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Short Communication

Gulf of Mexico offshore ecosystem services: Relative valuation by stakeholders

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ABSTRACT

While efforts to integrate ecosystem services into the management of coastal and terrestrial systems continue to advance, similar efforts for deepwater environments are still in the early stages of deliberation. To begin closing this gap, two workshops were held to engage participants in a discussion on ecosystem services provided by the deepwater Gulf of Mexico, and to facilitate the relative ranking of offshore ecosystem services using a non-monetary valuation scheme. Both workshops relied on a balanced representation of ocean users from multiple industry sectors, government and non-government organizations with interests in the deepwater Gulf. The following findings were made: (1) participants recognized the benefit of being able to rank multiple ecosystem services rather than limiting their attention to those services that were closely related to their respective constituents' interests; (2) both workshops yielded similar results, with food, raw materials (including hydrocarbons), and recreation being among the top three ranked ecosystem services; (3) participants in both workshops distinguished between direct (provisioning and cultural) and indirect (regulating and supporting) services; (4) there was a preference among participants to focus on ranking the direct services; and (5) participants of the workshops expressed that the role of the indirect services needed to be considered when designing monitoring and/or mitigation measures to protect the sustainability of the direct services. These results can be used in future discussions to further vet the viability of using such a non-monetary valuation scheme to assist in guiding the development or implementation of scientific and socio-economic indicators to monitor and maintain the health of ecosystem services in order to try to meet stakeholder needs.

1. Introduction

Ecosystem services are defined as the benefits people obtain from ecosystems [1] or, equivalently, the contributions from ecosystems that support, sustain, and enrich human life [2,3]. They are divided into provisioning, cultural, supporting, and regulating services [1] and can directly (e.g., fish harvesting) or indirectly (e.g., algal growth for fish food) benefit humans. Some ecosystem services such as food exploitation or transportation may be readily valued and recognized for their connection to human well-being. Other ecosystem services however, such as biological or waste regulation may be less clearly valued and understood [4–6].

Several studies discuss the potential uses of ecosystem services frameworks to support environmental management choices, including the consideration of ecosystem services trade-offs across spatial and temporal scales [7–10]. A prerequisite to applying such frameworks is the reasonable understanding of what services may be provided by different ecosystems, and how these services could contribute to human well-being. Both factors rely on the knowledge of complex scientific processes and indicators that are not always readily understood or available. Human actions in turn may also affect ecosystems and ecosystem services, thus proposing a combination of ecological and socio-economic measures to identify changes in the provision and value of ecosystem services [7,11–13].

Because of the complex interconnectivities between humans and ecosystems, linkages between the natural environment and

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human well-being can be difficult to express in quantitative or scientific terms. This situation can be compounded when examining the deep-sea environment, where data and scientific knowledge are generally less abundant than in coastal or terrestrial regions. Nevertheless, recent work has begun to capture the relationship between offshore systems and human well-being. For example, Armstrong et al. [14] catalogue and explore, through a review of the literature, the presence and values of ecosystem goods and services provided by the deep sea. They conclude that a significant amount of work still needs to be done to better understand the biodiversity, structure, and function of the deep-water system before offshore ecosystem services can be properly identified and addressed. Werner et al. [15] developed an approach that facilitates the qualitative assessment of offshore ecosystem services by linking them to the key ecological components of the deep sea, a method that promises potential but also highlights the need for improved knowledge on offshore ecosystem diversity and functioning.

Preserving the ability of the environment to provide valued ecosystem services is one of the overall objectives of environmental management. International standards and policies are being developed to meet this goal, but often lack a structured framework for capturing stakeholder input. In particular, the integration of ecosystem services into the management of deep-water marine systems has been limited by the absence of organized forums that could help determine the priorities placed on ecosystem services by multiple ocean users. To begin closing this gap, two workshops were organized to discuss offshore ecosystem services in the deepwater Gulf of Mexico. The workshops were meant to provide an informal forum to:

1) Aid the identification of offshore ecosystem services that are occurring or anticipated to occur in the deepwater Gulf;
2) Initially test a method to quantify, in non-monetary terms, the relative value of the identified offshore ecosystem services.

"Deepwater", for the purpose of this analysis, includes regions on the outer continental shelf, continental slope and in the abyss. Nearshore and coastal systems such as salt marshes, river outflows, wetlands or barrier islands were excluded from the workshop discussions.

2. Methodology

Two workshops were held to engage participants in a discussion about the deepwater Gulf of Mexico, its role in providing ecosystem services, and the interconnection between the offshore environment and human well-being. The first workshop took place on September 29th, 2013 in Houston, Texas and the second on November 21st, 2013 in Tampa, Florida. Both workshops relied on a balanced representation of ocean users consisting of participants from multiple industry sectors, government and non-government organizations with interest in the deepwater Gulf. Participants at the Houston workshop included representatives from recreational fishing, commercial fishing, oil and gas development (ExxonMobil), energy and ocean policy consulting, wind energy research, one Federal agency (National Oceanic and Atmospheric Administration), and three non-government organizations (Ocean Conservancy, Gulf of Mexico Foundation, Coastal Conservation Association-Texas). Participants at the Tampa workshop included members from recreational fishing, commercial fishing/seafood industry, aquaculture research (Mote Marine Laboratory), the diving industry, oil and gas development (ExxonMobil), the pipeline industry, two federal agencies (National Oceanic and Atmospheric Administration, Bureau of Ocean Energy Management), and one NGO (Conservation International). The number of participants in each workshop was between 9 and 10 not counting the workshop facilitators, a size which benefitted a group discussion and maintained focus on the workshop goals. Individual participants did not overlap between the two workshops, and results from the first workshop were not shared during the second workshop prior to completion of the valuation exercise.

To introduce the relative valuation process, both working groups were first presented with a list of fifteen offshore ecosystem services (Table 1) and asked to rank these services using the Relative Valuation of Multiple Ecosystem Services Index (RESVI) approach [16]. Application of this approach entailed answering the question: "If you were given one dollar, how would you spend this dollar to ensure the continued provision or enhancement of offshore ecosystem services?" Each participant could either assign his or her dollar to one ecosystem service alone, or divide it among as many ecosystem services as he or she desired. Under this approach, the relative value of each ecosystem service could be

Table 1
List of offshore ecosystem services (based on Yoskowitz et al. [2] and Farber et al. [7]).

Ecosystem functions and services	Description	Examples
Supportive functions and structures	Ecological structures and functions that are essential to the delivery of ecosystem services	
Net primary production	Conversion of sunlight to biomass	Algal growth
Dispersal of organisms	Seed and larval transport	Larvae dispersal by currents
Habitat	The locations organisms use	Spawning grounds
Regulating services	Maintenance of essential ecological processes and life support for humans	
Gas regulation	Regulation of the atmospheric and oceanic chemical composition	Downwelling of oxygen, carbon burial
Climate regulation	Regulation of global climate processes	Heat transfer and storage
Biological regulation	Species interactions	Preventing species invasions
Waste/pollutant regulation	Removal or breakdown of non-nutrients	Dilution and breakdown of hydrocarbons or human waste
Nutrient regulation	Cycling, recycling and maintenance of major nutrients	Nitrogen and phosphorus for phytoplankton growth
Provisioning services	Provision of natural resources and raw materials	
Food	Human consumption of organisms	Fish via commercial or subsistence harvesting
Raw materials	Abiotic resources used by humans	Hydrocarbons, wind/wave energy, sand
Genetic resources	Genetic resources	Temperature stable compounds, oil dispersing compounds
Medicinal resources	Substances for use in pharmaceuticals	Anti-cancer products
Cultural services	Enhancing emotional, psychological, and cognitive well-being	
Recreation	Rest, refreshment, and recreation	Boating, diving, fishing
Science and education	Scientific and educational enhancement	Field studies, excursion areas
Spiritual and historic values	Spiritual or historic information	Archaeological sites

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