ECOSISTEMAS Y RECURSOS AGROPECUARIOS

ECONOMIC VALUATION OF USE OF CORAL REEFS IN THE BAYS OF HUATULCO, OAXACA, MEXICO

Valoración económica del uso de los arrecifes de coral de bahías de Huatulco, Oaxaca, México

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ABSTRACT. The aim of this study was to determine the recreational use value of three coral reefs in the Bays of Huatulco (Bahías de Huatulco), Oaxaca, Mexico. In total, 263 domestic tourists were interviewed, and their socioeconomic profile and perception of the coral reef they visited were determined. Using the contingent valuation method, a willingness to pay $ 48.4 for conservation activities was determined, as well as a net annual benefit from the reef of $18 243 629.40. The results of the study show the high economic potential of the reef ecosystems in Huatulco, which should guide public policy strategies for the conservation and sustainable management of the resource.
Keywords: Coral reefs, Mexico; Oaxaca; Contingent valuation; Economic valuation

RESUMEN. El objetivo del presente estudio fue determinar el valor de uso recreacional de tres arrecifes de coral en Bahías de Huatulco, Oaxaca, México. Se entrevistaron 263 turistas nacionales, a los que se les determinó su perfil socioeconómico y su percepción sobre el arrecife de coral visitado. Mediante la técnica de valoración contingente, se determinó una disposición a pagar de $ 48.4 para actividades de conservación, y un beneficio neto del arrecife de $ 18 243 629.40 anuales. Los resultados del estudio revelan el alto potencial económico de los ecosistemas arrecifales en Huatulco, por lo que se debe guiar las estrategias de política pública para la conservación y manejo sustentable del recurso.
Palabras Clave: Arrecifes de coral, México, Oaxaca, valoración contingente, valoración económica

INTRODUCTION

Coral reefs are among the most productive and diverse ecosystems in the world, covering only 0.1 % of the ocean surface but providing a home to almost a third of the marine species on the planet (Wilkinson 2006). However, despite their global significance, they are one of the most vulnerable ecosystems and their degradation is occurring at an alarming rate (Burke *et al*. 2011). The latest World Resource Institute report indicates that about 75 % of coral reefs are currently at risk due to a combination of local and global pressures (Burke *et al*. 2011). The immediate and direct threats come from local sources, putting at risk more than 60 % of reefs. Unless measures are taken to ease local pressures and reduce the emission of greenhouse gases, the percentage of threatened reefs will increase to over 90 % by 2030 and to nearly 100 % by 2050 (Burke *et al*. 2011). One of the activities with the greatest impact on reef degradation is tourism (Jobbins 2006).

Reefs are a major source of income; for example, the Great Barrier Reef in Australia generates more than a billion dollars annually from tourism (Day and Dobbs 2013), while countries

like Indonesia, the Philippines, Egypt, and Israel, as well as the Caribbean Islands, also benefit from the flow of tourists (Gladstone *et al*. 2013, Schuhmann and Mahon 2015). It should be remembered that tourism development in coastal zones requires infrastructure development and land use for the construction of hotels, roads, airports and shops, among others, which, taken together, can have a negative impact on marine and coastal ecosystems (Jobbins 2006, Mora 2008).

In economic terms, the degradation of reef systems due to the impact of tourism is the result of a set of negative externalities (Wielgus *et al*. 2003). The agent that causes the damage benefits from an unsustainable economic activity, but the cost is borne by economic agents who depend on reefs (Garrod and Willis 2000). To address this problem, market failures can be internalized through government action with strategies such as the establishment of protected marine areas (McClanahan *et al*. 2006, Christie and White 2007) or co-management measures (Wamukata *et al*. 2012).

Studies have been conducted to determine the economic value of coral reefs, with regard to the benefits generated by recreational activities (Ahmed *et al*. 2007, Peters and Hawkins 2009), highlighted by the work of Brander *et al*. (2007), who assessed the economic benefits provided by coral reefs at the regional and national level, while Constanza *et al*. (1997) estimated the total value of coral reefs per hectare, based on the goods and services provided by this resource. In the case of Mexico, the only such study previously conducted was by Rivera-Planter and Muñoz-Piña (2005), who analyzed the economic benefits of entry fees levied for various reef systems in the state of Quintana Roo. Therefore, the aim of the present study was to determine the recreational value that tourists assign to snorkeling in three coral reefs in the Bays of Huatulco, two within Huatulco National Park and one in the area adjacent to the Park.

MATERIALS AND METHODS

Economic valuation of coral reefs

Economic valuation of environmental goods and services is complex, particularly for those goods and services for which there is no market. For such studies, non-conventional valuation techniques have been developed, one of which is the direct or preference construction approach, which allows valuating a series of goods for which there is no information (Enríquez-Andrade 2005). The information needed to carry out the valuation through this approach is derived from surveys that simulate hypothetical scenarios for valuating the good. Among these techniques, the most common method for evaluating hypothetical market scenarios is called the contingent valuation method (Arrow *et al*. 1993, Garrod and Willis 2000, Enríquez-Andrade 2005). The method is based on the assumption that individuals make consumer decisions that maximize their welfare level, according to the theory of rational consumer choice. In this way, individuals seek to maximize their utility function:

$$\max_{q,x} \; u(q, x; v)$$

$$s.a. pq + x \leq y$$

$$q, x \geq 0$$

Where q represents the quantity of an environmental good, p the price of the good, v its quality, Y the disposable income of the individual and x is the quantity of a good comprised of private goods.

Based on the above, it follows that the marginal rate of substitution between the quality of the environmental good (v) and the private good (x) must be equal to the change in the income of the individual, which he/she is willing to pay, which keeps his/her utility level constant as v changes. If the change in quality is positive, the individual is willing to reduce his/her income while maintaining his/her utility constant, and vice versa if it is negative. The method involves measuring these theoretical concepts through a survey

where the individual respondent declares his/her willingness to pay for a change in the quality of the environment.

Study area

Huatulco Bay is located at coordinates 15° 41' 09" and 15° 45' 4" NL and 96° 14´ 05" and 96° 04´ 56" WL. Along this coastal corridor there are reef communities, associated with bays and islands in areas protected from waves. These reefs are shallow, with a depth of between 0 and 14.3 m (Glynn and Leyte-Morales 1997), with corals of the genera Pocillopora and Pavona being the most common (Leyte-Morales 1997). Huatulco National Park (HNP) contains 18 coral communities, with the largest being San Agustín, Jicaral, Cacaluta and Maguey, which together comprise more than 50 % of the park´s coral area. San Agustín and Maguey are the most visited reef systems, due to their ease of access and services, while La Entrega Bay is the most popular and visited beach in the Bays of Huatulco area, but it is not within HNP; La Entrega coral reef covers an area of 7.1 ha. La Entrega and San Agustín have been impacted by significant anthropogenic influences, but the other reef systems have remained in a healthy state, with episodes of coral bleaching due to changes in temperature and dissolved carbon dioxide.

Sampling and survey design

In total, 263 questionnaires were applied to domestic tourists who went snorkeling in the bays under study. The sample was divided as follows: 85 surveys in Maguey Bay, 78 in San Augustín Bay and 100 in La Entrega Bay. The survey was conducted using systematic sampling (Schaeffer *et al*. 1996), which allowed greater coverage of the subjects to interview, since from the beach the group returning from the reef was identified and the first two and the last two individuals were interviewed, so long as they were not members of the same family.

The questionnaire was divided into three sections: the first included questions related to demographic profile, reasons to visit the site and demand for recreation. The second part of the survey focused on determining the level of tourist satisfaction, regarding their snorkeling experience, for which a five-point Likert scale, where 1 corresponds to no satisfaction and 5 means a very high level of satisfaction, was used. The third part of the questionnaire was designed to ascertain the individual´s willingness to contribute to environmental conservation, management and education, as well as to reef ecosystem monitoring. During the interview the hypothetical market was described. Hence the importance of face-to-face interviews, where the good to value can be defined and explained, thereby minimizing non-response (Arrow *et al*. 1993).

The independent variables in the contingent valuation model were: income, age, educational level, length of stay, previous visits, previous snorkeling experience and satisfaction. The dependent variable was willingness to pay. Data analysis was performed by least squares-adjusted multiple regression, and analyzes were performed using SPSS version 17.0 statistical package.

RESULTS AND DISCUSSION

The socioeconomic profile of the tourists is shown in Table 1. There are no significant differences with respect to age, length of stay at the recreation site, number of visits, previous snorkeling experience and WTP. The vast majority of visitors are of working age, with an average of 31 years old and an educational level of 13 years. The average income of the visitors ranged from 13 000-19 000 pesos a month. The vast majority of tourists come from Mexico City, Puebla, the state of Mexico, Guadalajara, Chiapas and Tabasco, with an average stay of between 4 to 6 d per visitor. Regarding the level of satisfaction, this was statistically different among the three bays, with the highest levels of satisfaction for Maguey beach. In terms of willingness to pay (WTP), there were no significant differences among the beaches, averaging $ 48.4, which is almost double the $ 25.00 fee. This means the WTP value could potentially raise $ 18 243 629.40, based on the 376 701 visitors in 2011.

The results should be framed in two contexts,

Tabla 1. Socioeconomic profile of tourists.

Variable	Reef		
	Maguey	San Agustín	La Entrega
Age			
Minimum	18.0	18.0	18.0
Maximum	67.0	71.0	62.0
Average	32.7^a	33.6^a	29.6^a
Educational level			
Minimum	10.2	6.5	11.4
Maximum	18.1	16.9	17.6
Average	15.4^a	11.4^b	12.9^b
Length of stay			
Minimum	2.0	3.0	1.0
Maximum	12.0	10.0	14.0
Average	4.9^a	5.2^a	4.7^a
Previous visits to the area			
Minimum	1.0	1.0	1.0
Maximum	5.0	8.0	7.0
Average	2.4^a	3.1^a	3.5^a
Previous snorkeling experience			
Minimum	0.0	0.0	0.0
Maximum	8.0	10.0	15.0
Average	3.2^a	4.4^a	3.5^a
Satisfaction			
Minimum	3.0	2.0	1.0
Maximum	5.0	5.0	5.0
Average	4.7^a	4.1^b	3.1^c
Income			
Minimum	30,000.0	3,500.0	4,000.0
Maximum	90,000.0	45,000.0	50,000.0
Average	19,458.5^a	13,760.2^b	13,921.0^b
Budget			
Minimum	600.0	4,000.0	8,000.0
Maximum	100,000.0	30,000.0	25,000.0
Average	15,694.99^a	13,314.10^b	14,315^b
Willingness to pay			
Minimum	5.0	10.0	10.0
Maximum	475.0	150.0	200.0
Average	46.4^a	46.1^a	52.8^a

^{a,b,c} = values with a different superscript in the same row are significantly different, HSD, $p < 0.05$.

Tabla 2. Determinants of willingness to pay for the three study sites.

Variable	Constant	P-value
Income***	0.007	0.003
Age	0.002	0.775
Educational level***	0.772	0.029
Length of stay	0.007	0.553
Previous visits	-0.213	0.854
Previous snorkeling experience***	0.034	0.026
Satisfaction***	0.356	0.033
Maguey	0.567	0.541
La Entrega	-0.123	0.229
San Agustin	0.443	0.664
Log likelihood	-187.457	
Pseudo R-squared	0.433	

***Significant at the 5 % probability level.

which together determine the reef-tourism dynamics in the Bays of Huatulco: a) plans to re-launch the tourist destination through hotel and services infrastructure (FONATUR 2014), as well as their potential impact on the ecosystem (FONATUR 2014) (Negri *et al*. 2002, Haynes and Loong 2002, Islam and Tanaka 2004, Fabricius 2005), and b) global climate change that affects the ecological processes of reef ecosystems by variations in ocean temperature and acidity (Burke *et al*. 2011, McClanahan *et al*. 2012, Ateweberhan *et al*. 2013). In light of the above, determining the economic value of coral reefs is one of the most important steps in establishing public policies for their sustainable management (Rivera-Planter and Muñoz-Piña 2005). The value determined in the present study does not represent the total value of the resource; this figure is a reflection of how society values the ecosystem and the options for levying access fees to HNP and its zone of influence.

For 2012, an average national income of $ 12 708 and an educational level of 8.6 years are reported (INEGI 2014). It was found that WTP correlated with income, educational level, previous snorkeling experience and level of satisfaction. In this regard Park *et al*. (2002) found a positive relationship between age and WTP, while other studies indicate a negative relationship between these two variables, which may be due to the fact that these studies show that seniors may be affected by economic constraints (Booth and Levinson 2000). It has also been found that educational level is associated with a greater willingness to pay for conservation (Arin and Kramer 2002), since more schooling results in greater environmental awareness (Ahmed *et al*. 2007).

In relation to satisfaction, the results are similar to those obtained by Dearden *et al*. 2006. In the present work, the level of satisfaction was determined by the presence of fish, their abundance, color and diversity. In this regard Wielgus *et al*. (2003) and Uyarra *et al*. (2009) mention that tourists usually assign a very high value to the presence of fish, added to which fish diversity and abundance are attributes of a healthy coral reef (Uyarra *et al*. 2009). Income has a significant and positive relationship with WTP, which is consistent with economic theory, which indicates that the higher the income the greater the willingness to pay (Garrod and Willis 2000), while Kristrom and Riera (1996) point out that under this positive relationship, environmental goods are typically normal goods, that is goods whose consumption increases as income increases. It is also known that individuals in higher-income brackets are willing to channel more resources into environmental improvement (Ahmed *et al*. 2007), suggesting that income is a constraint on the valuation of natural resources.

The WTP averages obtained for each study site are higher than the HNP entrance fee. In this regard studies report that society is willing to pay entry fees for protected marine areas (Arin and Kramer 2002, Ahmed *et al*. 2007, Peters and Hawkins 2009). Internationally there is a consensus on the benefits of a fee to fund conservation activities in protected natural areas (Uyarra *et al*. 2009, Wielgus *et al*. 2010). It is imperative, therefore, to develop a fee collection policy which favors the operation of each of the protected natural areas in terms of equity, coverage and average visitors.

The contingent valuation model is commonly and widely used to estimate recreational values, but it is important to consider its limitations, related to the psychological profile of the interviewee and the statistical design of the sample (Garrod and Willis 2000). For this reason, it is incorrect to assume that the obtained economic value of an environmental good or service is representative of the total value of the ecosystem (Hernández-Trejo *et al*. 2009). Economic valuation of the environmental goods and services of coral reefs is a key step towards proposing environmental policy strategies that promote their conservation and sustainable management. Assigning a value to this highly vulnerable resource means it can no longer be considered as a public good. In the case of the present study, a willingness to pay $ 48.4, a figure that is double the current entry fee, was determined. Therefore, the entry fee can be increased and the benefits of this income can be distributed equitably among the

various stakeholder involved in the tourism industry in Huatulco.

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