



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



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

^a Department of Geography, University of California at Santa Barbara, Santa Barbara, CA 93106-4060, USA

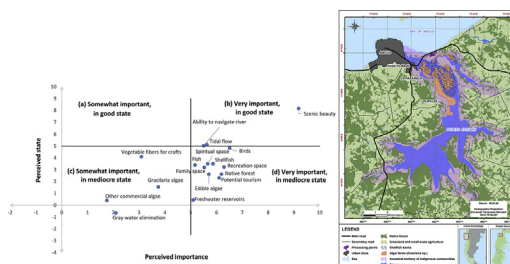
^b Laboratorio Internacional en Cambio Global and Center of Applied Ecology and Sustainability (CAPES), Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago 8331150, Chile

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

HIGHLIGHTS

- We examined people's perceptions of ecosystem services and management options.
- Our study integrated qualitative and quantitative field research methods.
- Those surveyed showed varying types and degrees of dependencies on nature's benefits.
- People overwhelmingly perceived scenic beauty as most important to wellbeing.
- People perceived several ecosystem services as important yet in mediocre states.

GRAPHICAL ABSTRACT



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ABSTRACT

Although ecosystem service (ES) approaches are showing promise in moving environmental decision-making processes toward better outcomes for ecosystems and people, ES modeling (i.e., tools that estimate the supply of nature's benefits given biophysical constraints) and valuation methods (i.e., tools to understand people's demand for nature's benefits) largely remain disconnected, preventing them from reaching their full potential to guide management efforts.

Here, we show how knowledge of environmental perceptions explicitly links these two lines of research. We examined how a diverse community of people with varying degrees of dependencies on coastal and marine ecosystems in southern Chile perceived the importance of different ecosystem services (ESs), their states (e.g., doing well, needs improvement), and management options. Our analysis indicates that an understanding of people's perceptions may usefully guide ecosystem modeling and management efforts by helping to: (1) define which ESs to enter into models and tradeoff analyses (i.e., what matters most?), (2) guide where to focus management efforts (i.e., what matters yet needs improvement?), and, (3) anticipate potential support or controversy surrounding management interventions. Finally, we discuss the complexity inherent in defining which ESs matter most to people. We propose that future research address how to design ES approaches and assessments that are more inclusive to diverse world views and notions of human wellbeing.

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* Corresponding author at: Department of Geography, University of California at Santa Barbara, 1832 Ellison Hall, Santa Barbara, CA 93106-4060, USA.
E-mail address: elwell@geog.ucsb.edu (T.L. Elwell).

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 Lattera (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

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