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Ecosystem Services

Comparison of methods for quantifying reef ecosystem services: A case study mapping services for St. Croix, USVI

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Susan H. Yee *, John A. Dittmar, Leah M. Oliver

US Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL 32561, USA

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ABSTRACT

A key challenge in evaluating coastal and watershed management decisions is that monitoring efforts are largely focused on reef condition, yet stakeholder concerns may be more appropriately quantified by social and economic metrics. There is an urgent need for predictive models to quantitatively link ecological condition of coral reefs to provisioning of reef ecosystem goods and services. We investigated and compared a number of existing methods for quantifying ecological integrity, shoreline protection, recreational opportunities, fisheries production, and the potential for natural products discovery from reefs. Methods were applied to mapping potential ecosystem services production around St. Croix, U.S. Virgin Islands. Overall, we found that a number of different methods produced similar predictions. Furthermore, areas predicted to be high in ecological integrity also tended to be high in other ecosystem services, including the potential for recreation, natural products discovery, and fisheries production, but this result depended on the method by which ecosystem services supply was calculated. Quantitative methods linking reef condition to ecosystem goods and services can aid in highlighting the social and economic relevance of reefs, and provide essential information to more completely characterize, model, and map the trade-offs inherent in decision options.

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1. Introduction

Ecosystem function and services are inextricably linked to human well-being, yet are often overlooked or taken for granted in social and economic decision-making (MEA (Millennium Ecosystem Assessment), 2005). A key challenge is that environmental assessments typically focus on ecological endpoints, failing to consider the social and economic values of stakeholders (Arvai and Gregory, 2003). A key to bridging ecological and socio-economic concerns is the concept of ecosystem goods and services (Wainger and Boyd, 2009).

In particular, coral reef ecosystems provide the ecological foundation that supports multi-billion dollar reef fishing and tourism industries vital to coastal and island economies (Burke and Maidens, 2004; C. I. (Conservation International), 2008; Pendleton, 2008). However, reef ecosystem goods and services are threatened by a rapidly growing regional human population, climate change, and serial over-exploitation (Waddell and Clarke, 2008; Wilkinson, 2008). Policies to protect coastal resources will be more effective if they account for the social and economic concerns of stakeholders in the watershed, and are responsive to potential tradeoffs among coastal resources or with other economic sectors such as agriculture or industry (Productivity Commission, 2003; Roebeling, 2006; Thomas et al., 2012). A key challenge is that reef monitoring efforts are largely focused on indicators of reef condition, such as coral cover and diversity, yet stakeholder concerns may be more appropriately quantified by health, social, or economic measures of factors such as subsistence from fisheries, opportunities for tourism or recreation, or coastal protection of property or lives during storm events (Cesar et al., 2003; Burke and Maidens, 2004). A quantitative link between attributes of reef condition and potential supply of ecosystem services will help identify meaningful indicators to compare decisions or monitor the success of their implementation, contribute to a conceptual link between coral condition and socio-economic relevance, and provide greater clarity in decision-making, including being able to estimate the potential consequences of alternative decisions on key stakeholder objectives (Yee et al., in press).

Insufficient scientific information can make it challenging to be able to estimate the consequences of potential management options. Coral reef modeling efforts to date have typically focused on the link between stressors and ecosystem condition, modeling a limited number of stressors such as land-based activities (Wolanski and De'ath, 2005), fishing pressure (Ault et al., 2005), or climate change (Buddemeier et al., 2008), and a few components of the ecosystem, such as reef fish or stony coral (e.g., McClanahan et al. (2007), Wakeford et al. (2008)). Other models