequency of these types of costs is required to establish a complete and defensible restoration cost claim.

3.5 Uncertainty in Restoration Costing

There are a variety of sources of uncertainty that may enter into the restoration costing process. For example, it may be difficult for trustees to develop firm cost estimates for some project components, given uncertainty in likely site conditions (e.g., the extent of contamination in a bay system) and other factors. Similarly, as with any major project, there may be unforeseen costs associated with an action. Finally, there may exist any number of conditions under which a project will fail. For example, for a project designed to create freshwater wetland there may be a possibility that the hydrologic conditions required to establish the wetland will not be achieved. Thus, trustees may wish to assure that sufficient funds are available to take actions to remedy failure or to undertake alternative actions.

It is impossible to account for and insure against all sources of uncertainty within the restoration costing process. This is particularly true for actions that involve novel restoration techniques or challenging field conditions. However, efforts should be made to account for obvious sources of uncertainty, and to make the assumptions used in accounting for these factors explicit in the restoration cost claim.

In some cases the responsible party may be willing to fund directly, or even conduct, the selected restoration option(s). This arrangement may be advantageous to the trustees, in that it places the burden on the responsible party to assure that sufficient funds are available for the required activities (e.g., the responsible party will be expected to cover any unexpected cost overruns). However, trustees should establish explicit and detailed performance goals; that is, the commitment on the part of the responsible party should not be for a given level of expenditure, but for the achievement of explicit restoration objectives.

3.6 RESTORATION COSTING EXAMPLE

An example restoration cost claim is detailed on Exhibit 3-2. This example involves the following restoration scenario:

> An oil spill has resulted in the abandonment of a seabird colony. In order to restore this colony, the trustees propose to initiate a bird recolonization project. This project will involve the use of decoys and audio cues to encourage breeding birds to return to the affected site. Given the technical nature of this project, several experts will be involved, as well as associated support staff. The site in question is located in a remote location; thus, the trustees need to account for travel costs and other costs associated with site access. The trustees plan to contract the restoration effort out to a private organization. It is expected that the project will require 10 years to complete.

The various cost components (for each year of expected activity), and the total present value of the claim are shown on Exhibit 3-2. The expected costs are broken into three categories: equipment, operating costs, and labor (i.e., "Salaries and Fringe"). Although presented in different categories, these cost components reflect the categories listed in Exhibit 3-1. For each cost component an estimate was made of the then-current cost of the item, expressed in 1994 dollars. For example, decoys were expected to cost $55,000, while the annual salary for a principal investigator was expected to be $47,000. The indirect costs associated with the required labor (i.e., "fringe benefits," in this case limited to health and other insurance charges) were calculated as a percentage of the total labor cost. In addition, the trustees allocated funds for management and peer review of the project.

In this example, costs were inflated at either three or five percent per year, depending on the cost component. The reported unit cost estimates were developed based on interviews with individuals involved in similar, on-going efforts. Note that the project was not expected to begin until 1997; thus, it was necessary to inflate the cost components over three years to estimate costs in the first year of the program.

Some of the cost components were expected to recur and/or increase over time, while others were expected to decline. For example, it was assumed that most of the equipment would be replaced in the sixth year of the program (i.e., a five year operating life was assumed). Thus, Exhibit 3-2 shows greater expenditures for equipment in year 6 of the program, as required equipment is replaced. Expenditures for equipment in years 2 through 5 and 7 through 10 represent maintenance costs. In addition, required labor was expected to decrease in year six to one-half of the initial value. In the intervening years the trustees expected to incur some costs associated with maintenance of the required equipment.

In this example the trustees accounted for possible uncertainty through the inclusion of a 10 percent contingency, which was applied to the total cost of the effort. This contingency rate was established based on the best professional judgement of the project planners; contingencies for other projects may be higher or lower, and may be expressed more appropriately in terms of absolute

Exhibit 3-2

EQUIPMENT	Inflation Rate	Unit Cost in Current 1994	YEAR 1 1997	YEAR 2* 1998	YEAR 3* 1999	YEAR 4* 2000	YEAR 5* 2001	YEAR 6* 67* 2002	YEAR 7* 2003	YEAR 8* 2004	YEAR 9* 2005	YEAR 10* 2006
Boat w/ Motor & Trailer	5%	$75,000	$86,822	$4,862	$5,105	$5,360	$5,628	$36,936	$6,205	$6,516	$6,841	$7,183
Zodiacs (2)	5%	$7,500	17,364	1,529	1,606	1,686	1,770	$21,586	1,952	2,049	2,152	2,259
Vehicles	5%	$50,000	57,881	5,095	5,350	5,618	5,899	$73,873	6,503	6,828	7,170	7,528
Decoys	5%	$55,000	63,669	6,518	6,844	7,186	7,546	6,338	6,655	6,988	7,337	7,704
Audio Equipment	5%	$30,000	34,729	6,597	6,926	7,273	7,636	$11,421	7,653	$8,036	8,438	8,860
Photo Equipment	5%	$7,500	8,682	1,630	1,711	1,797	1,887	1,981	2,080	2,184	2,294	2,408
Field Equipment	5%	$8,500	9,840	985	1,445	1,085	1,593	3,454	1,257	1,844	1,385	2,033
subtotal		--	$278,988	$27,216	$28,988	$30,005	$31,959	$155,590	$32,306	$34,445	$35,617	$37,976
OPERATING COSTS												
Gas and Oil	5%	$2,000	$2,315	$2,431	$2,553	$2,680	$2,814	$2,955	$3,103	$3,258	$3,421	$3,592
Overflights	5%	$8,500	9,840	10,332	10,848	11,391	11,960	12,558	13,186	13,846	14,538	15,265
Travel	5%	$40,000	46,305	48,620	51,051	53,604	56,284	59,098	62,053	65,156	68,414	71,834
Office and Support	5%	$100,000	115,763	121,551	127,628	134,010	140,710	147,746	155,133	162,889	171,034	179,586
subtotal		--	$174,223	$182,934	$192,080	$201,684	$211,769	$222,357	$233,475	$245,149	$257,406	$270,276
SALARIES AND FRINGE BENEFITS												
Principal Investigator (2)	3%	$47,000	$102,716	$105,798	$108,972	$112,241	$115,608	$59,538	$61,324	$63,164	$65,059	$67,011
Assistants (4)	3%	$25,000	109,273	112,551	115,927	119,405	122,987	$95,008	97,858	100,794	103,818	106,932
Fringe @ 30% of above		$21,600	$63,597	$65,505	$67,470	$69,494	$71,579	$46,364	$47,755	$49,187	$50,663	$52,183
Management & Review @ 5% of above	0.05	$4,680	$13,779	$14,193	$14,618	$15,057	$15,509	$10,045	$10,347	$10,657	$10,977	$11,306
subtotal		--	$289,365	$298,046	$306,987	$316,197	$325,683	$210,955	$217,284	$223,802	$230,516	$237,432
Total		--	$742,580	$508,200	$528,060	$547,890	$569,410	$588,900	$483,060	$503,400	$523,540	$545,680
Contingency	10%	--	$74,258	$50,820	$52,806	$54,789	$56,941	$58,890	$48,306	$50,340	$52,354	$54,568
Total + Contingency		--	$816,838	$559,020	$580,866	$602,679	$626,351	$647,790	$531,366	$553,740	$575,894	$600,248
Contractor Fee	10%	--	81,684	55,902	58,087	60,268	62,635	64,779	53,137	55,374	57,589	60,025
GRAND TOTAL		--	$898,522	$614,922	$638,953	$662,947	$688,986	$712,569	$584,503	$609,114	$633,483	$660,273
	Discount Rate											
Present Value (1994$)	0.0563	--	$762,372	$493,936	$485,884	$477,260	$469,569	$459,757	$357,027	$352,230	$346,797	$342,197
Total Present Value of Years 1 through 10 (1994$)			$4,547,028									

* Equipment costs incurred in these years reflect expected replacement and maintenance expenditures.

dollars. In addition, the trustees expected that the contractor hired for this effort would charge a 10 percent fee on all cost components.

The last two rows of Exhibit 3-2 contain estimates of the present value of this effort. This calculation is described in more detail in Chapter 6.

4

PRIMARY METHODS FOR COMPENSABLE VALUE DETERMINATION

4.1 INTRODUCTION

The second component of a claim for natural resource damages is compensation of the public for the interim loss of the injured resources' services. The monetized value of the interim lost services is known as "compensable value." Compensable values can be estimated in a number of ways, depending on the specific characteristics of the damage assessment. In certain cases, the results of existing research can be applied. This technique, referred to as "benefits transfer," is addressed in the next chapter. In other instances, primary studies may be required.[1] The range of primary techniques that can be applied to estimate compensable values, as identified in the DOI and NOAA rules, is the subject of this chapter.

The purpose of this chapter is not to provide step-by-step instructions for the conduct of primary economic studies. Rather, this chapter provides field staff who have little or no formal training in economics with a basic understanding of economic tools that may be applied in damage assessment. More specifically, this chapter:

- Provides guidance for conducting primary studies in simple assessments;
- Provides a general understanding of more complex valuation methods to allow field staff to conduct assessment planning and management activities for more complex cases; and
- Enables field staff to recognize the potential for claims based on various valuation approaches.

In addition, a better understanding of these techniques will help Service staff in drawing on the results of these types of studies in the context of benefits transfer.

The remainder of this chapter is organized into eight sections. Section 4.2 provides an overview of certain key economic concepts and links these concepts to the valuation techniques

[1] Primary studies involve collection of original data, and/or development of a model or valuation function specific to the case at hand.

described in this chapter. Sections 4.3 through 4.8 address each of the techniques individually, in the following order:

- Section 4.3: Market-based approaches (e.g., market price)
- Section 4.4: Added or Averted Cost
- Section 4.5: Revealed Preference
- Section 4.6: Factor Income
- Section 4.7: Contingent Valuation
- Section 4.8: Habitat Equivalency

Each of these sections includes a non-technical explanation of the technique, including a description of the data requirements, examples of ways in which it has been/could be applied in a damage assessment, and a discussion of its advantages and disadvantages.

Typically, no one method will capture all categories of economic damage resulting from a release event. Thus, multiple methods are often utilized. In cases where more than one method is applied there is the potential for double counting. The extent to which double counting may occur will depend on the methods used as well as case-specific factors (e.g., the extent of the market for a recreational opportunity). The last section of this chapter, Section 4.9, describes how to identify and eliminate double counting.

4.2 Overview of Economic Valuation

4.2.1 The Concept of Consumer Surplus

DOI's and NOAA's rules for damage assessment state that economic damages should be measured, in most cases, by a reduction in consumer and producer surplus. The concept of consumer surplus is based on the principle that some consumers benefit at current prices because they are able to purchase goods (or services) at a price that is less than the amount they are willing to pay for the good. If prices increase, the difference between prices and willingness to pay decreases, and thus utility derived from consuming the good decreases. Producer surplus reflects the fact that some producers would be willing to sell a good at a price that is less than the prevailing price in the market. The use of consumer surplus as a measure of overall economic welfare is widely accepted in economics.

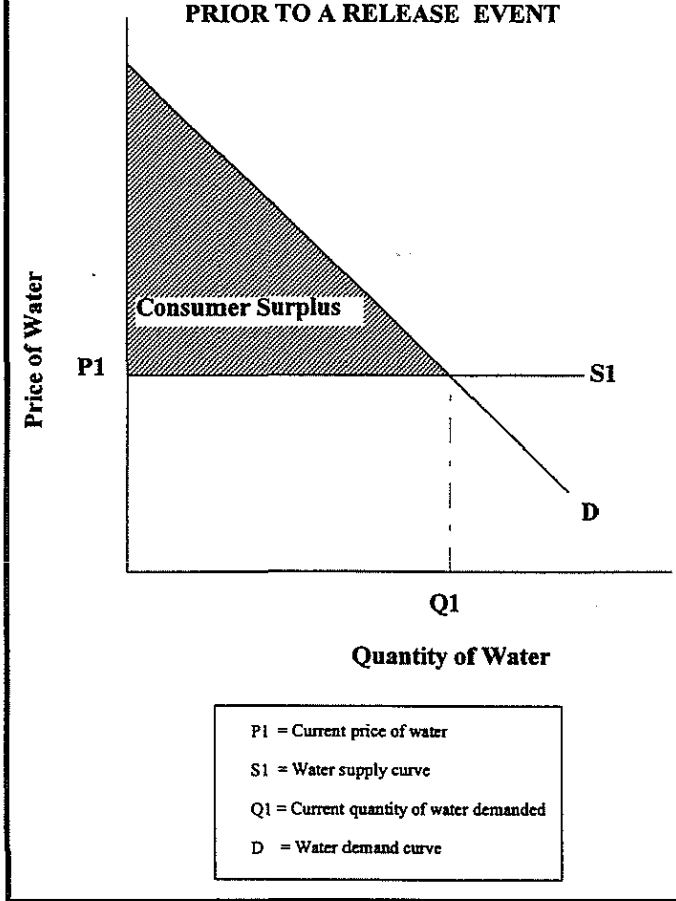
When many individuals think of "economic damages" resulting from a release event, they focus on how common measures of economic activity, such as jobs or business revenues, have changed in response to the event. While these measures of economic impact may be important at the local or regional level, they do not necessarily represent net "societal losses," the appropriate measure of damages. For example, an oil spill might cause a decrease in tourism revenues in the

immediate area of a spill; however, this decrease may be offset by increases in revenues at other locations. Total social welfare measures of economic damage (i.e., market-wide reductions in producer and consumer surplus associated with a natural resource and the services provided by that resource) take such substitution effects into account in estimating economic impacts.

The concept of consumer surplus is most easily understood through an example. Assume that a city receives most of its potable water from a lake that has recently been contaminated by a chemical spill. Exhibit 4-1 represents the market for potable water prior to contamination. The downward sloping demand curve (D) indicates the quantities of water demanded at different prices. As indicated by the slope of this curve, the quantity of water demanded is likely to decrease as price rises.

Exhibit 4-1

WATER SUPPLY AND DEMAND PRIOR TO A RELEASE EVENT



The horizontal line (at P1) indicates the current price of water. If the marginal costs of production are constant (i.e., the water utility's costs per unit supplied are constant), this line also represents the supply curve (S1). The intersection of the supply and demand curves represents the amount of water consumed (Q1) prior to the release event. The shaded area above the supply curve but below the demand curve represents the consumer surplus that accrues at the current price -- because some consumers' willingness to pay exceeds the price of the good.

Exhibit 4-2 indicates what happens to consumer surplus when the price (cost) of water increases due to the higher costs of substituting an alternative clean supply for the contaminated supply. The supply curve shifts upwards from S1 to S2, reflecting an increase in supply costs, and thus price. This change in price reduces both the quantity of water consumed and consumers' surplus. The loss in consumers' surplus is equal to the shaded area bounded by the two supply curves (S1 and S2) and the demand curve. This area represents a societal loss resulting from the contamination event. In other words, it represents the amount that the public has a right to be compensated for, or the "compensable value" component of the damage claim.[2]

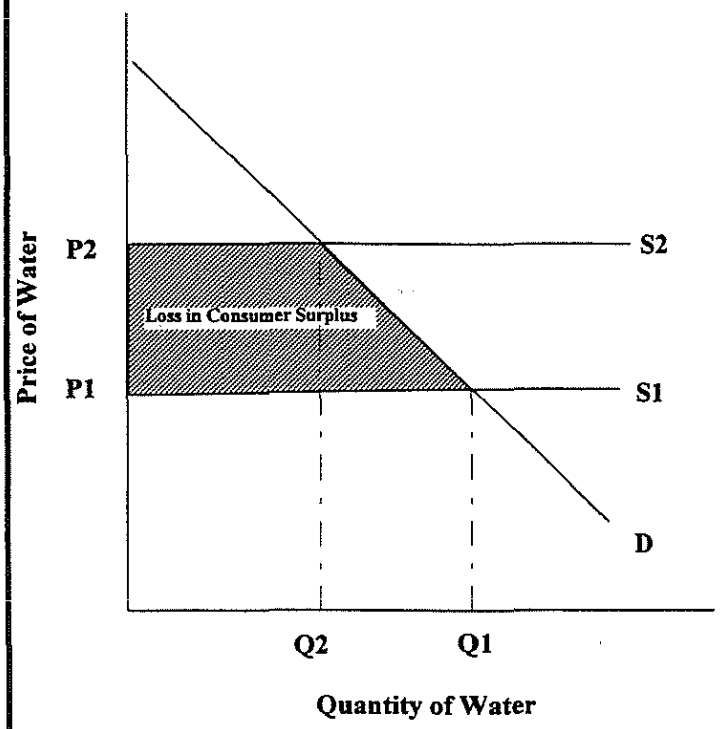
[12] In addition, as noted in Chapter 1, many claims will also include a restoration cost component.

4.2.2 METHODS FOR ESTIMATING COMPENSABLE VALUES

Economists have developed a variety of techniques to estimate societal losses resulting from reductions in environmental services. Exhibit 4-3 provides an overview of how certain economic methods can be used to value lost services. The first two columns of this exhibit present example categories of injury and lost services. The final column lists the valuation technique most commonly applied to value these lost services.[3] The economic methods listed in this table are described below.

Exhibit 4-2

LOSS IN CONSUMER SURPLUS FOLLOWING A RELEASE EVENT



P1 = Price of water before contamination
P2 = Price of water after contamination
S1 = Water supply curve before contamination
S2 = Water supply curve after contamination
Q1 = Quantity of water demanded before contamination
Q2 = Quantity of water demanded after contamination
D = Water demand curve

When goods and services are traded in the marketplace, economic losses can be estimated through an analysis of market behavior. These market-based techniques, and the circumstances under which they apply, are the subject of Section 4.3. In general, however, formal markets do not exist for the vast majority of public resources and services being analyzed within a damage assessment. As a result, compensable values must be indirectly derived by examining behavior in related markets (e.g., the housing market), or directly derived (e.g., the application of survey research techniques within a contingent valuation).

Indirect valuation methods infer environmental values by closely examining behavioral changes that result from release events. Indirect methods that focus on *substitutes* for environmental quality are generally referred to as analyses of averting behavior (see Section 4.4). Such studies look at willingness to pay to mitigate or avoid the effects of a release to infer the value placed on the damage. For example, expenditures on drinking water treatment can be used to estimate the value of changes in ground or surface water quality.

Alternatively, activities that are *complements* to environmental quality can be analyzed to infer damages resulting from a release event. These approaches, often referred to as "revealed

[3] The valuation methods listed in this table are common examples, and do not span the universe of possible options.

Exhibit 4-3

CATEGORIES OF INJURED RESOURCES, LOST SERVICES, AND COMMON VALUATION TECHNIQUES

Example Categories of Injured Resources*	Example Lost Services **	Common Valuation Techniques
Habitat (e.g., wetland, forested upland, grassland, riverine systems, coastal systems, sediments, coral reef)	Services provided to other resources, such as: clean water, sediments, soils, and food. Passive use ***	Market-based (e.g., appraisal) Factor Income Contingent Valuation
Fish and Wildlife	Endangered species Passive use	Habitat Equivalency Contingent Valuation
National Parks, National Wildlife Refuges, National Monuments, other public lands	Habitat Recreation Education Preservation Cultural Passive Use	Market-based (e.g., fee losses) Revealed Preference Contingent Valuation
Beaches, Rivers, Surface Water Bodies, Marine Corridors, Wetlands	Water quality Commercial use (e.g., municipal/ industrial/agricultural water supply; marine transport; economic development) Recreational use (e.g., swimming, fishing, hunting, wildlife viewing) Subsistence use Flood control/erosion prevention Education Research Passive use	Market-based Added Cost Revealed Preference Contingent Valuation Habitat Equivalence
Groundwater	Municipal/commercial/industrial/ agricultural use Discharge of clean groundwater to surface water Passive use	Market-based Added Cost Contingent Valuation
Archaeological and Cultural	Education Research Passive use	Revealed Preference Contingent Valuation

* The categories listed in this exhibit are not mutually exclusive (i.e., a release event may result in injury to multiple resource categories, as well as a range of lost services).
** The services provided by a natural resource can accrue to humans and to other natural resources, and need not be consumptive.
*** As used here, the term "passive use" incorporates values referred to by NOAA and DOI as "non-use" and "passive use" values, and by others as "existence" and "preservation" values.

preference" techniques, are addressed in Section 4.5. For example, if clean surface water is associated with increased recreational activity, then willingness to pay for recreational use can be used to indirectly estimate the value of clean water. For example, travel cost models, analyzing the

recreational choices that individuals make and the distance these individuals are willing to travel to access recreational opportunities, can be used to value resources and the services they provide. Other revealed preference techniques examine goods that include environmental quality as one of several attributes. For example, property value studies can be used in certain circumstances to statistically separate the effects of local environmental quality from other factors affecting property price.

Another way of indirectly deriving resource value is to evaluate the resource and the services it provides as part of a "production" process. For example, a freshwater wetland might serve to improve water quality. This approach, known as the factor income method, is described in Section 4.6.

Direct valuation methods generally involve surveying individuals' willingness to pay for a specific change in environmental quality. Direct methods include contingent valuation, which uses surveys to collect relevant data, and related methods such as conjoint analysis and contingent ranking. As discussed in Section 4.7, the contingent valuation method can be used to estimate both direct and passive use values, and is the only method available for estimating passive use values.

Finally, society can be compensated for resource service losses through the provision of additional services of the same type in the future. For instance, if a certain acreage of wetland is affected by the release of oil over a finite period, the public may be directly compensated for these interim lost services via the provision of additional wetland acreage in the future (wetland acres provided as compensation for interim losses are *in addition* to those provided to restore or replace the injured resource). This approach, which avoids any attempts to monetize the value of lost services, is generally referred to as the habitat equivalency approach. Section 4.8 addresses this approach in some detail.

4.3 Market-based Approaches

Compensable values may be estimated by examining markets for natural resources, in instances where such markets exist. In this section, we describe three market-based techniques: market demand and supply models, fee losses and appraisals.

4.3.1 Market Demand and Supply Models[4]

As indicated in DOI's and NOAA's rules, economic damages associated with some pollution discharge events may be estimated using market prices (43 CFR 11.83(c)(2)(i) and 15 CFR 990.78(b)(4), respectively). This technique is applicable when the injured natural resources, or some service they provide, are regularly traded in a competitive market. That is, the market must be characterized by several buyers and sellers and must not be constrained in any undue fashion. The correct measure of damages using this technique is the change in consumer surplus and economic rent associated with the resource as a result of the release event. Thus, the data generally required

[4] This methodology is referred to under "Marketed Resource Methodologies" in DOI's rule.

to implement this approach are the price and the quantity of the injured natural resources, or the services these resources provide, before and after the release event. These values can then be used to approximate the welfare loss associated with a release event.

In some cases it may be possible to apply a simplified market-based approach to estimate damage. For example, economic damages associated with the closure of a commercial fishery may be estimated using forecasts of expected commercial harvest levels and market prices in the absence of the release event. That is, if the impact of the event is limited in geographic scope and duration, economic damages may be approximated by the quantity of fish not harvested (i.e., catch foregone as a result of the event) multiplied by the market price of the species in question. The same approach can be applied to estimate damages resulting from a reduction in fish abundance, and thus a change in commercial fish harvest following a release event, in cases where the effect is of limited duration and extent.[5]

For large scale changes in regional catch rate, or for effects which continue for an extended period of time, a market price approach may not be appropriate, however. Specifically, a number of assumptions must be made to apply a simplified market price approach to estimate damages associated with a commercial fishing closure. For example, the release cannot lead to a large change in market price or to a long-term change in commercial fishing effort. If either of these assumptions does not hold, application of a simplified market-based approach may not be appropriate.

4.3.2 Fee Losses

Another component of compensable values under DOI's and NOAA's rules is losses in fees or payments made to federal or state agencies or Indian tribes by individuals or firms for the use of natural resources [43 CFR 11.83(c)(1)] and [15 CFR 990.77(h)(1)(ii)]. While not specifically identified as such, this approach is implicitly a market-based methodology, since fees represent prices that individuals or firms are willing to pay in the market.

To implement this method, trustees need to collect data on (1) the amount of the fee per unit of the good or service provided (e.g., per day) and (2) the number of units affected by the contamination event (e.g., persons per day). For example, assume that an oil spill affects a National Seashore, resulting in the closure of one portion of the seashore for eleven weeks during the summer while cleanup activities occur. The National Park Service charges a $5.00 entrance fee per car for access to the seashore. Based on a careful review of the three previous seasons' records, the trustees conclude that the number of trips to the seashore declined from what it would have been in the absence of the spill by 1,000 cars per week, or 11,000 in total over the eleven weeks that the beach was closed. Compensable values in this case would include the loss in fees for access to the

[5] Other examples of resources that might be valued using the market price approach include fur bearing animals and water supplies (where markets for water exist).

seashore, equal to $55,000.[6] The use of this methodology is appropriate in all situations where fees are typically collected for use of a resource affected by a release event.[7]

4.3.3 Appraisal Methodology

In certain cases, a change in the appraised value of a natural resource (or the services the resource provides) can be used as a proxy for compensable value. The measure of damages under this method is the difference between the appraised value of the resource with and without injury. The appraisal method is specifically listed as an option under DOI's rule [43 CFR 11.83(c)(2)(ii)], and is identified under the "market models" section of NOAA's proposed rule [15 CFR 990.78(b)(4)(ii)].

As with other market-based methods, this approach should only be applied when a well-defined market for the resource exists. In addition, its use is limited to those resources for which standard appraisal methods exist. For instance, remediation activities at a site might result in the loss of an area of commercial timberland. The appraised value of this timberland, both pre- and post-injury, could serve as a proxy for economic damage.

4.4 Added or Averted Cost

A release event may impose added costs on users of the affected resource. These added costs represent one measure of societal losses resulting from a release event. For example, following an oil spill it may be necessary to temporarily close a harbor or waterway to commercial shipping in order to undertake cleanup activities. In these cases the added cost of marine transportation, resulting from added shipping distances or delays in shipping, can be used as a measure of economic damage. Similarly, closure of a popular commercial fishing ground may result in commercial anglers incurring the added cost of motoring to alternative fishing sites.[8]

In many cases the data required to estimate damages using this technique, which include the cost of the affected activity pre- and post-release, will be readily available. Where site-specific data are not available, it may be possible to apply generic estimates. For example, experts within the U.S. Coast Guard or with private firms can provide general estimates of the hourly cost of operating commercial vessels.

This approach was recently applied to develop a preliminary damage estimate at a contaminated municipal water wellfield. Per-household data on the cost of tap water and the cost of bottled water were collected, as was an estimate of the impact of price changes on the demand for

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[6] Note that these lost fees may not fully reflect damages if visitors were willing to pay more for entrance to the site than was charged (i.e., there were consumer surpluses associated with use of the site).

[7] An alternative technique would be to use a simple site demand model which predicts demand given weather, time of year, etc.

[8] Both of the examples rely on measures of economic rent for estimating damages, as discussed in Chapter 1.

drinking water. These data were combined to estimate the loss in consumer surplus from switching from tap to bottled water in response to a contamination event. The estimated loss in consumer surplus was approximately $20 per-household per-month. By combining this figure with information on the number of households affected (approximately 2,000) and the number of months they were affected (24), compensable values were estimated to be approximately $1.0 million.

The principal strength of the averted cost method is that it is based on actual behavioral responses to a release event. Further, the approach is conceptually and practically straightforward. One drawback of this method is that actions taken which generate averted costs may not be exact substitutes for the activity or service affected by the release event. For example, bottled water and city water may not be exact substitutes, due to differences in taste. Bottled water purchases may provide the consumer with additional benefits beyond the avoidance of real or perceived risks associated with a contaminated water supply. Such additional benefits should be subtracted from the interim losses claimed as compensable values.

4.5 Revealed Preference

A range of valuation techniques exist under the general category of revealed preference. Revealed preference approaches are indirect methods premised on the assumption that compensable values can be estimated based on careful observation of individual behavior in response to a release event. For example, beach visitation may decline at a spill site following an oil spill event, while increasing at substitute sites. In the simplest case the added cost incurred by beach users in traveling to a substitute site can be used as a measure of economic damages. Revealed preference techniques that have been applied in natural resource damage assessment include travel cost models, random utility models, and repeat sale and hedonic property valuation models.[9] Examples of revealed preference approaches are included in the case studies which are appendices to this manual.

4.5.1 Travel Cost Models

Travel cost models are analytical tools frequently applied to value access to recreational opportunities, as well as to value changes in quality characteristics of these recreation opportunities. Basic travel cost models for a single site are based on the concept that the value of a recreation site can be estimated by analyzing the travel and time costs incurred by individuals in visiting the same site or an alternate site. Given a release event that changes the quality of a site (e.g., a fishery closure following an oil spill), one might expect to see a change in willingness to pay for the site, expressed as a reduction in the willingness to incur travel and time costs to access the site (or a willingness to incur additional travel and time costs to access a substitute site). In addition to simple travel cost models, researchers have also developed random utility (or discrete choice) models where the decisions to visit a particular site are evaluated as a function of the characteristics of available sites. The travel cost approach is specifically identified in both the DOI and NOAA rules [43 CFR 11.83(c)(2)(iv) and 15 CFR 990.78(b)(1)].

[9] While this chapter focuses on methods that have been applied in a wide-range of settings, other revealed preference techniques may be appropriate in certain circumstances.

Travel cost approaches require data on site visitation, which are often available from a range of local, state and federal resource management agencies. In certain cases, formal or informal site-specific surveys may need to be conducted. For example, a random utility model of fishing behavior was developed by the State of Montana for the Clark Fork River damage assessment (Morey and Rowe 1995). Fish populations in the Clark Fork River have been affected by the release of metals attributable to past mining activities. The model developed for this site predicts how many trips anglers take in southwestern Montana as a function of trip costs, expected catch rates, size of sites, and characteristics of the angler, such as gender, age, skill level and amount of free time. To develop this model, 443 Montana anglers were interviewed. The results of these interviews allowed the authors to estimate how angler behavior had been influenced by a lower than expected catch rate on the Clark Fork River. These behavioral changes (e.g., traveling farther to access a substitute site or taking fewer fishing trips altogether) represent damages resulting from injuries to the Clark Fork River fishery.

Travel cost approaches are limited by the quality of the underlying behavioral data, including the availability of data on substitute recreation opportunities. In addition, travel cost approaches are limited in their ability to measure small changes in the quality of a site.[10] However, in cases where the change in services provided by a site is obvious (e.g., a recreational fishing closure), and where sufficient data are available, these methods have the potential to provide highly defensible damage estimates.

4.5.2 Property Valuation Models

Property valuation models assess how proximity to various environmental amenities (e.g., a bathing beach) or disamenities (e.g., the site of a release event) influence the amount individuals are willing to pay for real property. There is no disagreement that location is an important factor in the value of residential and commercial property. For example, it is well understood that a house will sell for more or less depending on the attributes of the neighborhood in which it is located. While there is some disagreement as to the magnitude of the effect, most economists would agree with the premise that long-term damage to environmental resources, such as reductions in the quality of a beach or coastal wetland, could act to reduce nearby property values. Thus, this method uses changes in property values as a proxy for changes in nearby resource values.

Two principal methods have been used in the damage assessment context: the hedonic property valuation approach and the repeat sales approach. Hedonic property valuation involves the use of cross-sectional data on home characteristics for a range of homes in a given area at one point in time (e.g., data on lot size, number of bedrooms, or presence of a municipal landfill). Statistical regression analysis is then used to determine the contribution of each factor to sale price. Hedonic analyses have been conducted at the house-level, using data on individual properties, and at the regional level, using data on average home characteristics across towns and counties. This approach is specifically identified in the DOI and NOAA rules [43 CFR 11.83(c)(2)(v) and 15 CFR 11.78(b)(3)]. Repeat sale analysis, or panel data analysis, considers the relative rates of change in housing prices between affected and control (unaffected) areas. (Panel models follow a fixed sample

[10] For a fuller discussion of limitations of travel cost methods, see Randall 1994.

of homes through time.) For example, comparing the rates of home appreciation before and after a release event and between affected and unaffected areas would yield a measure of property value impacts. Repeat sale studies are particularly useful in cases where individual property characteristics data are not available.

For example, the property valuation approach was applied by NOAA to evaluate the reduction in the amenity services provided by New Bedford Harbor in Massachusetts, resulting from PCB contamination of the harbor (Mendelsohn 1992). A repeat sales model was developed to determine if the value of homes located near the harbor had been affected by the announcement that the harbor was contaminated with PCBs. Data collected for this analysis included sale prices for single family homes located within two miles of the New Bedford Harbor shoreline that sold at least twice between 1969 and 1985. Data on any improvements or renovations, which could increase home value, were also collected. To separate out the effect of the PCB contamination on home prices, a number of other factors that affect housing prices were controlled for, including inflation, interest rates, neighborhood characteristics, proximity to the harbor, and the length of time between sales. Using sophisticated regression analysis techniques, this analysis found that homes located within two miles of the harbor experienced property value changes that were 12 percent less than other properties in this area. The total damages resulting from this decline in harbor amenities was estimated to be between $26.2 million and $39.0 million dollars.

A fundamental advantage of the property valuation technique is that a reduction in property values can serve as a measure of many lost services associated with a change in environmental quality. Further, the method is based on observable behavior in a market that is well understood. There are a number of limitations associated with this approach, however. The most significant of these limitations include:

- Hedonic and repeat sales models require a large amount of relatively detailed data. In some cases sufficient data will not be available to implement this technique.

- Given the large number of factors that determine home value, it is often difficult to disentangle the influence of various factors; for example, it may be difficult to separate out the effects of a release of a hazardous substance from a uncontrolled hazardous waste site from the effects of the aesthetic impacts of the site.

- The ability of hedonic or repeat sales models to detect small changes in resource attributes is limited because a large number of factors act together to determine market price, some of which may correlate with the effect in question.

- These methods may result in damage estimates that double count other categories of damages, such as lost recreation opportunities. This issue is addressed further in Section 4.9.

Property valuation models are most appropriately applied at sites where the contamination event has a long duration. For instance, property valuation techniques are generally more relevant in the context of hazardous waste sites than oil spills, whose effects tend to be more transient in nature.

In addition, to separate the many influences on property values, the affected service flows must also be thought to have a strong link with property values.

4.6 Factor Income Methodology

Under the factor income approach, the services provided by the injured resource are viewed as inputs to the production of a service or commodity sold in the market. This approach is based on the economic concept of a production function; that is, inputs such as natural resources are combined to produce a good or service sold in the market. Changes in the cost of acquiring these inputs can serve as the basis for estimating damages. For instance, a reduction in the abundance of lower order aquatic species may increase the cost of acquiring a commercially valuable fish species, as the lower order species may serve as an important source of food for the commercially valuable species. As a result, the economic rent accruing to the producer from the use of the resource may diminish. The change in economic rent may be evaluated by calculating the change in surplus in either the final product or input markets. Similar approaches may be feasible in cases in which important recreational service flows are affected (e.g., bird viewing opportunities). The factor income approach is explicitly identified in both the DOI final and NOAA proposed rules [43 CFR 11.83(c)(2)(iii) and 15 CFR 11.78(b)(2)].

The factor income approach should only be applied in settings where the primary value of the injured resource affects the cost of producing (or harvesting) a more highly valued resource. Using this method to measure damages accurately requires a thorough understanding of the inputs in the production process, and how changes in these inputs affect production costs. In some cases, information on factor inputs simply will not lead to the generation of damage estimates that can withstand the scrutiny typically encountered in a litigation setting.

4.7 Contingent Valuation

The contingent valuation (CV) method uses survey techniques to directly elicit information on individuals' willingness to pay for goods that are not commonly traded in markets, such as natural resources and the services they provide. Components of this approach include developing a contingent market that provides survey respondents with a description of the good or service being valued, developing the institutional framework under which the good would be provided, creating a hypothetical payment vehicle, and providing respondents with an opportunity to express a value for the good or affected service. Both the DOI and NOAA rules specifically approve of the use of this method to assess the use value for a hunting or fishing day, or to better understand changes in beach use. Similarly, CV can be applied to estimate losses in passive use values resulting from oil spill events. The CV methodology is listed as a valid assessment technique in both the DOI and NOAA rules [43 CFR 11.83(c)(2)(viii) and 15 CFR 990.78(b)(5)], although DOI has not promulgated final regulations guiding the use of the technique. In addition to the CV method, related techniques such as contingent behavior, contingent ranking and conjoint analysis have been applied to directly elicit information on willingness to pay. The principal concept behind these approaches is the creation of a hypothetical market similar to the more widely utilized CV method.

The development of a full-scale CV study generally involves several stages. These include:

- Developing a preliminary survey instrument;
- Conducting focus groups to gauge the public's knowledge of the good or service being valued;
- Conducting one-on-one interviews to pretest the survey instrument;
- Implementing a pilot field test of the instrument;
- Implementing the final survey; and
- Analyzing the information obtained from the pilot and final surveys.

This multi-step process is designed to reduce biases that may be created by a poorly designed or administered survey.

The advantage of the CV method is that it can be used to capture the full range of values affected by a contamination event. In addition, because this method relies on stated values rather than observed behavior, it is the only method available for many service flows, including both direct use and passive use (e.g., in cases in which there are no behavioral data available to characterize demand for baseline conditions of the environment). However, the reliability and validity of this method has been the subject of much recent controversy. Some economists express particular concern about the ability of the method to provide meaningful estimates of passive use values for public goods.[11] The debate focuses largely on whether respondents can provide reliable estimates of the value of these types of goods, given that the public has little or no experience with purchasing such goods. Other criticisms are that respondents stated intentions may not equal true willingness to pay and that respondents are affected by the "warm glow" of giving, which influences their willingness to pay responses.

Due to the importance of the method in many damage assessments, a panel of eminent economists was convened by the National Oceanic and Atmospheric Administration (NOAA) to evaluate whether the CV method should be applied to estimate lost passive use values for the purposes of damage assessment. The panel concluded that "contingent valuation studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values," if the studies follow a series of relatively stringent guidelines.

[11] Many economists believe that this method is appropriate for estimating the use values associated with a resource or change in environmental quality.

The NOAA Panel

In 1992, NOAA commissioned a panel of economists and other experts to review the CV method and its application for measurement of passive use values. Drawing on presentations at a public hearing, written statements submitted by interested parties, and examination of the existing CV literature, the panel concluded that CV studies convey useful information about the valuation of natural resources, provided that a number of conditions are met in the design, implementation, and interpretation of the CV survey [see 58 FR 4601-4614].

One fundamental issue addressed by the panel was the concern that a hypothetical market, when posed to survey respondents, yields results that are biased upward in comparison to the results of actual market transactions. The panel concluded that calibration of these results to adjust for the upward bias associated with the framing and/or order of questions is currently not possible. Therefore, as a general guideline, the panel urged practitioners of CV surveys to "lean in the conservative direction [in making key survey design decisions], as a partial or total offset to the likely tendency to exaggerate [willingness to pay]." Also as general guidelines, the panel stressed the importance of asking respondents to consider alternative uses of funds, and the importance of confirming that respondents take the proposed payment vehicle seriously.

The panel's report also provides specific recommendations relating to CV surveys. For example, the panel favored personal interview formats, either telephone or face-to-face, over mail surveys because of the greater representativeness and control afforded by personal interviews. They stated that, "mail surveys should be used only if another supplementary method can be employed to cross-validate the results on a random subsample of respondents." In addition, the panel recommended that a "referendum format" be used in CV surveys. The referendum format directs respondents to "vote" either for or against the plan outlined in the survey, as they would for a state or local political referendum. The panel believed that respondents find it extremely difficult to provide a dollar value for a good in a hypothetical market, and that other common methods such as payment cards introduce a bias into the process. To verify that individuals understand the implications of the referendum and evaluated the choice as intended, the panel recommended follow-up questions to determine why a "yes" or "no" vote was cast, and recommended probing of respondents' comprehension and acceptance of the scenario. The panel also pointed out the desirability of including a "no opinion" option.

Finally, the panel also proposed conditions that future CV studies should adopt, to the extent possible. For example, the panel believed that alternative expenditure possibilities should be presented to respondents, to convey an understanding of the finite resources available for public goods expenditures.

In addition to the NOAA panel report, several economists have written extensively on concerns related to the use of CV, as well as on procedures that can be used to address these concerns. For example, Mitchell and Carson (1989) provide a comprehensive list of issues to consider in designing a new study or considering the quality of an existing study. The issues relate primarily to four topics:

- **Sampling and Survey Administration Procedures** - A CV study should use generally accepted sampling and survey administration procedures designed to promote the reliability of the results. These procedures include the use of probability sampling, large sample sizes, focus groups and pretesting of the survey instrument, and methods to minimize non-response.

- **Description of Commodity and Market** - The survey should present the valuation scenario in a realistic and understandable fashion that will be accepted by the respondents. For example, a well-designed survey should provide an accurate description of the nature and relative magnitude of the problem being addressed and should include reminders of budget constraints and substitute commodities.

- **Value Elicitation** - The method used to elicit values should be designed to encourage respondents to provide meaningful values. For example, the NOAA panel believes that a referendum format (where respondents are asked whether they would be willing to pay a specified amount for the program) is preferable because it is similar to the familiar experience of voting.

- **Evidence of Validity and Reliability** - CV studies should also provide evidence that respondents understood and accepted the valuation scenario and that the results are unbiased. For example, follow-up questions can be used to probe responses, and researchers can test for potential biases and for internal consistency.

Over the past two decades, numerous CV studies have been conducted to elicit willingness-to-pay values for environmental improvements. These surveys have generally implemented some, but rarely all, of the NOAA panel recommendations. A few recent studies, such as the study conducted by the State of Alaska for the *Exxon Valdez* oil spill and the study conducted for the Southern California Bight damage assessment, have met most, if not all, relevant criteria (Carson, et al. 1992).

As mentioned earlier, CV is the one method available for estimating passive use values. As a result, this technique serves an important function at sites where passive use losses are thought to be large in scale. One disadvantage of the approach is that the cost of conducting state-of-the-art CV research that is likely to stand up to the scrutiny typically encountered in a litigation setting can be quite high. For example, to develop, implement, and defend a full-scale CV survey of an oil spill could require funding of $500,000 to several million dollars. Thus, application of this method is likely to be appropriate only for very large-scale events. While less costly studies have been (and continue to be) performed, these studies generally do not meet the requirements outlined by the NOAA panel and other authorities.

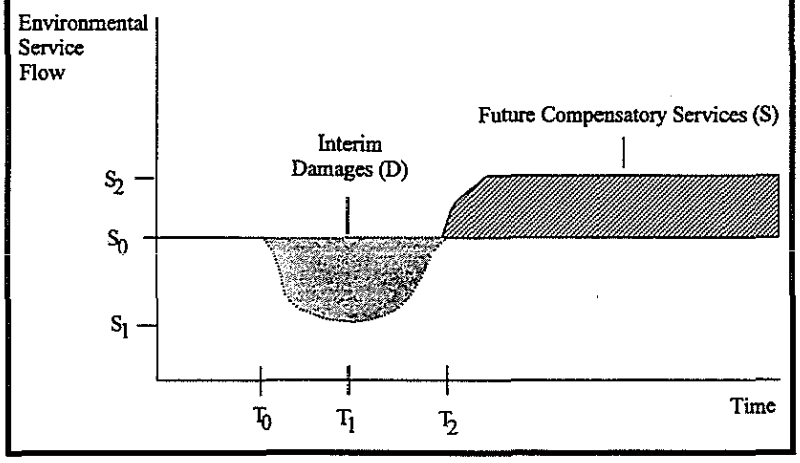
4.8 HABITAT EQUIVALENCY

The basic premise of the habitat equivalency approach is that the public can be compensated for interim losses in services through the provision of additional services of the same type in the future. These services are in addition to those provided to restore the resource to baseline conditions; they are meant to compensate for interim losses. The unique aspect of this approach is that the measure of compensable values is not dollars, but rather the diminished service itself. For instance, the public can be compensated for injuries to wetlands through the provision of additional "wetland acre years," in the future to account for the interim loss of wetland services.[12] The habitat equivalency method is not explicitly included in the DOI rule, but is included in NOAA's proposed rule [15 CFR 990.78(c)(2)], and could be considered within "other valuation methodologies" under DOI's rule.

The conceptual framework for the habitat equivalency method is illustrated in Exhibit 4-4. At time T_o, a resource has been injured as a result of a hazardous substance release, reducing the flow of service from the resource from S_o to S_1. Upon restoration of the resource at time T_2, these services have been restored, although compensable values, identified in this figure as interim damages (D), remain. If the magnitude of this loss in service flow can be measured, it is possible to estimate a flow of services in the future (represented in the graph as area S) that will be equivalent to area D.

Exhibit 4-4

CONCEPTUAL BASIS OF THE HABITAT EQUIVALENCY METHOD



Since the habitat equivalency approach can be applied in assessments without conducting primary economic analysis, a detailed example of the approach is provided in this section.[13] As illustrated in Exhibit 4-5, assume a hazardous substance release reduces annual fish populations by 100 fish, starting in 1985. That is, scientists determined that there would be 100 fewer fish in the affected ecosystem each year from 1985 through 1999. This loss is shown in the column labeled "Loss in Services." Note that this example assumes the recovery of damages from the responsible party in 1995, but that interim losses will continue until 1999.

[12] See Unsworth and Bishop 1994 and R2 Resources (1995) for examples of the application of this technique to damage assessment. The habitat equivalency approach is also referred to as the "environmental annuities" approach and the "biological equivalency" approach.

[13] Note, however, that application of this method may require primary scientific investigations. In addition, service field personnel applying this technique should request review of all calculations performed by the Division of Economics.

The third column of this exhibit reflects concepts known as compounding and discounting, as discussed in more detail in Chapter 6 of this manual. These concepts have much in common with the notion of interest, and are analogous to financial calculations made every day by individuals and businesses. For example, imagine a case in which an individual was to have received $100 per year from 1985 until 1999, but for some reason was not provided these payments. Those payments, if paid in one lump sum today (i.e., in 1995), would be worth $1,652, assuming a three percent rate of return on the annual payments. That is, the individual would be as well off financially between having received $100 each year from 1985 to 1999 and receiving $1,652 today. For example, in order to make the individual equally well-off today for the first payment that was missed in 1985, the individual would need $134 today. Similarly, anindividual would be willing to accept $89 dollars today instead of $100 in 1999, since this individual could invest and earn interest on the $89 from 1995 until 1999.

Exhibit 4-5

AN EXAMPLE CALCULATION OF THE PRESENT VALUE OF PAST LOSSES

Event	Year	Loss in Services (Fish)	Discount Calculation[1]	Present Value Loss (fish)
Release of Hazardous Substance	1985	100	$* (1 + 0.03)^{1995-1985} =$	134
	1986	100	$* (1 + 0.03)^{1995-1986} =$	130
	1987	100	$* (1 + 0.03)^{1995-1987} =$	127
	1988	100	$* (1 + 0.03)^{1995-1988} =$	123
	1989	100	$* (1 + 0.03)^{1995-1989} =$	119
	1990	100	$* (1 + 0.03)^{1995-1990} =$	116
	1991	100	$* (1 + 0.03)^{1995-1991} =$	113
	1992	100	$* (1 + 0.03)^{1995-1992} =$	109
	1993	100	$* (1 + 0.03)^{1995-1993} =$	106
	1994	100	$* (1 + 0.03)^{1995-1994} =$	103
Recovery of Damages	1995	100	$* (1 + 0.03)^{1995-1995} =$	100
	1996	100	$* (1 + 0.03)^{1995-1996} =$	97
	1997	100	$* (1 + 0.03)^{1995-1997} =$	94
	1998	100	$* (1 + 0.03)^{1995-1998} =$	92
	1999	100	$* (1 + 0.03)^{1995-1999} =$	89
TOTAL PRESENT VALUE LOST SERVICES				1,652

[1] Example assumes a three percent discount rate.

As shown, losses that occurred in the more distant past have a greater value today than losses that occurred more recently. For example, the present value of 100 fish lost in 1985 is 134 (assuming a three percent discount rate), while the present value of 100 fish lost in 1993 is 106. This is simply due to the fact that the earlier losses are being compounded over a greater period of time. Similarly, losses that occur in the future have a smaller present value than the same losses that occur today.

The total present value of the loss in this example is 1,652 present value fish years, where a "fish" is the provision of one fish for one year.[14]

In order to make the public whole, it will be necessary to provide a flow of services (in this example, fish) in the future with the same present value as the present value loss. In this simple example, the appropriate equivalent service flow is the 1,652 fish calculated in Exhibit 4-4. Using a computer spreadsheet, it is possible to determine that approximately 50 additional fish per year are needed in perpetuity to make the public whole for their interim loss.

The last column of Exhibit 4-6 presents the present value of a service flow (in this example, 50 fish), provided each year in perpetuity, with a present value equivalent to the loss. As shown, the present value of 50 fish provided in the year 1997 is approximately 47; the present value in 2075 is approximately five; and by 2148 the present value of this service flow has fallen to nearly zero. The present value of 50 additional fish provided in perpetuity is approximately 1,652.

In summary, the principle steps for a habitat equivalency analysis are:

1. Select a metric by which natural resource injury at the site is to be measured (e.g., wetland acres lost, fish population decline, beach days lost).

2. Estimate the reduction in units of that metric, each year, from the time of the release (or first year in which damages will be claimed through full resource recovery.

3. Calculate the present value of these compensable losses.

4. Select a period over which compensable resources or services will be provided (e.g., beginning in five years and extending for 20 years).

5. Calculate the number of units of additional resource or services required in each year of the compensation period, to generate a present value equivalent to that calculated in step 3.

6. Calculate the cost of providing these replacement resources or services. This calculation should be based on the most cost-effective replacement options available.

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[14] The formula for calculating this figure is:

$$\sum_{t=d}^{R} N_t \, (1 + i)^{T-t}$$

where: d = year in which injury first occurred
R = year resource will be fully restored
N_t = number of units of resource in year t
i = real interest rate; and
T = current year.

Exhibit 4-6

AN EXAMPLE CALCULATION OF THE PRESENT VALUE OF COMPENSABLE SERVICES

Event	Year	Equivalent Services Restored (Fish)	Discount Calculation[1]	Present Value Compensation
Compensatory Restoration Starts	1994	0	-	0
	1995	0	-	0
	1996	50	$*(1+0.03)^{(1995-1996)}=$	49
	1997	50	$*(1+0.03)^{(1995-1997)}=$	47
	1998	50	$*(1+0.03)^{(1995-1998)}=$	46
	1999	50	$*(1+0.03)^{(1995-1999)}=$	44
	2000	50	$*(1+0.03)^{(1995-2000)}=$	43
	2001	50	$*(1+0.03)^{(1995-2001)}=$	42
	2002	50	$*(1+0.03)^{(1995-2002)}=$	41
	2003	50	$*(1+0.03)^{(1995-2003)}=$	39
	2004	50	$*(1+0.03)^{(1995-2004)}=$	38
	2005	50	$*(1+0.03)^{(1995-2005)}=$	37
	2006	50	$*(1+0.03)^{(1995-2006)}=$	36
	2007	50	$*(1+0.03)^{(1995-2007)}=$	35
	2008	50	$*(1+0.03)^{(1995-2008)}=$	34
	2009	50	$*(1+0.03)^{(1995-2009)}=$	33
	2010	50	$*(1+0.03)^{(1995-2010)}=$	32
	-	-	-	-
	-	-	-	-
	-	-	-	-
	2075	50	$*(1+0.03)^{(1995-2075)}=$	5
	2076	50	$*(1+0.03)^{(1995-2076)}=$	5
	2077	50	$*(1+0.03)^{(1995-2077)}=$	4
	-	-	-	-
	-	-	-	-
	-	-	-	-
	2148	50	$*(1+0.03)^{(1995-2148)}=$	1
	2149	50	$*(1+0.03)^{(1995-2149)}=$	1
	2150	50	$*(1+0.03)^{(1995-2150)}=$	1
	2151	50	$*(1+0.03)^{(1995-2151)}=$	0
TOTAL PRESENT VALUE COMPENSATION				1,652

[1]Example assumes a three percent discount rate.

The habitat equivalency approach can be used for a number of different service losses resulting from various kinds of injuries. The technique is most appropriate given one or more of the following circumstances. First, the extent of injury (e.g., number of birds killed, acres of wetland lost) and the duration of the injury should be well quantified. Second, since this technique involves the provision of additional resources of the type that were injured, replacement projects need to be feasible and commonly undertaken (e.g., fish enhancement projects, bird breeding, wetland conservation). The public will not be compensated using this approach if the replacement project fails to provide the appropriate quantity of additional resources. Third, the value of the resource should be roughly constant over the period of analysis (e.g., from the onset of injury through the replacement period). If the value of the resource is thought to change significantly over this period, the public may be either under- or over-compensated using this approach, unless an adjustment is made to the calculation to account for the change in the value of the resource over time.[15] Finally, in all cases the resources or services provided as compensation for the loss must be qualitatively equivalent to the resources and services that were lost due to the injury. If these services and resources are not equivalent, this method may over- or under-compensate the public for the compensable loss.

Case Study: Injury to Service-Owned Lands

During the 1960s the National Gypsum Corporation disposed of large volumes of asbestos waste in the Great Swamp of New Jersey. As a result, five acres of wetland were destroyed, and a larger area of the swamp became contaminated with asbestos and other hazardous substances. In 1968 the U.S. Fish and Wildlife Service purchased the disposal site as an addition to the Great Swamp National Wildlife Refuge. In 1988 the site was added to the Superfund National Priorities List. In 1990, however, facing claims associated with a class action suit brought by individuals exposed to asbestos, the National Gypsum Company declared bankruptcy. As a result, DOI was forced to file a claim for damages to natural resources under very tight time constraints, and in the absence of an EPA approved remediation plan for the site.

In conducting its assessment, DOI focused on two categories of economic loss: lost recreational services associated with a trail closure, and the loss in services provided by wetland as a result of the asbestos disposal activities. This case study focuses on the application of the habitat equivalency approach for estimating the economic loss associated with the reduction in services provided by the injured wetland.

DOI determined that 5.58 acres of wetland had been lost from 1968 to the time that the assessment was conducted (1992). While the asbestos dump was created prior to 1968, no estimates of its size were available before 1968. DOI also determined that, following site remediation, approximately seven acres of wetland would be lost in total, due to the need for a cap on the existing asbestos waste pile. DOI assumed that replacement wetland could be established by 1997. That is, five years would be required to create replacement wetland, and thus compensable losses would continue through 1997.

[15] One way to minimize this problem is to shorten the replacement or "payback" period as much as possible. For instance, in the previous example, the number of fish could be increased above 50 per year and the replacement period could be shortened to less than 55 years in order to accelerate the recovery of compensable values.

As shown in Exhibit 4-7, the present value of compensable wetland acre-years lost in this case was 229. To calculate the number of acres of new wetland that would be required, in perpetuity, to compensate the public for these interim losses, DOI applied the following equation:

$$\text{Damages (expressed in wetland acre years)} = (N/0.03)*(1.03)^{-5}$$
$$229 = (N/0.03)*(1.03)^{-5}$$
$$N = (229/)*0.03$$
$$N = 7.96 \text{ acres}$$

Where N equals the number of wetland acres required in perpetuity to compensate the public for past losses.

The first part of this formula (i.e., N/0.03) calculates the number of wetland acres, which if provided from today in perpetuity, would provide an equivalent number of present value wetland acre years to those lost (i.e., 229). In performing this calculation the trustees assumed a three percent discount rate.[16] The second part of this formula (i.e., 1.03^{-5}) accounts for the fact that these replacement acres would not be provided for five years. That is, the estimate of required replacement wetland must be discounted for five years, resulting in the need for additional wetland acreage to make the public whole for waiting for this compensation.[17]

It is important to note that the eight acres of wetland required to compensate the public for interim losses from the time of the release until a replacement wetland was established is separate and distinct from the replacement wetland itself. That is, the responsible party must provide seven acres of *replacement* wetland for that lost due to the site cap, as well as eight additional acres of *compensatory* wetland to make the public whole for the fact that wetland services were lost from 1968 to 1997.

In this case DOI translated compensable damages expressed in terms of wetland acre years into dollars based on the cost of a combination of (1) actions to restore wetlands within the Refuge through the removal of dikes and installation of water control structures, and (2) the cost of purchasing wetlands off the Refuge that were threatened by development. While this case was ultimately presented in bankruptcy court, the court did not rule on whether the habitat equivalency approach was valid in this context. However, the habitat equivalency method has been successfully used in settlement negotiations with responsible parties in a range of cases involving fish populations, bird populations and wetland injury.

[16] The formula used to convert a present value to an equivalent annual value to be paid in perpetuity is PV $*$ i, where PV is the present value and i the discount rate expressed as a fraction.

[17] In this case only 6.84 acres of compensatory wetland would be required if that wetland acreage could have been provided at the time of the claim (i.e., without the five year delay).

Exhibit 4-7

APPLICATION OF THE HABITAT EQUIVALENCY APPROACH TO ESTIMATE COMPENSABLE LOSSES RESULTING FROM INJURY TO WETLANDS IN THE GREAT SWAMP NATIONAL WILDLIFE REFUGE

Year	Wetland Acres Lost	Present Value Calculation	Present Value Wetland Acres Lost
1968	5.58	$*(1+0.03)^{(1992-1968)}=$	11.34
1969	5.58	$*(1+0.03)^{(1992-1969)}=$	11.01
1970	5.58	$*(1+0.03)^{(1992-1970)}=$	10.69
1971	5.58	$*(1+0.03)^{(1992-1971)}=$	10.38
1972	5.58	$*(1+0.03)^{(1992-1972)}=$	10.08
1973	5.58	$*(1+0.03)^{(1992-1973)}=$	9.78
1974	5.58	$*(1+0.03)^{(1992-1974)}=$	9.50
1975	5.58	$*(1+0.03)^{(1992-1975)}=$	9.22
1976	5.58	$*(1+0.03)^{(1992-1976)}=$	8.95
1977	5.58	$*(1+0.03)^{(1992-1977)}=$	8.69
1978	5.58	$*(1+0.03)^{(1992-1978)}=$	8.44
1979	5.58	$*(1+0.03)^{(1992-1979)}=$	8.19
1980	5.58	$*(1+0.03)^{(1992-1980)}=$	7.96
1981	5.58	$*(1+0.03)^{(1992-1981)}=$	7.72
1982	5.58	$*(1+0.03)^{(1992-1982)}=$	7.50
1983	5.58	$*(1+0.03)^{(1992-1983)}=$	7.28
1984	5.58	$*(1+0.03)^{(1992-1984)}=$	7.07
1985	5.58	$*(1+0.03)^{(1992-1985)}=$	6.86
1986	5.58	$*(1+0.03)^{(1992-1986)}=$	6.66
1987	5.58	$*(1+0.03)^{(1992-1987)}=$	6.47
1988	5.58	$*(1+0.03)^{(1992-1988)}=$	6.28
1989	5.58	$*(1+0.03)^{(1992-1989)}=$	6.10
1990	5.58	$*(1+0.03)^{(1992-1990)}=$	5.92
1991	5.58	$*(1+0.03)^{(1992-1991)}=$	5.75
1992	5.58	$*(1+0.03)^{(1992-1992)}=$	5.58
1993	5.58	$*(1+0.03)^{(1992-1993)}=$	5.42
1994	5.58	$*(1+0.03)^{(1992-1994)}=$	5.26
1995	5.58	$*(1+0.03)^{(1992-1995)}=$	5.11
1996	5.58	$*(1+0.03)^{(1992-1996)}=$	4.96
1997	5.58	$*(1+0.03)^{(1992-1997)}=$	4.81
TOTAL			229

4.9 IDENTIFYING AND ADDRESSING DOUBLE-COUNTING

No one method will capture all categories of economic damage resulting from a discharge event. Some methods, however, if applied appropriately, will capture a broad range of economic effects (e.g., contingent valuation and property valuation-based techniques). In cases where more than one method is applied there is the potential for double counting. For example, assume that in the process of conducting a full-scale assessment at a contaminated bay site the trustees undertake both a property valuation study and an assessment of recreational fishing impacts. The damages being estimated using these two approaches could overlap, to the extent that one of the factors influencing home prices around the bay is easy access to a recreational fishing site.[18] In general, the extent to which double counting occurs will depend on the methods used as well as case-specific factors (e.g., the extent of the market for a recreational opportunity).

There are no hard and fast rules for addressing double-counting, other than the application of common sense. In instances where the damages calculated by two (or more) studies are likely to overlap, the trustees may wish to acknowledge the potential overlap by using a range to present the total value of the claim. A more sophisticated approach would be to try and identify and subtract from the total claim the values being counted more than once. For instance, if a hedonic study shows a decrease in property values of $50 million, and a travel cost study shows damages to the recreational fishery of $20 million, the total compensable values can be portrayed as between $50 and $70 million. Alternatively, if the recreational fishing damages can be segregated into "local" and "non-local" components, the property value results could be added to the "non-local" recreational fishing damages to produce a single total compensable values figure.

Finally, in some cases the trustee may wish to intentionally undertake parallel efforts to estimate damages. For example, both a contingent valuation study and a travel cost model might be used to estimate the change in economic value associated with a change in beach quality resulting from a release event. The reason for undertaking parallel studies is to evaluate the "robustness" of the individual study results, or the stability of the final damage estimate given changes in the method used and assumptions made in assessing damages. If the results of parallel studies are substantially similar, the trustees negotiating position will be strengthened.

[18] Another example: if the CV method is utilized to estimate total value (both use and passive use), the application of another technique to estimate use values (e.g., the avoided cost method) will lead to double-counting if the results of these studies are added to estimate total damages.

5

SECONDARY METHODS FOR NATURAL RESOURCE VALUATION: BENEFITS TRANSFER

5.1 INTRODUCTION

The goal of this chapter is to describe the "benefits transfer" method for assessing economic damages resulting from injury to natural resources. Benefits transfer involves the application of value estimates, functions, data, and/or models from existing studies to estimate natural resource damages for the case at hand. Benefits transfer is one of the methods designated for use in assessing compensable losses under DOI and NOAA's rules for damage assessment, and is referred to as the "unit value methodology" by DOI and the "benefits transfer approach" by NOAA [43 CFR 11.83 (c)(2)(vi) and 15 CFR 990.78 (c)]. This approach is considered a "secondary" valuation methodology, since it does not require primary data gathering or other primary economic research.

In natural resource damage assessment benefits transfer is often employed:

- When there is insufficient time or financial resources to gather primary data to support a full damage assessment;
- To generate preliminary, or "back-of-the-envelope," compensable loss estimates for purposes of damage assessment planning and budgeting;
- To generate preliminary compensable loss estimates for use in settlement negotiations; and
- When the expected magnitude of the damage claim does not justify the cost of primary economic research.

The existing literature provides a rich source of information on recreational user-day values, commercial fishing values, wetland values, passive use values, wildlife values and other values relevant to damage assessment. These value estimates have generally been developed using the

primary methods described in Chapter 4. This chapter is intended to provide a comprehensive discussion of benefits transfer, including guidance on the following topics:

- Definition of benefits transfer (Section 5.2)
- Steps for conducting benefits transfer (Section 5.3);
- Uses and types of benefits transfer (Section 5.4);
- Limitations of benefits transfer (Section 5.5); and
- Commonly referenced sources of valuation studies (Section 5.6).

Section 5.7 addresses a special case of benefits transfer -- the use of public and private expenditures and activities data as a means to infer resource values.

5.2 Definition of Benefits Transfer

Benefits transfer involves the application of value estimates, functions, data and/or models developed in one context to address a similar resource valuation question in an alternative context. Within damage assessment, benefits transfer in its simplest form involves the application of an existing estimate of the value of a natural resource (or a service provided by that resource) to estimate economic damages due to natural resource injury at the assessment site.[1] For example, an oil spill may have resulted in the temporary closure of a recreational fishery. Valuing economic damages associated with lost recreational fishing opportunities due to the spill event would first entail obtaining an estimate of the value of a recreational fishing day from the existing literature. This estimate would then be multiplied by the number of fishing days lost at the assessment site to generate an estimate of compensable value. Note that, in this example, primary research may be required at the assessment site to estimate the number of lost fishing days.

As described later in this chapter, such transfers may also include adjustments to account for differences in the characteristics of the service flow evaluated in the existing study versus the characteristics of the service flow at the assessment site. Continuing the oil spill example, the value per fishing day available from the literature may reflect the value for a day of fishing in general in the state in which the assessment is taking place. If, however, the injured resource represents a relatively high-quality trout fishery, it might be appropriate to adjust this value before estimating damages. Determining the appropriate adjustment factor would require additional review of the literature to evaluate the relationship between the value of a day of trout fishing versus other types of fishing. The trustee should consider whether such an adjustment is likely to have a significant enough effect on the magnitude of the estimated damages to warrant the time and effort required to estimate the adjustment factor.

[1] Throughout this chapter we refer to the site(s) or cases evaluated in existing study(s) as the "existing" site and the site affected by the release as the "assessment" site.

In addition, benefits transfer can involve the use of existing valuation functions or models. Such transfers allow trustees to develop value estimates using functions or models from existing studies that directly account for differences in the characteristics of the existing site versus the assessment site. For example, participants in a recreational activity considered in the existing study may have had higher income levels than participants at the site affected by the release. Such differences in income levels may affect the value per activity day held by the participants. If the existing study estimates the value per activity day as a function of income (and other variables), this defined relationship might be used to account for differences in the incomes of the households using or valuing the assessment site versus those represented in the existing study.

Although the technique of benefits transfer has been used for many years to assess natural resource damages, to support environmental policymaking, and to make resource management decisions, its use continues to generate some controversy in the economics community. This controversy focuses on the applicability of value estimates developed for a particular site, group of sites, or discharge incidents in one context to other sites or incidents in other contexts. In general, determining whether an existing study is appropriate for benefits transfer requires consideration of two factors: (1) the quality of the existing study (i.e., the defensibility of the research approach used), and (2) the similarity between the injured natural resource or lost service at the existing site and at the assessment site. Service personnel should consider the guidance provided in this chapter to help ensure the quality of the damage estimates generated by the benefits transfer approach.

5.3 Steps for Benefits Transfer

Evaluating economic damages using benefits transfer consists of four steps:

Step 1: Identifying the resource or services to be valued;

Step 2: Identifying potentially relevant existing studies;

Step 3: Evaluating the applicability of these existing studies; and

Step 4: Conducting the benefits transfer.

Each of these steps is discussed in detail below.

5.3.1 Identify Resources and Services

The first step in a benefits transfer is the identification of injured resources and/or lost services for which economic damages will be evaluated. In part this step will require identifying data that are or will be available to characterize the nature of the injury or service reduction (e.g., the number of lost use days or changes in the quality of the resource that would affect the values that the public holds for the resource). The types of data available and the nature of the service reduction will affect the types of transfers that can be applied. Second, trustees will determine whether to apply benefits transfer or one of the primary valuation methods described in Chapter 4 to evaluate economic

damages. Benefits transfer may be applied at various phases of the damage assessment process to: develop estimates of economic damages for use in negotiations with responsible parties; determine the expected magnitude of damages (for example, to identify those categories that may merit primary research); or document the likely magnitude of benefits that will result from a proposed restoration action.

5.3.2 Identify Relevant Existing Studies

The second step of benefits transfer involves review of the existing valuation literature to identify potentially applicable studies. This step entails identifying studies that evaluate similar resources and/or services as those affected at the assessment site. The types of studies to consider (e.g., contingent valuation, property valuation, travel cost) will depend on the types of injured resources and/or lost services. Note that if the transfer relies on the results from several studies, these studies need not apply the same valuation method.

Exhibit 5-1 summarizes the types of valuation approaches generally applied to various services and resource categories. Commonly referenced sources and bibliographies of studies that might be used for damage assessment are presented in Section 5.6.

5.3.3 Evaluate Applicability of Existing Studies

The third step in a benefits transfer involves careful review of the previously identified studies in order to determine whether the results are transferable to the assessment site. In addition, based on the types of information available from these studies (e.g., unit-day values, functions) and the nature of the injured resources or lost services, trustees can modify or refine the specific benefits transfer approach that they will utilize.

Evaluating the applicability of an existing study to the assessment site requires consideration of the nature of the services and resources addressed in the existing study and the services and resources affected at the assessment site. Without some degree of comparability between the existing site(s) and the assessment site, the transfer may not be reasonable or defensible. For example, transferring the value of a bald eagle to value mortality of a common bird species is not likely to be appropriate; however, a study that estimates the value of an additional nesting pair of bald eagles in Wisconsin may provide information for the valuation of the loss of a nesting pair of eagles in Michigan.

Three characteristics of a defensible benefits transfer are:

- The transfer relies on a high quality study(s) -- the results from the existing study should be based on adequate data, sound economic methods and correct empirical techniques;

- The characteristics of the resource/service evaluated in the existing study (including the availability of substitutes), and the characteristics of the

population that values the resource/service (e.g., age, income), are the same or similar to these characteristics at the assessment site;

- The transfer involves careful evaluation of the "extent of the market" in the existing study and the assessment site. Extent of market refers to the population likely to be affected by a change in the quality or quantity of the resource or service in question.

Exhibit 5-1

SUMMARY OF VALUATION METHODS

Resource or Service Category	Common Primary Valuation Approaches
RESOURCES	
Wetlands	Factor Income * Contingent Valuation
Surface Waters, Marine/ Aquatic Systems	Factor Income * Added or Averted Cost Contingent Valuation
Terrestrial Ecosystems	Factor Income * Contingent Valuation
Groundwater	Added or Averted Cost Appraisal Method Contingent Valuation
Wildlife Values (included fish, birds, mammals, etc.)	Travel Cost Methods Contingent Valuation
National Parks, Wildlife Refuges, etc.	Fee Losses Travel Cost Methods Contingent Valuation
SERVICES	
Recreation	Travel Cost Methods Contingent Valuation
Commercial Fisheries	Market Price Added or Averted Cost
Passive Use Values (e.g., existence values, nonuse values)	Contingent Valuation

* Various methods, including revealed preference techniques (e.g., travel cost methods, property valuation), added or averted cost, and contingent valuation can be used to value each of the services quantified through the factor income approach (e.g., the economic value of additional bird breeding habitat provided by wetland). For additional discussion, see Chapter 4.

Exhibit 5-2 lists some of the factors that may be considered when assessing whether existing studies will support a defensible benefits transfer. Below we discuss each of the characteristics of a defensible benefits transfer.

5.3.3.1 Quality of the Existing Study

The defensibility of a benefits transfer will depend on the quality of the existing studies used to estimate economic damages. In general, the results of the existing studies should be based on sound economic methods and empirical techniques. For example, studies that rely on population samples should use state-of-the-art sampling methods, with sample sizes and response rates sufficient to generate and obtain statistically reliable results. Studies should take into account substitute goods and services.

While there are no standard criteria with which to judge the quality of existing studies for purposes of benefits transfer, the literature does provide some general guidance. Some good references include:

- For travel cost and random utility models used for valuing recreational opportunities: McConnell (1985), Smith (1990), Bockstael et al. (1987), Morey et al. (1991), Randall (1994).
- For contingent valuation studies used to value direct use and passive use attributes of natural resources: NOAA (1993) and (1994), Mitchell and Carson (1989).
- For repeat sale and hedonic property valuation studies used to determine the effect of environmental contamination on real property values: Bartik and Smith (1987), Freeman (1979), McConnell et al. (1985), Palmquist (1982), Polinsky and Rubinfeld (1977).
- For studies designed to determine the commercial fishing value of a resource: Riely and Rockland (1988).
- For studies of wetland values: Batie and Shabman (1982).
- For other types of valuation studies, and a general review of available valuation approaches: Desvousges and Skahen (1986), Krupnick (1991), McConnell (1993).

Exhibit 5-2

ISSUES TO CONSIDER IN CONDUCTING A BENEFITS TRANSFER

Similarity Between the Existing Site and the Assessment Site

- How does the affected resource compare with the resource referenced in the existing study?
- For what purpose were the original benefit estimates generated?
- What population group(s) was considered in generating the initial benefit estimates (e.g., a specific user group, such as recreational anglers, versus all residents of an area)?
- What was the nature of substitutes in the existing study area (e.g., alternative recreational opportunities), and how does this compare to the nature of substitutes at the release site?
- Does the existing study consider the same or a similar geographic area? Are the demographic and socio-economic characteristics of the two areas similar?
- If the existing study presents a composite of existing values based on an earlier literature review, what methods were used to derive these composite values and what was the nature of the underlying studies?
- If the benefit estimate being considered is for a generic resource category (e.g., song birds), are the species considered in the original study relevant to the case at hand?
- Were baseline conditions (e.g., ambient water quality) in the existing study similar to baseline conditions in the case at hand?
- Have general attitudes, perceptions, or level of knowledge changed in the period since the existing study was performed in a way that would influence the value of the benefit estimate? Are these values likely to be consistent over time?
- Were variables omitted from the original study that are believed to be relevant to the case at hand (e.g., the availability of substitutes)? To what extent does such omission prohibit the transfer?

Quality of the Existing Study

- Was the existing study published in a peer reviewed journal, or did it receive other forms of peer review?
- How is the existing study viewed in the professional community? How was the study viewed by its sponsor?
- If current "best research practices" were not used to generate the existing value estimate, can the estimate be adjusted to reflect changes in the state-of-the-art?

5.3.3.2 SIMILARITY OF RESOURCE/SERVICE CHARACTERISTICS AND POPULATION CHARACTERISTICS

Evaluating the applicability of an existing study to estimate economic damages at an assessment site involves comparing the characteristics of the injured resource or lost services in the existing study with the characteristics of the assessment site. If these characteristics differ, it will be necessary to consider whether these differences are likely to have a significant effect on the valuation of damages and if so, whether adjustments can be made to account for these differences.

Evaluating whether resource/service and population characteristics are similar enough to support a transfer between an existing study and a damage assessment largely depends on the judgement of the analyst, and the purpose to which the final estimate is to be put. Such an evaluation involves consideration of all characteristics of the resources and services that might affect the way an individual values them. As indicated by NOAA in its proposed rule [15 CFR 990.78 (c)(iii)], the change in the quality or quantity of the affected resource and/or services at the assessment site should be comparable to the quality and/or quantity addressed in the existing study. Other characteristics that may be relevant include, but are by no means limited to, the aesthetics of the site, the location of the site, the type of activity, and the distance of the site from population centers. To the extent that these characteristics affect individuals' values for the services provided by natural resources at a site, the characteristics should be similar across the existing study and the assessment site.

Trustees also should consider the extent to which substitutes for the resources and services provided by the site are available for the existing study and the assessment site and whether these substitutes have similar prices (e.g., for recreational opportunities, the distance that must be traveled to access the site). Differences in the availability and cost of substitutes are likely to affect the magnitude of economic damages. For example, if the site represents one of many local fishing sites that are of comparable quality, individuals may not suffer a complete loss of recreational opportunity if the site is closed to fishing because they can go elsewhere. Note that consideration of substitute sites also comes into play in estimating the number of lost use days since if an angler continues to fish at an alternate site, this does not represent a lost use day. Fishing at an alternate site may result in a loss of value (i.e., consumer surplus), however, if the angler has to travel farther to reach the substitute site, or if the quality of the substitute site is less than the injured site. The availability of substitute sites also is of concern in considering potential passive use losses resulting from the natural resource damage. For example, if the site provides the only known habitat for an endangered species, individuals may be more willing to pay to protect this habitat than if many sites in the region provide such habitat.

For the results of an existing study to be applicable to a damage assessment, the characteristics of the population affected by the release and those included in the existing study should be comparable. Relevant characteristics include, but are not limited to age, income, education level, proximity to the site and the level of environmental concern. Also, the population's familiarity with the natural resources at the site should be similar in the existing study and the assessment. For example, did the existing study involve residents of a community located near the natural resources being valued? Had an event recently occurred to make the individuals surveyed in the existing study more aware of or sensitive to environmental issues in a way which may have influenced the

magnitude of the value estimates? Prior experiences may influence perceptions, and thus affect the value that an individual holds for natural resources.

To compare population characteristics, means, medians and the range of values for these characteristics can be evaluated. Significant differences in population characteristics can be accommodated if the study case estimates resource or service values as a function of these characteristics. Small differences in population characteristics are unlikely to have a significant effect on economic damage estimates.

Finally it is relevant to consider the age of the existing study. Older studies are likely to be less applicable because the value society places on a given natural resource or service may change over time. For example, changes in information, real income, relative prices, or the availability of substitutes may influence the valuations of environmental commodities. Unfortunately, sufficient research has not been performed to indicate how long the results of a primary study remain valid for benefits transfer applications. Thus, analysts will need to apply their best judgement in evaluating this factor.

5.3.3.3 EXTENT OF THE MARKET

The "extent of market" for a natural resource is similar to the extent of market for any good or service purchased by consumers. For example, an amusement park might serve one county in the mid-west (i.e., most visitors to the park come from the county in which the park is located), or, as is the case of a large-scale theme park, consumers might be drawn from across the country. Similarly, each natural resource will have a geographic area over which its users are drawn.

An important component of economic damage estimation involves defining the extent of the geographic market for the affected natural resources and the services they provide. The extent of the market determines the size of the population that values the resource and services provided and thus has a significant effect on the magnitude of the resultant economic damage estimate. For example, the magnitude of passive use values associated with a resource can depend on the size of the population assumed to hold values for the affected resource (e.g., local, regional, national). For example, a study of the passive use value of a regionally important historic site might find that residents of the state in which the park is located would be willing to pay $20 annually to preserve the park, on average, while the average resident of the U.S. may be willing to pay only five dollars. Note that the definition of the extent of market for a natural resource or service is a concern in applying all types of valuation methods, not just benefits transfer.

To estimate the extent of the market, analysts might consider the following factors:

- How unique is the resource? Are there other resources similar to it in the area? Is the resource locally important, regionally important, nationally important?

- How many households are likely to hold direct use or passive use values for the affected resources and what is the geographic extent of these households?

- How far do people travel to use the affected resources (prior to the release event)?

The definition of the market for the affected resources and services has implications for the transferability of values from the existing study to the assessment site. The size of the market considered in the existing study may have affected the magnitude of the value estimates generated. Thus, if the damage assessment does not involve a similarly defined market, transferring value estimates from the existing study to the assessment site may introduce a bias into the resulting economic damages estimate. For example:

- In valuing recreational activities, the distance of the individual's home from the site may affect the magnitude of the value held by the individual for the site. Thus, the size of the market considered will affect the reported average value for the site, and thus the transferability of the benefit estimate.

- The magnitude of passive use losses may depend on the proximity of the individuals surveyed to the assessment site. For example, individuals living close to a site may feel a greater stewardship responsibility for the site.

Unfortunately, the benefits transfer literature has not fully addressed the issue of how differences in the size and characteristics of the market affect the transferability of benefit estimates. When using benefits transfer techniques, analysts should carefully consider the extent of the market both in the assessment site and existing study and whether differences in these market definitions are likely to affect the value of the resources.

5.3.4 Conduct Full Benefits Transfer

The fourth and final step in benefits transfer is to calculate economic losses. This involves application of the values, functions, data and or models identified in steps 2 and 3.

Analysts may want to consider a range of applicable value estimates, evaluating each based on the factors described above. Once a final set of values has been chosen, consideration should be given to their general magnitudes. If the existing value estimates differ significantly from one another, or if values generated using alternative value functions differ significantly from one another, consideration should be given to whether they differ in a predictable and consistent manner. If available values or models appear equally applicable, trustees may apply a range of values to the assessment, or use an average of these values.

5.4 Uses and Types of Benefits Transfer

Two general concerns that may confront Service personnel applying the benefits transfer approach include:

- In what situations is it appropriate to apply benefits transfer? and,
- If benefits transfer is appropriate, what types of transfers can be applied?

This section addresses these two concerns.

5.4.1 When to Use Benefits Transfer

In natural resource damage assessment, benefits transfer is often used in situations requiring relatively inexpensive and fast approaches for estimating economic damages. Several factors that Service personnel should consider in deciding whether to use benefits transfer include:

- How does the expected magnitude of damages compare to the costs of assessing them?

  DOI's and NOAA's rules require that natural resource trustees use cost-effective approaches for estimating economic damages. In some instances, the expected magnitude of the damage claim may not justify the cost of conducting primary research, and benefits transfer might be a more suitable approach.

- How much time and financial resources are available to assess the economic damages?

  Since benefits transfer is relatively inexpensive and quick, this approach may be appropriate when resources are constrained.

- What is the purpose of the estimates?

  Benefits transfer may be appropriate in instances when Service personnel need to evaluate the relative magnitude of the damages, or to decide which injury categories warrant further analysis. For example, benefits transfer is commonly employed in preliminary damage assessments.

- What is the level of uncertainty associated with the estimated effects on natural resources at the site?

  Large uncertainties in the magnitude or scope of injured resources or lost services may influence the decision regarding the type of valuation

approaches to apply. That is, if estimates of the magnitude or scope of injured resources or lost services (e.g., the number of user-days lost) are highly uncertain, it may not be appropriate to spend significant time and resources assigning a precise dollar value to these effects.

Although benefits transfer is generally less expensive and time consuming than valuation methods involving original data collection and analysis, there are some instances in which relatively easy and inexpensive primary valuation approaches may be more suitable. For example, if a release results in the closure of a beach for which individuals paid an entrance fee, review of existing data on entrance fees collected before and after the release may serve as a means to estimate economic damages.[2] In fact, application of benefits transfer will generally involve some use of existing data combined with some original data collection. For example, assessment of damages resulting from the closure of a popular bird viewing area might entail an informal survey of area bird watchers to determine their response to the closure (e.g., visited another site, did not participate in bird viewing activities). Once the nature of the behavioral change is known, appropriate value estimates can be applied.

5.4.2 TYPES OF BENEFITS TRANSFERS

Benefits transfer is applicable to a wide range of valuation problems, and existing studies provide a wealth of information that can be applied in assessing economic damages. For example, benefits transfer might be used to assess reductions in:

- The number of recreational activity days at a site;
- The quality of a fishing experience at a site (e.g., a decrease in fish populations which reduces catch rates, or the imposition of a catch-and-release restriction to avoid public consumption of contaminated fish);
- The quality of a wildlife viewing experience at a site (e.g, reductions in bird populations leading to reductions in the number of birds, or the variety of species, seen by recreationalists);
- The quality of a hunting day due to reductions in bird populations (and thus, bag rates);
- The quality of a visitor day to a public park due to a release event at or near the park;
- Passive use values at a site;

[2] Note that these lost fees may not fully reflect damages if visitors were willing to pay more for entrance to the site than was charged (i.e., there were consumer surpluses associated with use of the site).

- Wetland values due to a release or site remediation activities (e.g., construction of a cap at a Superfund site); and
- Commercial fishing catch rates, or the closure of a commercial fishery.

Analysts can use any of several types of benefits transfer approaches to estimate economic damages, including simple transfers of resource values, transfers of valuation functions and models, or transfers of activity data. In the following subsections we describe the types of transfer approaches which are commonly used to assess economic damages in situations like those listed above.

5.4.2.1 VALUE TRANSFERS

Simple transfers of resource values involve the application of existing recreational activity values, species values, passive use values or other resource or service values (e.g., value per acre of wetland) to monetize changes in natural resource services provided by an assessment site. The transferred value can be a value reported in an individual study or the average from a set of studies that address the same or similar categories of resources or services.

The first case study presented below ("Economic Damages Resulting from Diminished Recreational Services") illustrates this type of transfer. This case study describes an analysis of economic damages resulting from lost use of a recreational fishery due to PCB contamination. Economic damages from lost recreational fishing opportunities at this site are estimated based on the average value per fishing day from several existing studies that considered the value of a fishing day in the eastern U.S. These existing values are adjusted to reflect inflation. As discussed above, additional adjustments can be made to account for differences in site and population characteristics of the existing study and the assessment site, as warranted. In this case study, no such adjustments were made since the existing studies covered a broad range of site and population characteristics (and thus were viewed as broadly representative), and because this factor was not seen as a significant source of uncertainty in the final damage estimate.

A second type of value transfer involves the application of existing estimates of the passive use values of natural resources. In general, the transfer of existing passive use values can be used to generate order-of-magnitude economic damage estimates. These estimates can be used to determine whether it is appropriate to conduct primary contingent valuation research to obtain a more precise estimate. The second case study presented below ("Economic Damages Resulting from Injury to Endangered Species") illustrates this type of transfer. In this case, existing studies were used to develop an estimate of potential passive use losses at a creek that provides habitat to fish and wildlife, including several endangered and threatened species. These estimates were also used in preliminary negotiations with the responsible party.

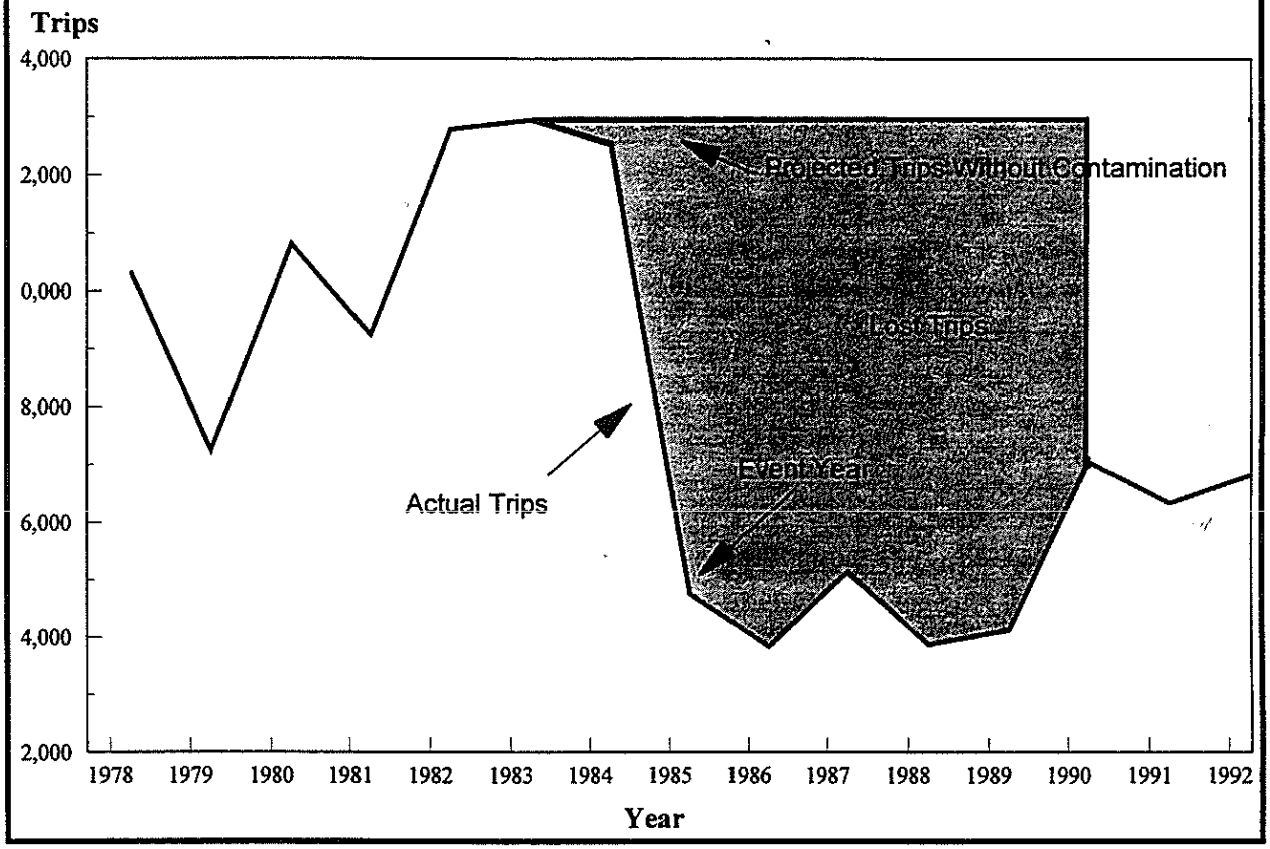
Case Study: Economic Damages Resulting from Diminished Recreational Services

In this hypothetical case, the on-going release of PCBs from a Superfund site resulted in contamination of a creek and associated floodplain within a National Monument. This creek

represented a regionally important and popular native and stocked trout fishery prior to the release event. As a result of the discovery of PCBs at the site, a catch-and-release restriction was instituted on the creek and health advisories were posted. In addition, the state Fish and Game Commission and several private organizations halted stocking activities at the creek. As a result of these events, which occurred in late 1984 and early 1985, there was a sharp reduction in public use of the creek as a recreational fishery (see Exhibit 5-3).

Exhibit 5-3

PATTERN OF RECREATIONAL SITE DEMAND PRIOR TO AND FOLLOWING PUBLIC KNOWLEDGE OF SITE CONTAMINATION



Given the need to generate a damage claim within the time frame of remedial action selection, a site-specific travel cost analysis was not possible. Thus, the trustees undertook a benefits transfer exercise to document the magnitude of damages to the resource. This analysis was made-up of two parts: (1) determination of the magnitude of the reduction in visitation to the creek; and (2) a review of the economics literature to estimate the value of a lost recreational fishing trip in the area of the release.

In order to determine the magnitude of reduced visitation to this site, the trustees reviewed fishing pressure data kept by the National Monument. These data were based on angler and car counts taken on a regular basis from the road by park employees. This historic record indicated that fishing pressure at the site was increasing prior to public knowledge of the contamination. For purposes of the assessment, however, the trustees made the conservative assumption that the total number of trips to the creek from 1985 to 1990 in the absence of the release event would have remained constant at the level experienced in 1983, the last year in which demand for the site was not affected by a health advisory. In 1990 the state had reclassified the creek as a "Class A" fishery. Creeks in this class are not stocked, since they are assumed to be capable of supporting self-sustaining wild trout populations. Since much of the demand for the creek prior to public knowledge of the contamination was associated with these stocking events, the trustees assumed that demand would have declined after 1990, since anglers would not have had the opportunity to catch stocked trout in the creek regardless of the level of PCB contamination. The trustees incorporated this factor into the analysis by assuming that no loss in recreational fishing opportunity had occurred as a result of PCB contamination after 1990. Based on this analysis, the trustees established the total number of trips lost due to PCB contamination from 1985 to 1990.

Given an understanding of the magnitude of lost recreational services, the trustees undertook a review of the recreational valuation literature to establish the economic value of these lost trips. The results of this review are presented in Exhibit 5-4. Recreational losses can generally be divided

Exhibit 5-4

USE VALUES PER FISHING DAY

Study Authors/ Publication Date	Model Type [1]	Source of Data	Scope of Study	Fishing Type	Year	Value (Reported)	Value (1992 $) [2]
Brown and Hay (1987)	CVM	1980 National Survey [3]	U.S.	Trout	1980	$12.00	$20.23
Brown and Hay (1987)	CVM	1980 National Survey	Pennsylvania	Trout	1980	$8.00	$13.49
Miller and Hay (1984)	TCM	1980 National Survey	Maine	Fresh water	1980	$23.00	$38.78
Miller and Hay (1984)	TCM	1980 National Survey	Tennessee	Fresh water	1980	$30.00	$50.59
Miller and Hay (1984)	TCM	1980 National Survey	Minnesota	Fresh water	1980	$29.00	$48.90
Vaughn and Russell (1982)	TCM	Private Fee Fishing Sites	U.S.	Trout	1979	$19.49	$35.97
Connelly, Brown, and Knuth (1990)	CVM	N.Y. State Angler Survey	New York	Cold water	1988	$13.42	$15.62
						Average	$31.94

1 CVM is Contingent Valuation Method; TCM is Travel Cost Method.

2 Economic values per fishing day are converted to 1992 dollars using the gross domestic product (GDP) implicit price deflator (BEA 1992).

3 1980 National Survey of Fishing, Hunting and Wildlife-Associated Recreation conducted by the U.S. Department of the Interior.

into three categories: (1) losses associated with trips foregone; (2) losses associated with trips taken to substitute sites that may be of lower quality or require additional travel; and (3) losses associated with trips still taken to the affected site, but which are of a diminished quality. In this case the trustees determined that those trips not taken to this site (as demonstrated by reduced demand for the site starting in 1984) represented trips foregone, not trips simply substituted to other sites. The principal supporting arguments for this assumption were the overall high quality of the fishing experience, as well as ease of public access afforded by this site, and the fact that the state agency and private organizations who had stocked the creek prior to discovery of PCBs did not switch these stocking operations to other sites (i.e., the fishing opportunity associated with these stocked fish was lost). The trustees did not consider economic losses associated with a reduction in the value of those trips that were taken to the site despite the catch-and-release restriction and health warnings.

As shown in Exhibit 5-4, the trustees identified seven estimates that were relevant to this case. These included fishing day value estimates based on travel cost studies and two contingent valuation studies. These estimates were selected following the benefits transfer protocol described earlier in this chapter. The review indicated that a lost recreational fishing day in this region would be expected to generate an economic loss of about $32 (1992 $).

The final damage calculation is summarized in Exhibit 5-5. The second and third columns of this exhibit summarize the estimated number of lost fishing trips to this site and the economic damage associated with these lost trips. In the third column the trustees net out the annual cost of stocking the creek. Since stocking operations were halted in response to the contamination event, and were not simply moved to another site, the trustees avoided these costs. The net economic damage estimate is presented in the final column of this exhibit.

Exhibit 5-5

ESTIMATED ECONOMIC DAMAGES FROM LOST USE DUE TO PCB CONTAMINATION

Year	Estimated Number of Lost Fishing Trips	Estimated Economic Damages (1992 dollars)	Avoided Cost of Stocking [1] (1992 dollars)	Present Value of Economic Damages (1992 dollars)[2]
1985	8,196	$262,272	$6,768	$410,284
1986	9,118	$291,776	$6,768	$427,720
1987	7,827	$250,464	$6,768	$341,796
1988	9,083	$290,656	$6,768	$372,119
1989	8,827	$282,464	$6,768	$337,739
1990	5,905	$188,960	$6,768	$208,592
	Total			$2,098,250

[1] Avoided stocking costs are estimated based on the number of acres (23.5) multiplied by the stocking rate (400 fish per acre) multiplied by the cost per stocked fish ($0.72 per fish).

[2] Yearly totals are discounted using a seven-percent interest rate.

This analysis indicated that interim lost use (i.e., compensable) values at this site were at least two million dollars. The trustees used this analysis to argue for a more comprehensive remedy at the Superfund site to address off-site environmental and human health risks.

Case Study: Economic Damage Resulting from Injury to Endangered Species

In this hypothetical case, an oil pipeline break results in the release of a petroleum product to a mid-western stream. The stream is a known habitat for several federally listed endangered species, and has been recognized by a national conservation organization as an important regional ecosystem. The federally listed species affected by the spill are freshwater fish and shellfish, not "charismatic megafauna." The site supports little on-site recreation or other direct use. A preliminary field assessment indicates that the spill may have resulted in the extirpation of several species of endangered shellfish from the creek (due to mortality resulting from direct contact with the oil), and likely eliminated fish from a segment of the creek.

In order to establish a preliminary estimate of damages for use in negotiations with the responsible party, and to assess the possible application of the contingent valuation technique to establish a compensable damage claim in this case, the trustees undertook a review of the economics literature to better understand the types of values that would be generated by a high- quality contingent valuation survey. This literature review followed the protocol for benefits transfer described in this chapter. Exhibit 5-6 summarizes the results of this review.

Five studies were identified that addressed resources similar to those of relevance to this case. These included studies of:

- Ohio residents' willingness-to-pay to finance resource management projects to maintain biodiversity, improve stream bed visibility (i.e., improve water clarity), and improve hiking trails at Big Darby Creek.

- The willingness of individuals with Montana fishing licenses (both in state and out-of-state) to pay to lease water rights, as needed, to increase instream flows in two Montana streams that are spawning habitat for several species of concern (the arctic grayling and cutthroat trout).

- Illinois households' willingness-to-pay to protect the quality of the state nature preserve at Illinois Beach State Park.

- Kentucky households' willingness-to-pay to preserve wetlands rather than permit development for coal mining.

- Wisconsin residents' willingness-to-pay to preserve the bald eagle and a less well known threatened species, the striped shiner.

Exhibit 5-6

ESTIMATED VALUES OF RESOURCES SIMILAR TO AFFECTED STREAM

Authors (Date)	Site Location	Description of Commodity	Annual Willingness to Pay (WTP) per Household: Reported Year $	Annual Willingness to Pay (WTP) per Household: 1993 $[4]
Wu (1991)[1]	Big Darby Creek, OH	WTP to finance resource management projects to maintain biodiversity, improve stream bed visibility, and improve hiking trails at Big Darby Creek.	Ohio Public: $8.84 - $11.78 Adj. Ohio Public: $2.54 - $3.46 (1990$)	Ohio Public: $9.69 - $12.91 Adj. Ohio Public: $2.78 - $3.79
Duffield and Patterson (1991)[2]	Swamp Creek and Big Creek, Montana	WTP to lease water as needed to increase instream flows in two creeks that are spawning tributaries for two Montana species of concern.	Unadjusted: $8.44 - $12.26 Adjusted: $0.93 to $6.15 (1990$)	Unadjusted: $9.25 - $13.44 Adjusted: $1.02 - $6.74
Boyle and Bishop (1985)[3]	Illinois Beach State Nature Preserve, IL	WTP to preserve the state nature preserve at Illinois Beach State Park, including construction of a breakwater and day-to-day park management.	$16.44 (1985$)	$21.63
Whitehead and Blomquist (1991)	Clear Creek, KY	WTP to preserve the Clear Creek wetlands rather than permit development of wetlands for coal mining.	$7.00 - $10.00 (1989$)	$8.01 - $11.45
Boyle and Bishop (1987)	Wisconsin	WTP to preserve the bald eagle and the striped shiner.	Contributors to state wildlife program: Mean: $5.66 Median: $1.00 Non-Contributors: Mean: $4.16 Median: $1.00 (1985$)	Contributors to state wildlife program: Mean: $7.45 Median: $1.32 Non-Contributors: Mean: $5.47 Median: $1.32

1. The values reported here are for the sample of Ohio households. The adjusted values assume that non-respondents have a zero value. The range of values reflect different models used to estimate WTP from the survey data.
2. These values are for the entire sample, including resident and non-resident households with Montana fishing licenses. The adjusted values assume non-respondents have a zero value. The range of values reflects the variation across the different versions of the survey (i.e., actual payments to the Montana Nature Conservancy, hypothetical payments to the Montana Nature Conservancy, and hypothetical payments to an unspecified foundation). Respondents may have considered their bids as one-time payments since the survey did not indicate otherwise.
3. The value reported here is the median WTP of households that have not used the nature preserve.
4. Values are adjusted to 1993 dollars using the GDP implicit price deflator, taken from The Economic Report of the President, February 1994. The deflator for 1993 is a preliminary estimate.

It was important for the trustees to note that none of these studies met all of the guidelines for contingent valuation research for purposes of damage assessment, as described by the NOAA Blue Ribbon Panel or as proposed by NOAA in its rule for damage assessment under the OPA. Based on this review, the trustees determined that, if they were to conduct a state-of-the-art contingent valuation study of this incident, they would likely find the public's stated willingness-to-pay to preserve the injured stream to be *at least* $2.50 to $5.00 per household. Based on additional consideration of the contingent valuation literature, this value was assumed to apply to all households in the two states traversed by the affected stream. The result of this effort indicated that damages associated with the spill were at least $15 to $30 million. This value range was used for damage assessment planning purposes by the trustees, and was used in settlement negotiations with the responsible party.

5.4.2.2 Transfers of Value Functions and Models

Transfers of value functions and models generally take on one of two forms in damage assessment cases. In one form, estimates of economic damages are developed by transferring available estimates of resource values expressed as a function of the site's characteristics and/or the characteristics of the affected population. For example, it may be possible to estimate a recreational user day value for an assessment site by transferring a value function from an existing study, and applying in that function median or average values for the physical and demographic characteristics of the assessment site. The following case study illustrates this type of transfer.

Case Example: Transferring a Valuation Function for Groundwater Valuation

This example considers the economic damages resulting in a hypothetical case in which the release of a toxic substance has contaminated a groundwater aquifer. This release has resulted in lost use and passive use values. In this case the trustees chose to evaluate lost use values using the averted behavior method described in Chapter 4. In addition, in order to evaluate total losses (including passive use losses), the trustees chose to apply the groundwater valuation function available from an existing contingent valuation study (McClelland et al. 1992). This study expresses groundwater value as a function of several variables, including the region of the country in which the aquifer is located, and average income levels in the local area.

The value function estimated in McClelland et al. is based on household responses to a contingent valuation survey. The question asked how much were households were willing to pay, in the form of increased water bills, for remediation of a defined groundwater contamination problem.[3] The resulting function is:

[3] See McClelland et al. (1992) for a complete review of the injury description used in this study.

$$Value = 3.0685 + (0.0665 * Income) + (0.7878 * Northwest)$$

where,

Value =	annual use and nonuse value per household for groundwater;
Income =	average annual income per household (thousands of dollars); and,
Northwest =	1 if the household is located in the northwest and 0 otherwise.

Note that McClelland provides coefficients similar to the "northwest" coefficient reported above for other regions of the U.S.

Assuming that the site is located in the northwestern U.S. and the average annual household income level in the counties surrounding the site is $35,000, then plugging these values into the above function yields an estimate of $6.18 per household. That is, the loss of this aquifer as a groundwater resource as a result of a contamination event has likely resulted in economic damages of about six dollars per household for each year in which the aquifer remains contaminated. The wording of the question in the McClelland survey implies that this estimate includes both direct use and passive use losses.

This example is provided as an illustration of the application of a value function to estimate compensable damages. To use this particular study and approach for valuing lost services resulting from contamination of groundwater due to a toxic release or oil spill, Service personnel would need to consider whether the valuation question in this existing contingent valuation study is applicable to their assessment site. In addition, this study has been subject to the general controversy surrounding the contingent valuation method, as well as some more study specific criticisms (e.g., an EPA Science Advisory Board has criticized the wording of questions used in the McClelland survey instrument). Thus, application of damage estimates based on this and other existing contingent valuation studies may be limited to preliminary assessments and use in settlement negotiations with responsible parties.

* * * * *

A second application of benefit function transfer involves the use of observed relationships between the value of a natural resource and/or service and the characteristics of the site. For example, the release of oil or other hazardous materials to the environment can affect recreational activities in three ways:

- Users may forego the activity entirely, given closure or degradation of the site;
- Users may go to substitute sites (thus incurring additional travel costs or reductions in the quality of the experience); and/or
- Users may continue to use the site, despite the decline in quality.

Since the value of a fishing day may in part depend on the number of fish caught, a reduction in catch rates at a site due to a contaminant release event may result in any or all of these behavioral

responses. In this case trustees could consider studies that examine the relationship between catch rate and the value per activity day and studies of the value of a lost fishing day in order to evaluate the economic damages resulting from this type of resource injury.[4]

Similarly, the value of a bird viewing day may depend on the number of birds seen at a site. Cooper and Loomis (1991) report that respondents to a contingent valuation survey were willing to pay to increase the number of birds seen on their most recent bird viewing trip. This research suggests that reductions in bird populations at a site can have a negative effect on the value of bird viewing trip. The relationship observed by Cooper and Loomis could be used to evaluate the change in the value of bird viewing days resulting from oil or other hazardous material releases. An example of this type of transfer appears in the case study presented below ("Economic Damage Resulting from Injury to Migratory Waterfowl"). Note that the proposed Type A model for the Great Lakes Environment uses the results of the Cooper and Loomis study and this type of benefits transfer approach to evaluate economic damages associated with non-consumptive wildlife-associated recreation.

Value function transfers have also been used to estimate economic damages resulting from injury to birds and the resulting effects on waterfowl hunting. For example, results of a study by Charbonneau and Hay (1978) evaluate the effect of increases in waterfowl populations on the value of a hunting day. The Type A model uses this approach in estimating damages associated with lost hunting services provided by waterfowl populations.

Case Study: Economic Damage Resulting from Injury to Migratory Waterfowl

This case draws on the restoration program costing example provided in Chapter 3. In this case an oil spill off the coast of Northern California resulted in the abandonment of a seabird colony. Based on a series of injury studies, the trustees concluded that this event significantly increased the probability that the entire southern range of this species could be lost, natural recovery and re-population of the colony was unlikely, and even if recovery did occur, the public would experience direct use (i.e., diminished bird viewing opportunities) and passive use losses from the time of the spill until full recovery was achieved. However, for a variety of reasons, no compensable damage claim was developed by the trustees.

Since the trustees did not believe that natural recovery was likely, they proposed an aggressive bird recolonization project. This proposed project involved use of decoys and audio cues to encourage breeding birds to return to the affected site. Given the technical nature of this project, several experts would be involved, as well as associated support staff. The abandoned colony was located in a remote location; thus, the trustees needed to account for travel costs and other costs associated with site access. The trustees planed to contract the restoration effort out to a private organization. It was expected that the project would require 10 years to complete, at a total cost of $4.5 million.

[4] Studies that address this issue include Samples and Bishop (1985), Brown and Plummer (1989), Vaughan and Russell (1982), Milon (1989), and Bockstael, McConnell and Strand (1989).

The responsible party contested this claim based on several arguments, including that the cost of the proposed restoration action was "grossly disproportionate" to the value of the lost resource. Three separate analyses were conducted by the trustees to document the likely benefits of their proposed restoration option. These included:

- A benefits transfer exercise, drawing passive use and total values from the literature for similar resources;
- A benefits transfer-based review of the recreational valuation literature, with a focus on studies that provide estimates of the marginal value of additional bird viewing opportunities; and
- An inventory of public uses of this resource, including commercial charter and private boat trips taken to the site prior to the spill.

The trustees first undertook a review of the contingent valuation literature to identify studies that provided passive use values (or total values incorporating both direct use and passive use) for non-game wildlife species. The trustees focused this review on studies that addressed the economic value of bird species and also satisfied the benefits transfer criteria described in this chapter. The results of this literature review are presented in Exhibit 5-7. The trustees did not use these results to generate an estimate of the total economic loss associated with this spill event, but instead used them to demonstrate that such resources have value, and that a state-of-the-art contingent valuation study of this event would likely demonstrate a significant willingness-to-pay by the public to undertake the selected restoration option.

The trustees also undertook a benefits transfer exercise, following the protocols described in this chapter, of recreational use value studies that consider the economic value of bird viewing opportunities. The first study (Hay 1988) used contingent valuation data from the U.S. Fish and Wildlife Service's 1985 National Survey of Fishing, Hunting and Wildlife Associated Recreation.[5] Hay uses responses to this survey from individuals who travelled at least one mile from their home for the primary purpose of observing or photographing wildlife, and reports a $32 per trip value for California (1985$).

The trustees considered a second study (Cooper and Loomis 1991) that uses the contingent valuation method to define a value per day of bird viewing activity in California, and a value per each additional bird seen during these trips. This study found the value for a day of bird viewing in California to be $37.33 (1987 $), which was determined to be reasonably close to the value reported by Hay, especially when Hay's value is inflated to 1987 dollars. In addition to providing an estimate of the value of a day of bird viewing, the Cooper and Loomis study was also used to estimate the

[5] Results from the 1991 version of this survey are now available.

Exhibit 5-7

A REVIEW OF PASSIVE USE AND TOTAL VALUES FOR NONGAME BIRD SPECIES BASED ON CONTINGENT VALUATION STUDIES *

Study	Description of Environmental Good Being Valued	Results ($ household)
Bowker and Stoll (1988)	Willingness-to-pay into a fund to maintain the Aransas National Wildlife Refuge for the Whooping Crane, in order to prevent extinction of the Whooping Crane. Residents of Texas, as well as residents of Los Angeles, Chicago, Atlanta and New York were surveyed.	$22 (1983 $)
Boyle and Bishop (1987)	Willingness-to-pay to preserve the bald eagle in Wisconsin. Donors and non-donors and a State of Wisconsin Endangered Resources Donation program were surveyed.	$5 (1984 $) (for non-donors)
Hoehn and Loomis (1993)	Willingness-to-pay to reduce agricultural contamination in the San Joaquin Valley, which results in reproductive failure in egrets, black necked swifts, herons and other waterfowl. California residents were surveyed.	$27 (1989 $)
Stevens et al. (1991)	Willingness to enhance New England populations of bald eagles and wild turkey.	$28 (1989 $) for bald eagle $7 (1989 $) for wild turkey
Hagen et al. (1992)	U.S. households' willingness-to-pay for a conservation plan to protect the Northern Spotted Owl in the Pacific Northwest.	$86 (1990 $)
Rubin et al. (1991)	Washington State residents' willingness-to-pay to preserve the Northern Spotted Owl.	$22 (1987 $) (For a 50 percent probability of owl survival.)
Rowe et al. (1992)	Washington State residents' willingness-to-pay to avoid the loss of 40,000 seabirds as a result of an oil spill off the Washington State Coast.	$19 (1989 $)
Loomis (1987)	California households' willingness-to-pay to protect Mono Lake, California as a habitat for a variety of bird species.	$89 (1986 $)

* The values presented in this exhibit are approximate and are presented only for illustrative purposes. They may not be appropriate for actual cases.

value of an increase in the number of birds seen. Specifically, the results of this study imply a willingness to pay of $0.54 per additional bird seen.

These results were used by the trustees to demonstrate that a reduction in bird viewing opportunities due to this oil spill most likely did result in a reduction in economic surplus provided by this resource. At a minimum, the 5,000 individuals who participated in charter boat trips which had included a visit to the affected site prior to the spill experienced such losses. In addition, individuals who viewed birds from the affected colony from other viewing locations (such as coastal vistas) would also have experienced some loss in surplus. The existing data were not sufficient to

calculate economic damages associated with lost viewing opportunities (e.g., the actual decline in the number of birds seen by bird viewers was unknown). However, this exercise provided evidence that such losses likely occurred, and that efforts to restore the lost colony would result in real economic gains associated with use of this resource.

Finally, the trustees undertook a telephone survey of charter boat operators and private bird viewing clubs and other organizations to gather information on (1) the number of boat trips taken to the injured colony prior to the spill event; (2) the nature of these trips (i.e., whether the trips involved bird viewing as the primary activity, whether the site in question was a feature of the trip, etc.); (3) the number of individuals participating on these trips; and (4) where these individuals were from (i.e., were they primarily local bird viewers, individuals from the rest of the U.S., or individuals from around the world). In addition, the trustees inquired as to whether the trips previously taken to this site were canceled after the spill, or if they were taken to substitute locations.

Based on this survey of site use, the trustees determined that approximately 5,000 individuals per-year had visited this site prior to the spill, primarily through two commercial charter operations out of a nearby harbor. These visits were generally taken as part of a longer boat trip, with attractions including whale watching and bird viewing at other locations; however, this colony, due to ease of access, was considered a popular stop on the tour. The average charge for these trips, in 1994, was $30. The majority of the participants were from California, but nearly all of the trips included individuals from other parts of the U.S. and other areas of the world. The charter boat operators had continued to run trips following the spill, but had not substituted alternative sites for the injured colony since travel times to possible substitute sites were too long. Based on this information, the trustees concluded that a real reduction in use value associated with the spill had occurred, and that if a formal survey of charter boat patrons were undertaken, these individuals would express a willingness-to-pay to restore the site. Thus, while this review did not produce an estimate of the dollar value of this site as a recreational resource, it did provide evidence that the site was used prior to the spill, and that a real loss had occurred as a result of the loss of abandonment of the colony.

These analyses were used in negotiations with the responsible party, and in preparing for deposition of the economic experts hired by the responsible party in this case.

5.4.3 TRANSFERS OF ACTIVITY DATA

Transfers of data, functions or models from existing studies can be used to estimate the number of lost recreation days at an affected site. For example, Brown and Hammack (1978) provide data on the relationship between the number of birds at a National Wildlife Refuge in Maryland, and the number of visitor days to the Refuge. This relationship could be used in estimating the magnitude of the decline in bird viewing days at a site resulting from injury to bird populations. Other examples of the transfer of activity data include:

- Bird Viewing Activity Data. Although site-specific data on bird viewing activities are not available for most sites, the U.S. Fish and Wildlife Service and some state agencies collect state-level data on non-consumptive wildlife-associated recreation,

including bird viewing activities. These data could be used in developing estimates of the level of bird viewing activities at a site.

- Recreational Fishing Activity Data. As with bird viewing, site specific data on fishing levels might not be available for each assessment site, but may be available for sites with similar characteristics or at a state-wide level. Such "fishing pressure" data (generally expressed in terms of number of participants per day per mile of river or acre of surface water body) may be transferred by considering the length of the affected stream or size of the affected water body, and such factors as the availability of site access and the baseline water quality of the affected stream relative to those sites for which fishing pressure data are available.

5.5 Limitations of Benefits Transfer

The limitations of the benefits transfer method principally relate to potential uncertainties (or bias) in the resulting damage estimates due to potential differences in the characteristics of the existing study and those of the assessment site, and the quality of available studies. The quality of the resultant estimate will depend on the quality and number of existing studies, and the level of effort and care taken by the trustees in performing the transfer. No benefits transfer will be perfect; however, the extent to which the criteria defined above are considered will determine the quality of the resultant estimate. In all cases trustees should attempt to be conservative (i.e., select assumptions and values that are more likely to understate damages than to overstate damages). In addition, trustees should consider the purpose for which the damage estimate is being generated. For example, a preliminary estimate that is developed to support the damage assessment planning process may not need to be as precise as one developed for settlement negotiation purposes.

Note that the limitations associated with the benefits transfer method are acute when the transfer involves passive use values. This is the case because (1) passive use values are viewed as being highly site-specific, and thus the transfer from one site to another may be controversial, and (2) few existing contingent valuation studies that evaluate passive use values meet the current criteria for a high-quality contingent valuation study. Thus, in most cases, passive use value estimates developed for an injured resource will be applicable for purposes of preliminary damage assessment or settlement negotiations with the responsible party, and not for purposes of the presentation of a damage claim in court.

5.6 Commonly Referenced Sources for Use in Benefits Transfer

There are a number of bibliographies and databases that can be used to identify potentially applicable existing studies. These include:

- The Environmental Benefits Database compiled by NOAA, EPA and others, and maintained by EPA's Office of Policy, Planning and Evaluation.[6]

- Various reviews of the existing contingent valuation literature (these studies include assessments of a wide-range of resource categories and services): Carson et al. (1994); Mitchell and Carson (1989) and Cummings et al. (1986).

- Several surveys of the recreation literature: Walsh et al (1989, 1992); Bockstael et al. (1986), Loomis and Sorg (1983).

- The fish kill valuation guidelines provided by the American Fisheries Society (1990).

- Surveys of the wildlife valuation literature, including (Iec 1991) and various state guidelines for restitution (e.g., State of Minnesota (1991), Talhelm (1990)).

- Surveys of the groundwater valuation literature, including Boyle (1994).

- Studies of the economic value of wetlands: Anderson and Rockel (1991), Scodari (1990), Douglas (1989) and King (1990).

- Studies of the economic value of marine resources, including Freeman (1993).

Benefits transfer has recently received increased attention in the economics literature. For further discussion of benefits transfer, see: Atkinson et al. (1992); Boyle and Bergstrom (1992); Brookshire and Neill (1992); Desvousges et al. (1992); Loomis (1991 and 1992); Luken et al. (1992); McConnell (1992); Smith (1992); Smith and Kaoru (1990); and Walsh et al. (1989).

5.7 Use of Public and Private Expenditures and Activity Data

Public policies protecting natural resources and public and private expenditures on endangered species and their habitats demonstrate that the public values these resources. For example, in passing the Endangered Species Act, Congress found that endangered and threatened species "are of aesthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people" [Section 2, 16 USC 1531]. Public and private expenditures reveal that the public is willing to make financial sacrifices to preserve important natural resources. For example, recent actions have been taken to preserve old-growth forests and the northern spotted owl, despite the fact that these actions will reduce revenues from timber sales and result in job loss in the logging industry.

Public and private expenditures to protect a natural resource, however, do not provide a measure of absolute value of a resource (Freeman 1993). There are several reasons why these

[6] Computer disk copies of this database can be obtained by contacting the U.S. Fish and Wildlife Service's Division of Economics.

expenditures do not provide an accurate value measure. First, public expenditures are affected by the political process and efforts by special interest groups to influence programs and policy (Coursey 1994). Second, state and federal government agencies have limited resources available to finance competing programs. Finally, and most importantly, direct expenditures do not reflect the opportunity costs of development (or other economic activity) foregone, which in many cases can be quite large.

Donations to and expenditures by private organizations also do not measure the full value of preserving natural resources (Freeman 1993). First, private donations suffer from the "free rider" problem, which causes donations to understate the value of a resource.[7] Second, private expenditures are complicated by the political process; that is, private organizations often spend money to advocate positions or influence policy. The magnitude of these expenditures may not depend on the value of the resource. Rather, a rational organization with limited resources would seek to maximize the benefits of its expenditures on its activities. Thus, expenditures for a particular activity will depend on the marginal productivity of a dollar spent across all activities. Finally, because organizations typically support a number of activities, it may be difficult to attribute contributions to a particular activity.

Despite these limitations, in some cases it may be useful for trustees to review information on public and private expenditures to preserve or enhance natural resources, as one indication of the value of these resources. This is a special case of benefits transfer, where the existing value is current public or private expenditures on the resource (or a similar resource) in question. For example, trustees might consider expenditures by federal and state governments to protect endangered and threatened species and their habitat under the Endangered Species Act, as well as specific expenditures by federal and state governments and private organizations to preserve the resource in question (or a similar resource) and/or to protect species that rely on that resource.

[7] The free rider problem refers to the fact that individuals have incentives to understate their willingness to pay for public goods, since they cannot be excluded from enjoying the benefits of public goods, and they therefore can get a "free ride" on the contributions of others.

6

THE ROLE OF TIME IN NATURAL RESOURCE DAMAGE ASSESSMENT

6.1 INTRODUCTION

In many cases natural resource damages will occur over an extended period of time. For example, the release of hazardous contaminants from an uncontrolled waste disposal site may have resulted in the loss of natural resource services in the past. In addition, these losses may be expected to continue into the future, pending full restoration of the resource. Similarly, trustees may have incurred natural resource damage assessment costs in the past, and may expect to incur costs associated with resource restoration in the future. Under DOI's final rule and NOAA's proposed rule, trustees are expected to present a single, "present value" damage claim to the responsible party. Thus, in many cases, it will be necessary for trustees to apply the concept of "discounting" to a damage claim. The application of appropriate discounting rules is necessary to assure that the public is appropriately compensated for compensable losses, made whole for the cost of conducting the damage assessment, and provided with sufficient funds for the completion of necessary restoration actions.

The purpose of this chapter is to provide a general introduction to discounting and capital budgeting for purposes of natural resource damage assessment. Specifically addressed are:

- The need to discount past and future compensable losses in developing a present value damage claim;[1]
- The need to put damage assessment costs in present value terms; and,
- The capitalization of future restoration costs.[2]

[1] Discounting values from the past to the present is often referred to as "compounding."

[2] Additional discussion of the importance of time in generating restoration cost estimates is presented in Chapter 3.

This chapter is divided into six sections. Section 6.2 provides a brief introduction to the key concepts in discounting. Section 6.3 reviews DOI's and NOAA's guidance on discounting in the context of natural resource damage assessments. Section 6.4 presents an approach for discounting past and future compensable losses, and Section 6.5 an approach for calculating the present value of past and expected future damage assessment costs. Section 6.6 provides guidance on capital budgeting for purposes of generating a present value restoration cost claim.

6.2 Key Concepts in Discounting

Discounting is a widely used economic procedure that allows individuals and organizations to convert flows of sums into single, present value dollar amounts. The principal behind discounting is that there is a "time value of money" -- that is, a dollar paid two years from now is worth less than a dollar paid today, all else held equal. Future dollars are worth less than current dollars, all else equal, since the individual receiving the dollar in two years will have to forego consumption (or investment) opportunities for that time period. Discount rates are analogous to interest rates paid by banks to attract depositors; banks must pay interest to get consumers to forego current consumption, and instead deposit their money in the bank. Thus, the present value of an economic benefit (or damage) depends on when that benefit is received.

Discounting is commonly applied in financial transactions. For example, a business might offer an investor a bond that promises to pay $100 per year for 10 years. In order to determine the right price to pay for the bond, the investor must "discount" the promised future payments to a single, present value. The "discount rate" used by the investor in this example is the rate the business must offer the investor to forgo some other investment opportunity.

Why Discount?

Given the effort required to do so, some trustee representatives may ask: why should we bother to discount past and future damages (i.e., "wouldn't it be easier to simply add-up the damages")? Discounting is required to assure that the public is as well off at the time of claim presentation as they would have been, but for the discharge. As described in this chapter, a dollar owed from some point in time in the past, or not owed until some point in time in the future, is not worth the same as a dollar owed today. The failure to compound past damages will result in the public being under-compensated for their losses, while the failure to discount expected future damages means the public will be over-compensated for their losses. Thus, the application of appropriate discounting rules is necessary to assure that the public is fairly compensated for damages to trust natural resources, and to assure that a cost-effective restoration program is selected.

The formula for calculating the present value of a series of future payments is as follows:

$$\text{Present Value of Payment}_{(\text{Current Year})} = \text{Payment}_{(\text{Year N})} * (1 + \text{Assumed Interest Rate})^{(\text{Current Year - Year N})}$$

In Exhibit 6-1 we apply this formula to calculate the present value of the bond described above, assuming a 10 percent discount rate. For example, the present value of $100 to be paid in the year 2000 is approximately $62, established using the formula:

$$\text{Present Value of Payment}_{(1995)} = \$100 * (1 + 0.10)^{(1995\text{-}2000)}$$

$$\text{Present Value of Payment}_{(1995)} = \$62.09$$

Exhibit 6-1

EXAMPLE APPLICATION OF DISCOUNTING TO CALCULATE THE PRESENT VALUE OF A SERIES OF FUTURE PAYMENTS

Year	Payment	Discount Calculation[1]	Present Value of Payment (1995 $)
1995	$100	$* (1 + 0.10)^{(1995\text{-}1995)} =$	$100.00
1996	$100	$* (1 + 0.10)^{(1995\text{-}1996)} =$	$90.91
1997	$100	$* (1 + 0.10)^{(1995\text{-}1997)} =$	$82.64
1998	$100	$* (1 + 0.10)^{(1995\text{-}1998)} =$	$75.13
1999	$100	$* (1 + 0.10)^{(1995\text{-}1999)} =$	$68.30
2000	$100	$* (1 + 0.10)^{(1995\text{-}2000)} =$	$62.09
2001	$100	$* (1 + 0.10)^{(1995\text{-}2001)} =$	$56.45
2002	$100	$* (1 + 0.10)^{(1995\text{-}2002)} =$	$51.32
2003	$100	$* (1 + 0.10)^{(1995\text{-}2003)} =$	$46.65
2004	$100	$* (1 + 0.10)^{(1995\text{-}2004)} =$	$42.41
TOTAL			$675.90

[1] Example assumes a 10 percent discount rate.

As shown in Exhibit 6-1, assuming an annual discount rate of 10 percent, the investor would offer no more than approximately $675 for this bond, which equals the sum of the present values of each of the expected payments associated with the bond.

This same formula can be used to "compound" payments due from the past. For example, imagine a case in which an individual was to have received $100 per year from 1985 to 1990, but for some reason was not provided these payments. That income stream, if paid in one lump sum in 1995, would be worth $1,242.60, assuming a 10 percent discount rate, as detailed in Exhibit 6-2. That is, a single payment of $1,242.60 in 1995 is the financial equivalent of having received $100 each year from 1985 to 1990 and of having invested and earned 10 percent interest on that money.

6.2.1 Discounting in Damage Assessment

The present value formula presented in the previous section can be used to estimate the present value of each component of a natural resource damage claim (i.e., compensable losses, assessment costs and restoration costs). What varies between these components is the discount rate used. Specifically:

- The appropriate discount rate for converting past and future compensable losses to present value terms is represented by an aggregated measure of individual rates of time preference.

- Assessment costs incurred by the trustees should be converted to present values using the trustee's cost of funds (i.e., the interest rate on funds borrowed by trustees to conduct the assessment).

- The present value of expected restoration costs should be estimated using a discount rate equal to the expected rate of return on recovered funds.

The remainder of this chapter discusses these guidelines further and provides example calculations for each damage category. This discussion begins with definitions of several key terms used in discounting: individual rate of time preference and "real" and "nominal" discount rates.

6.2.2 Individual Rate of Time Preference

An individual's rate of time preference is the rate of interest at which that individual is indifferent between consuming goods now and postponing consumption to a later date. For example, an individual may be indifferent between a guaranteed payment of $100 today and a guaranteed payment of $110 in one year, implying an individual rate of time preference of 10 percent. The appropriate discount rate for purposes of discounting past and future compensable losses can be thought of as the aggregate of individual rates of time preference.

Exhibit 6-2

EXAMPLE APPLICATION OF COMPOUNDING TO CALCULATE THE PRESENT VALUE OF A SERIES OF MISSED PAYMENTS

Year	Payment	Discount Calculation[1]	Present Value of Payment (1995 $)
1985	$100	$* (1 + 0.10)^{(1995-1985)}$ =	$259.37
1986	$100	$* (1 + 0.10)^{(1995-1986)}$ =	$235.79
1987	$100	$* (1 + 0.10)^{(1995-1987)}$ =	$214.35
1988	$100	$* (1 + 0.10)^{(1995-1988)}$ =	$194.87
1989	$100	$* (1 + 0.10)^{(1995-1989)}$ =	$177.16
1990	$100	$* (1 + 0.10)^{(1995-1990)}$ =	$161.05
TOTAL			$1,242.59

[1]Example assumes a 10 percent discount rate.

There are, however, no published estimates of aggregate measures of individual rates of time preference -- that is, we cannot look up the current social discount rate as we might mortgage rates or government bond rates. This rate must be inferred from individual behavior, and as such is not a fixed or known value. Researchers and government agencies have attempted to define this value using various techniques and assumptions. For example, the Congressional Budget Office (CBO) accepted the principle of discounting the costs and benefits of government programs according to individual rates of time preference and specified two percent as the best estimate of this rate. Professor A. Myrick Freeman, in his widely-referenced book on environmental economics, states that a rate of two to three percent is appropriate for discounting streams of benefits and costs that accrue to people in the same generation (Freeman 1993). DOI and NOAA have selected different discount rates for use in damage assessment, as described in Section 6.3.

6.2.3 Real and Nominal Discount Rates

In order to properly discount past and future values, trustees must first determine whether the values being discounted are expressed in "real" or "nominal" terms. Simply put, real values are values that have been adjusted for inflation, while nominal values are expressed in un-inflated terms. For example, the nominal cost of a movie ticket in Boston in 1980 was $4.00, while the nominal cost in 1995 was $7.50. In order to compare these values in real terms (i.e., adjusted for inflation), we must "inflate" the 1980 value to 1995 dollars. Using the Gross Domestic Product (GDP) implicit price deflator we find that the price of a movie ticket in 1980, expressed in 1995 dollars, is $7.20.[3] Thus, the price of a movie ticket increased from 1980 to 1995 relative to the average price increase of all goods sold in the economy.

This same type of calculation is performed in converting nominal natural resource damage estimates into real terms. For example, a trustee may wish to apply a recreational fishing day value, reported in 1985 dollars, to a case involving lost fishing opportunities in 1995. In this case the analyst needs to adjust for inflation by converting the 1985 value to a 1995 value, using an index such as the GDP price deflator. Exhibit 6-3 reports the GDP implicit price deflator for the years 1970 to 1995, and provides the formula that is used to convert values expressed in past dollars into current dollars.

For damages expected to occur in the future, trustees can assume a 3.0 percent annual increase in this index (i.e., assume that

Exhibit 6-3

GDP IMPLICIT PRICE DEFLATOR

Year	Implicit Price Deflator (1987=100)	Year	Implicit Price Deflator (1987=100)
1970	35.2	1983	87.2
1971	37.1	1984	91.0
1972	38.8	1985	94.4
1973	41.3	1986	96.9
1974	44.9	1987	100.0
1975	49.2	1988	103.9
1976	52.3	1989	108.5
1977	55.9	1990	113.3
1978	60.3	1991	117.6
1979	65.5	1992	120.9
1980	71.7	1993	123.5
1981	78.9	1994	126.1
1982	83.8	1995*	129.7

To inflate past (i.e., nominal) dollars into current (i.e., real) dollars:

$$\textit{Past Value} * \frac{\textit{Current Year Index}}{\textit{Base Year Index}}$$

For example, to convert $100, expressed in 1974 dollars, into 1995 dollars:

$$\$100 * \frac{129.7}{44.9} = \$288.36$$

* Estimated by Industrial Economics, Incorporated using Administration forecast; for future years, assume 3% Inflation.

Source: *Economic Report of the President*, Feb. 1995.

[3] Economists use the term "deflator" to refer to indices used to inflate or deflate dollar values to a given base year. The GDP implicit price deflator is an index commonly used to measure inflation.

inflation will be 3.0 percent annually).[4] For example, if a trustee expects compensable damages to be $500 in 1999, in nominal terms, the trustee can calculate a real value, in 1995 dollars, using the formula:

$$\text{Real Value} = \$500 * (1+0.03)^{(1995-1999)}$$

$$= \$444.24$$

In addition to real and nominal prices, economists define real and nominal discount rates. A nominal discount rate has not been adjusted for inflation, while a real discount rate has been adjusted for inflation. For example, the average rate of return on three month U.S. Treasury Bills during 1994, expressed in nominal terms, was 4.29 percent. Since the rate of inflation in 1994 was about 2.9 percent (as measured by the GDP implicit price deflator), the real rate of return on three month U.S. Treasury bills during this period was 1.39 percent.

In calculating the present value of the various components of a damage claim, trustees must express damage estimates and discount rates consistently in either real or nominal terms. That is, trustees must apply real discount rates to discount damages expressed in real terms (i.e., when damage estimates have been adjusted for inflation), and nominal discount rates to discount damages expressed in nominal dollars (i.e., when the damage estimates have not been adjusted for past or potential future inflation). As discussed below, trustees are encouraged to adjust for inflation first, and then apply real discount rates to calculate present value compensable losses to assure this consistency.

6.3 DOI AND NOAA GUIDANCE ON DISCOUNTING

DOI's final rule and NOAA's proposed rule for damage assessment provide guidelines to trustees for discounting, and suggest appropriate discount rates. Under both rules trustees are directed to discount all components of the damage claim. However, the recommended discount rates differ between these two rules.

DOI's rule on discounting for purposes of natural resource damage assessment, provided at 43 CFR 11.84(e), are as follows:

> (e) Discounting. (1) Where possible, damages should be estimated in the form of an expected present value dollar amount. In order to perform this calculation, a discount rate must be selected.
>
> (2) The discount rate to be used is that specified in "Office of Management and Budget (OMB) Circular A-94 Revised."

The March 1972 OMB circular referenced in DOI's final rule (issued March 25, 1994), specified a real discount rate of 10 percent. This circular has since been revised to state that the

[4] Economic Report of the President, 1995.

appropriate real discount rate for public investments is seven percent [Office of Management and Budget, Circular No. A-94, Revised, Transmittal Memorandum No. 64, 29 October 1992, p. 9]. In addition, the revised circular states that analyses should be conducted to show the sensitivity of the outcomes of the analysis to the discount rate. In its October 19, 1994 advanced notice of proposed rulemaking, DOI solicited comment on whether use of a seven percent discount rate is appropriate, or if trustees should be able to use different discount rates [59 FR 52749, Oct. 19, 1994]. In this notice of proposed rulemaking DOI cited NOAA's proposed guidelines (described below) as one possible alternative to its 1994 guidance on this issue.

DOI recognized in its final, March 1994, rule that in order to estimate total present value damages, trustees need to place all expected restoration costs and compensable losses in present value terms. Specifically, DOI's March 1994 rule stated that a discount rate should be used to calculate the present value benefits of any possible restoration actions [43 CFR 11.84(g)(iii)], and to calculate the expected present value losses of services not received as a result of the release [43 CFR 11.84(g)(iv)]. The present value of the expected total loss in services due to the release (assuming no restoration actions are undertaken), minus the present value of the total expected benefit of the proposed restoration actions represents economic damages [43 CFR 11.84(g)(v)].

In its proposed rule, NOAA also directs trustees to discount all damage estimates into present value terms, and provides guidance for the appropriate discount rates to use in these calculations. Specifically [990.79(e), 59 FR 1184, Jan. 7, 1994]:

> (e) Discounting. (1) The trustees should discount the three components of the damage claim: Compensable values; future restoration costs; and assessment and restoration costs already incurred. NOAA recommends that the trustee(s) use the U.S. Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis for discounting the value of each of the components. The reference date for the discounting calculation is the date at which the claim is presented. Section 9.14 of the proposed rule, as required by section 1005(b) of OPA, provides for pre-judgment interest and post-judgment interest to be paid at a commercial paper rate, starting from 30 calendar days from the date a claim is presented until the date the claim is paid.
>
> (2) Trustees are referred to Appendix C of OMB Circular A-94 for information about nominal and real U.S. Treasury rates of various maturities and for further guidance in calculation procedures. Copies of the Appendix, which is regularly updated, and of the Circular are available from the OMB Publications Office (202-395-7332).

6.4 Discounting Compensable Losses for Purposes of Natural Resource Damage Assessment

As noted above, the rules on discounting provided in DOI's March 1994 final rule and NOAA's 1994 proposed rule differ. In addition, DOI announced in its October 1994 notice of proposed rulemaking that it was considering revising its earlier guidance as part of the biennial review of these rules. Given these facts, the following guidance is provided to trustees:

- First, trustees should adjust all compensable value estimates for inflation (i.e., convert all compensable loss estimates to real dollars prior to applying a real discount rate.

- Second, a real rate of seven percent should be used for discounting and compounding compensable value losses. This analysis should be viewed as a "base case" that is in keeping with DOI's final rule.

- Third, trustees should estimate compensable losses assuming a three percent real discount rate. If this analysis indicates that the results are sensitive to the assumed rate, and if the damages are of a magnitude to warrant further consideration of this factor, the trustees may wish to consider presenting a damage claim based on an alternative real discount rate.[5]

This approach is in keeping with the current DOI guidelines, while recognizing the fact that a lower real discount rate may be appropriate for purposes of natural resource damage assessment.

EXAMPLE: DISCOUNTING COMPENSABLE LOSSES TO GENERATE A PRESENT VALUE DAMAGE CLAIM

An example application of discounting to generate a present value compensable losses damage claim is provided in Exhibit 6-4. This example involves the following scenario:

> Releases from an uncontrolled hazardous waste site have resulted in the contamination of a creek with PCBs and other toxics. As a result, the state health agency has posted warnings at the site, recommending that anglers not eat the fish they catch. As a result, fishing pressure (i.e., number of fishing trips to the site) declines. The warnings were first issued in 1985, and are expected to be lifted in 2000, following remediation of the site and recovery of the resource. A state resource management agency has estimated the number of fishing days lost at the site, and has estimated the total value of these trips for each year that the restrictions will be in place (see Exhibit 6-4). The trustees now want to calculate a present value damage claim for these losses, for presentation to the responsible party.

As shown on Exhibit 6-4, the first step in generating a present value damage claim is converting the estimated economic damages, expressed in nominal terms, into real terms (using the data and formula presented in Exhibit 6-3). The results of this calculation are provided in the fourth

[5] In most cases "significance" will be determined by the magnitude of the difference in the damage estimates generated using different discount rates, and the relative importance of this factor compared to other sources of uncertainty in the damage estimate.

Exhibit 6-4

EXAMPLE APPLICATION OF DISCOUNTING TO GENERATE A PRESENT VALUE DAMAGE CLAIM
(damages expressed in thousands of dollars)

	Year	Economic Damage (Nominal $)	Adjustment for Inflation	Economic Damage (1995 $)	Calculation to Compound (Past)/ Discount (Future) Damages	Present Value Damages
Compounding Past Damages	1985	$600	$* \left(\frac{129.7}{94.4}\right) =$	$824	$* (1 + 0.10)^{(1995-1985)} =$	$2,138
	1986	$700	$* \left(\frac{129.7}{96.9}\right) =$	$937	$* (1 + 0.10)^{(1995-1986)} =$	$2,209
	1987	$900	$* \left(\frac{129.7}{100.0}\right) =$	$1,167	$* (1 + 0.10)^{(1995-1987)} =$	$2,502
	1988	$800	$* \left(\frac{129.7}{103.9}\right) =$	$999	$* (1 + 0.10)^{(1995-1988)} =$	$1,946
	1989	$1,000	$* \left(\frac{129.7}{108.5}\right) =$	$1,195	$* (1 + 0.10)^{(1995-1989)} =$	$2,118
	1990	$1,100	$* \left(\frac{129.7}{113.3}\right) =$	$1,259	$* (1 + 0.10)^{(1995-1990)} =$	$2,028
	1991	$1,000	$* \left(\frac{129.7}{117.6}\right) =$	$1,103	$* (1 + 0.10)^{(1995-1991)} =$	$1,615
	1992	$1,200	$* \left(\frac{129.7}{120.9}\right) =$	$1,287	$* (1 + 0.10)^{(1995-1992)} =$	$1,713
	1993	$1,100	$* \left(\frac{129.7}{123.5}\right) =$	$1,155	$* (1 + 0.10)^{(1995-1993)} =$	$1,398
	1994	$1,400	$* \left(\frac{129.7}{126.1}\right) =$	$1,440	$* (1 + 0.10)^{(1995-1994)} =$	$1,584
	1995	$1,500	$* \left(\frac{129.7}{129.1}\right) =$	$1,500	$* (1 + 0.10)^{(1995-1995)} =$	$1,500
Discounting Future Damages	1996	$1,700	$* (1 + 0.03)^{(1995-1996)} =$	$1,650	$* (1 + 0.10)^{(1995-1996)} =$	$1,500
	1997	$1,800	$* (1 + 0.03)^{(1995-1997)} =$	$1,697	$* (1 + 0.10)^{(1995-1997)} =$	$1,402
	1998	$2,000	$* (1 + 0.03)^{(1995-1998)} =$	$1,830	$* (1 + 0.10)^{(1995-1998)} =$	$1,375
	1999	$2,200	$* (1 + 0.03)^{(1995-1999)} =$	$1,955	$* (1 + 0.10)^{(1995-1999)} =$	$1,335
	2000	$2,500	$* (1 + 0.03)^{(1995-2000)} =$	$2,157	$* (1 + 0.10)^{(1995-2000)} =$	$1,339
	TOTAL					$27,703

column of Exhibit 6-4.[6] For example, nominal damages in 1989 were $1 million. These are converted to 1995 values using the formula:

$$\text{Real Damages}_{1995\,\$} = \text{Nominal Damages}_{1989\,\$} * (\text{GDP price deflator}_{1995}/\text{GDP price deflator}_{1989})$$

$$= \$1{,}000{,}000_{(1989\,\$)} * (129.7/108.5)$$
$$= \$1{,}195{,}392$$

The next step is to calculate the present values of the real annual economic damage estimates. These values are then summed to get a total present value damage estimate. For example, the 1995 present value of 1989 damages is expressed by:

$$\text{Present Value of Damages}_{(1995)} = \$1{,}195{,}392 * (1 + 0.07)^{(1995-1989)}$$
$$= \$1{,}793{,}961$$

The total present value damages in this example are $25,450,000. This damage estimate assumes a seven percent real discount rate. For this example, damages given a three percent real discount rate would be $23,254,000. In this case the trustees might decide to use an alternative rate, or given the relatively small difference in these values and other sources of uncertainty in the estimate, simply make a claim based on DOI's suggested discount rate of seven percent.

6.5 Expressing Damage Assessment Costs in Present Value Terms

Both DOI's final rule and NOAA's proposed rule for damage assessment direct trustees to calculate interest on costs incurred in completing the damage assessment [43 CFR 11.15(a)(4) and 15 CFR 990.14]. Specifically, CERCLA and OPA allow for the collection of pre- and post-judgement interest from the later of (1) the point in time the claim is presented to the responsible party, and (2) the point in time assessment costs are incurred. In some cases responsible parties will be willing to pay for the conduct of damage assessment activities as they occur. In many cases, however, trustee agencies will effectively need to "borrow" the required funds pending settlement with the responsible party. For example, a Fish and Wildlife field office may request funds from Interior's Natural Resource Damage Assessment Fund to conduct a preassessment screen at a site. Thus, it is appropriate for trustees to recover interest on those funds expended for damage assessment activities.

For DOI and other federal agencies, one approximation of the cost of funds used for damage assessment activities is the federal funds rate. The federal funds rate represents the interest rate charged by banks with excess reserves in the Federal Reserve Bank system to banks needing overnight loans to meet their reserve requirements. This rate is considered the most sensitive indicator of the direction of interest rates, since it is set daily by the market.

[6] Had these values been expressed in real terms, this first step would be unnecessary.

Exhibit 6-5 reports equivalent annual rates for the time period 1980 to the present.[7] In order to calculate the present value (PV) amount due on funds expended for purposes of damage assessment, trustees should apply the following formula:

$$\text{PV of Costs}_{(\text{Current Year})} = \text{Costs}_{(\text{Year N})} * (1 + \text{Federal Funds Rate}_{(\text{Year N})})^{(\text{Current Year - Year N})}$$

Exhibit 6-5

FEDERAL FUNDS RATE

Year	Equivalent Annual Yield to 1995
1980	8.22%
1981	7.86%
1982	7.23%
1983	6.83%
1984	6.62%
1985	6.27%
1986	6.07%
1987	5.98%
1988	5.88%
1989	5.60%
1990	4.89%
1991	4.11%
1992	3.58%
1993	3.61%
1994	4.21%

Source: U.S. Federal Reserve

Thus, a present value would be calculated for each year in which costs were incurred, and summed to generate a total present value assessment cost estimate, as demonstrated in the following example. Note that these equivalent annual rates are expressed in nominal terms; thus, trustees should report assessment costs in nominal terms (i.e., trustees should not adjust these costs for inflation) and apply the rates reported to generate a present value damage claim. This guidance differs from that suggested for discounting past and future compensable damages, since the appropriate nominal discount rates used in these calculations are known, and past assessment costs are generally expressed in nominal terms.

EXAMPLE: CALCULATION OF PRESENT VALUE DAMAGE ASSESSMENT COSTS

Exhibit 6-6 provides an example application of discounting principles to estimate the present value of costs incurred by trustees during a natural resource damage assessment. This example is an extension of the one presented above, in which the release of PCBs and other toxics from an uncontrolled hazardous waste site has resulted in the contamination of a creek. The trustees undertook several studies in order to assess damages at this site. In addition, the trustees incurred costs while completing a preassessment screening document and preliminary damage assessment for this site, and while planning for and administering the injury and economic damage studies. These costs are summarized in the first column of Exhibit 6-6. Note again that these costs are expressed in nominal terms.

Using the equivalent annual yields shown in Exhibit 6-5, we estimate the total present value assessment costs for this case to be approximately $439,000. Since the equivalent annual yields reported in Exhibit 6-5 are expressed in nominal terms, there is no need to convert the assessment cost estimates to real values.

[7] The federal funds rate has varied through time; to reduce the number of calculations that trustees would need to perform we have calculated "equivalent annual rates," which if paid every year, would yield the same value at the end of a period as would be obtained by applying the actual annual rates for each relevant year during the period.

6.6 Capital Budgeting for Purposes of Restoration Costing

The final component of the natural resource damage claim for which a present value damage estimate must be established is the cost of planned restoration activities. The question trustees must ask is: what level of funds, if invested today, will yield a flow of funds sufficient to cover expected costs of the selected restoration program? This section describes the approach that should be followed in estimating this component of the claim.

6.6.1 Interest on Recovered Funds

In order to develop a single, present value damage claim, and to compare the present value cost of two or more restoration options, trustees need to consider the expected rate-of-return on recovered funds. This analytic step in the costing process involves calculating the dollar amount which, if paid and invested today, will yield a flow of funds sufficient to cover the expected cost of the restoration action. The rate of return assumed for this analysis should reflect the rate of interest the trustees expect to receive on the invested funds.

Exhibit 6-6

EXAMPLE CALCULATION OF PRESENT VALUE ASSESSMENT COSTS

Year	Assessment Costs Incurred	Present Valu Calculation[1]		Present Value
1992	$60,000	$*(1+0.0358)^{(1995-1992)}$	=	$66,677
1993	$240,000	$*(1+0.0361)^{(1995-1993)}$	=	$257,641
1994	$110,000	$*(1+0.0421)^{(1995-1994)}$	=	$114,631
TOTAL				$438,949

[1]Note: Calculation expresses costs in nominal dollars, and thus applies nominal discount rates.

There are a wide-range of investment opportunities available in the market, paying a wide-range of interest rates. Two questions relevant to a damage assessment are: what investments are available to trustees for recovered damages, and what are the expected interest rates on those investments? Trustees in natural resource damage cases must invest recovered funds to ensure a reliable flow of funds to cover anticipated costs of restoration actions. Thus, a low-risk investment with a steady and predictable yield is appropriate.

One type of account that is widely used for the investment of damages recovered in court is the United States Courts, Court Registry Investment System (CRIS). The CRIS is a cash management system for handling court registry funds. The Registry pools funds from a number of individual cases, which are then deposited in the Federal Reserve Bank or invested in U.S. Treasury securities with maturities of less than 100 days. From March of 1991 through March of 1992 the average return on CRIS investments was 4.95 percent (which is a nominal rate). This return is comparable to the rate of return received on commercial money market funds during this same period. Given the nature of this investment, the CRIS appears to be one reasonable and conservative investment strategy for natural resource trustees.[8]

[8] A second investment option is the Department of Interior's Natural Resource Damage Assessment and Restoration (NRDAR) Fund. Service personnel should consult with the case solicitor to determine whether this fund is an

In order to calculate the present value damage claim in a case, trustees will need to forecast the expected rate of return on funds recovered for the purpose of funding proposed restoration activities. For example, CRIS funds are invested in U.S. Treasury securities with maturities of less than 100 days (e.g., 90-day Treasury Bills). Thus, to determine the expected yield on an investment in the CRIS account, trustees need to consider the expected yield on 90- day Treasury bills over the time period during which funds will be required to accomplish the restoration objectives. Future yields on Treasury Bills are obviously unknown, but trustees can look at past yields as a general indication of likely future yields. For example, trustees might consider the last ten years as a reasonable base period (i.e., 1985 to 1994) for predicting returns over the next ten years. The average return in 90-day Treasury bills during this period of time was approximately 5.77 percent. This rate must be adjusted to reflect some transactions costs associated with the management of these funds. For example, historical costs indicate that investments in the CRIS account for more than 15 years will be charged a fee of 2.5 percent on all earned income. This 2.5 percent must be subtracted from the rate earned by the investment to provide the true yield available to the trustees. Thus, the trustees would receive an expected average yield of 5.63 percent on their investments in the CRIS account.[9] It is this rate that would be applied to calculate the present value of the claim.

The CRIS account example is provided for illustrative purposes only; trustees should consider the expected rate of return on recovered funds on a case-by-case basis. In many instances, the DOI solicitor assigned to the case will be able to provide guidance on the types of investment options available for recovered funds, and thus the rate-of-return to assume in establishing a damage claim. It is important to note, however, that the rate of interest assumed in estimating the present value cost of capital should not be assumed to be the discount rate suggested in the DOI rule.

EXAMPLE: ESTIMATING THE PRESENT VALUE OF A RESTORATION COST CLAIM

Chapter 3 considers an example budget for a bird recolonization project. The question facing the trustees in this example is: What level of funds, if recovered and invested today, would yield a flow of funds sufficient to cover the expected costs of the selected restoration action? This project was expected to extend over 10 years, beginning three years from the assumed settlement date of 1994, as shown in Exhibit 6-7.

The discount rate used in this example (i.e., the expected rate-of-return on recovered funds) is 5.63 percent. For example, the total expected cost of all required activities in 2004 is $609,114. The present value of this amount, in 1994 dollars, is $352,230, calculated as:

$$\text{Present Value}_{(1994)} = \text{Cost of Project}_{(2004)} * (1 + \text{Assumed Interest Rate})^{(1994\text{-}2004)}$$

Thus, in the example given, the calculation was:

$$\text{Present Value}_{(1994)} = \$609{,}114 * (1.0563)^{-10},$$
$$\text{Present Value}_{(1994)} = \$352{,}230.$$

appropriate investment vehicle for recovered damages.

[9] 5.77% - (2.5% * 5.77%) = 5.63%

That is, $352,230 deposited in 1994 at 5.63 percent interest, compounded annually, will be worth $609,114 in 2004.[39]

This same calculation was performed for each of the years in which costs were expected. The total cost of this project, expressed in present value terms, was approximately $4.5 million. Thus, if the trustees successfully recovered $4.5 million from the responsible party, and deposited this amount in an account that pays an annual interest rate of 5.63 percent, they would have sufficient funds to pay for the planned restoration program.

Exhibit 6-7

A CAPITAL BUDGETING EXAMPLE

Year	Restoration Funds Required	Present Value Calculation	Present Value of Annual Restoration Costs (1994 $)
1997	$898,522	$* (1 + .0563)^{(1994-1997)} =$	$762,372
1998	$614,922	$* (1 + .0563)^{(1994-1998)} =$	$493,936
1999	$638,953	$* (1 + .0563)^{(1994-1999)} =$	$485,884
2000	$622,947	$* (1 + .0563)^{(1994-2000)} =$	$448,464
2001	$688,986	$* (1 + .0563)^{(1994-2001)} =$	$469,569
2002	$712,569	$* (1 + .0563)^{(1994-2002)} =$	$459,757
2003	$584,503	$* (1 + .0563)^{(1994-2003)} =$	$357,027
2004	$609,114	$* (1 + .0563)^{(1994-2004)} =$	$352,230
2005	$633,483	$* (1 + .0563)^{(1994-2005)} =$	$346,797
2006	$660,223	$* (1 + .0563)^{(1994-2006)} =$	$342,171
Total Present Value, 1997-2006 (1994 $)			$4,518,207

[39] Readers should note that, since the restoration costs presented in this example are expressed in nominal terms, we apply a nominal discount rate.

7

ADDRESSING UNCERTAINTY AND DATA LIMITATIONS IN DAMAGE ASSESSMENT

7.1 INTRODUCTION

Uncertainties exist in any damage claim. For example, it may be difficult to establish the exact number of birds or fish killed as a result of an oil spill, to estimate the time period required for full recovery of a resource, or to measure the public's willingness to pay for an environmental improvement. Uncertainty in the context of damage assessment often extends beyond standard measures of statistical confidence to cases in which little or no primary data are available to support development of a claim. This is especially true for preliminary damage estimates developed for purposes of assessment planning or settlement negotiations. While not explicitly mentioned in DOI's proposed rule the treatment of uncertainty in an economic damage claim is addressed in NOAA's proposed rule, which state that "[u]ncertainty regarding the predicted consequences of restoration options and predicted supply and demand of natural resources and/or services should be addressed in the economic analysis of restoration alternatives and determination of compensable values and documented in the administrative record" [15 CFR 990.79(d)].

This chapter outlines the various factors that introduce uncertainty into an economic damage estimate. It also proposes a value of information approach for determining whether to undertake additional investigations to reduce such uncertainties. This approach can be applied during any phase of the damage assessment process as a means to prioritize potential data gathering and analytic tasks.

7.2 SOURCES OF UNCERTAINTY IN DAMAGE ASSESSMENT

An economic damage estimate may include multiple sources of uncertainty. Among the common sources of uncertainty are:

- The absence of data on the baseline condition of a resource, including the services provided by the resource prior to the release;
- A lack of detailed injury data (e.g., the precise change in ecosystem function resulting from a release, or the exact geographic area over which injury has occurred);

- The likely effectiveness of spill cleanup activities or a hazardous waste site remedy;
- Whether, and at what rate, natural recovery will occur;
- The estimated period over which a resource will be injured or service flows will be interrupted;
- The likely effectiveness of natural resource restoration activities;
- The reliability/accuracy of existing economic benefit estimates (if benefits transfer is used);
- The accuracy of primary benefit estimates; and
- The accuracy of restoration cost estimates.

In addition, other types of uncertainty associated with administrative, policy and legal matters are commonly encountered during a damage assessment. These include, but are by no means limited to, the availability of funds to conduct damage assessment activities, the ability to recover damages from a responsible party, and the actions taken by other trustee agencies. These factors, while important, are outside the scope of this manual.

7.3 The Value of Additional Information

While various factors act to introduce uncertainty into the economic damage estimate, it is often necessary for trustees to move forward with the development of damage claims based on available data and, in some cases, additional data gathering or analyses. Service employees involved in case management should consider formal or informal application of a value of information approach in determining whether to conduct additional assessment activities. The value of information framework allows analysts to consider whether the cost of additional studies is warranted given the likely improvement in the accuracy or precision of the final estimate. For example, a principal source of uncertainty in an oil spill damage assessment might be in the economic value of a day of recreational fishing at a site. Site-specific analyses might allow the trustees to measure this factor with a high degree of accuracy, but at some cost, in terms of both the funds and the time required to complete such analyses. In determining whether to proceed with additional analyses, trustees should consider such factors as the probability that a reasonable settlement can be reached with the responsible party in the absence of additional information, whether an estimate based on benefits transfer would be acceptable in a litigation setting, and whether the magnitude of the claim warrants additional research. In all cases, any assessment activities that are undertaken should represent the most cost-effective means of improving the accuracy or precision of the final damage estimate.

In undertaking a value of information analysis, trustees need to:

- List each factor believed to introduce significant uncertainty into the damage estimate;
- Rank these factors according to the magnitude of their effect;
- Determine the extent to which uncertainty in the damage estimate can be reduced through additional studies;
- Estimate the cost of undertaking additional studies; and,
- Identify those studies that most cost-effectively act to reduce uncertainty in the damage estimate to an acceptable level.

An informal application of the value of information framework is presented in Section 7.4.

In many cases the tradeoff faced by trustees is between a more certain damage estimate and a delay in the collection of damages, and thus the initiation of restoration activities. For example, the tradeoff may be between settlement with a responsible party in the near term, allowing for immediate initiation of some restoration activities, versus waiting until additional field study can be completed which might allow for a more comprehensive claim. In determining whether to undertake additional studies, trustees should consider such factors as the status of negotiations, the trustee's relationship with the responsible party, and the value of undertaking restoration activities in the short term.

In most cases, some degree of uncertainty will remain in the final damage estimate. In these cases it may be appropriate to report restoration cost and compensable values in the form of ranges, reflecting varying assumptions regarding the most significant factors. Presentation of a range of values based on explicitly stated assumptions is particularly important in the context of preliminary damage estimates. While these presentations need not reflect every potential source of uncertainty, significant factors should be described, and the sensitivity of the damage estimate to these factors reported (see the example below). In cases in which various factors act to potentially over- or understate economic losses, trustees should not assume that these factors cancel each other out, but should describe each significant factor and the influence it may have on the final estimate.

CASE STUDY: DAMAGE ASSESSMENT UNDER UNCERTAINTY

In early 1990, 500,000 gallons of number 2 fuel oil were accidentally released to the Arthur Kill of New York Harbor. This spill resulted in the oiling of regionally important wetlands, a bird and fish kill, and the closure of one of the country's busiest waterways for a period of five days. Following the release, the trustees undertook field investigations to determine the extent of natural resource injury resulting from the spill (e.g., number of birds, mammals and fish killed, acres of wetland and mudflat oiled). Soon after the release, the responsible party came forward with a

settlement offer. The trustees reviewed this offer and performed additional analyses in order to generate a comprehensive damage claim.

Exhibit 7-1 presents a summary of the damage estimates developed by the responsible party and the trustees. As shown, the responsible party considered four categories of economic loss: diminished recreational boating activity; lost or diminished bird viewing opportunities; disruptions in "other" intertidal services; and reductions in "existence" (i.e., passive use) values for the injured resources.

Exhibit 7-1

SUMMARY OF LOST USE AND PASSIVE USE VLAUE ESTIMATES

Category	Responsible Party	Trustee Estimates		
		Scenario A	Scenario B	Scenario C
Boating	$14,250	$14,250	$14,250	$14,250
Bird Viewing	11,250	11,250	11,250	11,250
Transportation +	0	84,000[1]	240,000[2]	400,000[3]
Other Intertidal Services	525,000	557,060[4]	743,000[5]	1,501,948[6]
Existence Values	2,564,000	12,820,000[7]	19,230,000[8]	25,640,000[9]
TOTAL	$3,114,500	$13,486,560	$20,238,500	$27,567,448

\+ Transportation impacts not considered by RP.
1 Assumes 35 vessels diverted for two days at a cost of $1,200 per diversion.
2 Assumes 40 vessels diverted for two days at a cost of $3,000 per diversion.
3 Assumes 40 vessels diverted for two days at a cost of $3,000 per diversion, 40 vessels delayed for 10 days at $400 per vessel.
4 Assumes 73 acres of wetland impacted.
5 Assumes 73 acres of wetland and 136 acres of mudflat impacted.
6 Assumes 73 acres of wetland and 136 acres of mudflat impacted, but assumes oiled areas provide no service flow until fully restored.
7 Assumes 1.0 million households hold existence values for study area.
8 Assumes 1.5 million households hold existence values for study area.
9 Assumes 2.0 million households hold existence values for study area.

Source: Meade and Unsworth (1990).

The trustees reviewed each component of this settlement offer, and developed a range of alternative damage estimates (shown as "scenarios" A, B and C in Exhibit 7-1). Based on a review of available information, the trustees determined that the responsible party's estimates of damages due to lost recreational boating and bird viewing activities were reasonable, especially given that the release had occurred in mid-winter (recreational boating in the Arthur Kill involves use of the Kill as a means to access other areas of New York Harbor from several marinas in New Jersey, while

recreational bird viewing principally involves occasional trips organized by bird viewing clubs in the New York metropolitan area). The damage estimates presented by the responsible party for these two categories of lost use were based on estimates of the number of lost trips (developed through discussions with marina operators and regional bird viewing clubs), multiplied by estimates derived from the economics literature of the trip values.

The responsible party also presented estimates of economic damage associated with "other intertidal services" and lost existence values for the resources of the Kill. The responsible party based its offer of $525,000 for lost intertidal services on an estimate of the number of acres of wetland heavily oiled as a result of the spill, the expected recovery period for these wetland acres, and a review of the literature on the economic surplus value of an acre of wetland. The trustees felt that this estimate was likely to understate actual losses, since it failed to account for lost services from partially impaired wetland, and for lost services provided by mudflats oiled as a result of the release. The trustees developed three alternative damage estimates, based on the following assumptions:

- An assumed loss in economic value of $3,000/impaired wetland acre/year (the same value as that used by the responsible party);
- An assumed loss of $1,500/impaired acre of mudflat/year (assumed equal to one-half of the value of wetland services);
- Estimates of the number of acres of wetland and mudflat impaired by the spill (also based on a field survey done for the trustees);
- The expected time period to full recovery of these resources (based on a field survey performed for the trustees and best professional judgement); and
- A real discount rate of three percent.

As shown on Exhibit 7-1, this analysis implied an economic loss of between $557,000 and $1.5 million associated with injured intertidal resources, with the high end estimate assuming that oiled areas provide no value until they are fully restored.

Similarly, the trustees reviewed the responsible party's offer for compensation for lost existence values resulting from the spill. Despite its urban location, the Kill provides habitat for several endangered and threatened bird species, and a number of species of migratory waterfowl. Given the level of attention paid to the spill in the New York press, the trustees felt that many residents of the New York-New Jersey metropolitan area placed a value on the resources injured by this spill. The responsible party assumed that as many as 200,000 households in the area of New Jersey bordering the Kill experienced existence value losses resulting from the spill, and estimated these losses to be about $13/household (assuming a one-time payment to preserve these resources). The responsible party based this per-household value on a review of contingent valuation studies of similar resources.

The trustees accepted the responsible party's estimate of $13/household, but estimated that at least 1.0 to 2.0 million households were likely affected. As a result, the trustees established a much higher estimate of lost existence values from this spill (i.e., $13 to $26 million).

Finally, the trustees considered one category of economic loss not addressed by the responsible party: the loss of the Kill as a commercial transportation corridor. As noted in Chapter 2, economic damages include lost economic rent resulting from a release event, whether or not that rent was collected prior to the release event. In this case the trustees estimated the lost economic rent associated with the closure of the Arthur Kill while oil spill cleanup activities were conducted.[1] Specifically, the trustees found that 35 to 40 large vessels were diverted for two days at a cost of between $1,200 and $3,000 per diversion; in addition, at least 40 vessels experienced delays for another 10 days (due to limits on vessel speed in the Kill), at a cost of $400/delay. The economic loss associated with these diversions was estimated by the trustees to be between $84,000 and $400,000.

In this case, settlement with the responsible party was reached relatively quickly. However, had settlement not been reached, it would have been necessary for the trustees to consider the need for, and value of, additional investigations to better understand the magnitude of damages resulting from this release event, and to generate damage estimates of sufficient quality to be presented in court. Exhibit 7-2 presents the relative magnitude of uncertainty and compensable value in each damage category (e.g., boating, transportation, etc.). For example, the trustees might have made the following determinations:

- Conduct no further assessments of boating and bird viewing impacts, and rely on the responsible party's estimate.

- Conduct additional interviews with regional transportation authorities and ship owners/operators to better define the magnitude of lost transportation services. Additional investigations on this topic might be called for, since: (1) the responsible party's estimate does not address this category of loss; (2) significant uncertainty exists in the trustee's current damage estimate (i.e., a five-fold difference between the high and low estimates); (3) the cost to conduct additional assessments on this topic is minimal ($20,000 or less); and (4) additional assessment is likely to substantially reduce the uncertainty in the final estimate.

- Conduct no additional investigations of economic damages associated with "other intertidal services." The responsible party's offer is very close to the low end of the trustees estimated range of damages for this category of compensable value (see

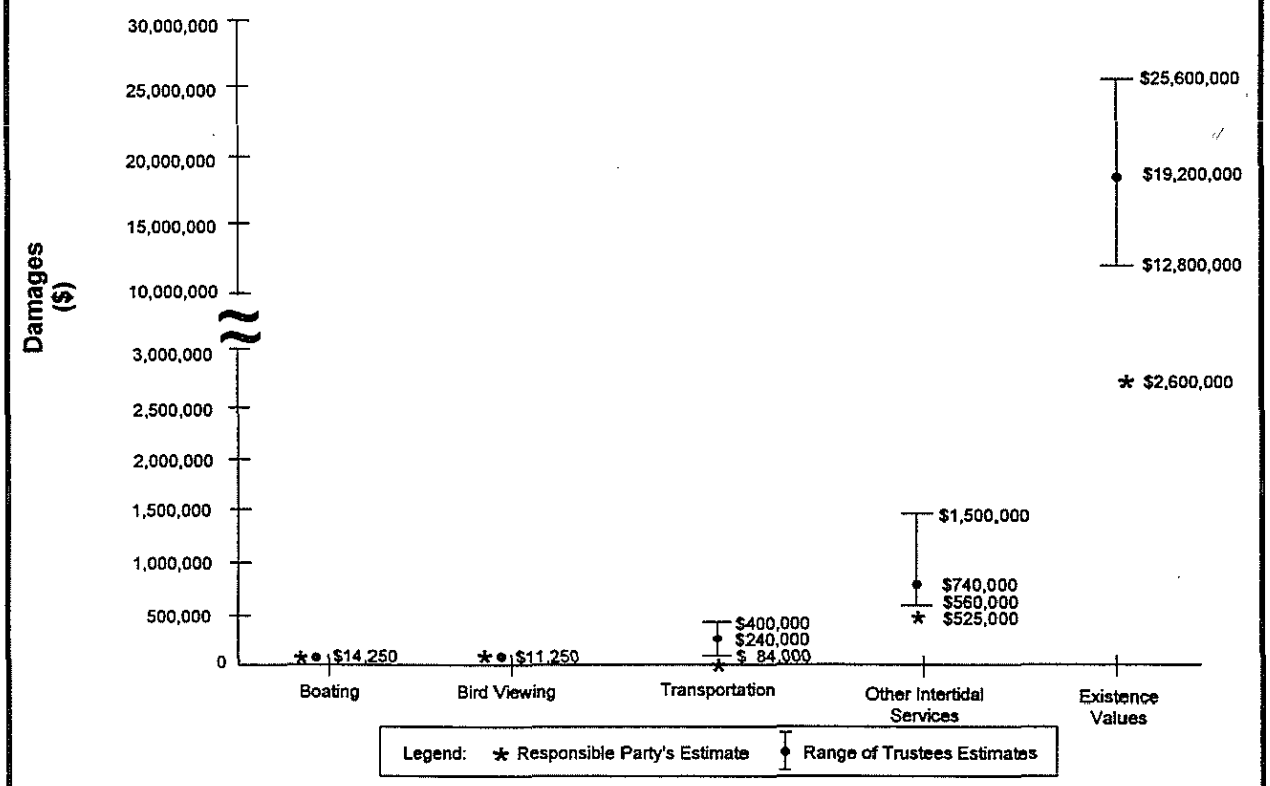
[1] Lost economic rent in this case represents the amount that individual vessel operators would have been willing to pay (e.g., in the form of an access fee to a regional transportation authority) for the unimpeded use of the Kill. These operators' willingness- to-pay was demonstrated by the fact that they were willing to incur extra costs in sailing around Staten Island during the period in which the Kill was closed.

Exhibit 7-2). In addition, new analyses may not substantially reduce the degree of uncertainty in the final estimate, and would require substantial funding relative to the magnitude of damages (i.e., $200,000 to $300,000). Also, such analyses would result in significant delays in recovery of damages (6-12 months).

- Consider additional investigations of existence values, if the responsible party is unwilling to increase their settlement offer. For this category of damages there was substantial disagreement between the responsible party's damage estimate and that of the trustees, although the willingness of the responsible party to consider such damages was unusual (see Exhibit 7-2). However, the cost of conducting a primary contingent valuation study would be substantial (i.e., one million dollars or more) and the research would be very time consuming (12 to 24 months), thus delaying initiation of restoration activities. In addition, it was unknown at the time of this assessment whether the government would be able to make a successful passive use value claim in court based on a contingent valuation survey.

Exhibit 7-2

SUMMARY OF COMPENSABLE DAMAGE ESTIMATES



APPENDIX A

ABBREVIATIONS AND GLOSSARY OF TERMS

ABBREVIATIONS

CBO	Congressional Budget Office
CDA	Comprehensive Damage Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CME	Coastal and Marine Environments (Damage Assessment Model)
CRIS	Court Registry Investment System
CV	Contingent Valuation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DOI	Department of Interior
EDA	Expedited Damage Assessment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FR	Federal Register
FWS	Fish and Wildlife Service
GDP	Gross Domestic Product
GLE	Great Lakes Model (Damage Assessment Model)
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
OMB	Office of Management and Budget
OPA	Oil Pollution Act
PV	Present Value
RUM	Random Utility Model
TCM	Travel Cost Method
USC	United States Code
WTP	Willingness To Pay

GLOSSARY OF TERMS

Averting Behavior — Any activity an individual undertakes to avoid or mitigate an external effect. For example, an individual might purchase bottled water to avoid a perceived health risk associated with a public water source.

Baseline Condition — The state of the environment that would exist in an assessment area but for a hazardous substance discharge or release.

Benefits Transfer — The application of economic data, functions or models collected or defined in one resource or service valuation context, to the valuation of resources or services in a second, similar context.

Bequest Value — A component of the *passive use value* of a natural resource to an individual, based on the individual's desire to ensure that future generations will have the opportunity to use or enjoy the resource; sometimes referred to as *preservation value*.

Biological Equivalency Method — *see Habitat Equivalency Method*

Committed Use — Either a current public use or a planned public use of a natural resource for which there is a documented legal, administrative, budgetary or financial commitment established before the release is detected.

Compensable Value — The amount of money (or monetary equivalent) required to make the public whole for losses incurred during the period between the release of a hazardous substance and the restoration of injured resources and services to their baseline conditions; also referred to as *interim loss*.

Compensation Formula — A simple tool used to determine economic damages associated with injuries caused by relatively small discharges of oil (10 gallons to 50,000 gallons).

Compensatory Services — Natural resource services provided in compensation for compensable value.

Compounding — The process of converting sums paid in the past to current values.

Consumer Surplus — The difference between what a consumer is willing to pay for a good and what is actually paid.

Contingent Valuation — A survey technique used to elicit the public's willingness to pay for goods or services that are not commonly available in markets (e.g., clean water). The survey involves the use of a hypothetical, or "contingent," market.

Cost Effectiveness — A project evaluation criteria wherein when two or more actions provide the same level of benefits, the least costly action is selected.

Damages — Compensation for injury to, destruction of, loss of, or lost use of natural resources, including the costs of assessing the nature and extent of such injury and the costs to restore injured resources to their baseline conditions.

Direct Costs — Those costs directly attributable to a selected restoration alternative *(see Indirect Costs).*

Direct Use Value — The value of *in situ* use of a natural resource.

Discounting — The process of converting sums paid in the past or future to current values. Discounting is based on the principle that a dollar paid today is worth more than a dollar paid sometime in the future. The discounting of past sums to present values is also referred to as *compounding.*

Discount Rate — The rate of interest at which past or future sums are converted to present values.

Economic Rent — The producer surplus provided by a resource after all factors of production have obtained the minimum return needed to keep them engaged in the activity.

Existence Value — A component of the *passive use value* of a natural resource to an individual, reflecting a willingness to pay to assure that the resource exists in a given state, regardless of any current use or planned use of the resource.

Expedited Damage Assessment — A damage assessment approach that generally relies on simplified valuation methods and available data (as opposed to a comprehensive assessment).

Grossly Disproportionate Test — The concept that the cost of a selected restoration option should not be substantially greater than the expected benefit of the option. *(see Chapter 1).*

Habitat Equivalency Method — An approach for determining compensation required as a result of natural resource injury based on the principle that the public can be compensated for the past loss of natural resource services through the provision of additional services of the same type in the future; sometimes referred to as the *biological equivalency method.*

Indirect Costs — Costs associated with activities or items required to support a restoration alternative. For example, labor overhead. *(see Direct Costs).*

Injury — An adverse change in the quality of a natural resource, or in the services provided by the resource, resulting directly or indirectly from the release of a hazardous substance into the environment. *(See 43 CFR 11.14 and 15 CFR 990.13 for complete regulatory definitions of injury.)*

Injury Determination — The process by which the nature of the injury to natural resources or services is documented.

Injury Quantification — The process by which the extent of the injury to natural resources or services is documented.

Interim Loss — The loss of natural resources or services during the period between the release of a hazardous substance and the restoration of the injured resources and services to their baseline conditions.

Natural Resources — Land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state or local government, any foreign government, or any Indian tribe. *(See 43 CFR 11.14(Z) and 15 CFR 990.13 for a complete regulatory definition of natural resources.)*

Nominal Discount Rate — A discount rate that has not been adjusted to account for inflation.

Nonuse Value — *see Passive Use Value.*

Passive Use Value — The component of the value of a natural resource that is not based on the *in situ* consumption or utilization of the resource *(see Bequest Value, Existence Value, Nonuse Value and Preservation Value).*

Preliminary Assessment — An estimate of economic damage, including the cost of restoration activities and compensable values, developed early in the damage assessment process.

Preassessment Screen A report that documents establish that injury has occurred to natural resources for which trustees are responsible and which evaluates the probability that a claim for damages will be successful. The preassessment screen is the final product of the preassessment phase of the damage assessment process.

Present Value The current, discounted value of a past or future sum.

Preservation Value A component of the *passive use value* of a natural resource to an individual, based on the individual's desire to ensure that current and future generators will have the opportunity to use or enjoy the resource (*see Bequest Value*).

Producer Surplus The difference between the price at which a producer is willing to sell a good for and the price actually received.

Random Utility Model A valuation approach based on the principle that an individual will choose among alternative recreation sites on the basis of the relative quality of the sites' characteristics, including the distance to the sites.

Real Discount Rate A discount rate that has been adjusted to account for inflation.

Restoration Actions taken to return an injured resource to its baseline condition; may involve replacement, rehabilitation or acquisition of the equivalent of the injured resource.

Services The physical, chemical, biological, aesthetic and cultural functions performed by natural resources, including the human uses of those functions. Services provided by natural resources can accrue to other, non-human resources and need not be consumptive.

Speculative Losses An economic loss associated with any resource use for which no significant consideration was given prior to the release.

Travel Cost Model A valuation approach that uses the cost of travel to a site as an implicit price for site usage in order to estimate a demand curve for that site.

Trustee An official of the federal government, a state government or an Indian tribe who may present a claim for and recover damages for injury to natural resources.

APPENDIX B

ANNOTATED BIBLIOGRAPHY

GENERAL TEXTS ON NATURAL RESOURCE DAMAGE ASSESSMENT AND ENVIRONMENTAL ECONOMICS

Freeman, A.M. III. 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Washington, D.C.: Resources for the Future.

A general text on environmental and resource economics. Does not focus specifically on natural resource damage assessment, but does cover many pertinent topics, such as: the economic concept of value; welfare measures of value; nonuse values; and direct and indirect valuation methods.

Kopp, R.J. and V.K. Smith. 1993. Valuing Natural Assets: The Economics of Natural Resource Damage Assessment. Washington, D.C.: Resources for the Future.

Collection of 14 articles by 13 authors, grouped under four parts: statutes, rulemaking and practice; measuring natural resource damages; conceptual dimensions of damage assessment; and research implications of damage assessment. Particularly interesting are the articles that comment directly on preceding articles, providing a dialogue of alternative viewpoints. Generally accessible to the layperson, although some of the articles are technical and presume a familiarity with the subject.

Ward, K.M. and J.W. Duffield. 1992. Natural Resource Damages, Law and Economics. New York: John Wiley & Sons, Inc.

Includes 23 chapters divided between three topics: law, economics and case studies. Provides a good overview of the relevant legal frameworks and the various economic concepts and valuation methods. Generally accessible to the layperson.

SURVEY ARTICLES ON NATURAL RESOURCE DAMAGE ASSESSMENT POLICY AND LAW

DuBey, Richard A. and James M. Grualva. 1991/92. "The Assertion of Natural Resource Damage Claims by Indian Tribal Trustees." Environmental Claims Journal 4(2):175-185.

Concise overview of role of Indian tribal trustees in the natural resource damage process and their significant interests in protecting natural resources and environmental rights.

Kopp, R. J., P. R. Portney and V. K. Smith. 1990. "Natural Resource Damages: The Economics Have Shifted After Ohio v. United States Department of the Interior." Environmental Law Reporter 20(4).

Analyzes six issues in the 1989 Ohio decision from an economics perspective. Provides a helpful understanding of how the current regulations came about and how economists view related court decisions.

Kopp, Raymond J. and V. Kerry Smith. 1989. "Benefit Estimation Goes to Court: The Case of Natural Resources Damage Assessments." Journal of Policy Analysis and Management 8(4):593-612.

Evaluates the feasibility of performing natural resource damage assessments under CERCLA. Using the analyses developed for two cases, explains the sources of the substantial divergences between plaintiffs' and defendants' estimates of damages, focusing on three factors: 1) time horizon used and treatment of capitalization effects of past damages, 2) extent of the market assumed in estimating the effects of a release of hazardous wastes on the demand for the affected natural resource, and 3) character and availability of substitutes for the resource involved.

Landreth, Lloyd W. and Kevin M. Ward. 1990. "Natural Resource Damages: Recovery Under State Law Compared with Federal Laws." Environmental Law Reporter 10134-10142.

Provides a chart listing natural resource damage statutes in all 50 states. Also describes statutes in five states (Connecticut, Montana, North Carolina, Pennsylvania and Washington), and suggests procedures for states to develop better natural resource damage statutes.

Menefee, Mark. 1982. "Recovery for Natural Resource Damages Under Superfund: The Role of the Rebuttable Presumption." Environmental Law Reporter 15057-15064.

Provides an explanation of the rebuttable presumption concept and an assessment of its role in CERCLA natural resource damage claims.

Shutler, Sharon K. and Elinor Colbourn. 1994. "Natural Resource Restoration: The Interface Between the Endangered Species Act and CERCLA's Natural Resource Damage Provisions." Environmental Law 24:717-760.

Advocates the position that where injured natural resources include endangered or threatened species or their habitats, trustees are authorized to seek compensation for restoration activities that protect or conserve these species. Argues that courts should not find the costs of an "on-site, in-kind" restoration strategy to be "grossly disproportionate" to the value of the natural resources injured where such resources include Endangered Species Act-protected species or their habitats.

REFERENCES FOR NATURAL RESOURCE VALUES AND VALUATION METHODS

ARCHAEOLOGY

Hutt, S., E. W. Jones and M. E. McAllister. 1992. Archaeological Resource Protection. Washington, D.C.: Preservation Press.

Chapter 4 covers damage assessment in archeological violation cases, including: value and cost assessments (commercial value, archeological value, cost of restoration and repair), credibility and conservatism in value and cost assessments, and damage assessment reporting. The focus is on law and procedure, rather than economic theory or methodology.

BENEFITS TRANSFER

The following papers appeared in Water Resources Research 28(3), 1992; which was dedicated to issues in benefits transfer. These papers are of a relatively technical nature.

Atkinson, Scott E., Thomas D. Crocker and Jason F. Shogren. "Bayesian Exchangeability, Benefits Transfer, and Research Efficiency." 715-722.

Boyle, Kevin J. and John C. Bergstrom. "Benefit Transfer Studies: Myths, Pragmatism and Idealism." 657-663.

Brookshire, David S. and Helen R. Neill. "Benefit Transfers: Conceptual and Empirical Issues." 651-655.

Desvousges, William, Michael Naughton and George Parsons. "Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies." 675-683.

Loomis, John B. "The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer." 701-705.

Luken, Ralph A., F. Reed Johnson and Virginia Kilber. "Benefits and Costs of Pulp and Paper Effluent Controls under the Clean Water Act." 665-674.

McConnell, Kenneth E. "Model Building and Judgement: Implications for Benefits Transfers with Travel Cost Models." 695-700.

Smith, V. Kerry. "On Separating Defensible Benefit Transfers from `Smoke and Mirrors'." 685-694.

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Grigalunas, Thomas A. and James J. Opaluch. 1992. Use of Benefit Transfers in Natural Resource Damage Assessments.

Four-page letter to the NOAA General Counsel commenting on the development of Oil Pollution Act damage assessment regulations. Suggests three minimum conditions for the use of benefit transfer: 1) studies must meet minimum standards for quality assurance in terms of data, theory, and analysis, 2) activities considered in the transferred studies must accurately mirror those affected by the incident, and 3) methodologies used for transfer should conform with standards for benefit transfer.

Smith, V. Kerry and Yoshiaki Kaoru. 1990. "Signals or Noise? Explaining the Variation in Recreation Benefit Estimates." American Journal of Agricultural Economics 72:419-434.

Technical analysis which summarizes the benefit estimates derived from 77 travel cost recreation demand models. Evaluates the influence of variables describing site characteristics, activities undertaken at each site, behavioral assumptions and specification decisions.

Walsh, Richard G., Donn M. Johnson and John R. McKean. 1989. "Issues in Nonmarket Valuation and Policy Application: A Retrospective Glance." Western Journal of Agricultural Economics 14: 178-188.

Illustrates the many issues involved in benefits transfer through development of some tentative estimates of the recreational use value of Forest Service resources. Highly quantitative, but relatively accessible to the layperson.

BIRDS

Brown, Jr., Gardner M. 1992. "Replacement Costs for Birds and Mammals." Prepared for the National Oceanic and Atmospheric Administration, Damage Assessment Center, Rockville, MD.

Estimates values for bird species affected by the *Exxon Valdez* oil spill based on the costs of relocation, replacement and rehabilitation. Covers murres, seaducks, cormorants, procellariids, gulls, marbelled murrelets, guillemots, grebes, loons, puffins, peregrine falcons, blacklegged kittiwakes, storm petrels and eagles.

Charbonneau, J. John and Michael J. Hay. 1978. "Estimating Marginal Values of Waterfowl for Hunting." Working Paper No. 8, prepared for Division of Program Plans, U.S. Fish and Wildlife Service.

A technical discussion of the theory and methodology used to derive marginal values of waterfowl for hunting. Also provides a simple table of marginal values for puddle ducks, diving ducks, geese and all waterfowl, broken out by the Atlantic, Mississippi, Central and Pacific flyways.

Cooper, Joseph and John Loomis. 1991. "Economic Value of Wildlife Resources in the San Joaquin Valley: Hunting and Viewing Values." in The Economics of Management of Water and Drainage in Agriculture. A. Dinar and D. Zilberman (eds.), Kluwer Academic Publishers.

Quantifies the effects of agricultural drainage on the recreational demand for wildlife resources in the San Joaquin Valley.

Huguenin, Michael T., James E. Neumann and Robert E. Unsworth. 1991. "Summary of Existing Unit Value Estimates for Selected Species Affected by the *Exxon Valdez* Oil Spill." Report by Industrial Economics, Incorporated prepared for the U.S. Department of Justice.

Summarizes existing estimates of the value of some species affected by the *Exxon Valdez* oil spill, presented on a per animal basis where possible. Species include bald eagle, eagle (general), pigeon guillemot, common murre, marbled murrelet, duck (general), migratory birds (general), waterfowl (general) and species that are endangered or threatened. Also includes a bibliography, species descriptions, and summaries of selected wildlife valuation literature.

CONTINGENT VALUATION

Bishop, Richard C. 1995. "Peer Review of 'Contingent Valuation of Natural Resource Damages Due to Injuries to the Upper Clark Fork River Basin'," prepared for State of Montana Natural Resource Damage Program.

Includes a draft paper (co-authored with Daniel W. McCollum) entitled "Assessing the Content Validity of Contingent Valuation Studies," which develops a 17-attribute, 100-point scale for assessing the quality of contingent valuation studies. Uses the 100-point scale to assess the contingent valuation studies of natural resources in the Clark Fork River basin, the *Exxon Valdez* oil spill and wilderness protection.

Carson, Richard T., Jennifer Wright, Aanna Alberini, Nancy Carson and Nicholas Flores. 1994. "A Bibliography of Contingent Valuation Studies and Papers." La Jolla, CA: Natural Resource Damage Assessment, Inc.

Provides 1,672 citations for contingent valuation studies and papers.

Cummings, Ronald G., David S. Brookshire and William D. Schulze, eds. 1986. Valuing Environmental Goods: An Assessment of the Contingent Valuation Method. Totowa, NJ: Rowman and Allanheld Publishers.

A critical review of the contingent valuation method, including four "reference operating conditions" for the accurate implementation of a contingent valuation study. Also includes a collection of papers and a concluding summary from a contingent valuation review conference.

Some material is highly technical, but the volume generally presents a helpful overview of the various aspects of contingent valuation.

Diamond, Peter A. and Jerry A. Hausman. 1993. "On Contingent Valuation Measurement of Nonuse Values." Paper prepared for presentation a symposium originated by Cambridge Economics, Inc., entitled "Contingent Valuation: A Critical Assessment." Washington, D.C., April 2-3.

This paper reports on the results of a group of surveys, funded by Exxon Company, USA, that were designed to test whether contingent valuation answers are consistent with consumer choice theory. This study concludes that contingent valuation surveys do not measure the economic values of natural resources, and describes other potential problems with the contingent valuation method.

Kahneman, Daniel and Jack L. Knetsch. 1992. "Valuing Public Goods: The Purchase of Moral Satisfaction." Journal of Environmental Economics and Management 22:57-70.

Smith, V. Kerry. 1992. "Arbitrary Values, Good Causes, and Premature Verdicts." Journal of Environmental Economics and Management 22:71-89.

Kahneman, Daniel and Jack L. Knetsch. 1992. "Contingent Valuation and the Value of Public Goods: Reply." Journal of Environmental Economics and Management 22:90-94.

Morrison, Glen W. 1992. "Valuing Public Goods with the Contingent Valuation Method: A Critique of Kahneman and Knetsch." Journal of Environmental Economics and Management 23:248-257.

Kahneman and Knetsch argue that responses to contingent valuation surveys do not reflect the economic value of public goods, but the willingness to pay for the moral satisfaction of contributing to these goods (i.e., the "warm glow" effect). Smith and Harrison provide replies to this argument, including alternative interpretations of the conclusions reached by Kahneman and Knetsch.

Mitchell, Robert C. and Richard T. Carson. 1990. Using Surveys to Value Public Goods: The Contingent Valuation Method. Washington, DC: Resources for the Future.

The most frequently referenced textbook on contingent valuation. Develops the theoretical basis for the method, examines potential sources of error and bias in estimates generated using this method, and provides guidelines for proper implementation of a contingent valuation study. Generally accessible to the layperson.

Portney, Paul R. 1994. "The Contingent Valuation Debate: Why Economists Should Care." The Journal of Economic Perspectives 8(4):3-18.

Hanemann, W. Michael. 1994. "Valuing the Environment Through Contingent Valuation." The Journal of Economic Perspectives 8(4):19-44.

Diamond, Peter A. and Jerry A. Hausman. 1994. "Contingent Valuation: Is Some Number Better than No Number." The Journal of Economic Perspectives 8(4):45-64.

A set of papers that provide (1) an overview of contingent valuation and the debate surrounding it (Portney); (2) arguments in favor of the use of this technique (Hanemann); and (3) arguments against its use (Diamond and Hausman). These papers are generally accessible to individuals without formal training in economics.

FISH

American Fisheries Society. 1990. "A Handbook of Monetary Values of Fish and Fishkill Counting Guidelines." Socioeconomics Section, Bethesda, MD.

Includes detailed tables for both replacement costs and economic values (the latter based upon measures of consumer and producer surplus). Highly accessible to the layperson, including guidance on how to choose between replacement costs and economic values.

GROUNDWATER

Boyle, Kevin J. 1994. "A Comparison of the Contingent Valuation Studies of Groundwater Protection." Report 456, University of Maine.

Summarizes, compares, and contrasts eight contingent valuation studies of the benefits of protecting groundwater quality.

McClelland, Gary H., William D. Schulze, Jeffrey K. Lazo, Donald M. Waldman, James K. Doyle, Steven R. Elliot and Julie R. Irwin. 1992. "Methods for Measuring Non-Use Values: A Contingent Valuation Study of Groundwater Cleanup." Draft report prepared by the Center for Economic Analysis, Department of Economics, University of Colorado, Boulder, for the Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency.

Comprehensive report on a 5,000-household contingent valuation survey of willingness to pay for groundwater cleanup. Builds the theoretical basis for estimating the benefits of groundwater cleanup, explores methodological issues in using contingent valuation to measure passive use values, covers surveys instrument design and testing issues, and analyzes results with an emphasis on different approaches to estimating passive use value.

Raucher, Robert L. 1986. "The Benefits and Costs of Policies Related to Groundwater Contamination." Land Economics 62(1):33-45.

Reviews and expands on a conceptual framework for measuring the benefits of groundwater protection, based on the premise that the probabilistic value of protection is at least as great as the expected costs of containment. Applies the framework to case studies of three waste disposal sites affecting vital aquifers. Indicates that preventing future contamination is not necessarily economically preferable to post-contamination corrective action.

Raucher, Robert L. 1983. "A Conceptual Framework for Measuring the Benefits of Groundwater Protection." Water Resources Research 19(2):320-326.

Establishes a framework for measuring the benefits of groundwater protection, based on the premise that the probabilistic value of protection is at least as great as the expected costs of contamination. Cost are sensitive to a variety of site-specific hydrogeologic and water use factors and general economic parameters. Relatively technical.

HABITAT EQUIVALENCY

National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program. 1995. "Habitat Equivalency Analysis, an Overview." 21 March.

NOAA's published guidance on the habitat equivalency method.

Unsworth, R.E. and R.C. Bishop. 1994. "Assessing Natural Resource Damages Using Environmental Annuities." Ecological Economics 11:35-41.

A paper proposing use of the habitat equivalency method for natural resource damage assessment. Includes an example of the application of the technique at the Great Swamp National Wildlife Refuge.

RECREATION

Bockstael, Nancy E., W. Michael Hanemann and Ivar E. Strand. 1986. "Measuring the Benefits of Water Quality Improvements Using Recreation Demand Models." Report to the Economic Analysis Division, U.S. Environmental Protection Agency.

Highly technical and thorough exposition of recreational demand models in the context of measuring the benefits of water quality improvements.

Bergstrom, John C. and H. Ken Cordell. 1991. "An Analysis of the Demand for and Value of Outdoor Recreation in the United States." Journal of Leisure Research 23(1):67-86.

Estimates the economic value of 37 outdoor recreational activities using a multi-site travel cost model. The model was developed using data from the Public Area Recreation Visitors Study (PARVS), which uses information collected through individual interviews conducted in public recreation areas throughout the U.S. from 1985 to 1987.

Cooper, Joseph and John Loomis. 1991. "Economic Value of Wildlife Resources in the San Joaquin Valley: Hunting and Viewing Values." in The Economics of Management of Water and Drainage in Agriculture. A. Dinar and D. Zilberman (eds.) Kluwer Academic Publishers.

Quantifies the effects of agricultural drainage on the recreational demand for wildlife resources in the San Joaquin Valley.

Freeman, A. Myrick. 1993. "The Economics of Valuing Marine Recreation: A Review of the Empirical Evidence." Economics Working Paper 93-102, Bowdoin College.

Addresses the question of whether the available economics literature provides a sufficient basis for estimating the benefits to marine recreation attributable to the water pollution control programs of federal, state and local agencies. Appendix provides summary descriptions of over 40 marine recreation studies.

Loomis, John, William Provencher and William G. Brown. 1988. "Evaluating the Transferability of Regional Recreation Demand Models." in R. Johnson and G. Johnson (eds.) Economic Valuation of Natural Resources: Issues, Theory, and Application. Boulder, CO: Westview Press.

Discusses the theoretical conditions that would be required for travel cost equations to be transferred between sites. Relatively technical.

Loomis, John B. and Cindy Sorg. 1983. "A Critical Summary of Empirical Estimates of the Values of Wildlife, Wilderness and General Recreation Related to National Forest Regions." Contract Report No. 40-82-FT-2-714, Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Fort Collins, CO.

Critically evaluates and standardizes many different contingent valuation, travel cost and hedonic studies to derive value estimates for 17 outdoor recreation activities. Focuses on producing standardized values for a 12-hour recreation visitor day that can be generalized across each Forest Service region. Accessible to the layperson, but somewhat dated.

McCollum, Daniel W., George L. Peterson, J. Ross Arnold, Donald C. Markstrom and Daniel M. Hellerstein. 1989. "The Net Economic Value of Recreation on the National Forests: Twelve Types of Primary Activity Trips Across Nine Forest Service Regions." Prepared for the Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, CO.

Estimates economic value of recreational activities at Forest Service sites based on data from the Public Area Recreation Visitors Study (PARVS), which uses information collected through individual interviews conducted in public recreation areas throughout the U.S. from 1985 to 1987. Estimates the average value per trip, by U.S. Fish and Wildlife Service region.

Olson, Darryll. 1990. Using the Contingent Valuation Method for Existence and Recreation Valuation Studies: An Annotated Bibliography of Key References. Monticello, IL: Vance Bibliographies.

Provides almost 50 pages of citations and relatively thorough summaries of a range of contingent valuation publications, divided into the areas of: theoretical and definitional context, institutional setting and welfare measures, contingent valuation method technology, survey instrument and research design, selected existence and option value studies.

Randall, Alan. 1994. "A Difficulty with the Travel Cost Method." Land Economics 70(1):88-96.

A review of potential limitations in the travel cost method. Concludes that the travel cost method should not be used as a stand-alone technique for estimating recreational benefits, but should be calibrated with information generated through other methods.

U.S. Department of Agriculture Forest Service. 1990. Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program. Washington, DC.

Provides "market-clearing prices" and "market-clearing prices plus consumer surplus values" per activity day for Forest Service recreational activities. Based on data from several studies that are in turn based upon an extensive literature review.

U.S. Department of the Interior Fish and Wildlife Service. 1993. 1991 Natural Survey of Fishing, Hunting and Wildlife-Associated Recreation. Washington, DC.

U.S. Department of the Interior Fish and Wildlife Service. 1989. 1985 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. Washington, DC.

Separate volumes for each state providing extensive data on fishing, hunting and nonconsumptive recreational activities. National Survey for 1991 is also available on CD-ROM.

U.S. Department of the Interior Fish and Wildlife Service. 1988. Analysis of the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Washington, DC.

Separate reports are available based on the 1985 survey for the following topics: black bass fishing in the U.S.; hunting on wetlands; net economic values of nonconsumptive wildlife-related recreation; net economic recreation values for deer, elk and waterfowl hunting and bass fishing; trout fishing in the U.S.; wildlife related recreation on public lands.

U.S. Department of the Interior Fish and Wildlife Service. 1994. 1980-1990 Fishing, Hunting, and Wildlife-Association Recreation Trends. Washington, DC.

Provides state trend information on the number of anglers, hunters and nonconsumptive wildlife-related recreation participants from 1980-1990.

Walsh, Richard G., Donn M. Johnson and John R. McKean. 1988. "Review of Outdoor Recreation Economic Demand Studies with Nonmarket Benefit Estimates, 1968-1988." Technical Report No. 54, Colorado Water Resources Research Institute.

Extensive review of 120 outdoor recreation demand studies. Provides standardized summaries of net economics values per activity day, statistical analysis of important explanatory variables across different studies, and summaries of existing studies for 10 different categories of recreation.

Walsh, Richard G., Donn M. Johnson and John R. McKean. 1992. "Benefit Transfer of Outdoor Recreation Studies, 1968-1988." Water Resources Research 28(3):707-713.

Provides 287 estimates of net economic value per day reported by 120 outdoor recreation demand studies for 19 recreation activities. Also performs statistical tests for the relationship of recreation benefits to selected explanatory variables.

WETLANDS

Douglas, Aaron J. 1989. "Annotated Bibliography of Economic Literature on Wetlands." U.S. Department of Interior, Fish and Wildlife Service, National Ecology Research Center. Washington, DC.

Covers 90 citations with relatively comprehensive summaries. Also includes an 11-page conceptual introduction. Highly accessible for the layperson.

King, Dennis M. 1990. "Summary of Literature Review of Wetland Values." King and Associates, Washington, DC.

Provides an extensive 13-page table with wetland values generally expressed in terms of dollars per acre, with information on state, wetland type, basis of estimate and citation.

Scodari, Paul F. 1990. Wetlands Protection: The Role of Economics. Washington, DC: Environmental Law Institute.

Monograph covering the science of wetland valuation, the economic principles and methods for valuing wetland services, the implementation of wetland valuation, and the relevant natural resource damage assessment regulations. Excellent overview for the layperson.

Unsworth, R.E. and R.C. Bishop. 1994. "Assessing Natural Resource Damages Using Environmental Annuities." Ecological Economics 11:35-41.

A paper proposing use of the habitat equivalency method for natural resource damage assessment. Includes an example of the application of the technique at the Great Swamp National Wildlife Refuge.

WILDLIFE

Boyle, Kevin J. and Richard C. Bishop. "The Economic Valuation of Endangered Species of Wildlife." in R.E. McCabe (ed.), Transactions of the Fifty-first North American Wildlife and Natural Resources Conference.

Develops a conceptual framework for examining the monetary values that members of the current generation assign to the preservation of endangered species of wildlife; reports on the results of two applications of the conceptual framework.

Brown, Jr., Gardner M. 1992. "Replacement Costs for Birds and Mammals." Prepared for the National Oceanic and Atmospheric Administration, Damage Assessment Center, Rockville, MD.

Estimates values for various mammal species based on the costs of relocation, replacement and rehabilitation for some of the marine and terrestrial mammals that may have suffered injury in the *Exxon Valdez* oil spill. Covers otters (sea and river), whales (killer and humpback), stellar sea lions, harbor seals, deer (white-tailed), bears (brown and black) and mink.

Huguenin, Michael T., James E. Neumann and Robert E. Unsworth. 1991. "Summary of Existing Unit Value Estimates for Selected Species Affected by the *Exxon Valdez* Oil Spill." Report by Industrial Economics, Incorporated, prepared for the U.S. Department of Justice.

Summarizes existing estimates of the value of some species affected by the *Exxon Valdez* oil spill, presented on a per animal basis where possible. Includes sea otter, otter (general), harbor seal, marine mammal (general) and species that are endangered or threatened. Also includes a bibliography, species descriptions, and summaries of selected wildlife valuation literature.

Sorg, Cindy F. and John Loomis. 1985. "An Introduction to Wildlife Valuation Techniques." Wildlife Society Bulletin 13:38-46.

Introduces wildlife valuation methodologies (gross expenditures, travel cost, and contingent valuation), explains adjustments that make economic values derived from the various techniques comparable, and presents illustrations of adjusted values from several studies on big game hunting. A helpful and accessible introduction for the layperson, though somewhat dated.

The following are examples of legally prescribed restitution values for game birds, big game, small game, endangered and threatened species, and game fish. Talhelm draft documents the theoretical basis and construction of the Minnesota values.

Texas Parks and Wildlife Department. 1986. Guidelines for the Determination of Values for Fish and Wildlife Illegally Killed, Taken, Possessed, or Injured. Austin, TX.

State of Minnesota. 1991. Proposed Rules Prescribing Restitution Values for Fish and Wildlife Illegally Killed, Injured, or Possessed: Statement of Need and Reasonableness. Department of Natural Resources, Division of Wildlife and Enforcement. St. Paul, MN.

State of Minnesota. 1991. In the Matter of the Proposed Adoption of Rules Prescribing Restitution Values for Fish and Wildlife Illegally Killed, Injured, or Possessed: Statement of Need and Reasonableness. Department of Natural Resources, Division of Wildlife and Enforcement. St. Paul, MN.

Talhelm, Daniel R. 1990. "Recommended Values for Computing Fair Restitution to the Citizens of Minnesota for Fish and Wildlife Illegally Killed, Injured, or Possessed." Prepared for Minnesota Department of Natural Resources. Resource Econometrics. East Lansing, MI.

U.S. Department of Agriculture. 1987. "Estimating Prices for Access to Opportunities for Hunting, Viewing, Fishing, and Viewing Wildlife on Public and Private Lands. Final Report of Natural Resources and Environment Steering Committee on Wildlife and Fish Access Prices. Washington, DC.

Qualitative overview and assessment of market price appraisal, contingent valuation, hedonic pricing and household production, and travel cost method.

EXAMPLE ASSESSMENTS

Bishop, Richard C. 1992. "The Potential Natural Resource Damages from the Asbestos Dump Sites in the Dietzman Tract, Great Swamp National Wildlife Refuge, New Jersey." Prepared for the U.S. Fish and Wildlife Service and the U.S. Department of Justice.

This report "is not intended to substitute for a full natural resource damage assessment," but instead its goal is "to explore the potential magnitude of the damages at the Great Swamp National Wildlife Refuge." Estimates on-site damages resulting from closure of recreational trails due to two hazardous waste dumps and applies a habitat equivalency based approach for valuing lost wetland services.

Carson, Richard T., Robert T. Mitchell, W. Michael Hanemann, Raymond J. Kopp, Stanley Presser and Paul A. Ruud. 1992. "A Contingent Valuation Study of Lost Passive Use Values Resulting from the *Exxon Valdez* Oil Spill." Prepared for the Attorney General of the State of Alaska.

Contingent valuation study of passive use value loss from injuries to natural resources arising from the March 1989 *Exxon Valdez* oil spill. Survey injury description includes oiled shoreline, bird and mammal deaths, and effects on fish.

Carson, Richard T., W. Michael Hanemann, Raymond J. Kopp, Jon A. Krosnick, Robert C. Mitchell, Stanley Presser, Paul A. Ruud, and Kerry Smith. 1994. "Prospective Interim Lost Use Value Due to DDT and PCB Contamination in the Southern California Bight." Natural Resource Damage Assessment, Inc., La Jolla, California.

Contingent valuation study of economic damages resulting from injuries to the natural resources of the Southern California Bight. Survey injury description includes impacts on fish and birds, including endangered species.

Division of Policy and Directives Management. 1988. "Damages to the Lake Michigan Sport Fishery from PCBs in Waukegan Harbor." U.S. Fish and Wildlife Service. Washington, DC.

Measures the economic value of the difference between the number of sport fishing days with and without the PCBs contamination at the site.

Freeman, A. Myrick III, Michael T. Huguenin and Douglas A. Rae. 1990. "Natural Resource Damages from the Charles George Landfill." Prepared for the Commonwealth of Massachusetts.

Assesses economic damages arising from contamination of the aquifer lying beneath the Charles George Landfill in Tyngsboro, Massachusetts, which rendered private wells unsuitable for both residential and non-residential use.

Hay, Michael J., Elizabeth W. Snell and Robert E. Unsworth. 1993. "Estimating Damages from PCBs to the Valley Creek Fishery in Valley Forge National Historic Park." Prepared for U.S. Fish and Wildlife Service.

Assesses economic damages due to PCB contamination originating from the Paoli Rail Yard Superfund site. Estimates use value damages due to lost fishing trips. Also reviews existing literature on passive use values for recreational fishing and fresh water resources, concluding that passive use losses could be significant and even exceed the use value losses.

McConnell, Kenneth E. and Industrial Economics, Incorporated. 1986. "The Damages to Recreational Activities from PCBs in the New Bedford Harbor." Prepared for the National Oceanic and Atmospheric Administration.

Measures reductions in willingness-to-pay for access to substitute beaches near this PCB contaminated harbor, and the increase in costs incurred by recreational fisherman who must travel further to avoid contaminated areas.

Meade, Norman and Robert Unsworth. 1990. "Preliminary Economic Damage Assessment of the January 2nd Exxon Oil Spill in the Arthur Kill Waterway/ Estimated Value of Selected Settlement Components." Prepared for the National Oceanic and Atmospheric Administration.

Estimates lost intertidal services. Lost value of the Arthur Kill as a transportation corridor, existence values and total losses.

Mendelsohn, Robert and Industrial Economics, Incorporated. 1986. "Assessment of Economic Damages: Analysis of Residential Property Values in the New Bedford Area." Prepared for the National Oceanic and Atmospheric Administration.

Estimates damages inflicted on residents in the area of New Bedford harbor from the PCB contamination of the harbor by using a hedonic price model and repeat sale data.

Natural Resource Damage Assessment, Inc. 1994. "Prospective Interim Lost Use Value Due to DDT and PCB Contamination in the Southern California Bight." Prepared for the National Oceanic and Atmospheric Administration.

Comprehensive contingent valuation study of prospective interim lost use value from natural resource injuries due to chemical contamination off the coast of Los Angeles. Survey injury

description includes two species of fish and two species of birds. Includes extensive advanced econometric analysis of survey data.

RCG/Hagler Bailly. 1995. "Assessment of Damages to Angles and Other Recreators from Injuries to the Upper Clark Fork River Basin." Prepared for State of Montana Natural Resource Damage Program.

Uses a travel cost model to estimate annual use value losses from reduced fishing quality at this site (for both Montana residents and nonresidents). Uses data from a postcard survey and unit value estimates from a literature review to estimate annual use value losses from nonfishing recreation (for both Montana residents and nonresidents).

RCG/Hagler Bailly. 1995. "Contingent Valuation of Natural Resource Damages Due to Injuries to the Upper Clark Fork River Basin." Prepared for State of Montana Natural Resource Damage Program.

Contingent valuation study of Montana households' willingness to pay for restoration of natural resources injured by four Superfund sites in the Clark Fork River Basin.

RCG/Hagler Bailly. 1991. "Contingent Valuation of Natural Resource Damage due to the *Nestucca* Oil Spill." Prepared for State of Washington Department of Wildlife, British Columbia Ministry of Environment, and Environment Canada.

Contingent valuation study of economic value to residents of Washington state and British Columbia of natural resource injuries from the December 1988 *Nestucca* 231,000 gallon oil spill. Injuries included oiled beaches, substantial seabird deaths, possible sea otter mortality, and effects on fisheries and other aquatic life.

Unsworth, Robert E., Elizabeth W. Snell and Richard C. Bishop. 1994. "Preliminary Economic Evaluation of Natural Resource Damages to Fish Creek: Final Memorandum Reporting on the Preliminary Economic Evaluation." Prepared for U.S. Department of the Interior Fish and Wildlife Service.

Preliminary assessment of the economic damages to natural resources injured by the September 1993 spill of about 30,000 gallons of diesel fuel into Fish Creek, a high quality stream in Indiana and Ohio. Estimates ecological and passive use values of the Fish Creek resource prior to the spill for Indiana and Ohio households.

APPENDIX C

SAMPLE FORMAT FOR ECONOMIC DAMAGE ASSESSMENT DOCUMENT

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SAMPLE FORMAT FOR ECONOMIC DAMAGE ASSESSMENT DOCUMENT

The following outline is suggested for use in reporting the results of preliminary economic damage assessments. While this outline is potentially applicable for presenting the results of full-scale, comprehensive assessments, reports of such assessments will often need to reflect case specific factors (e.g., separate reports might be prepared for each major study performed), and thus are likely to deviate from this proposed format. This sample format is intended as a general guide, not a template for all cases. Deviations from this format may be appropriate, as warranted by the unique characteristics of each case.

I. INTRODUCTION

The introduction should:

- Include an overview of the injured resource and the site of the release (a map of the site may be included);
- Include a summary of the release characteristics (e.g., date(s), hazardous material released);
- Include a brief summary of resource injury or suspected injury due to the release;
- Clearly define the purpose for which the document was developed (e.g., to support assessment planning, settlement negotiations, etc.); and
- Clearly define the scope of the document (e.g., the document is intended to address all known sources of injury; only addresses some sources of injury, a limited geographic area, or a limited time frame).

II. SUMMARY OF RESULTS

This section should summarize the estimates of economic damage, including both compensable values and restoration costs. For cases involving several categories of loss (e.g., recreational fishing, commercial fishing and marine transportation), a table of results may be useful. This table should include categories of restoration costs or compensable values for which no monetary damage estimate has been developed due to limits of available data. It may be appropriate to represent the results obtained as ranges, reflecting underlying uncertainty. The text of the summary should, if necessary, explain why certain categories of damages have not been quantified and describe all significant sources of uncertainty. Finally, this section should summarize proposed next steps.

III. Review of Natural Resource Injury

In order to allow the reader to link injuries to damages and proposed restoration options, the economic damage assessment document should include a brief review of natural resource injuries thought to exist at the site, including the geographic and temporal attributes of these injuries. Substantial uncertainties should be described, as should any ongoing research that might reduce these uncertainties or lead to alternative conclusions regarding economic loss. In cases in which assumptions have been made regarding the likely effectiveness of spill cleanup or site remediation efforts, such assumptions should be described in this section. This review need not be exhaustive, but should provide a general overview of the injury case.

IV. Estimation of Restoration Costs

This section should include a discussion of:

- The restoration options selected (assumed) for a site, including a table or text explicitly linking the selected options to the natural resource injuries/reductions in service flows resulting from the release.

- The restoration cost estimation methods used, and the assumptions made in these analyses. If a range of assumptions were considered, these should be reported and described. This review should be detailed enough, and present sufficient information, to allow the reader to replicate the results.

- The results obtained, presented as distributions, or as "unknown," where appropriate.

- The principal sources of uncertainty in the restoration cost estimate, including a discussion of restoration actions that were identified but could not be budgeted due to insufficient data.

- Proposed next steps to finalize the restoration cost estimate.

V. Estimation of Compensable Values

This section should include:

- A listing and discussion of relevant categories of compensable values. This section might include a table linking categories of injury to lost service flows.

- A description of the change in services provided by the injured resource (e.g., lost acres of wetland, lost fishing days). This should include all categories of loss, even those for which no economic damage estimate was developed. A discussion of the impact of selected or assumed restoration actions on the provision, or replacement

of, these service flows should be included (e.g., the ability of the trustees to take actions to restore wetland services in a given period of time).

- A presentation of the methods and data used to monetize lost service flows (e.g., benefits transfer, habitat equivalency). This review should be detailed enough to allow the reader to replicate the results presented.

- A presentation of the results obtained, reported as distributions (or as "unknown") where appropriate. Any possibility of double counting in these estimates should be described.

- A discussion of the principal sources of uncertainty in the compensable value estimates, including a discussion of service flow losses that were identified but which could not be monetized due to insufficient data.

- A list of proposed next steps to finalize the compensable value estimate.

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All documents and other sources relied on for the assessment should be referenced in a manner that allows the analysis to be replicated at a later date.

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