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Willingness to pay for ecosystem services of open oceans by choice-based conjoint analysis: A case study of Japanese residents

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ABSTRACT

Today, greater attention has never been dedicated to the challenges of a changing climate and efforts to explore and utilize the open ocean. A range of different valuation data are needed in order to accurately assess the tradeoffs of different management regimes. Nevertheless, many aspects of the open ocean remain unstudied, and few case studies have been conducted on the valuation of the open ocean.

This study explores the monetary value of open ocean ecosystem service (OPES) using conjoint analysis. A choice experiment with 814 Japanese respondents was conducted to elicit the marginal willingness to pay (WTP) of respondents for three main OPES: fish production, carbon dioxide absorption, and water purification. The case study in Japan found a 1% marginal WTP for fish production, carbon dioxide absorption, and water purification of open oceans with respective average per capita values of USD .06, .19 and .16 per year. We also found variation across different prefecture in WTP trends for the three OPES, implying the influence of traditional food culture, mass media and natural hazards. Differences in WTP trends were also found to depend on income level and gender. The case study included respondents across five income levels. Positive correlations can be observed between marginal WTP and income levels for each of the three OPES. In addition, female respondents were found to have a higher WTP than male respondents for improving each of the three OPES. Therefore, when formulating ecosystem-based management policies related to the open oceans, it is necessary to consider differences in WTP based on region, income, gender and other relative specific factors. This will aide in consensus-building and maximizing cost-benefit outcomes.

1. Introduction

"Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors. In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible esthetic and cultural benefits as well" (Daily, 1997).

In Daily (1997) definition, both terrestrial and marine ecosystems provide a multitude of ecological functions that directly or indirectly provide benefits and economic value to humans. Proper management aims to maintain ecosystems so that they can continuously provide services into the future without their productivity diminishing. An ecosystem's generation of certain benefits, however, may have an impact on its ability to provide other benefits (McLeod and Leslie, 2009). Due to the exploitation of natural resources since the Industrial Revolution, however, a number of natural resources have largely disappeared and global ecosystem services have been depleted at unprecedented and dramatic rates, raising concerns about unsustainable management (IPCC, 2007; Maler et al., 2008; Meadows et al., 1972).

Since the 1970s, natural ecosystems have begun to be considered as a type of social per capital (Westman, 1977). Since the end of the 20th century, worldwide efforts have promoted the valuation

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and protection of natural capital and ecosystem services (Alexander et al., 1998; Costanza et al., 1997; Daily's, 1997). In an attempt to address issues of unsustainable management towards promoting social development, studies of ecosystem services have been a major topic of interest in the interdisciplinary fields of economics, ecology, environmental sciences and policy management. Efforts have mainly focused on coastal and terrestrial ecosystems, with particularly encouraging efforts towards integrated management in terrestrial ecosystems (Bateman et al., 2013; Deal et al., 2012; Manes et al., 2012; Radford and James, 2013), coastal ecosystems (Barbier et al., 2011; Costanza, 1999; Liu et al., 2010; Remoundou et al., 2009; Samhouri, 2012) and their composite elements (Mendoza-Gonzalez et al., 2012; Rodriguez et al., 2006).

In addition, fruitful international projects have promoted the mass collection of case study findings, with two of the most comprehensive efforts being the Millennium Ecosystem Assessment (MA, 2005) and The Economics of Ecosystems and Biodiversity (TEEB, 2010). The MA analyzes the state of the earth's ecosystems and it referred to nature providing indispensable “ecosystem services” to humanity as a “life-support system”. The MA considers twenty-four ecosystem services, and concludes that only four of these have shown improvement over the last half century, while fifteen are in serious decline, and five are in a largely stable condition, but under threat in certain parts of the world (MA, 2005). The assessment advanced a powerful vision for the future and its outcomes have set the direction for subsequent studies on ecosystem services (Carpenter et al., 2009; Daily et al., 2009). Ecosystem degradation and the growing costs of biodiversity loss are the major concerns of TEEB. A prominent contribution of TEEB is the publication of summaries and guidelines that can help decision-makers recognize and demonstrate the values of ecosystems and biodiversity, and which include suggestions on how to incorporate these values into decision-making (TEEB, 2010). Despite the contributions by these projects on a global scale, they share a common shortcoming, as both have considerable limitations in their evaluation of OPES. The lack of assessments focused on the open oceans has also been noted by the “Trans-boundary Waters Assessment Program” of the Global Environment Facility (GEF, 2011). Similarly, gaps in data availability are also evident in the “Ecosystem Services Valuation Database” (ESVD) (Van der Ploeg and de Groot, 2010). In the 1310 data estimates included in the ESVD, only 11 refer to the open oceans, while the remainder all focus on coastal areas (including coastal wetlands, coral reefs and other biomes) and terrestrial areas. A review of the supplemental information provided by ESVD shows that all the data for the open oceans was estimated using alternative methods.

The international community is undertaking a number of different assessment efforts. The United Nations World Ocean Assessment, for example, has taken a leading role and provided an “Outline for the First Global Integrated Marine Assessment”, which set a clear direction for future assessment research (www.worldoceanassessment.org). Over 70% of the planet is covered by oceans and seas, of which over 60% can be considered open oceans. Many of the world's coastal areas have not been protected until the point of over-exploitation has been surpassed for mineral and biological resources. At the same time, human influence on open ocean ecosystems has continued to expand, and has even accelerated for certain services that have been under management for an extended time period (Doney, 2010; Worm et al., 2006). The ocean's provisioning services, specifically in terms of food, are the most widely studied OPES, and some studies have argued that degradation has occurred over the past fifty years due to direct catch activities (Myers and Worm, 2003; Pauly et al., 1998) and indirect climate change impacts (Cheung et al., 2013; Perry et al., 2005). Human activities in terrestrial areas have also impacted marine environments, ultimately contributing to an increasing rate of global climate change (IPCC, 2007; Kroeker et al., 2012; Wu et al., 2014). Such changes are transferred to the open oceans and accumulate over decades or even centuries through biogeochemical cycles (Doney, 2010; Doney et al., 2009). A variety of changes in ecosystem services can therefore ultimately feed back into human economic activities (Stern, 2007; Tol, 2009). Geoengineering[1] measures have been repeatedly proposed to take the initiative in mitigating such impacts (Keith, 2000; MacMynowski et al., 2011).

Ecosystem-based management has heralded broader usage of economic valuation of ecosystem services to balance the multiple benefits provided by ecosystems (Bermas-Atrigenio and Chua, 2013; Katsanevakis et al., 2011). In order to achieve both the development and protection of open oceans, it is necessary to understand the monetary value of range of ecosystem services as well as the trade-off relationships among them (Bateman et al., 2013; Murillas-Maza et al., 2011).

At the same time, it's already known that people living in different countries and areas are associated with different cultural norms that influence their readiness to engage in volunteer activities (Aydinli et al., 2013) or to donate money to support specific measures (Braun et al., 1999). At the same time, income and gender differences have also been found to influence donation activities (Baumgärtner et al., 2012; Musick and Wilson, 2007). This study seeks to deepen understanding of such influences on Japanese residents and their intentions to engage in marine conservation activities.

Drawing on the findings presented above, we hypothesize that even for the same ecosystem service, different focus groups will share different perceptions of value, and these differences should be considered when making relevant management policies. The study evaluates OPES in the case of Japanese residents to elicit their marginal willingness to pay (WTP) using environmental assessment techniques. In the next step, the degree to which marginal WTP is influenced by different factors, including location, gender and income level, is assessed. Possible reasons for the study's findings are likewise presented along with relevant data and information. Finally, the applicability and possible contributions of this type of research to open ocean governance mechanisms are assessed.

Environmental valuation is divided into two categories: revealed preference and stated preference. Revealed preference is calculated, for example, with the travel cost method or hedonic price method,[2] based on the environmental value reflected in existing market data. Stated preference, as calculated using the contingent valuation method or conjoint analysis, is not based on market data, but instead reveals environmental value based on answers provided by beneficiaries through questionnaires (Hanley et al., 2013; Kolstad, 2011). The latter is more suitable for evaluating OPES, which, aside from food services, are often ignored as market externalities (Costanza et al., 1997; Daily, 1997). Due to the research aim of identifying marginal WTP for three representative OPES, conjoint analysis is considered more appropriate than contingent valuation since it not only allows for direct comparison of various policy alternatives in a single questionnaire, but also reveals the valuation of each service.

[1] A deliberate action aimed at modifying the Earth's environment on a massive scale. Space mirrors, sulfur-spraying in the stratosphere, cloud seeding and iron fertilization for oceanic carbon sequestration are often introduced (Shepherd, 2009).

[2] The travel cost method refers to the use of travel expenditures incurred in moving to the site as a proxy for the price paid by visitors for a visit (Smith, 1989). The hedonic pricing method assesses how ecosystem services or environmental goods affect market prices to generate estimates of their economic value (see more details on: http://www.ecosystemvaluation.org/hedonic_pricing.htm).