NOAA Technical Memorandum NMFS-AFSC-457

Views on Marine Ecosystem Service Values in Policy and Management: A Survey of NOAA Fisheries Federal Employees

D. K. Lew, K. Wallmo, T. B. Murphy, D. Johnson, and M. McGregor

December 2022

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The NMFS-NWFSC series is currently used by the Northwest Fisheries Science Center.

This document should be cited as follows:

Lew, D. K., K. Wallmo, T. B. Murphy, D. Johnson, and M. McGregor. 2022. Views on marine ecosystem service values in policy and management: a Survey of NOAA Fisheries federal employees. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-457, 53 p.

This document is available online at:

Document available: https://repository.library.noaa.gov

Views on Marine Ecosystem Service Values in Policy and Management: A Survey of NOAA Fisheries Federal Employees

D. K. Lew[1], K. Wallmo[2], T. B. Murphy[3], D. Johnson[4], and M. McGregor[5]

[1]Resource Ecology and Fisheries Management Division
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE
Seattle WA 98115

[2]Office of Science and Technology
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway
Silver Spring MD 20910

[3]Social Sciences Branch
Northeast Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
166 Water Street
Woods Hole MA 02543-1026

[4]Sustainable Fisheries Division
Southeast Regional Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
75 Virginia Beach Drive
Miami FL 33149

[5]Sustainable Fisheries Division
Pacific Islands Regional Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1845 Wasp Boulevard
Building 176
Honolulu HI 96818

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

NOAA Technical Memorandum NOAA-TM-AFSC-457

December 2022

Abstract

Understanding the services that ecosystems provide to society, and the value of those services, is critical for decision-making under current and evolving ecosystem-based management approaches. In the United States, national directives have called on federal resource management agencies to develop and promote institutional policies and processes that consider ecosystem services in planning, investments, and regulatory contexts. This report provides insight from employees of the National Marine Fisheries Service (NMFS), the federal agency responsible for managing the Nation's living marine resources, on the use of ecosystem service values (ESV) in marine management. In April 2022 an online survey was sent to all NMFS federal employees, at the time about 2,860 individuals, to understand their familiarity and experience with marine ESV, opinions about appropriate decision contexts for their use, and challenges of incorporating ESV into policy and management. Results suggest that over half of respondents are at least moderately familiar with the concepts of ecosystem services and ecosystem services valuation, and about a third of respondents have used ESV information in their work. In terms of types of ecosystem services, the majority of respondents feel that ESV information on food provision, habitat provision for marine plants and animals, and shoreline protection are most useful for marine management and decision-making. A majority of respondents also believes that ESV information has utility for a variety of regulatory and non-regulatory analyses and products, and there is considerable support for including ESV information in ecosystem-based management approaches, particularly ecosystem-based fisheries management and marine spatial planning. Overall, the survey results indicate a fairly high level of support for ESV information and its use in policy and management and are suggestive of specific directions for research and for incorporating the use of ESV in a more systematic manner.

Contents

Introduction

The term *ecosystem services* broadly refers to the direct or indirect benefits to humans derived from ecosystems (Costanza et al. 1997, Daily 1997, MA 2005). Ecosystem services generally embody both goods and services produced by ecosystems (MA 2005). They include a wide variety of things, from ecosystem goods that are used directly by humans (e.g., as food) to ecosystem services such as habitat for species, minimizing climate variability, and filtering air and water pollution. The United Nations' (UN) Millennium Ecosystem Assessment (MA) classified ecosystem services into four types: provisioning, regulating, cultural, and supporting services (MA 2005). Provisioning services are produced by the ecosystem and used directly by humans. For example, provisioning ecosystem services include food, fuel, genetic resources, fresh water, and other raw materials. Regulating services are ecosystem services that benefit humans by regulating ecosystem processes and include, for example, climate regulation, water purification, and pollination. Cultural services are those that provide non-material benefits to humans, such as those that provide recreation, spiritual or religious, inspirational, educational, or cultural heritage benefits. And finally, supporting services are those services necessary for the production of all ecosystem services but are not themselves ones that directly benefit humans. These include things like nutrient cycling, soil formation and cycling, water cycling, and habitat services.

The value of ecosystem services are indicators of the benefits provided, and they may be economic or socio-cultural. Economic values can be represented by a price, such as the market price of seafood, or a non-market value (often referred to as willingness-to-pay) for a service that doesn't have a traditional market price. Socio-cultural values are shaped by individuals' interactions with and perceptions of the ecosystem and are typically non-economic in nature (Chan et al. 2012, Diaz et al. 2015). Both economic and socio-cultural values for ecosystem services are important to understand for ecosystem-based management approaches that recognize relationships between humans and the environment. For example, ecosystem service values (ESV) are central to payment for ecosystem services (PES) programs (Bulte et al, 2008, Farley and Costanza 2010, Jack et al. 2008) and UN-led System of Environmental-Economic Accounting (SEEA), a framework that integrates economic and environmental data to provide a comprehensive view of the relationships between the economy and environment (La Notte and Rhodes 2020, United Nations 2014). Other frameworks that benefit significantly from information on ESV include coupled socio-ecological systems (SES) (Liu et al. 2007), Integrated Ecosystem Assessments (IEA) (Levin et al. 2009), and tradeoff analyses (Johnston et al. 2018).

Research on ecosystem services and ESV emerged in the scientific literature in the 1970s and has steadily increased over the last half century (Vihervaara et al. 2010). The completion of the Millennium Ecosystem Assessment in 2005 marked a milestone and generated a surge in scientific research, evidenced by the launch of the journal *Ecosystem Services* (2012) and the continued and growing academic interest in the topic. In fact, a bibliometric search of the Web of Science Core Collection (WoS), which indexes publications in over 21,100 journals and books spanning 250 disciplines[7], indicated that over the period 1999-2019 the number of published ecosystem service documents grew steadily each year with an average annual growth rate over the most recent five years of 18% (Lew 2022).

In addition to scientific research, policy guidance related to the use of ecosystem services and ESV has been developed by international bodies (e.g., UNECE Recommendations on Payments for Ecosystem Services, 2007; the 2007 commission of The Economics of Ecosystems and Biodiversity (TEEB) Initiative) as well as national governments. In the United States, for example, the 2010 Executive Order 13547 (referred to as the National Ocean Policy) and the National Ocean Policy Implementation Plan (2013) both stress the need to further our understanding of ecosystem services provided by oceans and coasts. This was followed by the U.S. Executive Memorandum M-16-01 (2015), which instructed federal agencies that manage the Nation's resources to incorporate ecosystem services into federal decision-making to the extent appropriate and practicable. These policies, coupled with shifts to ecosystem-based management (EBM), in particular the current shift from single-species to ecosystem-based fisheries management (EBFM) (Townsend et al. 2019), require information on marine ecosystem services and their values to provide the most comprehensive and efficient guidance in decision-making.

Marine ecosystem services are the direct and indirect benefits to humans derived from coastal and marine ecosystems functions and ecological structures. Examples of marine ecosystem services may include protection from storm surge provided by coastal dunes, ocean waves for surfing, fish and shellfish for consumption, and cultural and spiritual benefits provided by oceans and coasts. Table 1 includes a list of common marine ecosystem services and the category of the service as defined by the Millennium Ecosystem Assessment (MA 2005).

[7] See https://clarivate.com/webofsciencegroup/solutions/web-of-science-core-collection/ for more details.

Table 1. -- Marine Ecosystem Services and Millennium Ecosystem Assessment (MA) Category.

Service	Description	MA Category
Food Source	-Fish, other animals, and plants harvested for human consumption via commercial fishing, aquaculture, hunting, and subsistence/artisanal fishing -Fish, other animals, and plants used as inputs in human production process (e.g., bait, feed used in agriculture) or other ecosystem production processes (e.g., forage fish)	Provisioning
Source of Non-food Materials	-Minerals, rare earth elements, petroleum/oil, natural gas, and other valuable materials that can be mined, dredged, or harvested -Materials needed for, or potentially useful for, medicine or pharmaceuticals -Water for industrial processes and other non-drinking purposes -Wave and wind energy that can be harnessed -Fish, other animals, and plants harvested for ornamental use (e.g., aquariums)	Provisioning
Supporting and Regulating Functions	-Carbon sink (i.e., carbon sequestration) and climate regulation -Pollutant filtration and remediation -Shoreline protection, storm buffering, and erosion control -Habitat for marine and coastal plants and animals -Medium for transportation of goods and people -Biodiversity -Atmospheric processes incl. weather (e.g., rain and wind), breathable air, etc.	Supporting and Regulating Functions
Recreational Benefits	-Water recreation (e.g., scuba diving, snorkeling, swimming, surfing, paddle boarding, kayaking, sailing, motor-boating, etc.) -Sport fishing and hunting opportunities -Wildlife and scenic viewing opportunities -Onshore/coastal recreation activities (e.g., tide pooling, sunbathing)	Cultural
Social, Cultural, and Religious Benefits	-Cultural heritage -Spiritual or religious importance, inspirational -Sense of place/identity -Educational opportunities	Cultural
Non-use Benefits	-Existence benefits (knowing that something exists even if it is never visited or used personally) -Bequest benefits (knowing that something will be available for future generations of people)	Cultural

Subsequent to Executive Memorandum M-16-01 and the increasing promotion of frameworks that benefit from ESV information (e.g., EBFM and IEA), the Science Advisory Board of the National Oceanic and Atmospheric Administration (NOAA) conducted an assessment of the use and potential use of ESV within the agency (2016). Two of the key findings from the assessment (among others) suggested that the agency should determine a) whether and how ESV are relevant to different types of decision contexts that occur at different spatial and temporal scales; and b) how to best integrate ecosystem service values as an organic and core part of NOAA's mission, and in what areas this is most appropriate (SAB 2016). In response to the Science Advisory Board's recommendations, as well as other science assessments conducted for NOAA, the National Marine Fisheries Service (NMFS), the office of NOAA responsible for the management and stewardship of living marine resources, formed the Marine Ecosystem Services Valuation Working Group (ESVWG) in 2017.

The ESVWG consists of social scientists and economists from NMFS' Science Centers and Regional Offices, including the Alaska Fisheries Science Center, Northwest Fisheries Science Center, Northeast Fisheries Science Center, Pacific Islands Regional Office, Southeast Regional Office, and NMFS Headquarters. The group has six primary members and two advisory members. The main working group objectives were to 1) develop a set of standards and best practices for identifying and measuring ecosystem service values in coastal and marine systems, and 2) to identify the challenges of systematically including these values in management and determine the most suitable avenues and approaches for their inclusion both in the near-term and longer term research and management. The remainder of this report describes all aspects of the fulfillment of the second objective.

Survey Development and Implementation

To address the second objective of the ESVWG, working group members developed a web-based survey on marine ESV that was specifically designed for NMFS federal employees. Survey development began in 2018 and occurred during a 3-year period. The objectives of the survey were to understand, from the perspective of NMFS staff and leadership, a) general opinions of and familiarity with ESV, b) decision contexts that are most appropriate for using ESV, and c) challenges and opportunities of using ESV in management. Utilizing input from NMFS scientists and policy analysts on the working group and staff in regional offices and science centers, the ESVWG developed an online survey containing three sections

and a short introductory video. A brief overview of the survey is below, and the complete survey instrument is contained in Appendix 1.

Introductory Video

Prior to beginning the survey, respondents watched a 40-second video that provided a general overview of marine ecosystem services and described why it was important to participate in the survey.

Section I

The first section of the survey asked respondents about their familiarity with the concept of ESV and their experience using ESV in their work.

Section II

The second section of the survey asked respondents for their opinions about the utility of ESV for policy, management, and decision-making. Respondents were asked about six categories of ecosystem service values: food sources, non-food material sources, supporting functions, recreational opportunities, social/cultural/religious benefits, and non-use benefits. Each category contained two to six specific services. Respondents were then asked about the utility of ESV for improving specific types of regulatory and non-regulatory analyses and several types of management frameworks (e.g., IEA, Coastal and Marine Spatial Planning [CMSP]). The last set of questions in this section asked respondents about their general opinions about ESV and valuation.

Section III.

The final section of the survey asked respondents about the type of work they do and the geographic region of focus for most of their work. Respondents were also asked about their highest level of education and the number of years they have worked in the field of marine resources/management.

The survey underwent several reviews by ESVWG members prior to programming for online implementation. After the instrument was programmed, a formal survey review was conducted in the spring of 2019 with staff from each region of NMFS (Table 2). Staff were asked in their review to address the four areas below:

Completeness: Is the list of marine ecosystem services complete – are there any services missing that are important? Are there key questions about this topic that are not listed?

Clarity: Are the questions clearly worded and clear? Are there any ambiguous terms or concepts?

Correctness: Are the terms used in the survey correct – should any additional terms be included?

Overall: Is the survey too long? How difficult is the survey to complete? What are your overall impressions? Could anything be improved to make the survey more appealing and increase the likelihood that people would take the survey?

Table 2. -- Reviewers of Marine Ecosystem Service Values survey instrument.

Region	Reviewers Area of Expertise
Northeast & Mid-Atlantic	Economist, Mid-Atlantic Fishery Management Council
	Economist, works with Integrated Ecosystem Assessments (IEA) and Ecosystem Based Fisheries Management (EBFM)
Southeast	Ecologist
HQ	IEA program lead
Alaska	Economist, works with IEA
	Biologist, co-chair Protection of the Arctic Marine Environment (PAME) and Arctic Council Ecosystem Assessment
Southwest	Economist, survey research and works with habitat and EBFM
	Economist, works with EBFM
	Resource manager, works with IEA and EBFM
	Ecologist, works with EBFM and California Current
Pacific Islands	Habitat manager
	Sustainable Fisheries manager
	Social Scientist, survey research and works with IEA
Northwest	Ecosystem Service Program Manager, works with IEA
	Ecologist, works with Ecosystem Services and EBFM

The survey instrument was revised based on feedback from the NMFS reviewers, and then provided to the North Pacific Marine Science Organization (PICES) working group on marine ecosystem services (WG41) for additional review. Feedback from PICES working group members was used to further revise the instrument. In September and December 2021, two high-level briefings were provided to NMFS leadership and key NMFS staff working on EBFM and IEA. Feedback from both briefings was incorporated into the final survey instrument and a survey FAQ document was developed by working group members to provide additional information to respondents.

An email invitation to participate in the survey was sent from the NMFS Acting Science Advisor to all NMFS federal employees (total population size of 2,860) on 26 April 2022. The population includes all federal employees who work at the NMFS regional offices, regional science centers, field offices and labs, and at headquarters. A follow-up reminder to complete the survey was sent in the last week of May 2022, and the survey closed on 3 June 2022. A total of 672 responses were returned; however, 168 of those returns did not contain any valid responses and were considered unit non-responses. The remaining 505 individuals partially or fully completed the survey for a response rate of 17.66%. These responses are included in the analysis.

Survey Results

Our analysis of survey responses for each question is limited to "item respondents." Item respondents for a given question refer to individuals who answered the question; that is, they did not skip or otherwise not provide an answer to the question. For each question, we note the number of item respondents.

Across the 377 item respondents to the questions asking about length of employment, the average respondent has worked in their current position for 12.4 years (median = 10 years) and 15.2 years (median = 14 years) in any marine resource management agency. The average respondent has also worked on marine resource issues for 16.1 years (median = 16 years) and has at least a master's degree (~75% of respondents). The survey included a question to elicit the type of work respondents do in their position, including research in different disciplines, management focused on fisheries, protected species, habitat, or social science, and other positions focused on communications, stakeholder coordination, planning, administrative support, and others. Respondents were able to select more than one of these areas. The nature of work (work function) of survey respondents is summarized in Figure 1 (item respondents = 391). For 61% of item respondents, their work involves conducting research, with two-thirds of those in research positions conducting research in biology or ecology (41% of all item respondents) and a smaller number conducting research in economics or other social sciences (10% of item respondents). 71% of item respondents indicated that they work in management or policy, which suggests many who conduct research also contribute or work on policy or management activities. Unsurprisingly, the management or policy area in which the most people indicated their work is focused on is related to fisheries (29% of item respondents), with another 21% and 16% working on

management and policy related to protected species and habitat, respectively. 23% of item respondents indicated being in coordination or planning roles, and 20% indicated working in communication, stakeholder facilitation, or outreach. 20% indicated working in administrative or support roles.

Figure 2 presents the breakdown of responses to a question aimed at understanding the geographic areas in which respondents' work was focused. The geographic areas included in the question were New England, Mid-Atlantic, Southeast, Gulf of Mexico, West Coast, Alaska, Pacific Islands, and Great Lakes. In addition, respondents could also indicate if their work was national or international. Respondents were able to select multiple regions if their work was focused in more than one region. Of 387 item respondents, 29% indicated their work was focused on the West Coast (California, Oregon, and Washington), 21% on New England, 17% on Alaska, and 16% each on the Mid-Atlantic and Southeast regions. Lower numbers of item respondents focus on the Pacific Islands (14%), Gulf Coast (11%), Caribbean (4%), and Great Lakes (2%). 16% of item respondents also indicated their work focuses on National issues, and 11% indicated working on international issues.

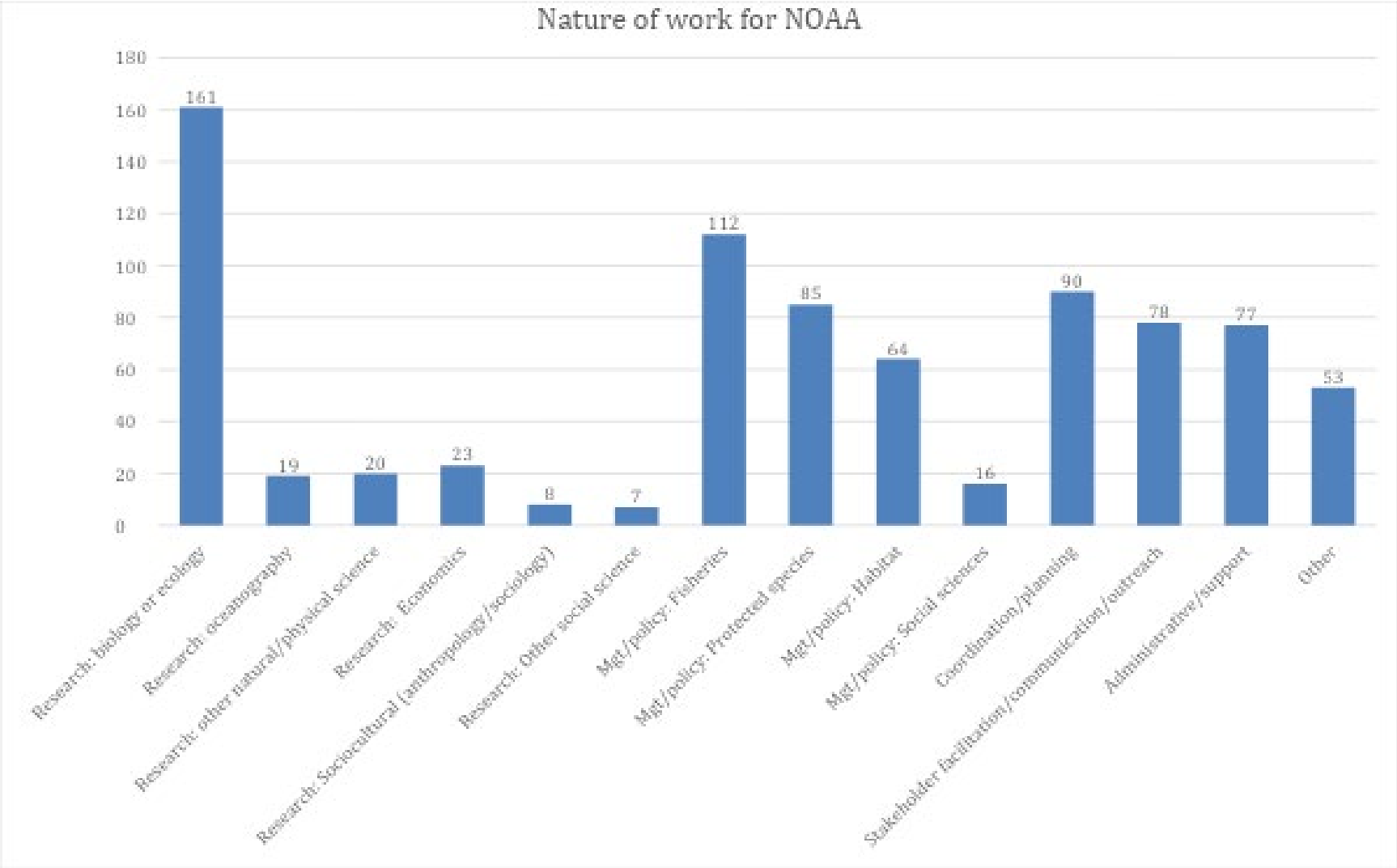


Figure 1. -- Nature of survey respondents' work. Item respondents = 391. Respondents were able to select all relevant areas for which their work is focused, so the total responses exceeds the number of respondents.

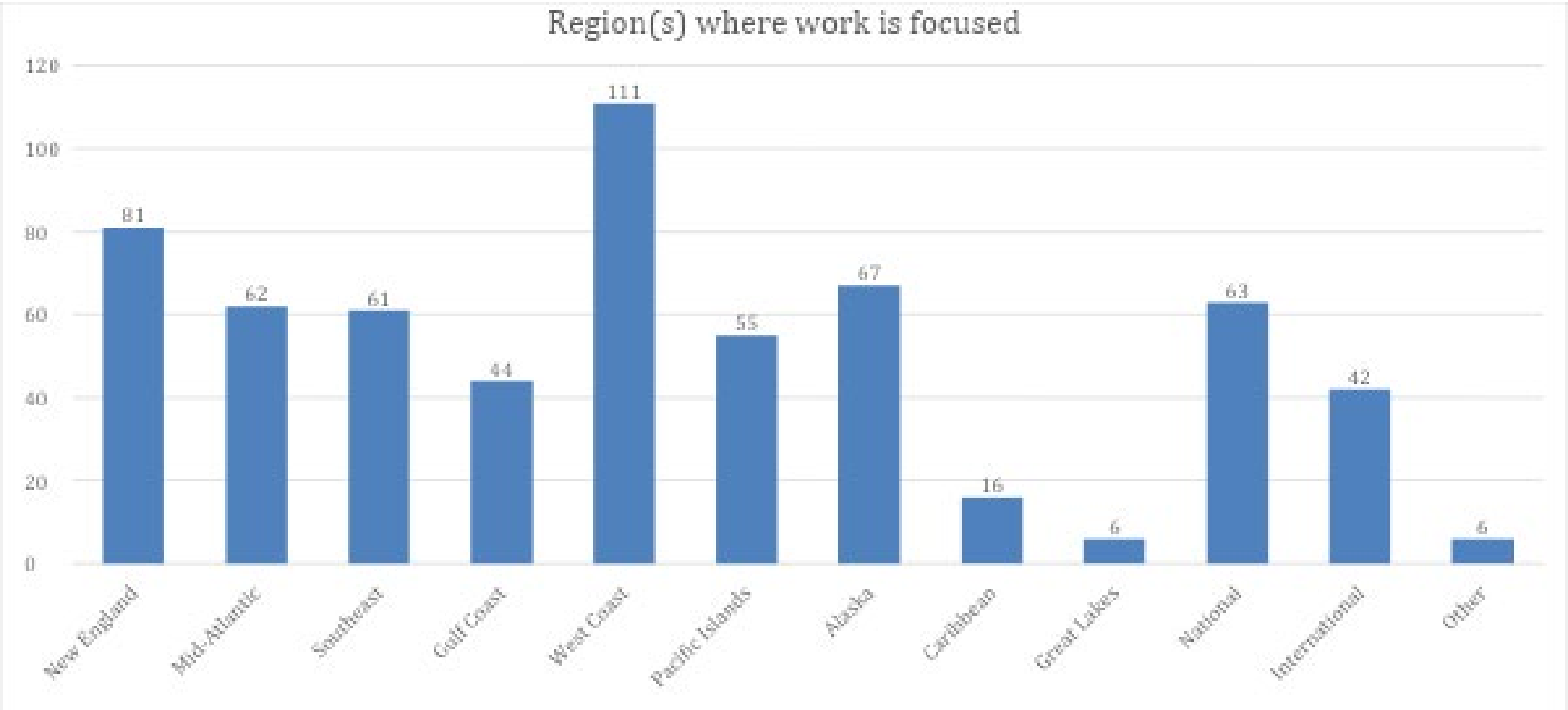


Figure 2. -- Geographic regions in which respondents' work is focused. Item respondents = 387. Respondents were able to select all regions in which their work is focused, so the total responses exceeds the number of respondents.

Familiarity with ecosystem services and ecosystem service values

The first section of the survey asked respondents about their experience and familiarity with ecosystem services and ESV. The concept of ecosystem services was "very familiar" for 37% of all respondents and "moderately familiar" to another 31% (see Fig. 3). The remaining 32% of respondents were either "only a little familiar" (15%) or "not at all familiar" (17%) with the concept.

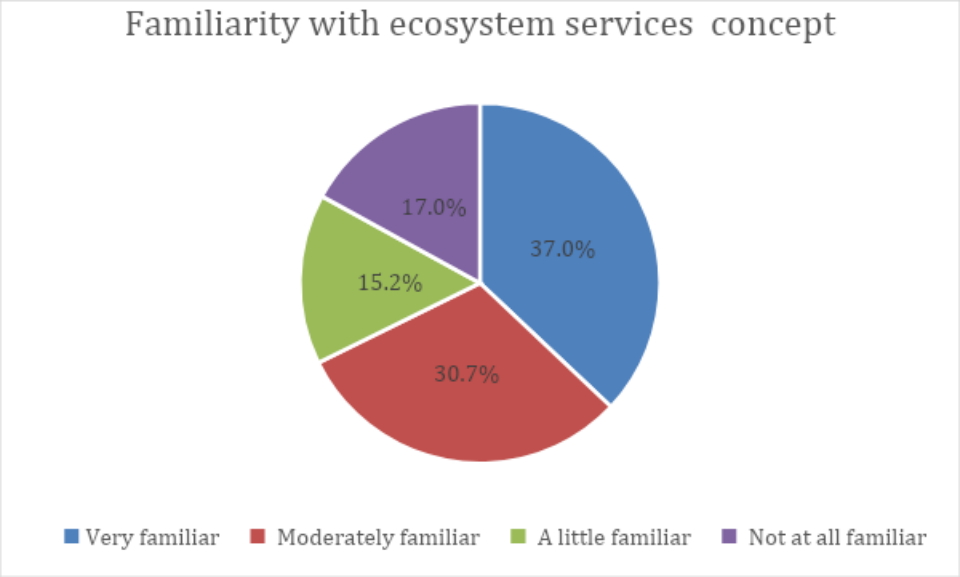


Figure 3. -- Familiarity with the ecosystem services concept. Total item respondents = 505.

Familiarity with the concepts involving the valuation of ecosystem services (ecosystem service valuation and ESV) was less strong overall, relative to the familiarity with the broader ecosystem service concept, with less than 20% indicating they were "very familiar" with the concepts, 34% indicating being "moderately familiar", and 23% indicating not being familiar at all (Fig. 4).

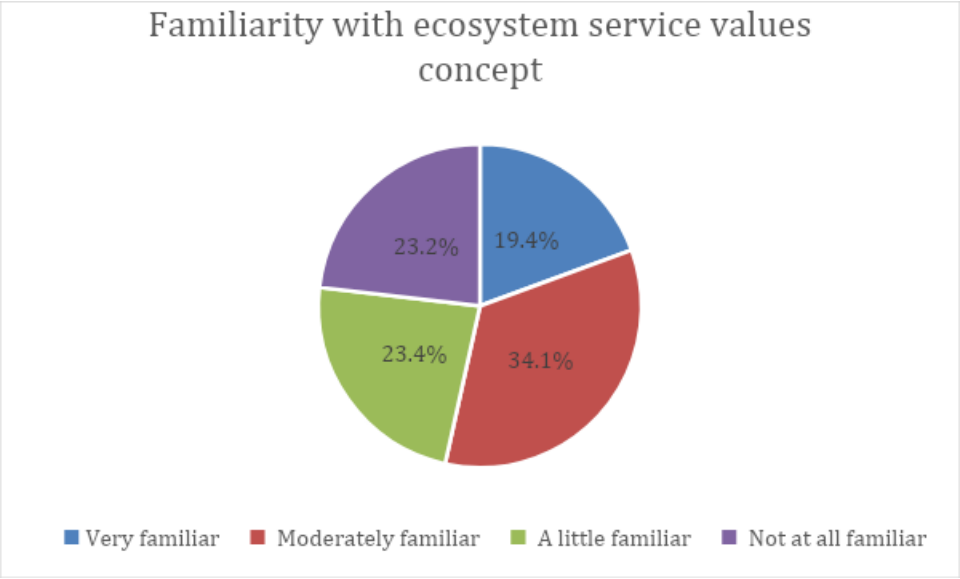


Figure 4. -- Familiarity with the ecosystem service valuation and/or ecosystem service value concept. Total item respondents = 505.

Only about 8% of respondents (out of 422 item respondents) indicated they conduct research on ESV, but about 31% indicated having used ESV information before and another 33% indicated having discussed or consulted on the use of such information (but not directly involved in the analysis or decision-making where the values would potentially be used) (Fig. 5). About 39% indicate not having any experience with ESV information.

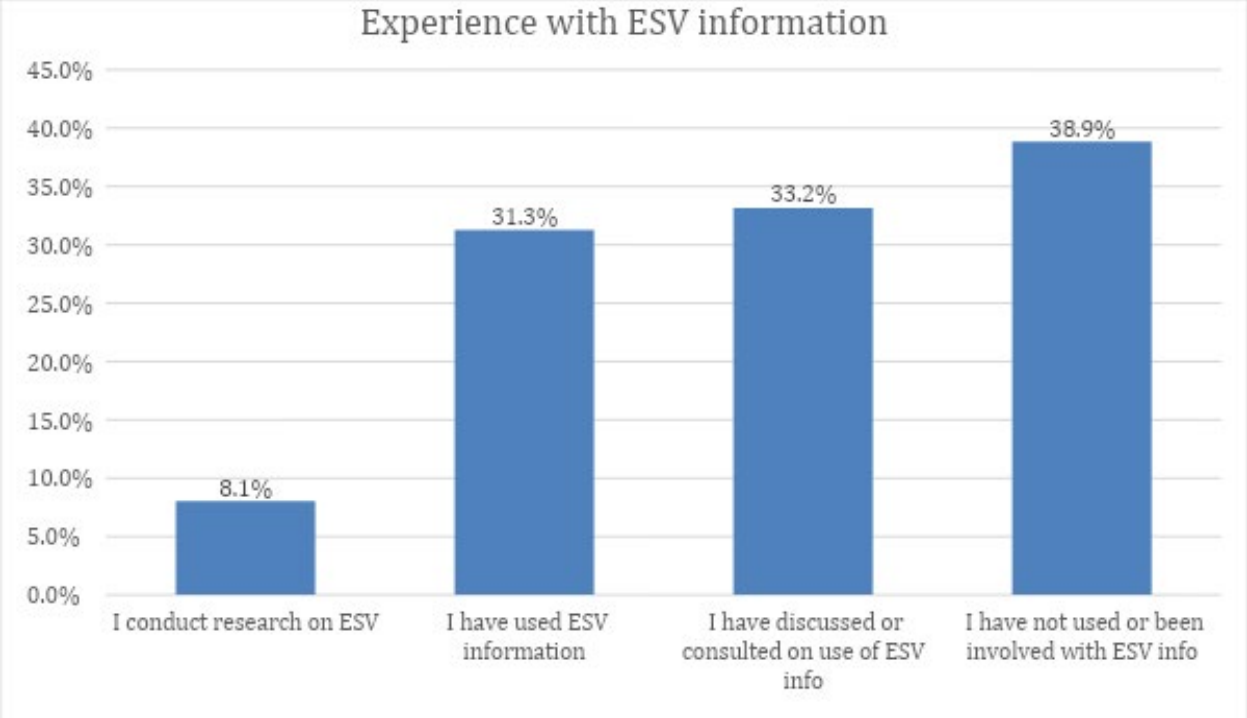


Figure 5. -- Respondent experience with ESV information. Item respondents = 422.

Two follow-up questions were asked of respondents who have at least some experience with ESV information (i.e., excluding those who indicated "I have not used or been involved with ecosystem service values"). The first question asked for more details about the respondent's work experience with ESV information. Of the respondents to this question (item respondents = 422), 28% indicated having used ESV information in analyses supporting a management framework (e.g., ecosystem-based fisheries management, management strategy evaluation, coastal and marine spatial planning, integrated ecosystem assessments, etc.) and 19% indicated having used ESV information in analyses supporting regulatory or management actions. About 11% of item respondents indicated being involved in research that produces ESV information (Fig. 6), 31% indicated they had discussed ESV information only for context in their work, and 20% indicated they had more detailed discussions or initially considered ESV information but ultimately did not use it in analyses.

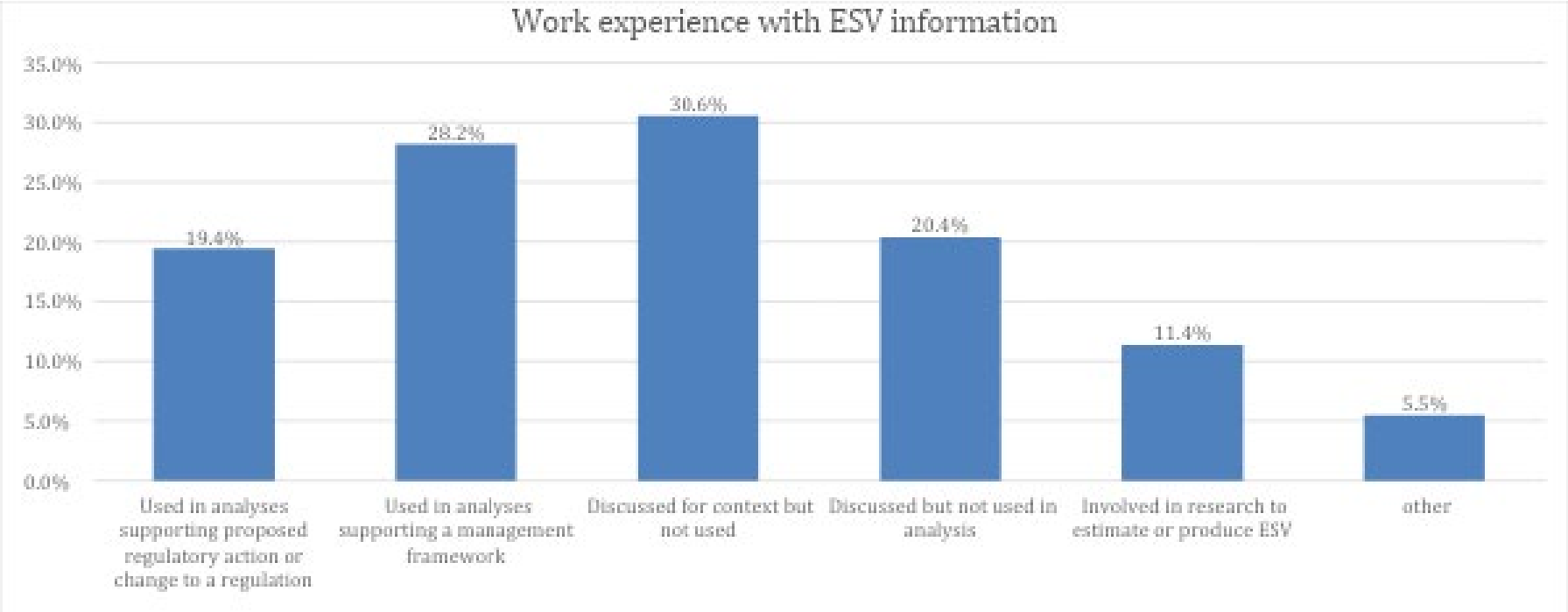


Figure 6. -- NOAA work experience with ESV information. As respondents were able to select multiple answers, the percentages do not add up to 100%. Item respondents = 422.

The second follow-up question asked how useful, in general, ESV information would be to the respondent's work. Half of respondents (item respondents = 258) indicated that that information would be "very useful", with another 37% indicating it would be "moderately useful" (see Fig. 7). Thus, almost 90% of respondents indicate ESV information would be at least moderately useful in their work.

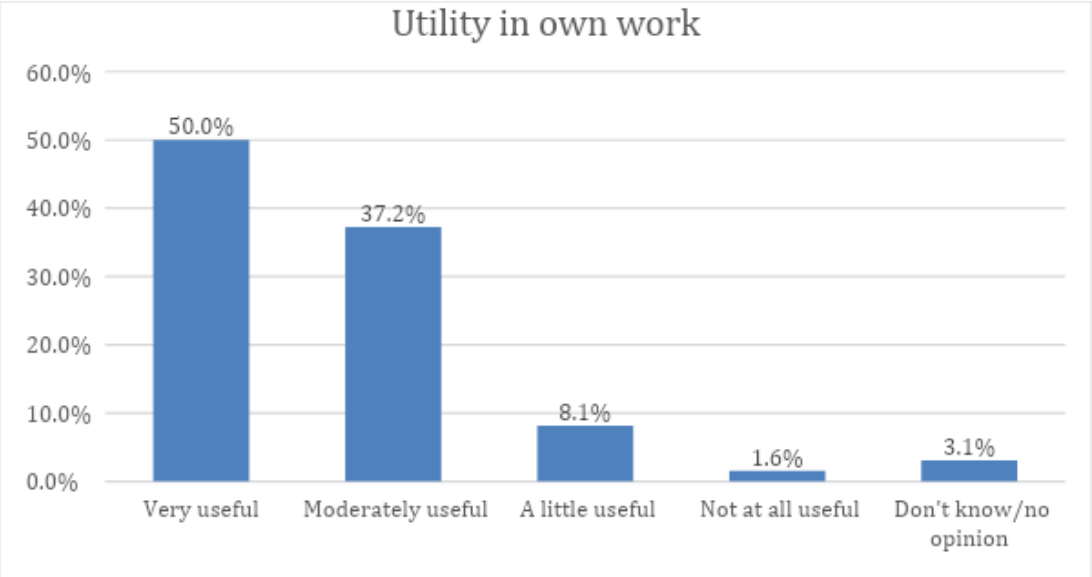


Figure 7. -- Usefulness of ESV information in respondent's own work. Item respondents = 258.

Usefulness of specific coastal and marine ecosystem service values

The second section of the survey elicited opinions about the usefulness of specific coastal and marine ESV for policy, management, and decision-making. This involved asking respondents questions to identify how useful values for specific ecosystem services would be for management and decision-making. The types of ecosystem services asked about were grouped into the Millennium Ecosystem Assessment (MA 2005) categories of provisioning services (Table 3), supporting and regulating services (Table 4), and cultural ecosystem services (Table 5). The provisioning service category includes food and non-food materials provided by the ecosystem. ESV information on food provisioning ecosystem services (fish and other living marine resources harvested or collected for human consumption), as well as for human production processes (fish and other living marine resources used to produce other food people eat) were viewed as "very useful" by a large majority of respondents (78 and 69%, respectively, for the 381 item respondents) (Table 3). For both, over 92% of the respondents indicate these values would be at least "moderately useful" for management and decision-making. While non-food

provisioning ecosystem service values were also viewed by a majority of respondents as at least "moderately useful", a majority of respondents (51%) indicate that ESV information on ocean and coastal renewable energy services (e.g., off-shore wind and solar) is "very useful." Less than 9% of respondents indicated that the non-food material values were "not at all useful."

Table 3. -- How useful economic value information – in the form of Ecosystem Service Values – is for management and decision-making for specific provisioning ecosystem services.

Type of Ecosystem Service	Very Useful	Moderately Useful	Only a Little Useful	Not At All Useful	Unsure / No Opinion
Food source (item respondents = 381)					
Fish, other animals, and plants harvested for human consumption via commercial fishing, aquaculture, hunting, and subsistence/artisanal fishing	77.7%	15.0%	3.4%	0.8%	3.1%
Fish, other animals, and plants used as inputs in human production process (e.g., bait, feed used in agriculture) or other ecosystem production processes (e.g., forage fish)	69.0%	23.1%	3.7%	0.8%	3.4%
Source of non-food materials (item respondents = 381)					
Minerals, rare earth elements, petroleum/oil, natural gas, and other valuable materials that can be mined, dredged, or harvested	37.0%	31.5%	14.2%	8.4%	8.9%
Materials needed for, or potentially useful for, medicine or pharmaceuticals	38.1%	33.1%	17.3%	3.4%	8.1%
Wave, wind, and geothermal energy that can be harnessed (incl. off-shore solar)	51.4%	31.0%	7.9%	2.9%	6.8%
Fish, other animals, and plants harvested for ornamental use (e.g., aquariums)	29.4%	27.8%	26.8%	8.9%	7.1%

At least 80% of respondents indicated that ESV information for supporting/regulating ecosystem services like pollutant filtration, shoreline protection, and storm buffering were at least "moderately useful" for management and decision-making purposes (Table 4). Values for shoreline protection and erosion control, and for habitat for coastal and marine plants and animals, had the most respondents indicating "very useful" (75 and 78%, respectively). Values associated with the oceans being used as a medium for transportation (maritime uses) received the lowest support by respondents with less than a third indicating these values would be "very useful."

Table 4. --How useful economic value information – in the form of Ecosystem Service Values – is for management and decision-making for specific supporting/regulating ecosystem services. Item respondents = 367.

Type of Supporting/Regulating Ecosystem Service	**Very Useful**	**Moderately Useful**	**Only a Little Useful**	**Not At All Useful**	**Unsure/ No Opinion**
Carbon sink (i.e., carbon sequestration)	63.2%	22.3%	8.4%	0.8%	5.2%
Pollutant filtration and remediation	68.4%	22.1%	5.2%	0.8%	3.5%
Shoreline protection and erosion control	74.9%	16.6%	4.1%	0.8%	3.5%
Storm buffering	68.7%	22.6%	4.4%	0.5%	3.8%
Medium for transportation of goods and people	32.7%	35.4%	21.8%	3.3%	6.8%
Habitat for coastal and marine plants and animals	78.2%	17.4%	2.2%	0.3%	1.9%

There were three types of cultural ESV asked about—those associated with recreational opportunities; social, cultural, and religious benefits; and nonuse benefits (Table 5). Among recreational ecosystem values, onshore/coastal recreation activities received the lowest amount of support for being useful for management and decision-making (42% of respondents; 367 item respondents). Nevertheless, all four categories (water recreation, sport fishing, wildlife and scenic viewing, and onshore/coastal recreation activities) were at least "moderately useful" to at least 75% of respondents. Likewise, at least 75% indicated that ESV information about social, cultural, and religious benefits are at least "moderately useful" for management and decision-making. A slightly lower percentage of respondents indicated that the ESV information about nonuse benefits, specifically existence benefits, would be at least "moderately useful." However, ESV information about the other major category of nonuse benefits, bequest benefits, were at least "moderately useful" in the minds of 80% of respondents.

Table 5. --How useful economic value information – in the form of Ecosystem Service Values – is for management and decision-making for specific cultural ecosystem services.

Type of Ecosystem Service	Very Useful	Moderately Useful	Only a Little Useful	Not at All Useful	Unsure/ No Opinion
Recreational Opportunities (item respondents = 367)					
Water recreation (e.g., scuba diving, snorkeling, swimming, surfing, paddle boarding, kayaking, sailing, motor-boating, etc.)	46.6%	34.9%	12.3%	2.5%	3.8%
Sport fishing opportunities	51.0%	33.8%	9.0%	1.6%	4.6%
Wildlife and scenic viewing opportunities	51.2%	33.5%	10.4%	1.1%	3.8%
Onshore/coastal recreation activities (e.g., tide pooling, sunbathing)	42.2%	33.5%	16.9%	3.0%	4.4%
Social, Cultural, and Religious Benefits (item respondents = 359)					
Cultural heritage	54.3%	30.9%	10.6%	0.8%	3.3%
Spiritual or religious importance	42.6%	33.4%	13.9%	3.9%	6.1%
Sense of place/identity	44.8%	31.2%	16.7%	2.5%	4.7%
Educational opportunities	52.4%	32.3%	11.4%	0.6%	3.3%
Nonuse Benefits (item respondents = 359)					
Existence benefits (knowing that something exists even if it is never visited or used)	39.0%	32.6%	19.8%	3.6%	5.0%
Bequest benefits (knowing that something will be available for future generations)	49.6%	30.6%	13.9%	2.2%	3.6%

Application of ESV Information in Policy and Management

Respondents were asked how useful ESV information would be for a wide variety of policy and management applications, including specific regulatory analyses (Table 6), non-regulatory products (Table 7), protected species analyses (Table 8), ecosystem approaches to management (Table 9), and other applications (Table 10).

Across a wide range of U.S. regulatory-related analysis types, the majority of respondents indicated that ESV information would be "very useful" (generally > 60% of item respondents) with very few respondents (generally less than 1%) indicating that it would not be useful at all (Table 6). This includes analyses done in support of management or policy decisions pertaining to marine fisheries (e.g., fishery allocations, closures, and catch shares programs), aquaculture (e.g., closures and siting decisions),

protected species (e.g., bycatch policies, dam re-licensing and removal, habitat modifications, and critical habitat designations), marine protected areas (e.g., National Marine Sanctuaries designations and regulatory changes), non-fisheries coastal management (e.g., coastal dredging, armoring, and habitat modification), off-shore non-fisheries activities (e.g., energy production, marine mining, etc.), and environmental justice assessments. Of these, environmental justice assessments was the application that the lowest percentage of respondents felt ESV information would be “very useful” (58%), and the largest percentage of respondents (72%) indicating “very useful” for protected species-related analyses.

Table 6. --Usefulness of including ecosystem service value information in different types of regulatory analyses (EIS, EA, RFA, and similar formal analyses mandated by statute or regulation). Item respondents = 335.

	The Inclusion of Ecosystem Service Values Would Be…				
Type of Regulatory Analysis	**Very Useful**	**Moderately Useful**	**A Little Useful**	**Not At All Useful**	**Unsure/ No Opinion**
Related to any U.S. marine fisheries management/policy decisions (e.g., allocations, spatial and temporal closures, catch shares, essential fish habitat (EFH), etc.)	69.6%	16.7%	7.2%	0.6%	6.0%
Related to U.S. aquaculture management/policy decisions (e.g., area closures, siting and permit decisions, etc.)	64.5%	20.0%	5.4%	0.9%	9.3%
Related to protected species management/policy decisions (e.g., protected species bycatch, area closures, dam re-licensing and removals, habitat modifications, ESA critical habitat designations, etc.)	72.8%	16.7%	6.0%	0.3%	4.2%
Related to marine protected area decisions (e.g., National Marine Sanctuaries designations, regulatory changes, etc.)	69.6%	17.0%	8.1%	0.6%	4.8%
Related to other non-fisheries coastal management decisions (e.g., coastal dredging, armoring, habitat modification, etc.)	65.1%	23.3%	5.4%	0.6%	5.7%
Related to other non-fisheries off-shore activities management decisions (e.g., energy production activities, marine mining operations, marine transportation, etc.)	62.1%	25.4%	5.4%	0.9%	6.3%
Related to environmental justice assessments	58.2%	23.6%	10.1%	1.8%	6.3%

The usefulness of ESV information for non-regulatory products was also assessed (Table 7). Non-regulatory products were classified into three types: 1) analyses done for program evaluation or internal assessment; 2) analyses done for white papers, research reports, or peer-reviewed publications; and 3) outreach or education materials. Of these, the usefulness of ESV information was highest for the latter

two with about 50% of respondents indicating ESV information would be “very useful” and 31% indicating it would be “moderately useful” for these types of products. For the first type of non-regulatory products, about 13% were unsure or had no opinion about whether ESV information would be useful. At the same time, about two-thirds indicated that they believed ESV information would be at least “moderately useful” for these types of products.

Table 7. --Usefulness of including ecosystem service value information in different types of non-regulatory products (policy and research-related products). Item respondents = 335.

	The Inclusion of Ecosystem Service Values Would Be…				
Type of Non-regulatory Product	**Very Useful**	**Moderately Useful**	**A Little Useful**	**Not At All Useful**	**Unsure/No Opinion**
Non-regulatory analyses (e.g., program evaluations, internal assessments)	31.9%	35.5%	17.3%	2.7%	12.5%
Science Centers/Labs and NOAA Fisheries HQ analyses (e.g., white papers, research reports, and peer-reviewed publications)	49.3%	31.3%	10.4%	1.8%	7.2%
Outreach/educational materials	51.3%	31.3%	11.3%	0.9%	5.1%

Having ESV information available for different types of protected species analyses was viewed by a majority of respondents (item respondents = 335) as “very useful” with roughly a quarter more believing it would be “moderately useful”. This was fairly consistent regardless of whether the information would be used to inform ESA-related analyses, other endangered and threatened species activities (e.g., international agreements), or MMPA-related activities (Table 8).

Table 8. --Usefulness of including ecosystem service value information in different types of protected species analyses. Item respondents = 335.

	The Inclusion of Ecosystem Service Values Would Be…				
Type of Protected Species Analysis	**Very Useful**	**Moderately Useful**	**A Little Useful**	**Not At All Useful**	**Unsure/No Opinion**
Endangered Species Act (ESA)-related activities (e.g., developing and evaluating recovery plans, critical habitat designations, and/or ESA consultations)	55.4%	23.7%	9.2%	3.1%	8.6%
Other endangered and threatened species activities (e.g., international agreements, etc.)	51.1%	25.2%	9.8%	1.8%	12.0%
Marine Mammal Protection Act-related activities (e.g., regulations, spatial/temporal area closures)	54.5%	24.6%	8.6%	2.2%	10.2%

Broadly speaking, there are a variety of ecosystem approaches to management that NOAA Fisheries has become involved with or initiated in recent years. These include IEA, EBFM, CMSP, climate vulnerability analyses (CVA), and other decision-support tools (particularly ones related to climate change). The use of ESV information in all of these were viewed by a majority (about 60% or more) of respondents (item respondents = 335) as “very useful,” with about 85% of respondents generally indicating ESV information would be at least “moderately useful” (Table 9).

Table 9. --Usefulness of including ecosystem service value information in different types of ecosystem approaches to management. Item respondents = 335.

	The Inclusion of Ecosystem Service Values Would Be…				
Type of Ecosystem-based Management Approach	**Very Useful**	**Moderately Useful**	**A Little Useful**	**Not At All Useful**	**Unsure/ No Opinion**
Integrated ecosystem assessments (IEAs)	64.0%	19.1%	3.7%	1.2%	12.0%
Ecosystem-based fisheries management (EBFM)	70.5%	16.6%	3.7%	0.9%	8.3%
Coastal and marine spatial planning (CMSP)	64.9%	20.6%	3.7%	1.2%	9.5%
Decision-support tools related to climate change	64.0%	19.4%	7.1%	1.5%	8.0%
Climate vulnerability analyses (CVA)	59.4%	18.5%	9.2%	2.2%	10.8%

Respondents were also asked to assess how useful ESV information would be in the application of management strategy evaluation (MSE) models, which are used to evaluate the effects of policy or management changes (Table 10). Only about 40% indicated that ESV information would be "very useful" in MSE applications, though in total over 63% indicated it would be at least "moderately useful." It should be noted, however, that one-quarter of respondents were unsure or had no opinion on this, which may be indicative that they did not know what MSE is. A similar percentage of respondents were unsure or had no opinion about how useful ESV information would be for application of socio-ecological systems (SES) models and coupled human and natural systems (CHANS) frameworks. However, about 70% of respondents did indicate ESV that ESV information would be at least "moderately useful" in those frameworks. Almost 85% of respondents, however, felt that ESV information would be at least "moderately useful" for education and outreach materials.

Table 10. -- Usefulness of including ecosystem service value information in other activities. Item respondents = 322.

	The Inclusion of Ecosystem Service Values Would Be…				
Other Activity Type	**Very Useful**	**Moderately Useful**	**A Little Useful**	**Not At All Useful**	**Unsure/No Opinion**
Management Strategy Evaluation (MSE)	40.1%	23.3%	9.0%	2.2%	25.5%
Social-ecological models and coupled human and natural systems (CHANS) frameworks	51.9%	18.0%	6.2%	1.2%	22.7%
Information, education, or outreach material	51.9%	32.3%	9.3%	1.2%	5.3%

General opinions about ESV information usage, need, and limitations

The final set of questions asked respondents to indicate the extent to which they agreed or disagreed with 10 statements about ESV information and its usage (Tables 11-12). Responses were presented as a 5-point Likert scale ranging from strongly agree to strongly disagree. There were 308 item respondents to these questions. Below, we group these questions into two groups: 1) statements regarding the general usage and need for ESV information and 2) statements about limitations and constraints to produce or use ESV information.

The first group of statements generally address aspects of using ESV information in decision-making (Table 11). The first statement related to the appropriateness of using ESV information to represent human preferences in decision-making. Over 68% of respondents indicated they agreed with the statement, “Using ecosystem service values is an appropriate way to include human preferences in decision-making.” About 7% of respondents disagreed with the statement, indicating that they did not feel ESV information is the appropriate manner in which to account for human’s preferences and values in policy and management. The second statement related to whether the use of ESV information should be evaluated on a case-by-case basis. About 42% agreed and 25% disagreed with the statement, “Including ecosystem service values is best done on a case-by-case basis,” with an additional 19% being neither agreeing nor disagreeing and 14% being unsure or not having an opinion. The third statement related to whether ESV information should be considered to the maximum extent possible in marine management decisions. About 71% at least “moderately agreed” and 8% at least “moderately

disagreed" with the statement, "Ecosystem service values should be included to the greatest extent possible when making decisions about the marine environment." 14% had no opinion or were unsure. A large majority (almost 77%) disagreed with the fourth statement, "Current practices are good enough for sound marine management so ecosystem service values are unnecessary," indicating they do feel like the addition of ESV information could benefit policy and management. However, about 6% agreed with the statement suggesting that the current practices that may ignore ESV information are good enough. And finally, about 73% agreed with the fifth general usage statement, "Using ecosystem service values is a good way to evaluate trade-offs associated with alternative management scenarios." Thus, a large majority of respondents viewed the use of ESV information for evaluating trade-offs positively. This is in contrast to almost 8% who disagreed with it. About 12% neither agreed nor disagreed, and 8% were unsure or had no opinion.

Table 11. --Likert scale responses to statements about general usage of and need for ESV information. Item respondents = 308.

Statement	**Strongly Agree**	**Moderately Agree**	**Neutral**	**Moderately Disagree**	**Strongly Disagree**	**Unsure/ No Opinion**
Using ecosystem service values is an appropriate way to include human preferences in decision-making.	21.1%	47.4%	16.6%	4.5%	2.9%	7.5%
Including ecosystem service values is best done on a case-by-case basis.	9.7%	32.8%	19.2%	19.8%	4.9%	13.6%
Ecosystem service values should be included to the greatest extent possible when making decisions about the marine environment.	33.1%	38.3%	14.3%	6.8%	1.6%	5.8%
Current practices are good enough for sound marine management so ecosystem service values are unnecessary.	2.9%	2.9%	9.1%	36.0%	40.9%	8.1%
Using ecosystem service values is a good way to evaluate trade-offs associated with alternative management scenarios.	29.9%	42.9%	12.3%	3.9%	2.6%	8.4%

The second group of statements address the limitations and constraints for producing or using ESV information (Table 12). The first statement related to the science underlying the valuation of ecosystem services. The majority of respondents (55%) indicated they disagreed with the statement that "The science underlying the economic valuation of marine ecosystem services is too uncertain to use ecosystem service values in management." About 19% agreed with the statement and almost 11% offered no opinion. About 16% were neutral to this statement, indicating they neither agreed nor disagreed with it. The second statement addressed the concern about the cost of undertaking research to produce ESV information. About 63% of respondents disagreed, and about 8% agreed, with the statement, "Estimating the value of ecosystem services is too expensive to make the undertaking worthwhile for management." Almost 15% were unsure or had no opinion. The third statement, like the first one, related to the underlying science but focused on what is known about the biophysical ecosystem functions and processes necessary to understand ecosystem services. About 50% disagreed, while 26% agreed, with the statement, "We currently do not know enough about physical/biological/ecological relationships within ecosystems to be able to estimate most ecosystem service values." An additional 15% were neutral, and 8% had no opinion or were unsure. The fourth statement addressed another potential obstacle to the use of ESV information, time and resource constraints. 59% agreed with the statement, "Time and resource constraints are a large impediment to systematically using ecosystem service values in management." This suggests a majority of respondents viewed using ESV information as a costly endeavor, which may influence whether or not they would actually pursue doing so. About 15% disagreed with the statement and another 15% were unsure or had no opinion. The final statement regarding ESV information concerns whether it is ethical to monetize the benefits of ecosystem services. 72% disagreed with the statement, "It is unethical to put an economic value on ecosystem services," while about 10% agreed with it. 13% were neutral, and 6% were unsure or had no opinion.

Table 12. -- Likert scale responses to statements about ESV information. Item respondents = 308.

Statement	Strongly Agree	Moderately Agree	Neutral	Moderately Disagree	Strongly Disagree	Unsure/ No Opinion
The science underlying the economic valuation of marine ecosystem services is too uncertain to use ecosystem service values in management.	3.9%	14.6%	15.6%	38.3%	16.9%	10.7%
Estimating the value of ecosystem services is too expensive to make the undertaking worthwhile for management.	3.2%	4.5%	14.6%	29.5%	33.1%	14.9%
We currently do not know enough about physical/biological/ecological relationships within ecosystems to be able to estimate most ecosystem service values.	8.4%	18.2%	15.3%	36.7%	13.6%	7.8%
Time and resource constraints are a large impediment to systematically using ecosystem service values in management.	22.4%	36.7%	11.4%	9.1%	5.8%	14.6%
It is unethical to put an economic value on ecosystem services.	4.5%	5.2%	13.3%	25.6%	45.8%	5.5%

Discussion

Several caveats are important to mention for properly interpreting the survey findings and their implications. First, the survey was limited to the population of NOAA Fisheries federal employees. Thus, contractors and grantees who often work side-by-side with federal employees in the agency and who contribute to its mission in important ways were not surveyed. Also excluded were management partners who work at the regional fishery management councils who are not considered federal employees for the purposes of federal survey data collection. Extending the survey to these non-federal employees, as well as to federal employees in other NOAA line offices (National Ocean Service, Office of National Marine Sanctuaries, National Weather Service, etc.) and other federal agencies (USDA, EPA, etc.), is being considered for future versions of the survey to get a more complete understanding of how the usefulness of ESV information is viewed beyond NOAA Fisheries. However, the current survey was

tailored to collect information from NOAA Fisheries federal employees and should be viewed within this more limited scope.

Second, the extent to which the sample results can be generalized to the population is difficult to assess. Less than 18% of the eligible population of NOAA Fisheries federal employees responded to the survey. Whenever response rates fall below 100%, but especially in cases of low response rates such as the 18% achieved here, non-response bias is a potential concern (Groves 2006). Non-response bias occurs when respondents to the survey differ in key aspects from non-respondents. This would imply the pattern of responses may differ had the non-respondents' views been collected, suggesting the survey sample is not representative of the population in those aspects. Non-response bias is typically evaluated by comparing auxiliary information known about both respondents and non-respondents, such as demographic or geographic information. When characteristics of respondents and non-respondents are found to differ, the sample results can be weighted based on those observable differences to better reflect the population (e.g., Lew, Himes-Cornell, and Lee 2015). This is a fairly common practice in survey research (Brick and Kalton 1996).

In this survey, however, there is little information about respondents that could be used to assess non-response bias, as anonymity was prioritized to ensure respondents could freely express their views. One potential variable that could be used for the purpose of weighting the survey results is position title, which was collected. However, only 371 of the 550 unit respondents provided this information, which limits our ability to evaluate the extent to which non-response bias may be an issue. While we continue to examine ways of better understanding this issue, the auxiliary data limitations may preclude fully understanding the extent to which non-response bias may be present in the data. Thus, while we don't have a reason to suspect a strong presence of this bias in the survey data, any generalizations of the survey findings presented here should be viewed cautiously. Additionally, any future extensions of the survey should prioritize collection of information that can be used for assessing this issue.

Third, the results presented in this report are for the full sample of respondents only. We leave for future work more detailed breakdowns of responses by respondent types of interest. These include examining how responses differ by type of work performed (research, policy/management, support, communications, leadership, etc.), disciplinary area (biologist/ecologist versus economist/social scientist), and length of tenure at NOAA Fisheries. Closer examination of the correlation these

characteristics have with responses, as well as the correlation between responses provided by individuals, will provide a richer understanding that is beyond the scope of the present report.

And finally, on a related note, there are limits to examining sample-level response distributions for understanding trade-offs between different ecosystem service values and the policy and management settings in which they could apply. For this, analysis of the pattern of responses individuals make is necessary and left for future research.

While much research remains to be done, and acknowledging the above caveats, the present analysis provides a useful overview of the general trends in views of ESV information and its usefulness in policy and management decision-making contexts. While there was not universal familiarity with the concepts of ecosystem services or ESV, a large majority were at least a little familiar with the concepts. There was also a fairly diverse set of experiences with ESV information, which is unsurprising given the diversity of job responsibilities represented among the survey respondents. Of those with some experience with ESV information, almost all indicated that the information is at least a little useful in their work.

How respondents viewed the utility of ESV information depended in part on the particular ecosystem service in question, with fisheries-focused provisioning ecosystem services, namely the harvest of fish and other living coastal and marine resources for human uses, being viewed as particularly useful in policy and management decision-making. Likewise, ESV information about two supporting/regulating ecosystem services, habitat services and shoreline protection and erosion control, were viewed by over 90% as being very useful for policy and management decision-making. Other types of coastal and marine ecosystem services generally scored lower in their perceived usefulness levels, but in almost all cases ESV information about all ecosystem services were thought to be at least moderately useful to a large majority of respondents (70% and above). Interestingly, ESV information about cultural ecosystem services like recreational, social, religious, and nonuse benefits provided by the ecosystem were viewed as at least moderately useful by three-quarters or more respondents, except for existence benefits, which was slightly lower (about 71%). For some of the ecosystem services for which NOAA Fisheries has a lesser role, like those related to maritime uses for the ocean and non-living resources (e.g., minerals), valuation information was viewed as being less useful. These results are suggestive that most NOAA Fisheries federal employees generally consider ESV information valuable for decision-making in relation to ecosystem services that are of principal concern to the agency.

Views on the usefulness of ESV information to specific types of policy or management-related activities were also enlightening. The results showed that respondents generally viewed this type of information very useful for the main NOAA Fisheries policy and management-related analyses and documents produced. Specifically, about 65% or more respondents believed the inclusion of ESV values in regulatory analyses related to policy or management of marine fisheries, aquaculture, and protected species was very useful. A similarly strong sentiment applied to views of the usefulness of this type of information in ecosystem approaches to management, like EBFM, IEA, and CMSP. This information being used in Management Strategy Evaluations, however, was viewed as useful by a slightly lower percentage of respondents, which could indicate that better communication about MSEs and their capabilities for integrating ESV information in a way consistent with CHANS or other SES model frameworks. This was also evidenced by the substantial percentage of respondents who responded "unsure/no opinion" when asked about this. ESV information was also viewed as useful generally for outreach and educational materials and non-regulatory research products.

There was also evidence that most respondents believed using ESV information in policy and management processes was appropriate and a useful way of incorporating human preferences and values and facilitates improved understanding of trade-offs. The results also indicated that most respondents believed that the scientific understanding and methods to produce reliable ESV information existed and that the costs of producing this information are outweighed by their utility. There was, however, evidence that most felt that there were time and resource constraints that could impede the incorporation of ESV information in policy and management.

Overall, these results suggest that NOAA Fisheries federal workers are generally aware of, and supportive of the use of, ESV information in a wide variety of applications in which the agency engages, particularly as it relates to ecosystem services of primary interest to the work done by NOAA Fisheries. There appears to be a broad understanding of the importance of using this type of information in policy and management, though support varied across the different types of application settings. Increased education about why, how, when, and in what contexts to apply ESV information could enhance and improve its usage.

Over the past 20 years, NOAA Fisheries has undertaken a number of initiatives aimed at understanding and estimating values for an array of ecosystem services (Lipton et al. 2014). Arguably the largest effort

has focused on estimating values associated with recreational fin-fishing and shell-fishing, with studies completed in every NMFS management region that provide values for additional harvest, regulatory changes, or other policy attributes of interest in a specific region (examples include Anderson and Plummer 2016, Lee et al. 2017; Lew and Larson 2015, Carter et al. 2020). Additionally, non-use values for protected marine species have been estimated for a number of species under the stewardship of NMFS (examples include Lew et al. 2010, Wallmo and Lew 2012), and values for supporting services such as habitat areas of particular concern (a part of essential fish habitat) have also been estimated (Wallmo and Edwards 2008). While the recreational fishing program (under NMFS' Marine Recreational Information Program) has a fairly well-developed mechanism for funding studies that generate values needed for policy, values for other ecosystem services have generally been one-off studies, as noted by the Science Advisory Board in their 2016 report on NOAA's use of ecosystem service values. Additional investments in people and projects that generate ESV information for ecosystem services of importance to the agency (as identified in part in this report) are needed to build an inventory of ESV information that informs decision-making and benefits policy and management settings.

Citations

Anderson, L. E., and Plummer, M. 2016. Recreational demand for shellfish harvesting under environmental closures. Mar. Resour. Econ. 32(1): 43-57.

Brick, J. M., and G. Kalton. 1996. Handling missing data in survey research. Stat. Meth. Med. Res. 5(3): 215-238.

Bulte, E. H., L. Lipper, R. Stringer, and D. Zilberman. 2008. Payments for ecosystem services and poverty reduction: Concepts, issues, and empirical perspectives. Environ. Develop. Econ. 13(3): 245-254.

Carter, D. W., S. Lovell, and C. Liese. 2020. Does angler willingness-to-pay for changes in harvest regulations vary by state? Results from a choice experiment in the Gulf of Mexico. Mar. Policy 121: 1-10.

Chan, K. M., A. D. Guerry, P. Balvanera, S. Klain, T. Satterfield, X. Basurto, A. Bostrom, R. Chuenpagdee, R. Gould, B. S. Halpern, N. Hannahs, J. Levine, B. Norton, M. Ruckelshaus, R. Russell, J. Tam, and U. Woodside. 2012. Where are cultural and social in ecosystem services? A framework for constructive engagement. BioScience 62(8): 744-756.

Costanza, R., R. d'Arge, R. De Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, P. Sutton, and R. G. Raskin. 1997. The value of the world's ecosystem services and natural capital. Nature 387(6630): 253-260.

Executive Memorandum M-16-01: Incorporating Ecosystem Services into Federal Decision Making. 2015. Available at: https://obamawhitehouse.archives.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf

Executive Order 13547: Stewardship of the Ocean, Our Coasts, and the Great Lakes. 2010. Available at: https://obamawhitehouse.archives.gov/the-press-office/executive-order-stewardship-ocean-our-coasts-and-great-lakes

Daily, G. 1997. Nature's Services (Vol. 3) Washington, D.C.: Island Press.

Díaz, S., S. Demissew, J. Carabias, C. Joly, M. Lonsdale, N. Ash, A. Larigauderie, J. Adhikari, S. Arico, A. Baldi, A. Bartuska, I. Baste, A. Bilgin, E. Brondizio, K. Chan, V. Figueroa, A. Duraiappah, M. Fischer, R. Hill, T. Koetz, P. Leadley, P. Lyver, G. Mac, B. Martin-Lopez, M. Okumura, D. Pacheco, U. Pascual, E. Perez, B. Reyers, E. Roth, O. Saito, R. Scholes, N. Sharma, H. Tallis, R. Thaman, R. Watson, T. Yahara, Z. Abdul, C. Akosim, Y. Al-Hafedh, R. Allahverdiyev, E. Amankwah, S. Asah, Z. Asfaw, G. Bartus, L. Brooks, J. Caillaux, G. Dalle, D. Darnaedi, A. Driver, G. Erpul, P. Escobar-Eyzaguirre, P. Failler, A. Fouda, B. Fu, H. Gundimeda, S. Hashimoto, F. Homer, S. Lavorel, G. Lichtenstein, W. Mala, W. Mandivenyi, P. Matczak, C. Mbizo, M. Mehrdadi, J. Metzger, J. Mikissa, H. Moller, H. Mooney, P. Mumby, H. Nagendra, C. Nesshover, A. Oteng-Yeboah, G. Pataki, M. Roue, J. Rubis, M. Schultz, P. Smith, R. Sumaila, K. Takeuchi, S. Thomas, M. Verma, Y. Yeo-Chang, and D. Zlatanova. 2015. The IPBES Conceptual Framework—connecting nature and people. Curr. Opinion Environ. Sustain. 14: 1-16.

Farley, J., and R. Costanza. 2010. Payments for ecosystem services: from local to global. Ecol. Econ. 69(11): 2060-2068.

Groves, R. M. 2006. Nonresponse rates and nonresponse bias in household surveys. Public Opinion Quarterly 70(5): 646-675.

Jack, B. K., C. Kousky, and K. R. Sims. 2008. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. Proc. Nat. Acad. Sci. 105(28): 9465-9470.

Johnston, R. J., C. Makriyannis, and A. W. Whelchel. 2018. Using ecosystem service values to evaluate tradeoffs in coastal hazard adaptation. Coast. Manage. 46(4): 259-277.

La Notte, A., and C. Rhodes. 2020. The theoretical frameworks behind integrated environmental, ecosystem, and economic accounting systems and their classifications. Environ. Impact Assess. Rev. 80: 106317.

Lee, M., S. Steinback, and K. Wallmo. 2017. Applying a bioeconomic model to recreational cod and haddock in the northeast United States fisheries management. Mar. Res. Econ. 32(2): 191-216.

Levin, P. S., M. J. Fogarty, S. A. Murawski, and D. Fluharty. 2009. Integrated ecosystem assessments: Developing the scientific basis for ecosystem-based management of the ocean. PLoS Biol. 7(1): e1000014.

Lew, D. K., D. F. Layton, and R. D. Rowe. 2010. Valuing enhancements to endangered species protection under alternative baseline futures: the Case of the Steller sea lion. Mar. Res. Econ. 25(2): 133-154.

Lew, D. K., and D. M. Larson. Stated preferences for size and bag limits of Alaska charter boat anglers. 2015. Mar. Policy 61: 66-76.

Lew, D. K. 2022. "Marine Ecosystem Services: Concepts and Classifications." Working paper.

Lew, D. K., A. Himes-Cornell, and J. Lee. 2015. Weighting and imputation for missing data in a cost and earnings fishery survey. Mar. Res. Econ. 30(2): 219-230.

Lipton, D., D. K. Lew, K. Wallmo, P. Wiley, and A. Dvarskas. 2014. The evolution of non-market valuation of US coastal and marine resources. J. Ocean Coast. Econ. 2014(1): 6.

Liu, J., T. Dietz, S. R. Carpenter, C. Folke, M. Alberti, C. L. Redman, S. H. Schneider, E. Ostrom, A. N. Pell, J. Lubchenco, W. W. Taylor, Z. Ouyang, P. Deadman, T. Kratz, and B. Provencher. 2007. Coupled human and natural systems. AMBIO J. Human Environ. 36(8): 639-649.

Millennium Ecosystem Assessment (MA) 2005. Millennium ecosystem assessment. Washington, DC: New Island, 13.

National Oceanic and Atmospheric Administration, Science Advisory Board. An Assessment of the Use and Potential Use of Ecosystem Service Valuation (ESV) within NOAA. 2016. Available at: https://sab.noaa.gov/wp-content/uploads/2021/08/ESV-Final-Report-to-NOAA-May-23.pdf

National Ocean Council. 2013. National Ocean Policy Implementation Plan. Available at: https://obamawhitehouse.archives.gov/administration/eop/oceans/policy

Townsend, H., C. J. Harvey, Y. deReynier, D. Davis, S. G. Zador, S. Gaichas, M. Weijerman, E. Hazen, and I. Kaplan. 2019. Progress on implementing ecosystem-based fisheries management in the United States through the use of ecosystem models and analysis. Front. Mar. Sci. (6). Available at: https://www.frontiersin.org/articles/10.3389/fmars.2019.00641

United Nations (UN) 2014. System of Environmental-Economic Accounting 2012— Central Framework. Available at: https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf

United Nations Economic Commission for Europe (UNECE) 2007. Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management. Available at: https://unece.org/DAM/env/water/publications/documents/PES_Recommendations_web.pdf

Vihervaara, P., M. Ronka, and M. Walls. 2010. Trends in ecosystem service research: early steps and current drivers. AMBIO J. Human Environ. 39(4): 314-324.

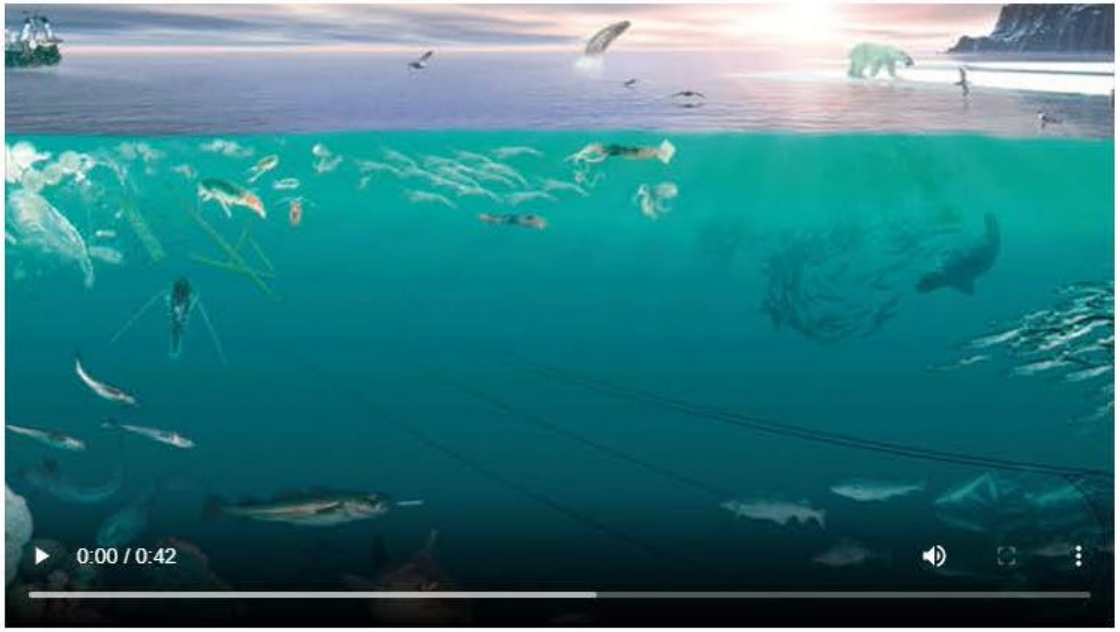
Wallmo, K., and D. Lew. 2012. The value of recovering threatened and endangered marine species: a Choice experiment approach. Conserv. Biol. 26(5): 830-39.

Wallmo, K., and S. Edwards. 2008. Valuation of marine protected areas in the Northeast EEZ: A latent class model to capture heterogeneous preferences. Mar. Res. Econ. 23(3).

Appendix

Survey Instrument

Ecosystem Services Valuation Survey



Welcome to the Ecosystem Services Valuation Survey! You and other NOAA Federal employees have been invited to participate in this survey to help us better understand how those in NOAA view ecosystem services and ecosystem service valuation. Even if your work doesn't directly involve using these concepts (or they are new to you), please take a moment to complete the survey, and thank you for helping NOAA sustainably manage our nation's marine resources.

Questions?

kristy.wallmo@noaa.gov

Start the Survey

Ecosystem Services Valuation Survey

We'd like to understand your views about ecosystem service values. For the purpose of this survey, we define ecosystem service values as indicators of the benefits ecosystem services provide to humans. They can be quantitative or qualitative and reflect economic values (measured in monetary units) or non-economic values like social, cultural, or ethical values people attribute to these services.

The first section is about your experience and familiarity with ecosystem services and ecosystem service values.

Q1. Before today, how familiar were you with the concept of **Ecosystem Services**? (Check one box)

- ○ Very familiar
- ○ Moderately familiar
- ○ Only a little familiar
- ○ Not at all familiar

Q2. Before today, how familiar were you with the concepts of **Ecosystem Service Valuation** and/or **Ecosystem Service Values**? (Check one box)

- ○ Very familiar
- ○ Moderately familiar
- ○ Only a little familiar
- ○ Not at all familiar

Next

Ecosystem Services Valuation Survey

Q3. Which of the following describes your work experience with **Ecosystem Service Values**? (Check all that apply)

- [ ] I conduct research on the topic of ecosystem service values
- [ ] I have used ecosystem service values in my work
- [ ] I have discussed or have been consulted on the use of ecosystem service values but was not personally involved in analysis or decision-making related to the values
- [ ] I have not used or been involved with ecosystem service values

Q3a. In your work experience with **Ecosystem Service Values**, which of the following apply? (Check all that apply)

- [ ] Ecosystem service values were used in analyses supporting a proposed regulatory action or change to a regulation
- [ ] Ecosystem service values were used in analyses supporting a management framework (such as Ecosystem Based Management, Coastal and Marine Spatial Planning, Integrated Ecosystem Assessment, Management Strategy Evaluation, etc...)
- [ ] Ecosystem service values were discussed for context but not used in the analysis
- [ ] Ecosystem service values were discussed, but not used in the analysis
- [ ] I was involved in research to estimate or produce ecosystem service values
- [ ] Other (please briefly explain the circumstances in which ecosystem service values were used)

Q3b. In your own work, how useful would having more information on **Ecosystem Service Values** be? (Check one box)

- ( ) Very useful
- ( ) Moderately useful
- ( ) Only a little useful
- ( ) Not at all useful
- ( ) Unsure/ no opinion

Q3c. If you would like to add any additional information related to your experience with **Ecosystem Service Values** please use the box below

Additional information related to your experience

Back Next

10%

Ecosystem Services Valuation Survey

The second section is about your opinions on the usefulness of coastal and marine ecosystem service values for policy, management, and decision-making.

Q4. In your opinion, how useful is it (or would it be) for management/decision-makers to have value information--in the form of Ecosystem Service Values--for the ecosystem services below? (Check one box for each item)

Type of Ecosystem Service	Very useful	Moderately useful	Only a little useful	Not at all useful	Unsure/ no opinion
Food source					
Fish, other animals, and plants harvested for human consumption via commercial fishing, aquaculture, hunting, and subsistence/artisanal fishing	○	○	○	○	○
Fish, other animals, and plants used as inputs in human production process (e.g., bait, feed used in agriculture) or other ecosystem production processes (e.g., forage fish)	○	○	○	○	○
Source of non-food materials					
Minerals, rare earth elements, petroleum/oil, natural gas, and other valuable materials that can be mined, dredged, or harvested	○	○	○	○	○
Materials needed for, or potentially useful for, medicine or pharmaceuticals	○	○	○	○	○
Wave, wind, and geothermal energy that can be harnessed (incl. off-shore solar)	○	○	○	○	○
Fish, other animals, and plants harvested for ornamental use (e.g., aquariums)	○	○	○	○	○

Back

Next

30%

Ecosystem Services Valuation Survey

Q4. In your opinion, how useful is it (or would it be) for management/decision-makers to have value information--in the form of Ecosystem Service Values--for the ecosystem services below? (Check one box for each item) [Continued].

Type of Ecosystem Service	Very useful	Moderately useful	Only a little useful	Not at all useful	Unsure/ no opinion
Supporting functions					
Carbon sink (i.e., carbon sequestration)	○	○	○	○	○
Pollutant filtration and remediation	○	○	○	○	○
Shoreline protection and erosion control	○	○	○	○	○
Storm buffering	○	○	○	○	○
Medium for transportation of goods and people	○	○	○	○	○
Habitat for coastal and marine plants and animals (incl. salmon and steelhead)	○	○	○	○	○
Recreational opportunities					
Water recreation (e.g., scuba diving, snorkeling, swimming, surfing, paddle boarding, kayaking, sailing, motor-boating, etc.)	○	○	○	○	○
Sport fishing opportunities	○	○	○	○	○
Wildlife and scenic viewing opportunities	○	○	○	○	○
Onshore/coastal recreation activities (e.g., tide pooling, sunbathing)	○	○	○	○	○

Back

Next

34%

Ecosystem Services Valuation Survey

Q4. In your opinion, how useful is it (or would it be) for management/decision-makers to have value information--in the form of **Ecosystem Service Values**--for the ecosystem services below? (Check one box for each item) [Continued].

Type of Ecosystem Service	Very useful	Moderately useful	Only a little useful	Not at all useful	Unsure/ no opinion
Social, cultural, and religious benefits					
Cultural heritage	○	○	○	○	○
Spiritual or religious importance	○	○	○	○	○
Sense of place/identity	○	○	○	○	○
Educational opportunities	○	○	○	○	○
Nonuse benefits					
Existence benefits (knowing that something exists even if it is never visited or used)	○	○	○	○	○
Bequest benefits (knowing that something will be available for future generations)	○	○	○	○	○

Q4a. Please list any other coastal and marine **Ecosystem Service Values** that you feel are important for management or decision-making purposes:

List any other coastal and marine ecosystem service

Back

Next

36%

Ecosystem Services Valuation Survey

Q5. In your opinion, how useful would having reliable information on **Ecosystem Service Values** be for improving the following? (Check one box for each item)

	The inclusion of ecosystem service values would be...				
	Very useful	Moderately useful	A little useful	Not at all useful	Unsure/No opinion
Regulatory analyses (Environmental Impact Statement, Regulatory Flexibility Analysis, Social Impact Analyses and similar formal analyses mandated by statute or regulation)					
Related to any marine fisheries management/policy decisions (e.g., allocations, spatial and temporal closures, catch shares, essential fish habitat (EFH), etc.)	○	○	○	○	○
Related to aquaculture management/policy decisions (e.g., area closures, siting and permit decisions, etc.)	○	○	○	○	○
Related to protected species management/policy decisions (e.g., protected species bycatch, area closures, dam re-licensing and removals, habitat modifications, ESA critical habitat designations, etc.)	○	○	○	○	○
Related to marine protected area decisions (e.g., National Marine Sanctuaries designations, regulatory changes, etc.)	○	○	○	○	○
Related to other non-fisheries coastal management decisions (e.g., coastal dredging, armoring, habitat modification, etc.)	○	○	○	○	○
Related to other non-fisheries off-shore activities management decisions (e.g., energy production activities, marine mining operations, marine transportation, etc.)	○	○	○	○	○
Related to environmental justice assessments	○	○	○	○	○
Non-regulatory analyses					
Non-regulatory analyses (e.g., program evaluations, internal assessments)	○	○	○	○	○
Science Centers/Labs and NOAA Fisheries HQ analyses (e.g., white papers, reports, peer-reviewed publications, etc.)	○	○	○	○	○
Outreach/educational materials	○	○	○	○	○

Back

Next

40%

Ecosystem Services Valuation Survey

Q5. In your opinion, how useful would having reliable information on ecosystem service values be for improving the following? (Check one box for each item) [Continued].

	Very useful	Moderately useful	A little useful	Not at all useful	Unsure/No opinion
Protected species analyses					
Endangered Species Act (ESA)-related activities (e.g., developing and evaluating recovery plans, critical habitat designations, and/or ESA consultations)	○	○	○	○	○
Other endangered and threatened species activities (e.g., international agreements, etc.)	○	○	○	○	○
Marine Mammal Protection Act-related activities (e.g., regulations, spatial/temporal area closures)	○	○	○	○	○
Ecosystem approaches to management					
Integrated ecosystem assessments (IEAs)	○	○	○	○	○
Ecosystem-based fisheries management (EBFM)	○	○	○	○	○
Coastal and marine spatial planning (CMSP)	○	○	○	○	○
Decision-support tools related to climate change	○	○	○	○	○
Climate Vulnerability Analyses (CVA)	○	○	○	○	○

Back

Next

44%

Ecosystem Services Valuation Survey

Q5. In your opinion, how useful would having reliable information on ecosystem service values be for improving the following? (Check one box for each item) [Continued].

	Very useful	Moderately useful	A little useful	Not at all useful	Unsure/No opinion
Miscellaneous					
Management Strategy Evaluation (MSE)	○	○	○	○	○
Social-ecological models and coupled human and natural systems (CHANS)	○	○	○	○	○
Information, education, or outreach material	○	○	○	○	○

Q5a Please describe any other items that would benefit from ecosystem service values or elaborate on any of the items described above:

Describe any other items that would benefit from ecosystem service values

Back

Next

48%

Ecosystem Services Valuation Survey

Q6. Please indicate your level of agreement with each of the following statements (Check one box for each item):

	Strongly agree	Moderately agree	Neutral	Moderately disagree	Strongly disagree	Unsure/no opinion
The science underlying the economic valuation of marine ecosystem services is too uncertain to use ecosystem service values in management.	○	○	○	○	○	○
Using ecosystem service values is an appropriate way to include human preferences in decision-making.	○	○	○	○	○	○
Estimating the value of ecosystem services is too expensive to make the undertaking worthwhile for management.	○	○	○	○	○	○
Including ecosystem service values is best done on a case-by-case basis.	○	○	○	○	○	○
Ecosystem service values should be included to the greatest extent possible when making decisions about the marine environment.	○	○	○	○	○	○
We currently do not know enough about physical/biological/ecological relationships within ecosystems to be able to estimate most ecosystem service values.	○	○	○	○	○	○
Current practices are good enough for sound marine management so ecosystem service values are unnecessary	○	○	○	○	○	○
Time and resource constraints are a large impediment to systematically using ecosystem service values in management.	○	○	○	○	○	○
It is unethical to put an economic value on ecosystem services.	○	○	○	○	○	○
Using ecosystem service values is a good way to evaluate trade-offs associated with alternative management scenarios.	○	○	○	○	○	○

Back

Next

50%

Ecosystem Services Valuation Survey

The final section will help us understand responses across different types of respondents.

Q7. Which of the following do you do for your work at NOAA or the Fishery Management Council? (Check all that apply)

- [ ] Research: biology or ecology
- [ ] Research: physical or chemical oceanography
- [ ] Research: other natural or physical science
- [ ] Research: economics
- [ ] Research: socio-cultural (e.g., anthropology or sociology)
- [ ] Research: other social science
- [ ] Management and/or policy analysis: fisheries
- [ ] Management and/or policy analysis: protected species
- [ ] Management and/or policy analysis: coastal or marine habitat
- [ ] Management and/or policy analysis: social sciences
- [ ] Coordination/planning
- [ ] Stakeholder facilitation/communication/outreach
- [ ] Administrative/support
- [ ] Other (please specify)

Back

Next

60%

U.S. Secretary of Commerce
Gina M. Raimondo

Under Secretary of Commerce for
Oceans and Atmosphere
Dr. Richard W. Spinrad

Assistant Administrator, National Marine
Fisheries Service. Also serving as
Acting Assistant
Secretary of Commerce for Oceans
and Atmosphere, and Deputy NOAA
Administrator
Janet Coit

December 2022

www.nmfs.noaa.gov

OFFICIAL BUSINESS

National Marine
Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, WA 98115-6349