Guide for Valuing Marine Ecosystem Services to Support Nearshore Management in Oregon

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Preface

Marine ecosystems generate myriad benefits to people, including providing for generations of fishermen, giving surfers their first wave, cycling nutrients, and storing atmospheric carbon, to name a few. They also support the industries of today and tomorrow, such as shipping and wave energy. Well-managed coastal and nearshore marine ecosystems are critical to the wellbeing of Oregonians who live at or visit the coast.

Our marine resources are vast but not infinite, and many uses of the ocean affect other uses—directly and indirectly, as well as locally and over large areas. For example, the construction of a wave-energy farm may directly exclude kayakers and fishermen from recreating in that area; or the ecological effects from commercial fishing may indirectly impact a recreational diver's experience. Such interactions imply tradeoffs between various uses, which natural resource agencies account for in their management decisions. One tool to support this decision-making is economic analysis. Economic analysis provides methods for estimating how people value various resources, which in turn informs an appropriate assessment of tradeoffs across different uses, environmental outcomes, and management scenarios.

Box 1 – Human uses of the marine environment

People use the ocean in myriad ways. These uses are increasing, as are their effects on the health of marine resources.

Below are just some examples of these uses:

- Surfing
- Whale watching
- Transportation and shipping
- Commercial and recreational fishing
- Pipelines and cables
- Harbor and port development
- Liquid natural gas

This guide offers a step-by-step "how to" on the application of specific economic methods to the evaluation of tradeoffs inherent in nearshore management decisions. Specifically, it describes a community-based approach that merges ecological and economic models to generate a survey-based tradeoff exercise that allows for a single set of marine ecosystem services to be valued by local stakeholders and measured by marine researchers, thus connecting social and environmental monitoring efforts. This guide also documents a real-world implementation of the approach in which researchers from Oregon State University examined stakeholders' values for ecosystem services delivered by marine ecosystems in Oregon.

Given the increasing environmental, economic, and social pressures on Oregon's marine ecosystem, a key challenge facing marine resource management agencies is to balance human uses and environmental protection in a way that increases societal wellbeing. The approach detailed in this guide is designed to contribute to addressing this challenge.

List of Terms

Term	Definition
Ecosystem-based management	An integrated approach to management that considers the entire ecosystem, including humans.
Practitioners	The target audience of this guide. Includes scientists and managers in state and federal natural resource agencies, members of community organizations, academic researchers in social and natural science disciplines, public officials, and anyone else interested in better understanding how economic data related to nearshore management is gathered and applied.
State waters	From the shoreline out to three nautical miles.
Nearshore	The area from the coastal high-tide line offshore to the 30-fathom (180 feet, or 55 meters) depth contour.
Coastal and marine spatial planning	A planning process that identifies which areas of the ocean are appropriate for different uses or activities, to reduce conflicts and achieve ecological, economic, and social objectives.
Ecosystem services	The end products of nature directly enjoyed, consumed, or used to yield human wellbeing.
Ecological production theory	A conceptual framework of the process by which ecosystems transform biophysical inputs into outputs.
Benefit	A valued good or experience derived from the use of ecosystem services.
Ecosystem components	The biophysical elements, features, attributes, or qualities of an ecosystem.
Ecological production function	A biophysical process that transforms inputs into outputs.
Economic demand function	A calculation of the marginal value of a commodity.

Term	Definition
Bioindicator	Components or variables inferring the state, conditions, or attributes of the coastal system.
Ecosystem service providers	Organisms, species, functional groups, populations, or communities, or their trait attributes, that contribute to the delivery of a specified ecosystem service.
Functional trait	Any morphological, physiological, or phenological feature, including its response to the environment or effect on one or several ecosystem functions.
Trait attribute	The particular value or modality taken by a functional trait at any place and time.
Ecosystem service provider efficiency	The least-cost method of an ecosystem service provider at delivering an ecosystem service.
Demand	An individual's or group's value or preference for something.
Nonmarket commodities	Environmental goods and services that are not traded in a market, and thus do not have a price.
Nonmarket valuation methods	Methods for deriving value for nonmarket commodities using existing, proxy, or hypothetical markets.
Stated-preference method	The elicitation of a statement of nonmarket value in a hypothetical market setting.
Commodification	Defining simulated environmental commodities for stated-preference valuation.
Tradeoff exercise	Comparing alternatives based on attributes.
Ecosystem service tradeoff	Giving up delivery (i.e., type, magnitude, and relative mix) of some ecosystem services for the delivery of others.
Relative preference weight	A measure of the relative importance of a criterion as judged by the decision maker.
Direct use value	Value derived from the on-site use of or interaction with a resource.

Term	Definition
Indirect use value	Value derived from the off-site use or interaction with a resource via its production of a good or service.
Nonuse value	Value derived without using or interacting with a resource.
Utility function	The wellbeing of an individual as a function of her consumption of goods and services.

About this Guide

Why is this guide needed?

To improve management and use of marine ecosystems, natural resource agencies in the United States and elsewhere are increasingly implementing what is called *Ecosystem-Based Management* (EBM). EBM can be defined as ***(def.)***: an integrated approach to management that considers the entire ecosystem, including humans. EBM stresses the interconnectedness among natural and social systems. Central to EBM is an emphasis on sustaining the ecosystem's ability to provide ecosystem services. Implementation of EBM requires an understanding of how the ocean provides ecosystem services, how human activities affect the delivery of ecosystem services, how people value ecosystem services, and how to weigh tradeoffs across management alternatives in order to sustain the delivery of ecosystem services. Economic analysis is a necessary tool for understanding these processes. However, as EBM is an emerging practice at many natural resource management agencies, so is economics. As a result, many agencies lack capacity for conducting economic analyses. In an effort to support the implementation of EBM in Oregon and elsewhere, this guide provides a step-by-step "how to" for conducting one type of economic analysis: the evaluation of tradeoffs across marine ecosystem services.

Box 2 - Ecosystem-Based Management (EBM)

***(def.)*: An integrated approach to management that considers the entire ecosystem, including humans.**

- Emphasizes the protection of ecosystem structure, functioning, and key processes
- Integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependence
- Sustains the delivery of ecosystem services
- A "way of doing business" that takes a holistic approach to natural resource management and considers the effect of policies on human behavior in addition to ecological processes

Box 3 – Economic analysis and EBM

Economic analysis of tradeoffs across marine ecosystem services supports EBM by

- quantifying the gains or losses of ecosystem service values from different management actions or planning scenarios
- identifying and evaluating tradeoffs across different resource uses, policies, or management alternatives—including when these changes have indirect effects via ecosystem impacts
- predicting impacts of management alternatives on different stakeholder groups
- identifying management actions that maximize benefits and minimize costs to society
- identifying biological and socioeconomic metrics to monitor progress toward management goals

Who should use this guide?

This guide is intended for individuals interested in or responsible for carrying out formal assessments of planning and development alternatives in coastal zones and state waters. These individuals include, but are not limited to, scientists and managers in state and federal natural resource agencies, members of community organizations, and academic researchers in social and natural science disciplines. Also, anyone else interested in better understanding how economic data related to nearshore management is gathered and applied—such as public officials—may benefit from the information provided in this guide. All these groups will hereafter be referred to in this guide as *practitioners*.

Box 4 – Practitioners

(def.): The target audience of this guide: scientists and managers in state and federal natural-resource agencies, members of community organizations, academic researchers in social and natural science disciplines, public officials, and anyone else interested in better understanding how economic data related to nearshore management is gathered and applied.

Practitioners may use this guide to

- understand what steps are involved in an economic evaluation of ecosystem service tradeoffs that may benefit decision making related to nearshore management
- decide whether undertaking an evaluation is appropriate and worthwhile
- improve their organization's capacity to undertake an evaluation where the need for one has been identified
- familiarize themselves with the concept of ecosystem service valuation and tradeoffs, or update and complement their existing knowledge and skills
- train new and emerging ecosystem service evaluation practitioners in an applied or classroom setting
- provide a resource for dialogue on methods for ecosystem service evaluations

How was this guide developed?

This guide was developed under a research grant from Oregon Sea Grant (grant number NA10OAR4170059) to researchers at Oregon State University. The purpose of the grant was to develop and implement an approach for evaluating tradeoffs across ecosystem services associated with nearshore management in Oregon. Additional funds were provided by the Oregon Department of Fish and Wildlife.

Researchers developed a conceptual model for the approach and implemented it in partnership with stakeholders from three communities in Port Orford, Newport, and Corvallis, Oregon, from 2010 to 2012. The conceptual model, an operational guide to implementing the model, and an account of its implementation are all presented in this guide.

Chapter 1 – Background and Conceptual Model

1.1 What is this chapter about?

This chapter provides a conceptual basis for the approach detailed in this guide. In order to implement the approach, practitioners should understand when economic analysis is useful, what types of ecological and economic data the approach requires and generates, and how that information can inform the work of marine resource agencies and other organizations. Also, by outlining relationships between the various components of the approach, this chapter provides practitioners an introduction and roadmap to the subsequent chapters of the guide.

1.2 How is this chapter organized?

⇒ Section 1.3 introduces nearshore management in Oregon, its foundations in ecosystem-based management, and its use of coastal and marine spatial planning.

⇒ Section 1.4 introduces coastal and marine spatial planning as a tool to implement ecosystem-based management and sustain the delivery of ecosystem services. The role of economic analysis as a tool to support these management practices is described, including the concept of ecosystem services as the link between ecosystems and human wellbeing, ecological indicators of their delivery, and their valuation through a survey-based tradeoff exercise.

⇒ Section 1.5 provides a detailed operational definition of ecosystem services.

⇒ Section 1.6 describes how to apply the operational definition of ecosystem services to determine which components of the environment are ecosystem services and which are not.

⇒ Section 1.7 provides a conceptual model for the approach.

⇒ Section 1.8 describes the ecological component of the conceptual model—ecological indicators (or bioindicators)—and how they can be operationalized and applied to coastal and marine spatial planning.

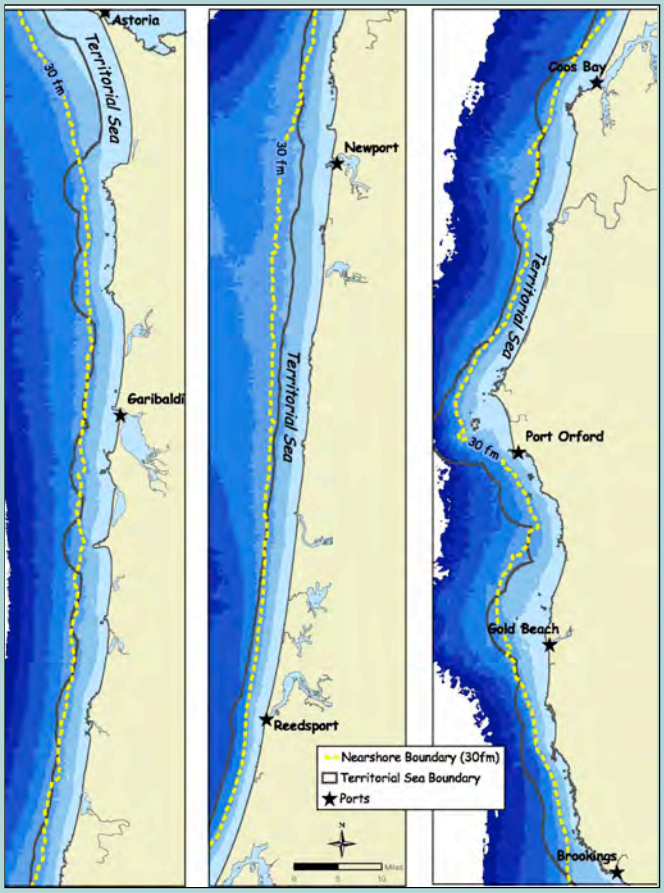
⇒ Section 1.9 describes the economic component of the conceptual model—relative preference weights—and how they can be operationalized and applied to coastal and marine spatial planning.

⇒ Section 1.10 Concludes Chapter 1 and guides the reader on to Chapter 2.

1.3 What is nearshore management?

In Oregon and elsewhere, much of the use and development of marine resources occur within *state waters*, defined as ***(def.)***: from the shoreline out to three nautical miles. State waters largely coincide with what is called the *nearshore*, defined in Oregon as ***(def.)***: the area from the coastal high tide line offshore to the 30-fathom (180-foot or 55-meter) depth contour (see Figure 1). This area supports not only an array of human activities, but also a diversity of habitats and marine organisms. With the goal of planning for the balanced use of the nearshore, the Oregon Department of Fish and Wildlife (ODFW) has formalized a comprehensive plan for management of the state's nearshore, called the Oregon Nearshore Strategy. The approach detailed in this guide is designed to advance this mission.

Figure 1 – Nearshore and Territorial Sea boundaries in Oregon



Source: http://www.dfw.state.or.us/mrp/nearshore/strategy.asp

1.4 Ecosystem-based management and coastal and marine spatial planning

One of the stated purposes of the Oregon Nearshore Strategy is to "take feasible steps in the direction of a broader management perspective and [EBM's] application."[1] One of these steps is the use of a planning tool called *coastal and marine spatial planning* (CMSP). CMSP can be defined as ***(def.)***: "a planning process…[that] identifies which areas of the ocean are appropriate for different uses or activities in order to reduce conflicts and achieve ecological, economic and social objectives."[2] CMSP is used by many marine resource agencies to implement EBM, as well as respond to increased user conflicts, growing environmental degradation, and the loss of marine ecosystem services. CMSP is currently being used in Oregon to site marine reserves, wave energy testing areas, potential liquid natural gas terminals, and other uses. In alignment with the

[1] Located at http://www.dfw.state.or.us/mrp/nearshore/strategy.asp [last accessed 10-3-2013]

[2] Lester et al., 2012, p. 1.

principles of EBM, these policy decisions are being made with the goal of enhancing the sustainability of ecosystem services.

Box 5 – Oregon Nearshore Strategy

The mission of the Oregon Nearshore Strategy is

"To promote actions that will conserve ecological functions and nearshore marine resources to provide long-term ecological, economic, and social benefits for current and future generations of Oregonians."

As recommended in the Strategy:

"Socioeconomic factors most useful to managers for planning or developing alternative management actions should be identified and monitored to obtain information on trends in coastal economies and the impacts of regulatory and other management changes."

Source: the Oregon Nearshore Strategy is available online at http://www.dfw.state.or.us/mrp/nearshore/strategy.asp

1.5 Ecosystem services defined

The concept of ecosystem services is not new, and natural and social scientists alike may already have some understanding of what they are. However, various definitions and typologies of ecosystem services are used for different analytical purposes. For the purposes of this guide, ecosystem services are defined as ***(def.)***: "the end products of nature…directly enjoyed, consumed, or used to yield human wellbeing."[3] This definition of ecosystem services is predominantly used by natural resource economists to translate ecological change into impacts on human wellbeing. This process makes ecosystem services operational as a tool for economic analysis and, in turn, decision-making about nearshore management. It generates information to represent environmental features that affect stakeholders' wellbeing, are quantified by natural and social scientists in monitoring efforts, and are incorporated into policy decisions by managers.

Figure 2 – Ecosystem service valuation

"[The] basis of deriving measures of the economic values of changes in resource environment systems is the effects of the changes on human welfare"

- Myrick Freeman, The Measurement of Environmental and Resource Values: Theory and Methods (p. 7)

1.6 Identifying ecosystem services

What is an ecosystem service? The definition of an ecosystem service used in this guide starts with the specification that it is an "end product" of nature. This term is based on the

[3] Boyd & Banzhaf 2007, p. 619

ecological production theory approach to ecological valuation. Ecological production theory can be defined as ***(def.)***: a conceptual framework of the process by which ecosystems transform biophysical inputs into outputs.[4] Characteristic #1 in Box 6 explains this distinction.

Box 6 – Ecosystem services

***(def.)*:** The end products of nature…directly enjoyed, consumed, or used to yield human wellbeing.

As an extension of the above definition, ecosystem services have four additional characteristics:

1. Ecosystem services provide a direct benefit to someone, as opposed to an indirect benefit.
2. Ecosystem services are purely natural components in a state prior to combination with any human production, rather than anything transformed through labor or technology.
3. Ecosystem services are biophysical components, as opposed to ecosystem processes and functions.
4. Ecosystem services can be measured as discrete quantities, rather than a rate.

It is important for the practitioner to note that the definition of an ecosystem service used in this guide does not come with pre-packaged examples of what are and what are not ecosystem services. Instead, this definition is an operational tool and must be applied in the real world to determine, in a consistent and replicable way, if a biophysical feature, quantity, or quality represents an ecosystem service valued by a particular group of stakeholders, or if it does not. Step-by-step instructions for making this determination are provided in Section 2.3.2.

So if ecosystem services directly provide a benefit, what is a *benefit*? A benefit can be generally defined as ***(def.)***: a valued good or experience derived from the use of ecosystem services. Ecosystem services are thus valued for their contribution to one's obtaining a benefit, and benefits are obtained through the input of ecosystem services plus human labor and/or technological inputs. For example, a fish in the boat of an angler is not an ecosystem service. Rather, it is a benefit obtained from the combination of the angler's time, gear, and a set of purely natural components consumed by the angler (ecosystem services—in this case, the presence of harvestable fish). Characteristic #2 in Box 6 explains this distinction.

To identify an ecosystem service, the practitioner should track the production of only natural components to the point where they are combined with human activity. Step-by-step instructions for making this identification are provided in Section 2.3.2 and further explained by Characteristic #3 in Box 6. Ecosystem components are defined as ***(def.)***: the biophysical elements, features, attributes, or qualities of an ecosystem. Ecosystem components are utilized directly; ecosystem processes and functions can only be utilized indirectly. For example, a fisherman goes fishing to catch fish, which are biophysical elements (components) of the ecosystem. While the availability of those fish depends on

[4] Two terms commonly used to distinguish "end products" from the natural processes that produce them are, respectively, *final ecosystem services* and *intermediate ecosystem services*. The natural processes underlying their delivery are "intermediate" because they benefit someone only indirectly via their effect on the final ecosystem service. The definition of an ecosystem service used in this guide corresponds to final ecosystem services only; intermediate ecosystem services are referred to as biophysical processes and functions.

complex ecological processes such as food web interactions, a fisher does not go out in his or her boat to experience the marine food web.

Characteristic #4 in Box 6 provides the further qualification that an ecosystem service is a component that can be expressed as a quantity (e.g., abundance, distribution, quality, or variability). This characteristic is required because in order to calculate its contribution to a benefit, a practitioner must be able to assign it a value.

1.7 A conceptual model for ecosystem service valuation

The conceptual model for ecosystem service valuation used in this guide is provided by ecological production theory, which aims to translate changes in natural features in the ecosystem into changes in human wellbeing. In order to implement this translation process, the practitioner will formulate two types of functions. The first is called an *ecological production function*, and can be defined as ***(def.)***: biophysical processes that transform inputs into outputs. An ecological production function predicts how natural features are related to the capacity of an ecosystem to deliver ecosystem services. The second function is called an *economic demand function*, and can be defined as ***(def.)***: a calculation of the marginal value of a commodity. Step-by-step instructions on how to formulate these two functions are provided in Chapter 2. First, however, the practitioner should understand the conceptual bases for these two functions, which are provided in the following two sections.

Figure 3 – Conceptual model for ecosystem service valuation

1.8 Ecological production function

In order to translate changes in natural features in the ecosystem into changes in human wellbeing, the practitioner must first translate changes in natural features in the ecosystem into changes in ecosystem services. This process is carried out by formulating an ecological production function. Step-by-step instructions for this formulation are provided in Section 2.3.3.

An ecological production function characterizes the ecological linkages underlying the delivery of ecosystem services. While this process can be very complex, the type of functions formulated in this guide are relatively basic and are designed to generate only that information necessary for measuring changes in ecosystem service delivery. As described in the previous section, an ecosystem service is a component of the ecosystem that directly provides a benefit to a beneficiary. Chances are this component is represented in an ecological indicator already measured and monitored by biologists and ecologists. An ecological indicator (hereafter *bioindicator*) can be defined as ***(def.)***:

"components or variables inferring the state, conditions or attributes of the coastal system."[5] The ecological production function detailed in this guide therefore connects ecosystem services to bioindicators that measure them.

The question then becomes: which bioindicators measure changes in ecosystem services? To answer this question, the approach starts with the concept of *ecosystem service providers* (ESPs). ESPs can be defined as ***(def.)***: "organisms, species, functional groups, populations or communities, or their trait attributes,[6] that contribute to the delivery of a specified ecosystem service."[7] For example, if the presence of harvestable fish is identified as an ecosystem service delivering a benefit to a fisherman, associated ESPs might be individuals of harvestable species of a harvestable size.

Changes in ecosystem service delivery are therefore measured by changes to ESPs. The relevant change to an ESP is the rate at which ESPs contribute to ecosystem service delivery, which is called the *ESP efficiency*.[8] ESP efficiency can be defined as ***(def.)***: the effectiveness of an ESP at delivering an ecosystem service. Thus, changes in delivery of a given ecosystem service are measured using bioindicators that measure the ESP efficiency. Returning to the example of harvestable fish, some example bioindicators are the growth of harvestable fish, the average size of harvestable fish species, the density of harvestable fish communities, and the population size of harvestable fish.

Practitioners can undertake a number of analyses during the CMSP process using bioindicators of marine ecosystem services. First and foremost, by monitoring those bioindicators tied to valued ecosystem services, practitioners can be sure that they are monitoring those changes in the nearshore ecosystem that really matter to stakeholders. Second, practitioners can use the set of bioindicators as a framework for analyzing existing studies on nearshore ecological change. Third, practitioners can use the set of bioindicators to develop more-complex ecological production functions, to better predict changes in ecosystem service delivery resulting from changes in the nearshore ecosystem. Furthermore, as is discussed in the next section, the tradeoff analysis detailed in this guide allows the set of bioindicators to be ranked from most to least important, which allows practitioners faced with limited financial resources to prioritize monitoring efforts.

1.9 Economic demand function

The second part of the conceptual model for ecosystem service valuation estimates changes in human wellbeing resulting from changes in ecosystem services, which is characterized using what is called an economic demand function. Step-by-step instructions to characterizing a demand function are provided in Section 2.3.4.

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[5] Fontalvo-Herazo et al., 2007, p. 783.

[6] In this definition, the term "trait" refers to a *functional trait*, which can be defined as ***(def.)***: Any morphological, physiological or phenological feature, including its response to the environment or effect on one or several ecosystem functions. Furthermore, a *trait attribute* can be defined as ***(def.)***: The particular value or modality taken by a functional trait at any place and time.

[7] Kremen, 2005, p. 469.

Natural resource economics employs a range of methods to estimate *demand* for ecosystem services. In general, the term *demand* can be defined as ***(def.)***: an individual's or group's value or preference for something. Value can be measured using a number of metrics. Many people think economics deals only with dollars and markets. In fact, dollars are just a metric of convenience to represent the economic basis for value: an individual's preference or marginal willingness to trade one good or service for another. Three main types of values exist: direct use, indirect use, and nonuse values. See Box 7 for definitions of these types of values. It will be important for the practitioner to understand the differences in these types of values.

While different policies indeed have economic impacts that can be measured in dollars, many ecosystem services are not directly traded and valued in dollars. This does not imply, however, that these services lack value. Rather, they are called *nonmarket commodities*, and can be defined as ***(def)***: environmental goods and services that are not traded in a market, and thus do not have a price. Nonmarket commodities can have significant value; hence including their value in management decisions is necessary. To measure the nonmarket value of nonmarket commodities, economists use *nonmarket valuation methods*. Nonmarket valuation methods can be defined as ***(def.)***: methods for deriving value for nonmarket commodities using existing, proxy, or hypothetical markets.

This guide applies one type of nonmarket valuation method: *stated-preference*, which can be defined as ***(def.)***: the elicitation of a statement of nonmarket value in a hypothetical market setting. Stated-preference methods rely on surveys for estimating value of ecosystem services by defining them so that value can be attached—a process called *commodification*.[9] Commodification can be

Box 7 – Nonmarket values

Though many environmental commodities are bought and sold in markets, like seafood, many are not. For example, one cannot purchase an increase in the number of critters in a tide pool when one brings one's kids to the beach. While this latter commodity isn't bought or sold, it certainly has value. Economists call this value *nonmarket value*. Nonmarket value can have very significant value—sometimes outweighing the value of marketed environmental commodities.

Economists divide nonmarket values into use values and nonuse values. Use value includes "direct use value" and "indirect use value." Direct use value can be defined as ***(def.)***: value derived from the on-site use of or interaction with a resource, and requires physically visiting the resource. Indirect use value can be defined as ***(def.)***: value derived from the off-site use or interaction with a resource via its production of a good or service, and requires consuming something produced by the resource. Nonuse value can be defined as ***(def.)***: value derived without using or interacting with a resource, and is derived from nonmaterial benefits, like the knowledge of a resources' existence. For this reason, nonuse value is also referred to as "passive use" value.

In order for policies to take into account the full range and value of ecosystem services, economic analysis should account for market values and both types of nonmarket values.

defined as ***(def.)***: defining simulated environmental commodities for stated-preference valuation. Step-by-step instructions for this process are provided in Section 2.3.4.

In order for simulated environmental commodities (hereafter referred to as "survey items") to be effective in a survey-based tradeoff exercise and produce valid and reliable results, their composition and presentation must communicate a specific level and type of information to the survey respondent. Specifically, they must provide survey respondents with accurate information about the relevant ecological system and its delivery of ecosystem services in a way that allows them to predict the effect of the expected ecological change on their wellbeing.

In order to generate survey items that meet these criteria, a number of factors regarding the appropriate amount of information, and the appropriate presentation of that information, must be considered. With respect to the amount of information, survey items must be sufficiently well-defined so that survey respondents do not rely on their own—and potentially misguided—assumptions. With respect to the presentation of information, survey items must communicate ecological information in a way that survey respondents understand and find meaningful. Step-by-step instructions for incorporating these factors into survey items are provided in Section 2.3.4.

To facilitate estimation of value for survey items, this guide employs a survey-based *tradeoff exercise*. A tradeoff exercise can be defined as ***(def.)***: comparing alternatives based on attributes. Alternate natural-resource allocations affect the type, magnitude, and relative mix of services delivered by ecosystems. Thus, nearshore management decisions can be informed by characterizing *ecosystem service tradeoffs*, which can be defined as ***(def.)***: giving up delivery (i.e., type, magnitude, and relative mix) of some ecosystem services for the delivery of others. A tradeoff exercise quantifies an individual's or group's preferences across the metrics being traded off. In the survey-based tradeoff exercise developed in this guide, individuals choose which ecosystem services they prefer. These choices generate *relative preference weights*, which can be defined as ***(def.)***: "measure[s] of the relative importance of a criterion as judged by the decision maker."[10]

Relative preference weights for marine ecosystem services can inform a number of analyses during the CMSP process. First, relative preference weights imply a ranking. Knowing the most- to least-valued ecosystem services allows managers to prioritize the delivery of some services over others. Also, associating highly ranked ecosystem services with benefits allows managers to identify higher-value resource uses, which in turn allows them to calculate the comparative advantages of different spatial allocations of uses and optimize the design of management areas in order to increase, rather than decrease, overall social benefits. Second, numerical weights can be incorporated into other types of cost-benefit calculations. For example, weighting changes in the delivery of ecosystem services may elucidate to a practitioner that increasing the delivery of a particular ecosystem service is worth the associated cost because that ecosystem service is relatively highly valued. Other applications of relative preference weights for ecosystem services, as well as other components of the approach developed in this guide, are provided in Section 2.3.5.

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[10] Yoe, 2002, p. 52.

From concept to practice

This chapter provided a conceptual basis for the approach detailed in this guide by describing nearshore management in Oregon, its grounding in EBM and use of CMSP, the role of economic analysis as a tool to support these management practices, and a specific approach to valuing and indicating the delivery of marine ecosystem services.

At this point, practitioners should have a general idea about whether such an approach is appropriate and worthwhile for them and their circumstances. For those who may need more information to make that decision, the rest of this guide will provide a more detailed picture of the resources and effort involved in implementing the approach. For practitioners who have already decided to undergo this analysis, the following chapter provides a step-by-step guide to implementing the approach.

Chapter 2 – Implementing Ecosystem Service Tradeoffs

2.1 What is this chapter about?

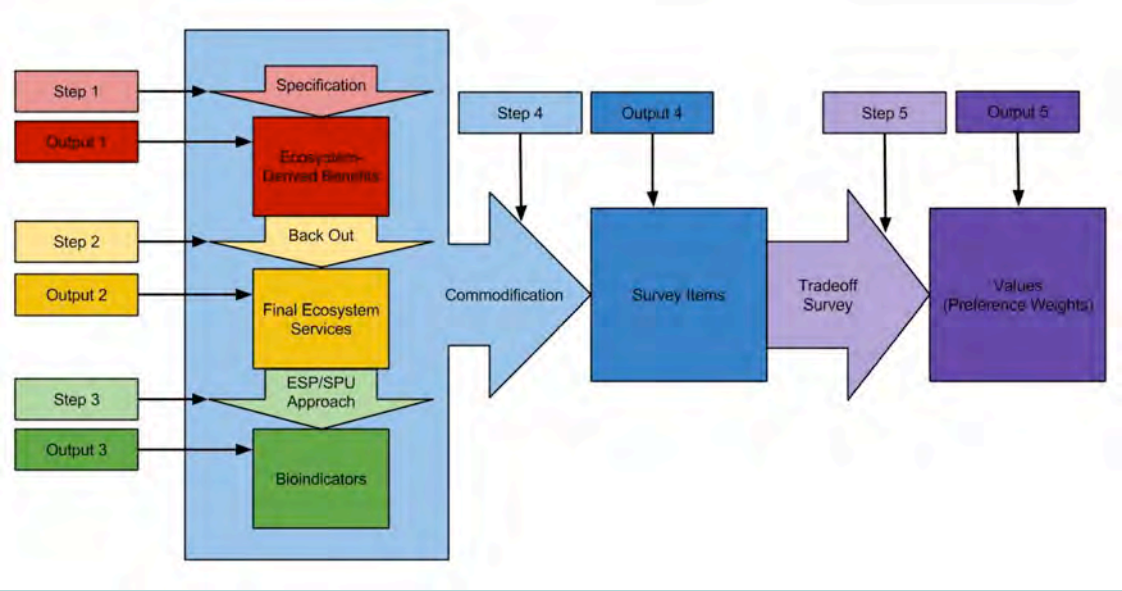
This chapter provides practitioners information necessary to implement the approach detailed in this guide in a real-world setting. Foremost, this chapter lays out a step-by-step "how to" for implementing the approach. Also included are supplementary materials that will help the practitioner enhance their abilities to implement the approach. By the end of this chapter, practitioners should have a clear understanding of the resources and effort involved in implementing the approach. Practitioners can use this information to decide to carry out an analysis or to go ahead and implement an analysis in their local communities.

2.2 How is this chapter organized?

This chapter is designed to be read as preparation for going out and implementing the approach in the real world, and as such provides the practitioner conceptual and practical information necessary to plan for and implement the approach.

The following five sections of the chapter correspond to the five "steps" involved in implementing the approach. These steps and their respective outputs are depicted below in Figure 4.

Figure 4 – Steps and outputs of the approach



In order to provide the practitioner with all the information necessary to implement the approach in the real world, each of the five sections include the following subsections:

1. **Introduction:** the conceptual and technical considerations involved in the step, including a statement of the overall objective.

2. **Procedure:** a detailed implementation process broken into "parts." Each part of the step includes the following subsections:

    - ***Objective:*** a succinct statement of the objective of the part of the step.

    - ***Perspective:*** conceptual information to guide implementation of the step.

    - ***Resources and practical considerations:*** resource needs (e.g., physical materials, human resources, information) and challenges to implementing the part of the step.

    - ***Method:*** technique or approach to implementing the part of the step.

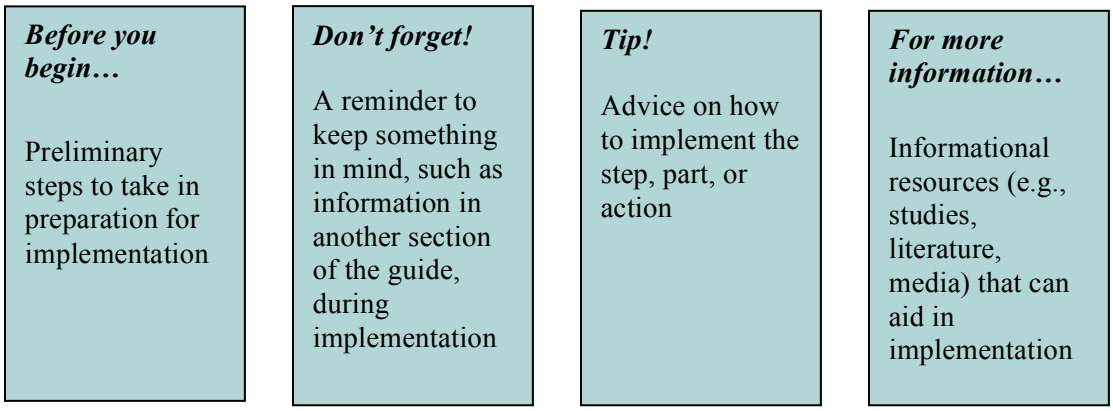
        - Actions: specific acts for implementing the method.

    - ***Output and documentation:*** the expected outcome (e.g., data, educational results, etc.) produced or compiled by the end of the part of the step, as well as suggestions for how the products should be documented.

3. **Case study:** the process and results of the real-world implementation of the step by researchers at Oregon State University.

    The practitioner should note that each application of the approach will generate unique data. Nevertheless, the "Case Study" section provides exampes to guide implementation.

Additionally, this chapter includes supplementary information identified in boxes:

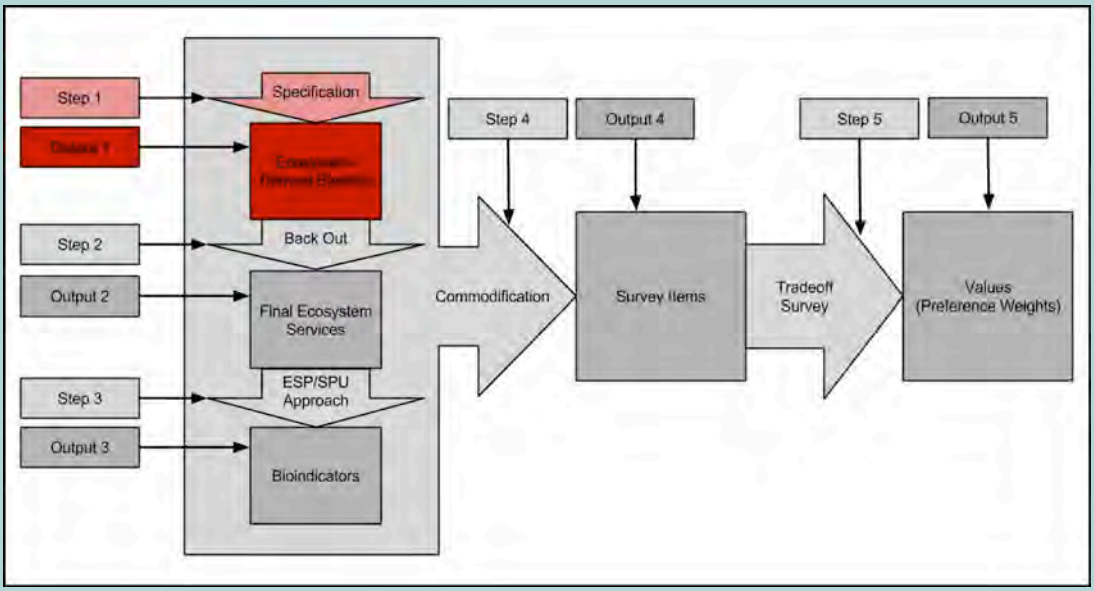


2.3.1 Step 1: Specification of benefits

Introduction

This section outlines the first of five steps to implement the approach detailed in this guide. See Figure 5 for a depiction of how Step 1 fits into the larger approach.

Figure 5 – Step 1 of approach: specification of benefits



The procedure that makes up this step is called *specification*. The objective of specification is for the practitioner to describe (i.e., specify) a complete, non-duplicative, and parsimonious list of benefits that stakeholders derive from their local nearshore ecosystem. This list of benefits will then serve as the input to Step 2 of the approach: backing out a list of ecosystem services. The practitioner will specify benefits using the methods of instruction and guided discussion in a focus group setting. For guidance on arranging and moderating a focus group, see Box 8 on the following page.

> ***Before you begin…***
>
> Refer back to Section 1.6 to review the definition of a benefit and how it relates to ecosystem services.

Procedure

This step is completed in 2 parts, each of which is detailed in turn.

Part 1: Educating focus group participants

Objective

Ensure focus-group participants fully understand the definition of a benefit.

Box 8 – Focus groups

The practitioner will use focus groups to complete a number of steps and parts of the approach detailed in this guide. Convening and facilitating a focus group is a challenging activity that requires considerable time, research, and effort, and should be prepared for adequately.

For information on focus-group methodology, see *The Focus Group Kit: Volumes 1–6* (1997), by David Morgan and Richard Krueger.

Also, the practitioner will want to keep the following things in mind when using focus groups to implement this approach:

Planning

- The size and composition of the focus group has implications for the means and ends of the analysis. In order to make these determinations, the practitioner must consider the motivation for undergoing the analysis, the analytical goal, and the intended impact on the local and greater communities of academia, policy-makers, and other organizations and citizens.

Materials and resources

- The practitioner should use an easel or blackboard to diagram the discussion in an interactive way. Also, she may want to provide participants with scrap paper so that they can organize their thoughts before participating in the discussion. She may also want to arrange for detailed note taking or documentation of the focus group proceedings. Researchers at Oregon State University used a smartphone to take an audio recording of the meetings and take pictures of the easels. If the practitioner chooses to make recordings, she may be required to obtain participants' permission beforehand.

Facilitating

- The principal challenge for the practitioner is to focus and contain the discussion to the task at hand. However, for each piece of data identified in a focus group, the contextual information (tangents, out-loud expressions of trying to find the right word, etc.) is equally valuable to other steps in the approach. For this reason, the practitioner should embrace and thoroughly document the rich discussions that occur during each focus-group meeting.
- Another challenge for the practitioner is to make the task at hand clear to focus group participants. In providing this information, she should weigh the benefits and costs of providing participants detailed information about her methodology. An optimal level of information is one that allows the participants to execute their task but does not distract or confuse them. In other words, provide the "what" but not necessarily the "why."

Other

- It is recommended that the same focus groups be used for the entire analysis. Since participants will already be familiar with previous steps, they will more readily be able to build upon that information to complete following steps. Each step will require multiple meetings, etc.
- While each focus group is different and each application of the approach generates unique data, researchers found that repeated applications with different focus groups gleaned a diminishing amount of new information.

Perspective

In order for focus group participants to identify benefits, the practitioner must first provide them a definition of a benefit. Though this may seem obvious, the practitioner should not underestimate the importance of ensuring focus-group participants thoroughly and completely understand what a benefit is and what it is not. There are two reasons for this. First, the approach detailed in this guide is logically sequential, and focus-group participants must understand how one step relates to another. Second, Step 4, *Commodification*, incorporates outputs of previous steps, including benefits. Therefore, focus-group participants must have a clear idea of what they have covered, and why, as they move through the steps of the approach. Also, in general, the practitioner should always be concerned with executing each step with clarity, so that focus-group participants are clear about their contributions.

Box 9 – Definition and examples of a benefit to provide to focus-group participants

Note: this is not the same definition as was provided in the previous chapter. That definition is for the purposes of *your* understanding; this definition is more appropriate for a focus-group setting.

***(def.)*:** A valued good or experience that the marine ecosystem provides you.

Qualifications and Examples:

1. The reason you pursue activities in and around the marine ecosystem.

Examples:

- You go fishing (the activity) to catch fish (the benefit).
- You walk along the beach in the evening (the activity) to enjoy the sunset (the benefit).
- You go surfing (the activity) to obtain exercise (the benefit) and a thrill (another benefit).

2. Something you enjoy or receive passively or alone, or actively with tools and other people.

- You get artistic inspiration (the benefit) watching the waves crash (passive and alone activity).
- You acquire scientific knowledge (the benefit) by retrieving a glider (a tool belonging to an institution).

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Instruction and guided discussion in a focus-group setting.

Action 1

Provide focus-group participants the definition of a benefit and clarifying qualifications and examples found in Box 9. Write them on the board or easel.

Action 2

Discuss the definition as a group until all focus-group participants are clear about benefits.

Output and documentation

There is no tangible output from this part. Rather, both the practitioner and the focus group participants should be confident that they thoroughly understand the definition of a benefit.

Part 2: Specifying benefits

Objective

Generate a complete, non-duplicative, and parsimonious list of benefits that focus-group participants derive from their local nearshore ecosystem.

Persepective

This part is very similar to the first part of this step, and as such the practitioner should refer to this section of the previous step.

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Guided discussion in a focus-group setting.

> ***Tip!***
>
> Participants will want to identify any and all examples of a benefit they can think of. Contain this mental wandering by reminding them to provide their own perspective and experience only.

Action 1

Ask focus-group participants to think about when they traveled to the coast within the past year, and to write down their activities (their activity).

Action 2

Ask focus-group participants to identify the benefits they received from those activities (their reason for going).

Action 3

With guidance from focus-group participants, combine the raw list of benefits into a non-duplicative list. Diagram through this process on the board or easel so that focus-group participants can follow your logic.

Action 4

Ask focus-group participants if there is any redundancy in the list of benefits and whether the list can be reduced or consolidated. For example, ask, “Are any of these similar? Can we combine them or assign them to a more general category?”

Action 5

Call a short break and write the final, complete, non-duplicative, and parsimonious list of benefits on the board or easel. This list will immediately serve as the input to Step 2, so make sure to leave as much space in between and around the list items as possible.

Output and documentation

A complete, non-duplicative, and parsimonious list of benefits written on the blackboard or easel.

Case Study

In 2011 and 2012, researchers at Oregon State University organized stakeholder focus-group meetings[11] in two coastal communities (Port Orford and Newport/Depoe Bay) and one non-coastal community (Corvallis, Oregon). Two meetings were held in each location. Focus-group participants were recruited to participate in focus groups based on their known activity in the ocean planning process in their community, as well as their affiliation to the eight stakeholder categories stipulated in Oregon House Bill 3013: local government, recreational fishing industry, commercial fishing industry, nonfishing industry, recreationalists, conservation, coastal watershed councils, and relevant marine and avian scientists. This sampling method was not intended to generate a representative sample. Rather, focus-group participants were recruited with the goals of further engaging active stakeholders and ensuring even stakeholder group representation. The practitioner should note that researchers applied this sampling method to each focus group recruited to implement this approach.

Each of the three focus-group meetings resulted in a set of benefits that were specific to that particular group and discussion. These unique sets are not presented here in full detail. Rather, a list of 12 generalized benefits (categorically consolidated) is presented below:

1. Physical activity and recreation
2. Human health: avoidance of pollution
3. Psychological and emotional health
4. Viewing of scenery
5. Viewing of wildlife
6. Using the beach
7. Marketing and consumption of seafood
8. Catching fish and invertebrates
9. Food security and sustainability
10. Cultural identity
11. Ecological knowledge
12. Opportunity for stewardship and conservation

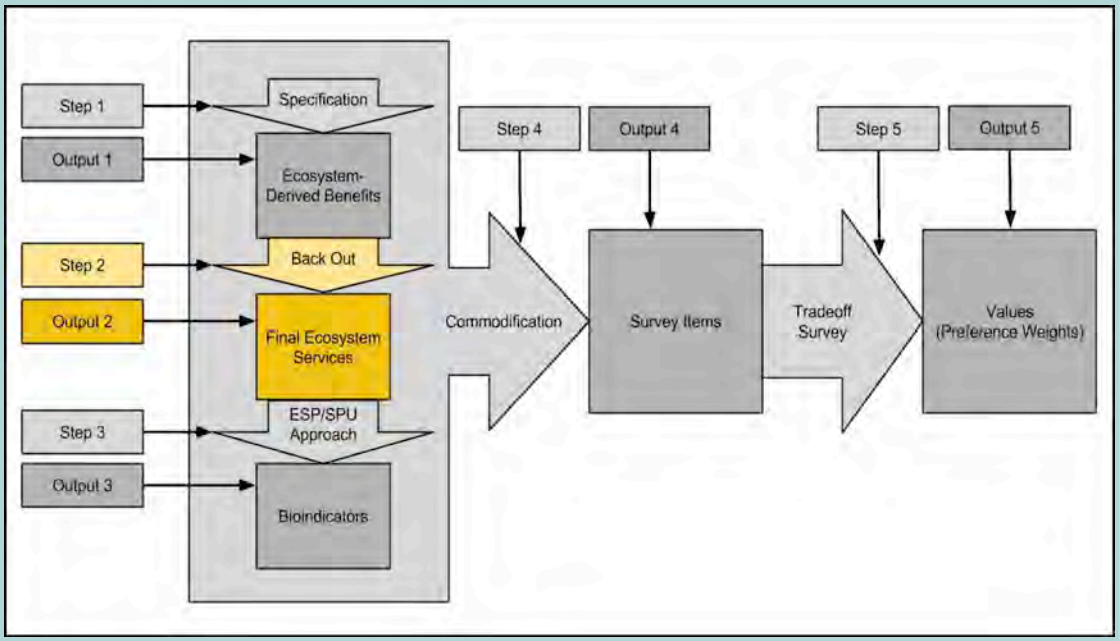
[11] The method of stakeholder focus groups was chosen with the goal of engaging local stakeholders in the MSP process on a community level. Stakeholder focus groups had been used previously to conduct an economic valuation of marine resources in Oregon (Hesselgrave et al., 2011). Furthermore, focus groups provide a forum for public discussion and education on the topic of ecosystem services, which researchers and state resource managers believed was a valuable contribution to the planning process.

2.3.2 Step 2: Backing out ecosystem services

Introduction

This section outlines the second of five steps to implement the approach detailed in this guide. See Figure 6 for a depiction of how Step 2 fits into the larger approach.

Figure 6 – Step 2 of the approach: backing out ecosystem services



The procedure that makes up this step is called *backing out*. The objective of backing out is to derive (i.e., back out) from the list of benefits a complete, non-duplicative, and parsimonious list of ecosystem services. This list will then serve as the input to Step 3 of the approach: applying the *ESP approach* to identifying bioindicators.

> ***Before you begin…***
>
> Refer back to Section 1.5 to review the operational definition and characteristics of ecosystem services.

Procedure

This step is completed in three parts, each of which is detailed in turn.

Part 1: Educating focus-group participants

Objective

Ensure focus-group participants fully understand the definition of an ecosystem service.

Perspective

Considerations for this part are similar to those provided in the previous part. In addition, however, it is important that practitioners define a benefit within the context of an ecosystem service, as well as define ecosystem services in the context of benefits. It is critical that focus-

group participants understand this link so they can follow the sequence of steps making up the approach.

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Instruction and guided discussion in a focus-group setting.

Action 1

Provide focus-group participants the definition of an ecosystem service and qualifications (examples are provided in Box 10).

Action 2

Discuss the definition as a group until all focus-group participants are clear on what a benefit is.

Output and documentation

There is no tangible output from this part. Rather, both the practitioner and the focus-group participants should be confident that they thoroughly understand the definition of an ecosystem service.

Box 10 – Definition and examples of an ecosystem service to provide to focus-group participants

Note: this is not the same definition as was provided in the previous chapter. That definition is for the purposes of *your* understanding; this definition is more appropriate for a focus-group setting.

(def.): The components of nature that you directly enjoy, consume, or use to obtain a benefit.

Qualifications and Examples:

1. Note the word "directly."

- If you go fishing, you go in order to catch fish (the benefit). The components of nature that most directly make that possible are the fish in the water (the ecosystem service). Everything else that is responsible for those fish being there, such as habitat and food, provide benefits only indirectly because you didn't go fishing to enjoy fish habitat, you went to catch fish.

2. Note the word "component." This means a "thing," in contrast to a process or ecosystem interaction.

- If you go fishing, the fish in the water (components) are the ecosystem services. Although they would not be around your boat if they didn't migrate there (a process) or feed there (a food web interaction), these are not ecosystem services because you do not experience them directly—and besides, you didn't go fishing to observe fish migration or feeding.

Part 2: Backing out ecosystem services

Objective

Generate a complete, non-duplicative, and parsimonious list of ecosystem services that are directly associated with the benefits focus-group participants derive from their local nearshore ecosystem.

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Guided discussion in a focus-group setting.

Action 1

Starting with the first benefit in the list generated in Step 1, ask focus-group participants to identify ecosystem services that they directly enjoy, consume, or use to obtain that benefit. Repeat this action for each benefit in the list.

Action 2

With the help of the focus-group participants, combine the list of ecosystem services into a non-duplicative list. To focus this task for focus-group participants, write the new list on a new sheet of paper or in a new area of the blackboard, separated from their associated benefits.

Action 3

Ask focus-group participants if there is any redundancy in the list of ecosystem services and whether the list can be reduced, consolidated, or categorized. For example, ask "Are any of these similar? Can we combine them or assign them to a more general category?"

Output and documentation

The practitioner should have written on the blackboard or easel a complete, non-duplicative, and parsimonious list of ecosystem services focus-group participants derive from their local nearshore ecosystem.

Box 11 – Whole-system processes and existence value

Participants may find the task of "backing out" constraining. Many people value the ecosystem for its intangibles and indivisible complexities, and may oppose the idea of breaking up their relationship with the ecosystem into "things." This happens most commonly when an individual takes a holistic view of the ecosystem and is concerned with its overall "health" or "condition," which inherently involves all parts interacting. Furthermore, the overall "health" of the ecosystem may not provide anything tangible, and thus the benefit is a psychological one: just knowing that the ecosystem is preserved, protected, or improving. When this happens, the practitioner will notice participants losing sight of the definition of ecosystem services in favor of discussing the holistic nature of their local marine ecosystem in a way that does not contribute to the task of "backing out."

If this happens, the tasks of the practitioner are to

1. acknowledge and validate this tendency
2. note that you will be addressing the concept at a different point (specifically, in part 3 of this step)
3. direct attention back to the task at hand

If this step is necessary, it is important for the practitioner to know that this sentiment is connected to what is called *existence value*, which can be defined as ***(def.)***: the value from knowledge of continued existence of a resource. People often hold existence value for the ecological processes that make up the whole ecosystem, and they hold this value out of moral conviction regarding an inherent quality of the ecosystem, rather than its production of outputs. Furthermore, people hold existence value in such a way that they

1. value it independently of their own use of the ecosystem
2. value the systematic processes of the ecosystem, rather than any specific component
3. are not interested in understanding the technical intricacies of those processes

For these reasons, existence value does not correspond well with ecological production theory. Nevertheless, the psychological benefit holding existence value is provided by ecosystem services. In order to facilitate participants' identifications of these ecosystem services, Part 3 of this step represents a slight modification to the approach. Mainly, the practitioner articulates the benefit providing existence value in order to lead participants to identifying related ecosystem services.

Part 3: Backing out ecosystem services providing a benefit associated with existence value

Objective

To identify ecosystem services that provide a benefit associated with existence value.

Perspective

This step is designed to expand the basic design of the approach. Focus-group participants may have this reaction to the approach, or they may not. Thus, this part may be unnecessary.

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Guided discussion in a focus-group setting.

Action 1

Inform focus-group participants that this activity is similar to, but a slight departure from, the previous activities. Explain that they will be identifying ecosystem services that directly provide a benefit, but they will be provided the benefit rather than have it solicited from them. If appropriate and helpful, point out that they are addressing the concept that was put aside during the last activity (i.e., ecosystem "health," "condition," "integrity," or whatever language focus-group participants used).

Action 2

Provide focus-group participants with the definition of the psychological benefit associated with existence value found in Box 12.

Box 12 – Definition and examples of the psychological benefit holding existence value

Note that this is not the same definition as was provided in the previous chapter. That definition is for the purposes of the practitioner's understanding; this definition is more appropriate for a focus-group setting.

Definition:

Just knowing that the ecosystem as a whole is functioning strongly and naturally.

Example:

Think of what you imagine the ecosystem looks like in a pristine area of the Amazon. Even though you may never have been there and may never go there, you want the Amazon to remain in that pristine state. Many people donate money to support the protection of those parts of the Amazon for just this reason. The psychological benefit that people receive is from just knowing that the ecosystem as a whole is functioning strongly and naturally provides existence value.

Tip!

Do not use the term "existence value" with participants. Instead, refer to the value generally (e.g., "that feeling we have just knowing…"). This tactic makes the concept seem less formalized and facilitates participants' using their imagination to identify ecosystem services.

Action 3

Ask focus-group participants to identify ecosystem services that provide this benefit. If the practitioner uses the Amazon example, ask them to identify ecosystem services within that context. Then, once a complete, non-duplicative, and parsimonious list has been generated, ask them if they can translate any of those services into the context of their local marine ecosystem.

Action 4

After adjourning the focus-group meeting, consolidate the greater list of ecosystem services into a list that is easier to integrate into ecological models.

> ***Tip!***
>
> Action 4 requires the practitioner to balance two competing demands: the need to translate the raw data into more-technical language, and the need to preserve the integrity of the raw data through the translation process. In other words, the consolidated list should be technical, yet still represent the raw data in spirit.
>
> For example, if participants identify "the number of rockfish" and "the number of lingcod" as two valued ecosystem services, the practitioner might want to consolidate them into "the abundance of harvestable fish species." However, going a step further to translate those ecosystem services into "population size of harvestable fish species," for example, misinterprets the data. This is because while this terminology might follow the logic of an ecologist, a species population size is not what provides a benefit to fishermen.
>
> This process may require referring to ecosystem services literature, especially studies that include production function models. This process is for the benefit of the practitioner, and will help integrate this step's output into the following steps.

Output and documentation

A complete, non-duplicative, and parsimonious list of ecosystem services that directly provide each benefit.

Case study

In 2011 and 2012, researchers organized focus groups in three communities in Oregon. (See previous section for description of the recruitment of these groups.) Researchers also organized an additional focus group meeting to characterize whole-system processes providing a benefit associated with existence value. Researchers "backed out" a unique set of ecosystem services for each group, then consolidated the unique data resulting from each focus-group meeting into a complete, non-duplicative, and parsimonious list of generalized ecosystem services. This process resulted in a total of 23 ecosystem services:

1. Production of harvested fish biomass
2. Production of harvested invertebrate biomass
3. Production of non-harvested fish biomass
4. Production of non-harvested invertebrate biomass
5. Production of marine mammal biomass
6. Production of seabird biomass
7. Ecological maintenance of harvested fish populations
8. Ecological maintenance of harvested invertebrate populations
9. Production of genetic diversity across fish species
10. Production of genetic diversity across invertebrate species
11. Production of genetic diversity across marine mammal species
12. Production of genetic diversity across seabird species
13. Removal of biological waste in water
14. Removal of chemical contaminants in water
15. Deposition and retention of sand

16. Formation of intertidal structure
17. Production of kinetic wave energy
18. Support of leisure and recreation
19. Formation of socially valued seascapes
20. Production of visible macroagla biomass
21. Production of visible aquatic plant biomass
22. Support of social and cultural relations
23. Support of socially valued lifestyle

Researchers observed a pattern in focus-group participants' identification of ecosystem services that is worth noting for the benefit of the practitioner planning on applying this approach. Focus group participants were quicker to identify certain types of ecosystem services, and needed additional facilitation to identify others. Specifically, what would be considered "provisioning services"[12,13] were most readily and clearly identified by focus-group participants in the first focus-group meetings. One possible explanation for these services being most-readily identified is that they are most-directly utilized. Services that are more-indirectly utilized, and therefore a bit less tangible, were identified with additional facilitation.

What would be considered "cultural services"[3,14] were the next-most-easily and -readily identified. Focus-group participants may have readily identified these services in part because of the value they place on their culture and social fabric, and also because of the multi-dimensional nature of these services. Focus-group participants displayed a strong yet irreducible identity with the culture of the Oregon coast, and their descriptions of this feeling were often nebulous, romanticized, and not directly attributable to any natural features or qualities over others.

Focus-group participants also identified what would be considered regulating services[3] less readily than provisioning services.[15] Regulating services include those beginning with "Ecological maintenance of" and "Removal of." Regulating services are distinct from provisioning services in that, in addition to the quantity of an environmental feature, they imply criteria for the delivery of the service. For example, the service "Ecological maintenance of harvested fish populations" implies a dynamic in the supply of, rather than the provision of, the fish at any given moment. Also, focus-group participants defined one ecosystem service as the "preservation of ecosystem integrity," which refers to whole system processes. For the purposes of generating data for the next step, researchers called this ecosystem service "Ecological maintenance of whole system processes." The fact that these services were not identified as readily as provisioning or cultural services was not a result of a limitation to this approach. Rather, it highlights that the focus group discussion becomes more in-depth as it moves on, and only later in the discussion are criteria—and therefore services implying criteria—identified.

As discussed in the previous section, focus-group participants at times resisted the task of extricating discrete ecosystem services and gravitated toward describing social and psychological

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[12] Millennium Ecosystem Assessment (2006) outlines four types of ecosystem services: provisioning, regulating, supporting, and cultural.

[13] Provisioning services include those that begin with "Production of" and "Formation of," with the exception of "Formation of socially valued seascapes" and "Deposition and retention of sand." These two terms are intended to communicate an increase in quantity but in different ways—the former being more instantaneous and the latter being more accumulative.

[14] Cultural services include "Support of leisure and recreation," "Support of social and cultural relations," "Formation of socially valued seascapes," and "Support of a socially valued lifestyle."

[15] Ecosystem services that would, by definition, be "supporting services" were not identified as such in this study because they are not directly utilized and therefore do not fit the definition of ecosystem services used in this approach.

benefits. Researchers addressed this tendency by convening an additional focus group—in 2012 in Corvallis, Oregon—dedicated to characterizing an ecosystem service that provides the psychological benefit of existence value.[16] Researchers recruited focus-group participants via the same sampling method as previous focus groups. The first set of questions developed for this additional focus-group meeting was aimed at generating a definition of ecosystem services that represent whole-system processes providing a psychological benefit associated with existence value.

Like the list of benefits in the previous section, researchers did not treat the above list of ecosystem services as an endpoint of the analysis, but rather as inputs to the following step. Since these services do not have to be interpretable by stakeholders at this point, researchers used their own language to describe these ecosystem services. These descriptions were based on the ecosystem services identified, as well as additional language describing focus-group participants' values, goals, and criteria related to their local marine ecosystem. This information was used to consolidate ecosystem services.

For example, some fishermen targeted urchins, and others targeted fish. Therefore, "production of harvested invertebrate biomass" and "production of harvested fish biomass" were differentiated into two ecosystem services. Also, some focus-group participants thought that, although leisure and recreation are important to the culture of their community, since many people from outside their community visit in order to recreate, the two services are actually very distinct.

Practitioners should note that differentiation might cause the list of ecosystem services to appear either redundant or generalized. For example, "Provision of non-harvested fish biomass" and "Provision of harvested fish biomass" are two distinct ecosystem services referring to mutually exclusive sets of species because of the differing substitutability between different species of fish across fishermen and nonconsumptive observers of fish. Specifically, commercial fishermen target—or are permitted to target—only certain species, while the recreational diver is able to view both targeted and non-targeted species.

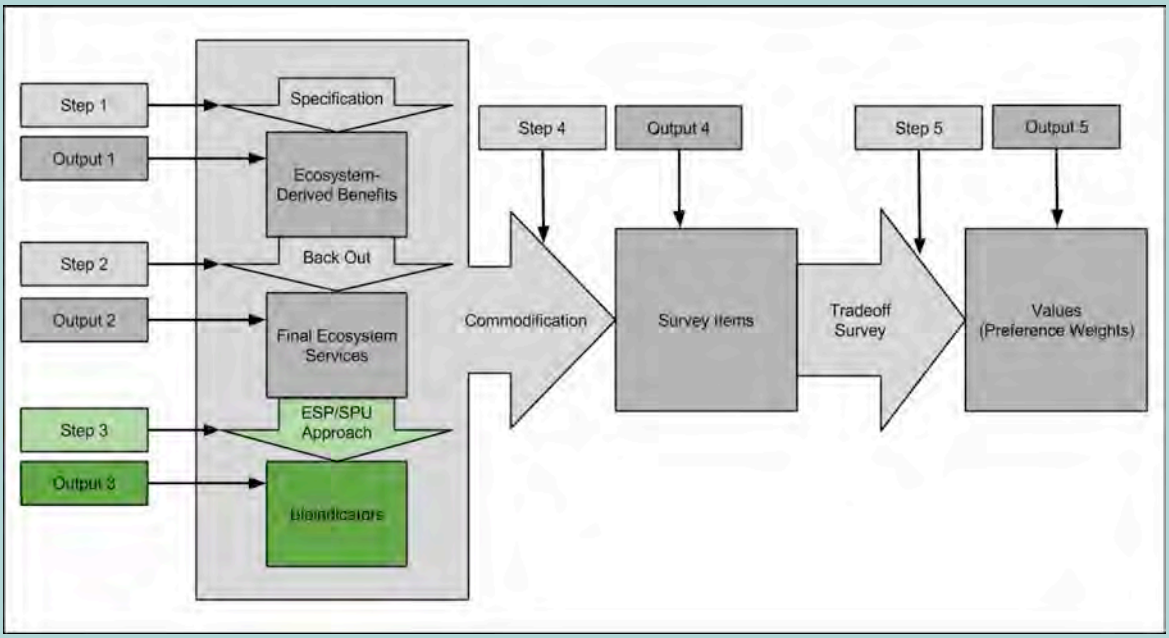
[16] The same focus-group meeting was used to identify those ESPs that provide the ecosystem services. This part of the case study is provided in the following section.

2.3.3 Step 3: ESP approach to identifying bioindicators

Introduction

This section outlines the third of five steps to implement the approach detailed in this guide. See Figure 7 for a depiction of how Step 3 fits into the larger approach.

Figure 7 – Step 3 of the approach: ESP approach to identifying bioindicators



The procedure that makes up this step involves applying the *ESP approach*, or an *ecological production function*. The objective of the ESP approach is for the practitioner to generate a complete, non-duplicative, and parsimonious list of bioindicators that correspond to the delivery of those ecosystem services that the study focus-group participants utilize to derive benefits from their local nearshore ecosystem. This list, along with the lists of benefits and ecosystem services, will then serve as the input to Step 4 of the approach: Commodification.

> ***Before you begin…***
>
> Refer back to Section 1.8 to review bioindicators, ecosystem service providers (ESPs), functional units, functions, functional traits and attributes, and ESP efficiencies.

The practitioner will apply the ESP approach using the methods of literature reviews and consulting natural- and social-science researchers. Also, if necessary, the practitioner may also employ guided discussion in a focus-group setting. A number of things are worth noting with regard to these methods. First, an ecological production function can best be characterized by combining the primary and secondary data generated by the approach thus far (i.e., benefits and ecosystem services, and descriptive language and perspectives, respectively) and the expertise of natural scientists. The benefits of this collaboration can be better understood when considering the three parts of this procedure.

The first part involves identifying ESPs. ESPs are not technical items and their identification does not require technical expertise. Rather, it requires the practitioner to refer back to the secondary information gathered during the focus groups. More often than not, focus-group

participants will talk through facets of ecosystem services in order to formulate and identify ecosystem services. These discussions include ESPs.

On the other hand, the second and third parts require the expertise of a biologist or ecologist, since they involve deconstructing ESPs into functions and ESP efficiencies (i.e., bioindicators). Not only is this procedure relatively technical, but chances are the resulting bioindicators are already measured and monitored by biologists and ecologists.

Objective

Specify a complete, non-duplicative, and parsimonious list of bioindicators that correspond to the delivery of those ecosystem services that the study focus group participants utilize to derive benefits from their local nearshore ecosystem.

Procedure

This step is completed in four parts, each of which is detailed in turn.

Part 1: Identify ecosystem service providers

Objective

Generate a complete, non-duplicative, and parsimonious list of *ecosystem service providers* (ESPs) that provide each ecosystem service.

Introduction

This part is relatively analytical, and primarily involves research into the fields of biology and ecology. Thus it should be carried out by someone with training in these areas. Like information gathered in previous steps, additional information gathered in this step will inform the initial phrasing of survey items (Part 1 of Step 4) and provide guidelines for monitoring efforts. For this reason, the practitioner should try to keep the language used to describe ESPs as non-technical as possible—while allowing it to be fully interpretable by biologists and ecologists.

> ***For more information…***
>
> Literature on the delivery of ecosystem services by ESPs include analysis of organisms such as fish (Holmlund & Hammer, 2004; Holmlund & Hammer, 1999), soil invertebrates (Lavelle et al., 2006), oysters (Coen et al., 2007), macrophytes (Engelhardt & Ritchie, 2001), and birds (Whelan et al., 2008). Similar analyses were done on other ecosystem levels, such as sedimentary communities (Snelgrove, 1997, 1999; Weslawski & Snelgrove, 2004), populations (Luck et al., 2003), marine functional groups (Micheli & Halpern, 2005), and coral reef ecosystems (Moberg & Folke, 1999).

Resources and practical considerations

The practitioner will rely largely on literature and other scientific information resources to identify ESPs. However, since this information will be integrated into subsequent analyses, it is important that the practitioner organize this information systematically, keeping track of all connections between ESPs and ecosystem services. In addition, the practitioner may want to annotate this table with information on why the ESPs relate to the ecosystem services.

Method

Literature review, expert opinion, and desktop analysis.

Action 1

Consult literature on the delivery of ecosystem services by the different classes of ESPs (i.e., organisms, species, functional groups, populations or communities, or their trait attributes).

Action 2

Reflect on the list of ecosystem services in context of the descriptive language focus-group participants used to describe the ecosystem services, identifying any ecosystem features that may qualify as ESPs.

Action 2

Adapt and assign relevant organisms, species, functional groups, populations or communities, or their trait attributes to the list of ecosystem services previously generated.

> ***Tip!***
> One of the secondary functions of ESPs is to inform the initial phrasing of survey items (Step 4) and provide guidelines for monitoring efforts. For this reason, the practitioner should try to keep the language used to describe ESPs as non-technical as possible—while allowing it to be fully interpretable by biologists and ecologists.

Output and documentation

A complete, non-duplicative, and parsimonious list of ESPs associated with each ecosystem service identified in Step 2. Additionally, the practitioner may want to annotate her lists of ESPs with information on how those ESPs provide each ecosystem service, including information gathered during the focus-group meetings held previously.

Part 2: Identify "modified ESPs" related to the ecosystem service that provides a benefit associated with existence value

> ***Before you begin…***
>
> The practitioner may want to consider merging this part with Part 3 of Step 2 by implementing the two parts in one focus-group meeting. As is described in the "Case Study" section below, researchers at Oregon State University implemented these two parts in one focus-group meeting to minimize both logistical costs and the burden on focus-group participants.

Objective

Generate a complete, non-duplicative, and parsimonious list of "modified ESPs" related to the ecosystem service that provides a benefit associated with existence value.

Perspective

This part, like Part 3 of Step 2, is necessary only if the practitioner found it necessary to implement that part. Also like Part 3 of Step 2, this part represents a departure from Part 1 of this step. Specifically, rather than identifying ESPs using the methods of literature and expert analysis, the practitioner will employ another stakeholder focus-group meeting to identify "modified ESPs" that focus-group participants associate with the ecosystem service that provides a benefit associated with existence value. "Modified ESPs," defined in Box 13, are used in this part to accommodate differences between this ecosystem service and the rest generated in the approach. See Box 11 for a discussion of this topic.

Resources and practical considerations

See Box 8 for a description of what is required to plan for, convene, and facilitate a focus group.

Method

Guided discussion in a focus-group setting.

Action 1

Provide focus-group participants with a thorough definition and description of the ecosystem service previously defined that provides a benefit associated with existence value.

Action 2

Ask focus-group participants to describe the ecosystem using characteristics, qualities, or dynamics of an ecosystem in which the whole-system processes (or whatever language was settled on by focus-group participants in Part 3 of Step 2[17]) are ecologically maintained. Questions and techniques that the practitioner may find helpful are presented in Box 13.

Action 3

Further refine responses by asking focus-group participants if they would still value that ESP alone and unrelated to the ecosystem service in question (see #6 in Box 13).

Action 4

Consolidate the list of modified ESPs into a complete, non-duplicative, and parsimonious list. This process can be informed by referencing academic literature, as well as reflecting back on the proceedings of the focus-group meeting.

Output and documentation

A complete, non-duplicative, and parsimonious list of modified ESPs (i.e., characteristics, qualities, and dynamics that characterize the ecosystem service related to benefits associated with existence value).

Box 13 – Modified ESPs

Since existence value is held for ecosystem processes rather than ecosystem components, associated ecosystem services are provided not by ESPs according to the definition used in this guide, but rather less-tangible characteristics, qualities, or dynamics, called "modified ESPs."

In order to elicit these descriptors of these modified ESPs, the practitioner may ask the following questions:

Questions:

1. How would you characterize an ecosystem in which the whole-system processes (or whatever language used by participants) are ecologically maintained?
2. Does this ecosystem have any qualities that a less well-maintained ecosystem does not have?
3. How would you describe the dynamic within this ecosystem?
4. What do you picture existing and happening in this ecosystem?

The practitioner may then ask participants to think of these characteristics, qualities, or dynamics in the form of indicators (i.e., measures of change).

5. How would you know that an ecosystem is becoming more ecologically sustained?

Additionally, since modified ESPs measure whole-system processes that hold existence value, they should not include ESPs that relate to other ecosystem services. In other words, modified ESPs should not hold value individually, but hold positive value when packaged to represent whole-system processes. To make this distinction, the practitioner should also ask focus-group participants:

6. Do you think you benefit directly from that characteristic/quality/dynamic?

An answer of "no" = a modified ESP. An answer of "yes" = regular ESP.

[17] The term "natural integrity" was chosen by the focus-group participants as best describing their concept of whole-system processes. It should be noted that this term implies complex values on the part of participants, a topic that is discussed in more detail in the following chapter.

Part 3: Identify functions, functional traits and trait attributes

Objective

Generate a complete, non-duplicative, and parsimonious list of the functions, functional traits, and trait attributes that relate ESPs or modified ESPs to their delivery of the relevant ecosystem service.

Perspective

Similar to the previous part, this part is also relatively analytical. It primarily involves research into the fields of biology and ecology, and thus should be carried out by someone with training in these areas.

Resources and practical considerations

The practitioner will rely largely on literature and other scientific information resources to identify functions, functional traits, and trait attributes. However, because this information will be integrated into subsequent analyses, it is important that the practitioner organize this information systematically, keeping track of all connections between ESPs and functions, functional traits, and trait attributes. Therefore, the practitioner may want to annotate her data on why she made these connections.

Method

Literature review and expert opinion.

Action 1

Consult literature on ecosystem functioning and functional ecology, both marine and terrestrial, focusing on any studies that address ecosystem services and inventory functions, functional traits, and trait attributes that may be relevant.

> ***For more information…***
>
> Literature on ecosystem functioning and functional ecology includes (Balvanera et al., 2006; De Bello et al., 2010; Kremen & Ostfeld, 2005; Naeem et al., 2009) and Eric Garnier & Marie-Laure Navas, 2012.

Action 2

Review the language focus-group participants used to describe ecosystem service delivery, identifying any ecological relationships or dynamics that may qualify as ESP functions, functional traits, or trait attributes.

Action 3

Adapt and assign relevant functions, functional traits, and/or trait attributes to the list of ESPs previously generated.

Output and documentation

A table or diagram with ESPs in one column and all functions, functional traits, and trait attributes associated with each ESP in another column. Additionally, this table should be linked back to each ecosystem service identified in the previous step.

Part 4: Identify ESP efficiencies

Objective

Identify ESP efficiency metrics for each function, functional trait, and/or trait attribute.

Perspective

Similar to the previous part, this part is also relatively analytical. It primarily involves research into the fields of biology and ecology, and thus should be carried out by someone with training in these areas.

Resources and practical considerations

Same as previous part.

Method

Literature review and expert opinion.

Action 1

Consult literature on marine bioindicators related to relevant ecosystem services, ESPs, functions, functional traits, and trait attributes.

Action 2

Adapt and assign relevant bioindicators (i.e., those that measure a rate or efficiency of an ESP's functioning) to respective functions, functional traits, and trait attributes.

For more information…

Literature used to support Part 4, identify ESP efficiencies, addressed bioindicators measuring:

- The effects of fishing (Fulton et al., 2005; Methratta & Link, 2006; Rochet, 2003)
- Ecological integrity and health (Burkhard et al., 2011; Karr, 1991; Leo, 1997; Müller, 2000; Parrish et al., 2003; Rice, 2003)
- Biodiversity loss (Eppink & Vandenbergh, 2007)
- Habitat classification (Tillin et al., indicators for ecosystem-based fisheries management (Babcock et al., 2005; Link, 2005)
- Trophodynamics (Cury et al., 2005)
- Coastal management (Håkanson & Blenckner, 2008)
- Marine reserve and protected area design and performance (Botsford et al., 2008; Hilborn et al., 2004; Pelletier et al., 2008; Pomeroy et al., 2005).

Output and documentation

A table or diagram with functions, functional traits, and trait attributes in one column and all ESP efficiencies associated with each function, functional trait, and trait attribute in another column. Additionally, this table should be linked to each ESP and ecosystem service identified previously.

Case study

In 2012, researchers at Oregon State University generated a list of ESPs, functions, functional traits, trait attributes, and ESP efficiency measures for each of the 23 ecosystem services previously identified, plus the ecosystem service providing a benefit associated with existence value. Researchers generated this list through consulting academic literature and the expert opinions of biologists and ecologists. The total effort resulted in 59 ESPs; 115 functions, traits, and trait attributes; and an equal number of ESP efficiency measures. The output of the ESP approach for one ecosystem service is provided below, in Table 1.

Table 1. The ESP approach to identifying bioindicators for one ecosystem service			
Ecosystem Service	Ecosystem Service Providers	Functions/ Functional Traits/ Trait Attributes	Efficiency Measures (Bioindicators)
Production of non-harvested fish biomass	Non-harvested fish of size large enough to see easily	Production of visible individuals	Growth of non-harvested larger/conspicuous demersal fish
		Production of visible individuals	Growth of non-harvested forage fish
		Production of visible individuals	Average size (length) of non-harvested larger/conspicuous demersal fish
		Production of visible individuals	Average size (length) of non-harvested forage fish
		Production of visible individuals	Abundance (count) of non-harvested larger/conspicuous demersal fish
		Production of visible individuals	Abundance (count) of non-harvested forage fish
		Production of visible individuals	Density (#individuals/100m^2) of non-harvested larger/conspicuous demersal fish
		Production of visible individuals	Density (#individuals/100m^2) of non-harvested forage fish
		Production of high-demand individuals	Biomass accumulation among sedentary focal species community assemblages

In addition, in 2012, researchers convened a focus group in Corvallis, Oregon, dedicated to characterizing this information for an ecosystem service that provides the psychological benefit of existence value, as well as those modified ESPs that provide them. This meeting built on Part 3 of Step 2, the objective of which was to generate a definition of whole-system processes that provide a psychological benefit associated with existence value. The objective of this meeting was to generate a list of modified ESPs (i.e., descriptors of the ecosystem in the form of characteristics, qualities, or dynamics that represent whole-system processes). In addition, this list was narrowed down by researchers according to the criteria that a modified ESP elicits 0 value alone but >0 when indexed to represent whole-system processes. Focus-group participants identified 11 modified ESPs:

1. Resilience to disturbances
2. Diversity of species
3. Mature range of organism size
4. Is not stressed or disturbed
5. Does not need management
6. Resembles a preserved area
7. Minimal human impact
8. General health
9. Displays dense biomass
10. Displays diverse habitat
11. Strong cycling of energy and materials

These 11 metrics most closely resembled those used by ecologists to quantify measures of marine ecosystem "health" and "integrity." In order to identify related ESP efficiencies, therefore, researchers reviewed the literature on ecosystem health and integrity, indexes of biotic integrity, and indicators used to measure deviation from undisturbed areas and across disturbance gradients.

With the input of biologists and ecologists, researchers then selected from the literature a set of functions and an associated set of ESP efficiencies. Results are presented in Table 2 below.

Table 2. ESP and modified ESP efficiencies identified to characterize the ecosystem service ecological maintenance of whole-system processes

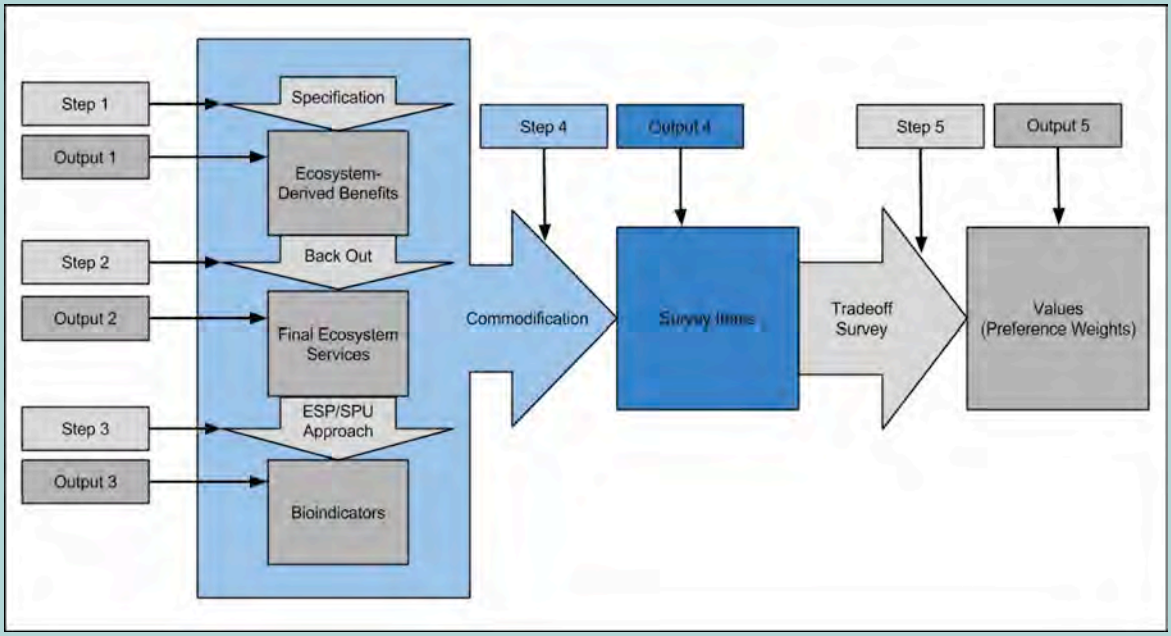
Modified ESPs	ESP Efficiencies
Resilience to disturbances (resilience)	Food web integrity Colonization and local extinction rates Local recruitment rate Recruitment success Survivorship
Diversity of species (biodiversity)	Species evenness Genetic diversity
Mature range of organism size (population structure)	Age ratio Sex ratio Spawning biomass Trophic role Growth rates of individuals Life-form proportions Biomass ratios (e.g., pelagic vs. demersal) Breeder biomass
Is not stressed or disturbed (functioning)	Functional diversity
Does not need management (self-organization)	Ascendancy Development capacity Emergence
Representative of natural comparison (representativeness)	Species distribution patterns Relative species abundance
Human impact (naturalness)	Area under no or reduced direct human impact Area showing signs of recovery
Parasitism (health)	Parasitism rates
Biomass, density (productivity)	Total benthic production Total biomass (community)
Habitat (structure)	Biotic habitat heterogeneity Abiotic habitat heterogeneity Habitat complexity Habitat integrity
Nutrient and energy flow (thermodynamics)	Net primary production Storage capacity Nutrient cycling Nutrient loss Nutrient cycling rates Size distribution Average trophic level

2.3.4 Step 4: Commodification of survey items

Introduction

This section outlines the fourth of five steps to implement the approach detailed in this guide, called *Commodification*. See Figure 8 for a depiction of how Step 4 fits into the larger approach.

Figure 8 – Step 4 of the approach: commodification of survey items



Commodification is the process of defining simulated environmental commodities (in this case representing ecosystem services) for use in stated-preference valuation surveys. As such, these simulated commodities will be referred to hereafter as "survey items." In order for a survey item to elicit valid responses in a stated preference survey, it must meet two basic criteria:

1. Provide survey respondents with accurate and complete information about the relevant ecological system and its delivery of ecosystem services.
2. Present that information in a way that allows survey respondents to predict the effect of the expected ecological change on their personal wellbeing.

> ***Before you begin…***
>
> Refer back to Section 1.9 to review stated-preference survey design.

In order to meet these criteria, the procedure in this step addresses two main efforts:

1. *Bundling*: Consolidating ecological information according to ecological relationships and the utility functions[18] of survey respondents.
2. *Phrasing:* Expressing survey items in a way that survey respondents find meaningful.

[18] "Utility function" can be defined as ***(def.)***: The wellbeing of an individual as a function of her consumption of goods and services (including, but not limited to, market and non-market ecosystem services).

Commodification requires detailed analysis on the part of the practitioner, as well as feedback and input from focus-group participants. Specifically, the practitioner will analyze basic functional relationships between ecosystem services and, by extension, to corresponding bioindicators. This analysis will be executed using the methods of graphical analysis and consulting the opinion of natural- and social-science researchers. She will then ground-test her results using guided discussion in a focus-group setting.

A number of things are worth noting with regard to these methods. First, the objective of this step is to take the information gathered so far (i.e., benefits, ecosystem services, bioindicators, and secondary information on focus-group participants' conceptualization and connection with their local marine ecosystem) and translate it into survey items that represent something valuable and meaningful to the population of stakeholders who will eventually be taking the survey, while at the same time accurately representing the relevant ecosystem. Carrying out this procedure therefore requires technical and scientific insight, as well as insight from her experience with the focus-group participants and study communities. In addition, the practitioner must also adhere to best practices for designing stated-preference survey items. In order to achieve this, the practitioner may find it worthwhile to consult some other resources first. See the *For more information* box below for a list of resources.

Also, as part of this step, the practitioner will organize and facilitate another focus group. As with previous focus groups, the practitioner must consider the difficulty of the task, as well as the secondary information that may result from the proceedings. However, this focus group is different from the previous ones. On one hand, it will largely be more efficient and concrete, since focus-group participants will be reacting to survey items provided to them rather than reflecting on their personal experiences. On the other hand, the practitioner must allow for this focus group to take on an iterative- or workshop-style format in which the group may rework her proposed survey items.

Bundling is necessary for two reasons. First, the practical constraints of survey administration may not allow for each and every ecosystem service to be individually presented for valuation. Second and more importantly, in order to provide survey respondents accurate and complete information about the relevant ecological system, ecological or economic complementarities between ecosystem services must be clearly expressed. Consolidating or differentiating ecosystem services through bundling allows these dynamics to be implied.

The principal challenge of bundling is the consolidation or reduction of ecosystem services into a survey item made up of smaller number of metrics or descriptive attributes. Furthermore, these survey items must at once be suitable for use in a tradeoff survey, as well as serve as guides for biological monitoring. To meet these dual purposes, the practitioner must consolidate ecosystem services in such a way that, respectively, does not confuse survey respondents by exhibiting colinearities between services (thus not allowing them to trade them off), nor confuse biologists by interacting or responding to drivers in opposite ways (thus not allowing coherent monitoring).

The practitioner will find an optimal level of consolidation through balancing the benefits of consolidation with the benefits of differentiation (i.e., un-consolidation). Consolidation and differentiation communicate, respectively, synergies or tradeoffs across final ecosystem services to survey respondents. These synergies and tradeoffs can relate both to survey respondents' utility functions and to their underlying ecological relationships, and the practitioner must try to preserve the integrity of each in the consolidation process.

Objective

Generate a complete, non-duplicative, and parsimonious list of survey items that are appropriate for use in a survey-based tradeoff exercise, as well as guides for ecological monitoring, according to the above criteria.

Before you begin…

The practitioner has many choices regarding the development and administration of the survey-based tradeoff exercise. These choices have bearing on the commodification process. Therefore, before you begin this step, read Box 15 on survey methodology.

Procedure

This step is completed in two parts, each of which is detailed in turn.

Part 1: Develop preliminary survey items

Objective

Develop a complete, non-duplicative, and parsimonious list of preliminary survey items that are appropriate for further testing and refinement.

Perspective

In this part of the step, the practitioner will develop a set of preliminary survey items to present to focus-group participants for refinement in Part 2 of this step. In order to meet the two criteria for valid survey items, the practitioner must consider the structure and presentation of survey items. The structure of the survey items will be determined in actions 1, 2, and 3. Actions 1 and 2 involve bundling ecosystem services according to interactive and productive ecological relationships between ecosystem services and bioindicators, respectively.

Interactive relationships imply synergies or tradeoffs between ecosystem services, which are communicated to survey respondents by consolidating ecosystem services into one survey item (i.e., consolidating) or separating them into different survey items (i.e., differentiating), respectively. Avoiding the consolidation of ecosystem services that interact or respond to drivers in opposite ways will help avoid complications in measurement.

Productive relationships between final ecosystem services refer to the potential for the same ecological component to be both an ecosystem service, as well as an input to the production of another ecosystem service. For example, clean water may be an ecosystem service for a swimmer who wants to avoid contact with pollution. To a fisherman, however, clean water may combine with physical habitat to serve as inputs to the ecosystem service of crab abundance. In this case, water quality and crab abundance should be separated into two survey indicators to represent two distinctly valued ecosystem services.

Tip!

As noted previously, analyzing ecological information is only the first part of this process, rather than the end point. For this reason, the practitioner should consider the concepts presented here as nothing more than tools for framing her thinking. What the practitioner should be looking for are stark ecological complementarities or tradeoffs that should be preserved for the sake of either the survey respondents or the resource managers monitoring change in the bioindicators. Note that it is not necessary to analyze the interactive relationships between all the bioindicators related to the ecosystem services. Nevertheless, an analysis of the interactive relationships between ecosystem services can be informed and enhanced by consideration of the dynamics of related bioindicators.

Action 3 involves bundling ecosystem services according to language from the first focus-group meetings on how focus-group participants value, associate, and conceive of the ecological relationships underlying the delivery of ecosystem services. The practitioner should apply this

information to further refine the level of differentiation across survey items. This part combines with Action 4, in which the presentation of survey items will be determined. In this action the practitioner will determine the initial phrasing of the survey items based on the secondary information gathered thus far in the approach.

Specifically, the practitioner should refer to the descriptive language and vocabulary—including that regarding benefits, activities, and indicators—used by focus-group participants to phrase survey items in a meaningful way.

As discussed in Section 1.9, meaningful language allows survey respondents to understand how ecological change results in changes to their wellbeing. The challenge is to translate ecological information into language that is comprehensible to lay survey respondents, while preserving the integrity of that information so the survey items can still serve as guides to biological monitoring efforts. As stated by one scholar, "effective communication of ecological [information] involve[s] more than simply transforming scientific phrases into easily comprehensible words. [It requires] language that simultaneously fit[s] within both scientists' and nonscientists'...frames of reference, such that resulting indicators [are] at once technically accurate and understandable."[19]

Resources and practical considerations

The process of bundling is executed independently by the practitioner using her own judgment, and may be supported by expert opinion or informational resources on similar research and computer programs such as Microsoft Excel and Word. Thus, the resource needs for this part of the procedure are minimal. The main challenge to bundling is reconciling the sometimes ambiguous intersection of ecological information and information on the perceptions and demands of focus-group participants. Advice for practitioners is to keep in mind that the scope and depth of ecological analysis in this step should be confined to the objective of presenting accurate yet digestible information to survey respondents who are likely not scientists. Actions outlined in this part of the procedure are therefore designed to provide mechanisms for simplifying ecological complexities in accord with survey methodology. Researchers' experience with this challenge is presented in the case-study section below.

Method

Basic graphical analysis using Microsoft Excel or Word.

Action 1

Analyze interactive relationships between ecosystem services.

Action 2

Analyze productive relationships between ecosystem services. The productive relationships between ecosystem services can be analyzed using a matrix with all ecosystem services on both the X and Y axis (see Table 3).

[19] Schiller et al. 2001, p. 3

Box 14 – Interactive relationships between ecosystem services

Linkages between the delivery of multiple ecosystem services can be characterized by examining the interactive relationships between services. Interactive relationships can have positive or negative effects on each other, which themselves can be unidirectional or bidirectional (reciprocal), and their responses to drivers of change can correlate or anti-correlate. An illustration of the types of relationships is provided in Bennet et al. (2009):

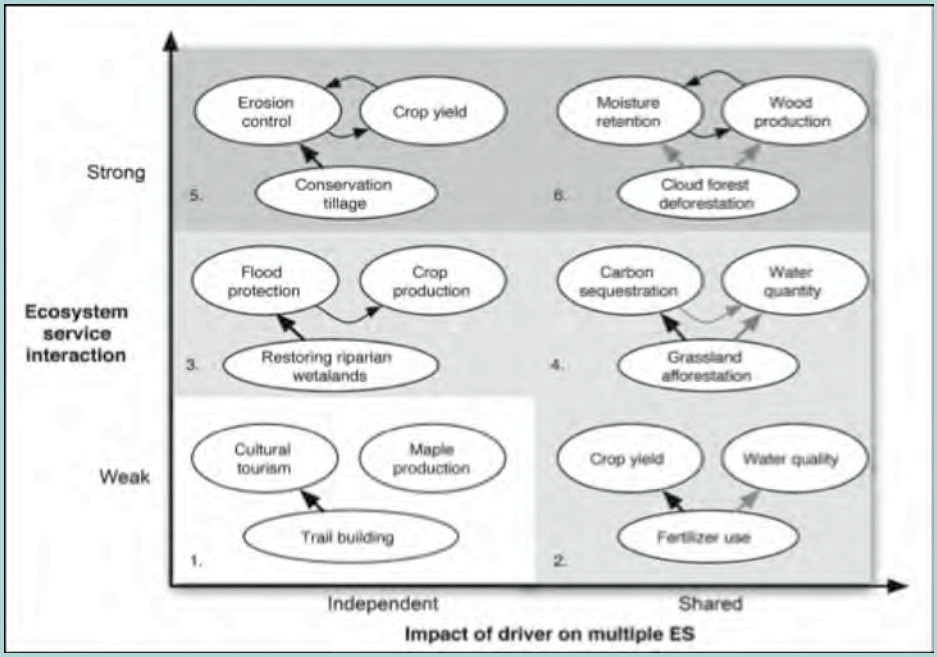


Table 3. Matrix for analyzing productive relationships between ecosystem services

Note: Ecosystem services below serve as inputs into ecosystem services to the right →	Provision of non-harvested fish	Provision of harvested fish	Environmental control of harvested fish populations	Provision of non-harvested invertebrates	Provision of harvested invertebrates	Environmental control of harvested invertebrate populations
Provision of fish		+/-	+/-	-	-	-
Provision of harvested fish	+/-		+/-	-	-	-
Environmental control of harvested fish populations	+/-	+				
Provision of invertebrates	+	+			+/-	+/-
Provision of harvested invertebrates	+	+		+/-		+/-
Environmental control of harvested invertebrate populations				+/-	+	

Ecosystem services down the left column are analyzed for their interaction with ecosystem services across the top row of the matrix. Instances of one ecosystem service serving as an input into the production of another are denoted with blue boxes containing a + symbol; negative inputs are denoted with orange boxes containing a - symbol; and context- or stakeholder-dependent interactions are denoted with yellow boxes containing a +/- symbol. Ideally, ecosystem services should not be consolidated if they interact in a positive (productive), negative, or context-dependent way (i.e., they are connected by a symbol in the matrix).

Action 3

Further bundle ecosystem services based on information on how focus group participants value, associate, and conceive of the ecological relationships underlying the delivery of ecosystem services.

Action 4

Phrase survey items based on the descriptive language and vocabulary—including that regarding benefits, activities, and indicators—used by focus-group participants to describe ecosystem services.

Action 5

Design the structure of each survey item to be applicable using a chosen survey methodology. See Box 15 in the following section for a discussion of survey methodologies.

Output and documentation

A complete, non-duplicative, and parsimonious list of preliminary survey items structured according to her chosen survey methodology. Additionally, for her own recordkeeping, the practitioner should be able to link each survey item to the inclusive ecosystem services, bioindicators, benefits, and other secondary information, as well as a log of her reasoning for making these connections. This information will be very valuable in the subsequent part of this step, where the practitioner may be asked to explain or amend these connections.

Part 2: Refine and finalize survey indicators

Objective

Generate a complete, non-duplicative, and parsimonious set of survey items that incorporate the interpretations, perspectives, and vocabulary of focus-group participants and need minimal further editing to reach their finalized, "survey-ready" form.

Tip!

This part outlines the procedure for ensuring survey items meet basic criteria for stated-preference methodologies; it does not speak to the form or content of the survey items beyond the basic elements (ecosystem services and bioindicators). These actions, therefore, might need to be adapted to the particulars of the preliminary survey items at hand, which resulted from the choices made in the previous part of this step regarding relative preference scale, etc. Furthermore, much of this step relies on the subjective judgment of practitioners, which may appear unscientific. Practitioners should therefore define their analytical task pragmatically: generate survey items that will work in the real world, and thus generate valid measures of real stakeholders' wellbeing.

Perspective

This part of the step allows the practitioner to adapt the initial set of survey items to interpretations, perspectives, and vocabulary of focus-group participants. Specifically, the practitioner is looking to ensure that the final structure and presentation of the survey items employ language and information that is meaningful, comprehensive, and comprehensible to survey respondents.

As part of this step, the practitioner will organize and facilitate another focus group. This focus group, however, is different from the previous ones. On one hand, it will largely be more efficient and concrete, since focus-group participants will be reacting to survey items provided to them rather than reflecting on their personal experiences. On the other

hand, the practitioner must allow for this focus group to take on an iterative- or workshop-style format in which her proposed survey items may be reworked by the group.

Resources and practical considerations

The practitioner will want to have each preliminary survey item printed out on a piece of paper or written up on an easel or blackboard so that they can be edited in real time as the focus group proceeds.

Method

Guided discussion in a focus-group setting and independent analysis.

Action 1

Explain to focus-group participants the format of the focus-group meeting; specifically, that the practitioner took all the information gathered in previous focus group meetings and synthesized it into a list of survey items, which she will now present to the group to ensure that they

1. are understandable
2. include all relevant information
3. are phrased in the best language possible

Action 2

Present the first survey item to focus-group participants and evaluate their *prima facie* understanding of the phrasing of the survey item by asking:

- Does this survey item make sense as it is worded now?
- Is there another way to say this that is clearer?
- Would you be able to respond to this, or is it confusing?

Edit the survey item according to the feedback of the focus-group participants.

Action 3

Present the first survey item to focus-group participants and identify features included in survey respondents' understanding of the survey item by asking:

- What comes to mind when you read this survey item?
- What features of the ecosystem are included in this survey item?
- What would this survey item look like if it increased or decreased?

Edit the survey item according to the feedback of the focus-group participants.

Action 4

Present the first survey item to focus-group participants and confirm the choice of bioindicators to include in the survey items and what form they should take by asking:

- How would you notice this survey item changing over time?
- Has this survey item changed in the past 10 years?

Edit the survey item according to the feedback of the focus-group participants.

Action 5

Repeat Actions 2, 3, and 4 for each preliminary survey item.

Action 6

Present all or groups of survey items to focus-group participants and gauge the level of differentiation by asking:

- Are any of these survey items similar enough that they can be combined?
- Is there too much information in this survey item?
- Should it be split into two separate survey items?

Edit the survey item according to the feedback of the focus-group participants.

Action 7

Incorporate the results of the focus-group meeting into final versions of the survey items.

Output and documentation

A complete, non-duplicative, and parsimonious list of survey items that meet the stated criteria and are ready for use in a survey instrument.

Case study

In 2012, researchers at Oregon State University generated 14 preliminary survey items by bundling the 15 benefits, 24 ecosystem services, and 115 bioindicators previously identified in their application of the approach. Researchers convened three focus-group meetings in 2012 to adapt the preliminary set of survey items to the interpretations, perspectives, and vocabulary of focus-group participants. Researchers applied feedback from focus-group participants to a final edit of the survey items. This process resulted in 11 finalized survey items. Figure 9 below provides an example of one finalized survey item; the survey presented in the following step includes all 11 survey items. Table 4 below diagrams along with the ecosystem services that were consolidated into each.

Figure 9 – Example survey item

The Variety of Sealife
This aspect represents the range of species of fish, shellfish, marine mammals, and plants and algae *inside* protected areas. An increase in this aspect means uncommon or previously unseen plants or animal species are more commonly present and visible.

Table 4. Bundling of final survey items

Ecosystem Services / **Survey Items**	The availability of fish and shellfish for harvest	The number and size of fish and shellfish	The abundance of marine mammals	The abundance of seabirds	The natural sustainability of the local fish and shellfish	The variety of sealife	The cleanliness of coastal waters	Areas for outdoor recreation and leisure	The natural aesthetic of the seascape	The natural integrity of the marine ecosystem	The coastal culture and lifestyle
Production of harvested fish[1] biomass	■										
Production of harvested invertebrate biomass	■								■		
Production of non-harvested fish biomass		■									
Production of non-harvested invertebrate biomass		■							■		
Production of marine mammal biomass			■								
Production of sea bird biomass				■							
Ecological maintenance of harvested invertebrate populations					■						

Ecosystem Services / Survey Items	The availability of fish and shellfish for harvest	The number and size of fish and shellfish	The abundance of marine mammals	The abundance of seabirds	The natural sustainability of the local fish and shellfish	The variety of sealife	The cleanliness of coastal waters	Areas for outdoor recreation and leisure	The natural aesthetic of the seascape	The natural integrity of the marine ecosystem	The coastal culture and lifestyle
Ecological maintenance of harvested fish populations					■						
Production of genetic diversity across fish species						■					
Production of genetic diversity across invertebrate species						■					
Production of genetic diversity across marine mammal species						■					
Production of genetic diversity across seabird species						■					
Removal of biological waste in water							■				
Removal of chemical contaminants from water							■				
Deposition and retention of sand								■			
Formation of intertidal structure								■	■		
Production of kinetic wave energy								■			
Support of leisure and recreation								■			
Formation of socially valued seascapes									■		
Production of visible macroalga biomass									■		
Production of visible aquatic plant biomass									■		
Ecological maintenance of ecosystem health and integrity										■	
Support of social and cultural relations											■
Support of socially valued lifestyle											■

As a prerequisite step to designing survey items, researchers chose their preference scale and weight solicitation technique (see Box 15). Specifically, researchers chose to design survey items that can be presented on a cardinal scale in a tradeoff exercise using the method of paired comparisons to generate relative preference weights. The use of cardinal metrics is particularly amenable to weighting multi-metric entities with incommensurate values such as ecosystem services. Environmental values may overlap or be interconnected with each other, as well as having many incommensurate properties—especially with respect to ecosystem services, which provide multiple benefits valued for multiple reasons.

To begin commoditizing ecosystem services into survey items on a cardinal scale, researchers analyzed the ecological relationships between ecosystem services and associated bioindicators, as well as information on how focus-group participants value, associate, and conceive of the ecological relationships underlying the delivery of ecosystem services.

> ***For more information…***
>
> For more information on the multi-metric nature of ecosystem services, see Boyd & Krupnick, 2009; Chan et al., 2012; Chee, 2004; Gatto & De Leo, 2000; Norton & Noonan, 2007; and Spash, 2008. For the application of the method of paired comparisons using cardinal level indicators to measure ecosystem service tradeoffs, see Chuenpagdee et al., 2010; Hanley et al., 1998; and Naidoo & Adamowicz, 2005.

Researchers made a number of observations during this analysis regarding their bundling decisions. In general, researchers favored differentiation over consolidation for three reasons. First and foremost, the structure of a survey item chosen by researchers did not allow for excessive information and language. Second, differentiation allows for more ecological

information to be included in the survey item, including bioindicators. This made it easier for researchers to control against "expansive priors" (survey respondents' making assumptions about unstated ecological connections). Third, differentiation facilitates the communication of context-dependent information about ecosystem services (i.e., their relation to benefits).

However, researchers balanced the benefits of differentiation with its costs, as well as the benefits of consolidation. First, consolidation allowed researchers to communicate synergies between ecosystem services. Researchers therefore developed consolidated survey items in instances where information from the previous focus groups indicated that survey respondents were valuing multiple ecosystem services like a package. Second, researchers found that differentiation of community-level ecosystem services had more potential costs than benefits. One potential cost is that presentation of a trade-off between abundance and diversity on a phylum-level may imply complex ecological concepts that could confuse survey respondents.

It should be noted that researchers found that their analysis of the ecological interactions between ecosystem services and their delivery did not ultimately change, but rather confirmed, the degree of differentiation of survey items that resulted from Part 1 of this step. This result suggests that focus-group participants understand the basic ecology behind the delivery of ecosystem services.

When researchers presented preliminary survey items to focus-group participants, a number of changes were made. For example, researchers differentiated the survey item *The abundance of mammals and seabirds* into two survey items, *The abundance of seabirds* and *The abundance of marine mammals*, because focus-group participants commented that some individuals participate in bird-watching *or* marine mammal-watching (e.g., whales, sea lions), and not the other. Conversely, researchers consolidated the two survey items *The variety of fish* and *The variety of marine mammals* into one survey item, *The variety of sealife*, because focus-group participants described their vision of diversity as a community-level feature of the ecosystem. For example, focus-group participants noted that a motivation for diving is viewing a diverse scene of interacting sea life, and that fishermen are excited by the surprise of pulling up a rare species of organism, regardless of whether it is a fish or invertebrate. This result suggests that the survey item representing species diversity enters into the utility functions of focus-group participants as a package. Furthermore, this result is contrasted with the view of focus-group participants that specific activities motivated by the benefit of *Viewing of wildlife* (i.e., bird-watching versus whale-watching) would correlate with the abundance of the targeted phylum, rather than the diversity between those species in that phylum.

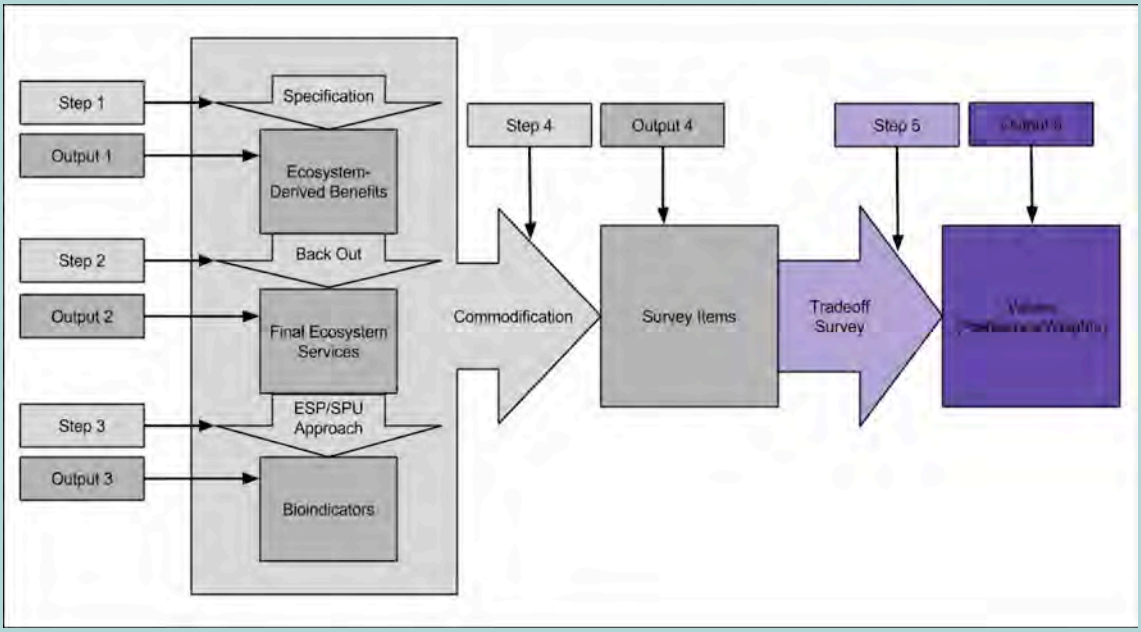
With regard to phrasing, researchers developed the survey item *The resilience of the fish and shellfish stock to catch, eat, and market locally* to include descriptive language gathered from the first focus-group meeting concerning the importance of the economic multiplier effect that seafood has in the local economy. However, focus-group participants had trouble interpreting it due to ambiguous and encumbered language, and thought the phrase elicited thoughts of the economic market for fish, rather than those species that are available for recreational and commercial harvest. In response, researchers jettisoned "to catch, eat, and market locally" in favor of a simpler and biologically focused survey item to which focus-group participants could ascribe their own meaning: *The resilience of the local fish and shellfish stock*.

2.3.5 Step 5: Developing a survey-based tradeoff exercise

Introduction

This section outlines the fifth and final step in implementing the approach detailed in this guide. Specifically, it outlines development, implementation, and analysis of a survey-based tradeoff exercise that generates preference weights for survey items of bundled ecosystem services. See Figure 9 for a depiction of how Step 5 fits into the larger approach.

Figure 9 – Step 5 of the approach: developing a survey-based tradeoff exercise



This step involves designing and administering a survey-based tradeoff exercise using the survey items developed in previous steps, as well as analyzing the relative preference weights generated by the exercise. The objective of this step is to quantify stakeholders' relative preferences for the various ecosystem services delivered by their local marine ecosystem. This information allows practitioners to understand, at minimum, how stakeholders "score" the value of various ecosystem services. These "scores" measure relative preferences for and imply a ranking of ecosystem services. This information can be used to support CMSP decision-making in a number of ways.

> ***Before you begin…***
>
> Refer back to Section 1.9 to review survey-based tradeoff exercises.

While this step is limited to a survey-based tradeoff exercise, practitioners should note an opportunity exists to survey stakeholders on other information that may also be useful to support CMSP decision-making. See the Case Study section of this step for guidance on developing a more expansive survey, as well as an example of one developed by researchers at Oregon State University.

The practitioner will design, administer, and analyze a survey-based tradeoff exercise using the methods of independent analysis and a chosen survey administration technique. Also, if necessary, the practitioner may also employ guided discussion in a focus-group setting to "pre-test" their survey-based tradeoff exercise.

Box 15 – Survey methodology

As with focus-group moderation, designing and administering a survey requires considerable time, research, and effort, and should be prepared for adequately.

The very first step to developing a survey is determining the motivation for administering the survey, the analytical goal, and the intended impact on the local community and greater community of academia, policy-makers, and other organizations and citizens. This process involves a number of determinations and actions that have implications for the value of the analysis to the CMSP process.

The next step is to choose a stated-preference methodology. Various methodologies exist, and each generates uniquely structured data that, in turn, generate unique quantifications of economic wellbeing. The approach developed in this guide is designed to gather information sufficient to design survey items to generate the three basic metrics: preferences measured on *ordinal, cardinal*, or *ratio* scales.

For resources on different stated-preference survey methodologies, see

- *A Primer on Nonmarket Valuation (The Economics of Non-Market Goods and Resources)* (2003) by Patricia Champ, Keven Boyle, and Thomas Brown
- *Stated Choice Methods: Analysis and Applications* (2000) by Jordan Lourviere, David Hensher, Joffre Swait, and Wiktor Adamowicz

In addition, however, the practitioner should keep in mind that administering a survey-based tradeoff exercise presents an opportunity for the practitioner to gather other types of information relevant to CMSP. Specifically, she can also gather data that places preferences in a larger context, as well as additional information about the survey respondent population.

If the practitioner chooses to administer a more expansive survey, she should ask the following questions about the objectives and technical aspects of the survey:

- What CMSP-related processes or decisions can the data generated by the survey (i.e., relative preference weights and additional variables and information) inform?
- What concepts, information, and stakeholder groups do you want the survey to draw conclusions about?
- What standards should the survey meet (i.e., repeatability of findings, accuracy of generalizations, breadth of inferences drawn, reliability, validity, representativeness, generalizability, etc.)?
- What types of questions will you ask?
- What type of statistics (i.e., descriptive, inferential, parametric, nonparametric) are required?
- What types of response data (i.e., nominal, ordinal, interval, or ratio level of measurement) are required?
- What function should the survey serve with respect to the stakeholder community?

Taking into consideration the responses to the above questions, the practitioner can design an appropriate survey instrument with respect to the following facets:

1. *Sample method*

The practitioner must choose to administer her survey using on-site interviews, telephone, mail, e-mail, or the Web. Nominal and methodological tradeoffs exist for each method, and the practitioner must decide which is most appropriate, given her research objectives and project resources.

2. *Survey length and detail*

The practitioner must determine the appropriate number of questions to include in the survey and how detailed those questions are. Making this determination involves balancing the marginal value of additional information with the potential to fatigue or burden the survey respondent.

Box 15 (continued) – Survey methodology

3. Statistical model

The practitioner must ensure that the statistical model comprised by the survey meets appropriate scientific objectives (i.e., repeatability of findings, accuracy of generalizations, breadth of inferences drawn, reliability, validity, representativeness, generalizability, etc.), allows for appropriate statistical analysis (i.e., descriptive, inferential, parametric, nonparametric), and employs appropriate levels of measurement (i.e., nominal, ordinal, interval, or ratio variables).

4. Overall format and feel

The practitioner must envision how the survey will both appear to and direct the survey respondent. Some surveys are bare questionnaires that do not require any instructions or background information, while others are more comprehensive and educational.

For more information on survey methodology, including design, administration, and statistical analysis, see:

- Survey research and analysis: Applications in parks, recreation, and human dimensions (2008) by Jerry Vaske.

Objective

To design, administer, and analyze a tradeoff survey to quantify stakeholders' relative preferences for the various ecosystem services delivered by their local marine ecosystem.

Procedure

This step is completed in three parts, each of which is detailed in turn.

Part 1: Design survey-based tradeoff exercise

Objective

Design a survey-based tradeoff exercise that quantifies stakeholders' relative preference weights for ecosystem services delivered by their local marine ecosystem.

Perspective

In previous steps, the practitioner has designed and structured survey items to be appropriate for a chosen stated-preference method. This part of the approach involves integrating those survey items into a well-designed survey instrument, which in turn requires integrating stated-preference methodology and general survey methodology. Box 15 provides guidance and resources on the range of relevant methods, and the case-study section below illustrates the survey-based tradeoff survey designed by researchers at Oregon State University.

Resources and practical considerations

The practitioner will not require many resources to design the survey-based tradeoff exercise. However, if she chooses to "pre-test" the survey, she will want to gain access to those resources she will use to eventually administer the survey. As is discussed in Part 2 of this step, pre-testing involves simulating the survey as accurately as possible for a small, controlled group of survey respondents.

Method

Expert opinion, literature review, independent analysis. Additionally, the practitioner may employ a chosen pretest methodology (i.e., survey administration method), as well as a chosen method of soliciting feedback (e.g., guided discussion or questionnaire).

Action 1

Conceptualize and design a survey instrument employing the chosen tradeoff exercise using survey items developed in the previous step.

Action 2

Pre-test survey instrument by administering it to a small, controlled group of survey respondents. After survey respondents have completed the survey instrument, ask the following questions to measure the validity of the exercise:

- Were the instructions clear?
- Did you have difficulty or confusion with any part of the survey?
- Were the survey items unambiguously described?
- What did you think was being asked of you during the tradeoff exercise?
- Were you able to make the tradeoffs that were being asked of you?
- Did you think there was any strategy involved?
- Was the tradeoff exercise compelling, or were you indifferent?
- Do you feel your responses were consistent? That is, if you were to be given the survey tomorrow, would your answers be the same?

Action 3

Refine the survey instrument in response to pretest feedback.

Output and documentation

A survey instrument that meets her objectives, meets the theoretical criteria for stated-preference methods, and is ready for administration via her chosen sampling method.

Part 2: Administration of the survey

Objective

Distribute the survey instrument to a chosen sample population with the goal of receiving a specified "response rate."

Perspective

This part requires considerable administrative effort and time, regardless of the chosen survey administration method. The practitioner should budget at least two months for data collection.

Resources and practical considerations

See informational resources referenced in Box 15.

Part 3: Analysis of survey results

Objective

Quantify values for survey items representing bundled marine ecosystem services and related bioindicators.

Perspective

The instructions provided in this part are very generalized because the calculations relevant to the practitioner's analysis will be specific to his or her chosen design for the tradeoff exercise. The case study below describes how researchers at Oregon State University quantified relative preference weights for survey items employed in a tradeoff exercise using the method of pairwise comparisons. This choice was based on their motivation for administering the survey, analytical goals, and intended impact on the local community and greater community of academia, policy-makers, and other organizations and citizens.

Resources and practical considerations

This part will require, at minimum, basic mathematical analysis. If the practitioner has developed and administered a survey instrument that gathers information additional to economic values for marine ecosystem services, more sophisticated statistical analysis may be required. Both types of analyses may require specialized software programs.

Method

Desktop mathematical and statistical analysis.

Action 1

Enter data from returned survey instruments into a database for mathematical and/or statistical analysis.

Action 2

Manipulate data so that the required mathematical and/or statistical calculations can be applied.

Action 3

Apply calculations and structure results so they can be applied to relevant CMSP decision-making contexts.

Case study

In 2012, researchers at Oregon State University designed a survey instrument that included a trade-off exercise using the survey items developed in previous steps, as well as additional questions aimed at gathering other information relevant to CMSP decision-making in Oregon. The full survey instrument is presented in Appendix A at the end of this guide.

Researchers designed survey items and the tradeoff exercise to solicit relative preference weights using the method of paired comparisons. See Section 2.3.4 for a discussion of researchers' reasons for choosing this method. Researchers designed the tradeoff exercise using an "abbreviated pairwise design" to reduce the cognitive burden on survey responses. In an abbreviated format, all

> ***For more information…***
>
> For more information on the application of the method of pairwise comparisons, including the abbreviated method, see Peterson & Brown, 1998; Saaty, 1980; and Strager & Rosenberger, 2006.

possible pairings of the criteria are not presented to the participant. Instead, pairs are sequentially assigned as A–B, B–C, C–D, etc. A complete ranking of criteria is based on the actual choices made and assuming transitive preferences. This assumption has been confirmed through a method of paired comparison. To reduce issues of "path dependency," the initial criterion and the second criterion in each subsequent pair were randomly assigned. In addition, the pairs of criteria were randomized (i.e., A–B, C–D, B–C, for example) to minimize the potential for "anchoring bias."

Preference weights imply a ranking of survey items. Calculation of "consistency ratios"—measures of consistent (transitive) preferences—is redundant with the abbreviated pairwise comparison format because transitivity is already assumed. Nevertheless, researchers confirmed the assumption of transitivity by administering a pretest to a small convenience sample of participants that included both a full pairwise design and an abbreviated pairwise design. Responses were tested for consistency in rank order of preference weights across methods, and consistency ratios were calculated for the full pairwise design data.

The first test resulted in all but one survey holding consistency in rank order. The survey that differed was the result of a tie in the ranking of weights from the abbreviated pairwise design, where the full pairwise design did not produce a tie. Preference weights generated by the abbreviated pairwise design have less resolution than those generated from the full pairwise design. This result also highlighted the study design issue of resolution and ties in preference weights. Ultimately, researchers chose the benefits of providing a less burdensome, abbreviated design in the survey instrument over the benefits of increased resolution in data. Researchers analytically treated tied ranks by assigning the average value of the tied ranks, although data transformed in this fashion have been shown to have nonlinear effects. The second test resulted in sufficiently high consistency ratios for data from all but one survey. Upon investigation, researchers learned that one particular respondent was confused by the tradeoff exercise because the ecological effects described by certain survey items were, to his knowledge, correlated. In an attempt to prevent similarly inconsistent results in the sample data, researchers included a disclaimer in the survey instructions to treat each survey item as an independent, ecologically unrelated outcome.

Researchers administered surveys by individual mailings to the same focus-group participants who contributed to previous steps in the approach, as well as stakeholders recruited to, but unable to, participate in the focus groups. The sampled survey respondents represent a small, but not random, group of stakeholders. Surveys were mailed to 50 individuals; 31 surveys were returned (a 62 percent response rate).

For each respondent, researchers calculated aggregated individual preference weights for the 11 survey items using Criterium DecisionPlus software (Info Harvest, 2012). Table 5 provides these aggregate preference weights. The rank order of relative preference weights across stakeholders can be analyzed with regard to three measures to inform management. The first is the overall ranking of all 11 survey items within groups. As ordinal data, this ranking illustrates the ecological and socioeconomic priorities of respondents within each group. The second includes the relative preference weights assigned to each survey item. As cardinal data, these weights can be quantitatively applied to other data used in planning and decision-making, such as costs and benefits used in CMSP decision matrices.

Table 5. Aggregate (non-grouped) preference weight rank and intra-group variation

Rank Order	Survey Item	Mean Rank
1	Number and Size of Fish and Shellfish	8.10
2	Variety of Sealife	7.40
3	Natural Integrity of Marine Ecosystem	7.30
4	Natural Sustainability of Fish and Shellfish Stock	6.63
5	Outdoor Recreation and Leisure	6.33
6	Cleanliness of Ocean Water	5.77
7	Abundance of Seabirds	5.45
7	Availability of Fish and Shellfish for Harvest	5.45
9	Natural Aesthetic of the Seascape	4.92
10	Abundance of Marine Mammals	4.87
11	Coastal Culture and Lifestyle	3.78

The ordinal ranking of survey items in the non-grouped, aggregate sample illustrate a few potential patterns with regard to the benefits that inclusive ecosystem services provide. These patterns have implications for efforts to set state- or region-wide priorities in MSP. The top two survey items, *The number and size of fish and shellfish* and *Variety of sealife*, point to a prioritizing of the nonconsumptive use of fish and invertebrates over the consumptive use of fish and invertebrates, as well as the nonconsumptive use of seabirds and marine mammals. The next most highly ranked survey items, *The natural integrity of the marine ecosystem* and *The natural sustainability of the fish and shellfish stock*, imply a high value on the condition of whole system processes and fish populations. The lower ordinal rankings do not illustrate as many patterns with respect to benefits. However, some relationships are likely interesting to policy-makers in Oregon. For instance, *Outdoor recreation and leisure* is more highly valued, *Availability of fish and shellfish for harvest* has a relatively small value, and *Coastal culture and lifestyle* is ranked as least important.

Chapter 3 – Conclusion

3.1 Motivation and justification for this guide

Given the increasing environmental, economic, and social pressures on Oregon's marine ecosystem, a key challenge facing marine resource-management agencies is to balance human uses and environmental protection in a way that increases societal wellbeing. To address this challenge, agencies are increasingly incorporating social science into their management toolbox. To support this growing practice, this guide provides a step-by-step "how to" for applying specific economic methods to the evaluation of tradeoffs inherent in nearshore management decisions. Specifically, this guide describes a community-based approach that merges ecological and economic models to generate a survey-based tradeoff exercise that allows for a single set of marine ecosystem services to be valued by local stakeholders and measured by marine researchers, thus connecting social and environmental monitoring efforts.

This guide is intended for individuals interested in or responsible for carrying out formal assessments of planning and development alternatives in coastal zones and state waters. These individuals include, but are not limited to, scientists and managers in state and federal natural-resource agencies, members of community organizations, and academic researchers in social and natural science disciplines. Also, anyone else interested in better understanding how economic data related to nearshore management is gathered and applied—such as public officials—may benefit from the information provided in this guide.

3.2 Application of this guide to nearshore management

The approach outlined in this guide is designed to support nearshore management through both its application and the application of information it generates.

As discussed throughout this guide, the approach is flexible and can be tailored to the specifics of a certain study area or policy scenario. What is not discussed, however, is the benefit to both practitioners and the stakeholder community of implementing this approach. The benefits of public and stakeholder engagement are detailed in the framework for CMSP provided in the *Final Recommendations of the Interagency Ocean Policy Task Force* (White House Council on Environmental Quality, 2010):

> "In addition to coordination and cooperation among all levels of government, robust public and stakeholder engagement is integral to a successful CMSP process. Given the multi-objective nature of CMSP it is critical to ensure there are numerous opportunities for a broad range of input to gain a better understanding of the human uses and influences on the planning area, and expectations, interests, and requirements for the future. Including a broad range of interests throughout the planning and implementation of CMSP is necessary to strengthen mutual and shared understanding about relevant problems and opportunities and will better inform the process and its outcomes" (p. 47).

When researchers at OSU solicited the feedback of study participants, they found that indeed the stakeholder community considered the process beneficial and educational, including the use of ecosystem services as a concept to frame their connection with the local marine environment. All parties expressed hope that the participants, as well as other members of their local community, would continue to be engaged in the CMSP process in Oregon.

Any application of approach will generate information that can improve practitioners' understanding of how the ocean provides ecosystem services, how human activities affect the

delivery of ecosystem services, how people value ecosystem services, and how to weigh tradeoffs across management alternatives to sustain the delivery of ecosystem services. The approach can be further tailored to specific needs and scenarios, and can be used to inform the creation, management, and monitoring of CMSP in Oregon by aiding decision-support, better defining the market for various marine ecosystem services, identifying stakeholder groups of interest, and prioritizing biological and socioeconomic indicators related to marine reserve performance.

Practitioners interested in implementing this approach have a number of options for potential adaptations and applications. First, presented in the "Case Study" sections of this guide is a real-world implementation of the approach in which researchers from OSU examined stakeholders' values for ecosystem services delivered by marine ecosystems in Oregon. This study is documented in extensive detail in a master's thesis by Peter M. Freeman titled *A Community-Based Approach for Evaluating Tradeoffs Across Marine Ecosystem Services in Oregon*.[20] This thesis documents an application of the approach that analyzes variation in stakeholder preferences for ecosystem services across grouping variables based on potential relationships between demand for ecosystem services and stakeholder demographics or attributes.

Practitioners may also consider the various other ways in which relative preference weights for marine ecosystem services can be applied. For example, aggregate relative preference weights can also be used to adjust a cost-benefit analysis of those ecosystem services gained or lost through a CMSP action. The aggregate rank order of preference weights can also be used to prioritize nearshore management monitoring activities, including that of biological and socioeconomic indicators related to MPA performance. Studies with similar objectives have successfully combined quantitative and qualitative information for decision-making to rank development scenarios on the basis of stakeholder values. Lastly, relative preference weights derived through similar methods have been integrated into spatial multi-criteria decision analysis scenarios.

Practitioners interested in extending the approach could also further refine the relationship between changes in bioindicators of ecosystem services and changes in the provision of those services as measured using a different metric—like monetary values. Such a connection would allow for more advanced tradeoff analyses to be developed. For example, ecologists could model ecosystem services provisions in a production possibility frontier, while economists could refine measurement of demand for the same ecosystem services in order to generate indifference curves. From these two functions, efficiency frontiers could be generated to identify management options that provide for the optimal delivery of any range of ecosystem services. Also, further development and research into the ecological production function underlying the provision of ecosystem services could be pursued, which could in turn inform development of a valuation instrument that more closely links ecosystem functions to economic value via an attribute-based choice model.

3.3 Final thoughts

As CMSP continues to be used to manage Oregon state waters, the approach and lessons learned from its application can guide future ecosystem service assessment and valuation studies in Oregon. It is hoped that the approach developed in this guide will be applied and adapted by practitioners in Oregon and elsewhere, and in the process will contribute to a range of emerging efforts to improve the stewardship of our valuable marine resources.

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[20] Available at http://hdl.handle.net/1957/35062

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Appendix A – Case study survey instrument

Oregon Marine Protected Areas Survey

A cooperative survey developed by:

Oregon Department of Fish and Wildlife

Oregon State University

Oregon Sea Grant

THANK YOU FOR PARTICIPATING IN THIS IMPORTANT SURVEY!

PLEASE READ ALL THE INFORMATION IN THIS SURVEY CAREFULLY BEFORE ANSWERING QUESTIONS

WHAT IS THIS SURVEY ABOUT?

This survey asks for your perspective on environmental, social, and economic aspects of Oregon's coast that may change as a result of coastal management policies.

WHAT SORT OF POLICIES?

Coastal and marine resource management in Oregon addresses a range of policies—from residential development to renewable energy. One policy in particular has provided the context for this survey: protected areas, such as "marine reserves" and "marine protected areas."

WHAT ARE MARINE RESERVES AND PROTECTED AREAS?

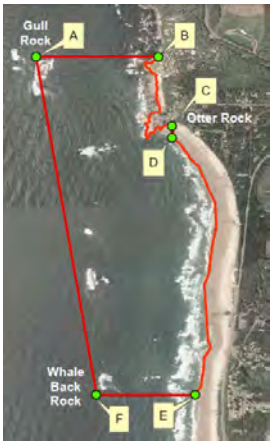
Marine reserves and marine protected areas (together referred to in the survey as "protected areas") are sections of the ocean zoned to protect specific marine resources from direct human impacts. Within protected areas, "extractive activities" and new developments are prohibited fully (in the case of marine reserves) or partially (in the case of marine protected areas). Extractive activities are defined as "fishing, hunting and harvesting of shellfish, other invertebrates, kelp and seaweed."

All other non-extractive activities not having "a negative impact on marine habitats and biodiversity protected within the site," such as diving and surfing, for example, are allowed within protected areas.

Currently, two marine reserves and one marine protected area have been established in Oregon (see below), three others are scheduled to be established over the next two years, and up to four more are under discussion.

CURRENT MARINE RESERVES AND PROTECTED AREAS

Otter Rock Marine Reserve
(north of Newport, OR)



Redfish Rocks Marine Reserve
(Port Orford, OR)

You can find more information on protected areas and nearshore management online @ www.oregonocean.info

HOW TO TAKE THIS SURVEY

This survey contains three parts:

1. The first (1st) part is called an "opinion survey" and starts on page 4. It consists of questions about your opinion of protected areas in Oregon and the environment in general.

2. The second (2nd) part is called a "comparison survey" and starts on page 6. It involves comparing different environmental, social, and economic aspects that may change as a result of coastal management, such as the establishment of protected areas.

3. The third (3rd) part is called a "demographic survey" and starts on page 12. It asks for some demographic information describing you.

Each survey begins with mini-instructions. Please read these instructions carefully before answering the surveys.

Please answer all surveys from YOUR PERSPECTIVE ONLY. We are interested in only your experiences and what is important to you.

THANK YOU FOR YOUR PARTICIPATION! ENJOY

OPINION SURVEY

This 1st part of the survey is what is called an "opinion survey." This survey includes questions about your familiarity with and opinion about the marine environment and its management.

These questions ask if and how you expect the establishment of marine protected areas in Oregon to affect the welfare of you and your community.

	(Please check one)			
As protected areas are established in Oregon, how do you expect the following to be affected?	Increase	Stay the Same	Decrease	Not Sure
1. Your household's economic welfare: • Income • Employment • Property value, etc.	☐	☐	☐	☐
2. Your community's economic welfare: • Community income • Community employment • Community property values • Tax revenues • Business and industry revenues • Development • Visitation and tourism, etc.	☐	☐	☐	☐
3. Your community's social and cultural welfare: • Cultural identity • Level of education and awareness • State visibility and publicity • Social relations • Connection to other communities in Oregon • Attractiveness of your community as a place to live, etc.	☐	☐	☐	☐
4. Your personal welfare: • Leisure and recreation • Inspiration • Discovery • Spirituality • Independence and self-sufficiency • Security, etc.	☐	☐	☐	☐

OPINION SURVEY

These questions ask about your ocean-going activities on the Oregon coast.

	In what ways do you use or enjoy your local ocean resources? (Please check all that apply)	On average, how many times per year do you partake in this activity? (Please provide a number)
5. Recreational fishing or harvesting: • Fish and/or shellfish • Plants • Algae	☐	_____
6. Commercial fishing or harvesting: • Fish and/or shellfish • Plants • Algae	☐	_____
7. Water sports: • Surfing • SCUBA diving • Kayaking • Swimming, etc.	☐	_____
8. Beach going: • Picnics • Exploring tide pools • Flying kites, etc.	☐	_____
9. Boating	☐	_____
10. Scientific or educational research	☐	_____
11. Stewardship activities: • Beach cleanups • Volunteer projects, etc.	☐	_____
12. Sightseeing from a distance: • Enjoying the sunset • Landscape photography, etc.	☐	_____

THANKS! NOW ON TO PART 2, THE COMPARISON SURVEY

COMPARISON SURVEY

This 2nd part of the survey is what is called a "comparison survey." This survey presents "aspects" representing different environmental, social, and economic aspects that may change as a result of coastal management, and asks you to say how important those aspects are to you compared to others.

Each aspect will appear as seen below:

THE VARIETY OF SEALIFE
This aspect represents the range of fish, shellfish, marine mammal, and plant and algae species *inside* protected areas. An increase in this aspect means uncommon or previously unseen plant or animal species are more commonly present and visible.

← The title of the aspect

← A more detailed description of what the aspect involves.

Eleven such "aspects" will be presented side-by-side, and you will be asked to mark whether you prefer an increase in one aspect more than the other, and by what relative degree.

The side-by-side comparisons will appear as seen below. To mark your answer, simply fill in <u>one</u> circle on the scale that matches your personal preference.

For example, the below choice says you "somewhat prefer" an increase in "The Number and Size of Fish and Shellfish" over an increase in "The Abundance of Seabirds."

An increase in…	Strongly prefer	Prefer	Somewhat prefer	Equal	Somewhat prefer	Prefer	Strongly prefer	An increase in…
THE NUMBER AND SIZE OF FISH AND SHELLFISH								***THE ABUNDANCE OF SEABIRDS***
This aspect represents the natural production of all fish and shellfish (harvested and non-harvested species) *inside* protected areas. An increase in this aspect means more and larger fish, crabs, sea stars, and anemones, for example, are present and visible.	O	O	●	O	O	O	O	This aspect represents the natural production of seabirds *inside* protected areas. An increase in this aspect means more seabirds are present and visible in flight or on the rocks or water inside protected areas.

<u>Please note:</u> Some of the aspects are environmentally related, and an increase in one may occur along with an increase in the other. For the purposes of this exercise, however, treat each aspect as an independent outcome and focus on which you would prefer to see increase.

COMPARISON SURVEY

So, for example, birds eat fish and therefore an increase in "The Number and Size of Fish and Shellfish" may eventually lead to an increase "The Abundance of Seabirds." However, if you are an avid bird watcher but not much of a SCUBA diver, you would prefer to see seabirds when you go to the beach, rather than fish and shellfish. In that case, you would mark that you prefer an increase in "The Abundance of Seabirds," even though the abundance of seabirds could increase via an increase in fish and shellfish.

Please answer this survey from YOUR PERSPECTIVE ONLY. We are interested in only your experiences and what is important to you.

This is the end of the instructions.
The comparison survey starts on the next page.

COMPARISON SURVEY

An increase in…	Strongly prefer	Prefer	Somewhat prefer	Equal	Somewhat prefer	Prefer	Strongly prefer	An increase in…
AREAS FOR OUTDOOR RECREATION AND LEISURE								***THE NATURAL AESTHETIC OF THE SEASCAPE***
This aspect represents the amount of areas suitable and available for outdoor recreation and leisure *inside or adjacent to* protected areas. An increase in this aspect means more beach area, tide pools with more sealife, and areas used for water sports (e.g. kayaking, diving, surfing).	O	O	O	O	O	O	O	This aspect represents the natural formation of coastal "scenery" *inside* protected areas. An increase in this aspect means a greater amount of areas displaying the natural features and dynamics that Oregonians find interesting, fascinating, or awe inspiring, such as forceful waves, rocky formations colonized by plants and animals, and kelp forests and intertidal plants.

THE CLEANLINESS OF COASTAL WATERS								***THE NUMBER AND SIZE OF FISH AND SHELLFISH***
This aspect represents coastal water quality (*inside and outside* protected areas) for human contact and consumption of local seafood. An increase in this aspect means less biological and chemical waste in the water and in the organisms that live in it.	O	O	O	O	O	O	O	This aspect represents the natural production of all fish and shellfish (harvested and non-harvested species) *inside* protected areas. An increase in this aspect means more and larger fish, crabs, sea stars, and anemones, for example, are present and visible.

THE NATURAL SUSTAINABILITY OF THE LOCAL FISH AND SHELLFISH STOCK								***AREAS FOR OUTDOOR RECREATION AND LEISURE***
This aspect represents the natural ability of harvested fish and shellfish populations *outside* protected areas to persist into the long-term future. An increase in this aspect means harvested stocks are more resilient to fishing or natural disturbance, and are more able to reproductively replace individuals.	O	O	O	O	O	O	O	This aspect represents the amount of areas suitable and available for outdoor recreation and leisure *inside or adjacent to* protected areas. An increase in this aspect means more beach area, tide pools with more sealife, and areas used for water sports (e.g. kayaking, diving, surfing).
THE VARIETY OF SEALIFE								***THE ABUNDANCE OF SEABIRDS***
This aspect represents the range of species of fish, shellfish, marine mammals, and plants and algae *inside* protected areas. An increase in this aspect means uncommon or previously unseen plants or animal species are more commonly present and visible.	O	O	O	O	O	O	O	This aspect represents the natural production of seabirds *inside* protected areas. An increase in this aspect means more seabirds are present and visible in flight or on the rocks or water.

COMPARISON SURVEY

An increase in…	Strongly prefer	Prefer	Somewhat prefer	Equal	Somewhat prefer	Prefer	Strongly prefer	An increase in…
THE ABUNDANCE OF MARINE MAMMALS								***THE NATURAL INTEGRITY OF THE MARINE ECOSYSTEM***
This aspect represents the natural production of marine mammals *inside* protected areas. An increase in this aspect means a greater number of Pacific harbor seals, California sea lions, and grey whales, for example, present and visible.	O	O	O	O	O	O	O	This aspect represents the ability of the marine ecosystem (*inside and outside* of protected areas) to self-organize and support a mature, rich community of organisms. An increase in this aspect means organism populations and interactions (such as the food web) naturally become more functional and resilient.

THE NATURAL INTEGRITY OF THE MARINE ECOSYSTEM								***THE CLEANLINESS OF COASTAL WATERS***
This aspect represents the ability of the marine ecosystem (*inside and outside* of protected areas) to self-organize and support a mature, rich community of organisms. An increase in this aspect means organism populations and interactions (such as the food web) naturally become more functional and resilient.	O	O	O	O	O	O	O	This aspect represents coastal water quality (*inside and outside* protected areas) for human contact and consumption of local seafood. An increase in this aspect means less biological and chemical waste in the water and in the organisms that live in it.

THE COASTAL CULTURE AND LIFESTYLE								***THE AVAILABILITY OF FISH AND SHELLFISH FOR HARVEST***
This aspect represents the vitality of the culture and lifestyle that Oregonians consider characteristic of the coast. An increase in this aspect means that coastal communities exhibit a stronger economic, social, and cultural connection to the ocean, and there is more ocean-based tourism, research and education, and stewardship opportunities, for example.	O	O	O	O	O	O	O	This aspect represents the natural production of harvestable fish and shellfish *outside* protected areas. An increase in this aspect means an increase in the stock of legal-size fish and shellfish of those species available for commercial and recreational harvest.

THE ABUNDANCE OF SEABIRDS								***THE NATURAL SUSTAINABILITY OF THE LOCAL FISH AND SHELLFISH STOCK***
This aspect represents the natural production of seabirds *inside* protected areas. An increase in this aspect means more seabirds are present and visible in flight or on the rocks or water.	O	O	O	O	O	O	O	This aspect represents the natural ability of harvested fish and shellfish populations *outside* protected areas to persist into the long-term future. An increase in this aspect means harvested stocks are more resilient to fishing or natural disturbance, and are more able to reproductively replace individuals.

COMPARISON SURVEY

An increase in…	Strongly prefer	Prefer	Somewhat prefer	Equal	Somewhat prefer	Prefer	Strongly prefer	An increase in…
THE NATURAL AESTHETIC OF THE SEASCAPE								***THE COASTAL CULTURE AND LIFESTYLE***
This aspect represents the natural formation of coastal "scenery" *inside* protected areas. An increase in this aspect means a greater amount of areas displaying the natural features and dynamics that Oregonians find interesting, fascinating, or awe inspiring, such as forceful waves, rocky formations colonized by plants and animals, and kelp forests and intertidal plants.	O	O	O	O	O	O	O	This aspect represents the vitality of the culture and lifestyle that Oregonians consider characteristic of the coast. An increase in this aspect means that coastal communities exhibit a stronger economic, social, and cultural connection to the ocean, and there is more ocean-based tourism, research and education, and stewardship opportunities, for example.
THE AVAILABILITY OF FISH AND SHELLFISH FOR HARVEST								***THE ABUNDANCE OF MARINE MAMMALS***
This aspect represents the natural production of harvestable fish and shellfish *outside* protected areas. An increase in this aspect means an increase in the stock of legal-size fish and shellfish of those species available for commercial and recreational harvest.	O	O	O	O	O	O	O	This aspect represents the natural production of marine mammals *inside* protected areas. An increase in this aspect means a greater number of Pacific harbor seals, California sea lions, and grey whales, for example, present and visible.

THANKS! NOW ON TO PART 3, THE DEMOGRAPHIC SURVEY.

ALMOST DONE…

DEMOGRAPHIC SURVEY

This 3rd part of the survey is called a "demographic survey" and is designed to give us a better picture of you as a person.

1. What year were you born in? _____

2. Including yourself, how many adults and children currently live in your household?

   _____ adults (18 years or older)
   _____ children

3. How many years have you been living in your current community? _____ years

4. Which of the following indicates your level of education? (check one)

   ☐ 8th grade or less
   ☐ 9th to llth grade
   ☐ 12th grade (high school graduate)
   ☐ 13-15 years (some college)
   ☐ 16 years (college graduate)
   ☐ 17+ years (some graduate work)
   ☐ Masters, Doctoral, or Professional Degree

5. Which of the following best describes your household income before taxes?

   ☐ Less than $15,000
   ☐ $15,000 - $24,999
   ☐ $25,000 - $34,999
   ☐ $35,000 - $49,999
   ☐ $50,000 - $74,999
   ☐ $75,000 - $99,999
   ☐ $100,000 or over

THAT'S IT! YOU'RE DONE!

THANK YOU FOR YOUR PARTICIPATION!

RETURNING THE SURVEY AND FUTURE CONTACT

Please return this survey in the self-addressed envelope included in the original mailing. If you've misplaced that envelope, please send the survey to:

Peter Freeman
104 CEOAS Admin Building
Corvallis, OR 97330

Also, please feel free to contact us with any questions or comments:

Peter Freeman (student researcher)

Email: pfreeman@coas.oregonstate.edu

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Mail: 2040 SE Marine Science Dr., Newport, OR 97365

You can find more information on protected areas and nearshore management online @ www.oregonocean.info

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