Scaling Compensatory Restoration Actions

Guidance Document for
Natural Resource Damage Assessment
Under the Oil Pollution Act of 1990

Damage Assessment
and Restoration Program

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NATURAL RESOURCE DAMAGE ASSESSMENT GUIDANCE DOCUMENT: SCALING COMPENSATORY RESTORATION ACTIONS (OIL POLLUTION ACT OF 1990)

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DISCLAIMER

Disclaimer: This guidance document is intended to provide guidance to trustees in selecting approaches for scaling compensatory restoration projects in Natural Resource Damage Assessments (NRDAs) under the Oil Pollution Act of 1990 (OPA). This document is not regulatory in nature. Trustees are not required to use this document in order to receive a rebuttable presumption for NRDAs under OPA.

NOAA would appreciate any suggestions on how this document could be made more practical and useful. Readers are encouraged to send comments and recommendations to:

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LIST OF EXHIBITS

LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended
HEA	Habitat Equivalency Analysis
NEPA	National Environmental Policy Act of 1969
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
OPA	Oil Pollution Act of 1990
RP	Responsible Party

GLOSSARY OF TERMS

Baseline [See section 1.5.1 for further discussion]
Baseline refers to the condition of natural resources and services that would have existed had the incident not occurred.

Capacity [See section 2.2.2 for further discussion.]
Capacity refers to the ability of a natural resource to provide services. The ability of a natural resource to provide services depends upon the on-site biophysical characteristics and the landscape context.

Discount rate
Discount rate refers to the rate at which dollars or other valued items or services being provided in different time periods are converted into current time period equivalents. A discount rate is used to compensate for delayed provision of services. For example, with zero inflation and a 3% interest rate, $100 available today could be invested to produce $103 one year from now. Under this scenario, if one wanted to compare dollars to be provided one year from now to dollars being provided today, a discount rate of 3% should be applied ($103 discounted at a 3% annual rate is equivalent to $100 in today's currency).

Exposure [See section 1.5.2 for further discussion]
Exposure means direct or indirect contact with the discharged oil.

Injury [See section 1.5.4 for further discussion]
Injury means an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service. Injury incorporates the terms "destruction," "loss," and "loss of use."

Interim losses/interim lost services (uses)
Interim losses and *interim lost services (uses)* refer to the reduction in resources and the services they provide, relative to baseline levels, that occur from the onset of an incident until complete recovery of the injured resources.

Natural resources and services [See section 1.5.5 for further discussion]
Natural resources means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the Exclusive Economic Zone), any State or local government or Indian tribe, or any foreign government, as defined in section 1001(20) of OPA (33 U.S.C. 2701(20)).
Services (or natural resource services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public.

Opportunity [See section 2.2.2 for further discussion.]
Opportunity refers to whether a natural resource is located in a landscape context that facilitates the flow of ecological and human services. The existence of a favorable landscape context will enable a natural resource that possesses capacity to provide ecological and human services.

Quality [See section 2.2.3 for further discussion.]
Quality refers to a multi-attribute characterization of a natural resource or service. The *quality* of a natural resource or service is a determinant of the economic value it provides.

Restoration action
Restoration action includes any of the actions authorized under OPA (restoration, rehabilitation, replacement, or acquisition of the equivalent), or some combination of those actions. Restoration actions by trustees are intended to complement the initial response and cleanup activities of response agencies.

Categories of restoration actions include:

- **Primary restoration action**
  Primary restoration is any action, including natural recovery, that returns injured natural resources and services to baseline. This may include actions to restore, replace, rehabilitate, or acquire the equivalent of injured natural resources or services.

- **Compensatory restoration**
  Compensatory restoration is any action taken to compensate for interim losses of natural resources and services that occur from the date of the incident until recovery of natural resources and services to baseline. The more quickly the selected primary restoration action expedites recovery of injured natural resources and/or services, the smaller will be the scale of the linked compensatory restoration action required to compensate for interim losses.

Actions to restore, replace, rehabilitate, or acquire the equivalent of injured natural resources or services may be considered in identifying both primary and compensatory restoration actions.

Restoration alternative
Restoration alternative is a combination of primary and/or compensatory restoration actions that address one or more specific injuries associated with the incident. Acceptable restoration alternatives include any of the actions authorized under OPA (restoration, rehabilitation, replacement, or acquisition of the equivalent), or any combination of those actions. Each restoration alternative must be designed so that, as a package of one or more actions, the alternative would make the environment and public whole.

Scaling

Scale refers to the size or spatial and temporal extent of restoration actions. *Scaling* refers to the process of determining, for identified restoration actions, the size or scale of the actions that would be required to expedite recovery of injured resources to baseline and compensate the public for interim lost resources and services.

Scaling approach

Scaling approach refers to the general framework used for scaling a restoration action. Trustees may use resource-to-resource or service-to-service approaches, or valuation approaches. In scaling compensatory restoration actions, each approach is used with the objective of providing benefits from compensatory actions equal to losses from resource injuries.

- **Resource-to-resource or service-to-service**
  Resource-to-resource or service-to-service scaling is an approach in which the natural resources injured and the services lost due to the incident are replaced by an equivalent quantity of discounted natural resources and services (or resource proxies).

  Given that the focus of this guidance document is on scaling compensatory restoration actions, we primarily employ the term *service-to-service* since the underlying concept is to ensure that not only are the same or comparable resources provided, but also that the resources provide a sufficient quantity of the same or comparable services.

- **Valuation**
  The *valuation* approach requires that the value of injured natural resources and/or services be measured explicitly, and that a restoration action provide natural resources and/or services of equivalent value to the public. The approach relies on the concept that lost value can be determined using one of a variety of possible units of exchange, including units of natural resource services or dollars. The primary valuation approach is value-to-value. Under some circumstances, a second valuation approach, value-to-cost, may be used.

  - **Value-to-value**
    Under the *value-to-value* approach to scaling, trustees determine the scale of restoration actions required to provide gains (or "value") equal to the value of the interim losses. Again, discounting is used to take into account differences in timing of losses and gains.

  - **Value-to-cost**
    Value-to-cost is a variant of the valuation approach. Under the value-to-cost approach, a restoration action is scaled by setting the cost of the restoration action equal to the value of losses due to the injury.

Scaling method

Scaling method is a technique (these terms are used interchangeably in the rule and guidance documents) that is employed to generate the required information under the different scaling approaches. Examples of scaling methods include habitat equivalency analysis under the service-to-service or resource-to-resource approaches, or the travel cost method under the valuation approaches. (See Appendix D for brief descriptions and short annotated bibliographies for various scaling methods). More than one method may be employed if needed to address the different injuries resulting from an incident, but trustees must be careful to avoid double-counting when using multiple methods.

Value

Value is measured as the maximum amount an individual is willing to give up to obtain a specific good or service (or the minimum amount an individual is willing to accept to forgo a specific good or service), net of the costs actually incurred to obtain the good or service.[1] The value of a natural resource or service includes the value individuals derive from direct use of the natural resource, for example, swimming, boating, hunting, or bird watching, as well as the value individuals derive from knowing a natural resource is available now and for future generations.[2] In many contexts, particularly in markets, value is represented in units of money. However, value can be measured using other units, such as units of natural resources or services.

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[1] The definition of value in the OPA rule refers to the gross value (or willingness-to-pay), from which costs are not netted out. Appendix C discusses the difference between gross value and net value (consumer surplus). When there is a natural resource injury, the losses to the public are measured by the net value.

[2] Total economic value is the sum of the value of direct uses and the value of passive uses. Note that both willingness-to-pay and consumer surplus encompass total economic value.

EXECUTIVE SUMMARY

According to the regulations for conducting natural resource damage assessments (NRDAs) under the Oil Pollution Act (OPA), the costs of implementing a Restoration Plan form the basis of a damage claim. A Restoration Plan consists of a set of restoration actions designed to meet the statutory goals of restoring natural resources to baseline (primary restoration) and compensating the public for the interim losses from the time natural resources are injured until they return to baseline (compensatory restoration). Note that primary and compensatory restoration actions are linked: the primary restoration action affects the speed of recovery to baseline, and therefore, the level of interim losses that need to be addressed by compensatory actions. For example, if primary restoration is achieved through natural recovery, the scale of the compensatory restoration action will be larger than if an active primary restoration action were chosen.

The Restoration Planning Phase of a NRDA includes "injury assessment" and "restoration selection." In the injury assessment process, trustees are responsible for determining and quantifying natural resource injuries. In the restoration selection process, trustees are responsible for formulating restoration alternatives that meet restoration objectives. The injury assessment and restoration selection processes typically occur in parallel.

This guidance document presents a decision-making framework for developing a reasonable range of restoration alternatives and scaling restoration alternatives. The goal of scaling is to select the appropriate size of the restoration actions so that the services they provide return resources to baseline and compensate the public for the interim losses. In particular, we focus on the selection and implementation of approaches (resource-to-resource/service-to-service or valuation) for scaling compensatory restoration actions.

The five steps in the decision-making process for developing and scaling restoration alternatives are:

(1) Review preliminary restoration objectives generated in the early stages of the injury assessment process.

The starting point in an NRDA is to assess injury to natural resources and the loss or impairment of the ecological and human services they support. Injuries to natural resources form the locus around which restoration plans are formulated.

The early stages of the injury assessment provide the following information, which helps the trustees in formulating preliminary restoration objectives:

- a preliminary identification of natural resources and services that have been injured or lost; and

- a preliminary identification of the degree, and spatial and temporal extent of injury, including a determination of the potential natural recovery period.

With this information, the trustees may define restoration objectives in terms of specific resources and services to be restored or replaced.

(2) Construct an inventory of possible restoration actions.

The goal of this step is to identify a range of primary and compensatory actions that address restoration objectives. Restoration alternatives comprised of one or more of these actions will be evaluated in the Draft Restoration Plan.

(3) Classify restoration actions according to type, quality and value of services provided by the action relative to lost services.

This step involves classifying restoration actions by whether or not they provide services of the same type and quality, and of comparable value, to the services lost due to the injury. The categories of ecological and human services provided by natural resources include (but are not limited to): geo-hydrological, habitat, recreational, commercial, cultural, health, and passive uses.

When restoration actions provide the same types of services, the determination of comparable value is based on an evaluation of the quality of the lost services relative to the quality of replacement services.[3] It also depends on the extent of changes in aggregate supply and demand for services during the period of injury and period of provision of services by the restoration actions. If the differences in quality or in the aggregate supply and demand are small, the values per unit of services may be comparable for the losses and gains, even if they occur in different time periods.

The classification of restoration actions serves two purposes:

(i) Prioritizing compensatory restoration actions

The OPA regulations place a priority on compensatory actions that provide resources and services of the *same type and quality, and of comparable value* to those injured. If the identified restoration actions do not provide alternatives with sufficient natural resources and services of the same type and quality (a determination made by the trustees), then actions that provide natural resources and services of at least *comparable type and quality* as those injured may be considered. Actions that do not provide comparable resources and services are not appropriate for inclusion in a Restoration Plan.

[3] A critical question in determining whether the lost services and the replacement services are of comparable quality is whether the metric used to characterize services captures any quality differences between lost and restored services. For example, an acre of replacement habitat may be more or less productive than an acre of the injured habitat. However, if it is possible to capture these differences in service levels per acre in a metric, then the quality differences may be accounted for in the calculations.

(ii) Selecting a suitable approach for scaling compensatory restoration actions

The type, quality, and value of the services provided by the restoration actions relative to the injured resources also has implications for the appropriate approach for scaling compensatory restoration (discussed below in step 5).

(4) Select an approach(es) and method(s) to scale primary restoration actions to return injured and lost resources and services to baseline, and design studies to collect the necessary data.

For primary restoration, the "scaling" question is: what scale of a primary restoration actions(s) is necessary to return the stock of resources and service flows to baseline levels in a timely manner?

Once the trustees identify an option for the type and scale of a primary restoration action(s), they can quantify the extent and duration of injury in space and time that will occur, based on the assumption that the specific primary restoration action was implemented. The quantification of interim losses, conditional on implementation of one or more specific primary restoration actions, becomes an input into the analysis of compensatory restoration actions in step (5).

(5) Select an approach(es) and method(s) to scale compensatory restoration actions that compensate the public for the interim loss of natural resources and services, and design studies to collect necessary data.

For compensatory restoration, the "scaling" question is: what scale of a compensatory restoration action is necessary to compensate for the interim loss of natural resources/services from the time of injury until full recovery? The process of “scaling” a restoration action involves adjusting the size of the action to ensure that the present discounted value of gains from the action equals the present discounted value of interim losses from the injury.

The scaling analysis for compensatory restoration requires:

- quantifying the extent and duration of service losses assuming a specified primary restoration action has been implemented,
- quantifying the extent and duration of the gain in resource services for different scales of compensatory restoration actions, and
- determining the trade-offs between the services lost due to injury and the gains in services from the restoration actions.

Scaling Approaches and the Process for Choosing an Approach

The two major categories of scaling approaches are as follows:

Resource-to-Resource or Service-to-Service Approach: Resource-to-resource or service-to-service scaling is an approach in which the appropriate quantity of replacement natural resources and the services they provide is determined by obtaining equivalency between the quantity of discounted services (or resource proxies) lost due to the injury and the quantity of discounted replacement services (or resource proxies) provided by compensatory actions.[4]

The implicit assumption of the service-to-service approach is that the public is willing to accept a one-to-one trade-off between a unit of services lost due to injury and a unit of services gained due to the restoration action. There is not necessarily a one-to-one trade-off in *resources* but instead in the *services* they provide. The assumption may be applicable when, in the judgment of the trustees, the proposed restoration action provides services of the same type and quality, and of comparable value as those lost due to the injury. The OPA regulations indicate that the service-to-service approach must be considered under these conditions.

Valuation Approach: Where the assumption of a one-to-one trade-off between service losses and gains does not apply, the valuation approach is used. A variety of economic methods may be used to determine the public's willingness to forego lost services for services provided by compensatory restoration projects. These methods determine the present discounted value of service increases from the proposed actions as well as the present discounted value of the interim losses. The approach relies on the concept that value can be determined using one of a variety of units of exchange, including units of natural resource services or dollars. The preferred version of the valuation approach, referred to as "value-to-value," scales a project by adjusting the size of a restoration action to ensure that the present discounted value of project gains equals the present discounted value of the interim losses.

In limited circumstances (generally small spills with limited damages), the **value-to-cost** variant of the valuation approach may be employed. With this approach, the compensatory restoration actions are scaled by equating the cost of the restoration actions to the value of losses due to the injury. To apply this procedure, the trustees must judge that the valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time frame or at a reasonable cost. These conditions may apply when literature values (from previous research) are available to value lost services but are not available to value the gains from

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4 The use of discounting takes into account the differences in the timing of injury and restoration. Discounting should be performed whenever losses or gains occur in different time periods, regardless of whether the service-to-service or valuation approach is used (see Appendix C for a discussion of discounting).

restoration actions. This situation could occur if the project would provide services currently unavailable at the injured site.

Criteria for Selecting Scaling Approach and Method(s)

The choice of a scaling approach cannot be made without identifying the data and methods that are available for implementing the scaling approaches under consideration. The integrated choice of scaling approach and methodology depends upon an evaluation of three sets of criteria:[5]

- *Applicability* of the approach and methods in the particular context;
- *Reasonableness of the incremental costs* of a more complex approach and/or methods, relative to the expected increase in the quantity and/or quality of relevant information; and
- *Validity* and *reliability* of the approach and the methods to implement it in the particular context.

If available methods for the first scaling approach considered by the trustees do not meet these conditions in the specific context, the trustees should consider methods for implementing another approach.

[5] OPA regulations at §990.27.

1.1 Background

A major goal of the Oil Pollution Act of 1990 (OPA)[6] is to make the environment and public whole for injury to or loss of natural resources and services as a result of a discharge or substantial threat of a discharge of oil (referred to herein as an "incident"). This goal is achieved through returning injured natural resources and services to the condition they would have been in if the incident had not occurred (otherwise referred to as "baseline" conditions), and compensating for interim losses from the date of the incident until recovery of such natural resources and services through the restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and/or services.

The U.S. Department of Commerce, acting through the National Oceanic and Atmospheric Administration (NOAA), issued final regulations providing an approach that public officials (Trustees) may use when conducting Natural Resource Damage Assessments (NRDA) under OPA.[7] These NRDA regulations (the OPA regulations) describe a process by which trustees may:

- Identify injuries to natural resources and services resulting from an incident;
- Provide for the return of injured natural resources and services to baseline conditions and compensation for interim lost services; and
- Encourage and facilitate public involvement in the restoration process.

The OPA regulations are included in Appendix A of this document for reference. The preamble discussion of the OPA regulations, along with a summary of and response to public comments received on the proposed regulations, is published at 61 Fed. Reg. 440 (January 5, 1996).

1.2 Purpose and Scope of this Document

The purpose of this Guidance Document is to provide trustees with general guidance for selecting approaches to scale compensatory restoration projects, an activity that is part of the restoration selection component of the Restoration Planning Phase of an NRDA. This guidance document outlines a decision-making framework for classifying

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6 33 U.S.C. §§ 2701 *et seq.*

7 The OPA regulations are codified at 15 CFR part 990 and became effective February 5, 1996.

restoration alternatives and, based on the classification, selecting an appropriate scaling approach and methods to implement the approach.

Chapter 1 provides an overview of the NRDA process under OPA and definitions of basic terms. To provide a consistent overview, this chapter is the same across all the OPA NRDA guidance documents. Chapter 2 outlines key concepts and a decision-making framework for scaling compensatory restoration. Chapters 3 and 4 elaborate on two key decision processes pertaining to scaling. Chapter 3 considers the process of classifying actions by type, quality and value of natural resource services, with examples for beach closure and habitat injuries. Classification by type, quality and value is relevant both for prioritizing efforts to identify restoration actions for evaluation, as well as for assessing the applicability of the alternative scaling approaches. Chapter 4 discusses evaluation criteria for selecting scaling approaches/methods, and follows through with the beach closure and habitat injury examples.

Appendix A provides a copy of the NRDA regulations under OPA. Appendix B lists other related guidance documents in support of the OPA regulations. Appendix C provides an overview of economic concepts of value and discounting applied in scaling. Appendix D presents brief bibliographies of various methods for scaling.

1.3 Intended Audience

This document was prepared primarily to provide guidance to natural resource trustees using the OPA regulations. However, other interested persons may also find the information contained in this document useful and are encouraged to use this information as appropriate.

1.4 The NRDA Process

The NRDA process in the OPA regulations, set out and illustrated in Exhibit 1.1, includes three phases outlined below: Preassessment, Restoration Planning, and Restoration Implementation.

1.4.1 Preassessment Phase

The purpose of the Preassessment Phase is to determine if trustees have the jurisdiction to pursue restoration under OPA and, if so, whether it is appropriate to do so. This preliminary phase begins when the trustees are notified of the incident by response agencies or other persons.

Once notified of an incident, trustees must first determine the threshold criteria that provide their authority to initiate the NRDA process, such as applicability of OPA

EXHIBIT 1.1: NRDA PROCESS UNDER THE OPA REGULATIONS

PREASSESSMENT PHASE

- Determine Jurisdiction
- Determine Need to Conduct Restoration Planning

RESTORATION PLANNING PHASE

- Injury Assessment
    - Determine Injury
    - Quantify Injury
- Restoration Selection
    - Develop Reasonable Range of Restoration Alternatives
    - Scale Restoration Alternatives
    - Select Preferred Restoration Alternative(s)
    - Develop Restoration Plan

RESTORATION IMPLEMENTATION PHASE

- Fund/Implement Restoration Plan

and potential for injury to natural resources under their trusteeship. Based on early available information, trustees make a preliminary determination whether natural resources or services have been injured. Through coordination with response agencies, trustees next determine whether response actions will eliminate the threat of ongoing injury. If injuries are expected to continue or significant service losses have already been incurred, and feasible restoration alternatives exist to address such injuries, trustees may proceed with the NRDA process.

1.4.2 Restoration Planning Phase

The purpose of the Restoration Planning Phase is to evaluate potential injuries to natural resources and services and use that information to determine the need for and scale of restoration actions. The Restoration Planning Phase provides the link between injury and restoration. The Restoration Planning Phase has two basic components: injury assessment and restoration selection.

1.4.2.1 Injury Assessment

The goal of injury assessment is to determine the nature, degree, and extent of any injuries to natural resources and services. This information is necessary to provide a technical basis for evaluating the need for, type of, and scale of restoration actions. Under the OPA regulations, injury is defined as an observable or measurable adverse change in a natural resource or an impairment of a natural resource service. Trustees determine whether there is:

- Exposure, a pathway, and an adverse change to a natural resource or service as a result of an actual discharge; or
- An injury to a natural resource or impairment of a natural resource service as a result of response actions or a substantial threat of a discharge.

To proceed with restoration planning, trustees also quantify the degree, and spatial and temporal extent of injuries. Injuries are quantified by comparing the condition of the injured natural resources or services to baseline.

1.4.2.2 Restoration Selection

(a) Developing Restoration Alternatives

Once injury assessment is complete or nearly complete, trustees develop a plan for restoring the injured natural resources and services. Under the OPA regulations, trustees must identify a reasonable range of restoration alternatives, evaluate and select the preferred alternative(s), and develop a Draft and Final Restoration Plan. Acceptable restoration actions include any of the actions authorized under OPA (restoration, rehabilitation, replacement, or acquisition of the equivalent) or some combination of those actions.

Restoration actions under the OPA regulations are either primary or compensatory. Primary restoration refers to actions taken to return injured natural resources and services to baseline, including natural recovery. If residual sources of contamination persist and prevent return to baseline, trustees may undertake residual source control. Compensatory restoration refers to actions taken to compensate for the interim losses of natural resources and/or services pending recovery. Each restoration alternative considered will contain primary and/or compensatory restoration actions that address one or more specific injuries associated with the incident. The type and scale of compensatory restoration will depend on the nature of the primary restoration action, and the level and rate of recovery of the injured natural resources and/or services given the primary restoration action.

When identifying the compensatory restoration components of the restoration alternatives, trustees must first consider compensatory restoration actions that provide services of the same type and quality, and of comparable value as those lost. If compensatory actions of the same type and quality and comparable value cannot provide a reasonable range of alternatives, trustees may then consider other compensatory restoration actions that will provide services of at least comparable type and quality as those lost.

(b) Scaling Restoration Actions

To ensure that a restoration action appropriately addresses the injuries resulting from an incident, trustees must determine what scale of restoration is required to return injured natural resources to baseline levels and compensate for interim losses. The approaches that may be used to determine the appropriate scale of a restoration action are the resource-to-resource or service-to-service approach and the valuation approach. Under the resource-to-resource or service-to-service approach to scaling, trustees determine the appropriate quantity of replacement natural resources and/or services to compensate for the amount of injured natural resources or services.

Where trustees must consider actions that provide natural resources and/or services that are of a different type, quality, or value than the injured natural resources and/or services, or where service-to-service scaling is inappropriate, trustees may use the valuation approach to scaling, in which the value of services to be returned is compared to the value of services lost. Responsible parties (RPs) are liable for the cost of implementing the restoration action that would generate the equivalent value, not for the calculated interim loss in value. An exception occurs when valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time frame or at a reasonable cost. In this case, trustees may estimate the dollar value of the lost services and select the scale of the restoration action that has the cost equivalent to the lost value.

(c) Selecting a Preferred Restoration Alternative

The identified restoration alternatives are evaluated based on a number of factors that include:

- Cost to carry out the alternative;
- Extent to which each alternative is expected to meet the trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses;
- Likelihood of success of each alternative;
- Extent to which each alternative will prevent future injury as a result of the incident, and avoid collateral injury as a result of implementing the alternative;
- Extent to which each alternative benefits more than one natural resource and/or service; and
- Effect of each alternative on public health and safety.

If the trustees conclude that two or more alternatives are equally preferable based on these factors, the trustees must select the most cost-effective of the two or more equally preferable alternatives.

(d) Developing a Restoration Plan

The Draft Restoration Plan will describe the trustees' preassessment and injury assessment activities and results, evaluate restoration alternatives, and identify the preferred restoration alternative(s). A Draft Restoration Plan will be made available for review and comment by the public, including where possible appropriate members of the scientific community. After reviewing public comments on the Draft Restoration Plan, trustees develop a Final Restoration Plan. The Final Restoration Plan will become the basis of a claim for damages.

1.4.3 Restoration Implementation Phase

The Final Restoration Plan is presented to the RPs to implement or to fund the trustees' costs of implementing the Plan, thereby providing the opportunity for settlement of the damage claim without litigation. Should the RPs decline to settle the claim, OPA authorizes trustees to bring a civil action for damages in federal court or to seek an appropriation from the Oil Spill Liability Trust Fund (FUND) for such damages.

1.5 Basic Terms and Definitions

Legal and regulatory language often differ from conventional usage. This section defines and describes a number of important terms used in this document and in the OPA regulations. Trustees should also refer to the OPA regulatory language (at § 990.30) in Appendix A. Also see the Glossary and Appendix C.

1.5.1 Baseline

> "*Baseline* means the condition of the natural resources and services that would have existed had the incident not occurred. Baseline data may be estimated using historical data, reference data, control data, or data on incremental changes (e.g., number of dead animals), alone or in combination, as appropriate." (OPA regulations at § 990.30)

Although injury quantification requires comparison to a baseline condition, site-specific baseline information that accounts for natural variability and confounding factors prior to the incident is difficult to obtain and may not be required. In many cases, injuries can be quantified in terms of incremental changes resulting from the incident, rather than in terms of absolute changes relative to a known baseline. In this context, site-specific baseline information is not necessary to quantify injury. For example, counts of birds killed by oil can be used to quantify incremental bird mortality resulting from an incident, thereby providing the basis for planning restoration.

The OPA regulations do not distinguish between baseline, historical, reference, or control data in terms of value and utility in determining the degree and spatial and temporal extent of injuries. These forms of data may serve as a basis of a determination of the conditions of the natural resources and services that would have existed in the absence of the incident.

Types of information that may be useful in evaluating baseline include:

- Information collected regularly in the area of the incident both before and after the incident;
- Information identifying historical patterns or trends in the area of the incident and injured natural resources and services;
- Information from areas unaffected by the incident, that are judged sufficiently similar to the area of the incident with respect to the parameter being measured; or
- Information from the area of the incident after particular natural resources or services have been judged to have recovered.

1.5.2 Exposure

> "*Exposure* means direct or indirect contact with the discharged oil." (OPA regulations at § 990.30)

Exposure is broadly defined to include not only direct physical exposure to oil, but also indirect exposure (e.g., injury to an organism as a result of disruption of its food web). Documenting exposure is a prerequisite to determining injury only in the event of an actual discharge of oil. The term *exposure* does not apply to response-related injuries and injuries resulting from a substantial threat of a discharge of oil.

1.5.3 Incident

> "*Incident* means any occurrence or series of occurrences having the same origin, involving one or more vessels, facilities, or any combination thereof, resulting in the discharge or substantial threat of discharge of oil into or upon navigable waters or adjoining shorelines or the Exclusive Economic Zone, as defined in section 1001(14) of OPA (33 U.S.C. 2701(14))." (OPA regulations at § 990.30)

When a discharge of oil occurs, natural resources and/or services may be injured by the actual discharge of oil, or response activities related to the discharge. When there is a substantial threat of a discharge of oil, natural resources and/or services may also be injured by the threat or response actions related to the threat.

1.5.4 Injury

> "*Injury* means an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service. Injury incorporates the terms "destruction," "loss," and "loss of use" as provided in OPA." (OPA regulations at § 990.30)

Section 1002(b)(2)(A) of OPA authorizes natural resource trustees to assess damages for "injury to, destruction of, loss of, or loss of use of" natural resources. The definition of *injury* incorporates these terms. The definition also includes the injuries resulting from the actual discharge of oil, a substantial threat of a discharge of oil, and/or related response actions.

Injury can include adverse changes in the chemical or physical quality, or viability of a natural resource (i.e., direct, indirect, delayed, or sublethal effects). Potential categories of injuries include adverse changes in:

- Survival, growth, and reproduction;
- Health, physiology and biological condition;
- Behavior;

- Community composition;

- Ecological processes and functions;

- Physical and chemical habitat quality or structure; and

- Services to the public.

Although injury is often thought of in terms of adverse changes in biota, the definition of injury under the OPA regulations is broader. Injuries to non-living natural resources (e.g., oiled sand on a recreational beach), as well as injuries to natural resource services (e.g., lost use associated with a fisheries closure to prevent harvest of tainted fish, even though the fish themselves may not be injured) may be considered.

1.5.5 Natural Resources and Services

> "*Natural resources* means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the Exclusive Economic Zone), any State or local government or Indian tribe, or any foreign government, as defined in section 1001(20) of OPA (33 U.S.C. 2701(20))." (OPA regulations at § 990.30)

Natural resources provide various services to other natural resources and to humans. Loss of services is included in the definition of injury under the OPA regulations.

> "*Services* (or *natural resource services*) means the functions performed by a natural resource for the benefit of another natural resource and/or the public." (OPA regulations § 990.30)

Natural resource services may be classified as follows:

- Ecological services - the physical, chemical, or biological functions that one natural resource provides for another. Examples include provision of food, protection from predation, and nesting habitat, among others; and

- Human services - the human uses of natural resources or functions of natural resources that provide value to the public. Examples include fishing, hunting, nature photography, and education, among others.

In considering both natural resources and services, trustees are addressing the physical and biological environment, and the relationship of people with that environment.

2.1 Introduction

The purpose of this chapter is to outline a decision-making framework for scaling restoration alternatives to achieve the goals of returning resources to baseline and compensating the public for the interim losses. Exhibit 2.1 illustrates how this five-step decision-making framework fits in the overall NRDA process. The framework covers the first two elements of Restoration Selection, which is part of the Restoration Planning Phase. This document focuses on the selection of approaches (resource-to-resource/service-to-service or valuation) for scaling compensatory restoration actions.

After a reasonable range of restoration alternatives is developed and scaled, the final stages of restoration planning are: selecting a preferred restoration alternative(s), and developing the Restoration Plan document.

The next three sections of this chapter describe the key concepts in the scaling process. The last section describes the five steps in the decision-making framework for scaling. Chapters 3 and 4 expand the discussion about the decision framework, focusing on classifying compensatory restoration actions and selecting approaches and methods to scale compensatory actions, respectively.

2.2 Concepts of Natural Resources and Services

2.2.1 Examples of Resources and Services

Natural resources can be viewed as natural assets, which provide services through time to other natural resources and humans. They are analogous to manufactured assets, such as housing, or manufacturing plants and equipment, which also may provide flows of services over an extended time period.[8] When natural resources are injured, the flow ecological and human services (and values) provided by the natural resources may be interrupted for a period of time. As a result, the public incurs interim losses from the injury.

To make the discussion more specific, we use the example of wetland habitat to illustrate the concept of resource services. Exhibit 2.2 identifies major categories of ecological services and associated human services provided by wetland habitats. Note that the state of scientific knowledge limits our ability to articulate all the services a

[8] A critical difference between "natural capital" and "manufactured capital," such as machines, is that the manufactured capital used in private production is privately owned and its use is controlled by the private owner (e.g., a firm) for its profit. Alternatively, ownership rights in resources ("natural capital") frequently are not well-defined, and the resources may be widely accessible to the public.

Exhibit 2.1: Decision-Making Framework

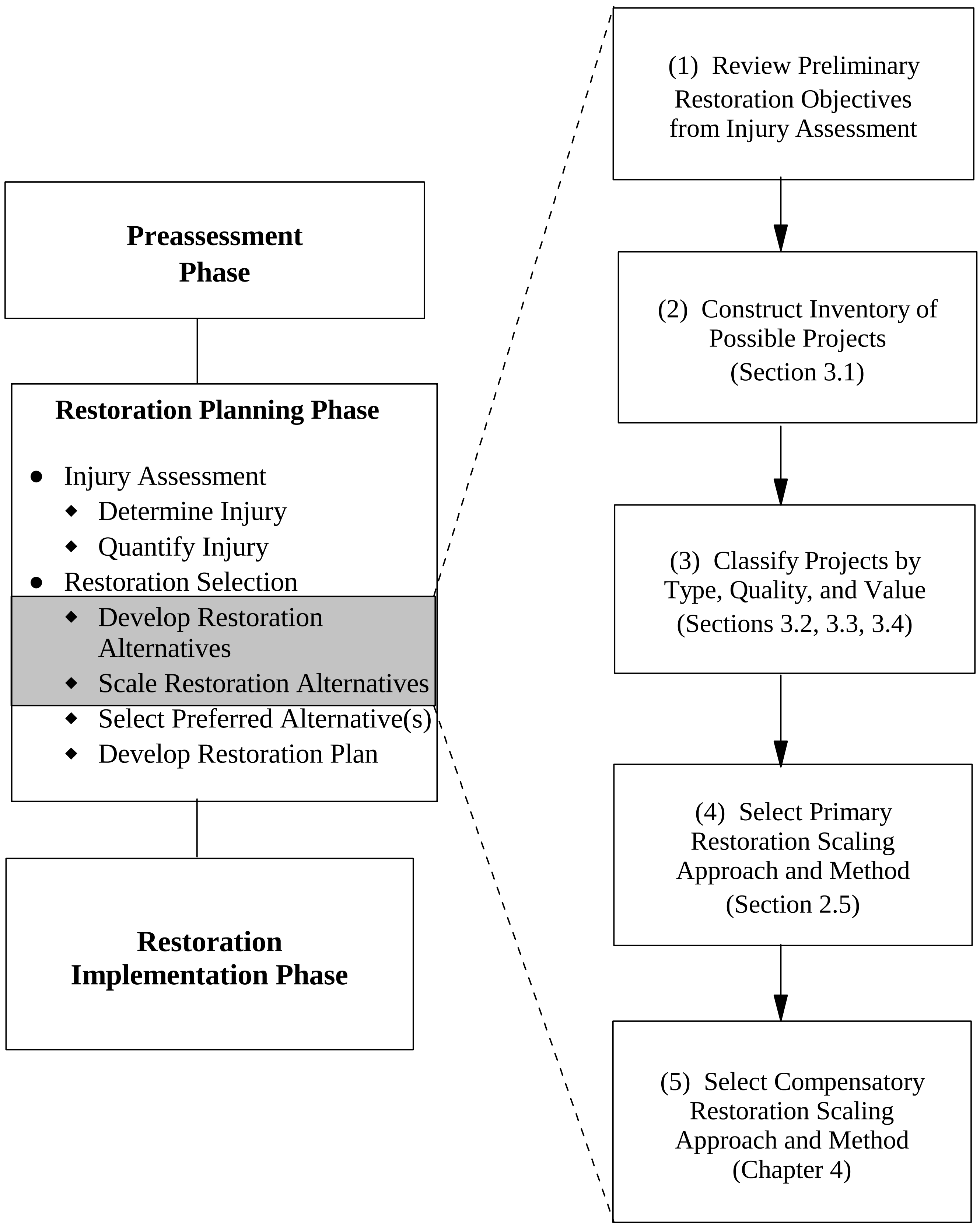

Exhibit 2.2: Wetland Ecosystem Services and Sources of Value

Ecological

Geo-Hydrological
- Floodwater storage and conveyance
- Groundwater recharge and discharge
- Pollution assimilation
- Sediment trapping and control
- Nutrient cycling
- Shoreline Stabilization

Production/Habitat
- Fish and shellfish habitat
- Habitat for furbearers, waterfowl, and other wildlife
- Food production
- Oxygen production
- Organic material
- Timber production
- Pollination
- Maintenance of gene pools
- Maintenance of plant populations

Ecosystem Integrity
- Natural open space
- Climate regulation
- Biodiversity storehouse
- Carbon cycling
- Resistance and resilience

Human

Recreational
- Beach use/swimming
- Fishing, boating
- Wildlife viewing
- Hunting

Commercial/Public or Private
- Drinking water
- Waterway navigation
- Hydropower generation
- Irrigation/commercial process water
- Property protection
- Agriculture, timber
- Fishing, trapping furbearers

Cultural/Historical
- Religion/spiritual uses
- Cultural uses
- Historical

Health
- Morbidity/mortality reductions due to provision of clean air, water, and food

Scientific
- Pharmaceutical (health)
- Increase productivity

Passive
- Species, habitats/ecosystems
- Genetic, species diversity and resiliency
- Life Support: carbon/nutrient cycles

resource may provide.

Focusing first on ecological services, we list below some of the major categories of services and provide examples.[9]

- **Geo-hydrological:** floodwater storage and conveyance, groundwater recharge, pollution assimilation, sediment trapping, nutrient cycling;

- **Habitat/production:** vegetation products; fishery, fur-bearer, bird habitat and production; and

- **Ecosystem integrity:** natural open space, micro- and macro-climate regulation, carbon cycling, biodiversity storehouse to provide resiliency.

Ecological services, in turn, may support direct uses by humans either *on-site* or *off-site*, as well as passive uses. For example, the floodwater storage function may provide storm protection for off-site property owners in the flood zone; the pollution assimilation and sediment trapping functions may increase water quality, supporting downstream water uses such as swimming or municipal drinking water supply; and the habitat function may support bird-watching elsewhere along the flyway.

For the wetland example, major categories of natural resource services to humans include, but are not limited to:[10]

- **Recreational**: beach use/swimming, fishing, boating, wildlife viewing (including bird-watching), and hunting;

- **Commercial/public or private**: waterway navigation, drinking water, aquaculture, agricultural irrigation, commercial process water, property protection from storms, commercial and subsistence fishing and hunting, timber harvest;[11]

- **Cultural/historical**: religious and cultural ritual uses, historical research;

[9] For further discussion of wetland ecological services, see "Water Quality Improvement by Wetlands," in *Nature's Services*, ed. Gretchen C. Daily (Island Press, 1997), pp. 329-344. Also see Chapter 6, "Biodiversity and Ecosystem Functioning: Ecosystem Analyses," in *Global Biodiversity Assessment*, ed. V.H. Heywood (Cambridge University Press, 1995), pp. 387-393.

[10] See "Freshwater Ecosystem Services," in Daily (*op. cit*), pp. 195-214, for a discussion of human services provided by wetlands. Also see Chapter 12, "Economic Values of Biodiversity," in Heywood (*op.cit*).

[11] Note that public sector claimants may recover commercial damages under Section 1002(b)(2)(D) of OPA, while loss of profits or earning capacity are only recoverable by those experiencing the loss (Section 1002(b)(2)(D) of OPA).

- **Health:** reductions in mortality and morbidity (e.g., through provision of clean water, air, foodstuffs);[12]

- **Scientific:** research promoting increased productivity in commercial and other activities and the development of life-saving pharmaceuticals; and

- **Passive use**: Species, habitat, and ecosystem protection for existence and for bequest value.

The first five categories of services represent *direct uses* by humans - i.e., the natural resources provide services directly to individuals. The last category, passive use value, captures the fact that individuals may value natural resources independent of direct uses. Individuals may value the services provided to others, or the protection of natural resources for their own sake or as bequests to future generations. For example, the public may value an ecosystem supporting endangered species, though they are seldom viewed.

2.2.2 Preconditions of Natural Resource Services: Capacity, Opportunity, Value

The services that flow from natural resources depend not only on the capacity of the resource to provide services, but also on opportunity to provide services.[13] *On-site biophysical characteristics* (e.g., soil, vegetative cover, hydrology) affect the *capacity* of an ecosystem to provide ecological and human services. *Landscape context* affects whether the ecosystem will have the *opportunity* to supply many of the ecological and human services and strongly influences whether humans will *value* the opportunities for services.[14]

Consider, for example, the wetland function of sediment trapping. A wetland's capacity to provide this function depends on such factors as slope and vegetative cover. The opportunity for the wetland to trap sediments depends on the expected flow of sediments from adjacent land, which will depend upon types of upland land uses (i.e., landscape context). Farms and residential sites generate greater sediment runoff than forests and grasslands and thus provide greater opportunity to use the sediment trapping capacity. The total value generated from water quality improvements due to sediment trapping will depend upon the uses of the affected downstream water bodies: the value

[12] Note that natural resource trustees generally do not claim for health effects.

[13] For further discussion see *Comparing Ecosystem Services and Values*, prepared by Dennis King for National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1997.

[14] An exception would be the case of global services, such as carbon sequestration (in forested land) which reduces the greenhouse effect for the global environment. In this case, the realization of the benefits of this service is not embedded in the landscape context.

will be greater if there are nearby shellfish beds and finfish spawning areas than if the water flows into a fast-moving river.

Or consider, for example, recreational uses of the wetland for wildlife viewing. The opportunity for recreational use of an acre of wetland will be greater if it is located in an urban site readily accessible to many potential users, than if located in a remote rural location with limited access.

2.2.3 Economic Concepts: Value and the Determinants of Value

A brief discussion of the concept of economic value and the factors that affect economic value is provided here. Appendix C provides a more technical discussion for the interested reader.

In economic analysis, the economic value of a specific good or service to an individual or household represents the level of satisfaction that individual or household derives from the good or service. The "total economic value" of a natural resource or service is the sum of the direct use values and passive use values of the natural resource for all households. A measure of economic value is consumer surplus,[15] which is the value of goods and services to an individual or household, in excess of the cost of access or purchase.[16]

Individuals derive economic value from natural resources because they value the human and ecological services that resources support. The concept of consumer surplus can be used to measure both the economic value of lost services during the time of interrupted service flows and the economic value generated by natural resources and services that are provided by restoration actions.[17]

The economic value of a good or service is affected by both the quality and the quantity of the good or service. Each natural resource or service can be described by a

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[15] Throughout this document, value and consumer surplus are used interchangeably.

[16] Consumer surplus is measured as the maximum amount an individual is willing to give up to obtain a specific good or service (or the minimum amount an individual is willing to accept to forgo a specific good or service), net of the costs incurred to obtain the good. This concept applies to goods and services supplied through a market, such as books and TVs, as well as non-market goods, such as recreational beach use or wildlife viewing. For goods sold in a market, consumers must pay the market price; for non-market goods, such as recreational beach use, consumers incur the cost of traveling to the site, which functions like a price.

[17] The definition of value in the OPA rule refers to the gross value (or willingness-to-pay), from which costs are not netted out. See Appendix C for a detailed discussion of the difference between gross value (willingness-to-pay) and net value (consumer surplus). The OPA rule defines value as total value, which is the sum of direct use values and passive use values. Thus, whether willingness-to-pay or consumer surplus is used to measure economic value, the measure reflects the value from both direct and passive uses.

suite of quality characteristics. For example, the quality of recreational beach use is a function of water quality, extent of congestion (crowding), and the range of recreational opportunities, among other beach characteristics. If quality changes, then economic value generally changes as well. For instance, if the environmental quality at a beach declines due to the presence of tarballs, the economic value of a user day at that beach may decline, since swimming and other water-based recreational activities may be unpleasant, or prohibited outright.

The consumer surplus also depends on the stock of natural resources (i.e., the quantity) and their capacity to provide services at a given point in time. In general, as a good or service becomes more scarce, the value of the last available unit tends to increase, and as the good or service becomes more plentiful, the value of the last available unit tends to decrease. For example, in years of scarce water supply in the Western US, provision of an additional unit of water will be more valuable than in years of heavy snow pack and ample supply.

In the damage assessment context, the total stock of natural resources and, therefore, service capacity varies during the injury period as well as during the lifetime of a restoration action. Relative to the no-injury context, the quantity of services will be more scarce in the region during the injury period, and will be more plentiful during the lifetime of a compensatory restoration project (after primary restoration has returned the injured resource and service flows to baseline). Consequently, during the injury period, the value of the last unit of services lost may be higher than the value of the last unit provided in the baseline context; during the lifetime of the compensatory restoration project, the value of the last unit of services provided each year may be lower than at baseline.

In summary, differences in the quality of and the stock of natural resources and services may result in differences in the economic value per unit of lost and restored natural resources and services.

The timing of the provision of services also affects how much they are valued from today's perspective. In general, providing a given quantity of goods and services in the future is worth less than providing that same quantity today, all else equal. In performing scaling calculations, trustees must take into account the delay in provision of natural resources and services by discounting to the present the quantity or value of interim lost services due to the injury, as well as the gain in quantity or value of services from the restoration action. Appendix C contains a more detailed discussion of discounting and the choice of a discount rate.

2.3 Concepts of Primary and Compensatory Restoration

The purpose of primary restoration actions is to return the injured natural resources and services to baseline conditions, while the purpose of compensatory restoration actions is to compensate the public for losses occurring from the time of the incident to the return of injured resources and services to baseline. Each restoration alternative must be designed so that, as a package of primary and compensatory restoration actions, the alternative would satisfy OPA's goal of restoring natural resources and services to baseline and compensating the public for interim losses resulting from the injury.

The trustees must consider a range of primary restoration actions, including natural recovery as well as active primary restoration actions. Active restoration may return natural resources and services to baseline more quickly than natural recovery, and consequently reduce the interim loss of services. Primary restoration actions include:

- natural recovery;
- actions to remove barriers or limitations that would prevent or delay return to baseline (e.g., control of residual sources of contamination);
- actions to restore the physical, chemical, and biological conditions necessary for recovery or restoration of the injured natural resources and services (e.g., replacement of sand or vegetation, or modifying hydrologic conditions); and/or
- actions focusing on natural resources and services upon which the injured natural resources and services depend, thereby facilitating the restoration of baseline conditions (e.g., replacing essential species, habitats, or services that would facilitate the restoration of other, dependent natural resource and service components).

2.4 Concept of Scaling Compensatory Restoration Actions

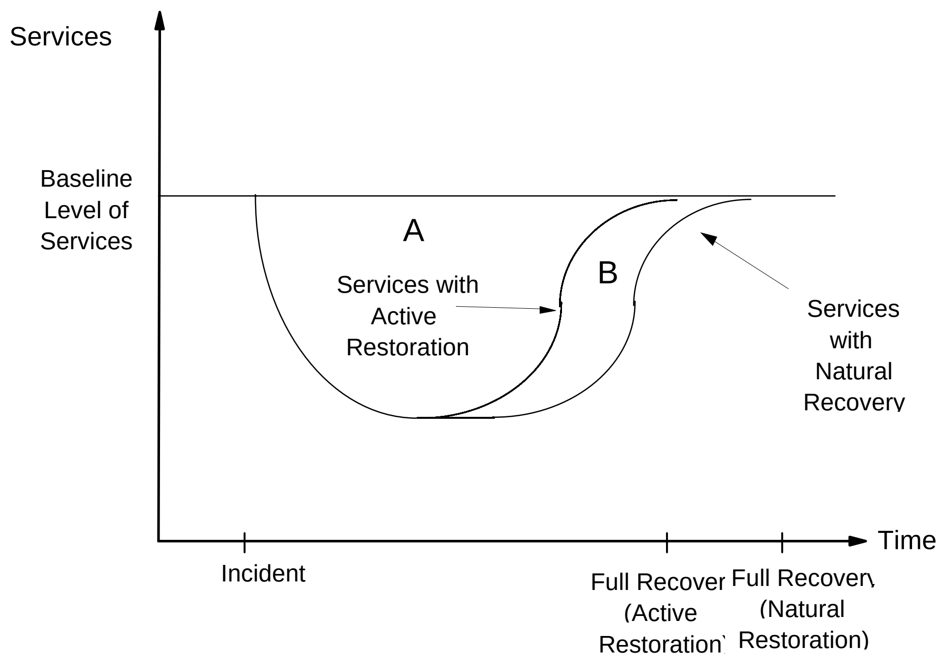
Exhibit 2.3 illustrates the concept of scaling compensatory restoration actions. The upper graph characterizes the level of services provided by an injured natural resource. The lower graph characterizes the increase in services provided by a compensatory restoration action. Time is represented on the horizontal axis and the level of services is represented on the vertical axis.

First consider the upper graph. The horizontal line labeled "baseline" indicates the baseline level of services.[18] After the incident occurs, the level of services declines. In the case depicted, services recover to baseline at some point in the future with natural recovery (no human intervention); however, services recover to baseline more quickly with active restoration.

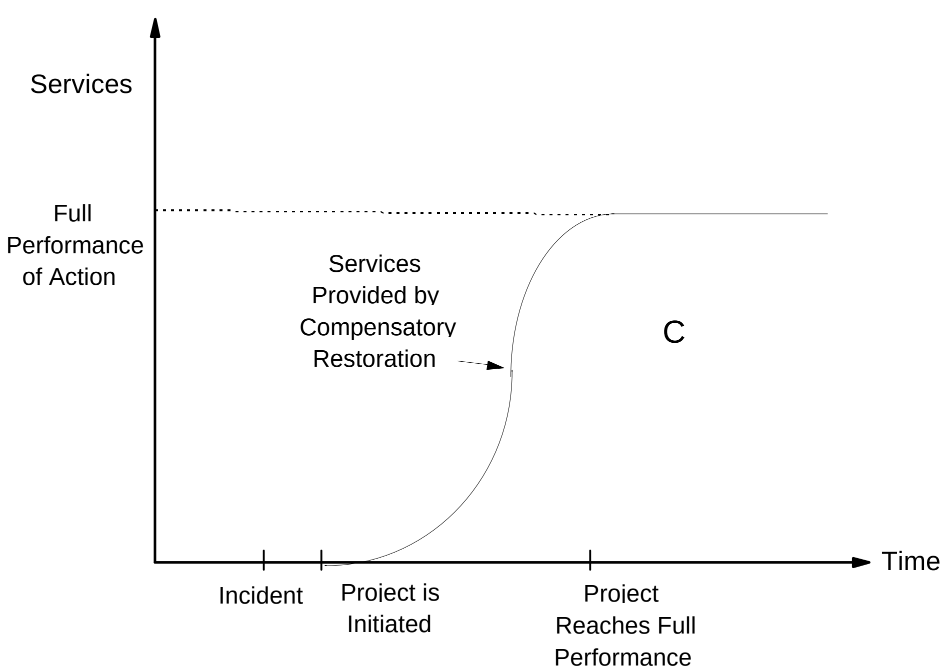
[18] The straight line representing the baseline level of services in Exhibit 2.3 is merely a simplification. The baseline level of services may follow different patterns over time.

EXHIBIT 2.3: PRIMARY AND COMPENSATORY RESTORATION

Level of Services Provided by Injury Site



Services Provided by Compensatory Restoration Action



The choice of primary restoration action(s) will affect the extent of interim natural resource and service losses that must be addressed by a particular compensatory restoration action. If no active primary restoration were undertaken in this context, the combined areas A and B would represent the total loss from the time of injury until the return of the natural resources to baseline. However, active primary restoration actions would accelerate the recovery and reduce the interim losses by the amount represented in area B. Under this scenario, the compensatory restoration action(s) would need to compensate for the loss of area A.

In the lower graph, area C represents the gain in resource services from a compensatory restoration action of a given scale. The trustees need to determine the appropriate scale of the compensatory restoration action, such that the services it provides compensate for the interim losses associated with the injury. With the active restoration action illustrated in the upper graph, the public would be compensated if the value to the public of area C equals the value to the public of the loss of area A.[19] Alternatively, with natural recovery, the public would be compensated if the value to the public of area C equals the value associated with the loss of areas A and B.[20]

2.5 Decision-Making Framework for Scaling Restoration Actions

This document outlines a decision-making framework for selecting approaches (resource-to-resource/service-to-service or valuation) and methods for scaling compensatory restoration actions.

The five steps in the decision-making framework are:

(1) Review preliminary restoration objectives generated in the early stages of the injury assessment process;

(2) Construct an inventory of possible restoration actions;

(3) Classify restoration actions according to type, quality, and value of natural resources and services provided by the action relative to lost natural resources and services;

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[19] Note that if lost and restored services are of equal value per unit of services, then the public is compensated when area C equals the area representing interim lost services. However, if lost and restored services are not of equal value per unit, then the result doesn't hold. For example, if the value per unit of restored services is less than the value per unit of lost services, then area C must be larger than the area representing interim lost services to compensate the public.

[20] Strictly speaking, the public is compensated when the *discounted* sum of the lost values during the injury period is equal to the *discounted* sum of the value of the restored services during the project lifetime. Discounting is discussed in section 2.2.3 and in Appendix C.

(4) Select an approach(es) and method(s) to scale primary restoration actions to return injured natural resources and lost services to baseline, and design studies to collect the necessary data; and

(5) Select an approach(es) and method(s) to scale compensatory restoration actions to compensate the public for the interim loss of natural resources and services, and design studies to collect the necessary data.

Each of these five steps is discussed below.

(1) Review preliminary restoration objectives generated in the early stages of the injury assessment process

The starting point in identifying restoration goals is to assess lost or impaired natural resources and the ecological and human services they support. The early stages of the injury assessment provide the following information that helps the trustees formulate preliminary restoration objectives:

- a preliminary identification of natural resources and services that have been injured or lost; and
- a preliminary identification of the degree, and spatial and temporal extent of injury, including an evaluation of the potential natural recovery period.

With this information, the trustees may define restoration objectives in terms of specific natural resources and services to be restored or replaced.

(2) Construct an inventory of possible restoration actions

The goal of this step is to identify a range of primary and compensatory restoration actions that address restoration objectives; restoration alternatives comprised of one or more of these actions will be evaluated in the Draft Restoration Plan. The preliminary identification of primary and/or compensatory restoration actions provides a useful starting point in the early stages of the injury assessment process. Section 3.2 discusses the identification of restoration alternatives.

(3) Classify restoration actions according to type, quality, and value of services provided by the action relative to lost services

This step involves classifying restoration actions by whether or not they provide services of the same type and quality,[21] and of comparable value, to the services lost due

[21] Each natural resource or service can be described as a suite of characteristics: quality refers to the multidimensional description of these attributes of the service. Section 2.2.2 and Appendix C describe how values of services depend on quality.

to the injury. The four possible outcomes of the classification process, starting with the highest priority class, are:

Class I.	Same type, same quality, and comparable value;
Class II.	Same type, same or different quality, and *not* of comparable value;
Class III.	Comparable type and quality; and
Class IV.	*Not* of comparable type and quality.

The process of classifying actions by type, quality, and value serves two purposes. First, classification forces a ranking of the restoration actions. The regulations place a priority on compensatory actions that provide services of the same type, quality, and comparable value to those lost (i.e. Class I). However, if trustees cannot identify sufficient restoration actions of the same type and quality and comparable value to provide a reasonable range of alternatives, they may identify actions that provide natural resources and services of comparable type and quality as those injured. Second, the classification of an action is an important consideration in the selection of a suitable approach for scaling restoration actions.

Chapter 3 covers classification of compensatory restoration projects in greater detail.

(4) Select an approach(es) and method(s) to scale primary restoration actions that return injured natural resources and lost services to baseline, and design studies to collect the necessary data

For primary restoration actions, the "scaling" question is: what scale of a primary restoration action is necessary to return the stock of natural resources and their service flows to baseline levels in a timely manner? The scaling analysis considered in this document is most relevant to primary restoration actions involving replacement and/or acquisition of equivalent natural resources and/or services. Consideration of scaling primary restoration actions designed to restore the physical, chemical, and/or biological conditions necessary to allow recovery of injured natural resources, for example modifying hydrologic conditions at the injury site, is beyond the scope of this guidance document.[22]

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[22] However, the scaling analysis considered in this document is also relevant for scaling primary restoration actions involving replacement and/or acquisition of equivalent resources and/or services. For a complete discussion about evaluating primary restoration actions, see *Primary Restoration, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990* , National Oceanic and Atmospheric Administration - Damage Assessment and Restoration Program, 1996. These topics are covered in separate guidance documents due to the difference in goals of primary and compensatory restoration. (See section 1.4.2.2(a) and the Glossary for the difference between primary and compensatory restoration.) The purpose of the guidance document on primary restoration is to inform

Once the scale of a primary restoration action has been identified, the trustees then can quantify the extent and duration of injury that is expected to occur, if that primary restoration action were implemented. The quantification of interim losses, conditional on implementation of a specific primary restoration action, is an output of this process and an input into the analysis of compensatory restoration actions to be linked with that primary option.

(5) Select an approach(es) and method(s) to scale compensatory restoration actions that compensate the public for the interim loss of natural resources and services, and design studies to collect the necessary data

For compensatory restoration, the "scaling" question is: what scale of a compensatory restoration action is necessary to compensate for the interim loss of natural resources/services from the time of injury until full recovery? The process of "scaling" a project involves adjusting the size of a restoration action to ensure that the present discounted value of gains from the action equals the present discounted value of interim losses from the injury.

Scaling Approaches and the Process of Choosing an Approach

Once a restoration action is classified, a preliminary choice of approach can be made based on that classification. The two major categories of scaling approaches are the resource-to-resource/service-to-service approach and the valuation approach, as described below. Both approaches frame the scaling question in terms of what trade-offs exist between services lost due to the injury and services to be provided by potential compensatory restoration actions. However, the valuation approach is based on quantitative estimation of the trade-offs people make between the injured and restored services, whereas the service-to-service approach is based on simplifying assumptions about these trade-offs.[23] When applying the service-to-service approach, the trustees should identify explicitly their logic for using the simplifying assumptions about the service trade-offs.

Resource-to-Resource or Service-to-Service Approach: Resource-to-resource or service-to-service scaling is an approach in which the appropriate quantity of replacement natural resources and the services they provide is determined by obtaining equivalency between the quantity of discounted services (or resource proxies) lost due to the injury and the quantity of discounted replacement services (or resource proxies) provided by

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trustees' decisions regarding primary restoration evaluation, planning, and implementation by reviewing state of the art information on various restoration techniques.

[23] The label "valuation approach" does not necessarily imply that the data collected to quantify the trade-offs will be in dollar value terms – as stated in the regulations, "value" may be determined in a variety of units of exchange, including units of natural resources or dollars.

compensatory actions. We simplify the terminology by referring to the approach as *service-to-service* for the remainder of the document.[24]

The implicit assumption of the service-to-service approach is that the public is willing to accept a one-to-one trade-off between a unit of services lost due to injury and a unit of services gained due to the restoration project. This does not necessarily imply a one-to-one trade-off in *resources* because, for example, the service flow per acre of tidal wetlands in one area (e.g., the injury site) may be greater than, or less than, the service flow per acre of tidal wetlands in another area (e.g., the replacement site). Rather, the trade-off is one-to-one in the units of key services provided by the lost and replacement resources (see Section 4.2 for further discussion of this point). The assumption of a one-to-one trade-off in services may be applicable when, in the judgment of the trustees, the proposed restoration action provides services of the same type and quality, and of comparable value as those lost due to the injury (and consequently is classified as Class I). Indeed, when actions are classified as Class I, the OPA regulations indicate the trustees must consider the service-to-service approach.

Valuation Approach: When impaired and replacement services are of different type, quality and/or value, the assumption of a one-to-one trade-off between units of services does not hold. When the one-to-one trade-off assumption is not appropriate, and restoration actions are classified as Class II or III, trustees are to consider collecting data on acceptable trade-offs using the valuation approach. The valuation approach allows for a variety of economic methods to determine the present discounted value of gains from the proposed actions as well as the present discounted value of the interim losses. In the preferred version of the valuation approach, referred to as ***value-to-value***, scaling a project involves adjusting the size of a restoration action to ensure that the present discounted value of service increases equals the present discounted value of the interim losses.

With the ***value-to-cost*** variant of the valuation approach, the compensatory restoration actions are scaled by equating the cost of the restoration actions to the value of losses due to the injury. Trustees may use this approach if they determine that the valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time frame or at a reasonable cost (see Sections 4.2 and 4.4).

The valuation approach relies on the concept that lost value can be determined using one of a variety of possible units of exchange, including units of natural resource services or dollars. For example, some stated choice methods, such as conjoint analysis, are flexible enough to elicit trade-offs between lost and replacement services in terms of dollars or in terms of natural resource services.

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[24] The choice of simplified terminology reflects that the goals are not only to ensure that the same or comparable types of resources are provided (accomplished through the selection of compensatory actions for evaluation), but also to ensure that the replacement resources provide a sufficient quantity of the same or comparable services as those lost.

Criteria for Selecting a Scaling Approach

The selection of a scaling approach is made concurrently with the selection of methods and data sources for implementation of the approach. The choice of scaling approach and methodology depends upon an evaluation of three sets of criteria:[25]

- *Applicability* of the approach and methods in the particular context;
- *Reasonableness of the incremental costs* of a more complex approach and/or methods, relative to the expected increase in the quantity and/or quality of relevant information; and
- *Validity* and *reliability* of the approach and the methods to implement it in the particular context.

The process for evaluating methods and approaches based on these criteria is presented in Chapter 4.

Once an appropriate approach and method(s) are found, the scaling can be implemented. If no approach or method appears appropriate, even after reconsidering the classification of restoration actions, trustees should reevaluate the assessment.

The selection of scaling approaches and methods and the selection of injury assessment methods should be made interactively.[26] Quantifying recovery from primary restoration actions and/or quantifying services gained in compensatory restoration actions may be performed more cost-effectively in conjunction with injury studies. Also, the scaling of portions of a primary restoration action may be conducted jointly with the scaling of a compensatory restoration action, particularly if the activities are the same (e.g., planting a degraded wetland area).

[25] The OPA regulations at §990.27 state that any assessment procedure used by trustees must meet these criteria.

[26] See *Injury Assessment, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1996 for a discussion of the injury component of restoration planning.

3.1 Introduction

This chapter focuses on the decision-making process for classifying restoration actions. The goals of this stage are to: (1) identify a range of restoration alternatives, each of which combines primary and compensatory actions; and (2) classify actions according to type, quality, and value of natural resources and services they provide relative to the natural resources and services lost due to injury (see Exhibit 2.1 in the previous chapter for a flow chart of the assessment process).

3.2 Identifying Restoration Alternatives

To identify restoration alternatives, the trustees may consult a variety of sources to ensure that they consider a comprehensive set of actions. Available sources include planning/management agencies and the general public.[27] Most states have agencies specifically focused on the planning and management of natural resources or recreational opportunities. Often, these agencies work in coordination with other federal, state, regional, or local agencies in the planning and management process. These agencies may have already developed regional natural resource or recreation plans that can provide a ready source of restoration actions to consider. Such plans are frequently developed in coordination with local university experts or consultants, who may represent another source of information.

Involvement of the general public can provide the trustees and responsible parties a direct source of information about the public's preferences for restoration actions and the quality attributes of natural resources and services. In addition, the public may provide ideas for specific projects to meet restoration objectives.[28]

The first steps in the restoration selection process are to review preliminary restoration objectives from the injury process and then to identify possible restoration actions/projects. The statute requires trustees to "...develop and implement a plan for the restoration, rehabilitation, replacement, or acquisition of the equivalent, of the natural resources under their trusteeship."[29] Consequently, when selecting compensatory

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[27] See *Primary Restoration, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1996 for a discussion of technical feasibility, efficacy, and costs of restoration actions. Though the purpose of the document is to provide guidance suitable to the design and selection of actions to restore injured resources to baseline, the same type of actions may be appropriate for compensatory restoration.

[28] Public involvement is addressed in: *Restoration Planning, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1996.

[29] 33 U.S.C. 2706(c)

restoration actions, trustees must demonstrate a nexus between the injured natural resources and lost services and the natural resources and services provided by the restoration actions.

Further, each restoration alternative must be designed so that, as a package of one or more actions, the alternative would satisfy OPA's objective to restore natural resources and services to baseline and compensate for the interim losses resulting from an incident. Incident-specific restoration objectives are developed by identifying the key characteristics and quality attributes of the natural resources and services lost due to the incident. This information is generated in the injury assessment process.

Under the OPA regulations, restoration actions determined to be technically infeasible or not in accordance with applicable laws, regulations, or permits may not be included among the alternatives under consideration in the Restoration Plan. Actions previously mandated to meet pre-existing legal obligations - independent of the injury - also may be considered unsuitable for inclusion in a Restoration Plan, if their inclusion would not provide a net increase in natural resources and/or services. An example of a previous obligation would be an action already required under a section 404 (Clean Water Act) permit. Further, actions that are not likely to achieve the restoration goals are unsuitable and should be eliminated from further consideration.

The OPA regulations identify criteria for selecting a preferred restoration alternative from the alternatives under consideration. See section 1.4.2.2 (c) for a partial listing of these criteria. These criteria should be used, along with incident-specific restoration objectives, to guide the development of restoration alternatives. Trustees may decide to add to these criteria, depending on applicable laws, regulations, or other site-specific or case-specific requirements.

While the goals of primary and compensatory restoration are distinct, the primary and compensatory restoration actions may involve the same type of restoration action on contiguous sites (e.g., planting of seagrass at a site where the seagrass has been destroyed by a grounding as well as at an adjoining site, for compensatory restoration).[30] Alternatively, they may involve different restoration actions at different locations (e.g., natural recovery at a wetland injury site and wetland creation at the compensatory site).

In general, compensatory restoration actions preserve or enhance the quantity, quality, and/or availability of the same or comparable type of natural resources as those lost; at the same time it is essential to ensure that the resources provide the same or comparable services as those lost. In natural resource damage assessments, a service is not to be viewed as an abstract activity that may be restored independently of the natural resources from which the service flows. However, trustees may consider actions to improve access to

[30] The actions may also take place at the same site. For example, if baseline conditions at an injured site are somewhat degraded, with further degradation resulting from the incident, it may be appropriate to implement a restoration alternative that returns services beyond the (degraded) baseline, thus achieving both primary and compensatory restoration.

natural resources. For such actions, the trustees must evaluate carefully the direct and indirect impacts of the improved access on natural resource quality and productivity.

3.3 Classifying Restoration Actions and Selecting Service Measurement Procedures

Projects are classified by whether or not they provide services of the same type and quality and of comparable value to the services lost due to the injury. The classification criteria are different than the selection criteria discussed in section 1.4.2.2(c). The classification criteria are useful in determining which restoration actions should be scaled. The selection criteria are used to select a preferred alternative from among the scaled restoration *alternatives*.

The four possible outcomes of the classification process, starting with the highest priority class, are:

Class I. Same type, same quality, and comparable value;

Class II. Same type, same or different quality, and *not* of comparable value;

Class III. Comparable type and quality; and

Class IV. *Not* of comparable type and quality.

The crux of classifying restoration actions is to evaluate how well the injured natural resources and services match the replacement natural resources and services on key characteristics and quality attributes.[31] Even when the proposed action provides the same type of natural resources and services, a variety of substitutions (in time, space, species, etc.) may be unavoidable. The result will be differences - in quality, in economic value, and in people who experience the service losses and those who experience the gains provided by the restoration actions.

Some proposed substitutions may be inconsistent with restoration objectives, making the project(s) unsuitable for consideration. Consider a case in which wild salmon stocks are eliminated in the upper reaches of a river and the restoration goal is to restore endangered wild fish stocks. A proposal for annual stocking of hatchery salmon, with no plan to achieve a naturally self-sustaining population, generally will not provide fishery services comparable to those lost. Compared to hatchery salmon, wild salmon yield a higher quality fishing experience, and support other services besides put-and-take fishing,

[31] For a detailed discussion and bibliography of citations pertaining to the evaluation of habitat quality and service provision see *Using Ecosystem Assessment Methods in Natural Resource Damage Assessment*, prepared by Dennis King for National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1997.

including food web services (supporting production of other fish and bird species) and genetic diversity.

Other substitutions may be consistent with restoration goals, but may yield services of different type, quality and/or value than those lost. Due to substitutions and variation between injured and restored natural resources and services, projects lie on a continuum from same type and quality to different type and quality. Classifying projects requires trustees' judgment; thus, the classification scheme should be used as a guide.

Exhibit 3.1 presents questions to guide the classification of proposed restoration actions. Exhibit 3.2 illustrates how the answers to the questions map into the classes of actions. In sections 3.4 and 3.5, we discuss these issues within the context of beach closure and habitat injury examples, respectively.

Question A: **Same Type of Resources and Services?**

Question A in Exhibit 3.1 addresses whether the ***same types*** of natural resources and services, both on-site and off-site, are lost due to the injury, and gained from the proposed compensatory restoration action. Two judgments are required. First, trustees must identify the key services provided by injured natural resources at baseline. See Exhibit 2.2 (in Chapter 2) for examples of ecological services provided by wetland ecosystems, and the associated on-site and off-site human services that the ecological services potentially support (the list is illustrative, not exhaustive).[32]

Second, trustees must determine whether the action may increase site *capacity* to provide the same type of services at the proposed site for a restoration action. However, an increase in capacity to provide services does not necessarily result in an increase in services provided. Trustees must evaluate whether the features of the landscape context at the restoration site suggest that the *opportunity* to provide the same type of services exists. Consider a case in which contamination of a wetland impairs its capacity to enhance water quality, which in turn had supported downstream water-based recreational uses. Assuming a proposed wetland project has the capacity to enhance water quality, based on its on-site ecological attributes, trustees need to address whether there are opportunities for improvements in water quality to have a positive impact on downstream water uses. For example,

- Are there uses downstream of the proposed restoration site that will benefit, such as fin fish spawning habitat or shellfish beds?

[32] Note that if the injury quantification includes both ecological and human service losses from injuries to a specific resource, care must be taken to avoid double-counting for that resource injury. However, we observe that trustees often focus on quantifying the ecological service losses from a resource injury because the related human uses occur off-site and/or they are difficult to quantify.

Exhibit 3.1: Decision framework for determining comparability of service type, quality, and value

A. ***Are the natural resources and services - both on-site and off-site - that are increased or enhanced by the action of the same type as those lost?***

- *Ecological services* include: hydrological (floodwater storage, pollutant trapping), habitat/production (nutrient cycling, primary and secondary productivity)
- *Human services* include: recreational, commercial, cultural/historical, and passive use services.

1. Do the replacement resources have the *capacity* to provide the same type of services as those that were lost?
2. Do the replacement resources have the *opportunity* to supply the same type of services as those lost? Will humans have demand for additional services?
   > i.e., will the action increase public value *either* by increasing the quantity of uses (services) *or* by enhancing the quality (or reducing cost of access) of current uses?

*If **yes to both 1. and 2.**, go to Question B. If **no to either**, go to Question AA.*

AA. ***Are the natural resources and services that are increased or enhanced by the restoration action of a comparable type and quality as those lost?***

*If they are similar or complementary to those lost, the actions are likely to be of comparable type and quality: **Class III.** If **no,** the action is likely to be **Class IV** and may be unsuitable for inclusion in Restoration Plan.*

B. Are the services provided of the same quality as those lost?

1. Does the metric that characterizes services at both injury and replacement sites incorporate differences in quality between sites?

- *Quality factors of ecological services:* natural resource density, genetic diversity, species diversity, and water, land, or air pollution levels.
- *Quality factors of human services:* access costs, diversity of activities, congestion, isolation, level of development, genetic and species diversity, and water, land, or air pollution levels.

2. If not, can the metric be adjusted to capture quality differences?

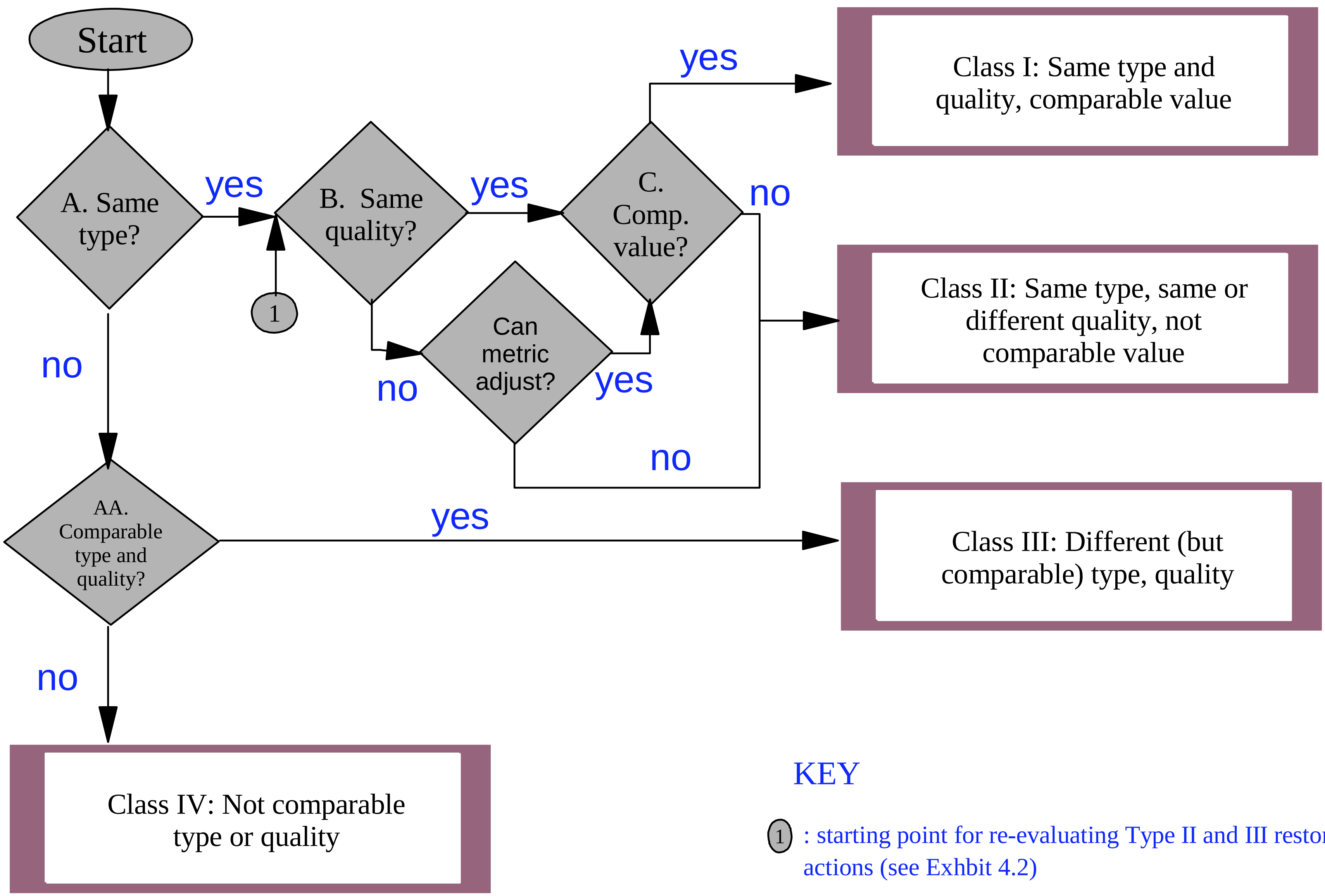
*If **yes to either**, actions may be classified as same quality, Go to Question C.*
*If **no to both,** actions are same type, comparable quality: **Class II.***

C. Are compensatory restoration action services of comparable value to lost services?

1. Are the changes in aggregate supply and demand over the period of injury and the period of service replacement small enough that the value of the last unit of services provided and the last unit injured is comparable (and thus neither shortages nor satiation become a significant factor)?

*If **yes**, actions may be of comparable value: **Class I.***
*If **no**, actions are not of comparable value: **Class II.***

Exhibit 3.2: Classifying Restoration Actions



KEY

(1) : starting point for re-evaluating Type II and III restoration actions (see Exhbit 4.2)

- Do the downstream habitats support human recreational or commercial uses?
- Are there downstream locations suitable for water-based recreational uses, such as swimming or sailing?
- Are pollutant loadings downstream sufficiently small that any enhancement of the water quality upstream will not be effectively negated?

*If trustees answer yes to the questions, identifying the natural resources and services to be of the same type, they move on to **Question B**. Otherwise, they turn to **Question AA**.*

Not Same Type - Question AA: Comparable Type and Quality?

When proposed restoration actions do not provide natural resources of the same type as those injured, trustees consider Question AA in Exhibit 3.1: are the natural resources and services that are provided by or enhanced by the proposed action of comparable type and quality to those injured? Natural resources and services that are similar or complementary to the injured natural resources and/or services may be classified as "comparable type and quality."

For example, consider a beach injury that impairs sandy shoreline and water resources, resulting in lost beach use. Suppose that a compensatory restoration action creates an off-shore reef for recreational snorkeling and fishing. This action would expand the range of water-based recreation services supported at the site, complementing the services already available. This replacement natural resource does not provide the same type of services, but the services might be considered of comparable type and quality to the injured natural resources and services. The determination ultimately requires the trustee to exercise judgment.

*If trustees determine that the proposed restoration action will provide natural resources and services of comparable type and quality as those injured, the action is classified as **Class III**.*

In some cases the proposed actions may provide natural resources of arguably the same "type," but the range and quality of services provided by the natural resources are not comparable and are not consistent with the restoration goals identified by the trustees. An example of this is found earlier in this chapter. In that example, trustees would stock hatchery salmon with no plan to achieve a naturally self-sustaining population. If a specific restoration goal is the restoration of endangered wild fish stocks, this project could be unsuitable because services associated with hatchery salmon are not comparable to services associated with wild salmon. A critical factor in determining unsuitability is lack of consistency with restoration goals articulated by trustees for primary and compensatory restoration actions.

Alternatively, if trustees determine that the proposed restoration action will provide natural resources and services that are neither the same type (the answer to Question A is "no") nor of comparable type and quality (the answer to Question AA is "no") as those injured, the proposed action is classified as ***Class IV****.*

With classification as ***Class IV***, the action may not be suitable for inclusion in the Restoration Plan.

Same Type - Question B: Same Quality?

For natural resources and services of the same type as those lost, Question B addresses whether the natural resources and services are also of the same quality. Judging whether a restoration action is of the same quality builds on the identification (from Question A) of key services provided by injured resources and the quality attributes of the resources and services. Each natural resource or service can be described by a suite of quality characteristics, which influence the economic value. For example, the quality of a beach to beachgoers (i.e., the characteristics that may be important to them) encompasses water quality, congestion, and the range of recreation opportunities, among other characteristics of the beach. Trustees are to compare the injured natural resources and/or lost services to the restored natural resources or services with respect to the quality (and cost) attributes that are relevant to the support of ecological and human services.

In order to compare type and quality of services from the injury site and the site of compensatory restoration, trustees must select a metric (or an index of metrics) to quantify services. We highlight three issues related to the metric selection. First, trustees must decide whether they will measure services directly or with proxies. If proxies are employed, trustees need to evaluate carefully the relationship between the proxy metric and service levels - it may not be a simple linear relationship. For example, consider the case where the ecological services of concern are primary and secondary productivity.[33] Stem (vegetation) density may serve as a resource-based proxy measure for primary productivity, but the relationship between stem density and productivity may not be a simple linear relationship, particularly for secondary productivity. In many cases a minimum threshold of stem density must be met before observable secondary productivity gains occur; and there may be another threshold of stem density at which productivity gains per unit of stem density may decline at an increasing rate.

Second, trustees need to evaluate whether the relationship between the key services and the resource proxy is the same at the injury site and the replacement project site. The relationships may well be different, due to differences between the sites in biophysical and landscape attributes and/or due to limitations of the restoration technologies. Return to the example in the previous paragraph. The relationship between productivity and its proxy measure, stem density, may vary between the injury and replacement project sites due to differing water quality or elevation of the sites. Assuming

[33] We refer to vegetation and production from lower trophic levels as primary productivity; secondary productivity includes production from higher trophic levels that feed on primary production.

trustees can characterize the relationships between stem density (the resource proxy) and service levels of primary and secondary productivity for both the injury and replacement project sites, the analysis can be conducted in terms of service levels (as determined from data on the resource proxy) at the injury and replacement project sites.

The third issue associated with the metric selection is that any metric is likely to incorporate some, but not all, dimensions of quality. Thus, when comparing lost and restored natural resources and services, one is only considering those dimensions captured by the chosen metric. If trustees determine that quality - as captured by the selected metric - is different between injury and restoration sites, it may be possible to adjust the metric or to choose a different metric to capture the quality differences.

Can Metric Adjust for Quality Differences?

For example, if the site of a restoration action to replace lost beach services has the same quality attributes as the injured beach site but is substantially farther away for most users, then the (net user-day) value should be lower for those users.[34] Or, consider the case where one of the proposed restoration sites has a diversity of on-shore or off-shore habitat (sand dunes, off-shore reefs, seagrass beds, etc.) providing a range of recreational activities (bird watching, snorkeling, fishing, etc.), and the other site has only sandy beaches. If all other quality attributes were equal between the two sites, the site with a wider range of habitat and recreational opportunities is likely to have a higher value for an additional beach trip. Using valuation methods, trustees may calculate an adjustment factor to capture the greater relative value of the higher quality/lower cost sites.

Alternatively, consider a wetland example. Some projects may enhance the quality of tidal wetland habitat, without increasing the total area of the habitat. The enhancements may increase the per-unit (e.g., per-acre) capacity of existing wetland to provide ecological and human services. With a metric that can measure per-acre service levels at sites of differing quality (and incorporates quality differences in the services as well as quality differences in the habitat resource), the level of baseline services per acre from the injury site can be used as a unit of measure. The increase in per-acre service levels at the restoration site can then be represented as a percentage of the per-acre service levels at baseline for the injury site.

Same Type and Quality - Question C: Comparable Value?

If projects provide services of the same type and quality as those lost, trustees answer Question C. This question guides the assessment of whether the simplifying assumption that the lost and restored services are of comparable value is reasonable by directing attention to two potential causes for non-comparable values: differences in the

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[34] Net user-day value (or consumer surplus) will be lower because it equals total trip value minus travel costs for trip, and travel costs will be higher at the new site.

aggregate supply or demand conditions.[35] Evaluating the possible differences requires trustees' judgment, because the restored services and the future aggregate supply and demand conditions are not observable when compensatory restoration actions are being classified.

Note that the simplifying assumption that services are of comparable value can be supported for services of the same type and quality and that are found under similar conditions of aggregate supply and demand. However, if the services provided by a restoration action are of a different type than the lost services, then the assumption of comparable value, without additional data collection, may not be justified because the key characteristics and quality attributes of the restored services are not the same as those lost due to injury.[36] Likewise, if the services provided by a restoration action are of the same type, but are not of the same quality, the assumption of comparable value may not be justified without further data. This is because the quality attributes, which determine value per unit of service (see Section 2.2.3 or Appendix C), are different at the injury and restoration sites. Thus, actions classified as Class II or III, where either type or quality are comparable rather than the same, are *not* assumed to be of comparable value without further data.

To answer Question C, we must determine whether the aggregate supply and demand conditions for the natural resources and services are sufficiently similar over the period of injury and the period of provision of services by the replacement project that the value of the last unit of services provided in each period is constant. During the injury period, the supply of services is decreased relative to baseline; throughout the lifetime of the restoration project, supply is increased relative to baseline. For a given level of aggregate demand, substantial differences in aggregate supply may lead to differences in the value of services due to shortages when injury decreases supply or satiation when restoration actions increase supply, even where the quality of services is the same at the injured and replacement project sites. Likewise, changes in demand conditions may lead to shortages or satiation and thus to differences in the service values.

For example, comparing services of the same type and quality, but found under different supply and demand conditions, is like comparing the value of additional water when water is in abundant supply with the value of additional water during a period of water shortage.[37] The loss in value per gallon of water from an incident that creates a

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[35] Demand conditions may be different due to changing preferences or population levels for potential users of the service, or due to differences in the aggregate supply conditions (in terms of both quantity and quality) of services that people may substitute for the type of service that has been injured. For more information on the effects of substitutes on the value of a service see Appendix C, particularly pages C-4 - C-7.

[36] By analogy, of course it is not impossible that the values of an apple and an orange (fruits of different types) are equal, but data collection and analysis are necessary to make this determination.

[37] We assume the quality of water is the same across the different supply conditions.

water shortage may be substantially greater than the increase in value per gallon of water from compensatory water-enhancing projects once response or primary restoration actions have returned water levels to baseline conditions of abundance.

Or consider a recreational context, in which the closure of hiking trails in a wildlife refuge due to oiling results in a substantial loss of use. If demand for hiking was fully satisfied by the original quantity of trails, a compensatory restoration action to add more hiking trails after the oiled trails are reopened will not add much additional value.

The smaller the injury and restoration action(s), the less likely it is that the change in aggregate supply of natural resources is significant, and consequently the less likely that the value of the last available unit of natural resources and services will change. However, there may still be significant changes in aggregate supply and demand due to other factors, such as the condition and availability of substitutes, that may cause the values to differ. The greater the willingness to accept substitutes over space and time for the lost services, the less likely is any change in value (see Appendix C, particularly pages C-4 - C-7, for a further discussion of these concepts).

When assessing whether the values of services at the injured and restoration sites are comparable, one must consider the effects of substitute sites. If the public substitutes for the lost or impaired natural resource services with services from an uninjured site, then the economic value of losses will be lower than if there had been no substitution. Similarly, if substitutes exist for the services provided by the restoration action, then the economic value of gains will be lower than if there were no substitutes. The analytically correct treatment of substitutes in formal demand modeling and the calculation of consumer surplus from quality changes is well established in the literature.

*If trustees determine that the proposed restoration action will provide natural resources and services of the same type and quality and of comparable value as those injured, the proposed action is classified as **Class I**.*

*If the lost and replacement services are of the same type but the values are not comparable because of differences in aggregate supply and/or demand, then the proposed action is classified as **Class II**.*

As noted earlier, the OPA regulations place a priority on compensatory restoration actions that provide natural resources and services of the same type and quality, and of comparable value to those lost or impaired due to the injury (Class I). Only in the case of Class I actions is it appropriate to make the simplifying assumption of a one-to-one trade-off between lost and replacement services without collecting data on the trade-offs accepted by the public. This result is critical to the selection of a scaling approach - the subject of Chapter 4.

In the following sections, we provide examples of alternative compensatory restoration actions designed to compensate for two different types of injury: beach closure and marsh habitat injury. These examples illustrate the decision-making process of classifying actions by the type and quality of natural resources and services they provide relative to those lost. The questions presented in Exhibit 3.1 guide the classification of these actions. The examples are simply illustrative and are not intended to present necessary or sufficient conditions for classifying actions.

3.4 Beach Closure Example

3.4.1 Key Attributes of the Beach Closure Injury

Consider a hypothetical vessel grounding and oil spill that occurred just off-shore from Flamingo Beach, a seven-mile long crescent-shaped beach north of Beach City. Rocky shoreline occurs at both ends of the sandy beach. See Exhibit 3.3 for an illustration of the site. The spill contaminated Flamingo Beach and the two-mile long Barracks Beach, just north of Flamingo Beach, resulting in the closure of each for three weeks. As a result of the closure, potential beachgoers lost the opportunity to use the beaches and water for sunbathing, beach volleyball, swimming, etc. Primary restoration was unnecessary because response actions returned the resources to baseline. Only after the beach was considered safe for human use was the closure lifted. Further, assume no continuing ecological service losses occurred.

Key quality attributes of the beach to evaluate in the comparison of injured and replacement natural resource services include, but may not be limited to:

- Water quality;
- Range and quality of recreational activities available (e.g., swimming, off-shore reefs for snorkeling);
- Quality and extent of access amenities (e.g., showers, bathrooms, picnic tables, food, beach-related paraphernalia);
- Diversity of habitat at beach (e.g., open beach, dunes, forested areas for cover);
- Congestion; and
- Proximity to potential users, relative to substitute sites with comparable attributes.

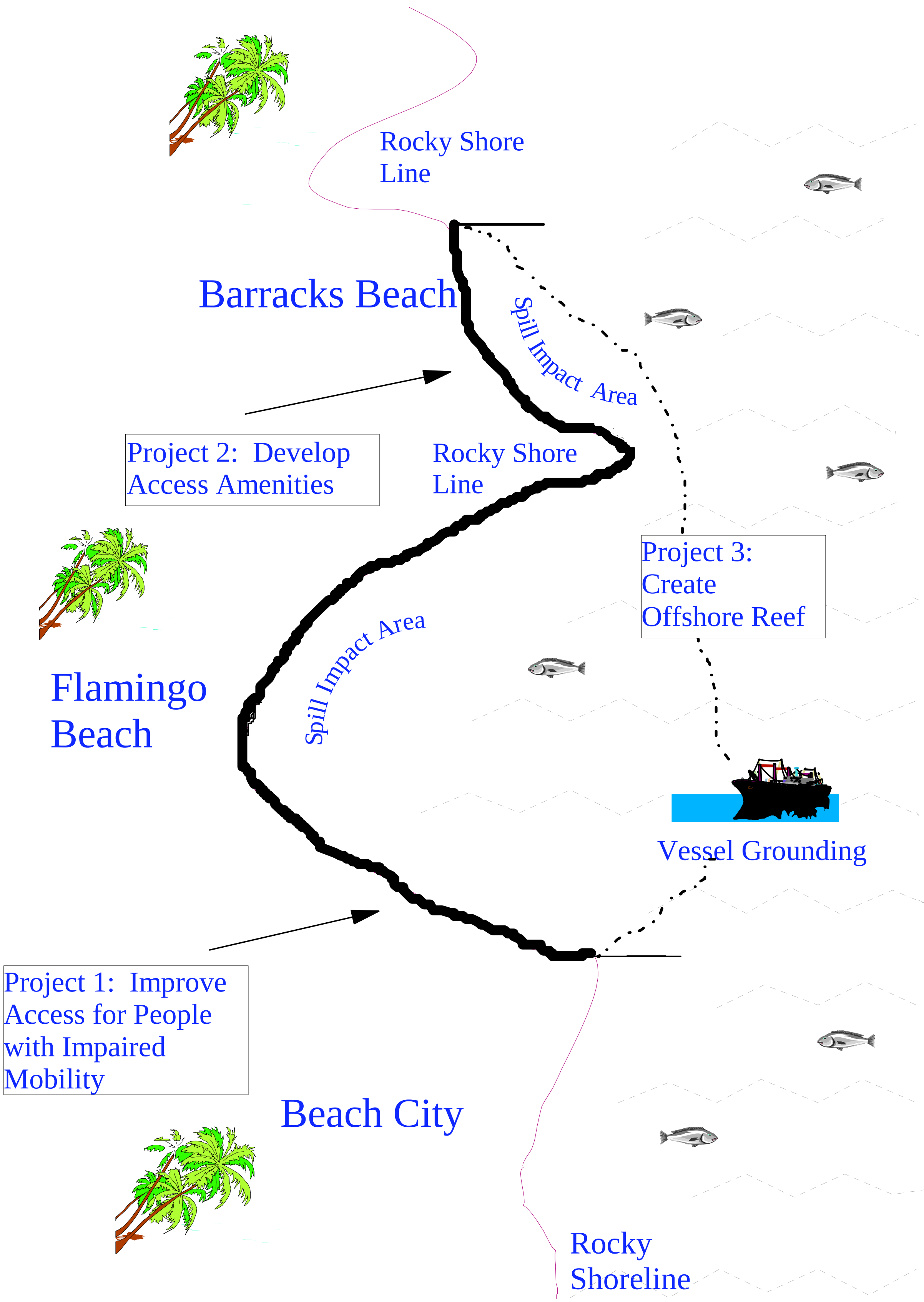
The nearest substitute beaches are 30 miles to the north (with rocky shorelines along the intervening coast) and 35 miles to the south (with the rocky, developed shoreline in between). Further, these substitute sites do not have the same diversity of beach habitat and range of access amenities as the oiled beaches.

The unit of services is beach user-days.

3.4.2 Classification of Compensatory Restoration Actions

Trustees have identified three possible compensatory restoration actions.

Exhibit 3.3: Map of Beach Injury and Proposed Restoration Sites



- Project 1 would improve access to Flamingo Beach for people with impaired mobility.
- Project 2 would develop access facilities (e.g., showers and picnic tables) at recently opened Barracks Beach which was previously restricted to military use.
- Project 3 would create reef habitat for snorkeling and recreational fishing use off-shore of Flamingo Beach.

Applying Exhibit 3.1 to Beach Injury: Comparing type, quality, value of natural resources and services at injury and restoration sites

Project 1: Enhance access to Flamingo Beach for people with impaired mobility (see Exhibit 3.3).

Question A: Will the project increase and/or enhance the same type of natural resources and services as those lost?

The project will not increase the quantity of beach *per se*, nor will it increase the number of access points. However, by enhancing access for individuals with impaired mobility, the project is expected to increase use at the site by increasing total beach trips of users in the region with impaired mobility.

Conclusion: Yes.[38]

Question B: Are the services provided of the same quality as those lost?

The increase in use is to occur at one of the closed beaches, so the quality of beach services will be the same as those lost in terms of water quality, range of recreational uses available, diversity of other habitat. If use were to increase substantially, congestion could occur, reducing the quality of the site. In this case however the expected increase in use is not expected to result in congested conditions.

Conclusion: Yes.

Question C: Are services provided by the compensatory restoration action of comparable value to lost services?

Beachgoers affected by the spill may have either substituted beach trips to other less preferred beaches or forgone the intended beach trips entirely. If the potential beachgoers

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[38] Some commenters on the draft of this document noted that these beach trips are not of the same type or quality as the lost beach trips. Under that interpretation, assuming the trips are of comparable type and quality as those lost, this project would represent a Class III restoration action.

did not go to the beach as a result of the spill, the appropriate comparison is between a beach day generated by creating access for people with impaired mobility and a beach day lost at Flamingo and Barracks beaches. To evaluate whether the types are of comparable value, trustees consider the relative quality and scarcity conditions at the injury and replacement project sites. In this context, quality is expected to be the same and the increase in services supplied is likely to be small relative to the total amount of beach opportunities in the area, thus the conditions for comparable value are probably met.

Alternatively, if potential beachgoers went to a less valuable substitute site as a result of the spill, the appropriate comparison is between the value of a beach day generated by creating access to people with impaired mobility relative to the reduction in value of a beach day due to the closures.[39] Generally these values will not be comparable.

Conclusion: Depends.

Project 2: Develop access amenities, including showers, picnic tables, and parking at Barracks Beach (see Exhibit 3.3). Previously part of a military base, the beach has only been open to public use since the base was decommissioned last year. A limited number of access amenities currently exist at the site.

Question A: Will the project increase and/or enhance the same type of natural resources and services as those lost?

The project will not increase beach resources *per se*, but will improve the quality of beach use for potential users of Barracks Beach. The addition of facilities may draw additional beach use to Barracks Beach; however, it is likely that the increase in user days at Barracks Beach will be primarily from users switching from another site to Barracks Beach, rather than from a net increase in regional beach use.

Conclusion: Yes.

Question B: Are the services provided of the same quality as those lost?

By adding access amenities, the project will only enhance the quality of beach services, relative to those lost, at Barracks Beach.

Conclusion: Probably not.

Question C: Are compensatory restoration action services of comparable value to lost services?

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[39] It should be noted, however, that a study that correctly incorporates substitutes in estimating the value of a beach day may present the final results in terms of a single average value for a beach day for people who would have gone to a substitute beach as well as those who would have foregone a beach trip.

In contrast to Project 1, which most likely will increase regional beach use, Project 2 is expected primarily to result in substitution to Barracks Beach from other beaches. However, the determination of comparable value is difficult for both projects without knowing whether the spill induced potential beachgoers to forgo beach trips, or to go to a less valuable substitute site. If the potential beachgoers did not go to the beach, the appropriate comparison is between the value of a beach day with the improved beach amenities, relative to the value of a (lost) beach day at Flamingo and Barracks beaches. Generally these values will not be comparable.

Alternatively, if the potential beachgoers went to a less valuable substitute site as a result of the spill, the question becomes: is the loss in value due to the substitution of beach sites comparable to the increase in value due to the amenity enhancements?

Conclusion: Depends.

Project 3: Develop reefs for snorkeling and recreational fishing use off-shore from Flamingo Beach (*See* Exhibit 3.3).

Question A: Same type of natural resources and services?

The replacement habitat, off-shore reef, is not the same type of natural resource as the injured habitat, which is sandy beach. The reef will provide services that complement current use of the beach, as well as other recreational services (fishing).

Conclusion: No.

Question AA. Are the natural resources and services that are increased or enhanced by the action of comparable type and quality as those lost?

The project will support beach-related recreational uses (e.g., snorkeling), as well as other water-based recreational uses, such as fishing. These uses are similar and/or complementary to the type of services lost and are likely to be of comparable type and quality.

Conclusion: Probably.

The first restoration action for the beach injury consists of enhancing handicap access to Flamingo Beach for people with impaired mobility. The project does not create additional beach, however it is expected to generate beach-user days for individuals whose access to Flamingo Beach was previously impeded (including people with impaired mobility as well as their friends and family). Thus, the project will increase the same type of services as those lost. Because the access will occur at Flamingo Beach, the project will also provide services of the same quality as those lost. Whether the value of replacement services is comparable to the lost services is inconclusive, and is an empirical question. Thus, this project presents a Class I or Class II action.

Project 2 will develop access amenities at the recently opened Barracks Beach north of Flamingo Beach, thereby enhancing the quality of currently available beach services. The replacement project provides the same type of services but probably not the same quality of services as those lost. Whether the replacement and injured services are of comparable value is an empirical question. Project 2, therefore, is a Class I or Class II restoration action.

The third restoration project includes developing off-shore reefs for snorkeling and recreational fishing in the vicinity of Flamingo Beach. By expanding the range of recreational uses available for beach users, it will increase the quality of beach use. In addition it will create the opportunity for other types of water-based recreational uses. Based on type and quality of the restored natural resources and services relative to those lost, Project 3 is likely to be a Class III (or Class IV) action.

The fact that our classification remains inconclusive illustrates the complexity of the classification process and the types of information that trustees require in order to classify restoration actions. However, based on the information provided, the first and second projects present the highest priority restoration actions, providing at least the same type of replacement resources and services as those lost. Project 3 restores resources and services of comparable type and quality and is the least preferred action.

Exhibit 3.4 summarizes the classification of compensatory restoration actions.

Exhibit 3.4: Classification of compensatory restoration actions for beach injury			
	Project 1	**Project 2**	**Project 3**
Description of compensatory restoration action	Create beach access for people with impaired mobility	Develop access facilities for public use.	Create reef off-shore of Flamingo Beach for snorkeling and fishing.
Same type of natural resources, services?	Yes	Yes	No
Comparable type and quality of natural resources, services?	Not relevant	Not relevant	Probably yes
Service metric?	Beach user-days	Beach user-days	Total recreation user-days
Same quality of services?	Yes	Probably not	Not relevant
Basis for determination of quality differences:	Improvement should increase number of trips	Enhancement does not restore trips	Not relevant
Comparable value of services?	Depends	Depends	Not relevant
Classification of restoration action?	Class I or II	Class I or II	Class III or IV

3.5 Marsh Habitat Injury Example

3.5.1 Key Attributes of the Marsh Injury

Consider an oil spill that affects a coastal area of tidal *Spartina alterniflora* marsh, causing extensive die-off of the marsh vegetation and associated biota. Natural recovery is selected as the primary restoration action, with full recovery to baseline expected in five years. The injury site is represented as Site A in Exhibit 3.5. Agricultural and residential upland uses provide sources of nutrient runoff into the wetland. Just off-shore of the coastal wetland are shellfish grounds and finfish spawning habitat. Fauna of an upland wildlife refuge, north of the agricultural zone, also have land-based access to the wetland.

The comparison between the natural resources at the injury site and at the site of compensatory restoration takes into account the types and levels of services provided by the habitats at each site. Trustees identify key on-site, direct ecological services provided by the injury site that are likely to have been impaired. These may include but are not limited to:

- Primary production
- Secondary production of fish/shellfish
- Habitat and food sources for wildlife and birds
- Nutrient cycling
- Pollution assimilation and water treatment
- Sediment trapping from off-site sources and on-site sediment stabilization; and
- Water storage and conveyance, and groundwater recharge.

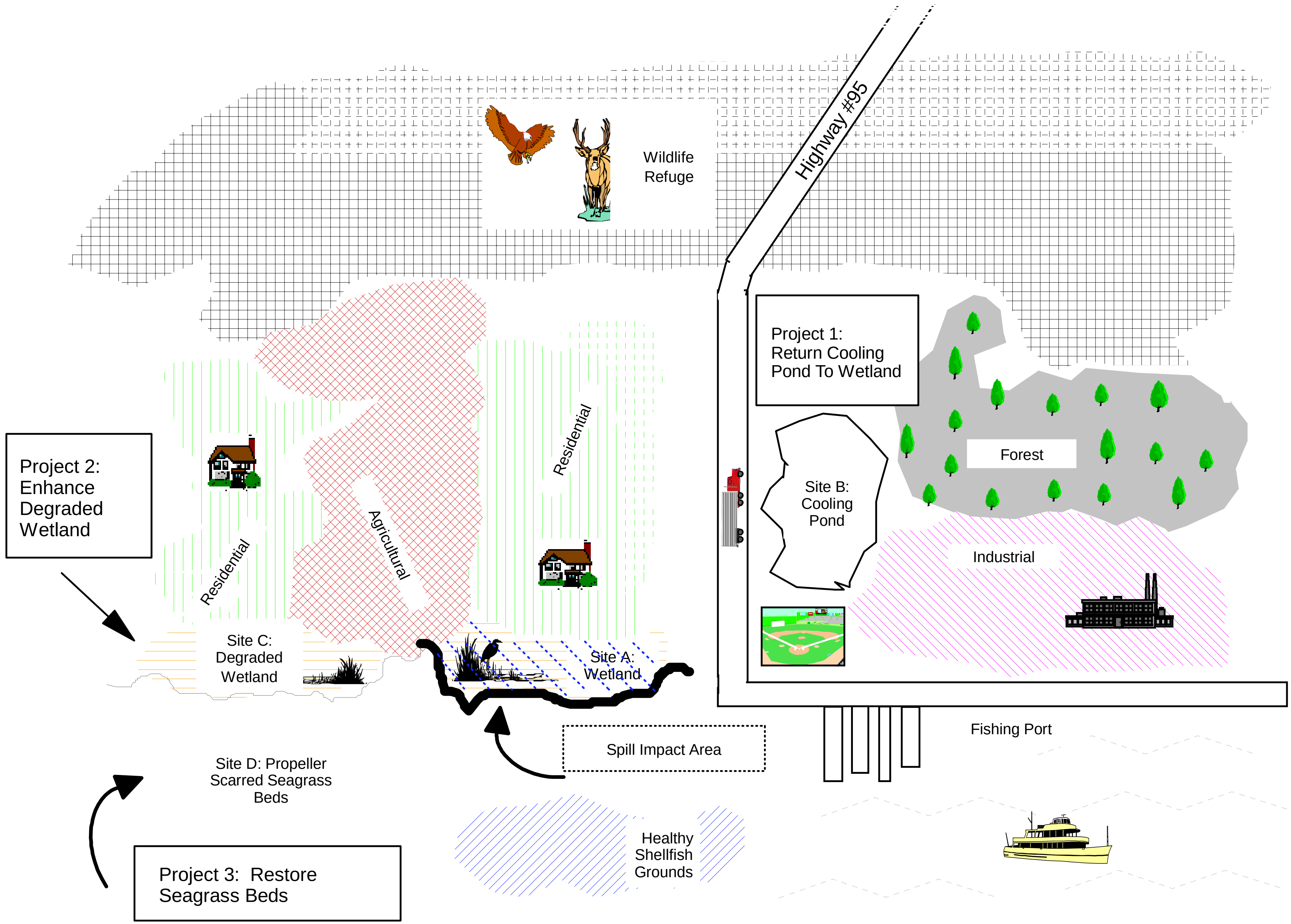
Key on-site and off-site human services supported by these on-site ecological functions include, but are not limited to:

- Wildlife viewing;
- Recreational and commercial fishing and hunting;
- Protection against coastal erosion; and
- Recreation-based uses of water and of open space.

Stem density (used in this example as an indicator of primary productivity per unit area) is the resource-based metric proposed as a proxy for service losses from the injury, as well as for service gains from the compensatory restoration action. This metric can take into account differences in primary productivity across sites, which may result from differences in biophysical characteristics or other factors that may limit the extent to which wetlands can be restored or rehabilitated (possibly due to lack of complete information or limits of knowledge in the science of restoration - engineering, planting strategies, etc.).

Exhibit 3.5: Map of Marsh Injury and Proposed Restoration Sites

Derived from *Comparing Ecosystem Services and Values, prepared by Dennis King for NOAA, 1997*



While stem density may be a good proxy for the range of ecological services associated with these sites, it only characterizes the capacity of a proposed action to provide services: it will not take into account whether the opportunity exists to provide services of the same type and quality, or whether humans take advantage of these opportunities to use the resources. If proposed restoration sites differ from the injury site in the opportunity to provide human services of the same type and quality and comparable value, then one-to-one trade-offs of lost and restored services in the scaling calculations may not be appropriate.[40]

3.5.2 Classification of Compensatory Restoration Actions

Trustees have identified three possible types of compensatory restoration actions that would occur at different sites in the vicinity of the spill.

- Project 1 would restore an industrial cooling pond to its original marsh habitat.
- Project 2 would enhance a degraded marsh in the same sub-watershed as the spill.
- Project 3 would restore degraded seagrass beds within the same sub-watershed as the spill.

Applying Exhibit 3.1 to Marsh Injury: Comparing type, quality, and value of natural resources and services at injury and restoration sites

Project 1: Create a tidal marsh by regrading and planting at the site of an artificial pond previously used to cool uncontaminated process water from the adjacent industrial facility's manufacturing processes (Site B in Exhibit 3.5).[41] The site had been a wetland prior to being used for a cooling pond and had very similar biophysical characteristics to the injured wetland and is located in the same sub-watershed within the area impacted by the spill.

Question A: Will the project increase and/or enhance the same type of natural resources and services (both on-site and off-site) as those lost?

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[40] This example does not directly address potential scale effects that might result in changes to aggregate supply conditions, which in turn may affect the extent to which the unit values of the services associated with the injured and restored areas are comparable. Interested readers are referred to Appendix C.

[41] The project also needs to provide for tidal influx, which might be achieved by elevating a portion of the road and/or constructing a culvert.

The marsh creation project will increase the total quantity of marsh resources in the area of the injury by returning the site to its original use as a tidal marsh. On-site biophysical characteristics and landscape context will influence whether the proposed site would provide the same type of services. Since the restoration action is designed to restore the area to its previous natural habitat type, with the same biophysical characteristics (i.e. capacity) as Site A, the marsh is expected to provide the same types of ecological services as the injured marsh. Similar off-site human services, such as bird watching, can be supported at both sites.

Conclusion: Yes.

Question B: Are the services provided of the same quality as those lost?

The proposed metric to measure services is stem density. This metric can serve as a proxy to capture predicted differences in (on-site) productivity between the two sites. In some cases, however, the restored marsh may be less (or more) productive than the injured marsh (pre-injury) for a given level of stem density, due for example to locational or engineering factors. Different wetland assessment techniques may allow this per unit productivity difference to be quantified, thus allowing adjustment of the metrics for such quality differences.[42] However, the metric does not reflect differences in off-site services between the injury and replacement project site. For example, both sites are expected to have the same biological capacity for nutrient cycling, but because of their respective locations within the landscape context, their opportunity to provide this service, and the benefit of doing so, may be significantly different. At the injury site (Site A), agricultural and residential upland uses provide a source of nutrient runoff into the wetland; off-shore from the wetland are shellfish grounds and fin fish spawning habitat that benefit from the improved water quality. In contrast, areas upland from Site B are forested, generating less nutrient loading. Also, pollutant loadings from industrial uses downstream limit the geographical range of any water quality benefits. Furthermore, the different upland uses limit the benefits of Site B's capacity to buffer storm impacts. Finally, Site B lacks Site A's land-based access to an upland wildlife refuge, north of the agricultural zone, due to the interfering presence of a major highway.

Conclusion: No, because of the expected difference in the quality of services provided due to differences in the landscape context.

Question C: Are compensatory restoration action services of comparable value to lost services?

Conclusion: No, if services are not of the same quality, they are not of comparable value either.

[42] For an overview of these methods see *Using Ecosystem Assessment Methods in Natural Resource Damage Assessment*, prepared by Dennis King for National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1997.

Project 2: Enhance a degraded marsh (Site C in Exhibit 3.5) in the same sub-watershed as the spill, through a combination of source control and vegetative transplanting. Because the elevation of the compensatory project site is slightly higher than the injured site, and ecological and engineering constraints may prevent regrading of the site, the compensatory marsh may be comprised of a mixture of *Spartina patens* and *Spartina alterniflora*, with *Spartina patens* as the predominant species.

Question A: Same type of natural resources and services?

The marsh enhancement project will increase the functionality of the marsh at the replacement site, thereby increasing the effective quantity of marsh resources in the area. If regrading can be done, the project will restore the same type of marsh and should provide the same types of services as the injured marsh. If regrading can not be done, the two tidal marshes may still provide the same type of services even with differences in the predominant plant species.

Conclusion: Yes.

Question B: Same quality of natural resources?

In contrast to Project 1, Project 2 presents a scenario where the injured and restored sites have similar landscape contexts but, if regrading the restoration site is not feasible, have different biological capacity to provide on-site ecological services. Because *Spartina patens* occurs at a higher elevation within the intertidal zone than *Spartina alterniflora*, the quality of the nursery habitat for fish at the replacement site may be lower than baseline conditions of the injured marsh. Note that in this example, simply looking at the distance from the location of the spill provides little insight into the landscape similarity, since both sites B and C are the same distance from the area of maximum impact from the spill. Though the differences between sites may not be captured with the proposed metric (stem density), they could potentially be captured with a higher order metric, such as fish density.[43]

Conclusion: Depends upon feasibility of regrading the restoration site to achieve similarity with the injury site in land characteristics and therefore in biological capacity. If the sites differ in biological capacity and provide different services, a higher order metric might be able to adjust for quality differences in services at the injury and restoration sites.

[43] Note, however, that such a higher order service metric might not be a good proxy for other services that may have been impaired, such as food services for birds and mammals.

Question C: Are compensatory restoration action services of comparable value to lost services?

Conclusion: Depends. If regrading the marsh is possible, then the value of restoration action services and lost services are comparable. Otherwise, it may be possible to find an alternative metric to adjust for differences in the quality and value of services across the two sites.[44]

Project 3: Restore nearby subtidal seagrass beds scarred by boat propellers by transplanting seagrass from designated donor beds and instituting resource management measures to prevent re-scarring. The seagrass rehabilitation (Site D Exhibit 3.5) would occur within the same sub-watershed as the spill.

Question A: Same type of natural resources and services?

Seagrass beds and marshes do not represent the same type of natural resource. While the restored natural resources will provide capacity for some of the services that are lost, they will not provide capacity for other lost services. Further, the replacement natural resources will create capacity for some services that were not lost. For example, seagrass beds serve as productive habitat for scallops, which may be harvested recreationally or commercially, while tidal marshes do not. Conversely, while both types of habitats enhance localized sediment stability, seagrasses may not provide significant protection from coastal erosion.

Conclusion: No.

Question AA: Comparable type and quality of natural resources?

The injury and proposed restoration sites overlap in categories of ecological services provided by the natural resources (e.g., food sources, productivity, nutrient cycling, sediment stabilization) and in categories of off-site human services. However the specific plant and animal species supported will differ.

Conclusion: Yes.

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[44] However, even where services are of the same quality and the restoration project does not have a significant effect on the aggregate supply of services, the value may differ if other factors cause changes in aggregate supply and demand conditions. For example, sometime after the injury occurred but before the replacement marsh was enhanced, a sharp decline may have occurred in bird populations that relied on fish as a food source. This may reduce the "ecological demand" for the fish and thus indirectly reduce the value to humans of an increase in fish density.

In the marsh injury example there are three alternatives for compensatory restoration actions. Project 1 proposes returning an artificial cooling pond to its original state as a tidal marsh. This project will create marsh habitat of the same type (with the same biophysical characteristics) as that lost at the injury site. However, the services lost from the injury site and provided by the replacement site are unlikely to be of comparable quality: the replacement site lies in a different landscape context and does not offer the same opportunity for services as the damaged wetland prior to injury. If the services from the replacement and injury site are not the same quality they are probably not comparable in value either. As a result, Project 1 would be classified as a Class II action.

The second restoration action is to enhance a degraded tidal marsh near the injury site. At the very least, the replacement site will restore a similar type of marsh habitat. If the technology permits, the replacement site will be constructed to the same specifications of the injury site and will support the same type of marsh. Both the injury and the replacement sites occur in the same landscape context. If the restoration project replicates the biophysical characteristics of the injury site, then the restored resource should provide services of the same quality as those lost. Without replicating the biophysical characteristics, the restored resource will not provide the same quality of services. However, an alternative metric, such as fish density, might be able to capture the differences in quality. Therefore, classification of Project 2 as either Class I or Class II depends on the success of the marsh re-creation and whether or not a metric that can adjust for quality and value differences in services can be identified.

Project 3 suggests restoring subtidal seagrass beds and instituting resource management to prevent re-scarring as a possible replacement action. Seagrass beds and marshes are not the same type of resource, yet they are comparable in type and quality. For example, both resources provide comparable ecological services including food sources, productivity, nutrient cycling, and sediment stabilization. Given the characteristics of the replacement resource relative to that lost, Project 3 would be classified as a Class III restoration action.

As in the beach injury example, our classification remains inconclusive. This reflects the complexity of the classification process and the types of information that trustees require in order to classify restoration actions. However, based on the information presented here, project 2 is likely to be the highest priority restoration alternative, followed by projects 1 and 3. Project 2 may provide resources and services of the same type and quality and comparable value to those lost, making it a Class I action. Project 1, as a Class II action, is the next best alternative providing the same type of services, but of different quality. The third project only restores resources and services of comparable type and quality and is the least preferred of the three alternatives.

Exhibit 3.6 summarizes the classification of compensatory restoration actions for the marsh habitat injury.

Exhibit 3.6: Classification of compensatory restoration actions for marsh injury			
	Project 1	**Project 2**	**Project 3**
Description of compensatory restoration action	Fill and replant artificial cooling pond, that previously was tidal marsh.	Enhance nearby degraded marsh.	Restore injured seagrass beds.
Same type of natural resources and services?	Yes	Yes	No
Comparable type and quality of natural resource?	Not relevant	Not relevant	Yes
Service metric?	Productivity	Productivity	Productivity
Same quality of services?	No	Depends	Not relevant
Basis for determination of quality differences:	Landscape Context	Potentially, biological capacity	Not relevant
Comparable value of services?	Not relevant	Depends	Not relevant
Classification of restoration action?	Class II	Class I or II	Class III

4.1 Introduction

After identifying and classifying the restoration actions, the next stage of the restoration planning process is selecting approaches and methods for scaling the restoration alternatives. As noted earlier, the primary focus of the guidance document is on scaling the compensatory restoration actions within each restoration alternative under consideration.

This chapter presents a decision-making framework for identifying and selecting applicable, reliable, and valid scaling approaches, and the methods to implement them. It presents the data requirements for scaling implementation and provides a discussion of scaling methods available to implement each scaling approach. The chapter concludes by illustrating the selection of scaling approaches and methods for the beach and marsh habitat injuries introduced in Chapter 3.

4.2 Scaling Approaches

The process of "scaling" a compensatory restoration action involves adjusting the size of a restoration action to ensure that the *present discounted value of project gains* equals the *present discounted value of the interim losses*.[45] The two major scaling approaches are service-to-service, a simplified approach applicable under certain conditions, and valuation, applicable under more general conditions.

Both approaches frame the scaling question in terms of what trade-offs exist between services lost due to the injury and services provided by potential compensatory restoration actions. However, the valuation approach is based on quantitative estimation of the trade-offs people make between services, whereas the service-to-service approach is based on simplifying assumptions about these trade-offs.[46]

According to the OPA regulations at § 990.53(d)(2), trustees must consider using the service-to-service approach. The implicit simplifying assumption of the service-to-service approach is that the public is willing to accept a one-to-one trade-off between a unit of lost services and a unit of services provided by the restoration project. Note the focus is on *services* here, not resources: because services per unit of resource are not

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[45] Trustees should be aware that some restoration actions are "lumpy," and for practical reasons, it may not be feasible to implement an action at the size indicated by the scaling analysis. For example, there may be a minimum size of a restoration action, below which it lacks the capacity to provide services. Or, there may be features of a restoration action, such as beach access points, that can only be constructed in certain discrete sizes.

[46] The label "valuation approach" does not necessarily imply that the data collected to quantify the trade-offs will be in dollar value terms – as stated in the regulations, "value" may be determined in a variety of units of exchange, including units of natural resources or dollars. When applying the service-to-service approach, the trustees should identify explicity their logic for using the simplifying assumptions about the service trade-offs.

necessarily the same at the injury and replacement sites, the trade-off may not be one-to-one in *resources*.[47] The assumption of a one-to-one trade-off between services may be appropriate when, in the judgment of the trustees, the proposed restoration action provides services of the same type and quality, and of comparable value as those lost or impaired due to the injury (i.e., when the restoration action is Class I).[48] *Service-to-service* scaling then simplifies to determining the scale of a restoration action that provides a quantity of discounted replacement services equal to the quantity of discounted services lost due to the injury.

Consider the example of a wetland habitat injury presented in section 3.5. The service metric identified for the wetland habitat losses and replacement actions is primary productivity; stem density was the proxy measure of productivity per acre. Suppose trustees classify the restoration action as Class I and select the service-to-service approach to scale restoration projects. This implies that trustees have determined (1) productivity is an adequate indicator or proxy for the services provided by the habitat (in particular, those identified as goals for restoration) and (2) the values of services at the injury site are comparable to the values at the replacement site.

Where the assumption of a one-to-one trade-off between service losses and gains does not apply, the trustees are to consider the valuation approach (see OPA regulations at § 990.53(d)(3). A variety of economic methods may be used to determine the public's willingness to trade-off replacement services provided by compensatory restoration projects for lost services. These methods determine the present discounted value of gains from the proposed actions as well as the present discounted value of the interim losses. The preferred version of the valuation approach, referred to as "value-to-value," scales a

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47 Consider the case where a marsh is to be created to compensate for a marsh injury, and primary productivity is selected as the key service for comparing sites. Primary productivity per acre of marsh may differ across the two sites. However, the assumption of a 1:1 value trade-off between ***productivity services*** at the injury and replacement project sites does not presume a 1:1 trade-off in ***acres*** between the two sites.

Analogously, the assumption of a 1:1 value trade-off between replacement and lost services does not necessarily imply a 1:1 trade-off in ***resource-based proxies for services*** either. Recall the case discussed in chapter 3, in which stem density is employed as the proxy metric for productivity services. In a particular context, the replacement project site may be judged to provide 50% of the productivity per unit of stem density that the injury site provides. In this case, the assumption of a 1:1 value trade-off between productivity services at the injury and replacement project site would imply a 2:1 trade-off in the stem density per acre proxy measure for comparing sites.

48 Chapter 3 describes a decision-making process for classifying restoration actions. The following analogies illustrate the importance of concepts of type, quality, and comparable value in selecting a scaling approach. Comparing services of the same type but different quality is like comparing fresh salmon to canned salmon. On the other hand, comparing services of the same type and quality that are provided under different supply and demand conditions is like comparing the value of harvesting another salmon when salmon are in abundant supply to the value of another salmon in a year with smaller salmon runs. The value of providing another pound of salmon may be substantially greater when the salmon are fresh or in scarce supply, all else equal. Valuation methods can measure the rate of trade-off individuals or households are willing to accept among salmon under different quality or scarcity conditions.

project by adjusting the size of a restoration action to ensure that the present discounted value of project gains equals the present discounted value of the interim losses.

The approach relies on the concept that lost value can be determined using one of a variety of possible units of exchange, including units of natural resource services or dollars. For example, some stated choice methods, such as conjoint analysis, are flexible enough to elicit trade-offs between lost and replacement services in terms of dollars or in terms of natural resource services.

With the value-to-cost approach, the restoration actions are scaled by equating the cost of the restoration to the value (in dollar terms) of losses due to the injury. The value-to-cost variant of the valuation approach may be employed in circumstances where the trustees judge that the valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services imposes unreasonable time or cost requirements (see the OPA regulations at § 990.53(d)(3)(ii)). This will generally occur when literature values (from previous research) are available to value lost services but are not available to value the gains from restoration actions.[49] This could occur, for example, if the project would provide services currently unavailable at the injured site. Section 4.4 discusses the conditions under which this approach may be selected.

4.3 Criteria for Selection of Approaches and Methods

The choice of a scaling approach cannot be made without identifying the data and methods that are available for implementing the scaling approaches under consideration. The choice of methods and the implied data collection requirements have implications for costs, as well as for the reliability and validity of the results.

Section 990.27 of the OPA regulations require assessment procedures to comply with the following standards:

- *Applicability*: capable of providing useful information in determining type and scale of appropriate restoration;

- *Reasonableness of the incremental costs*: additional costs of a more complex procedure should be reasonable based on the expected increase in the quantity and/or quality of relevant information provided by the more complex procedures; and

- *Validity and reliability*: the procedure must be reliable and valid for the particular incident.

[49] Generally, trustees would not initiate a site-specific data collection and analysis to value interim losses without incorporating a data collection and analysis to value the gains from restoration actions. If the cost and time requirements of initiating a site-specific valuation study for interim losses are judged reasonable, then it is likely to be reasonable to design a unified site-specific study(ies) which values both losses and gains.

Applicability

The criterion of applicability pertains primarily to the choice of approach. If an action provides services of same type, quality, and comparable value as lost services, then the assumptions of the service-to-service approach seem reasonable. Otherwise, the valuation approach should be considered. The value-to-cost version of the valuation method may be applicable in some circumstances, which we consider below.

Incremental cost

The criteria of reasonableness of incremental costs and of reliability and validity (discussed explicitly below) need to be considered together in evaluating the integrated choice of approach and methods/data needs. The information gains of more complex approaches and methods are to be weighed against any expected increase in costs and the expected change in quality and quantity of information regarding the extent of gains and/or losses. Information gains accrue from being able to target measurements *more closely* to the specific concepts of interest (validity) and to make measurements with greater precision (reliability). Some methods may provide better information at a lower cost, e.g., construction of a unified model that values the losses due to the injuries as well as the benefits from all the restoration projects under consideration.

Validity and reliability

Validity and reliability require that scaling methods used to implement an approach be consistent with the best technical practices appropriate for the level of precision required in the context. Validity pertains to the accuracy and completeness of the measurements of the specific concepts of interest. Reliability pertains to the precision and replicability of these measurements.

4.4 Selecting Approaches and Methods: The Decision-Making Framework

Exhibit 4.1 outlines a decision-making framework for identifying and selecting applicable, reliable, and valid scaling approaches, and the methods to implement them. Exhibit 4.2 presents a flowchart of the decision-making framework.

The starting point for decision-making (Question A in Exhibit 4.1) is to determine what approach should be considered first, based on the project classification. For Class I projects, service-to-service must be considered first. For Classes II and III, the value-to-value approach should be considered first since the service-to-service approach is not appropriate when services are not of the same type and/or quality. The next step (Question B of Exhibit 4.1) is to determine what methods are applicable. In order to determine applicability, the trustees should consider (1) data needs, (2) the quality and relevance of currently available data and models, and (3) the feasibility of collecting additional data and conducting additional analyses required to implement the method.

Exhibit 4.1: A decision-making framework for selecting a scaling approach and method.

Question A: How has the project been classified?

- If Class I, then service-to-service approach applies (services of same type, quality and comparable value).
- If Class II or III, valuation approach applies (in this case the value-to-value variant should be considered before value-to-cost is considered).
- If Class IV, the action may not be suitable for inclusion in the Restoration Plan.

Question B: What methods are applicable for the approach under consideration? Consider the following:

- What are the data requirements?
- What data and/or models are currently available and appropriate?
- What additional data collection and/or analysis would be necessary?

Question C: Do the methods and approach meet the regulatory criteria for inclusion in a damage assessment?

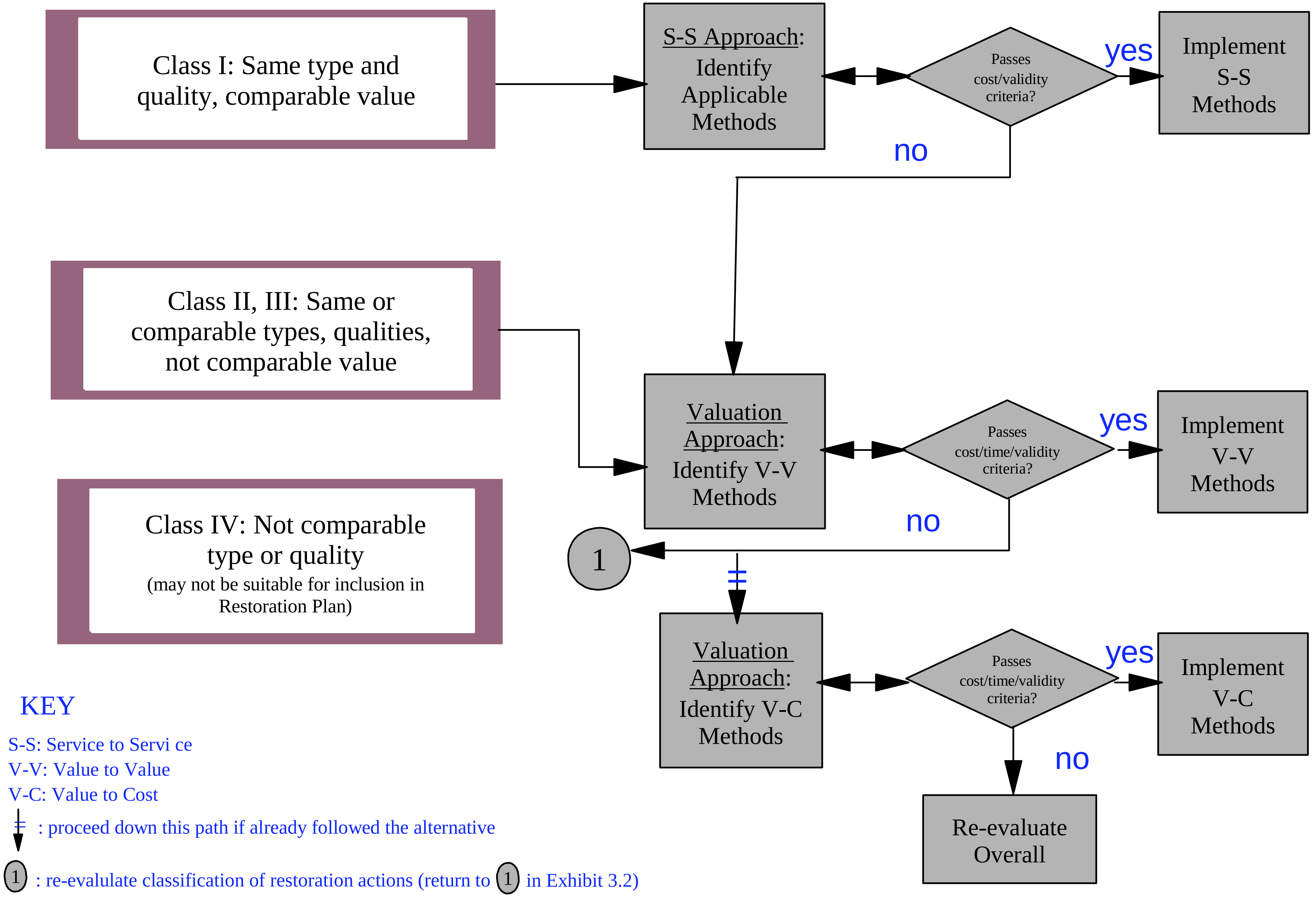
- For the approach under consideration, are applicable methods available?
- Are the incremental costs of using these methods for the given approach reasonable relative to the gain in information over the alternative methods?
- Are the methods valid and reliable in the given context?

These determinations provide a basis for the evaluation of the alternative approaches and methods, based on the regulatory criteria (Question C of Exhibit 4.1).

Question C in Exhibit 4.1 illustrates that if the methods for implementing the first scaling approach considered by the trustees (the initial, conditional recommendation) do not meet the criteria, the trustees should consider methods for implementing another approach. The evaluation of approaches and methods can be an iterative process, in which trustees may reevaluate approaches previously considered. Consequently, trustees may use service-to-service methods for actions in which the incremental costs of valuation are unreasonable, even if the valuation approach seems more applicable and could generate more accurate results. Note the value-to-cost option should not be recommended without reconsidering all others.

Consider an example in which trustees have initially passed over the service-to-service approach because an action was determined to provide services that are not of the same quality as those lost (i.e., not a Class I action). Suppose that methods for the value-to-value approach have unreasonable time or money costs. The next step should be a reconsideration of whether the service-to-service approach can be implemented. This is shown in Exhibit 4.2, where the path to value-to-cost is marked with a double bar, indicating it is only to be considered after the other path has been pursued. If the project being scaled has not already been classified as Class I, the other path leads to a

Exhibit 4.2: Selecting Scaling Approaches and Methods



reconsideration of the classification of an action, shown in Exhibit 3.2. The point at which reconsideration begins is marked in Exhibits 4.2 and 3.2 with a symbol of an encircled number 1. Upon reconsideration, it may be possible to develop an adjustment factor for the service metric so that differences in quality attributes can be taken into account. Only after that option is ruled out should the value-to-cost approach be considered.

4.5 Data Requirements for Scaling

4.5.1 Comprehensive Data Requirements

The scaling process for compensatory restoration combines three categories of data, which are obtained at different stages in the Restoration Planning Phase of an assessment. The first category is the quantification of service losses; the second is the quantification of service gains from proposed actions; and the third is data on the trade-off between replacement and lost services. Each category is described in greater detail in this section.

1. ***Quantify the degree, extent, and duration of the loss of services, assuming a specific primary restoration action will be implemented***

The loss of services may include a reduction in the *quantity* of services, and/or a reduction in the *quality* of services provided. For example, when oil is widely distributed across beach shorelines, potentially impacted beaches may remain open if it is difficult to predict the trajectory of tar balls. All else equal, the quality of a beach day is presumed to be lower at sites where tar balls are washing up onto the beach.

Data requirements include:

- identifying the initial extent of injury, which involves identifying service levels immediately following the incident[50] and the baseline level of services; and

- predicting the path of recovery of service levels until full recovery to baseline (which may involve a period of increasing injury).[51]

2. Quantify the expected gain in resource services, for different scales of compensatory restoration actions

The gain in services may include an increase in *quantity* and/or an enhancement of the *quality* of services already available. For example, beach projects at a particular

[50] Where relevant, identifying the post-incident service levels may involve identifying whether the public chose to substitute services from other natural resources for the lost services during the period of injury.

[51] It is not always the case that maximum injury occurs at or shortly after the time of the spill. For example, the death of trees in a mangrove may not be realized for several years after oiling occurs. In such cases, the path of recovery during the first few years will incorporate an increasing level of injury.

site in South Beach Miami may enhance the value of a recreational user day at that site, leading Miami beachgoers to switch from their current beach choice to South Beach. However, the total quantity of beach visits in the Miami area may remain the same.

Data requirements include:

- identifying the trajectory of service growth in the "maturity" phases of the restoration action (and of possible service decreases during the period of construction);[52]
- predicting the pattern of service levels when "full function" is achieved at the restoration site; and
- identifying the lifetime of the project.

Additional factors may be quantified at this stage, including the likelihood of success of each alternative, the potential for preventing future injuries or causing collateral injuries, and the effects on public health and safety. Availability and quality of this data may be considered in evaluating the criteria for assessment procedures. This data should also be considered in the evaluation of restoration alternatives.

3. Determine the trade-offs acceptable to the public between the services to be provided by replacement projects and the loss in services due to the injury.

Once the resource losses and restoration gains have been quantified, trustees must determine how to trade-off the services to be provided and the loss in services due to the injury. The trustees should use a one-to-one trade-off when the replacement and lost services are the same type, quality, and value. When replacement and lost services are not comparable in value and a one-to-one trade-off is not applicable, trustees must value the gains and losses and trade-off the values of the replacement and lost services. The next sections discuss the approaches for making the trade-offs and the methods for implementing the approaches. Examples are included.

4.5.2 Data Requirements for the Different Scaling Approaches

The two scaling approaches and the data required to implement them are as follows.

[52] When considering this item and the next item in the list, trustees should be aware of substitutes for the services provided by the restoration action, and whether any increase in public use involves a reduction in use of other (substitute) natural resources.

Service-to-Service Approach

Application of the service-to-service approach assumes the public is willing to accept a one-to-one trade-off between a unit of lost services and a unit of services provided by the restoration. The assumption may be met when the proposed restoration action provides services of the same type and quality, and of comparable value as those lost or impaired due to the injury (Class I actions). Thus, to implement service-to-service scaling, trustees may make qualitative judgments about the values of lost and replacement services. However, quantitative data about service losses relative to baseline and service gains from compensatory restoration actions are required.

Valuation Approach: Value-to-Value

Alternatively, when impaired and replacement services are not of the same type and quality, or comparable value, the assumption of a one-to-one trade-off between service losses and gains does not apply. In this context, the preferred valuation approach (value-to-value) allows for a variety of economic methods to determine what trade-offs the public is willing to accept between impaired and replacement services.

With this information the trustees can determine the scale of compensatory restoration actions that is necessary to compensate for the losses. In this case, the trustees need all three elements of information discussed in section 4.5.1: (1) service losses, (2) service gains, and (3) their relative values (identifying service-to-service trade-offs).

Valuation Approach: Value-to-Cost

With the **value-to-cost** approach, the restoration plan is scaled by equating the cost of the restoration plan to the value of losses due to the injury. Only information on service losses and their values is required for this approach.

Exhibits 4.1 and 4.2 highlight that if the trustees determine the time or cost requirements of value-to-value are not reasonable in the context, they first must reconsider alternative ways of implementing the service-to-service approach. Only after reconsidering and rejecting the service-to-service approach may the trustees select the value-to-cost approach.

4.6 Scaling Methods

Various methods, or techniques, may be employed to implement either scaling approach. Application of the methods generates the required information about service losses, services gains, and/or relative values. Question B of Exhibit 4.1 outlines the process for identifying applicable methods to implement either scaling approach. The process begins with identifying data requirements, taking an inventory of the data and models currently available, and determining any additional data collection and/or analysis required to complete a scaling analysis. Trustees may consider designing an incident-specific study if currently available information is inadequate or inappropriate.

Generally, the data on service losses and gains will be generated by a combination of on-site sampling and modeling. Current service levels may be directly observable and measurable. Note however that neither baseline levels *during the injury period* (category 1), nor *future* service levels at the replacement project site (category 2) are directly observable at the time of the assessment.[53] Consequently, analysts must make observations at other sites and/or other times and then extrapolate to the service levels at the injury site during the injury period, or at the replacement project site during the project lifetime. The data necessary for this extrapolation may become available through ongoing data collection procedures; if not, they may be collected through an incident-specific data collection effort. These extrapolations may be based on: developing formal site-specific models; applying models developed for related purposes to predict service levels at the site (by incorporating data on some site-specific characteristics into the model); applying predictions of service levels from published results of models developed for "comparable" sites, based on expert judgment; or imposing simple assumptions (such as, "participation during the injury period would have been the same as in previous or subsequent periods, if the spill had not occurred.")

Question C of Exhibit 4.1 summarizes the evaluation criteria for selecting among alternative approaches and methods.

Whenever feasible, the same methods should be used for measuring losses and gains. However, trustee(s) may use different methods to perform separate scaling analyses for different services from the same injury. Analysts should be aware of the potential for double-counting losses from injuries or gains from restoration actions, since double recovery of losses is prohibited.

4.6.1 Service-to-Service Methods

Selecting a method to implement the service-to-service approach depends upon the type of services the injured natural resources supported. Direct human use losses (e.g., wildlife viewing) that are readily quantified are usually measured/modeled individually. Feasibility and cost-effectiveness conditions may limit measurement and modeling to on-site human use losses, rather than off-site losses.

On the other hand, lost services may be ecological services, such as fish spawning, which in turn supported human services, such recreational fishing, elsewhere in the estuary. For habitat injuries the service-to-service approach may be implemented with Habitat Equivalency Analysis (HEA).[54] Applications typically employ an on-site

[53] The future level of services at the proposed restoration site that would exist in the absence of the restoration may also need to be estimated in order to determine the expected increase in services resulting from the project. These service levels are not directly observable at the time of the assessment in cases where they are expected to vary due to factors other than the restoration project (e.g., there might be declining service levels due to development occurring at adjacent properties.)

[54] The HEA method is described more fully in *Habitat Equivalency Analysis: An Overview*, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1996.

ecological service metric as a proxy for human services, which are difficult and costly to quantify when they occur off-site.

4.6.2 Valuation Methods

Various valuation methods are available to measure losses and gains, either in units of natural resources, natural resource services, or money. The choice of method will, in part, determine the units. A description of various valuation methods, along with a reference list, appears in Appendix D of this document.

In the next two sections of this chapter, we return to the beach closure and marsh habitat injuries introduced in Chapter 3 and illustrate the selection of scaling approaches and methods.

4.7 Selecting Scaling Approach and Methods: Beach Closure Example

Consider again the beach closure example and the three proposed restoration projects that were classified in Chapter 3. (See Exhibit 3.4 for a summary of the results.) Project 1 involves the creation of beach access for people with impaired mobility. Project 2 adds access amenities to public beachfront. Project 3 creates reef off-shore of Flamingo Beach for snorkeling and fishing.

4.7.1 Identify Applicable Methods to Implement Scaling Approaches

To evaluate the data collection and modeling options for conducting a scaling analysis, trustees first must identify data requirements and take an inventory of the data and models currently available for each of the scaling approaches.

Service-to-service approach

On first examination, it appears the service-to-service approach is applicable to Project 1. Beach user-days is the metric selected for measuring service losses from the injury and service gains from the beach projects.

Data requirements

Data requirements for implementing the service-to-service approach in this context are:

1. Extent and duration of the loss of services, which requires information on actual level of use during the impact period and on predicted baseline use levels (i.e., number of beach user-days expected during the closure period if the spill had not occurred).

2. Gain in services during the lifetime of the replacement project, which requires predictions of the number of beach user days at replacement project sites throughout the lifetime of the project, both with the projects and at baseline (i.e., without the project).

Data and Assessment of Modeling/Analysis Options

To implement service-to-service, trustees generally measure actual level of use during the impact period. They may also measure baseline participation at the compensatory restoration site. However, to calculate losses and gains, it is necessary to predict baseline beach use at the injury site and increases in use expected at the compensatory restoration sites. Models to predict beach use for these situations (for which no observations exist) take into account factors that influence beach use at specific sites on specific days. These factors include: quality attributes of the site (and of other substitute sites); travel costs to site (and to other substitute sites, particularly those with comparable quality attributes); weather (temperature, sunny/cloudy/rainy); weekday/weekend/holiday; and time of year (seasonally expected weather, school holidays).

The modeling and analysis possibilities depend on the type of data currently available or collected as a result of the spill. Data limitations may influence the accuracy of beach use predictions. Whether the reliability and validity of some of the measurements are adequate must be evaluated in each context.

A. Data: No site-specific data are available, but regional beach participation data exist.
Modeling option: Transfer participation estimates from elsewhere in region.

In some contexts, aggregate regional beach participation data exist, but are not specific to the injury or replacement project sites: they may pertain to different beaches within the region, or they may be aggregated to a broader geographical area, including sites of diverse quality and accessibility.

This transfer of regional data is unlikely to be useful in predicting any increase in beach participation that might occur as a result of a proposed project, though it could be used to predict baseline use at the injury site. The validity of the estimate of baseline beach use for the injury site will be affected by how similar the affected beach is to the other beaches in the region, and the degree to which temporal factors can be taken into account.

B. **Data:** Records of daily site-specific beach participation counts are available for a number of years.
Modeling options: Use count data directly, or estimate statistical models of participation (not travel cost models, since travel cost data are not available).

Count data are collected in many areas as part of beach operations: e.g., counts of cars or entrants while collecting user fees, or lifeguard counts of on-beach participants. Using a count of beach users at the spill site during the anniversary of the spill closure period as a proxy for baseline use during the spill year does not take into account variations between the years in weather patterns, or other factors that influence beach use (the economy, pollution, substitutes, etc.). For example, if the spill year was rainy and the year in which the proxy was taken was sunny, the estimate of baseline participation would be overstated and consequently the estimate of losses would be overstated.

If count data exist for a long enough time period, then a statistical model of participation can be estimated; with such a model, predictions of baseline participation can be generated that take into account specific features of the time period, including weather.

It is more challenging, however, to use count data, either directly or in a statistical model of participation, to predict increases in beach use as a result of compensatory restoration projects. That task becomes easier if there is a site with similar enough characteristics to the project site (after the project is implemented) from which it is possible to transfer participation estimates.

C. **Data:** Individual- (or household-) specific information on beach use at different sites, possibly supplemented with stated participation data.
Modeling option: Estimate travel cost model.

Data, including origin point for beach trips and number of people in the travel party, can be collected specifically for damage assessment and restoration planning for the spill. If the range of quality attributes of the projects is not within the range currently available, then stated choice data will have to be collected to supplement data collected from current beach users regarding their existing choice of beaches.

Note that the travel cost model could be used either to measure service losses and gains for use in a service-to-service application or to measure the values of losses and gains for use in a valuation application.

Valuation approach

In Chapter 3, we determined that the quality of services from beach enhancement at a substitute site was probably not of the same quality as the lost services at the oiled beach. In this case, for a Class II project, we consider the valuation approach.

Data requirements

In addition to the data on extent and duration of the service losses and gains, a third category of information is also needed:

3. Trade-offs acceptable to the public between the services to be provided by replacement projects and the services lost due to the injury.

Data and Assessment of Modeling/Analysis Options

Some valuation methods are geared to valuing specific types of services. For example, the travel cost method is generally employed to value recreational uses of sites; a given model application generally focuses on the value of specific types of recreational uses (e.g., beach use ***or*** recreational fishing). Other methods, such as conjoint analysis, are more flexible: they can value different services in the same model. When the projects under consideration provide a variety of different types of services (e.g., Project 3, reef creation), the trustees need to choose between performing one conjoint study to value the range of services provided by all projects under consideration or separate travel cost studies measuring gains for the different types of recreational services.

The value-to-cost variant of the valuation approach may be employed where the trustees judge that the valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services imposes unreasonable time or cost requirements. With the value-to-cost approach, the restoration plan is scaled by equating the cost of the restoration plan to the value (in dollar terms) of losses due to the injury.

A. **Data:** Participation counts with or without a statistical model of participation; beach user-day values are available in the literature.
   Modeling option: Perform benefits transfer of literature user day values.

   If the site-specific data necessary to estimate a travel cost model to value beach days at the affected sites are not available, then it may be possible to employ a benefits transfer procedure. Trustees could use the value(s) of a beach day as reported in an existing travel cost study (ies) for comparable sites, or transfer the model from an existing travel cost study to the site and re-calculate values with site-specific user characteristics.

   However, most currently available travel cost studies for beach use have not incorporated quality attributes (that might be affected by restoration actions) in the valuation model. Consequently, the options for valuing quality changes attributable to restoration actions are limited. In such a circumstance the trustees must determine whether to conduct the site-specific data collection and modeling (see option B below) necessary to implement a value-to-value analysis or to implement a value-to-cost analysis using this data and modeling option.

B. **Data:** Individual- (or household-) specific information on beach use at the injury and replacement action sites and their substitutes, possibly supplemented with stated participation data for site quality changes.
   Modeling option: Estimate travel cost model to value beach days at the injury and restoration action sites.
   A travel cost model generates not only predictions of the number of beach trips, but also an estimate of the value for each trip taken. As noted above, if the range of quality attributes of the restoration actions is outside of the range of currently

available opportunities, then stated choice data will have to be collected to supplement data collected from current beach users regarding their choice of beaches. In a stated choice survey, respondents are offered alternative beach sites with varying quality attributes and asked to identify which sites they would choose (or whether they would choose not to participate).

C. **Data:** Individual- (or household-) specific survey information is available.
Modeling option: Estimate conjoint analysis (stated choice) model.

To collect the data to estimate stated choice models, individual survey respondents are asked to make choices among alternative 'product' scenarios with varying quality, quantity, and cost attributes. The choices reveal the trade-offs individuals are willing to make between the quality and cost attributes of natural resources and the services they provide.

4.7.2 Evaluation of Alternative Scaling Approaches and Methods for Beach Projects

After alternative scaling approaches and the methods to implement them have been identified, the trustees evaluate them with the criteria outlined in Question C of Exhibit 4.1:

1. Are conditions of applicability met?

2. Are the incremental costs of performing more complex approaches and methods reasonable relative to the incremental information gains?

3. Are the procedures valid and reliable in the given context?

4.8 Selecting Scaling Approach and Methods: Marsh Habitat Example

Consider again the marsh habitat injury example and the three proposed restoration projects classified in Chapter 3. (See Exhibit 3.6 for a summary of the classifications.) Project 1 regrades an artificial pond into marsh habitat and is classified as Class II. Project 2 enhances a nearby degraded marsh and is classified as Class I or II. Project 3 restores damaged seagrass beds and is classified as Class III.

4.8.1 Identify Applicable Methods to Implement Scaling Approaches

Service-to-service approach

On first examination, it appears that the service-to-service approach is only applicable to Project 2. The ecological service chosen to characterize natural resource service losses and gains (denoted the "indicator service") could be either primary or secondary productivity; examples of proxy metrics include stem density for primary productivity and fish density for secondary productivity.

To meet the conditions for the service-to-service approach, the measurements or predictions of service levels (e.g., as a function of proxy measures) are assumed to capture all significant ecological and human services relevant to the scaling process. Further, trustees would assume that: (1) the functional relationship between any resource-based proxy measure and the ecological service can be specified for both the injury and the replacement project sites (note: the relationships may be different at the two sites); and (2) a fixed functional relationship exists between the quantity and quality of ecological services and the quantity and quality of human services.

Data requirements:

The data requirements for implementing service-to-service in this context are:

1. Extent, degree, and duration of loss of services: baseline level of resource density, resource density after injury, plus predictions of resource density each year during the recovery period; and

2. Gain in services during the lifetime of the replacement project: predicted gain in natural resource density during recovery and at full maturity of the restoration action, for the lifetime of the project.

Data and Assessment of Modeling/Analysis Options

A. **Data:** No site-specific data for restoration project gains, injury site baseline conditions (site-specific data limited to time of injury).
Modeling option: Transfer models, using site-specific parameter values, or transfer model results generated with parameter values in the literature.

   Trustees may use data and models for productivity reported in existing studies to predict the baseline productivity at the injury and replacement sites, the maximum productivity at the replacement site, the recovery function for productivity after primary restoration at the injury site, and the maturity function for productivity after compensatory restoration at the replacement site. Using site specific characteristics or characteristics from comparable sites will improve the prediction of productivity at the two sites.

B. **Data:** Data from reference sites and/or pilot projects are available.
Modeling option: Use data to forecast productivity at the injury and restoration sites.

   Trustees may collect data on productivity from reference or control sites, or from pilot projects, or monitor the early stages of the recovery process at the injured site. The data would allow estimation of the increase in productivity over time, taking into account biophysical and landscape features of the sites (e.g., species of vegetation, weather conditions, human and faunal uses), technical constraints in restoration technology, and threshold effects in the relationships.

Valuation approach

Projects 1 and 3 in the marsh injury example can not be scaled with the service-to-service approach because the services are of a different type and/or quality from those lost. In such cases, the valuation approach is to be considered.

Data requirements

As noted above, in addition to the data on extent and duration of the service losses and gains required for the service-to-service approach, the valuation approach requires a third category of information:

3. Total value of the reduction in services and total value of the gain in services.

Data and Assessment of Modeling/Analysis Options

Which options are available will depend upon whether only one, or multiple types of services need to be valued. Valuation of multiple types of services may be needed when a specific project provides different types of services from those lost, or when the goal is to perform one study valuing a mix of projects providing varying types of services.

A. **Data:** Measures of service levels are available.
Modeling option: Perform benefits transfer of values per service unit (see discussion in Section 4.6).

B. **Data:** Individual- (or household-) specific survey information is available.
Modeling option: Estimate conjoint analysis (stated choice) model.

To collect data to implement stated preference methods, individual survey respondents are presented with choices that include currently unavailable goods, such as injured resources or services from potential restoration projects. To meet the cost-effectiveness criterion, trustees would first consider designing data collection to estimate a unified model of resource losses and gains.

4.8.2 Evaluation of Alternative Scaling Approaches and Methods for Wetland Projects

After alternative scaling approaches and the methods to implement them have been identified for habitat injuries, the trustees evaluate them with the criteria outlined in Exhibit 4.1:

1. Are conditions of applicability met?

2. Are the incremental costs of performing more complex approaches and methods reasonable relative to the incremental information gains?

3. Are the procedures valid and reliable in the given context?

A thorough understanding of the requirements for and limitations of the specific procedures under consideration is needed before these questions can be answered. The studies described in Appendix D should be a help to readers seeking to expand their knowledge and understanding of scaling methods.

OIL POLLUTION ACT REGULATIONS

PART 990--NATURAL RESOURCE DAMAGE ASSESSMENTS

Subpart A--Introduction

Subpart F--Restoration Implementation Phase

Authority: 33 U.S.C. 2701 et seq.

Subpart A--Introduction

§ 990.10 Purpose.

The goal of the Oil Pollution Act of 1990 (OPA), 33 U.S.C. 2701 et seq., is to make the environment and public whole for injuries to natural resources and services resulting from an incident involving a discharge or substantial threat of a discharge of oil (incident). This goal is achieved through the return of the injured natural resources and services to baseline and compensation for interim losses of such natural resources and services from the date of the incident until recovery. The purpose of this part is to promote expeditious and cost-effective restoration of natural resources and services injured as a result of an incident. To fulfill this purpose, this part provides a natural resource damage assessment process for developing a plan for restoration of the injured natural resources and services and pursuing implementation or funding of the plan by responsible parties. This part also provides an administrative process for involving interested parties in the assessment, a range of assessment procedures for identifying and evaluating injuries to natural resources and services, and a means for selecting restoration actions from a reasonable range of alternatives.

§ 990.11 Scope.

The Oil Pollution Act of 1990 (OPA), 33 U.S.C. 2701 et seq., provides for the designation of federal, state, and, if designated by the Governor of the state, local officials to act on behalf of the public as trustees for natural resources and for the designation of Indian tribe and foreign officials to act as trustees for natural resources on behalf of, respectively, the tribe or its members and the foreign government. This part may be used by these officials in conducting natural resource damage assessments when natural resources and/or services are injured as a result of an incident involving an actual or substantial threat of a discharge of oil. This part is not intended to affect the recoverability of natural resource damages when recoveries are sought other than in accordance with this part.

§ 990.12 Overview.

This part describes three phases of a natural resource damage assessment. The Preassessment Phase, during which trustees determine whether to pursue restoration, is described in subpart D of this part. The Restoration Planning Phase, during which trustees evaluate information on potential injuries and use that information to determine the need for, type of, and scale of restoration, is described in subpart E of this part. The Restoration Implementation Phase, during which trustees ensure implementation of restoration, is described in subpart F of this part.

§ 990.13 Rebuttable presumption.

Any determination or assessment of damages to natural resources made by a Federal, State, or Indian trustee in accordance with this part shall have the force and effect of a rebuttable presumption on behalf of the trustee in any administrative or judicial proceeding under OPA.

§ 990.14 Coordination.

(a) Trustees. (1) If an incident affects the interests of multiple trustees, the trustees should act jointly under this part to ensure that full restoration is achieved without double recovery of damages. For joint assessments, trustees must designate one or more Lead Administrative Trustee(s) to act as coordinators.

(2) If there is a reasonable basis for dividing the natural resource damage assessment, trustees may act independently under this part, so long as there is no double recovery of damages.

(3) Trustees may develop pre-incident or incident-specific memoranda of understanding to coordinate their activities.

(b) Response agencies. Trustees must coordinate their activities conducted concurrently with response operations with response agencies consistent with the NCP and any pre-incident plans developed under Sec. 990.15(a) of this part. Trustees may develop pre-incident memoranda of understanding to coordinate their activities with response agencies.

(c) Responsible parties--(1) Invitation. Trustees must invite the responsible parties to participate in the natural resource damage assessment described in this part. The invitation to participate should be in writing, and a written response by the responsible parties is required to confirm the desire to participate.

(2) Timing. The invitation to participate should be extended to known responsible parties as soon as practicable, but not later than the delivery of the ‘‘Notice of Intent to Conduct Restoration Planning,” under Sec. 990.44 of this part, to the responsible party.

(3) Agreements. Trustees and responsible parties should consider entering into binding agreements to facilitate their interactions and resolve any disputes during the assessment. To maximize cost-effectiveness and cooperation, trustees and responsible parties should attempt to develop a set of agreed-upon facts concerning the incident and/or assessment.

(4) Nature and extent of participation. If the responsible parties accept the invitation to participate, the scope of that participation must be determined by the trustees, in light of the considerations in paragraph (c)(5) of this section. At a minimum, participation will include notice of trustee determinations required under this part, and notice and opportunity to comment on documents or plans that significantly affect the nature and extent of the assessment. Increased levels of participation by responsible parties may be developed at the mutual agreement of the trustees and the responsible parties. Trustees will objectively consider all written comments provided by the responsible parties, as well as any other recommendations or proposals that the responsible parties submit in writing to the Lead Administrative Trustee. Submissions by the responsible parties will be included in the administrative record. Final authority to make determinations regarding injury and restoration rest solely with the trustees. Trustees may end participation by responsible parties who, during the conduct of the assessment, in the sole judgment of the trustees, cause interference with the trustees' ability to fulfill their responsibilities under OPA and this part.

(5) Considerations. In determining the nature and extent of participation by the responsible parties or their representatives, trustees may consider such factors as:

(i) Whether the responsible parties have been identified;

(ii) The willingness of responsible parties to participate in the assessment;

(iii) The willingness of responsible parties to fund assessment activities;

(iv) The willingness and ability of responsible parties to conduct assessment activities in a technically sound and timely manner and to be bound by the results of jointly agreed upon studies;

(v) The degree of cooperation of the responsible parties in the response to the incident; and

(vi) The actions of the responsible parties in prior assessments.

(6) Request for alternative assessment procedures.

(i) The participating responsible parties may request that trustees use assessment procedures other than those selected by the trustees if the responsible parties:

(A) Identify the proposed procedures to be used that meet the requirements of Sec. 990.27 of this part, and provide reasons supporting the technical adequacy and appropriateness of such procedures for the incident and associated injuries;

(B) Advance to the trustees the trustees' reasonable estimate of the cost of using the proposed procedures; and

(C) Agree not to challenge the results of the proposed procedures. The request from the responsible parties may be made at any time, but no later than, fourteen (14) days of being notified of the trustees' proposed assessment procedures for the incident or the injury.

(ii) Trustees may reject the responsible parties' proposed assessment procedures if, in the sole judgment of the trustees, the proposed assessment procedures:

(A) Are not technically feasible;

(B) Are not scientifically or technically sound;

(C) Would inadequately address the natural resources and services of concern;

(D) Could not be completed within a reasonable time frame; or

(E) Do not meet the requirements of Sec. 990.27 of this part.

(7) Disclosure. Trustees must document in the administrative record and Restoration Plan the invitation to the responsible parties to participate, and briefly describe the nature and extent of the responsible parties' participation. If the responsible parties' participation is terminated during the assessment, trustees must provide a brief explanation of this decision in the administrative record and Restoration Plan.

(d) Public. Trustees must provide opportunities for public involvement after the trustees' decision to develop restoration plans or issuance of any notices to that effect, as provided in Sec. 990.55 of this part. Trustees may also provide opportunities for public involvement at any time prior to this decision if such involvement may enhance trustees' decisionmaking or avoid delays in restoration.

§ 990.15 Considerations to facilitate restoration.

In addition to the procedures provided in subparts D through F of this part, trustees may take other actions to further the goal of expediting restoration of injured natural resources and services, including:

(a) Pre-incident planning. Trustees may engage in pre-incident planning activities. Pre-incident plans may identify natural resource damage assessment teams, establish trustee notification systems, identify support services, identify natural resources and services at risk, identify area and regional response agencies and officials, identify available baseline information, establish data management systems, and identify assessment funding issues and options. Potentially responsible parties, as well as all other members of the public interested in and capable of participating in assessments, should be included in pre-incident planning to the fullest extent practicable.

(b) Regional Restoration Plans. Where practicable, incident-specific restoration plan development is preferred, however, trustees may develop Regional Restoration Plans. These plans may be used to support a claim under Sec. 990.56 of this part. Regional restoration planning may consist of compiling databases that identify, on a regional or watershed basis, or otherwise as appropriate, existing, planned, or proposed restoration projects that may provide appropriate restoration alternatives for consideration in the context of specific incidents.

Subpart B--Authorities

§ 990.20 Relationship to the CERCLA natural resource damage assessment regulations.

(a) General. Regulations for assessing natural resource damages resulting from hazardous substance releases under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. 9601 et seq., and the Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. 1321 et seq., are codified at 43 CFR part 11. The CERCLA regulations originally applied to natural resource damages resulting from oil discharges as well as hazardous substance releases. This part supersedes 43 CFR part 11 with regard to oil discharges covered by OPA.

(b) Assessments commenced before February 5, 1996. If trustees commenced a natural resource damage assessment for an oil discharge under 43 CFR part 11 prior to February 5, 1996 they may complete the assessment in compliance with 43 CFR part 11, or they may elect to use this part, and obtain a rebuttable presumption.

(c) Oil and hazardous substance mixtures. For natural resource damages resulting from a discharge or release of a mixture of oil and hazardous substances, trustees must use 43 CFR part 11 in order to obtain a rebuttable presumption.

§ 990.21 Relationship to the NCP.

This part provides procedures by which trustees may determine appropriate restoration of injured natural resources and services, where such injuries are not fully addressed by response actions. Response actions and the coordination with damage assessment activities are conducted pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR part 300.

§ 990.22 Prohibition on double recovery.

When taking actions under this part, trustees are subject to the prohibition on double recovery, as provided in 33 U.S.C. 2706(d)(3) of OPA.

§ 990.23 Compliance with NEPA and the CEQ regulations.

(a) General. The National Environmental Policy Act (NEPA), 42 U.S.C. 4321 et seq. and Council on Environmental Quality (CEQ) regulations implementing NEPA, 40 CFR chapter V, apply to restoration actions by federal trustees, except where a categorical exclusion or other exception to NEPA applies. Thus, when a federal trustee proposes to take restoration actions under this part, it must integrate this part with NEPA, the CEQ regulations, and NEPA regulations promulgated by that federal trustee agency. Where state NEPA-equivalent laws may apply to state trustees, state trustees must consider the extent to which they must integrate this part with their NEPA-equivalent laws. The requirements and process described in this section relate only to NEPA and federal trustees.

(b) NEPA requirements for federal trustees. NEPA becomes applicable when federal trustees propose to take restoration actions, which begins with the development of a Draft Restoration Plan under Sec. 990.55 of this part. Depending upon the circumstances of the incident, federal trustees may need to consider early involvement of the public in restoration planning in order to meet their NEPA compliance requirements.

(c) NEPA process for federal trustees. Although the steps in the NEPA process may vary among different federal trustees, the process will generally involve the need to develop restoration plans in the form of an Environmental Assessment or Environmental Impact Statement, depending upon the trustee agency's own NEPA regulations. (1) Environmental Assessment.

(i) Purpose. The purpose of an Environmental Assessment (EA) is to determine whether a proposed restoration action will have a significant (as defined under NEPA and Sec. 1508.27 of the CEQ regulations) impact on the quality of the human environment, in which case an Environmental Impact Statement (EIS) evaluating the impact is required. In the alternative, where the impact will not be significant, federal trustees must issue a Finding of No Significant Impact (FONSI) as part of the restoration plans developed under this part. If significant impacts to the human environment are anticipated, the determination to proceed with an EIS may be made as a result, or in lieu, of the development of the EA.

(ii) General steps. (A) If the trustees decide to pursue an EA, the trustees may issue a Notice of Intent to Prepare a Draft Restoration Plan/EA, or proceed directly to developing a Draft Restoration Plan/EA.

(B) The Draft Restoration Plan/EA must be made available for public review before concluding a FONSI or proceeding with an EIS.

(C) If a FONSI is concluded, the restoration planning process should be no different than under Sec. 990.55 of this part, except that the Draft Restoration Plan/EA will include the FONSI analysis.

(D) The time period for public review on the Draft Restoration Plan/EA must be consistent with the federal trustee agency's NEPA requirements, but should generally be no less than thirty (30) calendar days.

(E) The Final Restoration Plan/EA must consider all public comments on the Draft Restoration Plan/EA and FONSI.

(F) The means by which a federal trustee requests, considers, and responds to public comments on the Draft Restoration Plan/EA and FONSI must also be consistent with the federal agency's NEPA requirements.

(2) Environmental Impact Statement. (i) Purpose. The purpose of an Environmental Impact Statement (EIS) is to involve the public and facilitate the decisionmaking process in the federal trustees' analysis of alternative approaches to restoring injured natural resources and services, where the impacts of such restoration are expected to have significant impacts on the quality of the human environment.

(ii) General steps. (A) If trustees determine that restoration actions are likely to have a significant (as defined under NEPA and Sec. 1508.27 of the CEQ regulations) impact on the environment, they must issue a Notice of Intent to Prepare a Draft Restoration Plan/EIS. The notice must be published in the Federal Register.

(B) The notice must be followed by formal public involvement in the development of the Draft Restoration Plan/EIS.

(C) The Draft Restoration Plan/EIS must be made available for public review for a minimum of forty-five (45) calendar days. The Draft Restoration Plan/EIS, or a notice of its availability, must be published in the Federal Register.

(D) The Final Restoration Plan/EIS must consider all public comments on the Draft Restoration Plan/EIS, and incorporate any changes made to the Draft Restoration Plan/EIS in response to public comments.

(E) The Final Restoration Plan/EIS must be made publicly available for a minimum of thirty (30) calendar days before a decision is made on the federal trustees' proposed restoration actions (Record of Decision). The Final Restoration Plan/EIS, or a notice of its availability, must be published in the Federal Register.

(F) The means by which a federal trustee agency requests, considers, and responds to public comments on the Final Restoration Plan/EIS must also be consistent with the federal agency's NEPA requirements.

(G) After appropriate public review on the Final Restoration Plan/EIS is completed, a Record of Decision (ROD) is issued. The ROD summarizes the trustees' decisionmaking process after consideration of any public comments relative to the proposed restoration actions, identifies all restoration alternatives (including the preferred alternative(s)), and their environmental consequences, and states whether all practicable means to avoid or minimize environmental harm were adopted (e.g., monitoring and corrective actions). The ROD may be incorporated with other decision documents prepared by the trustees. The means by which the ROD is made publicly available must be consistent with the federal trustee agency's NEPA requirements.

(d) Relationship to Regional Restoration Plans or an existing restoration project. If a Regional Restoration Plan or existing restoration project is proposed for use, federal trustees may be able to tier their NEPA analysis to an existing EIS, as described in Secs. 1502.20 and 1508.28 of the CEQ regulations.

§ 990.24 Compliance with other applicable laws and regulations.

(a) Worker health and safety. When taking actions under this part, trustees must comply with applicable worker health and safety considerations specified in the NCP for response actions.

(b) Natural Resources protection. When acting under this part, trustees must ensure compliance with any applicable consultation, permitting, or review requirements, including but not limited to: the Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.; the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et seq.; the Migratory Bird Treaty Act, 16 U.S.C. 703 et seq.; the National Marine Sanctuaries Act, 16 U.S.C. 1431 et seq.; the National Historic Preservation Act, 12 U.S.C. 470 et seq.; the Marine Mammal Protection Act, 16 U.S.C. 1361 et seq.; and the Archaeological Resources Protection Act, 16 U.S.C. 470 et seq.

§ 990.25 Settlement.

Trustees may settle claims for natural resource damages under this part at any time, provided that the settlement is adequate in the judgment of the trustees to satisfy the goal of OPA and is fair, reasonable, and in the public interest, with particular consideration of the adequacy of the settlement to restore, replace, rehabilitate, or acquire the equivalent of the injured natural resources and services. Sums recovered in settlement of such claims, other than reimbursement of trustee costs, may only be expended in accordance with a restoration plan, which may be set forth in whole or in part in a consent decree or other settlement agreement, which is made available for public review.

§ 990.26 Emergency restoration.

(a) Trustees may take emergency restoration action before completing the process established under this part, provided that:

(1) The action is needed to minimize continuing or prevent additional injury;

(2) The action is feasible and likely to minimize continuing or prevent additional injury; and

(3) The costs of the action are not unreasonable.

(b) If response actions are still underway, trustees, through their Regional Response Team member or designee, must coordinate with the On- Scene Coordinator (OSC) before taking any emergency restoration actions. Any emergency restoration actions proposed by trustees should not interfere with on-going response actions. Trustees must explain to response agencies through the OSC prior to implementation of emergency restoration actions their reasons for believing that proposed emergency restoration actions will not interfere with on-going response actions.

(c) Trustees must provide notice to identified responsible parties of any emergency restoration actions and, to the extent time permits, invite their participation in the conduct of those actions as provided in Sec. 990.14(c) of this part.

(d) Trustees must provide notice to the public, to the extent practicable, of these planned emergency restoration actions. Trustees must also provide public notice of the justification for, nature and extent of, and results of emergency restoration actions within a reasonable time frame after completion of such actions. The means by which this notice is provided is left to the discretion of the trustee.

§ 990.27 Use of assessment procedures.

(a) Standards for assessment procedures. Any procedures used pursuant to this part must comply with all of the following standards if they are to be in accordance with this part:

(1) The procedure must be capable of providing assessment information of use in determining the type and scale of restoration appropriate for a particular injury;

(2) The additional cost of a more complex procedure must be reasonably related to the expected increase in the quantity and/or quality of relevant information provided by the more complex procedure; and

(3) The procedure must be reliable and valid for the particular incident.

(b) Assessment procedures available. (1) The range of assessment procedures available to trustees includes, but is not limited to:

(i) Procedures conducted in the field;

(ii) Procedures conducted in the laboratory;

(iii) Model-based procedures, including type A procedures identified in 43 CFR part 11, subpart D, and compensation formulas/schedules; and

(iv) Literature-based procedures.

(2) Trustees may use the assessment procedures in paragraph (b)(1) of this section alone, or in any combination, provided that the standards in paragraph (a) of this section are met, and there is no double recovery.

(c) Selecting assessment procedures. (1) When selecting assessment procedures, trustees must consider, at a minimum:

(i) The range of procedures available under paragraph (b) of this section;

(ii) The time and cost necessary to implement the procedures;

(iii) The potential nature, degree, and spatial and temporal extent of the injury;

(iv) The potential restoration actions for the injury; and

(v) The relevance and adequacy of information generated by the procedures to meet information requirements of restoration planning.

(2) If a range of assessment procedures providing the same type and quality of information is available, the most cost-effective procedure must be used.

Subpart C--Definitions

§ 990.30 Definitions.

For the purpose of this rule, the term:

Baseline means the condition of the natural resources and services that would have existed had the incident not occurred. Baseline data may be estimated using historical data, reference data, control data, or data on incremental changes (e.g., number of dead animals), alone or in combination, as appropriate.

Cost-effective means the least costly activity among two or more activities that provide the same or a comparable level of benefits, in the judgment of the trustees.

CEQ regulations means the Council on Environmental Quality regulations implementing NEPA, 40 CFR chapter V.

Damages means damages specified in section 1002(b) of OPA (33 U.S.C. 1002(b)), and includes the costs of assessing these damages, as defined in section 1001(5) of OPA (33 U.S.C. 2701(5)).

Discharge means any emission (other than natural seepage), intentional or unintentional, and includes, but is not limited to, spilling, leaking, pumping, pouring, emitting, emptying, or dumping, as defined in section 1001(7) of OPA (33 U.S.C. 2701(7)).

Exclusive Economic Zone means the zone established by Presidential Proclamation 5030 of March 10, 1983 (3 CFR, 1984 Comp., p. 22), including the ocean waters of the areas referred to as ‘‘eastern special areas” in Article 3(1) of the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Maritime Boundary, signed June 1, 1990, as defined in section 1001(8) of OPA (33 U.S.C. 2701(8)).

Exposure means direct or indirect contact with the discharged oil. Facility means any structure, group of structures, equipment, or device (other than a vessel) which is used for one or more of the following purposes: exploring for, drilling for, producing, storing, handling, transferring, processing, or transporting oil. This term includes any motor vehicle, rolling stock, or pipeline used for one or more of these purposes, as defined in section 1001(9) of OPA (33 U.S.C. 2701(9)).

Fund means the Oil Spill Liability Trust Fund, established by section 9509 of the Internal Revenue Code of 1986 (26 U.S.C. 9509), as defined in section 1001(11) of OPA (33 U.S.C. 2701(11)).

Incident means any occurrence or series of occurrences having the same origin, involving one or more vessels, facilities, or any combination thereof, resulting in the discharge or substantial threat of discharge of oil into or upon navigable waters or adjoining shorelines or the Exclusive Economic Zone, as defined in section 1001(14) of OPA (33 U.S.C. 2701(14)).

Indian tribe (or tribal) means any Indian tribe, band, nation, or other organized group or community, but not including any Alaska Native regional or village corporation, which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians and has governmental authority over lands belonging to or controlled by the tribe, as defined in section 1001(15) of OPA (33 U.S.C. 2701(15)).

Injury means an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service. Injury incorporates the terms ‘‘destruction,” ‘‘loss,” and ‘‘loss of use” as provided in OPA.

Lead Administrative Trustee(s) (or LAT) means the trustee(s) who is selected by all participating trustees whose natural resources or services are injured by an incident, for the purpose of coordinating natural resource damage assessment activities. The LAT(s) should also facilitate communication between the OSC and other natural resource trustees regarding their activities during the response phase.

NCP means the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan) codified at 40 CFR part 300, which addresses the identification, investigation, study, and response to incidents, as defined in section 1001(19) of OPA (33 U.S.C. 2701(19)).

Natural resource damage assessment (or assessment) means the process of collecting and analyzing information to evaluate the nature and extent of injuries resulting from an incident, and determine the restoration actions needed to bring injured natural resources and services back to baseline and make the environment and public whole for interim losses.

Natural resources means land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the Exclusive Economic Zone), any state or local government or Indian tribe, or any foreign government, as defined in section 1001(20) of OPA (33 U.S.C. 2701(20)).

Navigable waters means the waters of the United States, including the territorial sea, as defined in section 1001(21) of OPA (33 U.S.C. 2701(21)).

NEPA means the National Environmental Policy Act, 42 U.S.C. 4321 et seq.

Oil means oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil. However, the term does not include petroleum, including crude oil or any fraction thereof, that is specifically listed or designated as a hazardous substance under 42 U.S.C. 9601(14)(A) through (F), as defined in section 1001(23) of OPA (33 U.S.C. 2701(23)).

On-Scene Coordinator (or OSC) means the official designated by the U.S. Environmental Protection Agency or the U.S. Coast Guard to coordinate and direct response actions under the NCP, or the government official designated by the lead response agency to coordinate and direct response actions under the NCP.

OPA means the Oil Pollution Act of 1990, 33 U.S.C. 2701 et seq.

Pathway means any link that connects the incident to a natural resource and/or service, and is associated with an actual discharge of oil.

Person means an individual, corporation, partnership, association, state, municipality, commission, or political subdivision of a state, or any interstate body, as defined in section 1001(27) of OPA (33 U.S.C. 2701(27)).

Public vessel means a vessel owned or bareboat chartered and operated by the United States, or by a state or political subdivision thereof, or by a foreign nation, except when the vessel is engaged in commerce, as defined in section 1001(29) of OPA (33 U.S.C. 2701(29)).

Reasonable assessment costs means, for assessments conducted under this part, assessment costs that are incurred by trustees in accordance with this part. In cases where assessment costs are incurred but trustees do not pursue restoration, trustees may recover their reasonable assessment costs provided that they have determined that assessment actions undertaken were premised on the likelihood of injury and need for restoration. Reasonable assessment costs also include: administrative, legal, and enforcement costs necessary to carry out this part; monitoring and oversight costs; and costs associated with public participation.

Recovery means the return of injured natural resources and services to baseline.

Response (or remove or removal) means containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines, and beaches, as defined in section 1001(30) of OPA (33 U.S.C. 2701(30)).

Responsible party means:

(a) Vessels. In the case of a vessel, any person owning, operating, or demise chartering the vessel.

(b) Onshore facilities. In the case of an onshore facility (other than a pipeline), any person owning or operating the facility, except a federal agency, state, municipality, commission, or political subdivision of a state, or any interstate body, that as the owner transfers possession and right to use the property to another person by lease, assignment, or permit.

(c) Offshore facilities. In the case of an offshore facility (other than a pipeline or a deepwater port licensed under the Deepwater Port Act of 1974 (33 U.S.C. 1501 et seq.)), the lessee or permittee of the area in which the facility is located or the holder of a right of use and easement granted under applicable state law or the Outer Continental Shelf Lands Act (43 U.S.C. 1301-1356) for the area in which the facility is located (if the holder is a different person than the lessee or permittee), except a federal agency, state, municipality, commission, or political subdivision of a state, or any interstate body, that as owner transfers possession and right to use the property to another person by lease, assignment, or permit.

(d) Deepwater ports. In the case of a deepwater port licensed under the Deepwater Port Act of 1974 (33 U.S.C. 1501-1524), the licensee.

(e) Pipelines. In the case of a pipeline, any person owning or operating the pipeline.

(f) Abandonment. In the case of an abandoned vessel, onshore facility, deepwater port, pipeline, or offshore facility, the persons who would have been responsible parties immediately prior to the abandonment of the vessel or facility, as defined in section 1001(32) of OPA (33 U.S.C. 2701(32)).

Restoration means any action (or alternative), or combination of actions (or alternatives), to restore, rehabilitate, replace, or acquire the equivalent of injured natural resources and services. Restoration includes:

(a) Primary restoration, which is any action, including natural recovery, that returns injured natural resources and services to baseline; and

(b) Compensatory restoration, which is any action taken to compensate for interim losses of natural resources and services that occur from the date of the incident until recovery.

Services (or natural resource services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public.

Trustees (or natural resource trustees) means those officials of the federal and state governments, of Indian tribes, and of foreign governments, designated under 33 U.S.C. 2706(b) of OPA.

United States and *State* means the several States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Commonwealth of the Northern Marianas, and any other territory or possession of the United States, as defined in section 1001(36) of OPA (33 U.S.C. 2701(36)).

Value means the maximum amount of goods, services, or money an individual is willing to give up to obtain a specific good or service, or the minimum amount of goods, services, or money an individual is willing to accept to forgo a specific good or service. The total value of a natural resource or service includes the value individuals derive from direct use of the natural resource, for example, swimming, boating, hunting, or birdwatching, as well as the value individuals derive from knowing a natural resource will be available for future generations.

Vessel means every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water, other than a public vessel, as defined in section 1001(37) of OPA (33 U.S.C. 2701(37)).

Subpart D--Preassessment Phase

§ 990.40 Purpose.

The purpose of this subpart is to provide a process by which trustees determine if they have jurisdiction to pursue restoration under OPA and, if so, whether it is appropriate to do so.

§ 990.41 Determination of jurisdiction.

(a) Determination of jurisdiction. Upon learning of an incident, trustees must determine whether there is jurisdiction to pursue restoration under OPA. To make this determination, trustees must decide if:

(1) An incident has occurred, as defined in Sec. 990.30 of this part;

(2) The incident is not:

(i) Permitted under a permit issued under federal, state, or local law; or

(ii) From a public vessel; or

(iii) From an onshore facility subject to the Trans-Alaska Pipeline Authority Act, 43 U.S.C. 1651, et seq.; and

(3) Natural resources under the trusteeship of the trustee may have been, or may be, injured as a result of the incident.

(b) Proceeding with preassessment. If the conditions listed in paragraph (a) of this section are met, trustees may proceed under this part. If one of the conditions is not met, trustees may not take additional action under this part, except action to finalize this determination. Trustees may recover all reasonable assessment costs incurred up to this point provided that conditions in paragraphs (a)(1) and (a)(2) of this section were met and actions were taken with the reasonable belief that natural resources or services under their trusteeship might have been injured as a result of the incident.

§ 990.42 Determination to conduct restoration planning.

(a) Determination on restoration planning. If trustees determine that there is jurisdiction to pursue restoration under OPA, trustees must determine whether:

(1) Injuries have resulted, or are likely to result, from the incident;

(2) Response actions have not adequately addressed, or are not expected to address, the injuries resulting from the incident; and

(3) Feasible primary and/or compensatory restoration actions exist to address the potential injuries.

(b) Proceeding with preassessment. If the conditions listed in paragraph (a) of this section are met, trustees may proceed under Sec. 990.44 of this part. If one of these conditions is not met, trustees may not take additional action under this part, except action to finalize this determination. However, trustees may recover all reasonable assessment costs incurred up to this point.

§ 990.43 Data collection.

Trustees may conduct data collection and analyses that are reasonably related to Preassessment Phase activities. Data collection and analysis during the Preassessment Phase must be coordinated with response actions such that collection and analysis does not interfere with response actions. Trustees may collect and analyze the following types of data during the Preassessment Phase:

(a) Data reasonably expected to be necessary to make a determination of jurisdiction under Sec. 990.41 of this part, or a determination to conduct restoration planning under Sec. 990.42 of this part;

(b) Ephemeral data; and

(c) Information needed to design or implement anticipated assessment procedures under subpart E of this part.

§ 990.44 Notice of Intent to Conduct Restoration Planning.

(a) General. If trustees determine that all the conditions under Sec. 990.42(a) of this part are met and trustees decide to proceed with the natural resource damage assessment, they must prepare a Notice of Intent to Conduct Restoration Planning.

(b) Contents of the notice. The Notice of Intent to Conduct Restoration Planning must include a discussion of the trustees' analyses under Secs. 990.41 and 990.42 of this part. Depending on information available at this point, the notice may include the trustees' proposed strategy to assess injury and determine the type and scale of restoration. The contents of a notice may vary, but will typically discuss:

(1) The facts of the incident;

(2) Trustee authority to proceed with the assessment;

(3) Natural resources and services that are, or are likely to be, injured as a result of the incident;

(4) Potential restoration actions relevant to the expected injuries; and

(5) If determined at the time, potential assessment procedures to evaluate the injuries and define the appropriate type and scale of restoration for the injured natural resources and services.

(c) Public availability of the notice. Trustees must make a copy of the Notice of Intent to Conduct Restoration Planning publicly available. The means by which the notice is made publicly available and whether public comments are solicited on the notice will depend on the nature and extent of the incident and various information requirements, and is left to the discretion of the trustees.

(d) Delivery of the notice to the responsible parties. Trustees must send a copy of the notice to the responsible parties, to the extent known, in such a way as will establish the date of receipt, and invite responsible parties' participation in the conduct of restoration planning. Consistent with Sec. 990.14(c) of this part, the determination of the timing, nature, and extent of responsible party participation will be determined by the trustees on an incident-specific basis.

§ 990.45 Administrative record.

(a) If trustees decide to proceed with restoration planning, they must open a publicly available administrative record to document the basis for their decisions pertaining to restoration. The administrative record should be opened concurrently with the publication of the Notice of Intent to Conduct Restoration Planning. Depending on the nature and extent of the incident and assessment, the administrative record should include documents relied upon during the assessment, such as:

(1) Any notice, draft and final restoration plans, and public comments;

(2) Any relevant data, investigation reports, scientific studies, work plans, quality assurance plans, and literature; and

(3) Any agreements, not otherwise privileged, among the participating trustees or with the responsible parties.

(b) Federal trustees should maintain the administrative record in a manner consistent with the Administrative Procedure Act, 5 U.S.C. 551-59, 701-06.

Subpart E--Restoration Planning Phase

§ 990.50 Purpose.

The purpose of this subpart is to provide a process by which trustees evaluate and quantify potential injuries (injury assessment), and use that information to determine the need for and scale of restoration actions (restoration selection).

§ 990.51 Injury assessment--injury determination.

(a) General. After issuing a Notice of Intent to Conduct Restoration Planning under Sec. 990.44 of this part, trustees must determine if injuries to natural resources and/or services have resulted from the incident.

(b) Determining injury. To make the determination of injury, trustees must evaluate if:

(1) The definition of injury has been met, as defined in Sec. 990.30 of this part; and
(2)(i) An injured natural resource has been exposed to the discharged oil, and a pathway can be established from the discharge to the exposed natural resource; or

(ii) An injury to a natural resource or impairment of a natural resource service has occurred as a result of response actions or a substantial threat of a discharge of oil.

(c) Identifying injury. Trustees must determine whether an injury has occurred and, if so, identify the nature of the injury. Potential categories of injury include, but are not limited to, adverse changes in: survival, growth, and reproduction; health, physiology and biological condition; behavior; community composition; ecological processes and functions; physical and chemical habitat quality or structure; and public services.

(d) Establishing exposure and pathway. Except for injuries resulting from response actions or incidents involving a substantial threat of a discharge of oil, trustees must establish whether natural resources were exposed, either directly or indirectly, to the discharged oil from the incident, and estimate the amount or concentration and spatial and temporal extent of the exposure. Trustees must also determine whether there is a pathway linking the incident to the injuries. Pathways may include, but are not limited to, the sequence of events by which the discharged oil was transported from the incident and either came into direct physical contact with a natural resource, or caused an indirect injury.

(e) Injuries resulting from response actions or incidents involving a substantial threat of a discharge. For injuries resulting from response actions or incidents involving a substantial threat of a discharge of oil, trustees must determine whether an injury or an impairment of a natural resource service has occurred as a result of the incident.

(f) Selection of injuries to include in the assessment. When selecting potential injuries to assess, trustees should consider factors such as:

(1) The natural resources and services of concern;

(2) The procedures available to evaluate and quantify injury, and associated time and cost requirements;

(3) The evidence indicating exposure;

(4) The pathway from the incident to the natural resource and/or service of concern;

(5) The adverse change or impairment that constitutes injury;

(6) The evidence indicating injury;

(7) The mechanism by which injury occurred;

(8) The potential degree, and spatial and temporal extent of the injury;

(9) The potential natural recovery period; and

(10) The kinds of primary and/or compensatory restoration actions that are feasible.

§ 990.52 Injury assessment--quantification.

(a) General. In addition to determining whether injuries have resulted from the incident, trustees must quantify the degree, and spatial and temporal extent of such injuries relative to baseline.

(b) Quantification approaches. Trustees may quantify injuries in terms of:

(1) The degree, and spatial and temporal extent of the injury to a natural resource;

(2) The degree, and spatial and temporal extent of injury to a natural resource, with subsequent translation of that adverse change to a reduction in services provided by the natural resource; or

(3) The amount of services lost as a result of the incident.

(c) Natural recovery. To quantify injury, trustees must estimate, quantitatively or qualitatively, the time for natural recovery without restoration, but including any response actions. The analysis of natural recovery may consider such factors as:

(1) The nature, degree, and spatial and temporal extent of injury;

(2) The sensitivity and vulnerability of the injured natural resource and/or service;

(3) The reproductive and recruitment potential;

(4) The resistance and resilience (stability) of the affected environment;

(5) The natural variability; and

(6) The physical/chemical processes of the affected environment.

§ 990.53 Restoration selection--developing restoration alternatives.

(a) General. (1) If the information on injury determination and quantification under Secs. 990.51 and 990.52 of this part and its relevance to restoration justify restoration, trustees may proceed with the Restoration Planning Phase. Otherwise, trustees may not take additional action under this part. However, trustees may recover all reasonable assessment costs incurred up to this point.

(2) Trustees must consider a reasonable range of restoration alternatives before selecting their preferred alternative(s). Each restoration alternative is comprised of primary and/or compensatory restoration components that address one or more specific injury(ies)

associated with the incident. Each alternative must be designed so that, as a package of one or more actions, the alternative would make the environment and public whole. Only those alternatives considered technically feasible and in accordance with applicable laws, regulations, or permits may be considered further under this part.

(b) Primary restoration. (1) General. For each alternative, trustees must consider primary restoration actions, including a natural recovery alternative.

(2) Natural recovery. Trustees must consider a natural recovery alternative in which no human intervention would be taken to directly restore injured natural resources and services to baseline.

(3) Active primary restoration actions. Trustees must consider an alternative comprised of actions to directly restore the natural resources and services to baseline on an accelerated time frame. When identifying such active primary restoration actions, trustees may consider actions that:

(i) Remove conditions that would prevent or limit the effectiveness of any restoration action (e.g., residual sources of contamination);

(ii) May be necessary to return the physical, chemical, and/or biological conditions necessary to allow recovery or restoration of the injured natural resources (e.g., replacing substrate or vegetation, or modifying hydrologic conditions); or

(iii) Return key natural resources and services, and would be an effective approach to achieving or accelerating a return to baseline (e.g., replacing essential species, habitats, or public services that would facilitate the replacement of other, dependent natural resource or service components).

(c) Compensatory restoration. (1) General. For each alternative, trustees must also consider compensatory restoration actions to compensate for the interim loss of natural resources and services pending recovery.

(2) Compensatory restoration actions. To the extent practicable, when evaluating compensatory restoration actions, trustees must consider compensatory restoration actions that provide services of the same type and quality, and of comparable value as those injured. If, in the judgment of the trustees, compensatory actions of the same type and quality and comparable value cannot provide a reasonable range of alternatives, trustees should identify actions that provide natural resources and services of comparable type and quality as those provided by the injured natural resources. Where the injured and replacement natural resources and services are not of comparable value, the scaling process will involve valuation of lost and replacement services.

(d) Scaling restoration actions. (1) General. After trustees have identified the types of restoration actions that will be considered, they must determine the scale of those actions that will make the environment and public whole. For primary restoration actions, scaling generally applies to actions involving replacement and/or acquisition of equivalent of natural resources and/or services.

(2) Resource-to-resource and service-to-service scaling approaches. When determining the scale of restoration actions that provide natural resources and/or services of the same type and quality, and of comparable value as those lost, trustees must consider the use of a resource-to-resource or service-to-service scaling approach. Under this approach, trustees determine the scale of restoration actions that will provide natural resources and/or services equal in quantity to those lost.

(3) Valuation scaling approach. (i) Where trustees have determined that neither resource-to-resource nor service-to-service scaling is appropriate, trustees may use the valuation scaling approach. Under the valuation scaling approach, trustees determine the amount of natural resources and/or services that must be provided to produce the same value lost to the public. Trustees must explicitly measure the value of injured natural resources and/or services, and then determine the scale of the restoration action necessary to produce natural resources and/or services of equivalent value to the public.

(ii) If, in the judgment of the trustees, valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time frame or at a reasonable cost, as determined by Sec. 990.27(a)(2) of this part, trustees may estimate the dollar value of the lost services and select the scale of the restoration action that has a cost equivalent to the lost value. The responsible parties may request that trustees value the natural resources and services provided by the restoration action following the process described in Sec. 990.14(c) of this part.

(4) Discounting and uncertainty. When scaling a restoration action, trustees must evaluate the uncertainties associated with the projected consequences of the restoration action, and must discount all service quantities and/or values to the date the demand is presented to the responsible parties. Where feasible, trustees should use risk-adjusted measures of losses due to injury and of gains from the restoration action, in conjunction with a riskless discount rate representing the consumer rate of time preference. If the streams of losses and gains cannot be adequately adjusted for risks, then trustees may use a discount rate that incorporates a suitable risk adjustment to the riskless rate.

§ 990.54 Restoration selection--evaluation of alternatives.

(a) Evaluation standards. Once trustees have developed a reasonable range of restoration alternatives under Sec. 990.53 of this part, they must evaluate the proposed alternatives based on, at a minimum:

(1) The cost to carry out the alternative;

(2) The extent to which each alternative is expected to meet the trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim
losses;

(3) The likelihood of success of each alternative;

(4) The extent to which each alternative will prevent future injury as a result of the incident, and avoid collateral injury as a result of implementing the alternative;

(5) The extent to which each alternative benefits more than one natural resource and/or service; and

(6) The effect of each alternative on public health and safety.

(b) Preferred restoration alternatives. Based on an evaluation of the factors under paragraph (a) of this section, trustees must select a preferred restoration alternative(s). If the trustees conclude that two or more alternatives are equally preferable based on these factors, the trustees must select the most cost-effective alternative.

(c) Pilot projects. Where additional information is needed to identify and evaluate the feasibility and likelihood of success of restoration alternatives, trustees may implement restoration pilot projects. Pilot projects should only be undertaken when, in the judgment of the trustees, these projects are likely to provide the information, described in paragraph (a) of this section, at a reasonable cost and in a reasonable time frame.

§ 990.55 Restoration selection--developing restoration plans.

(a) General. OPA requires that damages be based upon a plan developed with opportunity for public review and comment. To meet this requirement, trustees must, at a minimum, develop a Draft and Final Restoration Plan, with an opportunity for public review of and comment on the draft plan.

(b) Draft Restoration Plan. (1) The Draft Restoration Plan should include:

(i) A summary of injury assessment procedures used;

(ii) A description of the nature, degree, and spatial and temporal extent of injuries resulting from the incident;

(iii) The goals and objectives of restoration;

(iv) The range of restoration alternatives considered, and a discussion of how such alternatives were developed under Sec. 990.53 of this part, and evaluated under Sec. 990.54 of this part;

(v) Identification of the trustees' tentative preferred alternative(s);

(vi) A description of past and proposed involvement of the responsible parties in the assessment; and

(vii) A description of monitoring for documenting restoration effectiveness, including performance criteria that will be used to determine the success of restoration or need for interim corrective action.

(2) When developing the Draft Restoration Plan, trustees must establish restoration objectives that are specific to the injuries. These objectives should clearly specify the desired outcome, and the performance criteria by which successful restoration will be judged. Performance criteria may include structural, functional, temporal, and/or other demonstrable factors. Trustees must, at a minimum, determine what criteria will:

(i) Constitute success, such that responsible parties are relieved of responsibility for further restoration actions; or

(ii) Necessitate corrective actions in order to comply with the terms of a restoration plan or settlement agreement.

(3) The monitoring component to the Draft Restoration Plan should address such factors as duration and frequency of monitoring needed to gauge progress and success, level of sampling needed to detect success or the need for corrective action, and whether monitoring of a reference or control site is needed to determine progress and success. Reasonable monitoring and oversight costs cover those activities necessary to gauge the progress, performance, and success of the restoration actions developed under the plan.

(c) Public review and comment. The nature of public review and comment on the Draft and Final Restoration Plans will depend on the nature of the incident and any applicable federal trustee NEPA requirements, as described in Secs. 990.14(d) and 990.23 of this part.

(d) Final Restoration Plan. Trustees must develop a Final Restoration Plan that includes the information specified in paragraph (a) of this section, responses to public comments, if applicable, and an indication of any changes made to the Draft Restoration Plan.

§ 990.56 Restoration selection--use of a Regional Restoration Plan or existing restoration project.

(a) General. Trustees may consider using a Regional Restoration Plan or existing restoration project where such a plan or project is determined to be the preferred alternative among a range of feasible restoration alternatives for an incident, as determined under Sec. 990.54 of this part. Such plans or projects must be capable of fulfilling OPA's intent for the trustees to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources and services and compensate for interim losses.

(b) Existing plans or projects--(1) Considerations. Trustees may select a component of a Regional Restoration Plan or an existing restoration project as the preferred alternative, provided that the plan or project:

(i) Was developed with public review and comment or is subject to public review and comment under this part;

(ii) Will adequately compensate the environment and public for injuries resulting from the incident;

(iii) Addresses, and is currently relevant to, the same or comparable natural resources and services as those identified as having been injured; and

(iv) Allows for reasonable scaling relative to the incident.

(2) Demand. (i) If the conditions of paragraph (b)(1) of this section are met, the trustees must invite the responsible parties to implement that component of the Regional Restoration Plan or existing restoration project, or advance to the trustees the trustees' reasonable estimate of the cost of implementing that component of the Regional Restoration Plan or existing restoration project.

(ii) If the conditions of paragraph (b)(1) of this section are met, but the trustees determine that the scale of the existing plan or project is greater than the scale of compensation required by the incident, trustees may only request funding from the responsible parties equivalent to the scale of the restoration determined to be appropriate for the incident of concern. Trustees may pool such partial recoveries until adequate funding is available to successfully implement the existing plan or project.

(3) Notice of Intent To Use a Regional Restoration Plan or Existing Restoration Project. If trustees intend to use an appropriate component of a Regional Restoration Plan or existing restoration project, they must prepare a Notice of Intent to Use a Regional Restoration Plan or Existing Restoration Project. Trustees must make a copy of the notice publicly available. The notice must include, at a minimum:

(i) A description of the nature, degree, and spatial and temporal extent of injuries; and

(ii) A description of the relevant component of the Regional Restoration Plan or existing restoration project; and

(iii) An explanation of how the conditions set forth in paragraph (b)(1) of this section are met.

Subpart F--Restoration Implementation Phase

§ 990.60 Purpose.

The purpose of this subpart is to provide a process for implementing restoration.

§ 990.61 Administrative record.

(a) Closing the administrative record for restoration planning. Within a reasonable time after the trustees have completed restoration planning, as provided in Secs. 990.55 and 990.56 of this part, they must close the administrative record. Trustees may not add documents to the administrative record once it is closed, except where such documents:

(1) Are offered by interested parties that did not receive actual or constructive notice of the Draft Restoration Plan and the opportunity to comment on the plan;

(2) Do not duplicate information already contained in the administrative record; and

(3) Raise significant issues regarding the Final Restoration Plan.

(b) Opening an administrative record for restoration implementation. Trustees may open an administrative record for implementation of restoration, as provided in Sec. 990.45 of this part. The costs associated with the administrative record are part of the costs of restoration. Ordinarily, the administrative record for implementation of restoration should document, at a minimum, all Restoration Implementation Phase decisions, actions, and expenditures, including any modifications made to the Final Restoration Plan.

§ 990.62 Presenting a demand.

(a) General. After closing the administrative record for restoration planning, trustees must present a written demand to the responsible parties. Delivery of the demand should be made in a manner that establishes the date of receipt by the responsible parties.

(b) When a Final Restoration Plan has been developed. Except as provided in paragraph (c) of this section and in Sec. 990.14(c) of this part, the demand must invite the responsible parties to either:

(1) Implement the Final Restoration Plan subject to trustee oversight and reimburse the trustees for their assessment and oversight costs; or

(2) Advance to the trustees a specified sum representing trustee assessment costs and all trustee costs associated with implementing the Final Restoration Plan, discounted as provided in Sec. 990.63(a) of this part.

(c) Regional Restoration Plan or existing restoration project. When the trustees use a Regional Restoration Plan or an existing restoration project under Sec. 990.56 of this part, the demand will invite the responsible parties to implement a component of a Regional Restoration Plan or existing restoration project, or advance the trustees' estimate of damages based on the scale of the restoration determined to be appropriate for the incident of concern, which may be the entire project or a portion thereof.

(d) Response to demand. The responsible parties must respond within ninety (90) calendar days in writing by paying or providing binding assurance they will reimburse trustees' assessment costs and implement the plan or pay assessment costs and the trustees' estimate of the costs of implementation.

(e) Additional contents of demand. The demand must also include:

(1) Identification of the incident from which the claim arises;

(2) Identification of the trustee(s) asserting the claim and a statement of the statutory basis for trusteeship;

(3) A brief description of the injuries for which the claim is being brought;

(4) An index to the administrative record;

(5) The Final Restoration Plan or Notice of Intent to Use a Regional Restoration Plan or Existing Restoration Project; and

(6) A request for reimbursement of:

(i) Reasonable assessment costs, as defined in Sec. 990.30 of this part and discounted as provided in Sec. 990.63(b) of this part;

(ii) The cost, if any, of conducting emergency restoration under Sec. 990.26 of this part, discounted as provided in Sec. 990.63(b) of this part; and

(iii) Interest on the amounts recoverable, as provided in section 1005 of OPA (33 U.S.C. 2705), which allows for prejudgment and post-judgment interest to be paid at a commercial paper rate, starting from thirty (30) calendar days from the date a demand is presented until the date the claim is paid.

§ 990.63 Discounting and compounding.

(a) Estimated future restoration costs. When determining estimated future costs of implementing a Final Restoration Plan, trustees must discount such future costs back to the date the demand is presented. Trustees may use a discount rate that represents the yield on recoveries available to trustees. The price indices used to project future inflation should reflect the major components of the restoration costs.

(b) Past assessment and emergency restoration costs. When calculating the present value of assessment and emergency restoration costs already incurred, trustees must compound the costs forward to the date the demand is presented. To perform the compounding, trustees may use the actual U.S. Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. For costs incurred by state or tribal trustees, trustees may compound using parallel state or tribal borrowing rates.

(c) Trustees are referred to Appendices B and C of OMB Circular A-94 for information about U.S. Treasury rates of various maturities and guidance in calculation procedures. Copies of Appendix C, which is regularly updated, and of the Circular are available from the OMB Publications Office (202-395-7332).

§ 990.64 Unsatisfied demands.

(a) If the responsible parties do not agree to the demand within ninety (90) calendar days after trustees present the demand, the trustees may either file a judicial action for damages or seek an appropriation from the Oil Spill Liability Trust Fund, as provided in section 1012(a)(2) of OPA (33 U.S.C. 2712(a)(2)).

(b) Judicial actions and claims must be filed within three (3) years after the Final Restoration Plan or Notice of Intent to Use a Regional Restoration Plan or Existing Restoration Project is made publicly available, in accordance with 33 U.S.C. 2717(f)(1)(B) and 2712(h)(2).

§ 990.65 Opening an account for recovered damages.

(a) General. Sums recovered by trustees in satisfaction of a natural resource damage claim must be placed in a revolving trust account. Sums recovered for past assessment costs and emergency restoration costs may be used to reimburse the trustees. All other sums must be used to implement the Final Restoration Plan or all or an appropriate component of a Regional Restoration Plan or an existing restoration project.

(b) Joint trustee recoveries. (1) General. Trustees may establish a joint account for damages recovered pursuant to joint assessment activities, such as an account under the registry of the applicable federal court.

(2) Management. Trustees may develop enforceable agreements to govern management of joint accounts, including agreed-upon criteria and procedures, and personnel for authorizing expenditures out of such joint accounts.

(c) Interest-bearing accounts. Trustees may place recoveries in interest-bearing revolving trust accounts, as provided by section 1006(f) of OPA (33 U.S.C. 2706(f)). Interest earned on such accounts may only be used for restoration.

(d) Escrow accounts. Trustees may establish escrow accounts or other investment accounts.

(e) Records. Trustees must maintain appropriate accounting and reporting procedures to document expenditures from accounts established under this section.

(f) Oil Spill Liability Trust Fund. Any sums remaining in an account established under this section that are not used either to reimburse trustees for past assessment and emergency restoration costs or to implement restoration must be deposited in the Oil Spill Liability Trust Fund, as provided by section 1006(f) of OPA (33 U.S.C. 2706(f)).

§ 990.66 Additional considerations.

(a) Upon settlement of a claim, trustees should consider the following actions to facilitate implementation of restoration:

(1) Establish a trustee committee and/or memorandum of understanding or other agreement to coordinate among affected trustees, as provided in Sec. 990.14(a)(3) of this part;

(2) Develop more detailed workplans to implement restoration;

(3) Monitor and oversee restoration; and

(4) Evaluate restoration success and the need for corrective action.

(b) The reasonable costs of such actions are included as restoration costs.

In support of the NRDA regulations under OPA and for the purpose of facilitating the NRDA process under OPA, NOAA has produced a number of related guidance documents, in addition to "Scaling Compensatory Restoration Projects" that are relevant to restoration scaling. All of these documents are currently available in final form.

NOAA. 1996. Natural Resource Damage Assessment Guidance Document: Preassessment Phase (Oil Pollution Act of 1990). National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, Silver Spring, MD.

NOAA. 1996. Natural Resource Damage Assessment Guidance Document: Specifications for Use of the NRDAM/CME Version 2.4 to Generate Compensation Formulas. National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, Silver Spring, MD.

NOAA. 1996. Natural Resource Damage Assessment Guidance Document: Injury Assessment (Oil Pollution Act of 1990). National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, Silver Spring, MD.

NOAA. 1996. Natural Resource Damage Assessment Guidance Document: Primary Restoration (Oil Pollution Act of 1990). National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, Silver Spring, MD.

NOAA. 1996. Natural Resource Damage Assessment Guidance Document: Restoration Planning (Oil Pollution Act of 1990). National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, Silver Spring, MD.

This Appendix provides a discussion of the economic concept of value, which was introduced in Chapter 2. The economic concept of value is defined and the concept of a willingness-to-pay (WTP) function, or demand function, is introduced. Determining value losses using the WTP function is illustrated, and an explanation of how per-unit values vary with changes in the quantity and quality of goods is provided. The last section contains a discussion of discounting in NRDAs under OPA.

Concept of Value

The maximum amount of goods, services, or money that a household[55] is willing to give up to obtain a specific good or service within a given time period is referred to as a household's willingness-to-pay (WTP) for that good or service.[56] Total willingness-to-pay for a natural resource or service is a function of a household's direct and passive use of the good or service.[57]

Generally, WTP does not increase, and tends to decline as additional units of a good or service are consumed. This property of WTP can be illustrated by household demand for cars. Consider a household comprising two adults, who both work outside the home, and two children. For this household, a car is necessary for transportation to work, child care, and school. A second car would be useful since it would allow the adults to distribute child care and other transportation responsibilities, although it may not be as essential as the first car. A third car, however, would provide essentially no benefit because there are only two drivers, and neither is a car buff who derives pleasure from owning cars for reasons other than transportation. In this scenario, WTP declines with each additional car "consumed": WTP is essentially zero for the third car.

Generally, a household will only consume a good when the price of the good is less than or equal to the household's WTP. When the price of a good is less than a household's WTP, the difference between the price and WTP is the surplus value that accrues to the household beyond the amount it has to pay for the good. This is referred to as "consumer surplus," and it is an alternative measure of total value.[58] Consumer surplus

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[55] Note that while this section refers to values held by households, all the concepts and relationships described apply to individuals as well.

[56] An alternative measure of gross value is willingness to accept (WTA), which is the minimum amount of goods, services, or money that a household or individual is willing to accept to forgo a specific good or service.

[57] The OPA rule defines the "total value" as the sum of direct use value and passive use value.

[58] In Chapter 1 through Chapter 4, the terms "consumer surplus" and "value" are used interchangeably, and refer to net value. Note that in the OPA rule, the term "value" refers to gross value (WTP or WTA).

is the value of goods and services to an individual or household, in excess of the cost of access or purchase. The concept of consumer surplus can be used to measure both the value of lost services during the time of interrupted service flows and the value generated by the compensatory natural resources and services.

In market contexts, where money is the basis for exchange, value is measured in terms of units of money. However, the value of a loss or a gain can be measured in units of goods or services, such as units of a natural resource or service. It follows that the compensatory trade-off for a loss of natural resources can be measured in terms of gains in natural resources.

Household Consumer Surplus Losses

To illustrate the concept of consumer surplus, Exhibit C.1 presents a household's demand curve for trips to Crane's Beach in Massachusetts - an 8-mile long beach, with adjacent sand dune and salt marsh habitat, located one hour north of Boston, a densely-populated area with numerous other beaches. On the horizontal axis is the number of visits to Crane's Beach by the household during the summer; on the vertical axis is expenditures, or travel costs, for a visit to the beach. The line ABC represents the household's marginal WTP for increasing numbers of trips.[59] The household is willing to pay a lot in travel costs for this first trip. However, household's marginal willingness-to-pay decreases as the number of trips taken increases. The household's total willingness-to-pay for the number of trips taken in a summer is the area under the WTP curve, between the y-axis and the number of trips chosen.

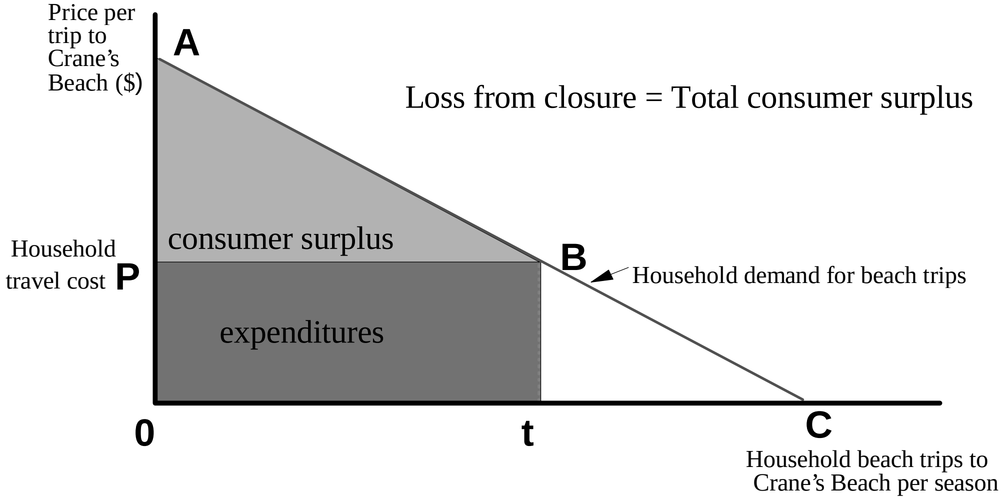
There is no market, and hence there is no market price, for beach trips. However, the cost of travel to the beach *functions* as the price. When deciding whether to go to a beach, a household must decide whether it is worth incurring the associated costs of travel (gasoline, time, meals and lodging) as well as any costs of gaining access to the beach (fees). A demand function can be estimated showing the relationship between household travel costs to a site and the number of trips to the site the household chooses to make in a season, taking into account the travel cost and quality of substitute sites. This is the essence of the travel cost model of recreational demand.

Suppose that a visit to Crane's Beach costs $\$P$ for a given household. The WTP curve indicates that the household will choose to go t times per season. They won't take an additional trip, because the cost of the $t+1^{th}$ trip, $\$P$, is greater than the household's willingness-to-pay for the additional trip. (Note that when the number of trips is greater than t, all points on the WTP function lie below $\$P$.) The total willingness-to-pay for t

[59] It would be more accurate to represent WTP as a step function over a discrete number of trips. However, in order to simplify the explanation of Exhibits C.1 through C.3, we show WTP as a continuous function. Note that when aggregating trips over all households (as in Exhibits C.2 and C.3), the assumption of a continuous demand function (WTP for all households) may be reasonable.

EXHIBIT C.1

INDIVIDUAL HOUSEHOLD LOSS OF CONSUMER SURPLUS FOR CRANE'S BEACH EXAMPLE



trips is the area under the demand curve up to *t* trips, area 0ABt.[60] The amount $\$P \times t$ (the area 0PBt) is the total cost per season the household will incur for trips to Crane's beach.

If the beach were closed for the season and the household did not take any trips to the site, the value it would lose is the consumer surplus: the extra value the household would receive from consuming the good. Again, consumer surplus is the difference between WTP and the price. To calculate the loss, the household's cost of going to the beach (0PBt) is deducted from the total value of the forgone beach visits (0ABt). Because of the closure, the household did not incur the costs of going to the beach (0PBt) and can spend that money elsewhere. Lost consumer surplus is the remaining area PAB.

Exhibit C.1 illustrates four different measures of value: marginal WTP, WTP for all trips, marginal consumer surplus, and consumer surplus for all trips. First, marginal WTP is the gross value to the household of an additional unit of goods or services. It is given by the height of the WTP function; at any point on the function, the WTP is the value of a single additional unit. Second, the WTP associated with a level of consumption is equal to the area under the WTP function, up to the level of consumption. Third,

[60] The total willingness-to-pay over all visits made to the beach is obtained by adding up the willingness-to-pay for each visit. In the above figure with demand for visits to the beach, the person is willing to pay A dollars for the first trip, somewhat less for the second trip, P dollars for the t^{th} trip, and so on.

consumer surplus of an additional unit of goods or services (the marginal consumer surplus) is the WTP for an additional unit minus the expenditure required to consume that additional unit. Finally, the consumer surplus associated with a given level of consumption is equal to the area under the WTP curve and above the price.

Aggregate Consumer Surplus Losses

Exhibit C.2 shows the WTP function (line segment DE) for beach services aggregated over all households. The vertical axis is the WTP per trip and the horizontal axis is the number of beach trips taken. The capacity of the beach to support trips is essentially fixed and is known as the carrying capacity of the beach resources. Carrying capacity is the number of beach trips of a given quality that the beach resources can support, otherwise known as the supply of beach trips. In Exhibit C.2, the supply for Crane's Beach is represented by the vertical line TT_0, and the travel cost is \$*P*.[61] Aggregate WTP associated with the baseline trip capacity is $0DFT_0$. Aggregate consumer surplus associated with the baseline trip capacity is the area under the aggregate WTP function and above the travel cost, up to the baseline trip capacity, T_0, which is area PDF.[62] Expenditures for beach trips for the season is $0PFT_0$.

Determinants of value per trip

Several points about the determinants of the value of a unit of natural resource services are relevant to the scaling discussion. First, the total WTP and consumer surplus for natural resource services - such as trips to Crane's Beach - depends on:

- price (travel cost in this example);
- characteristics of the household (e.g., income, members' ages, household head's employment status, etc.);
- characteristics of the site (e.g., site accessibility/isolation, water quality, wildness of habitat vs. level of commercial development, etc.);
- characteristics of substitute beaches (how many? how close in quality and travel cost to Crane's beach?); and
- other characteristics (e.g., weather).

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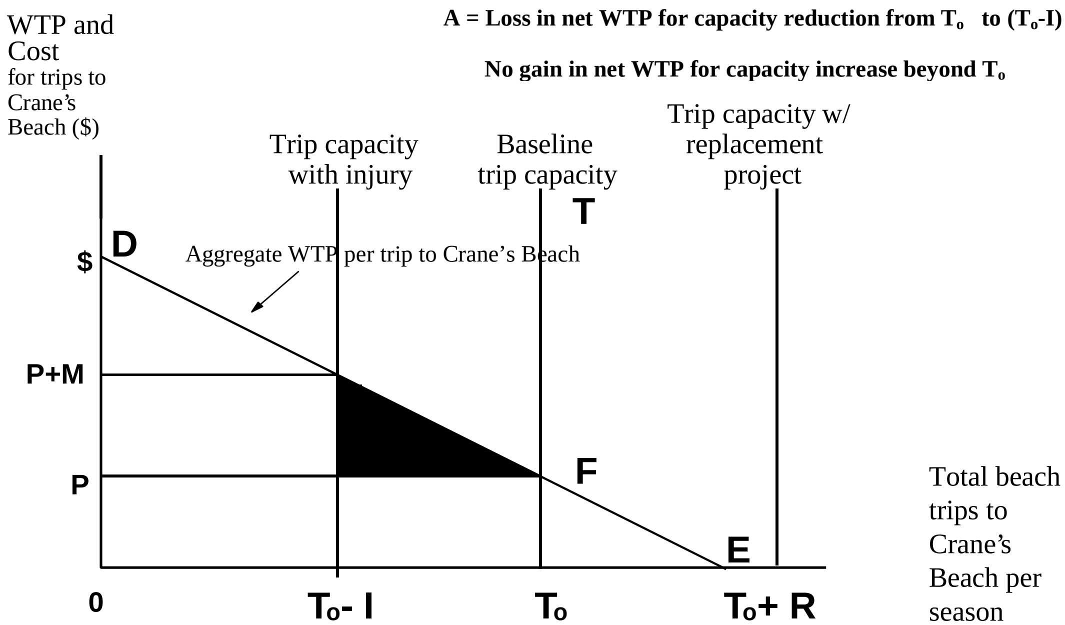
[61] Unlike demand, the trip capacity does not vary with price, though it may vary for other reasons. For instance, the beach trip capacity could be limited by the available parking if it is limited and most beachgoers drive to the beach.

[62] This is the correct calculation of value only when the supply of available beach trips is rationed to households by setting the entry fee high enough so that quantity supplied just equals quantity demanded. Alternatively, if supply is rationed on a first-come, first-served basis, then the consumer surplus per trip will be the average consumer surplus per trip under the demand function.

EXHIBIT C.2

NET WILLINGNESS-TO-PAY (WTP) FOR TRIPS

TO CRANE'S BEACH: SUPPLY CHANGES



Second, the consumer surplus produced by the last unit of services depends on the total trip capacity available at a given point of time. Changes in trip capacity are represented by shifts in the supply curve. As a result of a change in trip capacity, the point of intersection of the supply and WTP curves also shifts changing the value of the last feasible trip. In the damage assessment context, the total stock of beach resources and, therefore, trip capacity varies during the injury period as well as during the lifetime of a replacement project. Relative to the no-injury context, the quantity of services will be more scarce in the region during the injury period, and will be more plentiful during the lifetime of the replacement project (after recovery to baseline of the injured natural resource). In general, as a good or service becomes more scarce, the value of an incremental unit tends to increase, and as the good or service becomes more plentiful, the value of an incremental unit tends to decrease.

Due to differences between lost and restored natural resources in terms of quality and the total stock of services, the per-unit values of lost and restored services may not be comparable. In that case, there will not be a one-to-one ratio between the value of a unit of lost services and the value of a unit of restored services.

Value per Trip when Supply Changes: Example

Consider the following example. Closure of Crane's beach due to oil contamination may cause a substantial loss in use during the period of closure. However, after the site is decontaminated and the beach has been re-opened, expanding beach resources to compensate for the lost beach visits may not add much additional value if the demand for beach visits, given travel costs, was fully satisfied by the previous quantity of beach resources. In this case, consumer surplus for an additional trip is zero. This is illustrated in Exhibit C.2. At the baseline beach capacity of T_0 visits and travel cost per trip of $*P*,[63] the value of an additional visit equals the travel cost, and consumer surplus for an additional visit is zero. During the beach closure, the supply is reduced to T_0-I trips; at that level of supply, the lost consumer surplus relative to baseline supply is the shaded area.[64] Suppose, we could implement a compensatory restoration project immediately following a spill, and prior to recovery of the injured beach. For example, we might expand the beach by creating access to adjacent beach front property that was not impacted by the spill. In this case, if travel costs remain *$P*, there might not be any loss of consumer surplus. But immediate implementation is rarely if ever possible. When the beach is clean and reopened, a total of T_0 beach trips are again available. If the beach is expanded in a compensatory restoration project, and the capacity is increased by an additional R beach trips, the increment in consumer surplus would be zero because consumer surplus is zero at T_0, given travel costs $*P*. Thus, part or all of the public's loss would go uncompensated.

Value Per Trip when Quality Changes: Example

If the quality of natural resources and/or services changes, the change would be reflected in a shift in the WTP function. Consider a change in beach quality, for example a change in turbidity (murkiness of the water), which causes the WTP curve to shift. If the turbidity decreased, the household and aggregate WTP curves would shift up, indicating that the households would be willing to pay more for a given number of beach trips. Alternatively, if the turbidity increased, the household and aggregate WTP curves would shift down, indicating that the households collectively would be willing to pay less for a given number of beach trips. This is illustrated in Exhibit C.3. The original WTP for beach trips is represented by the line DD'. At travel cost $*P*, the WTP for T_0 trips is $0DGT_0$ and total consumer surplus is equal to area PDG. At trip capacity T_0, the consumer surplus from an additional trip is zero. Suppose a compensatory restoration project improves the turbidity and, therefore, the quality of a trip to Crane's beach. The WTP shifts to EE' and, at travel cost $*P*,[65] households would want to take more trips to the beach (from T_0 to T_1). However, since the beach cannot support more than T_0 trips, the value of an additional trip at T_0 increases from $*P* to $*P+M* and the consumer surplus

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[63] Assume travel costs and entrance fees are the same for all households.

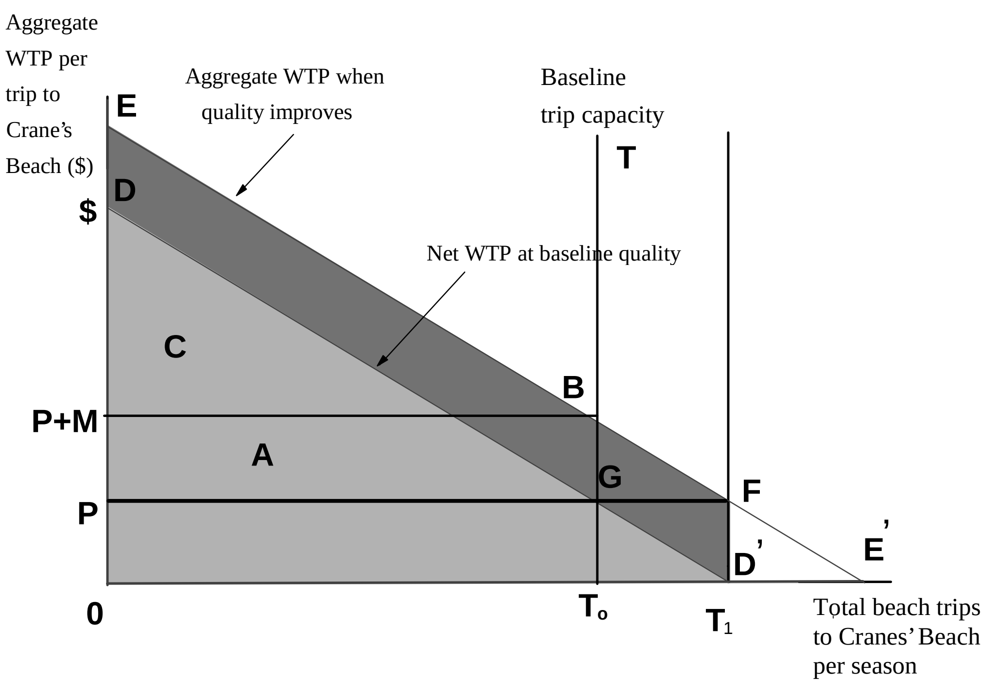
[64] See footnote 52.

[65] Assume travel costs and entrance fees are the same for all households.

EXHIBIT C.3

NET WILLINGNESS-TO-PAY FOR TRIPS TO CRANE'S BEACH: QUALITY CHANGES

B+D= Gain in aggregate WTP for increase in beach quality



associated with T_0 trips is the area (P+M)EB.[66] Hence, both the consumer surplus of the last unit and the total consumer surplus associated with a given number of trips depends upon the quality of the natural resource and/or service.

Calculating Losses

Note that when there is an injury to a recreational area, there may be several results. First, the area may be closed so that there are no trips to the site. In this case, all

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[66] Assuming that supply is rationed by setting the entry fee high enough so that supply just equals demand, area $0(P+M)BT_0$ represents expenditures on travel costs and entrance fees to visit Crane's Beach.

trips are forgone until the area is reopened. The losses are the aggregate consumer surplus associated with the forgone trips.[67]

Second, the area may not be closed so that some people continue to make trips to the site before recovery to baseline. In this second case, some people may forgo recreation altogether. The loss to a household forgoing trips is equal to the consumer surplus for all trips that are forgone. Others may continue to go to the injured site, but may not enjoy their activities as much because of the injury. The loss to each of these households is the change in consumer surplus due to the reduced quality at the injured site.

Trustees must consider these different effects of an injury when measuring the losses.

Discounting

Compensation is achieved by selecting a restoration action for which equating the discounted value of lost benefits equals the discounted value of gained benefits provided by the restoration actions. This section reviews the guidance on discounting provided in the OPA regulations.

Natural resources can be viewed as natural assets that provide services throughout their lifetime. A fundamental principle of asset valuation is that the total value of an asset is equal to the present discounted value of the future stream of all service flows from the natural resource.[68] It follows that the value of a natural resource is the present discounted value of the future stream of all the service flows from the natural resource.

Individuals generally have positive rates of time preference for goods and services, so that a given amount of goods or services today is valued more from today's perspective than the same amount of services in the future. Discounting the streams of past and future service losses and gains takes into account the fact that the further in the future a service is provided, the less it is valued today. For example, given a choice between receiving one thousand dollars today or one thousand dollars one year from today, most people would prefer to have one thousand dollars today. Assume money received today can be invested in a savings account at 5% annual nominal interest rate. Since an individual can invest today at 5%, receiving $952.38 today and investing the

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67 For those individuals who use substitute sites, we assume the effect of substitution on lost value is accounted for in the demand modeling and that the average value of a trip accounts for people who would have gone to substitute sites as well as those who would have foregone trips. If substitutes exist for the services provided by the affected area, the economic value of losses will be lower than if there were no substitutes.

68 For example, the purchase price of a house is approximately equal to the present discounted potential income from renting the house each year over its lifetime, after taking into account the differential tax treatment of the different circumstances.

sum at the 5% annual nominal interest rate will yield $1000 in one year. So, with the benefit of discounting, the choice between $1000 today and $1000 one year from today can be reinterpreted as a choice between $1000 today and the equivalent of $952.38 in today's dollars.

For scaling restoration actions, trustees discount past and future flows of service losses due to the injury, and of service gains from the restoration actions. The regulations recommend using risk-adjusted measures of losses and gains and a discount rate reflecting the social rate of time preference for natural resource services (i.e., the rate at which society is willing to substitute between present and future consumption of natural resources with certainty).[69] Since the streams of losses and gains are not known with certainty, risk-adjusted measures of losses and gains of natural resource services take account of the fact that people tend to be risk averse and must be compensated for bearing uncertainty. For example, it may be possible to compensate for uncertainty in the outcomes of compensatory restoration actions with larger scale actions.

It is difficult to determine the rate of time preference for goods that are not generally sold in a market (such as natural resources). However, many economists recommend using a real rate of three percent (3%) as an approximation to the social rate of time preference when discounting the value of natural resource services.[70] NOAA recommends the use of a 3% real discount rate unless justification is presented for a rate more appropriate for the specific context. Alternatively, if the streams of losses and gains cannot be adequately adjusted for risk and uncertainty, a discount rate should be used that incorporates a suitable risk adjustment.

Discounting Example

An example will be used to illustrate the discounting of past losses due to injury and future gains due to restoration. Suppose an oil spill in 1995 results in the closure of a beach. After two months, the site is restored to baseline. The losses to the public during the period of closure are $1 million, in 1995 dollars. One of the restoration actions that is proposed would increase the quality of services at the site. The quality improvements of this action are valued at $10,000 per year and the action is expected to have a lifetime of 10 years, starting in 1998. The following table shows the annual losses and gains from the injury and restoration action.

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[69] Discounting guidance is found in the Preamble to the OPA rule, at F.R. Vol. 61, No. 4, section III.B.4.c (page 453).

[70] See Chapter 7 in: Freeman, A. M. 1993. *The Measurement of Environmental and Resource Values*. Washington, DC: Resources for the Future.

Table C.1. Annual losses and gains in value of natural resource services (values in the current dollars - i.e., values are not discounted)

Year	Losses due to Injury (Dollars)	Gains due to Restoration Action (Dollars)
1995	1,000,000	0
1996	0	0
1997	0	0
1998	0	10,000
1999	0	10,000
2000	0	10,000
2001	0	10,000
2002	0	10,000
2003	0	10,000
2004	0	10,000
2005	0	10,000
2006	0	10,000
2007	0	10,000

The trustees submit a natural resource damage claim in 1997. To calculate the claim, the interim lost value estimate must be discounted forward from 1995 to 1997 dollars, and the annual benefits from the restoration action must be discounted back to 1997 dollars. The discount rate is 3%;[71] the formula to discount gains or losses is:

$$VALUE\ (1997\$) = \sum_{t=1995}^{2007} VALUE_t * (1+r)^{(1997-t)}$$

$VALUE_t$ is the interim lost value or gains from restoration in year t. The term by which the losses are multiplied is known as the discount factor. The following tables show the annual losses and gains, the discount factors applied, and the discounted losses and gains.[72]

[71] This example assumes zero inflation over the relative time periods.

[72] Note that while the tables show the discount factors rounded to two decimal places, the discounted values reflect calculations based on factors rounded to four decimal places.

Table C.2. Discounted Interim Lost Value

Year	Losses (Current Dollars)	Discount Factor $[(1+r)^t]$	Discounted Values (1997 Dollars)
1995	1,000,000	1.06	1,060,900
1996	0	1.03	0
1997	0	1	0
		Total Discounted Losses	1,060,900

Table C.3. Discounted Gains From Restoration

Year	Gains (Current Dollars)	Discount Factor $[(1+r)^{(1997-t)}]$	Discounted Values (1997 Dollars)
1997	0	1.00	0
1998	10,000	0.97	9,709
1999	10,000	0.94	9,426
2000	10,000	0.92	9,151
2001	10,000	0.89	8,885
2002	10,000	0.86	8,626
2003	10,000	0.84	8,375
2004	10,000	0.81	8,131
2005	10,000	0.79	7,894
2006	10,000	0.77	7,664
2007	10,000	0.74	7,441
		Total Discounted Gains	85,302

It is clear that the restoration action will not compensate for the losses due to injury. Thus, trustees must either propose additional restoration actions or they must propose an alternative action that compensates for the losses.

A. Habitat Equivalency Analysis (HEA)

This simplified scaling method may be used under certain conditions to scale restoration actions that replace habitats supporting multiple species or that replace individual species. With HEA, the trustees select the scale so the present discounted quantity of services provided by the restoration action(s) equals the present discounted quantity of lost services. To ensure that the scale of the restoration action does not over- or under-compensate the public for injuries incurred, trustees must, when applying this method, judge that the restoration actions provide services that are of the "same type and quality, and are of comparable value" to those lost due to the injury.

Selected References

NOAA Guidance Document

National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program (1995), "Habitat Equivalency Analysis: An Overview." Policy and Technical Paper Series, No. 95-1, (Revised June 1997).

Abstract: This NOAA guidance paper provides an overview of Habitat Equivalency Analysis and illustrates the method with a simple hypothetical example, using graphs and tables. Mathematical formulas are presented in the Appendix.

Overview Publications

Mazzotta, M.J., J.J. Opaluch, and T.A. Grigalunas (1994), "Natural Resource Damage Assessment: the Role of Resource Restoration." *Natural Resources Journal* Vol. 34, 153-178.

Abstract: This paper proposes a resource-based measure of compensation for spill-related injuries, integrating legal concepts of the public trust, economic definitions of compensation, and scientific approaches to restoration. It uses a case study of the Amazon Venture oil spill to illustrate this method (which is analogous to Habitat Equivalency Analysis). The authors also discuss problems that arise in defining and implementing restoration, and suggest methods for addressing some of these problems.

Shabman, Leonard and Sandra S. Batie, (1987), "Mitigating damages from coastal wetlands development: policy, economics and financing." *Marine Resource Economics*, Vol. 4, 227-248.

Abstract: This paper uses an approach which is analogous to Habitat Equivalency Analysis to calculate annualized replacement costs per acre of wetland in the Louisiana coastal wetlands.

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

Abstract: As an alternative to more traditional valuation techniques, this technical paper proposes a simplified approach (which is analogous to Habitat Equivalency Analysis) for valuing lost wetland service flows based on the concept of environmental annuities. The paper discusses a case study of a natural resource damage claim for two hazardous waste sites in the Great Swamp National Wildlife Refuge.

NRDA Applications

Chapman, D., N. Iadanza and T. Penn (1997), "Calculating Resource Compensation: An Application of the Service-to-Service Approach to the Blackbird Mine, Hazardous Waste Site." National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program Technical Paper 97-1.

Abstract: This paper applies the service-to-service approach (using habitat equivalency analysis) to determine the scale of compensatory restoration actions that will compensate the public for natural resource injuries resulting from releases of hazardous substances from the Blackbird Mine in east-central Idaho. The appropriate mix and scale of restoration actions were estimated through a salmon life cycle model that projects adult returns and smolt outmigrations as a function of the restoration actions.

Julius B.E., J.W. Iliff, C.M. Wahle, J.H.Hudson and E.C. Zobrist (1995), "Natural Resource Damage Assessment: M/V Miss Beholden Grounding Site Western Sambo Reef, Florida Keys National Marine Sanctuary, March 13, 1993." Report prepared for the National Oceanic and Atmospheric Administration, August 16, 1995.

Abstract: This damage assessment uses habitat equivalency analysis (HEA) to calculate damages from a coral reef grounding in the Florida Keys National Marine Sanctuary. In U.S. et al. v. M/V Miss Beholden et al. (December 1995), the U.S. District Court for the Southern District of Florida found that the U.S. had proven its case and awarded damages to the U.S. for natural resource injury and interim lost ecological services to the coral reef resources based on this HEA application.

Great Swamp National Wildlife Refuge Reports

Bishop, R.C. (1992), "The Potential Natural Resource Damages From the Asbestos Dump Site in The Dietzman Tract, Great Swamp National Wildlife Refuge, New Jersey." Report prepared for the Department of Interior, May.

Abstract: This report uses habitat equivalency analysis to calculate the amount of additional wetland needed to compensate for the loss of wetland services in the Great Swamp National Wildlife Refuge due to asbestos contamination.

Kopp, R.J. (1992), "An Analysis of Natural Resource Damages Claimed By the U.S. Government From Dietzman Tract OU-3, Asbestos Dump, Great Swamp National Wildlife Refuge, New Jersey." Report prepared on behalf of National Gypsum Company, May.

Abstract: This report evaluates the injury determination, injury quantification and lost economic value components of the U.S. Government's claim for natural resource damages in the Great Swamp National Wildlife Refuge. This report, commissioned by the responsible parties in the case, specifically presents an evaluation of the assumptions and methodology employed in Bishop's report cited above.

U.S. vs. Melvin A. Fisher et al. Reports

Zieman, J.C., (1997), "United States v. Fisher et al." Report prepared for the National Oceanic and Atmospheric Administration, Damage Assessment Center, January.

Abstract: This report, prepared for the case of U.S. vs. Melvin A. Fisher et al., tried in the U.S. District Court for the Southern District of Florida, examines the physical injury to seagrass beds in Coffins Patch caused by prop wash deflectors. The report describes the extent of injury and the estimated recovery horizon.

Fonseca, M.S., (1997), "United States v. Fisher et al." Report prepared for the National Oceanic and Atmospheric Administration, Damage Assessment Center, January.

Abstract: This report, prepared for the case of U.S. vs. Melvin A. Fisher et al., tried in the U.S. District Court for the Southern District of Florida, determines appropriate compensation projects for the lost interim services of the seagrass habitat destroyed at Coffins Patch. The Court awarded damages to the U.S. for natural resource injury and interim lost ecological services to the seagrass beds based on the analysis of this report and Julius (1997).

Julius, B.E., (1997), "U.S. vs. Melvin A. Fisher et al." Report prepared for the National Oceanic and Atmospheric Administration, Damage Assessment Center, January.

Abstract: This report, prepared for the case of U.S. vs. Melvin A. Fisher et al., tried in the U.S. District Court for the Southern District of Florida, uses habitat equivalency analysis (HEA) to calculate the damages to sea grass beds from prop wash deflectors.

B. Travel Cost Method

The travel cost method is employed primarily to model demand for recreational experiences using individuals' observed behavior. This measurement procedure evolved from the insight that the travel costs an individual incurs to visit a site are equivalent to a price for the site visit. In essence, the travel cost method assesses an individual's willingness to travel further (thereby incurring higher travel costs) in order to recreate at more highly valued sites. It is important to take into account the availability and quality of substitute recreation sites. Multiple-site models of recreational demand, such as the random utility model, focus attention on the recreationist's choice among alternative recreational sites. This version of the travel cost model is particularly appropriate where many substitutes are available to the individual and/or when the incident has affected quality at multiple sites.

In addition to traditional travel cost studies that use information on individuals' observed behavior (revealed preference data), this bibliography section includes studies that combine revealed preference data with information on individuals' contingent behavior or stated preferences. Contingent behavior refers to the stated intentions of individuals to use a natural resource service under various scenarios presented to them in a survey. More generally, stated preference methods ask individuals to pick their preferred alternative when two scenarios (or sets of scenarios) are presented to them in a survey. This additional information can provide insights into recreationists' preferences in cases where the change in the quantity or quality of natural resource services to be analyzed is outside of the range of observed behavior.

Selected References

Overview Publications

Bockstael, N.E., K.E. McConnell, and I. Strand (1991), "Recreation." In *Measuring the Demand for Environmental Quality*, edited by J.B. Braden and C.D. Kolstad, (New York: North-Holland).

Abstract: This chapter provides a thorough and technical assessment of the travel cost method as well as an assessment of attempts to combine hedonic and travel cost methods. The authors explore issues in obtaining recreation benefit estimates from continuous demand models and the random utility model. They also look at basic issues in recreation valuation.

Freeman III, A.M. (1993), "Recreational Uses of Natural Resource Systems." In *The Measurement of Environmental and Resource Values: Theory and Methods*, (Washington, DC: Resources for the Future).

Abstract: This technical chapter begins by outlining the basic travel cost model of the demand for a single site. It then discusses important issues involved in implementing and estimating the model and explains how the standard travel cost model can be used to value recreation sites and changes in the characteristics of sites. Finally, the chapter discusses the random utility model of recreational choice and the hybrid hedonic travel cost model of recreation demand.

Smith, V.K. (1989), "Taking Stock of Progress with Travel Cost Recreational Demand Models: Theory and Implementation." *Marine Resource Economics* 6, 279-310.

Abstract: This article summarizes the conceptual development and empirical implementation of the travel cost recreation demand model by (1) describing its theoretical underpinnings, (2) outlining how theory must be adapted to address the available data, and (3) explaining issues to be considered in the future.

Additional References

Adamowicz, W., J. Louviere and M. Williams (1994), "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." *Journal of Environmental Economics and Management* 26, 271-292.

Abstract: This technical paper combines stated preference data (contingent-behavior) with revealed preference data from the same individuals to characterize their choice of water-based recreation sites in the Highwood and Little Bow rivers in southwestern Alberta, Canada.

Adamowicz, W., J. Swait, P. Boxall, J. Louviere and M. Williams (1997), "Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation." *Journal of Environmental Economics and Management* 32, 65-84.

Abstract: This paper examines perceptions and objective attribute measures in discrete choice models of recreation site choice behavior. These forms of attribute measurement are examined in individual and combined revealed preference/stated choice models.

Fletcher, J.J., W.L. Adamowicz and T. Graham-Tomasi (1990), "The Travel Cost Model of Recreation Demand: Theoretical and Empirical Issues." *Leisure Sciences* 12, 119-147.

Abstract: This technical article provides an overview of selected theoretical and empirical issues in the economics literature on the travel cost model of recreation demand. Issues are identified and some solutions are discussed. Research results from related disciplines that may have application to travel cost models are also discussed.

Morey, E.R., R.D. Rowe, and M. Watson (1993), "A Repeated Nested-Logit Model of Atlantic Salmon Fishing." *American Journal of Agricultural Economics* 75, 579-592.

Abstract: In this technical paper, participation (total trips in a season) and site choice for Atlantic salmon fishing are modeled with a repeated three-level nested-logit model. For comparison, six other travel-cost models are estimated. The empirical analysis is conducted with data from a random sample of 168 Maine residents who held Maine Atlantic salmon fishing licenses in 1988.

Morey, E.R., D. Waldman, D. Assane, and D. Shaw (1995), "Searching for a Model of Multiple-Site Recreation Demand that Admits Interior and Boundary Solutions." *American Journal of Agricultural Economics* 77, 129-140.

Abstract: This technical paper critiques eight recreation demand models in terms of their ability to accommodate boundary solutions. Three models are recommended for consideration when there are multiple sites and the data set includes a significant number of boundary solutions: a repeated nested-logit model, a multinomial share model, and a Kuhn-Tucker model.

Kaoru, Y., V.K. Smith and J.L. Liu (1995), "Using Random Utility Models to Estimate the Recreational Value of Estuarine Resources." *American Journal of Agricultural Economics* 77, 141-151.

Abstract: This technical paper describes a model using a household production framework to link measures of nonpoint source pollution to fishing quality and a random utility model to describe how fishing quality influences sport fishing parties' decisions in North Carolina.

Randall, A. (1994), "A Difficulty with the Travel Cost Method." *Land Economics* 70, 88-96.

Abstract: In this technical paper the author argues that visitation costs in travel cost estimates are inherently subjective, but are ordinally measurable so long as the cost increases with distance traveled.

NRDA Applications

Hausman, J.A., G.K. Leonard, and D. McFadden (1995), "A Utility-Consistent, Combined Discrete Choice and Count Data Model: Assessing Recreational Use Losses Due to Natural Resource Damage." *Journal of Public Economics* 56, 1-30.

Abstract: This technical paper, based on research funded by Exxon, USA, uses a utility-consistent, combined discrete choice and count data model to assess recreational use losses due to the Exxon Valdez oil spill. The paper uses a two-stage budgeting approach. The second stage, which is specified as a multinomial choice model, produces a price index for the commodity (recreation alternatives in Alaska). The price index is then used to estimate the first stage (number of trips taken), which is specified as a count data model.

New Bedford Harbor CERCLA Reports

Cicchetti, C.J., J.A. Dubin and L.L. Wilde (1991). "The Use and Misuse of Surveys in Economic Analysis: Natural Resource Damage Assessment under CERCLA. Social Science Working Paper 768. Pasadena, CA: Division of Humanities and Social Sciences, California Institute of Technology.

Abstract: This paper, funded by the responsible parties, critiques the use of contingent behavior data in the McConnell (1986) paper. The authors use the initial survey and two follow-up surveys developed for the New Bedford Harbor Superfund case to analyze potential biases associated with the use of contingent behavior data.

McConnell, K.E. (1986), "The Damages to Recreational Activities from PCBs in New Bedford Harbor." Report to the National Oceanic and Atmospheric Administration, December.

Abstract: The PCB contamination of New Bedford Harbor has lowered the use value of recreation resources in the New Bedford Harbor area. This report, funded by the natural resource trustees, estimates the value of damages to beach use and recreational angling by combining revealed preference data and contingent behavior data. The empirical work is based on a telephone survey of households in the New Bedford area in 1986.

Upper Clark Fork Basin Reports

Desvousges, W.H., S.M. Waters and K.E. Train (1996), "Supplemental Report on Potential Economic Losses Associated with Recreation Services in the Upper Clark Fork River Basin." Report to the United States District Court, District of Montana, Helena Division, February.

Abstract: This report, commissioned by the Atlantic Richfield Company, estimates 1992 annual recreational fishing use value damages for Silver Creek and the upper Clark Fork River in Montana due to the release of hazardous substances from mining and mineral processing. This is an updated version of their original report (not cited here).

Hanemann, W.M. (1995), "Review of Triangle Economic Research Report on Economic Loss to Recreational Fishing in the Upper Clark Fork Basin." Report to State of Montana, October.

Abstract: This report commissioned by the State of Montana critiques the original Triangle Economic Research report on economic loss to recreational fishing in the upper Clark Fork Basin (not cited here).

Morey, E.R., R.D. Rowe and D. Waldman (1995), "Revised Report and Rebuttal: Assessment of Damages to Anglers and Other Recreators From Injuries to the Upper Clark Fork River Basin." Report to the State of Montana, Natural Resource Damage Program by RCG/Hagler Bailly, October.

Abstract: This report, commissioned by the State of Montana, estimates 1992 annual fishing and nonfishing recreation use value damages for Silver Creek and the upper Clark Fork River in Montana due to the release of hazardous substances from mining and mineral processing. This is an updated version of their original report (not cited here). This report also includes a rebuttal to ARCO's expert witness reports, which were made available to the State of Montana in July 1995 (not cited here).

McFadden, D.L. (1996), Expert Rebuttal Report of the October 18 Revised Report and Rebuttal of the State of Montana, January.

Abstract: This report, commissioned by the Atlantic Richfield Company, responds to the Revised Report and Rebuttal of the State of Montana by Morey, Rowe, Waldman (1995) and comments given by Hanemann (1995) on the original damage estimation conducted by Desvousges, Waters and Train.

C. Factor Income and Market Models of Demand and Supply

For those goods and services regularly traded in markets, economists typically rely upon market transactions to reveal the values that individuals place on the goods and services, as well as the costs of producing the goods and services. When the quality of the natural resource directly affects the value individual consumers place on a good or service, the correct measure of damages claimable by natural resource trustees is the change in consumer surplus (individuals' willingness-to-accept compensation) plus the economic rent component of producer surplus, if any, for the injuries associated with the discharge.

The factor income method can be employed to calculate changes in economic rent under certain special conditions; in more general cases, the method appropriate for calculating economic rent is market models of supply and demand. The factor income method relies upon the production function model, which relates the contribution of inputs to the production of an output. (Inputs are also referred to as factors of production.) An incident may decrease the quantity and/or quality of a natural resource, and thereby effectively increase the cost of employing a natural resource input in a production process. For example, contamination of water supplies or of sediments in navigational waterways may increase the costs of providing drinking water or of maintaining navigational waterways through dredging. Where the prices of the final product and of the other factors of production do not change, the change in economic rent is simply the sum of the changes in factor costs (or factor income) for the affected inputs.

Selected References

Overview Publications

Callan, S. and J. Thomas (1996), *Environmental Economics and Management: Theory, Policy and Applications*. (Chicago, IL: Richard D. Irwin).

Abstract: This textbook contains a brief overview of the basic concepts involved in measuring damages to the environment and measuring benefits from improvements to environmental quality.

Freeman III, A.M. (1993), "Defining and Measuring Welfare Changes: Basic Theory." In *The Measurement of Environmental and Resource Values: Theory and Methods*, (Washington, DC: Resources for the Future).

Abstract: This technical chapter reviews some of the basic terminology and theory involving individual preferences and demand. The theory of measuring the welfare value of changes in the prices of goods is examined. In addition to other topics, the case of the welfare effects of changes in the quantities of nonmarket goods is examined. The last two sections examine issues involved in aggregating measures of individual welfare change for public policy decision making and issues involved in selecting the appropriate welfare measure.

Freeman III, A.M. (1993), "Models for Indirect Benefit Estimation: Basic Theory" In *The Measurement of Environmental and Resource Values: Theory and Methods*, (Washington, DC: Resources for the Future).

Abstract: This technical chapter explores some of the possible relationships between demands for private goods and demands for environmental services in an effort to explain how the demands for environmental services can be inferred from information on market transactions for the related private goods.

Freeman III, A.M. (1993), "Environmental Quality as a Factor Input." In *The Measurement of Environmental and Resource Values: Theory and Methods*, (Washington, DC: Resources for the Future).

Abstract: This technical chapter describes the basic theory for estimation of productivity costs due to environmental damage. The simple case of single-product firms is discussed first and then the more general case of multiproduct firms is examined. The chapter then examines how the welfare effects on factor owners and consumers are passed through vertically linked markets for inputs and intermediate products. The last section outlines how the methods presented earlier can be used to value changes in the productivity of natural resource systems such as commercially exploited forests and fisheries.

Just, R.E., D.L. Hueth, and A. Schmitz (1982), *Applied Welfare Economics and Public Policy*. (Englewood Cliffs, NJ: Prentice-Hall, Inc.).

Abstract: This book develops economic welfare theory in the context of application to public policy questions. It provides a review of economic welfare theory and illustrates how this theory can be used to obtain policy information in the area of environmental economics as well as other areas.

D. Hedonic Price Model

The hedonic price model relates the price of a marketed commodity to its various attributes. In the natural resource damage assessment context, it may be used to determine the change in value of some nonmarket services from public trust natural resources (for example, environmental amenities such as water or air quality) where they function as attributes of private market goods, such as property. For example, the value of beach front property may be directly related to the quality and accessibility of the adjacent coastline. If an incident causes a long term, large scale reduction in the quality and accessibility of the coastline, the change in use value of the natural resources accruing to local property owners may be capitalized in property values. Because of substantial transaction costs in the housing market, this method is not sensitive to limited changes in quality. Further, this measure of the reduction in the value of coastline natural resources will not capture any loss in value of the natural resources that may accrue to members of the public who do not own property in the area.

Selected References

Overview Publications

Callan, S. and J. Thomas (1996), *Environmental Economics and Management: Theory, Policy and Applications*. (New York, McGraw-Hill).

Abstract: This textbook contains a brief overview of the basic concepts involved in measuring damages to the environment and measuring benefits from improvements to environmental quality.

Freeman III, A.M. (1993), "Property Value Models." In *The Measurement of Environmental and Resource Values: Theory and Methods*, Washington, DC: Resources for the Future).

Abstract: This chapter provides a detailed and technical exposition of the cross-section hedonic property value model. Some of the areas discussed include: problems in estimating the hedonic price function; approaches to recovering information on preferences and the demands for characteristics from the hedonic price function; and the measurement of welfare change.

Palmquist, R.B. (1991), "Hedonic Methods." In *Measuring the Demand for Environmental Quality*, edited by John B. Braden and Charles D. Kolstad, (New York: North-Holland).

Abstract: This chapter contains a thorough and technical discussion of the hedonic price method. Some of the topics covered include the following: theoretical models that can form the basis for hedonic estimation; econometric issues that arise in the estimation of the hedonic equation and the demands for characteristics, respectively; the uses of hedonic results for measuring benefits under a variety of situations; and discrete choice models of residential location as alternatives to hedonic studies.

Additional References

Bartik, T.J. (1987), "The Estimation of Demand Parameters in Hedonic Price Models." *Journal of Political Economy* 95, 81-88.

Abstract: This technical paper demonstrates that the econometric problem of estimating hedonic demand parameters is caused by the endogeneity of both prices and quantities when households face a non-linear budget constraint. An instrumental variables solution to this problem is suggested using instruments that exogenously shift the budget constraint.

Bartik, T.J. (1988), "Measuring the Benefits of Amenity Improvements in Hedonic Price Models." *Land Economics* 64, 172-183.

Abstract: This technical paper examines the immediate welfare effects of a change in attributes and then examines how the welfare gains are magnified and redistributed by the rational adjustments of individuals and ensuing price changes in the hedonic market.

Epple, D. (1987) "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products." *Journal of Political Economy* 87, 59-80.

Abstract: This technical paper identifies problems with identification and estimation of parameters in hedonic models and discusses potential resolutions of these problems. A stochastic structure for hedonic equilibrium models is proposed, identification results are presented and estimation procedures are outlined.

Michaels, R.G., and V.K. Smith. (1988), "Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Sites." *Journal of Urban Economics* 28, 223-242.

Abstract: This technical paper discusses the effects of market segmentation on valuing housing amenities (proximity to hazardous waste sites) in Boston from 1977-1981. Dividing the market into four distinct submarkets based on realtors' opinions leads to different results.

Palmquist, R.B., and L.E. Danielson (1989), "A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values." *American Journal of Agricultural Economics* 71, 55-62.

Abstract: This technical paper demonstrates the use of a hedonic land value study to determine the value of erosion control and drainage, using data from North Carolina. This study's estimates are compared with estimates derived from a variety of other types of studies.

NRDA Applications

Mendelsohn, R.,D. Hellerstein, M. Huguenin, R. Unsworth, and R. Brazee (1992), "Measuring Hazardous Waste Damages with Panel Models." *Journal of Environmental Economics and Management* 22, 259-271.

Abstract*:* This study uses panel data to analyze the damage associated with proximity to a hazardous waste site in the harbor area surrounding New Bedford, MA. In order to study the effect of PCBs on residential properties, the authors collected data on sales of homes between 1969 and 1988 from single family neighborhoods.

E. Contingent Valuation

The contingent valuation (CV) method determines the value of goods and services based on the results of carefully designed surveys. The CV method obtains an estimate of the total value, including both direct and passive use values of a good or service, by using a questionnaire designed to objectively collect information about the respondent's willingness to pay for the good or service. A CV survey contains three basic elements: (i) a description of the good/service to be valued and the context in which it will be provided, including the method of payment; (ii) questions regarding the respondent's willingness to pay for the good or service; and (iii) questions concerning demographics or other characteristics of the respondent (used to interpret and validate survey responses).

Selected References

Overview Publications

Arrow, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner and H. Shuman (1993), "Report of the NOAA Panel on Contingent Valuation." *Federal Register* 58, 1993, 4601-4614.

Abstract: This report begins by introducing the concepts involved in the contingent valuation (CV) method. The report presents several guidelines that the Panel believes CV studies should adhere to. The panel's final conclusion is that CV studies can produce estimates reliable enough to be the starting point of a judicial process of natural resource damage assessment.

Bishop, R.C. and T.A. Heberlein (1992), "The Contingent Valuation Method," in *Natural Resource Damages: Law and Economics*, edited by K. Ward and J. Duffield (New York: Wiley).

Abstract: This chapter provides a non-technical review of the contingent valuation (CV) method and the issues that any successful study must address. The chapter also provides examples of actual CV studies. The examples explore several issues related to CV methods, including how different payment vehicles affect valuations and how contingent values compare to values from simulated markets.

Carson, R.T. (1991), "Constructed Markets." In *Measuring the Demand for Environmental Quality*, edited by J. B. Braden and C. D. Kolstad, (New York: North-Holland).

Abstract: This is a technical overview of the CV method. Some of the topics covered in this overview include the theoretical foundations of constructed markets, the design of constructed markets, methods of eliciting CV responses, sample design, and the estimation of valuation functions.

Carson, R.T., N.E. Flores, and N.F. Meade (1996), "Contingent Valuation: Controversies and Evidence," Discussion paper 96-36, Department of Economics, University of California, San Diego, October.

Abstract: This paper discusses key areas of the debate over contingent valuation and the validity of passive use value. The authors conclude that recent criticisms of CV and passive use value have produced few new theoretical or methodological insights and that many arguments pertain generally to applied welfare economics rather than CV specifically. According to the authors, claims that CV findings are theoretically inconsistent are not supported by the literature taken as a whole.

Cummings, R.G., and G.W. Harrison (1992), "*Identifying and Measuring Nonuse Values for Natural and Environmental Resources: A Critical Review of the State of the Art*." Report to the American Petroleum Institute, April.

Abstract: The purpose of this study is to review methods for identifying nonuse values for natural and environmental resources and for measuring them with the CV method. The major issues discussed in this article are: the theoretical foundation of nonuse values; the conditions under which nonuse values can be measured; the theoretical foundation of the CV method; and the extent to which responses to willingness to pay questions can be interpreted as values that represent a real economic commitment.

Mitchell, R.C., and R.T. Carson (1989), *Using Surveys to Value Public Goods: The Contingent Valuation Method*. (Washington, DC: Resources for the Future).

Abstract: This book contains a detailed explanation and discussion of the contingent valuation method. First the book describes how contingent valuation works, its theoretical basis in welfare economics, the nature of the benefits it can be used to measure, how it compares to other methods for measuring benefits and the technique of gathering data on which CV is based. The book then addresses the objections of those who believe CV methods can not provide useful information. Finally, the book looks at several issues that need to be addressed in CV surveys to obtain data that are sufficiently reliable for policy purposes.

Additional References

Journal of Economic Perspectives Papers

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

Abstract: This is the first of three overview articles in this issue of the Journal of Economic Perspectives that discusses the contingent valuation method. This article provides an overview of the technique and debate surrounding the contingent valuation method. It serves as an introduction to the articles by Diamond and Hausman (1994) and Hanemann (1994).

Diamond, P.A. and J.A. Hausman (1994), "Contingent Valuation: Is Some Number Better than No Number?" *Journal of Economic Perspectives* 8, 45-64.

Abstract: This article argues against the use of the contingent valuation method. In this paper the authors report that the evidence supports the conclusion that to date, contingent valuation surveys do not measure the preferences they attempt to measure. They also present reasons for thinking that changes in survey methods are not likely to change this conclusion.

Hanemann, W.M. (1994), "Valuing the Environment Through Contingent Valuation." *Journal of Economic Perspectives* 8, 19-43.

Abstract: This paper supports the feasibility of using contingent valuation to measure people's value for the environment and describes how researchers go about conducting reliable surveys. It then addresses some common objections to surveys and, lastly, considers the compatibility of contingent valuation with economic theory.

Edited Conference Volumes

Bjornstad, D.J. and J.R. Kahn (1996), *The Contingent Valuation of Environmental Resources: Methodological Issues and Research Needs* (Brookfield, VT: Edward Elgar).

Abstract: This volume reports on a workshop sponsored by the Department of Energy and the Environmental Protection Agency. The goal of the workshop was to initiate a dialogue leading to a research agenda to narrow the gap between CV critics and advocates. The book, which presents the papers presented at the conference, includes a summary of the current state of the art in CV, including such issues as CV's theoretical foundations, measurement, validation and calibration, and alternatives.

Hausman, J.A., ed. (1993), *Contingent Valuation: A Critical Assessment*. (New York: North-Holland).

Abstract: The papers in this book are revised versions of research, which was supported by Exxon, presented at a conference organized by Cambridge Economics, Inc., and held in Washington, DC, on April 2-3, 1992. Included in this volume are both empirical studies and theoretical papers that discuss potential problems with the contingent valuation method.

Kopp, R.J., W.W. Pommerehne and N. Schwarz, eds. (1997), *Determining the Value of Non-Marketed Goods. (Norwell, MA: Kluwer Academic Publishers).*

Abstract: This volume contains revisions of the papers that were presented at a conference on CV that took place at Bad Homburg, Germany in the summer of. The articles in this volume provide background into the issues underlying the discussion of CV and focus on issues that have formed the core of the CV debate. These issues include: sensitivity of WTP estimates to the size of the program offered, tests for theoretical consistency and the sensitivity of the results to the features of the survey. The concluding articles address the application of CV to actual economic valuation tasks.

NRDA Applications

Carson, R.T., R.C. Mitchell, W.M. Hanemann, R.J. Kopp, S. Presser, and P.A. Ruud (1992*), A Contingent Valuation Study of Lost Passive Use Values Resulting from the Exxon Valdez Oil Spill*: *Volumes 1 & 2*, Report to the Attorney General of the State of Alaska, November.

Abstract: This report summarizes the development, implementation, and results of a CV study designed to measure the loss of passive use values arising from the injuries to natural resources caused by the Exxon Valdez oil spill of March, 1989.

Carson, R.T., W.M. Hanemann, R.J. Kopp, J.A. Krosnick, R.C. Mitchell, S. Presser, P.A. Ruud, and V.K. Smith (1994), *Prospective Interim Lost Use Value Due to DDT and PCB Contamination in the Southern Californian Bight: Volumes I & 2*, Report to the National Oceanic and Atmospheric Administration, September.

Abstract: This report estimates the prospective interim lost use value, the amount of money required to compensate the public for losses due to natural resource injuries resulting from DDT and PCB contamination in the Southern California Bight. The design and administration of the CV survey test various proposals of the NOAA CV panel report (Arrow et al., 1993).

<u>*Upper Clark Fork Basin Reports*</u>

Schulze, W.D., R.D. Rowe, W.S. Breffle, R. Boyce and G. McClelland (1995), *Contingent Valuation of Natural Resource Damages Due to Injuries to the Upper Clark Fork River Basin*, Report to the State of Montana, Natural Resource Damage Program by RCG/Hagler Bailly, December.

Abstract: This report computes values held by the citizens of Montana for complete cleanup and partial cleanup at the Clark Fork National Priorities List sites. The estimation of damages is conducted using the CV method implemented with residents of Montana.

Desvousges, W.H. (1995), "Critique of the State of Montana's Contingent Valuation Study." Report to the United States District Court, District of Montana, Helena Division, July.

Abstract: This report commissioned by ARCO critiques the 1995 contingent valuation study prepared by Schulze, Rowe, Breffle, Boyce and McClelland.

F. Conjoint Analysis [*]

Conjoint analysis is a survey procedure used to determine the values for the attributes of goods or services. The values are determined by collecting and analyzing information about individuals' choices between goods that vary in terms of their attributes or service levels. If price is included as an attribute in the choice scenarios, values can be derived in terms of dollars. Alternatively, it is possible to value attributes in terms of units of replacement resource services.

Selected References

Overview Publications

Adamowicz, W., J. Louviere and M. Williams (1994), "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." *Journal of Environmental Economics and Management* 26, 271-292.

Abstract: This technical paper combines stated preference data with observed (revealed preference) data from the same individuals to characterize recreationist choice of sites in the Highwood and Little Bow rivers in southwestern Alberta, Canada.

Carson, R.T., J.J. Louviere, D.A. Anderson, P. Arabie, D.S. Bunch, D.A. Hensher, R.M. Johnson, W.F. Kuhfeld, D. Steinberg, J. Swait, H. Timmermans, J.B. Wiley, (1994), "Experimental Analysis of Choice," Special Issue On Workshop Reports From the Duke Invitation Conference On Consumer Decision Making and Choice Behavior (D. Lehmann, Ed.), *Marketing Letters*.

Abstract: This paper reviews the design, conduct, analysis and use of data from choice experiments, and indicates gaps in current knowledge that should be addressed in future research. Design strategies consistent with probabilistic models of choice process and parallels between choice experiments and real markets are considered.

Hensher, D. A. (1994), "Stated Preference Analysis of Travel Choices: The State of Practice." *Transportation* 21, 107-133.

Abstract: This technical paper reviews recent developments in the application of stated preference methods. The main themes include a comparative assessment of choice models and preference models, the importance of scaling when pooling different types of data, and ways of accommodating dynamics in stated preference modeling.

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[*] Terminology is not consistently applied in this literature. For example, 'conjoint analysis' may refer narrowly to methods of rating and ranking goods or broadly to methods that require choosing between alternatives (stated choice methods). In the abstracts, we attempt to identify explicitly whether a paper applies rating, ranking and/or choice approaches. Note: the term "stated preference" is applied to methods that encompass rating, ranking and choice elicitation approaches.

Louviere, J.J. (1994), “Conjoint Analysis” in *Advances in Marketing Research* edited by R. Bagozzi, (Cambridge, MA: Blackwell Publishers).

Abstract: This technical paper provides a general review of conjoint analysis and its role in the understanding and predicting individual decision-making and choice behavior. This chapter also discusses random utility theory as a behavioral and theoretical basis for conjoint analysis and also describes recent advances in conjoint methods associated with random utility theory.

Mathews, K.E., F.R. Johnson, R.W. Dunford and W.H. Desvousges (1996), “The Potential Role of Conjoint Analysis in Natural Resource Damage Assessments.” TER Technical Working Paper. Durham, NC: Triangle Economic Research.

Abstract: This paper presents a basic overview of rating, ranking and choice methods for in-kind compensation. The paper discusses advantages and disadvantages of conjoint analysis and choice analysis along with the process of conducting these types of analyses.

Additional References

Adamowicz, W., J. Swait, P. Boxall, J. Louviere and M. Williams (1997), “Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation.” *Journal of Environmental Economics and Management* 32, 65-84.

Abstract: This paper examines perceptions and objective attribute measures in discrete choice models of recreation site choice behavior. These forms of attribute measurement are examined in individual and combined revealed preference/stated choice models.

Green, P.E., and V. Srinivasan (1990), “Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice.” *Journal of Marketing* 54, 3-19.

Abstract: This technical article reviews new developments in conjoint analysis. This paper will be more beneficial to readers who have a prior knowledge of conjoint analysis.

Louviere, J.J., and H. Timmermans (1990), “Stated Preference and Choice Models Applied to Recreation Research: A Review.” *Leisure Sciences* 12, 9-32.

Abstract: This technical article discusses the use and usefulness of stated choice models in recreation research. The authors compare stated choice modeling approaches with modeling approaches based on observations of choices made in real markets. The conceptual and theoretical bases of stated choice models are discussed; and procedures for developing such models, including different design strategies, are outlined.

Louviere J.J., and G. Woodworth (1983), "Design and Analysis of Simulated Consumer Choice or Allocation Experiments: An Approach Based on Aggregate Data." *Journal of Marketing Research* 20, 350-367.

Abstract: This article is concerned with estimating the parameters of stated-choice functions from discrete choice data. Emphasis is placed on the multinomial logit model and aggregate choice or allocation data to illustrate the concepts in a series of empirical examples. This article provides a good overview of the concepts involved in the design of a choice experiment.

Mackenzie, J. (1993), "A Comparison of Contingent Preference Models." *American Journal of Agricultural Economics* 75, 593-603.

Abstract: This technical paper compares the informational efficiencies of contingent rating, contingent ranking and two contingent paired-comparison methods as alternatives to the referendum contingent valuation method. Data are for waterfowl hunting in Delaware.

Roe, B., K.J. Boyle, and M.F. Teisl (1996), "Using Conjoint Analysis to Derive Estimates of Compensating Variation." *Journal of Environmental Economics and Management* 31, 145-159.

Abstract: This technical paper explores the assumptions that must be made to derive welfare estimates from conjoint rating data and examines the empirical implications of assuming transitive preferences to compress ratings into rankings and binary responses. Data were collected using a mail survey designed to evaluate changes in the management of Atlantic salmon on the Penobscot River in Maine.

Swait, J. and J. Louviere (1993), "The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models." *Journal of Marketing Research* 30, 305-314.

Abstract: If two sources of data (revealed preference and stated preference) are the outcome of a common choice process which differs only in the variability of the random component, utility parameters estimated from each data source should be proportional. This technical article shows how to estimate the ratio of the scale units in two or more data sets, and proposes a method to rescale one set of data against the second and test for a common choice process.

Swait, J. (1994), "A Sequential Approach to Exploiting the Combined Strengths of SP and RP Data: Application to Freight Shipper Choice." *Transportation* 21, 135-152.

Abstract: This technical paper proposes a sequential approach to combining revealed preference (RP) data and stated preference (SP) data. The approach fixes the RP parameters for independent variables at the estimated SP parameters but uses the RP data to establish alternative-specific constants. The approach is tested with freight shippers' choice of carrier in three major North American cities.

Applications

Boxall, P.C., W.L. Adamowicz, J. Swait, M. Williams, and J. Louviere (1996), "A Comparison of Stated Preference Methods for Environmental Valuation." *Ecological Economics* 18, 243-253.

Abstract: This paper presents an empirical comparison of the contingent valuation (CV) method and stated choice experiments. The empirical application involves the effect of environmental quality changes arising from forest management practices on recreational moose hunting values in the area of Alberta, Canada. Significant differences were found between the CV method and the conjoint (stated choice) analysis.

Gan, C., and E.J. Luzar (1993), "A Conjoint Analysis of Waterfowl Hunting in Louisiana." *Journal of Agricultural and Applied Economics* 25, 36-45.

Abstract: In this paper conjoint analysis is used to estimate willingness-to-pay for recreation experience attributes. The data were obtained through a mail survey of waterfowl hunters who purchased waterfowl stamps in Louisiana for the 1990-91 waterfowl hunting season.

G. Benefits Transfer Approach

Benefits (or valuation) transfer involves the application of existing value estimates or valuation functions developed in one context to address a comparable natural resource valuation question in a different context. Where natural resource values have been developed through an administrative or legislative process and are relevant and reliable under the circumstances, the trustees may use these values, as appropriate, in a benefits transfer context. Other values or valuation functions may be used so long as three basic issues are considered in determining the appropriateness of their use: the comparability of the users and of the natural resource and/or service being valued in the initial studies and the transfer context; the comparability of the change in quality or quantity of natural resources and/or services in the initial study and in the transfer context (where relevant); and the quality of the studies being transferred.

Selected References

Overview Publications

Atherton, T.J., and M.E. Ben-Akiva (1976), "Transferability and Updating of Disaggregate Travel Demand Models." *Transportation Research Record* 610, 1976.

Abstract: Several possible approaches for transferring a model estimated in one area to another are developed and discussed from a theoretical perspective in this technical paper. For an empirical evaluation, a work-trip modal-split model estimated on Washington DC data is transferred to New Bedford, MA.

Cameron, T.A. (1993), "Weighted Estimation Procedures For Benefits Transfer Applications." Working Paper, University of California at Los Angeles.

Abstract: This technical paper uses exogenously weighted maximum likelihood estimation to recalibrate study sample models to reflect relative frequencies in the policy population of different sociodemographic groups and environmental attributes.

Parsons, G.R., and M.J. Kealy (1994), "Benefits Transfer in a Random Utility Model of Recreation." *Water Resources Research* 30, 2477-2484.

Abstract: This technical paper presents the results of an experiment designed to help judge the viability of transferring a random utility model of recreation in Wisconsin. The authors divide a 1978 data set on lake recreation in Wisconsin into two nonoverlapping samples, Milwaukee residents and non-Milwaukee residents. Then they consider several hypothetical benefit transfers from a non-Milwaukee-based random utility model to Milwaukee residents.

Papers from a special issue of Water Resources Research

Atkinson, S.E., T.D. Crocker, and J.F. Shogren (1992), "Bayesian Exchangeability, Benefit Transfer, and Research Efficiency." *Water Resources Research* 28, no. 3, 715-722.
Brookshire, D.S., and H.R. Neill (1992), "Benefit Transfers: Conceptual and Empirical Issues." *Water Resources Research* 28, 651-655.
Boyle, K.J., and J.C. Bergstrom (1992), "Benefit Transfer Studies: Myths, Pragmatism, and Idealism." *Water Resources Research* 28, 657-663.
Desvousges, W.H., M.C. Naughton, and G.R. Parsons (1992), "Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits Using Existing Studies." *Water Resources Research* 28, 675-683.
Loomis, J.B. (1992), "The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer." *Water Resources Research* 28, 701-705.
Luken, R.A., F.R. Johnson, and V. Kibler (1992), "Benefits and Costs of Pulp and Paper Effluent Controls Under the Clean Water Act." *Water Resources Research* 28, 665-674.
McConnell, K.E. (1992), "Model Building and Judgment: Implications for Benefit Transfers with Travel Cost Models." *Water Resources Research* 28, 695-700.
Smith, V.K. (1992), "On Separating Defensible Benefit Transfers From "Smoke and Mirrors"." *Water Resources Research* 28, 685-694.
Walsh, R.G., D.M. Johnson, and J.R. McKean (1992), "Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988." *Water Resources Research* 28, 707-713.

Abstract: The papers in this special issue examine the conceptual and empirical issues associated with benefit transfer applications. The papers address the ongoing development of the procedures for benefit transfers through a case study approach. The papers generally suggest that there are legitimate reasons for employing benefits transfers but that benefits transfer analysis should undergo continued theoretical development.

Additional References

Freeman III, A. Myrick (1995), "The Benefits of Water Quality Improvements for Marine Recreation: A Review of the Empirical Evidence." *Marine Resource Economics*, 10, 385-406.

Abstract: This paper reviews the empirical literature on the economic value of marine recreation fishing, beach visits, and boating. Questions addressed include: What values do people place on changes in the attributes of recreation sites and activities? What do we know about how water pollution control policy affects these attributes? And, is it feasible to use the value information obtained for specific sites and/or activities to estimate the benefits of improving marine water quality?

Koppelman, F.S., and C.G. Wilmot (1985), "The Effect of Omission of Variables on Choice Model Transferability." *Transport Research* 20B, 205-213.

Abstract: This paper investigates the effect of omissions of relevant explanatory variables on the level of effectiveness of transferring transportation models in the Washington, D.C. metropolitan area. An empirical analysis of transferability among three sectors within an urban area is undertaken to verify and clarify the analytical results.

Gaver, D.P., D. Draper, P.K. Goel, J.B. Greenhouse, L.V. Hedges, C.N. Morris, C. Waternaux and J.R. Tucker (1992), "Combining Information: Statistical Issues and Opportunities for Research." Report of the Panel on Statistical Issues and Opportunities for Research in the Combination of Information to the National Research Council, (National Academy Press: Washington, DC. NTIS PB94-118528).

Abstract: This report surveys the techniques by which information from a variety of sources in natural and social sciences is combined to produce more informative summaries and better decisions than those possible based only on each separate information source. Attention is given to existing methods and to opportunities for research on new and/or improved methods.

Smith, V.K. and Y. Kaoru (1990),"Signals or noise? Explaining the Variation in Recreation Benefit Estimates." *American Journal of Agricultural Economics* 72, 419-433.

Abstract: This paper uses meta analysis (statistical methods that combine similar studies) to characterize the benefit estimates derived from travel cost recreation demand models. Using data from 77 studies, the paper evaluates the influence of variables describing the site characteristics, the activities undertaken at each site, the behavioral assumptions, and the specification decisions.

Van Der Heijden, R.E.C.M. and H.J.P. Timmermans (1988), "The Spatial Transferability of a Stated Multi-Attribute Preference Model." *Environment and Planning* A20, 1013-1025.

Abstract: This technical paper uses a model of spatial shopping behavior, estimated for the city of Maastricht, to predict shopping patterns in a part of the city of Eindhoven. The results indicate that the goodness of fit of the model was reduced only slightly when the model was transferred from one study area to the other. This supports the assumption that models using rating methods may be used to uncover utility functions that are independent of spatial structure.

Walsh, R.G., D.M. Johnson, and J.R. McKean (1990), "Nonmarket Values from two Decades of Research on Recreation Demand." In *Advances in Applied Micro-Economics*, vol. 5, edited by A.N. Link and V.K. Smith, (Greenwich, CT: JAI Press Inc.).

Abstract: This technical paper addresses some of the issues in past applications of valuation methods and their relative importance for future policy decisions. It is a retrospective glance at 20 years of empirical research using the contingent valuation, travel cost, and related methods. Statistical methods are applied to determine what variables help explain the observed variation in the benefit estimates.

Walsh, R.G., D.M. Johnson, and J.R. McKean (1988), "Review of Outdoor Recreation Economic Demand Studies with Nonmarket Benefit Estimates, 1968-1988." Colorado Water Resources Research Institute Report Number 54, Fort Collins, CO.

Abstract: This report illustrates how past studies can be adjusted to develop some tentative estimates of the recreation use value of Forest Service resources. This study uses meta-analysis to develop an understanding of the variables that explain the observed difference in benefit estimates from studies on demand for outdoor recreation with nonmarket benefit estimates from 1968-1988.

NRDA Applications

American Trader Oil Spill Reports

Dunford, W.D., E.S. West, R.B. Fowler, L.A. Sturtevant and S.E. Holden (1995), "A Review of the Trustees' Use Damage Estimates for the *American Trader* Oil Spill." Report submitted to Williams, Woolley, Cogswell, Nakazawa and Russell, May 30.

Abstract: This report, commissioned by Attransco, reviews the reports of Hanemann (1994) and Rudd (1994).

Hanemann, W.M. (1997a), "Final Conclusions of Professor Michael Hanemann Regarding Lost Recreational Damages Resulting From the *American Trader* Oil Spill." August 15.

Abstract: This report, commissioned by the State of California, estimates the value of the damages caused by the *American Trader* oil spill on February 7, 1990 with respect to lost recreation. The oil spill led to the closure of beaches along a 14-mile stretch of shoreline, from Alamitos Bay to Cove State Beach in southern California. This report contains and refines information presented on previous occasions, including Hanemann (1997b, 1996 and 1994).

Hanemann, W.M. (1997b), "A Report on the 1997 Orange County Boating and Surfing Survey." June 6.

Abstract: This report, commissioned by the State of California, discusses a study conducted over the period February 8 – March 14, 1997 to survey boaters and surfers in areas affected by the *American Trader* oil spill.

Hanemann, W.M. (1996), "A Report on the Orange County Beach Survey." September 16.

Abstract: This report, commissioned by the State of California, discusses a study conducted in February and March 1996 to survey beaches affected by the *American Trader* oil spill and to measure attendance during the period corresponding to the spill.

Hanemann, M. (1994), "Expert Report of Professor Michael Hanemann Regarding the *American Trader* Oil Spill." December 4.

Abstract: This report, commissioned by the State of California, presents an analysis of the lost use values for some of the recreation activities impacted by the oil spill from the *American Trader*, on February 7, 1990