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From coast to coast: Public perception of ocean-derived benefits in Canada



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ABSTRACT

The ocean provides many benefits, such as food provision, tourism opportunities, and coastal protection, to people around the world. To manage ocean uses in a sustainable way, managers need to limit some activities, but which benefits are most important to preserve? To answer this question, an opinion survey of 2000 Canadians was conducted, combining a best-worst scaling experiment and a Likert-scale choice instrument, to determine their perception of 10 ocean-derived benefits. Both approaches showed that 'Clean Waters' is highly important across all Canadians. The importance of other benefits such as 'Food Provision' and 'Biodiversity' varied with respondent age, political affiliation, and/or seafood-eating frequency. A majority (83%) of Canadians favoured non-extractive over extractive benefits. This case study demonstrates how survey approaches can reveal the values and preferences of the general public and provide an inclusive means to help managers align environmental policies with public priorities.

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1. Introduction

The continued provision of ecosystem services has become a prominent argument for environmental conservation [8,10,38]. Ecosystem services are the benefits people derive from nature. These range from marketable products (e.g., seafood, timber) to supporting functions (e.g., climate regulation, coastal protection, nutrient cycling) and non-material benefits (e.g., recreational, spiritual and aesthetic values) [30]. The benefits of multiple ecosystem services can rarely be maximized simultaneously by any single management scenario [26,32]. For example, maximizing the economic benefit of capture fisheries in the ocean is viewed as incompatible with maintaining the existential value of biodiversity or the cultural value of customary practices that depend on commercial species. The trade-offs involved in optimizing the delivery of multiple ecosystem services lie at the heart of ecosystem-based management (EBM), which is held as the most promising strategy

for sustainable ocean management [29].

While successful EBM must be based on scientifically sound information, it must also incorporate the views of stakeholders who may hold divergent opinions about the importance of various ecosystem benefits [3,17,25]. In marine conservation, these conflicting views have commonly pitted well-organized proponents of extractive activities against diffusely organized groups that favour non-consumptive benefits [5,24]. In some cases, the result has been rejection of proposals to close marine areas to extraction because of opposition by a minority of stakeholders (e.g., [6]). Arguably, the values of all users should be considered when developing management options, to reduce conflict and increase support and compliance (e.g., [15,38]). At a societal level, an inclusive approach is necessary because environmental policy change does not succeed without public interest [31]. In this respect, large-scale, representative surveys offer a better opportunity to estimate the preferences of the general public than limiting consultation to a few stakeholders or to expert opinion (e.g., [19,36]).

There are many ways to unravel stakeholder preferences for ocean-derived benefits. Formal participatory processes or public hearings can generate qualitative information regarding stakeholder opinions. However, quantitative social science methods can provide a more objective evaluation of stakeholder attitudes.

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Multivariate stated-preference methods, such as discrete choice experiments (DCE), can capture the trade-offs stakeholders are willing to make among alternative options [28]. In DCEs, individual preferences are elicited based on the decisions that individuals make when choosing between different hypothetical options described by their attribute levels [28]. One type of DCE that allows to estimate the utility (i.e., importance) of attributes themselves across all levels is best-worst scaling (BWS) [13,14]. In BWS experiments, respondents repeatedly indicate the most and least preferred attributes from a series of subsets of all attributes. By forcing respondents to reveal only their extreme preferences, BWS avoids the problem of respondents discriminating poorly among attributes of middling importance [14]. BWS experiments have been used to address conservation questions, e.g. to elicit preferences for management options for farmland (e.g., [16,23]), forests [27], and fisheries [11], and to reveal concern for environmental issues affecting lakes [2].

The aim of this study was to estimate the relative importance of different ocean-derived benefits to the Canadian public. We focus on Canada because its federal government has been criticised for its poor record at sustaining marine biodiversity over the past two decades [1,21]. In particular, progress in establishing marine protected areas (MPAs) has been slow [21]. Therefore, this study examined whether the apparent implicit government policy that favours extraction over conservation reflects the values of the Canadian public. Ten ocean-derived benefits were considered (Table 1), which corresponded approximately to the 10 goods and services considered in the Ocean Health Index [18] but were customised to reflect a Canadian context. Two approaches were used: a Likert 5-point importance question and a complementary BWS experiment, to measure the importance accorded to each benefit by a broad sample of 2000 Canadians distributed from the Pacific to the Atlantic coasts. Latent-class analysis was used to identify cohorts of respondents with similar attitudes and examine the socio-economic and attitudinal predictors of cohort membership.

2. Methods

2.1. Opinion survey

To evaluate the public perception of benefits provided by the ocean, a market research company (ResearchNow; www.researchnow.com) was used to distribute an online survey to a representative cross-section of Canadians in each of five regions ($n \geq 400$ respondents per region): British Columbia (BC), the Prairies (PR; Alberta, Saskatchewan and Manitoba), Ontario (ON), Quebec (QC), and the Atlantic provinces (AT; New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland). There were not enough potential respondents residing in Canada's northern

territories in the database to include this region.

Our survey requested information on: (1) basic demographics: age, income, education, household size, gender, and location; (2) potential indicators of ocean-related ideology: frequency of seafood consumption, participation in marine-based employment and recreational activities, membership to an environmental organization (ENGO), and participation in environmental protests; and (3) the perceived importance of 10 ocean-derived benefits, which are based on the goods and services considered in Halpern et al. [18].

The perceived importance of these 10 ocean-derived benefits was measured with two complementary methods. Respondents were first asked to read the definition of each benefit (Table 1) as part of a learning exercise and rate the importance of each benefit on a Likert scale (1 – “Not Important” to 5 – “Very Important”). The respondents were then presented with 10 unique sets of five benefits (Table S1) and asked to identify which benefit in each set was the most and least important to them (Fig. S1).

2.2. Analysis

Likert-scale scores for each ocean benefit were compared with a Kruskal-Wallis rank sum test and Nemenyi-Tests were used for pairwise multiple comparisons.

We conducted latent-class analysis (LCA) in Latent GOLD v5.0 to analyse BWS responses. A one-class model was first fitted, which allowed the calculation a mean utility score for each ocean benefit that was interpreted as its relative importance across all respondents. A two-class model was then fitted to reveal any clustering of similar responses and identified important demographic and attitudinal covariates of class membership. Using ≥ 3 latent classes slightly improved model fit, but the additional classes were intermediate between those identified in the two-class model and did not improve interpretability.

To estimate the relative importance of the benefits for each individual, a logit model was used, similar to the one underpinning the Latent GOLD, on the BWS responses of each respondent. The means of individual-level importance estimates were equivalent to those of the one-class model. Generalized Linear Models (GLM) were used to determine which of the demographic/attitudinal variables affected the importance of each benefit, as measured by the logit parameter estimates. Normality and homogeneity of variance were confirmed using multivariate Shapiro-Wilk's test from the MVN package for R [24]. Tukey's post-hoc comparisons were used to identify significant categorical variables, and the slope of linear relationships between continuous variables were reported (Table S2). To visualize relative effect size of the demographic/attitudinal factors on each of the benefits, Cohen's d was calculated from the GLM tables [7].

Finally, extractive benefits (i.e., Food Provision, Aboriginal

Table 1
Definitions of 10 ocean-derived benefits, as presented in a survey of public perception among Canadians.

Benefit	Definition
Food Provision	The amount of fish and seafood we can extract sustainably from our oceans
Aboriginal Needs	The extent to which Canada's Aboriginals are able to access ocean resources for subsistence, social and ceremonial purposes
Natural Products	The amount of non-food products we can harvest sustainably from our oceans to make, for example, pharmaceutical products, fertilisers, jewellery, etc.
Carbon Storage	The extent of coastal habitats, like seagrass beds and marshes, we have that help remove atmospheric carbon that would otherwise contribute to climate change
Coastal Protection	The extent of coastal habitats, like kelp and seagrass beds, we have to break wave action and protect coasts during storms
Coastal Livelihoods	The number of people employed in and the revenue generated from marine-related industries (such as fishing and tourism, for example)
Tourism & Recreation	The number of people (both local and tourists) that take part in recreational activities on the coast
Iconic Places & Species	The health of and level of protection given to species and places that are particularly special to Canadians
Clean Waters	The cleanliness of our coastal waters, that is, how free of trash, chemicals, disease, agricultural effluent they are
Biodiversity	The extent to which the variety of marine life in Canada is being maintained

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