UC Santa Barbara

UC Santa Barbara Previously Published Works

Title

Using people's perceptions of ecosystem services to guide modeling and management efforts.

Permalink

<https://escholarship.org/uc/item/4356c0m5>

Authors

Elwell, Tammy L
Gelcich, Stefan
Gaines, Steven D
et al.

Publication Date

2018-10-01

DOI

10.1016/j.scitotenv.2018.04.052

Peer reviewed

Tammy L. Elwell ^{a,*}, Stefan Gelcich ^b, Steven D. Gaines ^c, David López-Carr ^a

^c Bren School of Environmental Science and Management, University of California, Santa Barbara, CA 93106, USA

GRAPHICAL ABSTRACT

-
- (a) Somewhat important, in good state**
- (b) Very important, in good state**
- (c) Somewhat important, in mediocre state**
- (d) Very important, in mediocre state**
- Legend**
- Very important
 - Somewhat important
 - Not important
 - Very important and in mediocre state
 - Somewhat important and in mediocre state
 - Not important and in mediocre state
 - Very important and in good state
 - Somewhat important and in good state
 - Not important and in good state

ABSTRACT

Keywords:
Natural resource management
Coastal marine spatial planning
Human wellbeing
Valuation
Tradeoff analysis
Chile

© 2018 Elsevier B.V. All rights reserved.

<https://doi.org/10.1016/j.scitotenv.2018.04.052>
0048-9697/© 2018 Elsevier B.V. All rights reserved.

1. Introduction

One of the most urgent challenges of the 21st century is to improve human wellbeing while sustaining ecosystems. Ecosystems underpin human wellbeing, which rests upon basic requirements needed to lead a good life (e.g., water, food, spiritual inspiration) (MA, 2005; Guerry et al., 2015). Ecosystem service (ES) approaches—based on an understanding that ecosystems provide myriad benefits called ecosystem services (ESs) to people—are increasingly showing promise in moving environmental decision-making processes toward better outcomes for ecosystems and people (Daily, 2000; Clark and Dickson, 2003; Ostrom, 2007; Halpern et al., 2013; McKenzie et al., 2014; Arkema et al., 2015; Ruckelshaus et al., 2015). On one hand, spatially explicit models that incorporate biophysical and economic sector data allow users to predict the provision of ESs under different management scenarios (e.g., business as usual, development, conservation) (Polasky et al., 2008; Guerry et al., 2012) and identify tradeoffs and synergies among ESs, which result from complex interactions that occur across time and space and following management decisions (Rodriguez et al., 2006; White et al., 2012; Lester et al., 2013; Estévez and Gelcich, 2015). Such analyses allow modelers to estimate which combinations of ESs are possible given biophysical constraints. On another hand, a range of qualitative and quantitative valuation methods help elicit what matters to people (Klain and Chan, 2012; Marín et al., 2014; Gould et al., 2015) and explore how ESs underpin human wellbeing (Bratman et al., 2012; Hicks and Cinner, 2014; Bratman et al., 2015; Hicks et al., 2015).

However, despite rapid advances in ES modeling and valuation methods, these two lines of research largely remain disconnected, preventing them from reaching their full potential to improve decision-making. Whereas studies on biophysical tradeoffs among ESs often take people's preferences for ESs as a given or something left to decipher, ES valuations tend to focus on eliciting what people value and why, rather than show how such insights may further modeling efforts or inform management decision-making. Notable exceptions include studies by Mastrangelo and Laterra (2015) and Cavender-Bares et al. (2015), which examined farmers' preferences when agricultural productivity traded off with biodiversity. While these studies begin to link the supply of ESs (i.e., which combinations of benefits are possible given biophysical constraints) with demand for ESs (i.e., which benefits people prefer), both studies present a limited understanding of people's preferences for ESs since they focused on two choices farmers faced: to use land for agriculture or to leave land forested. Here, we build on this work that links ES tradeoff analyses with valuation methods, yet we present empirical data that captures a broader understanding of people's demand for ESs. We examined how a diverse community of people perceived the importance of different ESs, the states of those ESs, and how to best manage the ESs. In so doing, we address a critical question: How may knowledge of people's perceptions of different ESs and management options guide ecosystem modeling and management efforts?

Perceptions, defined as “beliefs or opinions, often held by many people and based on how things seem” (Cambridge Dictionary, 2016), provide insights into how people may respond to ecosystem management initiatives (Gelcich et al., 2005; McClanahan et al., 2005; McClanahan et al., 2012; Gelcich and O'Keeffe, 2016). The efficacy of such initiatives largely depends on people's participation and support (McClanahan et al., 2005; de Groot and de Groot, 2009; Jefferson et al., 2015; Bennett, 2016; Bockstael et al., 2016). For example, community leaders, NGOs, and managers benefit from knowing what matters most to people so as to anticipate potential support or controversy surrounding decisions that impact ESs. Moreover, insights into people's perceptions of ESs and management options inform discussions on how to proceed when faced with tradeoffs among ESs perceived as priorities.

Our results indicate that knowledge of people's perceptions of different ESs and management options may usefully guide ecosystem

modeling and management efforts in three key ways. Such knowledge may help to (1) define which ESs matter most and to whom (i.e., which ESs to enter into models and tradeoff analyses), (2) compare how people perceive the states of ESs relative to perceived importance to wellbeing (e.g., in a poor state, very important; doing well, somewhat important)—so as to focus management efforts, and (3) assess how people perceive the impacts of management interventions on the environment and future wellbeing. This latter knowledge may allow managers to identify which interventions garner potential controversy or support.

2. Methods

2.1. Research setting

We assessed how people living along the Pudeto estuary and its coastal zone (ca. 843 km²) located on the northern portion of the Chiloé Archipelago in southern Chile (41°–43°S) perceived different ESs and management options (Fig. 1). This region is known for a cultural heritage of small-scale farmer-fishers whose livelihoods and ways of life depend directly on coastal, marine, and terrestrial ESs. The urban sector of Pudeto is mainly comprised of government housing for families displaced by a 1960 earthquake and tidal wave—the same event that formed the estuary. Its brackish waters contain farms of the red algae *Gracilaria* sp., grown to produce agar, as well as natural shellfish banks of mussels, clams, and oysters. Processing plants for farmed salmon, shellfish, and algae line part of the estuary zoned for industrial use (Ilustre Municipalidad de Ancud, 2013), while patches of native forest give way to coastal wetlands, critical habitat for migratory birds (Andres et al., 2009) (Fig. 1). Like other coastal regions worldwide, Chiloé is experiencing rapid sea- and land-use change (e.g., unregulated extraction of kelp from sea and *Sphagnum* moss from forest, introduction of industrial-scale wind farms) and unprecedented environmental change (e.g., algal blooms, droughts).

2.2. Field research methods

We applied integrated qualitative and quantitative methods to examine how people with different types of dependencies on ESs perceived the importance of ESs to wellbeing (Singleton et al., 1988; Poteete et al., 2010; Cheong et al., 2012). Participatory mapping and semistructured interviews with key informants informed the design of a survey questionnaire that included closed and open-ended questions (Fig. 2). Qualitative data—collected through participatory mapping with indigenous community members, interviews with small-scale fishers, and a survey of estuary residents—allowed us to interpret patterns observed through the analysis of quantitative data (Sayer, 1992; Carr, 2003; Creswell, 2009). Participants gave informed consent as per protocol approved by the Human Subjects Committee at the University of California, Santa Barbara (Submission 12-485).

2.2.1. Identifying benefits associated with the estuary and its coastal zone

This study examined the perceptions of people who lived or worked near the estuary. In the initial qualitative research phase, we sought to identify potential ES priorities. Thus, we first spoke with people whose livelihoods and ways of life depended directly on the estuary. In March 2013, we completed participatory mapping with two registered indigenous communities who perceived the estuary as ancestral territory and, between June and December 2013, we interviewed 41 small-scale fishers who fished or harvested shellfish or algae in the estuary. The term “small-scale fisher” in Chile encompasses a range of activities, including shellfish and algae harvesting, boat ownership, and fishing (Chile's Fishery and Aquaculture Law 18892, 1991). While some small-scale fishing organizations held territorial user rights to the estuary, the two indigenous communities did not enjoy special rights to the estuary. However, at the time of writing, the communities intended to solicit rights based on ancestral uses, as several coastal indigenous

Fig. 1. Map of research setting that shows types of ecosystems, aquaculture processing plants, algal farms, and area perceived as ancestral territory by indigenous communities.

communities in southern Chile had done in accordance with [Chile's Law 20.249 that Creates Coastal Marine Space for Native Peoples \(2008\)](#).

Mapping and interviews followed several months of fieldwork in which the first author analyzed coastal policy documents and observed and participated in harvests (e.g., cleaning algae). These initial months of fieldwork helped gain access into communities.

We then held a workshop in which six indigenous community members generated a list of benefits granted by the estuary and completed in situ participatory mapping of the estuary perceived as ancestral territory. We used the participatory mapping methods described in [NOAA \(2009\)](#) to guide the process. Although six seems like a low sample size, the six members represented four of the eight total households that constituted the two indigenous communities. Four of these six

participants served as informants in the interview sample of small-scale fishers.

We conducted interviews in Spanish at the 41 small-scale fishers' workspaces (shoreline) or homes. We first contacted fishing organizations to request participation and lists of members. From these lists, we purposefully sampled at least two members of the organization and one leader from the directorate board. We sought to capture a potential diversity of perceptions based on factors thought to influence what people value and prioritize. Criteria for inclusion in this purposeful sample included: livelihood sources ([Gelcich et al., 2009](#); [Hicks et al., 2013](#); [Marín et al., 2014](#)); membership in livelihood-related organizations ([Gelcich et al., 2005](#)); rural versus urban place of residence, years of schooling, age, and gender ([Martín-López et al., 2012](#)); ethnicity

Fig. 2. Diagram of the field research methods we used to examine how people who resided or worked in the Pudeto estuary perceived the importance of different ecosystem services (ESs), the state of those ESs, and how to manage those ESs. In the follow-up qualitative phase, practitioners and researchers check that their interpretations align with the reasoning of participants. This follow-up can include open-ended survey questions (Section 2.2.2.2., Appendix A Supplementary Data) and/or interviews or focus groups with key informants.

and ancestral ties to place (Gould et al., 2014; Winthrop, 2014); and, ability to access ESs (Leach et al., 1999; Daw et al., 2011; Hicks and Cinner, 2014; Wieland et al., 2016). To capture the latter, we interviewed people who accessed the estuary via territorial user rights (i.e., access gained through membership in a fishing organization), or open access areas. Fishers not in organizations were approached at the shoreline, an area of open access.

2.2.1.1. Sample of key informants interviewed. The interview sample consisted of 19 female and 22 male small-scale fishers, ranging in age from 21 to 82, with an average age of 51. Interviewees had lived along the estuary from less than a year to 82 years, with an average duration of 29 years. Thirty-two interviewees (78%) belonged to a small-scale fishing organization, five belonged to a registered indigenous community, and two belonged to both. Four interviewees did not belong to either. Interviewees represented the range of livelihoods that the term “small-scale fisher” encompasses in Chile, including coastal gleaner, boat owner, diver, and fisher (Chile’s Fishery and Aquaculture Law 18892, 1991), and all but five depended directly on coastal and marine ESs from the estuary (Fig. 3).

2.2.1.2. Design of semi-structured interview. Interviews followed a semistructured format of open ended questions that allowed informants to respond in their own words. First, we collected background information to better understand informants’ history in the social-

ecological system, including degree and type of reliance on ecosystems for subsistence and income, harvests per unit effort, and access to natural resources (Ostrom, 1990). We then asked informants what the coastal land marine ecosystems provided them, using follow-up questions such as, “Anything beyond immediate sources of livelihood or food?” From these responses, along with those yielded from participatory mapping (Section 2.2.1), we tallied a list of 17 ESs granted by the estuary (Table 1). We also asked if informants perceived any tradeoffs among existing or projected uses of the ecosystems, how they perceived current management, and how they envisioned the estuary’s future. For instance, we asked what informants would like to see change or remain the same, and what other potential uses or changes, if any, they thought would add to their wellbeing. From these responses, we generated a list of ten plausible interventions included in the survey questionnaire (Section 2.2.2.2.).

2.2.1.3. Analysis of participatory mapping and interview data. First we tallied estuary benefits and plausible interventions identified by indigenous community members in the participatory mapping exercise. We then transcribed interviews with small-scale fishers, compiled responses to each question (Kitchin and Tate, 2000), and compared responses from the participatory mapping exercise and interviews to aggregate lists (Table 1).

2.2.2. Prioritizing benefits associated with the estuary and its coastal zone

From the participatory mapping and interview responses, we compiled a list of 17 benefits, or ESs, granted by the estuary, and a list of ten plausible management interventions identified by estuary residents (Fig. 2, Table 1). We corroborated these lists with officials at the local office of Chile’s National Fishing Service to ensure interventions would be plausible. Between 26 February and 3 March 2014, the first author and a trained team used a questionnaire (in Spanish) to survey residents (Section 2.2.2.2., Appendix A Supplementary Data), either in individuals’ homes or worksites (e.g., fishing organization headquarters, shoreline) in urban Pudeto, peri-urban La Pasarela, and rural Pupelde—the three main sectors that border the estuary. We approached every house and experienced two refusals. We surveyed the household member who was present. Most often only one adult was present. In seven households, we surveyed two members because both were available and presented distinct livelihoods related to the estuary (e.g., diving for shellfish to sell, collecting algae for subsistence).

2.2.2.1. Sample of estuary residents surveyed. We surveyed 168 residents (71 women and 97 men) ranging in age from 16 to 82 years, with an average age of 48. Survey participants had lived along the estuary from less than a year to 82 years, with an average duration of 20 years. The sample covered the range of livelihoods representative of the study

Fig. 3. The sources of livelihood of the small-scale fisher key informants we interviewed. In order to identify potential ESs and management interventions to include in the survey questionnaire, we first spoke with people whose livelihoods and ways of life depended directly on the estuary.

Table 1
The field research methods, questions asked, and types of responses elicited and analyzed in order to assess people's perceptions of different ecosystem services and management options.

Field research method	Questions asked	Type of response
Qualitative phase		
Participatory mapping with indigenous community members ($n = 6$)	What does the estuary provide for you and your family?	Qualitative, coded and tallied (Section 2.2.1)
Semi-structured interviews with small-scale fishers ($n = 41$)	What, if anything, does the estuary provide beyond livelihood sources and food?	
	What would you like to see change or remain the same in the estuary?	
	How do you envision the future of the estuary?	
	What new uses or changes might appear?	
Quantitative phase	What tradeoffs, if any, do you perceive among existing or projected uses of the estuary?	Continuous scale from +10 to -10 (Section 2.2.2)
	Survey of people who resided or worked in the estuary ($n = 168$)	
	Ecosystem services (list of 17)	
	How important is each aspect for the wellbeing of you and your family?	
	In what situation or state is each of the aspects today?	
Management interventions (list of 10)	What would be the impact on the wellbeing of you and your family following each change?	Qualitative, coded and tallied* (Section 2.2.2)
	What would be the impact on the environment following each change?	
	What do you think would change?*	
	*Follow-up used for responses between -7 and -10 and 7 and 10	

area. We categorized participants according to main source of livelihood (Section 2.2.2.3). As Fig. 4 shows, eighty-six participants (51%) depended directly on shellfish, *Gracilaria* sp. algae, fish, or a combination of coastal and marine provisioning services from the estuary. We categorized these participants as *estuarine*. Fifty-eight participants (35%) earned relatively steady incomes as wage workers (e.g., processing plant workers, people with work contracts), pension earners, taxi drivers, electricians, and mechanics who depended indirectly on provisioning, regulating, and supporting ESs. We categorized these participants as *wage earners*. Twenty-four participants (14%) sold natural resources from forests (e.g., *Sphagnum* moss, timber), worked as farmers, carpenters, and artisans who, overall, depended more directly on terrestrial supporting, regulating, and provisioning services. Two participants sold seafood caught from areas other than the estuary and one worked as a tourism operator. We categorized these three participants as *other* because they relied on ESs beyond those immediately provided by the estuary (Fig. 4).

2.2.2.2. Design of survey questionnaire. We included the 17 ESs and ten interventions identified through participatory mapping and key informant interviews in a survey questionnaire (Fig. 2, Table 1, Appendix A

Fig. 4. Number and percentages of survey participants, or ES users, grouped according to main source of livelihood. Participants categorized as *estuarine* depended directly on shellfish, *Gracilaria* sp. algae, fish, or a combination of coastal and marine provisioning services from the estuary. *Wage earners* earned relatively steady incomes as wage workers, pension earners, taxi drivers, electricians, and mechanics who depended indirectly on provisioning, regulating, and supporting ESs. Participants categorized as *other* included farmers, carpenters, artisans, people who sold natural resources from forests (e.g., *Sphagnum* moss, timber), two people who sold seafood caught from areas other than the estuary, and one tourism operator. We categorized these latter three as *other* because they relied on ESs beyond those immediately provided by the estuary. Overall, participants categorized as *other* depended more directly on terrestrial supporting, regulating, and provisioning services.

Supplementary Data). To improve question wording and ensure fluidity, we piloted the questionnaire with a similar population in a different part of the municipality. As opposed to open-ended questions that had allowed informants to respond in their own words, the survey questionnaire mainly included closed questions where participants moved a scale to mark responses.

The questionnaire included:

- A Google Earth image that defined the estuary and its coastal zone.
- Closed questions to assess the perceived importance of each service to personal and familial wellbeing, and the perceived state of each service in terms of provision (Table 1). We asked participants to indicate how important each of the 17 aspects of the Pudeto estuary proved to be for her or his wellbeing and that of her or his family. To mark responses, we used a continuous scale with two anchor points denoted by a happy and sad face — “very important” and “not important”, and a clear “indifference” line in the middle. We then asked participants to express the current state of each ES on the continuous scale, with two anchor points, “excellent” and “terrible”, and a clear “indifference” or “unsure” line in the middle.
- Closed questions to assess perceived impacts following ten plausible interventions in the estuary (Table 1). We asked participants to indicate how each intervention would impact her or his wellbeing and that of her or his family, and how the intervention would impact the environment. We marked responses using a continuous scale with two anchor points, “excellent” and “terrible”, and a clear “indifference” or “unsure” line in the middle.
- Responses could be marked from -10 to 10. We chose this scale because participants could intuitively move the scale's marker either positively or negatively away from the zero indifference or “I don't know” line, or toward the anchor points denoted by the happy and sad faces.
- For responses marked between -7 and -10 or 7 and 10 for the ten interventions, we followed up with the question, “What do you think would change?” to record reasons behind perceived impacts on the environment and future wellbeing (Table 1).

2.2.2.3. Survey data analysis. We analyzed survey data using Microsoft Excel, SPSS, and R. We grouped participants into three categories based on their main source of livelihood: *estuarine* (86 people, 51%), *wage earners* (58 people, 35%), and *other* (24 people, 14%) (Section 2.2.2.1). We chose to group participants according to main sources of livelihood because, in the initial qualitative research phase, we found that livelihoods best explained residents' relationships to the estuary and captured other differences (e.g., age and gender; access

to ESs) (Section 2.2.1). In the seven cases where we surveyed two people per household, we grouped participants according to the households' main source of livelihood (Section 2.2.2).

To compare mean scores among the three livelihood groups, we used a Kruskal-Wallis H test with Dunn's posteriori tests (Rice, 1989; Elliott and Woodward, 2007; IBM SPSS 24). Written-in reasons behind scores between -7 and -10 and 7 and 10 for interventions were coded to compose main categories of responses and then tabulated to assess response frequency (Saldaña, 2013).

3. Results

3.1. Ecosystem services and plausible interventions identified

Key informants in the qualitative research phase identified a range of benefits granted by the estuary. The participatory mapping exercise yielded a list of 17 benefits, or ESs, associated with the estuary—each of which were mentioned by at least one informant in interviews (Tables 2 and 3). Informants conveyed several potential interventions for the estuary, which ranged from expanding (e.g., more algal farms) or renewing (e.g., reseeded shellfish banks) existing uses to introducing new uses (e.g., small-scale tourism, mussel farming) (Tables 4 and 5).

3.2. Ecosystem service users grouped according to livelihoods

The sample population surveyed included three main types of ES users: *estuarine*, whose livelihoods depended directly on marine and coastal provisioning ESs from the Pudeto estuary; *wage earners*, whose livelihoods depended indirectly on ESs; and, *other*, whose livelihoods depended more directly on regulating and supporting ESs (Fig. 4, Section 2.2.2.1). *Estuarine* users ($n = 86$) often applied strategies to ride out resource variability (e.g., switching between resources, adding value to resources, supplementing income with other activities) given the seasonal and unstable nature of their work. *Wage earners* ($n = 58$), in contrast, earned more stable income. While *wage earners* did not depend directly on marine and coastal ESs, some *wage earners* fished or gathered edible algae and shellfish for subsistence. Overall, *other* users ($n = 24$) depended more directly on terrestrial supporting, regulating, and provisioning services (e.g., native forest from which carpenters build, vegetable

fibers from which artisans make crafts, farmers who depended on wetlands and peatlands for freshwater reservoirs). Nearly all in the *other* livelihood group worked independently without a work contract, much like *estuarine* users.

3.3. Perceived importance of ecosystem services to wellbeing

Mean scores for importance ranged from near zero (unsure or indifferent) to near ten (very important) (Tables 2 and 3). The ES perceived as most important to wellbeing, by far, was scenic beauty (Table 2). This result was consistent across livelihood groups. Survey participants shared similar perceptions on importance to wellbeing for nine ESs (Table 2), while perceptions differed significantly ($P < 0.046$) for eight ESs (Table 3). For these differences, *estuarine* users' scores for importance of ESs were significantly higher than those of *wage earners*. As expected, *estuarine* users' mean score for perceived importance of the commercial algae *Gracilaria* was significantly higher than both *wage earner* and *other* users' scores for this provisioning ES (Table 3). *Estuarine* and *other* users' scores for perceived importance of the estuary as spiritual space were higher than *wage earners*' mean score for this cultural ES (Table 3).

3.4. Perceived states of ecosystem services

Survey participants shared similar perceptions of the states of 13 of 17 ESs (Tables 2 and 3). Overall, participants perceived most ESs in a somewhat positive state. Scenic beauty stood out as being perceived in an excellent state. Participants perceived tidal flow of salt water, ability to navigate the estuary, and variety and number of birds in good states (Tables 2 and 3). Overall, the estuary's ability to eliminate gray water and drainage from houses was the only ES perceived in a poor state (negative mean score) (Table 2). Mean scores were near zero for the states of other commercial algae, which most participants marked as zero (unsure), and wetlands and peatlands that serve as freshwater reservoirs, where participants' scores appeared across the spectrum (Table 2).

Perceptions regarding the state of ESs differed significantly ($P < 0.038$) among the livelihood groups in four cases (Table 3). *Other* ES users perceived the state of the estuary as a spiritual space in a significantly better state than did *wage earners*. *Other* ES users also

Table 2

Similarities in livelihood groups' mean scores for perceived importance of different ecosystem services to wellbeing (left columns) and perceived state of each service (right columns).

Category of ecosystem service	Ecosystem service	Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	Perceived importance to wellbeing			Perceived state of ecosystem service		
						P	Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	P
Cultural	Scenic beauty	9.2 (0.132)	9.3 (0.166)	8.9 (0.266)	9.2 (0.307)	0.771	8.2 (0.281)	7.8 (0.435)	8.7 (0.313)	8.3 (0.935)	0.548
Cultural	Variety and number of birds	6.5 (0.319)	6.8 (0.448)	6.0 (0.583)	6.6 (0.666)	0.357	4.8 (0.375)	5.1 (0.576)	4.3 (0.618)	5.3 (0.658)	0.298
Provisioning	Presence of edible algae (luche, cochayuyo)	5.7 (0.387)	5.9 (0.567)	5.5 (0.656)	5.5 (0.871)	0.544	2.6 (0.478)	2.0 (0.719)	2.9 (0.778)	4.1 (0.997)	0.515
Regulating	Tidal flow of salt water in the river	5.6 (0.386)	6.5 (0.485)	5.0 (0.732)	4.0 (0.987)	0.055	5.1 (0.407)	5.7 (0.530)	4.3 (0.797)	5.0 (0.868)	0.417
Provisioning, regulating, supporting	Wetlands and peat lands that serve as reservoirs of freshwater	5.1 (0.415)	5.7 (0.578)	4.7 (0.747)	4.0 (0.918)	0.075	0.4 (0.456)	0.4 (0.638)	0.0 (0.774)	1.6 (1.228)	0.56
Regulating	Ability to eliminate greywater and drainage from houses	2.1 (0.597)	2.8 (0.839)	2.7 (0.956)	−1.8 (1.592)	0.051	−0.7 (0.583)	−0.5 (0.859)	0.2 (0.951)	−3.2 (1.309)	0.159
Provisioning	Presence of other commercial algae (luga)	1.8 (0.532)	2.7 (0.755)	0.6 (0.864)	1.2 (1.437)	0.088	0.4 (0.438)	0.1 (0.669)	0.1 (0.666)	2.2 (0.998)	0.188

Size of livelihood groups: Total $n = 168$, Estuarine $n = 86$, Wage earner $n = 58$, and Other $n = 24$. Survey participants marked responses on a continuous line with two anchor points "not important at all" or "not good at all" ($= -10$) and "very important" or "very good" ($= 10$), and a clear "indifference" or "I don't know" line in the middle ($= 0$). Responses were recorded as positive or negative distances from the central zero point.

Table 3
Differences among livelihood groups' mean scores for perceived importance of different ecosystem services to wellbeing (left columns) and perceived state of each service (right columns).

Category of ecosystem service	Ecosystem Service	Perceived importance to wellbeing					Perceived state of ecosystem service				
		Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	P	Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	P
Cultural	Space to recreate and practice sports	6.3 (0.418)	6.9a (0.545)	4.8b (0.842)	7.6 (0.557)	0.043 **	3.2 (0.526)	2.7 (0.769)	2.8 (0.906)	6.2 (0.931)	0.088
Provisioning, regulating, supporting	Support for the growth of native forest	6.2 (0.376)	6.4 (0.570)	6.0 (0.559)	6.1 (1.006)	0.423	2.6 (0.434)	1.7b (0.665)	3.1 (0.584)	4.9a (1.14)	0.033 **
Cultural, potentially provisioning	Space to develop tourism	6.1 (0.460)	7.1a (0.557)	4.9b (0.875)	5.5 (1.323)	0.046 **	2.3 (0.530)	1.3 (0.771)	2.6 (0.874)	5.2 (1.127)	0.095
Provisioning	Presence of natural shellfish banks (mussels, clams, oysters)	5.9 (0.378)	6.9a (0.456)	4.3b (0.734)	5.9 (0.902)	0.001 ***	3.5 (0.378)	3.7 (0.544)	2.5 (0.659)	5.2 (0.704)	0.082
Cultural	Spiritual space	5.7 (0.413)	6.3a (0.561)	4.1b (0.731)	7.4a (0.936)	≤0.033 **	3.5 (0.498)	3.7 (0.704)	2.1b (0.836)	6.4a (1.130)	0.006 **
Cultural	Space to practice traditional activities with family	5.5 (0.419)	6.8a (0.448)	3.7b (0.869)	5.4 (1.074)	0.011 **	3.2 (0.479)	3.1 (0.703)	2.4 (0.816)	5.2 (0.954)	0.224
Provisioning	Ability to navigate the estuary	5.5 (0.440)	7.4a (0.444)	2.7b (0.872)	5.4 (1.139)	0.000 ***	5.0 (0.433)	5.4 (0.629)	4.4 (0.727)	5.3 (1.040)	0.347
Provisioning	Presence of fish (robalo, pejerrey)	5.2 (0.410)	6.1a (0.520)	3.9b (0.765)	4.8 (1.076)	0.022 **	3.4 (0.399)	3.88a (0.577)	2.16b (0.673)	4.6 (0.833)	0.038 **
Provisioning	Quantity and quality of commercial algae <i>Gracilaria</i> (pelillo)	3.7 (0.494)	6.2a (0.573)	1.0b (0.843)	1.5b (1.373)	≤0.002 ***	1.5 (0.408)	1.3 (0.574)	1.4 (0.679)	2.9 (1.102)	0.37
Provisioning, cultural	Presence of vegetable fibers (junquillo, quilineja) to make crafts	3.1 (0.475)	2.6 (0.707)	2.8 (0.796)	5.6 (0.870)	0.149	4.1 (0.398)	4.6a (0.596)	2.9b (0.650)	5.2 (0.759)	0.037 **

Symbols show significant differences among group perceptions based on Kruskal-Wallis and Dunn's posteriori tests. Livelihood groups that are not statistically significant share the same letter.

Size of livelihood groups: Total $n = 168$. Estuarine $n = 86$, Wage earner $n = 58$, and Other $n = 24$. Survey participants marked responses on a continuous line with two anchor points "not important at all" or "not good at all" ($= -10$) and "very important" or "very good" ($= 10$), and a clear "indifference" or "I don't know" line in the middle ($= 0$). Responses were recorded as positive or negative distances from the central zero point.

** denotes p-values less than or equal to 0.05.

*** denotes p-values less than or equal to 0.005.

perceived the state of the estuary's support in the growth of native forest significantly better than did *estuarine* users. *Estuarine* users perceived the presence of vegetable fibers (e.g., *Juncus procerus* E. Mey., *Luzuriaga radicans*) and fish in significantly better states than did *wage earners* (Table 3).

3.5. Perceived impacts of interventions on wellbeing

Interventions fell into three categories based on perceived impacts on wellbeing (i.e., anchor points "excellent" and "terrible"): those perceived as having strongly positive impacts, those having fairly positive impacts, and those whose means averaged near zero (Tables 4 and 5).

Strongly positive: Participants perceived that developing small-scale tourism, creating a protected area for nature, and installing a lookout point for birds would positively impact their own wellbeing and that of their families (Table 4). Mean scores >7.5 across livelihood groups indicate that nearly everyone strongly supported tourism and conservation interventions. As expected, *estuarine* users showed significantly strong support ($P \leq 0.014$) for expanding *Gracilaria* algal farms and reseeded shellfish banks—resources on which they depend for income (Table 5). Interestingly, *wage earner* and *other* users perceived that these estuary-specific interventions would positively impact their wellbeing (Table 5).

Fairly positive: Participants across livelihood groups perceived that introducing a mussel seed farm and installing another shellfish processing

Table 4
Similarities in livelihood groups' mean scores for how potential interventions would impact personal and familial wellbeing (left columns) and the environment (right columns).

Typology	Intervention	Perceived impact on wellbeing					Perceived impact on the environment				
		Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	P	Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)	P
New use	Development of small scale tourism	7.6 (0.263)	7.5 (0.365)	7.7 (0.400)	7.4 (0.893)	0.926	4.8 (0.332)	5.0 (0.464)	4.4 (0.569)	5.1 (0.885)	0.547
Conservation	Creation of a protected area for nature	7.5 (0.271)	7.3 (0.414)	7.8 (0.334)	7.7 (0.881)	0.722	5.0 (0.344)	5.2 (0.481)	4.7 (0.546)	4.5 (1.065)	0.632
Conservation	Installation of a lookout point to observe birds	7.5 (0.228)	7.6 (0.315)	7.2 (0.425)	8.3 (0.461)	0.331	4.8 (0.329)	5.0 (0.450)	4.2 (0.581)	5.4 (0.866)	0.431
New use	Establishment of a mussel farm (seed)	4.8 (0.448)	5.4 (0.644)	4.3 (0.730)	4.0 (1.193)	0.102	2.3 (0.359)	2.9 (0.534)	1.6 (0.549)	2.0 (0.923)	0.344
Expand use	Installation of a new shellfish processing plant	4.2 (0.499)	4.5 (0.695)	5.0 (0.705)	1.3 (1.683)	0.261	0.3 (0.460)	0.1 (0.623)	1.0 (0.783)	-0.7 (1.350)	0.389
New use	Establishment of a salmon farm (smolt)	0.2 (0.575)	-0.9 (0.829)	2.0 (0.899)	0.1 (1.537)	0.192	-2.2 (0.494)	-3.4 (0.692)	-0.8 (0.793)	-1.2 (1.353)	0.078
Development	Filling wetlands to build roads and houses	-0.7 (0.546)	-0.2 (0.736)	-1.6 (0.993)	-0.1 (1.391)	0.465	-3.6 (0.493)	-3.1 (0.715)	-4.4 (0.795)	-3.8 (1.305)	0.469

Size of livelihood groups: Total $n = 168$. Estuarine $n = 86$, Wage earner $n = 58$, and Other $n = 24$. Survey participants marked responses on a continuous line with two anchor points "not important at all" or "not good at all" ($= -10$) and "very important" or "very good" ($= 10$), and a clear "indifference" or "I don't know" line in the middle ($= 0$). Responses were recorded as positive or negative distances from the central zero point.

Table 5

Differences among livelihood groups' mean scores for how potential interventions would impact personal and familial wellbeing (left columns) and the environment (right columns).

Typology	Intervention	Perceived impact on wellbeing					P	Perceived impact on the environment					P
		Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)			Total n (SE)	Estuarine (SE)	Wage earner (SE)	Other (SE)		
Expand use	More <i>Gracilaria</i> algal farms	7.0 (0.334)	8.7a (0.197)	5.5b (0.651)	4.3b (1.267)	≤0.001	***	3.3 (0.337)	4.0 (0.518)	2.3 (0.460)	3.2 (0.878)		0.082
Renew use	Reseeding natural shellfish banks	7.0 (0.319)	8.0a (0.358)	5.8b (0.629)	6.1b (0.885)	≤0.014	**	3.9 (0.350)	4.6 (0.498)	3.1 (0.594)	3.7 (0.840)		0.180
Restrict use	Establishment of territorial user rights fishery	1.9 (0.549)	0.5b (0.837)	4.1a (0.717)	1.5 (1.456)	0.028	**	0.8 (0.406)	0.3 (0.624)	1.2 (0.588)	1.3 (1.044)		0.576

Symbols show significant differences among group perceptions based on Kruskal-Wallis and Dunn's posteriori tests. Livelihood groups that are not statistically significant share the same letter.

Size of livelihood groups: Total $n = 168$, Estuarine $n = 86$, Wage earner $n = 58$, and Other $n = 24$. Survey participants marked responses on a continuous line with two anchor points "not important at all" or "not good at all" ($= -10$) and "very important" or "very good" ($= 10$), and a clear "indifference" or "I don't know" line in the middle ($= 0$). Responses were recorded as positive or negative distances from the central zero point.

plant near the estuary would have fairly positive impacts on wellbeing (Table 4). Larger standard errors of scores for these interventions indicate greater variation of perceived benefits within the livelihood groups.

Near zero: Mean scores for perceived impacts on wellbeing from establishing territorial user rights, introducing a salmon farm, and filling wetlands were near zero (Tables 4 and 5). While several participants marked wellbeing impacts at zero (unsure or indifferent), overall, scores appeared polarized—either negative or positive, thus averaging to zero.

Establishing territorial user rights in the estuary's shellfish banks garnered the most divergent scores among livelihood groups (Table 5). *Wage earners* perceived significantly more positive impacts on wellbeing ($P < 0.028$) from restricting access to shellfisheries than did *estuarine* users (Table 5). Roughly half of *estuarine* users perceived positive impacts on wellbeing from restricting access, while half perceived extremely negative impacts (Fig. 5). Similarly, introducing a salmon smolt farm in the estuary incited polarized scores; participants were split on whether a salmon farm would have negative or positive impacts on wellbeing (Fig. 5). Only one intervention garnered negative wellbeing scores from all livelihood groups: filling wetlands to build infrastructure. However, larger standard errors point to greater variation within groups (Table 4). Indeed, several participants perceived that filling wetlands would positively impact wellbeing; hence, mean scores averaged near zero (Fig. 5).

3.6. Perceived impacts of interventions on the environment

The people surveyed similarly perceived how the ten interventions would affect the environment (Tables 4 and 5). People perceived that creating a protected nature area, developing small-scale tourism, installing a bird lookout point, reseeded shellfish banks, expanding *Gracilaria* algal farms, and introducing a mussel farm would positively impact the environment. Mean scores for perceived environmental impacts were near zero for installing a new processing plant and establishing territorial user rights for shellfisheries (Tables 4 and 5). For these interventions, responses clustered at zero; that is, people were unsure or did not know how a processing plant or territorial user rights would impact the environment.

4. Discussion

The empirical evidence we present in this article conveys a broader understanding of people's demand for ESs. We argue that knowledge of environmental perceptions helps to connect ES modeling (i.e., tools that estimate the supply of ESs given biophysical constraints) with valuation methods (i.e., tools to understand people's demand for ESs). Our analysis suggests that an understanding of how people perceive the importance of different ESs, their states (e.g., doing well, needs

improvement), and management options may usefully guide ecosystem modeling and management efforts in three key ways.

4.1. Defining which ESs to enter into models and tradeoff analyses (i.e., what matters most?)

Understanding how people perceive the importance of different ESs to wellbeing may help to define which ESs matter most and to whom. Analysts may then enter ESs identified as priorities into models that estimate the provision of those ESs under different management scenarios and given biophysical constraints. In this way, analysts could focus on ESs perceived as priorities. While this point may seem obvious, it is not always apparent what people perceive as most important to wellbeing. For example, through this study we found that the 168 people surveyed overwhelmingly perceived scenic beauty as most important to wellbeing (Section 3.3). We did not expect this result, and discuss this in more detail in another paper (T.L. Elwell, D. López-Carr, S. Gelcich, and S.D. Gaines, *unpublished manuscript*). With ES priorities defined, practitioners and researchers may explore how other ESs interact with those perceived as most important to wellbeing (Raudsepp-Hearne et al., 2010; Martín-López et al., 2012) and consider how different management interventions could impact priority ESs (Polasky et al., 2008; Guerry et al., 2012; Arkema et al., 2015; Ruckelshaus et al., 2015). In this case, for example, we might ask which ESs, if any, potentially trade off with or contribute to scenic beauty, and how different management interventions could impact this cultural ES. In sum, knowing which ESs people perceive as most important to wellbeing could potentially save time by focus modeling efforts toward what truly matters to stakeholders.

At the same time, we assert the complexity inherent in defining which ESs matter most to people. Perceptions change (Gelcich and O'Keefe, 2016). People tend to perceive things (e.g., endangered species) as more valuable as they become more scarce (Hall et al., 2008). Furthermore, and perhaps most importantly, world views shape environmental perceptions (Tuan, 1974). From perspectives in which ecosystems and their different aspects are conceived as whole unit entities, human wellbeing corresponds with the wellbeing of ecosystems in their entirety: they are inextricably interrelated (Escobar, 2014; Escobar, 2015; Chan et al., 2016). In asking participants to convey the importance of different aspects of an ecosystem (i.e., different ecosystem services), we assumed that the importance of each aspect could be considered individually; however, participants were free to convey the same level of importance for any of the ESs (Section 2.2.2.2). Yet, how amenable are ES approaches and valuation methods to world views in which everything is inextricably interrelated? Future research may better integrate insights from anthropologists, among others, in order to design conceptual frameworks and assessments of ESs that

Fig. 5. Histograms (a)–(f) that show frequency distributions of survey participants' and *estuarine* users' scores (marked on a continuous scale from –10 “not good” to 10 “very good” with a clear “indifferent” or “I don't know” line at zero) for perceived impacts on wellbeing following the establishment of a territorial user rights shellfishery, the establishment of a salmon farm, and filling wetlands to build infrastructure (Tables 4 and 5). The scores show more or less bimodal distributions, or polarized perceptions, that averaged near zero and indicate potential controversy (Sections 3.5 and 4.3). (a) Total survey participants' ($n = 168$) perceived impacts on wellbeing following the establishment of territorial user rights for shellfish banks. (b) *Estuarine* users' ($n = 86$) perceived impacts on wellbeing following the establishment of territorial user rights for shellfish banks. (c) Total survey participants' ($n = 168$) perceived impacts on wellbeing following the establishment of a salmon farm. (d) *Estuarine* users' ($n = 86$) perceived impacts on wellbeing following the establishment of a salmon farm. (e) Total survey participants' ($n = 168$) perceived impacts on wellbeing following the filling of wetlands to build roads and houses. (f) *Estuarine* users' ($n = 86$) perceived impacts on wellbeing following the filling of wetlands to build roads and houses.

are more inclusive of diverse world views and notions of human wellbeing (Díaz et al., 2015; Chan et al., 2016; Díaz et al., 2018).

4.2. Guiding where to focus management efforts (i.e., what matters yet needs improvement?)

Understanding how people perceive the states of ESs in relation to perceived importance may allow managers and other practitioners to see where to focus efforts. Plotting the perceived states of ESs (e.g., doing well, in a mediocre state, doing poorly) and perceived importance of ESs to wellbeing (e.g., very important, somewhat important, not important) allowed us to see that participants perceived several ESs as very important yet in need of improvement (Sections 3.3 and 3.4). A

quadrant drawn onto the plot highlights where managers and other practitioners may focus management efforts toward improved wellbeing (Fig. 6). For example, we found that survey participants perceived scenic beauty, the most highly valued ES, in an excellent state (Table 2, Fig. 6). In contrast, participants perceived several ESs (e.g., space to develop small-scale tourism, space to recreate) as very important to wellbeing yet in mediocre states (Tables 2 and 3, Fig. 6). ESs perceived as important but in mediocre states suggest potential room for improvement. Managers and other practitioners may then use qualitative methods (e.g., focus groups, interviews) to delve into the reasoning behind people's perceptions (Fig. 2, Section 2.2.2.2). For instance, does the perceived state of an ES concern an ability to access that ES, its links with other ESs, or its quality? In exploring these

Fig. 6. Mean scores of perceived importance and state of ecosystem services (continuous scale from -10 to $+10$) for the total survey sample population ($n = 168$). The quadrant indicates ecosystem services perceived as (a) somewhat important, in good state; (b) very important, in good state; (c) somewhat important, in mediocre state; and, (d) very important, in mediocre state. The location of an overlaid quadrant may vary according to the location of scores. Here, we drew the quadrant in the upper right corner because participants perceived nearly all 17 ecosystem services as important to wellbeing and in good or mediocre states (i.e., positive values).

questions, models of ESs would allow for comparisons between actual versus perceived states of ESs. Answers to such questions may help practitioners and researchers design management strategies that better address shortcomings in ES perceived as important yet in mediocre or poor states (Gelcich and O’Keeffe, 2016). Similarly, perceptions may be assessed again following management interventions in order to evaluate any changes in how people perceive the states of targeted ESs.

4.3. Anticipating support or controversy surrounding management interventions

Finally, understanding how people perceive the ways in which different management interventions would impact the environment and future wellbeing may help managers and other practitioners anticipate potential controversy or support. Significant differences among people’s perceptions point to potential controversies, while similarities point to interventions with potential widespread support (Tables 4 and 5, Section 3.5). Qualitative field research methods, particularly those that help practitioners and researchers understand the historical context of social-ecological systems, shed light on reasons behind differences and similarities (Fig. 2) (McClanahan and Abunge, 2015; Bennett, 2016; Berbés-Blázquez et al., 2016).

For example, we found that survey participants similarly perceived the states of ESs (Tables 2 and 3), yet held different opinions on how to manage shellfish and *Gracilaria* algae (Table 5). As expected, *estuarine* users strongly supported expanding algal farms and reseeded shellfisheries, yet were polarized on establishing territorial user rights for shellfisheries (TURF) (Table 5, Fig. 5). While most participants could potentially access benefits from expanding algal farms and reseeded shellfisheries (i.e., more algae accessible via drift, more shellfish in open access waters), a TURF would spatially allocate shellfish harvesting rights, thus including some people while excluding others (Christy, 1982; Gelcich et al., 2006). Given the survey questionnaire wording, participants did not know if they would be able to access potential benefits (Appendix A Supplementary data). Access would largely depend on whether or not participants belonged to an organization that obtained *de jure* rights to the TURF. This example underlines a type of tradeoff that involves winners and losers because of differing abilities to access ESs (Leach et al., 1999; Daw et al., 2011; Vira et al., 2012;

Halpern et al., 2013; Hicks and Cinner, 2014; Daw et al., 2015; Wieland et al., 2016; Berbés-Blázquez et al., 2016). In such cases, participants need specific details surrounding the management intervention in order to judge how they think future wellbeing would change as a result.

Alternatively, knowledge of perceptions may shed light on interventions that garner widespread support, in spite of varying dependencies on ESs. Here, both *wage earner* and *other* users favored expanding *Gracilaria* algal farms—an intervention specific to *estuarine* users who sell the algae (Table 5). We did not expect this result; however, our familiarity with the historical context of the social-ecological system allowed us to understand why participants whose livelihoods did not depend on the estuary supported this estuary-specific intervention (Fig. 2, Section 2.2.1). When *Gracilaria* booms, people, regardless of livelihood, extract the algae. These boom and bust cycles create a variable population of extractors. The study area, like many natural resource-dependent places, developed around booms and busts (Grenier, 1984) (Section 2.1). Given this history, it is likely that non-estuarine users perceived the expansion of algal farms as an opportunity to supplement income. Furthermore, survey participants’ interpretations of personal and familial wellbeing played a role in reasoning (Table 1, Section 2.2.2.2). Some participants explained that expanding algal farms signified more work for more people, thereby increasing the wellbeing of the broader community. Others reasoned that more algae would expand habitat for shellfish and fish. In sum, participants surmised that expanding algal farms would positively impact wellbeing in different ways (e.g., an opportunity to supplement income, more algae habitat to support fish and shellfish, a livelihood source for fellow residents). This finding indicates that people’s perceptions vary along with their interpretations of wellbeing, which further underscores the importance of incorporating diverse world views and notions of human wellbeing into conceptual frameworks and assessments of ESs (Section 4.1) (Díaz et al., 2015; Chan et al., 2016; Díaz et al., 2018).

Perceived impacts following an intervention involve multiple dimensions (e.g., quality, provision, and access to ESs; personal and familial wellbeing) and may or may not correctly forecast any changes in ESs. Models that project the provision of ESs under different management scenarios may help practitioners and researchers assess how perceived impacts compare with model-estimated impacts (White et al., 2012;

Lester et al., 2013). Perceived impacts that differ greatly from actual impacts flag a need for better science (e.g., more robust models that project ESs under different management scenarios, biophysical tradeoff analyses that consider management constraints) or a need to better communicate science (Bennett et al., 2015).

5. Conclusion

Establishing better links between ES modeling and valuation methods is critical for leveraging the full potential of these two rapidly advancing, yet largely disconnected, lines of research. The empirical data we present here shows how knowledge of people's perceptions of different ESs and management options may guide ecosystem modeling and management efforts by helping to define which ESs to enter into models, highlight where to focus management efforts, and anticipate potential support or controversy surrounding management interventions. In this way, our study explicitly bridges ES valuation methods (i.e., tools that assess demand for nature's benefits, which we examined through people's perceived importance of ESs to wellbeing) with modeling and tradeoff analyses (i.e., tools that project supply of nature's benefits given biophysical constraints). As our findings indicate, different world views and notions of human wellbeing require more attention in ES approaches. Future research may examine how different interpretations of wellbeing affect people's perceptions of ESs and their management. At the same time, there is a dire need for studies that convey lessons learned in applying ES approaches to actual decision-making processes that involve interests, power, and politics at different scales of space and time (Kingdon, 1995; Sabatier, 1999), as well as diverse world views and notions of human wellbeing. Such insights, gleaned from experiences, would help to move environmental decision-making processes toward better outcomes for diverse ecosystems and people.

Acknowledgments

We thank research participants who made this study possible, Alvaro Montaña Soto and Christian Guzmán Lagos for help with figures, and Samuel Yang and Justin Suarez for help with data entry and analysis. Comments from Barbara Walker, Peter Alagona, and three anonymous reviewers helped us improve the manuscript. Fulbright Chile, the University of California (UC) Pacific Rim Research Program, Conference of Latin Americanist Geographers, Sara's Wish Foundation, and Mellon Foundation Sawyer Seminars supported field research and UC Santa Barbara's Department of Geography, Graduate Division, and Affiliates funded writing time. SG thanks The Walton Family Foundation, Basal 0002, and Núcleo Milenio NC-120086.

Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version, at <https://doi.org/10.1016/j.scitotenv.2018.04.052>. These data include Google map of the most important areas described in this article.

References

Andres, B.A., Johnson, J.A., Valenzuela Rojas, J., Morrison, R.G., Espinosa, L.A., Ross, R.K., 2009. Estimating eastern Pacific coast populations of Whimbrels and Hudsonian Godwits, with an emphasis on Chiloé Island, Chile. *Waterbirds* 32 (2):216–224. <https://doi.org/10.1675/063.032.0202>.

Arkema, K.K., Verutes, G.M., Wood, S.A., Clarke-Samuels, C., Rosado, S., Canto, M., ... Guerry, A.D., 2015. Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. *Proc. Natl. Acad. Sci.* 112 (24):7390–7395. <https://doi.org/10.1073/pnas.1406483112>.

Bennett, Nathan James, 2016. Using perceptions as evidence to improve conservation and environmental management. *Conserv. Biol.* 30 (3):582–592. <https://doi.org/10.1111/cobi.12681>.

Bennett, E.M., Cramer, W., Begossi, A., Cundill, G., Díaz, S., Egoh, B.N., ... Woodward, G., 2015. Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. *Open Issue* 14:76–85. <https://doi.org/10.1016/j.cosust.2015.03.007>.

Berbés-Blázquez, Marta, González, José A., Pascual, Unai, 2016. Towards an ecosystem services approach that addresses social power relations. *Curr. Opin. Environ. Sustain.* 19: 134–143. <https://doi.org/10.1016/j.cosust.2016.02.003>.

Bockstael, Erika, Bahia, Natália C.F., Seixas, Cristiana S., Berkes, Fikret, 2016. Participation in protected area management planning in coastal Brazil. *Environ. Sci. Pol.* 60:1–10. <https://doi.org/10.1016/j.envsci.2016.02.014>.

Bratman, G.N., Hamilton, J.P., Daily, G.C., 2012. The impacts of nature experience on human cognitive function and mental health. *Ann. N. Y. Acad. Sci.* 1249 (1): 118–136. <https://doi.org/10.1111/j.1749-6632.2011.06400.x>.

Bratman, G.N., Daily, G.C., Levy, B.J., Gross, J.J., 2015. The benefits of nature experience: improved affect and cognition. *Landsc. Urban Plan.* 138:41–50. <https://doi.org/10.1016/j.landurbplan.2015.02.005>.

Cambridge Dictionary, 2016. <https://dictionary.cambridge.org/us/dictionary/english/perception?q=perceptions>, Accessed date: 1 March 2018.

Carr, D.L., 2003. Migración rural-rural y deforestación en la Reserva de la Biosfera Maya, Guatemala. *Método de entrevistas. Tiempos de América: revista de historia, cultura y territorio* 10, 19–27.

Cavender-Bares, J., Polasky, S., King, E., Balvanera, P., 2015. A sustainability framework for assessing trade-offs in ecosystem services. *Ecol. Soc.* 20 (1):17. <https://doi.org/10.5751/ES-06917-200117>.

Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., ... Turner, N., 2016. Opinion: why protect nature? Rethinking values and the environment. *Proc. Natl. Acad. Sci.* 113 (6):1462. <https://doi.org/10.1073/pnas.1525002113>.

Cheong, S.-M., Brown, D.G., Kok, K., López-Carr, D., 2012. Mixed methods in land change research: towards integration. *Trans. Inst. Br. Geogr.* 37 (1):8–12. <https://doi.org/10.1111/j.1475-5661.2011.00482.x>.

Christy, F.T., 1982. *Territorial Use Rights in Marine Fisheries: Definitions and Conditions*. Food and Agriculture Organization of the United Nations, Rome.

Clark, W.C., Dickson, N.M., 2003. Sustainability science: the emerging research program. *Proc. Natl. Acad. Sci.* 100 (14):8059–8061. <https://doi.org/10.1073/pnas.1231333100>.

Creswell, J.W., 2009. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 3rd ed. SAGE Publications, Inc Retrieved from. <http://www.ceil-conicet.gov.ar/wp-content/uploads/2015/10/Creswell-Cap-10.pdf>.

Daily, G.C., 2000. Management objectives for the protection of ecosystem services. *Environ. Sci. Pol.* 3 (6):333–339. [https://doi.org/10.1016/S1462-9011\(00\)00102-7](https://doi.org/10.1016/S1462-9011(00)00102-7).

Daw, T., Brown, K., Rosendo, S., Pomeroy, R., 2011. Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being. *Environ. Conserv.* 38 (04):370–379. <https://doi.org/10.1017/S0376892911000506>.

Daw, T.M., Coulthard, S., Cheung, W.W.L., Brown, K., Abunge, C., Galafassi, D., ... Munyi, L., 2015. Evaluating taboo trade-offs in ecosystems services and human well-being. *Proc. Natl. Acad. Sci.* 112 (22):6949. <https://doi.org/10.1073/pnas.1414900112>.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., ... Zlatanova, D., 2015. The IPBES Conceptual Framework – connecting nature and people. *Open Issue* 14:1–16. <https://doi.org/10.1016/j.cosust.2014.11.002>.

Díaz, Sandra, Unai, Pascual, Stenseke, Marie, Martín-López, Berta, Watson, Robert T., Molnár, Zolt., ... Shirayama, Yoshihisa, 2018. Assessing nature's contributions to people. *Science* 359 (6373):270–272. <https://doi.org/10.1126/science.aap8826>.

Elliott, Alan C., Woodward, W.A., 2007. *Statistical Analysis Quick Reference Guidebook: with SPSS Examples*. Sage, Thousand Oaks, Calif.

Escobar, Arturo, 2014. *La invención del desarrollo*. Universidad del Cauca, Popayán, Cauca, Colombia.

Escobar, Arturo, 2015. *Territorios de diferencia: la ontología política de los "derechos al territorio"*. Cuadernos de Antropología Social 41.

Estévez, R.A., Gelcich, S., 2015. Participative multi-criteria decision analysis in marine management and conservation: research progress and the challenge of integrating value judgments and uncertainty. *Mar. Policy* 61:1–7. <https://doi.org/10.1016/j.marpol.2015.06.022>.

Gelcich, S., O'Keeffe, J., 2016. Emerging frontiers in perceptions research for aquatic conservation. *Aquat. Conserv. Mar. Freshwat. Ecosyst.* 26 (5):986–994. <https://doi.org/10.1002/aqc.2714>.

Gelcich, S., Edwards-Jones, G., Kaiser, M.J., Watson, E., 2005. Using discourses for policy evaluation: the case of marine common property rights in Chile. *Soc. Nat. Resour.* 18 (4):377–391. <https://doi.org/10.1080/08941920590915279>.

Gelcich, S., Edwards-Jones, G., Kaiser, M.J., Castilla, J.C., 2006. Co-management policy can reduce resilience in traditionally managed marine ecosystems. *Ecosystems* 9 (6), 951–966.

Gelcich, S., Godoy, N., Castilla, J.C., 2009. Artisanal fishers' perceptions regarding coastal co-management policies in Chile and their potentials to scale-up marine biodiversity conservation. *Ocean Coast. Manag.* 52 (8):424–432. <https://doi.org/10.1016/j.ocecoaman.2009.07.005>.

Gobierno de Chile, 1991. *Ley de Pesca y Acuicultura*. Pub. L. No. Ley 18892 Retrieved from. <https://www.leychile.cl/Navegar?idNorma=30265>.

Gobierno de Chile, 2008. *Crea el Espacio Costero Marino de los Pueblos Originarios*. Pub. L. No. 20.249 Retrieved from. <https://www.leychile.cl/Navegar?idNorma=269291>.

Gould, R.K., Ardoin, N.M., Woodside, U., Satterfield, T., Hannahs, N., Daily, G.C., 2014. The forest has a story: cultural ecosystem services in Kona, Hawai'i. *Ecol. Soc.* 19 (3):55. <https://doi.org/10.5751/ES-06893-190355>.

Gould, R.K., Klain, S.C., Ardoin, N.M., Satterfield, T., Woodside, U., Hannahs, N., ... Chan, K.M., 2015. A protocol for eliciting nonmaterial values through a cultural ecosystem services frame. *Conserv. Biol.* 29 (2):575–586. <https://doi.org/10.1111/cobi.12407>.

- Grenier, P., 1984. *Chiloé et les Chilotes: marginalité et dépendance en Patagonie chilienne: étude de géographie humaine*.
- de Groot, Mirjam, de Groot, Wouter T., 2009. "Room for river" measures and public visions in the Netherlands: a survey on river perceptions among riverside residents. *Water Resour. Res.* 45 (W07403). <https://doi.org/10.1029/2008WR007339>.
- Guerry, A.D., Ruckelshaus, M.H., Arkema, K.K., Bernhardt, J.R., Guannel, G., Kim, C.-K., ... Spencer, J., 2012. Modeling benefits from nature: using ecosystem services to inform coastal and marine spatial planning. *Int. J. Biol. Sci.* 8 (1–2):107–121. <https://doi.org/10.1080/21513732.2011.647835>.
- Guerry, A.D., Polasky, S., Lubchenko, J., Chaplin-Kramer, R., Daily, G.C., Griffin, R., ... Vira, B., 2015. Natural capital and ecosystem services informing decisions: from promise to practice. *Proc. Natl. Acad. Sci.* 112 (24):7348–7355. <https://doi.org/10.1073/pnas.1503751112>.
- Hall, R.J., Milner-Gulland, E.J., Courchamp, F., 2008. Endangering the endangered: the effects of perceived rarity on species exploitation. *Conserv. Lett.* 1 (2):75–81. <https://doi.org/10.1111/j.1755-263X.2008.00013.x>.
- Halpern, B.S., Klein, C.J., Brown, C.J., Beger, M., Grantham, H.S., Mangubhai, S., ... Possingham, H.P., 2013. Achieving the triple bottom line in the face of inherent trade-offs among social equity, economic return, and conservation. *Proc. Natl. Acad. Sci.* 110 (15):6229–6234. <https://doi.org/10.1073/pnas.1217689110>.
- Hicks, C.C., Cinner, J.E., 2014. Social, institutional, and knowledge mechanisms mediate diverse ecosystem service benefits from coral reefs. *Proc. Natl. Acad. Sci.* 111 (50):17791–17796. <https://doi.org/10.1073/pnas.1413473111>.
- Hicks, C.C., Graham, N.A.J., Cinner, J.E., 2013. Synergies and tradeoffs in how managers, scientists, and fishers value coral reef ecosystem services. *Glob. Environ. Chang.* 23 (6):1444–1453. <https://doi.org/10.1016/j.gloenvcha.2013.07.028>.
- Hicks, C.C., Cinner, J.E., Stoeckl, N., McClanahan, T.R., 2015. Linking ecosystem services and human-values theory. *Conserv. Biol.* 29 (5):1471–1480. <https://doi.org/10.1111/cobi.12550>.
- Ilustre Municipalidad de Ancud, 2013. *Plan Regulador Comunal de Ancud. Informe Ambiental, Región de Los Lagos*.
- Jefferson, R., McKinley, E., Capstick, S., Fletcher, S., Griffin, H., Milanese, M., 2015. Understanding audiences: making public perceptions research matter to marine conservation. *Making Marine Science Matter: Issues and Solutions from the 3rd International Marine Conservation Congress*. 115:pp. 61–70. <https://doi.org/10.1016/j.ocecoaman.2015.06.014>.
- Kingdon, John W., 1995. *Agendas, Alternatives, and Public Policies*. HarperCollinsCollege, New York.
- Kitchin, R., Tate, N.J., 2000. *Conducting Research in Human Geography: Theory, Methodology and Practice*. Prentice Hall, Harlow.
- Klain, S.C., Chan, K.M.A., 2012. Navigating coastal values: participatory mapping of ecosystem services for coastal planning. *Ecol. Econ.* 82:104–113. <https://doi.org/10.1016/j.ecolecon.2012.07.008>.
- Leach, M., Mearns, R., Scoones, I., 1999. Environmental entitlements: dynamics and institutions in community-based natural resource management. *World Dev.* 27 (2):225–247. [https://doi.org/10.1016/S0305-750X\(98\)00141-7](https://doi.org/10.1016/S0305-750X(98)00141-7).
- Lester, S.E., Costello, C., Halpern, B.S., Gaines, S.D., White, C., Barth, J.A., 2013. Evaluating tradeoffs among ecosystem services to inform marine spatial planning. *Mar. Policy* 38:80–89. <https://doi.org/10.1016/j.marpol.2012.05.022>.
- MA, 2005. *Millennium Ecosystem Assessment*, 2005.
- Marín, A., Gelcich, S., Castilla, J.C., 2014. Ecosystem services and abrupt transformations in a coastal wetland social-ecological system: Tubul-Raqui after the 2010 earthquake in Chile. *Ecol. Soc.* 19 (1). <https://doi.org/10.5751/ES-05633-190122>.
- Martín-López, B., Iniasta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Amo, D.G.D., ... Montes, C., 2012. Uncovering ecosystem service bundles through social preferences. *PLoS One* 7 (6), e38970. <https://doi.org/10.1371/journal.pone.0038970>.
- Mastrangelo, M.E., Laterra, P., 2015. From biophysical to social-ecological trade-offs: integrating biodiversity conservation and agricultural production in the Argentine Dry Chaco. *Ecol. Soc.* 20 (1):20. <https://doi.org/10.5751/ES-07186-200120>.
- McClanahan, Timothy R., Abunge, Caroline A., 2015. Perceptions of fishing access restrictions and the disparity of benefits among stakeholder communities and nations of south-eastern Africa. *Fish. Fish.* 17 (2):417–437. <https://doi.org/10.1111/faf.12118>.
- McClanahan, Timothy R., Maina, J., Davies, J., 2005. Perceptions of resource users and managers towards fisheries management options in Kenyan coral reefs. *Fish. Manag. Ecol.* 12 (2):105–112. <https://doi.org/10.1111/j.1365-2400.2004.00431.x>.
- McClanahan, Timothy R., Abunge, Caroline A., Cinner, Joshua E., 2012. Heterogeneity in fishers' and managers' preferences towards management restrictions and benefits in Kenya. *Environ. Conserv.* 39 (4):357–369. <https://doi.org/10.1017/S0376892912000197>.
- McKenzie, E., Posner, S., Tillmann, P., Bernhardt, J.R., Howard, K., Rosenthal, A., 2014. Understanding the use of ecosystem service knowledge in decision making: lessons from international experiences of spatial planning. *Eviron. Plann. C. Gov. Policy* 32 (2):320–340. <https://doi.org/10.1068/c12292j>.
- NOAA, 2009. *Stakeholder Engagement Strategies for Participatory Mapping (Social Science Tools for Coastal Programs)*. Office for Coastal Management, United States Retrieved from. www.coast.noaa.gov.
- Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.
- Ostrom, E., 2007. A diagnostic approach for going beyond panaceas. *Proc. Natl. Acad. Sci.* 104 (39):15181–15187. <https://doi.org/10.1073/pnas.0702288104>.
- Polasky, S., Nelson, E., Camm, J., Csuti, B., Fackler, P., Lonsdorf, E., ... Tobalske, C., 2008. Where to put things? Spatial land management to sustain biodiversity and economic returns. *Biol. Conserv.* 141 (6):1505–1524. <https://doi.org/10.1016/j.biocon.2008.03.022>.
- Poteete, A.R., Janssen, M.A., Ostrom, E., 2010. *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton University Press.
- Raudsepp-Hearne, C., Peterson, G.D., Bennett, E.M., 2010. Ecosystem service bundles for analyzing tradeoffs in diverse landscapes. *Proc. Natl. Acad. Sci.* 107 (11):5242–5247. <https://doi.org/10.1073/pnas.0907284107>.
- Rice, W.R., 1989. Analyzing tables of statistical tests. *Evolution* 43 (1):223–225. <https://doi.org/10.2307/2409177>.
- Rodriguez, J.P., Beard Jr., T.D., Bennett, E.M., Cumming, G.S., Cork, S.J., Agard, J., ... Peterson, G.D., 2006. Trade-offs across space, time, and ecosystem services. *Ecol. Soc.* 11 (1), 28.
- Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., ... Bernhardt, J., 2015. Notes from the field: lessons learned from using ecosystem service approaches to inform real-world decisions. *Ecol. Econ.* 115:11–21. <https://doi.org/10.1016/j.ecolecon.2013.07.009>.
- Sabatier, Paul A., 1999. *Theories of the Policy Process*. Westview Press, Boulder, Colo.
- Saldaña, J., 2013. *The Coding Manual for Qualitative Researchers*. SAGE Publications, Los Angeles [i.e. Thousand Oaks, Calif].
- Sayer, A., 1992. *Method in Social Science: A Realist Approach*. Hutchinson, London u.a.
- Singleton, R., Straits, B.C., Straits, M.M., McAllister, R.J., 1988. *Approaches to Social Research*. Oxford University Press.
- Tuan, Yi-Fu, 1974. *Topophilia: A Study of Environmental Perception, Attitudes, and Values*. Prentice-Hall, Englewood Cliffs, NJ.
- Vira, B., Adams, W.M., Agarwal, C., Badiger, S., Hope, R.A., Krishnaswamy, J., Kumar, C., 2012. Negotiating tradeoffs: choices about ecosystem services for poverty alleviation. *Econ. Polit. Wkly.* 47 (2012), 67–75.
- White, C., Halpern, B.S., Kappel, C.V., 2012. Ecosystem service tradeoff analysis reveals the value of marine spatial planning for multiple ocean uses. *Proc. Natl. Acad. Sci.* 109 (12):4696–4701. <https://doi.org/10.1073/pnas.1114215109>.
- Wieland, R., Ravensbergen, S., Gregr, E.J., Satterfield, T., Chan, K.M.A., 2016. Debunking trickle-down ecosystem services: the fallacy of omnipotent, homogeneous beneficiaries. *Ecol. Econ.* 121:175–180. <https://doi.org/10.1016/j.ecolecon.2015.11.007>.
- Winthrop, R.H., 2014. The strange case of cultural services: limits of the ecosystem services paradigm. *Ecol. Econ.* 108, 208–214.