Social Indicators Research (2019) 149:347–374
https://doi.org/10.1007/s11205-019-02239-0

ORIGINAL RESEARCH

Parallel Subjective Well-Being and Choice Experiment Evaluation of Ecosystem Services: Marine and Forest Reserves in Coastal Oregon, USA

Kreg Lindberg[1] · **Tommy Swearingen**[2] · **Eric M. White**[3]

Accepted: 1 December 2019 / Published online: 7 December 2019

Abstract

There is significant policy and research interest in (a) ecosystem services as a framework for understanding the benefits humans receive from natural systems and (b) subjective well-being as a lens for understanding the effects of public policy decisions. The present study occurred at the intersection of these two fields. Choice experiment and contingent subjective well-being (SWB) models were estimated to understand the potential effects of coastal marine and forest reserves in Oregon, USA. Both models indicated heterogeneity in effects across groups defined by environmental worldview and, for marine reserves, recreation use of reserve areas and employment in the commercial fisheries sector. Methodologically, results suggested that a similar process underlays responses to both types of survey task, with similar model coefficient patterns and frequent consistency in responses. However, differences also were indicated, and differences may be more pronounced in other studies, such as those involving between-subject designs. Contingent SWB is a potentially important measurement approach, but further evaluation is needed, including with respect to the effects of task complexity and evaluation object salience.

Keywords Subjective well-being · Choice experiment · Ecosystem services · Protected areas · Passive-use or non-use value · Environmental attitude and worldview

✉ Kreg Lindberg
Kreg.Lindberg@osucascades.edu

[1] Department of Forest Ecosystems and Society, Oregon State University – Cascades, 1500 SW Chandler Avenue, Bend, OR 97702, USA

[2] Oregon Department of Fish and Wildlife, Newport, USA

[3] USDA Forest Service, Pacific Northwest Research Station, Olympia, USA

1 Introduction

There is significant policy and research interest in ecosystem services, defined broadly as the benefits that flow from nature to people.[1] These benefits typically are measured using various metrics of human well-being (Breslow et al. 2016; King et al. 2014), including monetary metrics such as willingness-to-pay. There are substantial theoretical and empirical foundations for monetary metrics, but also concerns regarding nonmarket monetary valuation and sometimes distrust of monetary valuation generally (Hysing and Lidskog 2018; Milner-Gulland et al. 2014).

There also is significant interest in subjective well-being (SWB), which reflects how people experience and evaluate their lives in general and specific domains of life in particular, with domains representing life components such as social relationships or financial status (Stone and Mackie 2013). Relative to monetary measures, SWB more directly reflects human well-being (the central focus of ecosystem service assessment) and avoids concerns about monetary trade-offs and incommensurability in the stated preference tasks often used for monetary valuation. Thus, SWB approaches may represent a useful complement to monetary approaches in understanding ecosystem services and other goods and services (Kenter et al. 2016; Loewenstein and Ubel 2008; Stone and Mackie 2013, p. 78).

The primary objective of this study was to evaluate the potential effect of protected area designation using both monetary and SWB approaches, with particular focus on heterogeneity in the effects of such designation. A relatively novel "contingent SWB" method was used because more traditional SWB methods are not well-suited for assessing passive-use benefits potentially generated by protected area designation. People may value, and benefit from, the existence of a protected area and the ecosystem it preserves even if they never visit the area. This is known as passive-use or non-use value.

Due to the novelty of the contingent SWB approach, a secondary objective was to assess consistency between that approach and a parallel choice experiment task. Because of that methodological orientation, the literature review provides background on methods and previous evaluation of consistency.

Researchers have applied monetary and broad well-being approaches to ecosystem services in general and protected areas in particular. For example, Dallimer et al. (2014) used choice experiments to measure (a) willingness-to-pay for biodiversity enhancement at urban green spaces and (b) self-assessed psychological gains in well-being from visits to those areas in their current form.

However, the present study appears to be the first assessment of potential evaluative SWB (life satisfaction) effects of non-urban protected areas, in this case marine and forest reserves in the Oregon, USA, coastal region. In addition, the present study used the same evaluation objects across the choice and SWB tasks.

[1] We take a broad view of ecosystem services, one that includes passive-use values and benefits (Wainger et al. 2018).

2 Literature Review

2.1 Ecosystem Services and Protected Areas

The conservation of natural areas in the form of national parks, national forests, and similar protected area designations represents one approach to sustaining ecosystem services. Of particular interest here were non-urban protected areas and systems of such areas, rather than city parks or other urban or peri-urban areas. Within this focus, examples of monetary evaluation include the Jobstvogt et al. (2014) evaluation of recreationist willingness-to-pay for marine protected areas in the United Kingdom and the Wallmo and Kosaka (2017) evaluation of general population willingness-to-pay for marine protected areas on the West coast of the United States.

Designation and management of protected areas can generate diverse effects on human well-being (Naidoo et al. 2019; Stolton et al. 2015), with many effects being positive but others being negative (Ban et al. 2019; McNeill et al. 2018). One reason for the diversity of effects is that designation and management may change the distribution of ecosystem services across service type (e.g., decrease in provisioning services, such as seafood or timber harvest, and increase in benefits associated with passive-use values) with concomitant change in distribution across individuals or groups. Moreover, well-being effects may depend on factors beyond the direct change in ecosystem service distribution (McNeill et al. 2018).

Therefore, it is important to assess heterogeneity in the effects of area designation and management. Wallmo and Edwards (2008) illustrated a latent class choice experiment approach, in which multiple segments (classes) were identified by the software during model estimation, with segments differing in model parameters and associated willingness-to-pay for the evaluated attributes. In that study, segments were created based on respondent ocean-oriented employment ties, as well as attitudes toward environmental conservation and economic growth. The segments varied in their willingness-to-pay for increasing the size of the marine protected area system in the northeastern United States; a potential increase in system size would generate benefits for some respondents and losses for others.

An alternative approach is illustrated by Aanesen and Armstrong (2019), who used separate models to assess rural–urban heterogeneity, as well as interaction terms to assess demographic heterogeneity, with respect to preferred size of protected areas for cold-water coral in Norway. Differences across these categories were modest in that case.

Studies such as the above provide a foundation for understanding the potential ecosystem service benefits of protected areas in a monetary metric. There is less of a foundation for understanding them in a SWB metric. As a complement to the Jobstvogt et al. (2014) monetary evaluation of marine sites, Bryce et al. (2016) reported on marine recreationist level of agreement with multiple indicator statements, such as "I have made or strengthened bonds with others through visiting these sites" and "I feel a sense of belonging in these sites." However, Bryce et al. (2016) focused on one type of protected area benefits (recreation) and used a broader conception of SWB than those illustrated by Appendix A in OECD (2013). The present study contributes to this SWB foundation by using a "standardized" SWB measure, covering potential benefits beyond in situ recreation, and assessing benefit heterogeneity.

2.2 Monetary and Subjective Well-Being Methods

2.2.1 Monetary Evaluation of Ecosystem Services

In economics, market transactions provide a basis for assessing value, but people may value goods and services that are not purchased in markets; this has led to two categories of nonmarket valuation techniques. Revealed preference (indirect) methods infer benefits from consumption choices about related goods. However, not all ecosystem services can be assessed with such methods due to the lack of associated markets or observed behavior. Specifically, benefits associated with passive-use are not amenable to measurement using indirect methods (Boxall et al. 2012; Flores 2017), yet such benefits may represent important components of ecosystem services derived from protected areas. For example, in their study of marine protected areas in the northeastern United States, Wallmo and Edwards (2008) found that approximately 80 percent of respondents agreed with the statement: "I like knowing that part of the ocean in the Northeast Region is protected even if I never see or use it" (see also Wainger et al. 2018).

Stated preference methods, which rely on direct questioning, typically are used when relevant markets are unavailable.[2] For example, dichotomous choice contingent valuation involves respondent choice between the status quo and a hypothetical scenario that includes both a good and a price for its provision. Choice experiments commonly involve respondent choice across a status quo option and one or more change options comprised of attributes with levels that vary systematically based on an experimental design. Contingent valuation *scenario*, choice experiment *alternative* or *option*, and subjective well-being *vignette* are treated here as similar terms representing descriptions of hypothetical situations that stimulate self-reported responses. Champ et al. (2017) describe nonmarket valuation techniques, while Bishop et al. (2017) and Wallmo and Kosaka (2017) illustrate stated preference applications.

2.2.2 SWB Evaluation of Ecosystem Services

SWB measures can be categorized as evaluative (satisfaction with life overall and life domains), eudaimonic (flourishing), and affect (experienced, happiness at specific time periods) (OECD 2013). Although the SWB approach can be used to estimate willingness-to-pay (Frey et al. 2010; Fujiwara and Dolan 2016), the present focus is on the native SWB metric.

As with monetary approaches, SWB assessment of ecosystem services or other evaluation objects can be conducted through approaches categorized as indirect or direct. The indirect approach commonly uses secondary data to cross-sectionally and/or longitudinally correlate SWB with potential predictors. Fujiwara and Dolan (2016) describe indirect approaches, with a focus on their connection to monetary valuation, while Welsch and Ferreira (2014) describe applications in the context of ecosystem services.

However, regions vary in the availability of secondary data for indirect analysis. Even in Europe, with relative data abundance, it may not be possible to evaluate ecosystem services at small spatial scales (Kopmann and Rehdanz 2013, p. 29). In addition, analysts may

[2] Stated preference and direct nonmarket valuation are used synonymously here. In some classifications, contingent valuation and choice experiments are viewed as direct and indirect methods, respectively, within the stated preference category (Tietenberg and Lewis 2020, p. 79).

be interested in evaluating the potential SWB effects of ecosystem services beyond those experienced to date.

Moreover, it may not be possible to use available data and indirect approaches to estimate SWB benefits associated with passive-use.[3] For example, proximity to either the Arctic region or the Amazon basin may be inadequate predictors of potential SWB benefits from knowing that polar bears or the Amazon rainforest exist. More broadly, important predictors of SWB may be unavailable or collinear, and there is uncertainty about causality due to the correlative nature of the analysis (Fujiwara and Dolan 2016; Lawless and Lucas 2011; Stone and Mackie 2013).

Some, but not all, of these limitations may be overcome via primary data collection. Primary data were used by Wolsko et al. (2019) to understand the contribution of nature-based recreation to SWB, and by Tsurumi and Managi (2015) to assess the contribution of green spaces.

Longitudinal SWB measurement using the experience sampling method may be correlated with the experience of evaluation objects (MacKerron and Mourato 2013; Stone and Mackie 2013). That approach is limited to existing evaluation objects, potentially constrained forms of interaction and benefits associated with the objects (e.g., recreation and aesthetic benefits but not necessarily passive-use benefits), and potentially constrained SWB metrics (e.g., affect SWB may be more suitable than evaluative or eudaimonic). Reliance on affect SWB may be limiting both because the sum of affective experiences may represent only one factor in well-being (Kahneman and Sugden 2005, p. 176) and because reporting of affective experiences may depend on personality (Seligman 2011, p. 239).

The direct method is an alternate approach that uses self-reports in response to vignettes, either retrospectively (perceived SWB change due to past occurrence of the evaluation object) or prospectively (predicted SWB change contingent on the evaluation object occurring). One contingent SWB technique is for analysts to (a) elicit the respondent's baseline (current) SWB, (b) present a vignette "event" (e.g., change in the size of a protected area or system of areas), and (c) elicit the respondent's new SWB contingent on the vignette occurring.

Loewenstein and Frederick (1997) illustrated a variation on this, in which respondents reported baseline evaluative SWB followed by predicted SWB change in the next 10 years, on a seven-point scale from "decrease by a large amount" to "increase by a large amount." Assessed vignette events included rain forest loss, restricted sport fishing due to pollution, and recovery of endangered species.

More recently, Benjamin et al. (2014) used contingent SWB in the context of residency choices amongst students graduating from medical schools in the USA. In addition, Gallup assesses contingent SWB in their Gallup-Healthways Well-Being Index with a forecast of evaluative SWB five years into the future (Harter and Gurley 2008; Kapteyn et al. 2015). In that case, the affective forecast is across time, with respondents presumably also forecasting likely events that would affect their well-being.

[3] A literature search for subjective well-being (or life satisfaction or happiness) and various terms relevant to passive-use benefits (e.g., passive-use, non-use, and existence values) did not identify any literature on the topic. Responses for some evaluation objects in Loewenstein and Frederick (1997), which involved a direct approach, presumably reflect passive-use benefits; other examples from the literature may exist without appearing in response to these specific search terms.

2.2.3 Consistency Between Choice Experiment and Contingent SWB Approaches

Monetary and SWB approaches represent two broad categories of approaches. Within each there are indirect and direct approaches. Indirect approaches typically are preferred, but they may (a) be unavailable for the ecosystem service being evaluated or (b) involve other limitations that raise concerns (e.g., lack of data on relevant predictors). These limitations motivate direct approaches (e.g., contingent valuation, choice experiment, and contingent SWB), but direct approaches rely on responses to hypothetical vignettes and affective forecasting—the prediction of how one will feel in response to a stimulus. This reliance also raises concerns.

For example, underestimation of adaptation to the vignette object may lead to overstatement of SWB effects. Indeed, respondents may focus on the well-being effects of transition to a new state (e.g., an expanded protected area system) rather than the effects of the new state itself, after adaptation to that state (Kahneman and Sugden 2005).

The focusing illusion also may lead to overstatement of SWB effects because respondents may focus “disproportionately on, and thus exaggerate the importance of, things that would change in the future while ignoring things that would remain the same” (Ubel, Loewenstein, and Jepson 2005, p. 112); Kahneman and Sugden (2005) note that this can be a particular issue for environmental amenities, on which respondents may focus more intensely in questionnaire vignette contexts than in daily life. In addition, respondents may inaccurately predict their future tastes and preferences and thus the utility associated with the vignette object (Loewenstein and Schkade 1999).

Subsequent studies have led some to temper concerns arising from early SWB analyses (Lucas 2016; Wolfers 2018). In addition, studies with unexpected results may be more likely to be published than those with expected results (Loewenstein and Frederick 1997). Nonetheless, these concerns indicate a need for further evaluation and methodological refinement to more fully understand the accuracy of SWB prediction and whether inaccuracies can be sufficiently minimized to provide useful results.

One evaluation approach involves gauging consistency between choice and SWB. In their foundational study, Benjamin et al. (2014) evaluated two aspects of consistency between medical residency choices and contingent (anticipated) SWB. Choices reflected each respondent’s top four residency programs as submitted to the national resident matching program. For example, the most preferred program might be anesthesiology at Hospital A, the second most preferred might be at Hospital B, and so on. The authors separately regressed choice rankings and SWB rankings on respondent self-reported beliefs about residency program attributes, such as program prestige and social life while participating in the program. They found that the ratios of coefficients across program attributes (the marginal rates of substitution) varied across the dependent variables modeled (actual choice, contingent affect SWB during residency, contingent evaluative SWB during residency, and so on).

Benjamin et al. (2014) also pairwise compared choice with SWB rating. For example, if a respondent ranked the Hospital A program over the Hospital B program in the choice context, did the respondent report higher contingent SWB for the Hospital A program? With respect to evaluative SWB, in 59% of the pairs the respondent reported higher SWB for the more highly ranked program, in 23% of the pairs the respondent reported the same SWB, and in 18% of the pairs the respondent reported higher SWB for the less highly ranked program.

In sum, Benjamin et al. (2014) found mixed indications of consistency. The present analysis continues such evaluation in a context that differs in various ways, including with respect to the vignette object and its salience, the nature of the choices, and the consistency evaluations conducted. The present analysis is presented as informative, but not as a formal evaluation of validity, for two reasons.

First, substantively, inconsistencies may reflect inherent differences in the approaches, rather than flaws in either. Insofar as choices reflect respondent prediction of relative well-being effects across choice options, one might expect consistency between choice and contingent SWB responses. However, choices may be made using criteria other than maximizing SWB (Adler et al. 2017), and, specifically, other than maximizing the respondent's individual SWB (Benjamin et al. 2014, p. 3526).[4]

Second, methodologically, a within-subjects design was used due to budgetary constraints. Thus, the degree of consistency found in this analysis may be thought of as an "upper bound" (Benjamin et al. 2014).

2.3 Research Questions

The following research questions were addressed.

1. Are the willingness-to-pay and SWB effects of expanding or reducing the area of marine and forest reserve systems heterogeneous across groups defined by recreational use of reserves, employment in the commercial fishing sector, and environmental worldview?

Based on relevant literature (e.g., McNeill et al. 2019; Wallmo and Edwards 2008) and anecdotal perspectives expressed in the study region, we expected a negative correlation between (a) system area and (b) willingness-to-pay and SWB effects among recreational fishers and participants in the commercial fishing sector. In general, we expected a negative correlation between (a) and (b) among respondents high in anthropocentrism, and a positive correlation among respondents high in connectedness to nature. We did not have directional expectations with respect to respondents engaging in other forms of recreation or respondents with matched combinations of anthropocentrism and connectedness to nature (e.g., high, low, or moderate in both).

2. As the first measure of consistency, are coefficient significance, sign, and relative magnitude similar across choice and SWB models?

This aspect was exploratory, though we treated cost as the "starting point" numéraire for evaluation of relative magnitude.

[4] There may be additional substantive reasons for differences across methods. For example, choice experiment and dichotomous choice contingent valuation tasks commonly involve choice across the status quo and vignettes, whereas contingent SWB may require estimating the magnitude of SWB change in ordinal or interval terms. Differences in task familiarity and difficulty may affect relative cognitive demands, feeling of fluency, and use of System 1 (intuition) relative to System 2 (reasoning) processes during task completion (Dhar and Gorlin 2013, p. 532). Moreover, there may be aspects of choices, such as "yea saying" and a responsibility effect, that lead to differences between choice and SWB tasks (Loewenstein and Frederick 1997, pp. 68–69).

3. As the second measure of consistency, are respondent selections of options in the choice experiment consistent with reported SWB changes across the same set of options?

This aspect also was exploratory, with allocation into consistency categories based on criteria described below.

3 Methods

3.1 Study Context

The questionnaire contained both choice experiment and SWB tasks and was administered in 2017 to coastal residents in the state of Oregon, USA. The Oregon coast is generally rural in character, with the most populous community, Coos Bay, having a 2017 population of 16,615 (Portland State University Population Research Center 2018).

The questionnaire included questions related to regional marine and forest reserves, with more coverage of the former. In 2012, Oregon designated five marine reserves in its territorial sea, with variation in sub-designation (marine reserve and marine protected area) and related use. We considered forest reserves to be federal land in the Coast Range that is Congressionally-designated wilderness, areas administratively withdrawn from resource extraction, and late successional reserves designated under the Northwest Forest Plan (Garber-Yonts et al. 2004). These forest lands currently have little or no resource extraction and are managed with a goal of enhancing biodiversity values. Marine and forest reserves are spread unevenly along the coast, but there is some area of each type in each of the broad north, central, and south coast regions. Because the fishing and wood products industries are important coastal economic sectors, policy changes related to these reserves can affect the distribution of ecosystem services across stakeholders.

3.2 Survey Method and Measures

The project sampling frame was comprised of Oregon driver license or identity card holders 18 years old or older with postal addresses located in the coastal counties (Clatsop, Tillamook, Lincoln, Coos, and Curry) or in the coast postal code areas of partly-coastal counties (Lane and Douglas). A random sample of names and mailing addresses was drawn from this sampling frame.

The questionnaire was developed and refined through a multi-step process that included an in-person “think out loud” evaluation, two sequential mixed mode (mail and online) pilots, and a final mixed mode administration. Responses during the second pilot were included in the final data set because only modest changes were made across those two administrations. During the second pilot and final administration, residents were sent an invitation letter, a reminder letter approximately 1 week later, and a final reminder approximately 3 weeks later.

The invitations included a request for the adult in the household with the most recent birthday to complete the questionnaire, which could be done in either online or paper format. The questionnaire included a map showing marine reserve location, size, and regulations. The response rate was a combined 17% for invitations sent in the second pilot and final administration phases. More than half the completed questionnaires (59%) were submitted online. The data were weighted by respondent age, household income, and geography to be representative of the coast region, based on US Census data and the sampling frame distribution across postal codes. There remains the inherent limitation in survey samples that weighting may not fully correct for differences between respondents and non-respondents.

Several questions were used to prepare respondents for the choice experiment and SWB tasks (Lindberg and Wolsko 2019). These questions covered past recreation visits to marine reserves and other coastal areas, awareness of marine reserves, evaluation of changes due to marine reserves, preferences for future reduction or expansion of marine and forest reserves, and importance of reducing or expanding marine and forest reserves relative to four other potential coast policy priorities. Such prioritization across vignette attributes and other priorities may help reduce the focusing illusion.

"The Appendix" contains questionnaire wording for examples of the choice and SWB tasks, including introductory text that provided context and described current conditions. Each respondent completed one choice task followed by contingent SWB tasks for each of the two "change" options in the choice task.

3.2.1 Attributes and Non-attribute Predictors

The choice and SWB tasks both involved vignettes with options comprised of four attributes: marine reserve area (MR), forest reserve area (FR), additional annual cost per household (Cost), and change in the number of coast-wide jobs in the fishing and timber sectors (Regional Jobs). Table 1 shows attributes and their levels, of which there were four for Cost and three for the other attributes.

The marine and forest reserve attributes reflected project sponsor information needs and the goal of applying the contingent SWB approach in an ecosystem service context. Ideally, the attributes would reflect outcomes, such as variation in species viability, but there was uncertainty regarding the link between management actions (e.g., reserve area, location, and use regulations) and such outcomes. Therefore, the attributes reflected reserve area aggregated across the coast (Wallmo and Kosaka 2017). Reserve area attribute levels included decrease, no change, and increase.

Household cost was used to calculate willingness-to-pay. The regional jobs attribute was included due to public concern about the loss of jobs in natural resource sectors in the region. Feedback during the pilot phases indicated that some residents viewed reserve size and number of regional jobs as strongly negatively correlated (i.e., that larger reserves mean fewer jobs). However, employment in natural resource sectors depends on many factors, not simply reserve size, and attributes should be statistically independent in experimental designs to assess their respective contributions to choice and SWB. That context motivated inclusion of explanatory text about other factors that affect job numbers.

The attributes were the core of the choice and SWB models, but responses were potentially affected by non-attribute predictors, which are described in Table 2. Past research indicates the potential importance of predictors that reflect environmental worldview and employment in industries whose access to natural resources is potentially affected by protected area designation and management. Likewise, designation and management may affect people who recreate in the area, with effects dependent on management actions and public perceptions of them. For example, management actions may increase interpretive material and the broader quality of the experience for some recreation activities. Conversely, actions may decrease access for other recreation activities.

Table 1 Attributes and their levels[a]

Attribute	Level 1	Level 2	Level 3	Level 4
MR—marine reserve area, in percent of territorial sea and percent change from current	4.5% (50% decrease)	No change	13.5% (50% increase)	
FR—forest reserve area, in percent of coastal forests and percent change from current	5% (50% decrease)	No change	15% (50% increase)	
Cost—annual cost increase per household, in dollars	No additional cost	50	200	500
Regional Jobs—change in number of fishing and timber jobs in the coast region	−500	−100	No change	

[a]Four levels were used for the Cost attribute; three levels were used for the other attributes. Each choice option included all four of the attributes, as illustrated by the graphical image above Question 9 in "Appendix". The level presented for each attribute in each option was based on a fractional factorial experimental design created in Ngene software. Additional discussion of the attributes is provided in Sect. 3.2.1

Table 2 Non-attribute predictors[a]

Variable	Description and item wording	Mean	Standard deviation
The MR Evaluation variable was the mean of following five items; for each item, respondent feels that changes in the item due to current marine reserves are 1 = very negative to 7 = very positive for self and household			
	Reduced opportunities for commercial or charter fishing (including shellfish)	3.78	1.65
	Reduced opportunities for recreational fishing (including shellfish)	3.61	1.64
	Increased conservation of the marine environment	5.07	1.69
	Change in community jobs/income	3.93	1.57
	Change in character of the community	4.07	1.63
Environmental worldview clusters were formed based on K-means cluster analysis of the following items (see Sect. 3.2.1 in the narrative), 1 = strongly disagree to 7 = strongly agree; the first five items reflect connectedness to nature, the second five anthropocentrism			
	I feel that all inhabitants of Earth, human and nonhuman, share a common "life force"	5.22	1.80
	I think of the natural world as a community to which I belong	5.54	1.49
	I often feel a kinship with animals and plants	5.21	1.69
	I often feel a sense of oneness with the world around me	4.86	1.61
	Like a tree can be part of a forest, I feel embedded within the broader natural world	4.86	1.62
	The main reason to protect the environment is to conserve fish, timber, and other natural resources for future human benefit	4.85	1.86
	Nature is important mostly because of what it can contribute to human well-being	4.63	1.91
	The main goal of natural resource management should be to provide a stable flow of resources to sustain jobs and local communities	4.77	1.70
	Natural resource management should focus primarily on benefits to humans	3.53	1.68
	Plants and animals exist primarily for the benefit of humans	3.09	1.90
The following variables (1 = respondent in cluster, 0 = not in cluster) arose from the environmental worldview cluster analysis			
High-Low	High in anthropocentrism, low in connectedness to nature, 10% of respondents		
Low-High	Low in anthropocentrism, high in connectedness to nature, 21% of respondents		
High-High	High in anthropocentrism, high in connectedness to nature, 29% of respondents		

Table 2 (continued)

Variable	Description and item wording	Mean	Standard deviation
Low-Low	Low in anthropocentrism, low in connectedness to nature, 8% of respondents		
Moderate	Used as the base level, 32% of respondents		
Coast Recreation, mean across the following three categories for frequency of recreating in marine reserve areas, 1 = never, 2 = seldom, 3 = often			
	Ocean-oriented sightseeing, photography, or wildlife viewing (birds, whales, etc.)	1.96	.79
	Beach walking, running, shell collecting, or rockhounding	1.91	.80
	Exploring tide pools	1.70	.75
Recreational Fishing	Ocean recreational fishing (including charter) or collecting shellfish (e.g., crabs or clams) in marine reserve areas, 1 = never, 2 = seldom, 3 = often	1.31	.59
Other Ocean Recreation	Ocean swimming, kayaking, surfing, boogie boarding, snorkeling, or diving in marine reserve areas, 1 = never, 2 = seldom, 3 = often	1.23	.53
Fishing Job	Respondent's primary job is in either (a) Commercial or charter fishing or (b) Other fishing-related employment; 1 = yes, 0 = no	.02	.14
Choice Certainty	Certainty with respect to choice experiment response, 0 = not at all certain to 100 = completely certain (illustrated by Question 10 in "Appendix")	74.74	24.91
SWB Change Certainty	Certainty with respect to SWB change responses, 0 = not at all certain to 100 = completely certain	78.45	21.20

[a] Except where noted, all results, including the means and standard deviations presented in this table, were based on data weighted by age, household income, and geography. Additional discussion of the variables is provided in Sect. 3.2.1

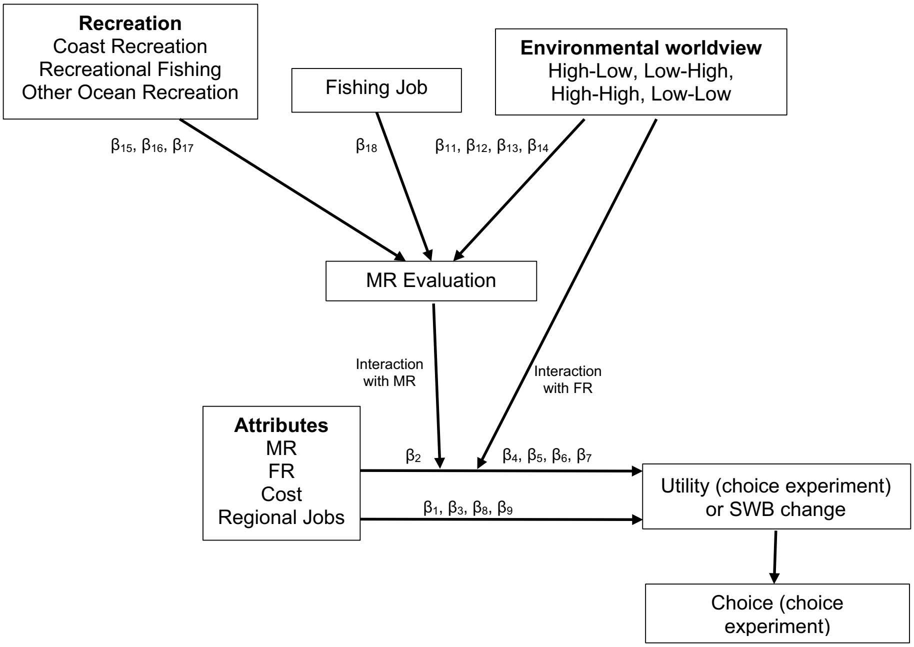

Fig. 1 Model relationships. Variables are as described in Tables 1 and 2. Betas refer to the coefficients in Eqs. 4 and 5 in Sect. 3.2.2. Attributes were modeled as predicting utility or SWB change both directly (bottom horizontal arrow between attributes and utility) and in interaction with non-attribute predictors (top horizontal arrow). Respondent evaluation of current marine reserves (MR Evaluation) was modeled as an intermediary between recreation, employment, and environmental worldview characteristics, on the one hand, and utility or SWB change via interaction with the MR attribute, on the other hand

Respondent evaluation of current marine reserves (MR Evaluation, Fig. 1 and Table 2) plays an intermediary role in the marine reserve component of the model. Specifically, environmental worldview, recreational use of current marine reserves, and employment in the commercial fishing sector (regardless of whether employment is directly affected by current marine reserves) were modeled as predicting respondent evaluation of current marine reserves. In turn, this evaluation was modeled as interacting with the marine reserve attribute. MR Evaluation was the mean of five questionnaire items that reflect diverse potential effects stemming from the current reserves.

Environmental worldview was based on responses to ten survey items, with five items reflecting the Connectedness to Nature Scale (Cronbach's alpha = .889) and five items reflecting anthropocentric conservation (alpha = .788) (Mayer and Frantz 2004; Milfont and Duckitt 2010; Vucetich et al. 2015). The items were randomly ordered in the online questionnaire and alternately ordered (connectedness to nature item, then anthropocentrism item) in the paper questionnaire.

K-means cluster analysis was applied with solutions involving three, four, and five environmental worldview clusters. The five-cluster solution generated the most intuitive grouping. Dummy variables were created to reflect each cluster. The reference cluster was Moderate and reflected mid-range responses (primarily 4 and 5 on the 7-point scale) for the ten items. The cluster dummy variables were labeled relative to strength of anthropocentric responses followed by connectedness to nature responses. Thus, persons in the High-Low cluster responded more highly than others on the anthropocentrism scale and less highly than others on the connectedness to nature scale. This set of items provided the richness of multiple combinations across the eco-anthropocentrism continuum and the connectedness to nature continuum.

Three of the recreation activity variables were highly correlated, and their mean was used to represent coast-oriented recreation. The other two recreation variables reflect ocean-oriented activities: recreational fishing and other ocean recreation activities. Employment in the fishing sector was represented by the Fishing Job variable.

3.2.2 The Choice Experiment Approach

Discrete choice models (choice experiments) are widely used to understand preferences across presented alternatives, to assess the importance of specific attributes included in the alternatives, and to estimate willingness-to-pay for goods and services characterized by such attributes (Hensher et al. 2015; Holmes et al. 2017). The basic discrete choice model uses random utility theory (Manski 1977) to relate the probability that a certain alternative is chosen to (a) characteristics of the alternative, (b) characteristics of competing alternatives, and (c) characteristics of the individual. A linear-in-parameters form commonly is assumed, with respondent preference for an alternative represented as a weighted sum of preferences associated with each attribute in the alternative.

The number of alternatives and attributes typically is limited due to concerns about cognitive complexity. An illustrative choice task involves respondents choosing across three alternatives, with one being a status quo option, such as no change in the area of reserves. The other two alternatives are change options, with changes being characterized by multiple attributes. Question 9 in "Appendix" illustrates the choice experiment task in this study.

The utility of alternative a out of a choice set with N alternatives is given by the following (subscripts for individual respondents are omitted):

$$U_a = V_a + \varepsilon_a \tag{1}$$

where U_a is the utility of alternative a, V_a is the systematic component of the utility function, and ε_a is the random error component. V is characterized as:

$$V_a = \beta X_a \tag{2}$$

where β is a vector of coefficients and X_a is a vector of attributes associated with alternative a. The probability that alternative a is chosen across N alternatives is given by:

$$\mathrm{P}(a) = \frac{\exp\left(\beta X_a\right)}{\sum_{j=1}^{N} \exp\left(\beta X_j\right)} \tag{3}$$

The model estimated here is illustrated in Fig. 1 and reflects:

$$\begin{aligned} V = {} & \beta_0 + \beta_1 MR + \beta_2 MR * MR\,Evaluation + \beta_3 FR \\ & + \beta_4 FR * High\text{-}Low + \beta_5 FR * Low\text{-}High + \beta_6 FR * High\text{-}High \\ & + \beta_7 FR * Low\text{-}Low + \beta_8 Cost + \beta_9 Regional\,Jobs + \varepsilon \end{aligned} \tag{4}$$

In Fig. 1, the bottom horizontal arrow between attributes and utility reflects the effect of each attribute alone (coefficients β_1, β_3, β_8, and β_9), whereas the top horizontal arrow reflects the effect of the MR and FR attributes in interaction with predictors (coefficients β_2, β_4, β_5, β_6, and β_7).

Respondent evaluation of current marine reserves (MR Evaluation) was modeled as an intermediary between recreation, employment, and environmental worldview characteristics, on the one hand (Eq. 5), and utility via interaction with the MR attribute, on the other hand (Eq. 4). This followed a path model approach (Kelloway 2015; Kline 2016), which falls between traditional specifications of multinomial logit choice models and hybrid choice models, with the latter also involving latent variables (Hensher et al. 2015, pp. 927–936).

$$\begin{aligned} MR\,Evaluation = {} & \beta_{10} + \beta_{11} High\text{-}Low + \beta_{12} Low\text{-}High + \beta_{13} High\text{-}High \\ & + \beta_{14} Low\text{-}Low + \beta_{15} Coast\,Recreation \\ & + \beta_{16} Recreational\,Fishing + \beta_{17} Other\,Ocean\,Recreation \\ & + \beta_{18} Fishing\,Job + \varepsilon \end{aligned} \tag{5}$$

In brief, observed choice depends on unobserved utility, which depends on attribute levels across alternatives (current situation, Option 1, Option 2). Utility also depends on the interaction between the reserve attributes (MR and FR) and non-attribute predictors, such as environmental worldview.

The software package Ngene was used to create a D-efficient fractional factorial design of 12 sets of alternatives for use in the choice and SWB tasks. Each questionnaire included one set (one choice task), with the resulting 12 versions being administered on a random selection basis.

Using Mplus software, the dependent variable (choice of the current situation, Option 1, or Option 2) was specified as nominal in a combined path and multinomial logit model (Table 3). To facilitate interactions with other variables, all attribute variables were modeled in linear form rather than sets of dummy or effects-coded variables. Areal changes in reserve size were modeled in percent change from the current. For example, a marine reserve area of Level 1 = 4.5% of the territorial sea in an alternative would be entered in the model as -50 to reflect a 50% decrease from the current 9% of the territorial sea. A decrease of 100 jobs was entered in the model as − 100 for the regional jobs attribute.

The first constant shown in Table 3 reflects preference for either change option (Option 1 or Option 2) over the status quo option, all else held constant. Because the change options were unlabeled, the constant and attribute coefficients were constrained to be equal across the two change options.

Willingness-to-pay was based on the marginal rate of substitution between the attribute of interest (e.g., marine reserve area) and the cost attribute, and it was calculated as the negative of the ratio of the respective coefficients (Holmes et al. 2017, Eq. 5.18). This calculation was more complex in the present case due to interaction terms. For example, willingness-to-pay for a one percent increase in the size of marine reserves would be the negative of $(\beta_1 + \beta_2 * \text{MR Evaluation})/\beta_8$, with MR Evaluation being calculated as shown in Eq. 5 above.

3.2.3 The SWB Approach

After completing the choice task, respondents reported their baseline evaluative SWB (life satisfaction) for life overall and across six domains, using a scale of 0 for "not at all satisfied" to 100 for "completely satisfied" (see question 11 in "Appendix"). Next, they sequentially reported how each of the two vignettes in the choice task would affect their SWB for life overall and five of the six domains. For brevity, the present analysis focused on life overall. Respondents were asked (a) to consider the importance of these changes relative to other factors affecting well-being, to potentially reduce focusing illusion effects, and (b) to consider the long term, not just the immediate impact, to potentially reduce adaptation effects. An example was provided to illustrate the task (question 13 in "Appendix").

Respondents were asked to report their SWB change in both ordinal (5-point scale from "decrease a lot" to "increase a lot") and interval terms (new SWB on the 0 to 100 scale, with interval change being the difference from baseline SWB). A consistency check was conducted to determine whether to undertake further analyses with ordinal or interval responses. Ordinal and interval changes were considered inconsistent if (a) ordinal change was non-zero[5] while interval change was zero; (b) ordinal change was zero while interval change was non-zero; or (c) ordinal change was non-zero while interval change was in the unexpected direction (e.g., ordinal change indicated an increase while interval change indicated a decrease). Responses were considered consistent if (d) ordinal change and interval change were both zero or (e) non-zero ordinal change was associated with interval change in the same direction.

Based on these criteria, 79% of responses were considered consistent between ordinal and interval tasks, with the percentage increasing modestly if ceiling effects are taken into account. Of the 10% of responses that fell into the first inconsistency category, 16% involved ordinal increases from a baseline SWB of 100. Because new SWB could not exceed 100 (the ceiling), SWB increase was constrained to zero in such cases, which were classified as inconsistent. Analysis of variance indicated the expected positive relationship between ordinal and interval responses SWB ($p < .001$). This check suggested broad consistency between ordinal and interval responses, but also enough inconsistency to argue for use in the present analysis of ordinal responses, which presumably involved less cognitive effort and thus greater accuracy.

The SWB model (Table 3) used the same predictors and path structure as that outlined above for the choice model, but with the dependent variable being ordinal change in SWB, on a scale of 1 = decrease a lot to 5 = increase a lot. SWB change was reported for each of Option 1 and Option 2, such that there were twice as many observations in the SWB model (two per respondent) than in the choice experiment model (one per respondent).

In the paper version of the questionnaire, the baseline and contingent SWB questions were on facing pages. They were on separate screens in the online version, but responses to the baseline SWB question were reproduced on (carried forward to) the contingent SWB question screen. Thus, all respondents could see their reported baseline SWB when completing the contingent SWB task.

In the online version, respondents were not able to review their choice experiment responses when completing the SWB task. In the paper version, it was possible for respondents to flip back to their choice experiment responses.

3.2.4 Consistency Between Choice Experiment and SWB Responses

Consistency between the choice experiment and contingent SWB approach was evaluated in two respects. First, the ratio between attribute coefficients was evaluated, using the coefficients for the MR attribute and its interaction with MR Evaluation. In Table 4, the

5 For this discussion of ordinal-interval consistency, ordinal change of "zero" reflects "no effect" responses in Question 13a and 14a. Ordinal change of "non-zero" reflects responses of decrease or increase.

cell in the first numeric column, first numeric row shows the ratio of the coefficient on MR to the coefficient on Cost for the SWB model relative to the ratio of the same for the choice model. Using the coefficient numbering in Eq. 4, that cell was calculated as $(\beta_{1,SWB}/\beta_{8,SWB})/(\beta_{1,Choice}/\beta_{8,Choice})$. The next cell to the right reflects substitution of β_2 for β_1. Continuing to the right, the above two calculations were repeated with regional jobs instead of cost as the numéraire; β_9 was substituted for β_8.

These calculations were repeated with data weighted by certainty in addition to the base weight that reflected the demographic and geographic variables described above. Certainty weighting was calculated as the base weight multiplied by the average of the respondent's Choice Certainty and SWB Change Certainty (see Table 2), scaled to a mean of one. That approach more highly weighted the observations from respondents who reported greater certainty during those tasks. Question 10 in "Appendix" illustrates the choice certainty task.

The second evaluation was based on raw responses to the choice and SWB tasks. Responses were classified as inconsistent if the respondent (a) chose the current situation in the choice experiment task and indicated a positive change (increase) for either change option in the SWB task; (b) chose either change option in the choice experiment task and indicated negative change for both in the SWB task; or (c) chose either change option while indicating the selected option was less positive or more negative than the other in the SWB task (e.g., chose Option 1 in the choice experiment, while Option 1 would lead to a small SWB increase and Option 2 would lead to a large increase); or (d) both (b) and (c) occurred.

Responses were considered consistent if (e) there was a three-way tie (e.g., with no SWB effect in either change option, a choice experiment selection of Option 1, Option 2, or current situation was consistent); (f) there was a two-way tie, with the expected direction relative to the remaining option (e.g., with no SWB effect in Option 1 and "decrease a little" in Option 2, choice experiment selection of either Option 1 or the current situation was consistent); or (g) there was no tie and the choice experiment selection was consistent with the SWB changes.

4 Results

The model (Fig. 1) and results (Table 3) provide insight into preferences for, and the effects of, change in areal extent of marine and forest reserves. Most Table 3 model coefficients are statistically significant, and McFadden R^2 values typically are lower than the ordinary least squares equivalents. Nonetheless, the R^2 values indicate that substantial variance remains unexplained by the Table 3 models. The present focus was on a modest set of predictors that were of conceptual interest and that facilitated inter-model comparability, rather than on a fuller set that might explain more variance. For example, inclusion of a variable reflecting awareness of the marine reserves, as a predictor of choice of one of the change options, would increase the choice model McFadden R^2, but a parallel inclusion in the SWB model was not possible.

Table 3 Choice experiment and SWB model results[a]

	Choice experiment			SWB		
	Coeff.	SE	*p* value	Coeff.	SE	*p* value
Choice/SWB regressed on						
Constant	−.57100**	.109	.000			
MR	−.01328*	5.438	.015	−.00978**	2.054	.000
MR * MR Evaluation	.00537**	1.315	.000	.00314**	.484	.000
FR	.00336	2.652	.205	.00120	1.385	.385
FR * High-Low	−.01459**	4.740	.002	−.00720**	2.483	.004
FR * Low-High	.01652**	4.288	.000	.01299**	2.122	.000
FR * High-High	.00651	3.752	.083	.00288	1.831	.116
FR * Low-Low	.00908	5.572	.103	−.00066	3.168	.835
Cost	−.00192**	.409	.000	−.00067**	.162	.000
Regional Jobs	.00135**	.447	.003	.00076**	.203	.000
MR Evaluation regressed on						
Constant	3.801**	.172	.000	3.706**	.128	.000
High-Low	−.823**	.153	.000	−.835**	.119	.000
Low-High	.874**	.146	.000	.861**	.104	.000
High-High	.294*	.135	.030	.289**	.089	.001
Low-Low	.326*	.159	.040	.330*	.147	.025
Coast Recreation	.266**	.088	.002	.272**	.059	.000
Recreational Fishing	−.332**	.112	.003	−.325**	.059	.000
Other Ocean Recreation	.036	.113	.749	.034	.076	.653
Fishing Job	−1.150**	.410	.005	−1.139**	.174	.000

[a]Variables are as described in Tables 1 and 2. "*" in variable names indicates interaction variables (an attribute variable multiplied by a non-attribute predictor variable). "Coeff." is the model coefficient for each variable and "SE" is the standard error. For the choice experiment, the model is path multinomial logit, dependent variable is choice, N = 875, model McFadden $R^2 = .07$ (constants only). For SWB, the model is path ordered logit, dependent variable is ordinal change in SWB, N = 1750, model McKelvey and Zavoina $R^2 = .12$

*,**Significance level $p < .05$, $p < .01$

4.1 Effects and Predictors (Research Question 1)

Starting with the non-interacted attributes, both cost and regional jobs significantly predicted choice and SWB effects in expected directions. Options with higher cost and greater job loss (greater negative change in Regional Jobs) were less likely to be selected in the choice experiment and more likely to lead to losses in SWB.

The coefficient for the forest reserve attribute (FR) was non-significant in both models, suggesting that the effects of forest reserve area depended heavily on environmental worldview. The negative sign for FR * High-Low indicates that respondents high in anthropocentrism and low in connectedness to nature scores (High-Low) were less likely to prefer options—and were more likely to report negative SWB change—with increased forest reserve area. The reverse was true for respondents low in anthropocentrism and high in connectedness to nature (FR * Low-High). Respondents high in both or low in both scores were not statistically different from the reference respondents.

Table 4 Coefficient ratios, SWB model relative to choice experiment model

	Numéraire = Cost		Numéraire = Regional Jobs	
	MR	MR * MR Eval.	MR	MR * MR Eval.
Not weighted by certainty (based on Table 3)	2.11	1.67	1.31	1.04
Weighted by certainty	1.70	1.35	1.21	0.95

[a]The cell in the first numeric column, first numeric row shows the ratio of the coefficient on MR to the coefficient on Cost for the SWB model relative to the same ratio for the choice model. Based on the coefficient numbering in Eq. 4, that cell was calculated as $(\beta_{1,SWB}/\beta_{8,SWB})/(\beta_{1,Choice}/\beta_{8,Choice})$. The next cell to the right reflects substitution of β_2 for β_1. Continuing to the right, the above two calculations were repeated with Regional Jobs instead of Cost as the numéraire; β_9 was substituted for β_8. For the second numeric row, the above calculations were repeated with data weighted by certainty in addition to the base weight reflecting demographic and geographic variables. Certainty weighting was calculated as the base weight multiplied by the average of the respondent's Choice Certainty and SWB Change Certainty (see Table 2), scaled to a mean of one. The analysis was conducted for the MR coefficients, but not for the FR coefficients, due to the nonsignificance of the latter (Table 3)

The coefficient for the marine reserve attribute (MR) was significant in both models, as was the interaction with MR Evaluation. In turn, MR Evaluation was significantly predicted by the environmental worldview variables, with the same general pattern found above for forest reserves (though with greater statistical significance for the High-High and Low-Low coefficients).

MR Evaluation also was significantly predicted by engagement in coast-oriented recreation and in recreational fishing, but not by engagement in other ocean recreation. The positive sign for Coast Recreation in the MR Evaluation model component indicates that respondents who engaged in coast-oriented recreation in reserve areas were more likely to report positive evaluations of current marine reserves and, ultimately, prefer—and report SWB gains from—options reflecting greater marine reserve area. The reverse was true for respondents who engaged in recreational fishing in reserve areas or whose primary employment was in commercial fishing.

The choice experiment coefficients can be used to calculate willingness-to-pay for attributes of interest (see last paragraph of Sect. 3.2.2). Assume Person A is high in anthropocentrism and low in connectedness to nature (High-Low = 1 with other worldview dummy variables = 0), never engages in coast recreation (Coast Recreation = 1) or other ocean recreation (Other Ocean Recreation = 1), often engages in recreational fishing (Recreational Fishing = 3), and works in commercial fishing (Fishing Job = 1). The predicted value for MR Evaluation for Person A would be 1.13. Person A's estimated annual household willingness-to-pay for a 1% increase in marine reserve area would be the negative of $(-.01328 + .00537 * 1.13)/-.00192$, which is negative $3.75.

Assume Person B is low in anthropocentrism and high in connectedness to nature (Low-High = 1 with other worldview dummy variables = 0), often engages in coast recreation (Coast Recreation = 3), never engages in recreational fishing (Recreational Fishing = 1) or other ocean recreation (Other Ocean Recreation = 1), and does not work in commercial fishing (Fishing Job = 0). The predicted value for MR Evaluation for Person B would be 5.18, and estimated willingness-to-pay for a 1% increase in marine reserve area would be $7.58. Persons A and B reflect relative extremes, and other combinations are possible. For example, a person in the commercial fishing sector may engage in coast recreation but not recreational fishing or other ocean recreation, and may have a worldview high in both anthropocentrism and connectedness to nature.

4.2 Evaluation of Consistency (Research Questions 2 and 3)

In both models (Table 3), coefficient signs were as expected where a priori expectations existed, such as negative signs for the Cost coefficients. In addition, there was general consistency in coefficient sign and significance across models.

Consistency results with respect to coefficient ratios are shown in Table 4, with a focus on the two marine reserve coefficients (MR and MR * MR Evaluation). The calculations are described in Sect. 3.2.4. The value 2.11 in the upper left of Table 4 was calculated as the ratio of the MR coefficient for the SWB model (−.00978) to the Cost coefficient for the SWB model (−.00067), divided by the same ratio for the choice model (−.01328/−.00192). Table 3 shows rounded numbers, while Table 4 calculations were conducted with unrounded numbers.

A value of 1 would reflect consistency in coefficient ratios across the two models, such that 2.11 reflects inconsistency. The results in the second set of columns indicate that coefficient ratios become more consistent (closer to 1) when regional jobs, rather than cost, is used as the numéraire. This suggests greater differences across approaches when responding to cost characteristics than to jobs characteristics.

Results in the second row reflect additional weighting by respondent certainty. Overall, certainty weighting led to a narrowing of differences between the choice and SWB results. Full results from the certainty models are available from the authors.

Consistency results with respect to comparison of choices and reported SWB change, based on the criteria described in Sect. 3.2.4, indicate that 90% of respondents were consistent in their responses between the choice and SWB tasks.

5 Discussion and Conclusion

Multiple approaches are available for assessing ecosystem services, including their distribution across individuals and groups. Given differing assumptions and limitations, alternate approaches can complement each other. Monetary evaluation is widely used, but SWB evaluation conceptually reflects a more fundamental and holistic measure of well-being relative to economic metrics. Likewise, indirect monetary and SWB approaches often are preferred, but direct approaches may be desirable or necessary in some contexts. The effects of protected area designation and management is one such context given the potentially substantial role of passive-use components. The present study involved both the well-established choice experiment approach and the exploratory contingent SWB approach.

Numerous studies have been undertaken of the effects of protected area designation and management, with effects assessed using diverse metrics. However, assessment in "standardized" SWB metrics (e.g., those in Appendix A of OECD 2013) is uncommon, especially when one looks beyond urban parks and a particular type of use (e.g., recreation).

The primary contribution of this study was to assess effects in an evaluative SWB metric as a complement to the more traditional monetary metric. The study relied on a contingent SWB approach given the potential importance of passive-use benefits. In order to understand heterogeneity within the population, it also utilized a multi-dimensional measure of environmental worldview to complement measures of recreational and commercial interests. Though not a focus of the analysis, the use of path analysis illustrated the intermediary role of respondent evaluation of current marine reserves as a predictor of choice and SWB effects.

Consistent with McNeill et al. (2019), Wallmo and Edwards (2008), and other studies, the present choice and SWB models indicated heterogeneous effects across coast residents from hypothetical change in marine and forest reserves. The negative signs on Fishing Job and Recreational Fishing were expected given concern that marine reserves may reduce commercial and recreational fishing opportunities. We did not have expectations regarding signs on Coast Recreation or Other Ocean Recreation. The positive sign on Coast Recreation suggests such visitors expect marine reserve designation and management to generate benefits such as increased interpretive material or otherwise enhanced visitor experiences. The nonsignificant sign on Other Ocean Recreation suggests such visitors expect net changes from designation and management that are either negligible or neutral.

Importantly, environmental worldview variables complemented recreational and commercial interest variables as predictors of marine reserve evaluation and, ultimately, choice and SWB. Though passive-use ecosystem services were not specifically evaluated, the significance of environmental worldview variables (in addition to variables reflecting resource use) suggests that willingness-to-pay and SWB effects in part reflect passive-use aspects.

Although the present study focused on a specific ecosystem service context, and a systematic evaluation of validity was not undertaken, the comparison of choice and contingent SWB task results can inform the broader question of contingent SWB's suitability for assessing SWB effects. The results in Table 4 provide a mixed picture of consistency. The ratio of the MR attribute coefficient to the cost attribute coefficient was more than twice as high in the SWB task as in the choice task, but the difference decreased when accounting for respondent certainty and when using an alternate numéraire (the coefficient for Regional Jobs). Indeed, variation in inconsistency across numéraires may provide insight regarding differences in respondent processes governing self-reports in choice versus SWB contexts. For example, respondents may "feel the pain" of reduced employment opportunities for themselves or others yet not make choices that fully reflect that well-being effect. Alternatively, cost may affect choices more dramatically than it affects well-being.

With respect to consistency in raw responses, 90% of responses were consistent across the two tasks, although that reflects classification of ties as consistent. One might expect respondents to choose outcomes that maximize their well-being, and the broad consistency between choice and SWB outcomes found here and elsewhere (e.g., Benjamin et al. 2012, 2014) suggests similarities in the evaluative processes that underlay responses to each task. Nonetheless, consistency in the present study was imperfect, and it may diminish with alternate evaluation objects, between-subject study designs, and application of more conservative criteria when assessing consistency. Importantly, inconsistencies may reflect substantive differences in the approaches, such as choices being made on criteria other than maximization of one's own overall life satisfaction.

We believe there is value in utilizing multiple methods—monetary and SWB; direct and indirect—to provide complementary information (Azevedo et al. 2003; Stone and Mackie 2013). Nonetheless, the contingent SWB method remains exploratory, and additional evaluation is needed. This includes assessment of the effect of task complexity, object salience, and the balance between the two.[6]

There are at least three aspects of task complexity. First, multi-attribute tasks (SWB analogs to choice experiments) provide substantially more information than single-attribute tasks (SWB analogs to contingent valuation), and the number of attributes, levels, and presented vignettes can be minimized to reduce complexity. Nonetheless, they typically are more complex than single-attribute tasks.

Second, interval SWB responses presumably are more difficult than ordinal responses. Third, responding across life overall and multiple domains presumably is more difficult than responding across a single dimension (life overall or a single domain). This study involved a multi-attribute task, both ordinal and interval responses, and responses across multiple dimensions.

The present evaluation object appeared highly salient to some, based on responses to (a) a marine reserve awareness question, (b) the ordinal SWB question, and (c) open-ended questions. However, it appeared much less salient to others. Approximately half the respondents were "not aware" or "slightly aware" of the marine reserve program. Likewise, approximately half the presented options were reported to have "no effect" in the ordinal SWB task. A low level of awareness and engagement in this context is not uncommon (Aanesen and Armstrong 2019, p. 2).

The general consistency of the choice and ordinal SWB responses suggests that respondents generally were sufficiently engaged to accurately complete those tasks. The lower consistency found between the ordinal and interval SWB responses during the ordinal-interval consistency check, despite both being SWB tasks completed contemporaneously, suggests that some respondents were insufficiently engaged to accurately complete the more difficult interval SWB task.

One alternative is to use a dichotomous task, with respondents indicating whether the option would change their SWB by at least as much as a predetermined amount, analogous to the set of bids used in dichotomous choice contingent valuation. That approach is worth evaluating, though it places greater demands on sample size, with increasing complexity if responses occur across multiple SWB dimensions. It is also possible to simplify choice experiment task complexity and SWB task length by presenting the current situation and a single change option, rather than two change options.

The balance between engagement and respondent burden also may be enhanced beyond the SWB task itself. In the present study, the choice experiment and SWB tasks were part of a questionnaire that covered substantial additional content. Some of that content prepared respondents for the choice and SWB tasks, but future questionnaires could be focused solely on content designed to increase attention and reflection

[6] We thank an anonymous reviewer for stressing the importance of systematic assessment across objects with varying degrees of salience.

on these tasks. Likewise, face-to-face interviews or valuation workshops may increase engagement and justify the associated expense in high-impact evaluation contexts (e.g., Aanesen et al. 2015; Bishop et al. 2017).

In summary, relative to direct monetary evaluation tasks, such as choice experiments, direct SWB tasks potentially are more novel and more cognitively demanding. The present evaluation object appeared sufficiently salient for respondents to complete the simpler ordinal SWB task. It was not clear that the object was sufficiently salient for the more complex interval SWB task. Other objects, such as a change in the viability of a valued species, may be sufficiently salient. Alternatively, simpler contingent SWB tasks may be needed for less salient objects.

In the present study, the "think out loud" pilot enhanced researcher understanding of respondent cognitive processes, and led to questionnaire refinement, but it was not extensive enough to evaluate differential processes across the two types of tasks. More extensive "think out loud" evaluations, combined with open-ended queries after choice and SWB tasks, may provide additional insight into respondent processes (Lindberg and Wolsko 2019).

As usual, the present analysis reflected the study context, including the evaluation object. This study followed the principles outlined in Johnston et al. (2017) to the extent feasible. However, budget constraints limited questionnaire development and administration procedures. In addition, consequentiality was limited by the nature of the protected area designation process; we could not state that future designation decisions would be based on survey responses. Lastly, the analysis focused on the life overall SWB measure for simplicity, but analysis of the domain measures may provide additional insight.

Appendix: Choice experiment and SWB questionnaire wording

Below, we ask you to respond to hypothetical options. The following is background information.

State records indicate about 63,400 private sector jobs along the entire coast in 2016, with an average wage of $33,000 per year. Coast jobs in fishing / seafood and timber / wood products are shown below, based on state records. Jobs in these industries could be affected by the size of marine and forest reserves, or by many other factors. These industries support jobs in other industries and thus contribute to the broader economy.

Marine reserves. Currently, 9% of Oregon's territorial sea is designated as reserve. Assume these areas could be expanded or reduced by policy makers.

Forest reserves. Currently, 10% of Oregon's coastal forest area is in reserves. Assume these areas could be expanded or reduced by policy makers.

Cost to your household. Reserve management funding could come from income taxes, property taxes, or other sources. Assume there may be an additional cost to your household, above current levels.

Fishing and timber, including seafood + wood products. Currently, 7,000 people are directly employed in fishing and timber jobs. Average yearly wages range from $32,000 to $62,000.

These options are computer-generated, and the direction and amount of change vary from person to person. Some combinations may not seem logical, but please treat them as realistic. Take your time to consider the options so your response accurately reflects your perspective. Your response provides important insight into the priorities of coast residents.

Current	Option 1	Option 2
9% of territorial sea is marine reserve	↑ 13.5% of territorial sea is marine reserve	↓ 4.5% of territorial sea is marine reserve
10% of coastal forests is forest reserve	↑ 15% of coastal forests is forest reserve	↓ 5% of coastal forests is forest reserve
No additional cost to your household	↑ $500 per year additional cost to your household	= No additional cost to your household
No change in fishing + timber jobs	= No change to fishing + timber jobs	= No change to fishing + timber jobs

9. If you had to choose between staying with the current situation (no change), Option 1, or Option 2, which would you choose? Please check the box to indicate your choice.

☐ Current situation ☐ Option 1 ☐ Option 2

10. How certain are you that your choice reflects your priorities? Please circle the appropriate number on this scale.

Not at all certain										Completely certain
0	10	20	30	40	50	60	70	80	90	100

11. Please indicate below how satisfied you have been with your life overall and with some specific aspects of your life over the past year (your well-being).

Write in a number from 0 to 100 that reflects your satisfaction with each listed aspect, using a scale from 0 = Not at all satisfied to 100 = Completely satisfied.

Well-being table – your satisfaction with…	
Aspect	**Well-being in past year, 0 to 100**
Your life overall, considering all aspects	
Your financial situation	
Your job situation, if currently employed	
Recreation opportunities in the region	
Quality of the natural environment in the region	
The community and its culture	

13. Please imagine that Option 1 is implemented, even if you did not select it in the earlier question. In column 13a on the next page, indicate whether Option 1 would decrease, have no effect on, or increase each aspect of your well-being.

For each aspect that would be decreased or increased by Option 1, please also write a number in column 13b to indicate what your new well-being would be, assuming the changes in Option 1 occur.

Please consider how important the specific changes in Option 1 are to you relative to everything that affects your well-being. Consider the long term, not just the immediate impact of these changes.

Start with 13a + 13b, Option 1
Rate how implementation of Option 1 would affect each aspect of your well-being, which you reported in question 11.

First, check the box for direction of change in column 13a. Second, write what your new well-being number would be in column 13b.

Example: If your life overall well-being currently is 80, and the changes in Option 1 would increase it by 3, check the box for "Increase a little" in the first row of 13a and write "83" in the first row of 13b. Then answer for other aspects.

Current	Option 1
9% of territorial sea is marine reserve	↑ 13.5% of territorial sea is marine reserve
10% of coastal forests is forest reserve	↑ 15% of coastal forests is forest reserve
No additional cost to your household	↑ $500 per year additional cost to your household
No change in fishing + timber jobs	= No change to fishing + timber jobs

Aspect	13a. Direction of well-being change: Decrease a lot	Decrease a little	No effect	Increase a little	Increase a lot		13b. New well-being (number)
Your life overall, considering all aspects	☐	☐	☐	☐	☐	→	
Your financial situation	☐	☐	☐	☐	☐	→	
Your job situation, if currently employed	☐	☐	☐	☐	☐	→	
Recreation opportunities in the region	☐	☐	☐	☐	☐	→	
Quality of natural environment in region	☐	☐	☐	☐	☐	→	
The community and its culture	☐	☐	☐	☐	☐	→	

Funding Funding was provided by Oregon Department of Fish and Wildlife (Agreement No. IGA #331-16) and USDA Forest Service Pacific Northwest Research Station (Agreement No. 16-JV-11261995-086).

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