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# Marine ecosystem services: Perceptions of indispensability and pathways to engaging citizens in their sustainable use

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ABSTRACT

Research on attitudes towards the conservation and sustainable use of natural systems has predominantly focused on terrestrial systems. While marine systems provide crucial ecosystem services that support human well-being, some are significantly more tangible in people's everyday lives, leading to more complex perceptions of their value. An assessment of perceptions about marine ecosystem services as well as willingness to engage in the conservation and sustainable use of these ecosystem services through taxation, donation, volunteering, or other activities is provided here based on a randomized survey of 1434 residents of the USA. Statistical analysis is presented, which suggests that: (1) respondents view oceans as a truly global commons with little distinction between the national and international indispensability of the ecosystem services they provide; (2) among the options for engaging citizens in the sustainable use of ecosystem services, respondents were most averse to taxation, a trend that is strongly correlated with age and more weakly correlated with gender; (3) perceptions about the potential loss of ecosystem services are a much stronger indicator for willingness to engage in their sustainable use than perceptions about the current status of the ecosystem services; (4) there is little or no correlation between political leanings and geographical location of respondents and their perceptions of marine ecosystem services or readiness to engage in their conservation and sustainable use. Among other things, these findings provide a basis for developing policies aimed at maximizing public engagement in sustainable management of marine ecosystem services, while identifying mechanisms most likely to meet with resistance from the general public.



## Introduction

Ecosystem services provide the foundation for human well-being. Current trends of environmental deterioration around the world compounded by a rapidly growing global population, however, mean that more and more people will be dependent upon ecosystems that are losing their capacity to sustain life as we know it. Unsustainable economic processes reliant on the externalization of negative environmental impacts constitute one driver of ecosystem degradation, leading to a concerted effort to assess the value of ecosystems themselves so that such costs can be responsibly internalized into economies [40].

Notable milestones in the process towards evaluating ecosystem services include the Millennium Ecosystem Assessment (MA) concluded in 2005, which provided a distinction among the provisioning services, regulating services, cultural services and supporting services of ecosystems [29]. Building on this typology, a number of efforts have sought to specify the value of each of these services, for example, Costanza et al. [12] and multiple publications from The Economics of Ecosystems and Biodiversity (TEEB) project [39,40]. Such efforts rapidly encounter challenges in finding conclusive and mutually agreeable indicators for such a diverse range of factors. Generally, more progress has been made towards evaluating the benefits derived from provisioning services, which are arguably more tangible and measureable than some of the other categories such as cultural services, for which considerable gaps in the literature have been cited [15].

Efforts have been made to understand people's place in nature, leading to the concept of coupled social-ecological systems in which humans are considered an integral part of nature, and where the delineation between social and ecological systems is

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**Table 1**
Overview of questionnaire design.

| Section | Example | Type of response |
|---|---|---|
| 1: General information (3 questions) | Gender: Male/female<br>Age: 20s/30s/40s/50s/60s<br>Zipcode: xxxxx | Multiple choice, five-digit zip code |
| 2: Indispensability of marine ecosystem services for the USA and for the world (25 questions) | "The loss of foodstuffs provided by the ocean would have a negative effect on the diets of people in my country." (Q1S1)<br>"The loss of foodstuffs provided by the ocean would have a negative effect on the diets of people around the world." (Q1S2) | Five-point Likert Scale (strongly agree, somewhat agree, neutral, somewhat disagree, strongly disagree) |
| 3: Current state of marine ecosystem services in the USA and the world (25 questions) | "The oceans currently produce an abundant supply of foodstuffs for human consumption in my country." (Q2S1)<br>"The oceans currently produce an abundant supply of foodstuffs for human consumption by people around the world." (Q2S2) | **Note**: Questions designed to match the four types of ecosystem services described in MA |
| 4: Willingness to support and/or engage in the conservation and sustainable use of marine ecosystem services (15 questions) | "I would be willing to pay a tax that would be used to sustain the ocean's production of seafood and other marine foodstuffs." (Q3S1)<br>"I would be willing to donate money that would be used to sustain the ocean's production of seafood and other marine foodstuffs." (Q3S4)<br>"I would be willing to engage in volunteer activities aimed at sustaining our supply of seafood and other marine foodstuffs." (Q3S7)<br>"I would be more interested in supporting companies if they also engage in activities that contribute to sustaining our supply of seafood and other marine foodstuffs." (Q3S10)<br>"I would be more interested in purchasing seafood and other marine foodstuffs if they are environmentally friendly, even if the price is higher." (Q3S13) | |

seen to be artificial and arbitrary [3]. Such systems have formed around the world through co-adaptation between humans and the landscapes surrounding them, leading to mosaic agricultural landscapes, known by a variety of different names. In Japan, for example, over the course of generations traditional communities shaped landscapes into coupled systems known as "Satoyama", which have played an important role in maintaining ecosystem services [19]. Surveys of such landscapes suggest that residents have stronger perceptions of the value of ecosystem services, which can form the basis for sustainable management activities. For the ecosystems to be better understood and managed, it is important to examine human perceptions of ecosystems and the services they provide.

With the exception of coastal areas, the world's oceans and the high seas, in particular, exist largely beyond the daily rhythms of coastal or inland communities. Still, the oceans collectively constitute the largest ecosystem and habitat for life on the planet, producing fish that provide the primary source of protein for over one billion people, and acting as the world's largest carbon sink. Despite the scale and scope of the ecosystem services provided by the oceans, estimated by Costanza et al. as over 65% of the total value of all the world's ecosystem services, efforts to evaluate the value of marine ecosystem services have been even more fragmented and piecemeal than for terrestrial ecosystem services [12,2,36,40,43,11].

Studies have found evidence for gender differences in regards to perceptions of ecosystem services, willingness to take action towards conserving resources, and commitment to environmentally-friendly activities [23,32,35,7,44]. Likewise, although studies have often concluded that gender differences exist in terms of knowledge about environmental problems, it has also been shown that increased awareness and knowledge does not necessarily translate into action [20]. Are these differences founded on daily interactions with the ecosystems in question, and would the same distinctions be evident in attitudes towards both terrestrial systems and distant marine ecosystems?

The conservation and sustainable use of ecosystems is crucial to continued human well-being, yet the optimal pathway to achieving this goal is disputed [4,33]. Internalization of negative ecosystem impacts into production activities may provide some part of the solution if suitable and mutually agreeable valuation and assessment criteria could be found and subsequently formalized into policies around the world [27]. Substantial barriers would exist, however, at each step in such a top-down process [21,9]. A bottom-up approach would entail actions taken by individuals, and could span a broad range of activities including volunteering, donating, and generally supporting what UNEP has coined the "green economy" through their consumer activities and other actions [28,41].

This study aims to explore these issues from several angles based on responses provided to a large-scale survey conducted in the USA in 2014 on attitudes towards marine ecosystem services. Despite limitations inherent in such large-scale surveys, the decision to understand broader public attitudes towards marine ecosystem services is intentional. The formation of individual public attitudes is based to some extent on the society in which the individual lives, while that society in turn is shaped by an aggregation of these individual attitudes [13].

## Materials and methods

A large-scale survey was conducted in February 2014, using an online questionnaire to collect responses from residents of the USA about their attitudes towards various aspects of marine ecosystem services. The survey was commissioned by The University of Tokyo through the marketing research company Macromill, participation was entirely voluntary, and respondents were informed that the data was being collected for research purposes aimed at better understanding perceptions of marine ecosystem services. The questionnaire was comprised of four sections as summarized in Table 1.

A total of 1684 responses were collected, and a preliminary inspection of the data was conducted, leading to the exclusion of some responses from the analysis. In these cases, respondents had provided the same answer to all of the questionnaire's five-option