



SUMMARY REPORT

THE ECONOMIC VALUE OF U.S. CORAL REEFS



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NOTE: This summary document is a companion document to another report entitled "The Total Economic Value of US Coral Reefs: A Review of the Literature" - Brander et al (2013). The Brander report presents a detailed analysis of US coral reef valuation studies. The authors conducted a meta-analysis of the seven studies presented in this report in addition to a few other valuation studies not included here. The Brander study is a more technical document than this summary report. However for those who require more in depth analysis they are free to refer to it at the web link provided here: <http://coralreef.noaa.gov/Library/Publications/valuemetaanalysis.pdf>

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Introduction

Coral reefs are among the most valuable ecosystems on Earth, they provide humans with billions of dollars in economic and environmental services (also known as ecosystem services) such as food, protection for coasts, and tourism. However, increasing population growth rates along with economic and industrial development has resulted in unprecedented pressure to coral reefs. These pressures include impacts from climate change, unsustainable fishing, and land-based pollution.

Domestically, the NOAA Coral Reef Conservation Program (CRCP) funds and equips reef conservation activities by NOAA and its partners in the seven US states and jurisdictions containing coral reefs (American Samoa, the Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai`i, Puerto Rico, and the US Virgin Islands), as well as in uninhabited islands including the Northwestern Hawaiian Islands and the Pacific Remote Island Areas.

Given some of the threats mentioned above, there are a few questions to consider. *How much are coral reefs worth to society? How much do people care about coral ecosystems? Can we demonstrate the value of these unique ecosystems and account for what we stand to lose if they are irreparably damaged?* Providing answers to these questions can assist with better decisions that influence coral reef resource management and policy. One way to provide answers is through the use of Economic Valuation techniques.

The CRCP recognizes the benefits gained from the strategic use of social science tools in US coral reef jurisdictions and one of these tools includes Natural Resource Valuation. Since 2001, the program has funded social science activities including, valuation studies in seven (7) US coral reef jurisdictions. This document attempts to summarize the major findings of these studies in order to provide an overall report on the value of US coral reefs.



Background

This document summarizes the work done over a ten year period on seven US coral reef jurisdictions. NOAA was a significant contributor to the seven valuation studies that were conducted during the period. It should be noted that while all the studies were economic valuation studies, they each may have used slightly different approaches. Additionally, each of these studies varies slightly in terms of the theoretical economic assumptions (Total Economic Value, Benefit Transfer, Economic Impact). A list of common valuation approaches is shown in the table below. The references provided for each individual study contain more details on methodology and findings.

Table 1 Common valuation techniques for goods and services of coral reefs

Technique	Goods and services
Directly applicable market techniques	
Loss of earnings / Human capital approach (HC)	Tourism/recreation
Change in Productivity / Effect of production (EoP)	Fisheries/ornamental use/tourism
Stock (houses, infrastructure, land) at Risk (SaR)	Coastal protection
Preventive expenditures (PE)	Coastal protection
Damage Costs (DC)	Coastal protection
Replacement costs (RC)	Coastal protection
Revealed preference techniques	
Travel-cost approaches (TC)	Tourism/recreation
Hedonic pricing method (HP)	Amenity value
Stated preference techniques	
Contingent valuation methods (CVM)	Cultural services, biodiversity
Choice Experiment (CE)	Cultural services, biodiversity

Source: Adapted from Dixon (1990), Barton (1994).

Notwithstanding the application of slightly different methodological approaches, which produce different ranges of values¹, the results and findings in each study support and confirm that coral reefs provide significant benefits to society. Understanding the value of coral reefs therefore provides information that can be used to improve the allocation of resources to ensure conservation.

The report summaries are presented in chronological order

- Florida (2001)
- Hawaii (2002)
- American Samoa (2004)
- Commonwealth of the Northern Mariana Islands (CNMI-Saipan) (2006)
- Guam (2007)
- Puerto Rico (2008)
- US Virgin Islands (2011)

The table below outlines the annual values converted to 2012 dollars (real dollars) for comparison across jurisdictions. Results presented below are based on CRCP funded projects only.

Table 2 Total Economic Values of US Coral Reef Jurisdictions (2012\$)

Location	Study Year	Present Value (2012\$ Million/Year)
Florida	2001	324
Hawaii	2002	455
American Samoa	2004	11
CNMI – Saipan	2006	68
Guam	2007	150
Puerto Rico	2008	1,161
US Virgin Islands	2011	210

¹For example the Puerto Rico study used the Total Economic Valuation approach that sums different types of estimated values and this in turn results in a very high (aggregated) dollar amount.



Title: Socioeconomic Study of Reefs in Southeast Florida: Final Report (2001)

Johns, Leeworthy, Bell and Bonn

This study determined the net economic value of southeast Florida's natural and artificial reef resources to the local economies and the reef users. Southeast Florida is defined as the counties of Palm Beach, Broward, Miami-Dade and Monroe. The study area included, from north to south, the cities of West Palm Beach, Fort Lauderdale, and Miami, and the Florida Keys.

Using survey research methods the researchers measured the economic contribution and the use values of artificial and natural reefs over the twelve-month period of June 2000 to May 2001. The reef users surveyed were boaters who are recreational fishers (commercial fishers were not included), reef divers, reef snorkelers and/or visitors viewing the reefs on glass-bottom boats. The study used a combination of approaches including estimating the economic contribution of visitor and Florida resident spending as well as reef users' willingness to pay for maintaining the condition of the reefs. The study was funded by each of the four counties, the Florida Fish and Wildlife Conservation Commission through the use of Federal Aid in Sport Fish Restoration funds, and the National Oceanic and Atmospheric Administration through the Socioeconomic Monitoring Program for the Florida Keys National Marine Sanctuary.

Between 2000 and 2001, surveys were conducted on the following groups of respondents: Resident boaters (mail survey), General visitors (intercept survey), Visitor boaters (intercept survey) and Charter/Party boats (mail survey). The surveys collected information that was used to estimate participation rates in reef related activities, expenditures related to reef use, willingness to pay and demographic information.

Findings

Contribution of Reef-Related Spending to the County Economies

The total economic contribution of the reefs to each county is measured as the contribution of reef-related expenditures to county sales, income and employment. As residents and visitors spend money in the county to participate in reef-related recreation, income and jobs are created within the county. Economic contribution² includes the direct, indirect and induced effects of visitor spending and the direct effects of resident spending.

Reef-related expenditures generated **\$505 million** in sales in Palm Beach County, **\$2.1 billion** in sales in Broward County, **\$1.3 billion** in sales in Miami-Dade County and **\$490 million** in sales in Monroe County during the 12-month period **from June 2000 to May 2001**. These sales resulted in \$194 million in income to Palm Beach County residents, \$1.1 billion in income to Broward County residents, \$614 million in income to Miami-Dade County residents and \$139 million in income to Monroe County residents during the same time period. **Reef-related expenditures provided 6,300 jobs in Palm Beach County, 36,000 jobs in Broward County, 19,000 jobs in Miami-Dade County and 10,000 jobs in Monroe County**

Table 3 Economic Contribution of Reef-Related Expenditures to Each County*

Type of Economic Contribution	Palm Beach	Broward County	Miami-Dade County	Monroe County
Sales – All Reefs (in millions of 2000 dollars)	\$505	\$2,069	\$1,297	\$490
Artificial Reefs	\$148	\$961	\$419	\$127
Natural Reefs	\$357	\$1,108	\$878	\$363
Income – All Reefs (in millions of 2000 dollars)	\$194	\$1,049	\$614	\$139
Artificial Reefs	\$52	\$502	\$195	\$33
Natural Reefs	\$142	\$547	\$419	\$106
Employment – All Reefs (number of full- and part-time jobs)	6,300	36,000	19,000	10,000
Artificial Reefs	1,800	17,000	6,000	2,000
Natural Reefs	4,500	19,000	13,000	8,000

**The economic contributions cannot be summed over the four counties to get the total economic contribution of the reefs to southeast Florida. This is because the concept of economic contribution looks at the economy of the individual geographic area as a separate entity from its neighbors.*

²Please note, economic contribution (or impact) as described here is different from “economic benefit or value”. Economic value resides in the contributions that ecosystem functions make to human well-being, while economic impact describes localized economic effects on local businesses and communities (sales, employment, income and taxes). Economic impacts do not measure benefits to resource users.

Economic Value that Reef Users Place on the Reefs

While the results above highlight the economic impacts from sales and expenditures the researchers also conducted an economic valuation exercise. The researchers used a contingent valuation approach to derive the economic values Florida reef users have. Users were asked about their willingness to pay for specific reef programs. The study estimated four types of use values, these were: (1) the value to natural reef users of maintaining the natural reefs in their existing condition; (2) the value to artificial reef users of maintaining the artificial reefs in their existing condition; (3) the value to artificial and natural reef users of maintaining both the artificial and natural reefs in their existing condition; and (4) the value of adding and maintaining additional artificial reefs. The respondents were asked: *"If your total cost per trip would have been \$_____ higher, would you have been willing to pay this amount to maintain the (kind of reef – artificial or natural or both) in their existing condition."* Estimates of value were derived from the survey data using econometric analytical techniques.

The report found that the aggregate value of visitor and resident reef users in all four counties was \$255 million per year for the purpose of maintaining both the artificial reefs and the natural reefs in southeast Florida in their current condition by maintaining water quality, limiting damage to reefs from anchoring, and preventing overuse of the reefs. When the projects to protect the artificial and natural reefs are considered separately, visitor and resident reef users in all four counties are willing to pay **\$85 million** per year to protect the artificial reefs and **\$228 million** per year to protect the natural reefs in southeast Florida.

8 For further details see full study <http://coastalsocioeconomics.noaa.gov/core/reefs/02-01.pdf>



Economic valuation of the coral reefs of Hawaii (2002)

Cesar, van Beukering, Pintz and Dierking

Coral reefs are essential for the livelihood of many Hawaiians, through both the provision of tourism and fisheries. Reefs also protect coastal infrastructure, tourist beaches and communities through their ability to dissipate wave energy. In addition, coral reefs play an important spiritual and cultural role in Hawaiian society. The objective of the study were threefold: (i) to assess the economic value of selected case study areas (see below) and of Hawaii as a whole, (ii) to determine the economic costs of reef degradation; (iii) to compare the costs and benefits of various management options which aim to reverse these trends. The economic valuation of natural resources presents a major challenge: how to put a price-tag on goods and services from coral reefs that are not typically traded in the market. A host of valuation techniques are available to value these ecosystem goods and services. Those used in this study are the Effect on Production (EoP); Replacement Costs (RC); Damage Costs (DC); Travel Costs (TC); and the Contingent Valuation Method (CVM)².

Findings

The average annual benefits that accrue from Hawaiian coral reefs amount to \$364 million. This leads to a net present value of nearly \$10 billion (at a discount rate³ of 3%). This figure represents the asset value of the coral reefs of the Main Hawaiian Islands. Sensitivity estimates suggest that without discounting, this asset value would be as much as \$19 billion, while a discount rate of 15% would produce a corresponding net present value of \$2.8 billion. The largest contribution (85%) to the yearly benefits of \$364 million is the annual value added by recreation and tourism (\$304

² Refer to Table 1

million). Second contributor to overall value is the amenity/property value, with benefits of \$40 million per annum. The impact of reefs on the total property value in Hawaii is modest, but as total property values are so high in Hawaii, a high coral reef related value is still generated. The third most important benefit is biodiversity. This is partly expressed in terms of reef-related research expenditures (\$10 million per year) and partly in terms of non-use value (\$7 million per year). The latter value was estimated through benefit transfer⁴.

Table 4 Annual benefits and the net present value of the Hawaiian coral reefs and the different study sites

		Hanauma Bay, Oahu	Kihei Coast, Maui	Kona Coast, Hawaii	Hawaii - overall
Recreational value	Million\$/year	36.23	8.02	8.06	304.16
Amenity value	Million\$/year	0.00	18.26	4.47	40.05
Biodiversity value	Million\$/year	1.11	1.71	4.35	17.00
Fishery value	Million\$/year	0.01	0.10	0.7	2.50
Education spill-over value	Million\$/year	0.22	-	-	-
Total annual benefits	Million\$/year	37.57	28.09	17.68	363.71
Net Present Value @ 3%	Million\$	1,503	522	389	9,722

The table above shows the various benefits for the three case studies, as well as the figures for the State of Hawaii. For Hawaii overall, the asset value of its coral reefs are estimated to be **\$ 9.7 billion**. This is determined as the sum of all future quantified benefits streams over a 50-year period and a 3% discount rate. The last column in the table shows the composition of the main economic benefits of the coral reefs in Hawaii.

The average annual value of the coral reef ecosystem amounts to **\$364 million**. This leads to a **net present value at a discount rate of 3% of nearly \$10 billion**. Without discounting this value would be nearly \$19 billion, **while at a discount rate of 15% the net present value amounts to \$2.8 billion**. These high numbers certainly indicate that it is important, both from an ecological and an economic perspective, to take care of this valuable resource. (For more on discount rates <http://www.iearesearch.com/papers/discounting.pdf>)

It should be noted that a related study was sponsored by NOAA's Office of Response and Restoration. A choice experiment study of the Northwestern Hawaiian Islands was conducted and the researchers' estimated a coral reef value of approximately \$34 Billion dollars (Bishop et al 2011). This figure represents non-use value⁵ for the entire US Population. However as mentioned previously, the results of that study are not included in this report.

For further details on the 2002 Hawaii study, go to: http://www.hcri.ssri.hawaii.edu/files/research/pdf/cesar_noaa_final_report_01-02.pdf

³ Similar to "interest rate", discount rate is used in cost-benefit analysis and discounted cash flow analysis to calculate the present value of profits that will be received in the future.

⁴ Benefit transfer involves transposing existing monetary environmental values estimated at one site (study site) to another (policy site), usually with similar context or physical characteristics.

⁵ Economists classify ecosystem values into several types. Two common categories are use values and non-use, or "passive use" values. Use values are based on actual use of the environment (diving, fishing) while non-use values are values that are not associated with actual use (direct use) of an ecosystem or its services. Another category is "existence value", which is the non-use value that people place on simply knowing that something exists, even if they will never see it or use it.

Economic Valuation of Coral Reefs and Adjacent Habitats in American Samoa (2004)

Spurgeon, Roxburgh, O' Gorman, Lindley, Ramsey and Polunin

The coral reefs of American Samoa are one of its most valuable assets, providing benefits to generations of islanders. However, with one of the fastest population growth rates in the world and rapid economic and industrial development the island's coral reefs have come under pressure from habitat loss, over fishing and pollution. In December 2003, the Department of Commerce commissioned a study to undertake an economic valuation of the coral reefs and adjacent habitats of American Samoa. The overall aim of the study was to undertake an economic valuation of coral reefs and adjacent habitats in American Samoa, of sufficient quality and content, to guide future use of resources and management for the territory. In particular, the aim was to focus on current and potential values for corals and mangroves focusing on artisanal and subsistence fisheries, shoreline protection and recreation/tourism (ecotourism). The study also attempted to estimate **potential nonuse values**. That is, values that were predominantly related to social, cultural and biodiversity aspects. **Potential nonuse values result from the** fact that people may have a value for maintaining coastal resources irrespective of their actual use of the resource. The ultimate hope of this effort was that the study information produced would be used to assist in overall policy decision-making, particularly to guide resource management for future generations.

A **general public contingent valuation questionnaire** was designed and used to collect information about the use and importance of coral reefs and mangroves to the local residents on American Samoa. The main aim was to elicit a willingness to pay value covering use and non-use values. The survey was initially piloted amongst a small sample (14 persons) in January 2004 before being modified and conducted island wide in February 2004. Responses were obtained from 300 residents from 44 villages on Tutuila, Ofu and Olosega. Interview sampling locations and

respondents were selected to be reasonably representative of population distribution (e.g. 90% in southern Tutuila) and socio-economic characteristics (e.g. gender, age, place of birth). Potential future values were calculated based on two scenarios; a business as usual (BAU) scenario and an optimum sustainable management (OSM) scenario.

Findings

The coral reefs and mangroves of American Samoa both provide significant benefits to the territory and mainland US. Total benefits to American Samoa residents and visitors are estimated to be worth around **US\$ 5 million/year for coral reefs** and **US\$ 0.7 million/year for mangroves**. When potential **non-use benefits accruing to US citizens** are included, overall benefits could be in the order of at least US\$ 10 million/year for coral reefs and **US\$ 1.5 million/year for mangroves**. The economic value of corals in American Samoa was shown to be relatively low when compared to other US coral reef jurisdictions. This is because tourism and recreational access to corals is limited, extensive man-made shoreline defenses have already been constructed (due to significant beach sand and rubble mining) and because there is a relatively small and poor population.

Table 5 Current coral reef annual values (US\$/year)

Type of benefit		Residents	Visitors	US public	Total
Use benefits	Direct subsistence fishery products	572,000	-	-	572,000
	Direct artisanal fishery products	44,000	-	-	44,000
	Direct subsistence fishing CS1	73,000	-	-	73,000
	Direct snorkelling/diving CS1	38,000	12,000	-	50,000
	Direct snorkel/dive expenditure2	17,000	7,000	-	23,000
	Indirect artisanal fishery products3	70,000	-	-	70,000
	Indirect shoreline protection	447,000	-	-	447,000
Non-use benefits		3,598,000	216,000	4,964,000	8,778,000
Total benefits		4,858,000	235,000	4,964,000	10,057,000

1. CS = Consumer Surplus

2. Visitor expenditures are actually a cost to visitors and a benefit to local businesses/residents

3. Offshore reef-associated bottomfish.

Table 6 Current mangrove annual values (US\$/year)

Type of benefit		Residents	Visitors	US public	Total
Use benefits	Direct subsistence fishery products	29,000	-	-	29,000
	Direct subsistence fishing CS1	4,000	-	-	4,000
	Indirect fishery products2	13,000	-	-	13,000
	Indirect shoreline protection	135,000	-	-	135,000
Non-use benefits		541,000	32,000	745,000	1,318,000
Total benefits		722,000	32,000	745,000	1,499,000

1. CS = Consumer Surplus

2. Component of the direct coral reef fishery (accounted for in Table 1)

The tables above also highlight that with US public non-use values included, around 50% of coral reef and mangrove values accrue to residents of American Samoa, equivalent to **US\$ 4.9 million/year and US\$ 0.7 million/year** respectively. Around 75% of the resident values are related to non-uses, which partly capture traditional and social values. However, of particular significance for residents are subsistence fishery catches (worth US\$ 0.6 million/year), shoreline protection services (US\$ 0.5 million/year) and subsistence consumer surplus, which represents part of the way of life in American Samoa (US\$ 73,000/year).

When considered at a macro-scale (e.g. the entire territory or an individual island), the total values appear reasonably large. For instance, the annual coral reef resident and visitor use and non-use values (**US\$ 5 million**) outweigh the current coastal zone management expenditure of around US\$ 2 million per year by two and a half times. Including non-use values for the US population, the total of **US\$10 million** outweighs the management expenditure by five times. Without this investment in management, the coral and mangrove values would rapidly decline to virtually zero.

For more details you can find the full report here http://www.coralreef.gov/meeting18/ascoralvaluation_samoa_2007.pdf



The Economic Value of the Coral Reefs of Saipan (2006)

van Beukering, Haider, Wolfs, Liu, van der Leeuw, Longland, Sablan, Beardmore, di Prima, Massey, Cesar and Hausfather

van Beukering et al (2006) estimate the total economic value of coral reefs and associated resources on Saipan in the CNMI. This study was commissioned by the US Department of the Interior and NOAA. The main objective of the study was to carry out an economic valuation of the coral reefs and associated resources on Saipan and examine the potential for sustainable financing of conservation efforts. The primary purpose of the household survey (of 375 local residents) was to determine the nature and level of the use and non-use values of coral reefs, from the perspectives of local communities on Saipan.

The survey covered a number of issues, such as respondents' level of beach and marine recreation, environmental awareness, fishing activities and the importance of fish in their diet. The survey showed that the residents of Saipan are strongly connected to the coral reefs and the ocean. Citizens of Saipan heavily use the marine environment surrounding the island for fishing and recreational activities. As such, there is strong concern about further deterioration of the marine environment on Saipan and strong support policy interventions by the CNMI government to reverse the negative trend.

To estimate the economic value of the above-mentioned non-market values, a Discrete Choice Experiment (DCE) was used. Respondents were presented with a series of choice sets, composed of different attributes associated with reefs and their management (e.g. recreation, fisheries, tax payments). They were then asked to choose between these choice sets. Saipan's residents appeared to place a similar value on the ability of reefs to provide local recreational benefits and supply culturally significant fish species. Although there is some indication that Saipan's residents may support increasing the size of the MPA in the lagoon, they are much more concerned with the effects of pollution and managing pollution as a threat to the reefs. They are generally willing to pay more tax for this issue to be addressed. The total annual values for each service are summarized in Table 7 below. The table shows that reef related tourism values account for the largest share of total economic value.

Table 7 Total coral reef values for CNMI (millions US\$/Year; 2007 prices)

Ecosystem service	Valuation method	Total value (millions, US\$)
Amenity	Value transfer	3
Commercial fishery	Net factor income	1
Tourism	Travel cost method	45
Recreation	Travel cost method	6
Coastal protection	Avoided damage costs	9
Research	Net factor income	1
Total Economic Value		65

The researchers also investigated the spatial dimension of interactions between the economy and coral reefs. They found that in general, the beneficiaries of the reefs' goods and services were not spread evenly throughout Saipan, but varied from location to location. They used Geographic Information System (GIS) tools to analyze this spatial variation in economic values. They found that the **average value of reefs per square kilometer amounted to \$0.8 million however the highest value per square kilometer was around \$9 million**. The highest value categories were attributed to the most popular diving and snorkeling sites. Based on their comparison of the distribution of reefs' total economic value and their anthropogenic threats, the authors conclude that, in general, the more valuable the reef, the poorer their condition and the greater their threats.

Based on the study findings and in conjunction with Saipan's Local Action Strategy, the following policy recommendations were provided;

1. Tackle the problem of non-point and point source pollution;
2. Make use of the cultural importance residents place on marine ecosystems to improve coral reef management;
3. Develop a comprehensive system of user fees for visitors of the Marine Protected Areas on Saipan.

For further details the full study can be found here: <http://www.crm.gov.mp/pubs/22.pdf>



Economic Value of Guam's Coral Reefs (2007)

16 *van Beukering, Haider, Longland, Cesar, Sablan, Shjegstad, Beardmore, Liu, Garces*

The objective of this study was to carry out a comprehensive economic valuation of the coral reefs and associated resources in Guam. The focus was on valuing the five main uses of coral reefs in Guam. Some of these are extractive uses, such as fisheries (i); others are non-extractive, such as recreation/tourism (ii), cultural/traditional uses (iii), and education and research (iv). Indirect uses such as shoreline and infrastructure protection (v) are also included in the study. The aim being that with a better understanding of the economic importance of coral reefs, Guam's decision makers can formulate more effective policies utilizing limited funds.

The valuation of Guam's coral reefs involved a series of steps leading to the estimation of the total economic value. The researchers also examined the underlying motives and mechanisms that lie behind the estimated values. In particular, they focused on (1) people's relationships with marine ecosystems; (2) local willingness to pay for coral reef conservation; (3) the economic importance of Guam's reefs; and (4) the spatial variation of reef-associated values and threats. The main purpose of the household survey (of 400 local residents) was to determine the nature and level of the cultural value of coral reefs. The survey covered a number of issues, such as respondents' level of beach and marine recreation, environmental awareness, fishing activities and the importance of fish in their diet.

Findings

The study found that local residents utilize the coastal marine ecosystems for recreational purposes. A majority of the respondents in Guam have barbeques, swim or wade at the beach. Nevertheless, only a minority can actually swim. A significant share of respondents participates in snorkeling and diving. Clean, clear and safe water and good public facilities were considered to be the most important recreational amenities. Coral reefs and fish abundance were also mentioned as relevant, but were not considered to be crucial amenities. Most local residents reported witnessing a degradation of the

marine environment in recent decades, in particular a decline in both water quality and fish abundance. Between 35% and 45% of respondents were active fishermen. On average, fishermen go fishing around once a week. Despite the depleted fish stocks, fishing has not declined in popularity. In fact, because fishermen have grown older and have more time available, they now go fishing more frequently. Residents of Guam use the marine environment for fishing and recreational activities. As a result, people are concerned about degradation of the marine environment and are willing to support policy interventions that will address the issue. In fact, residents of Guam have clear ideas about the direction in which these policies should move.

The researchers also conducted a Discrete Choice Experiment valuation survey to estimate total economic values (TEV) for Guam’s coral reefs. The study valued the six main ecosystem services provided by coral reefs in Guam, namely support for commercial fisheries, recreation, tourism, cultural/traditional uses, research, and shoreline protection. The total annual values for each ecosystem service and the valuation methods used are summarized in Table 8. The total economic value of Guam’s coral reefs is dominated by the value of tourism activities, which represents approximately three quarters of the TEV.

Table 8 Total coral reef values for Guam (millions US\$/year; 2007 prices)

Ecosystem service	Valuation method	Total value (millions, US\$)
Tourism	Travel cost method	104
Recreation	Value transfer and net factor income	10
Commercial Fishery	Net factor income	4
Amenity	Hedonic pricing	11
Coastal protection	Avoided damage costs	9
Research	Net factor income	2
Total Economic Value		139

The authors identified a number of important areas in need of protection:

- The most valuable coral reefs are located within 200 meters of the most popular diving and snorkeling spots.
- Coral reefs in the inner areas of Tumon, Agana and Piti Bays are valuable because of their proximity to the numerous hotels, beaches and parks in these bays.
- Coral reefs along the southern coastline of Guam have a relatively high economic value because of their roles in tourism, fisheries, coastal protection and amenities provision. However, due to serious sedimentation, these reefs are highly threatened.
- The coral reefs located in the north and northeast of the island are in better condition, but their economic (use) value is relatively low.

The report offered some policy recommendations for consideration. The authors suggest that in order to provide economically-sound guidance to decision makers on the management of coral reefs, it was important to:

1. Identify both the most valuable, and most seriously threatened, reefs in Guam;
2. Determine the type of threat endangering a specific reef and select a number of potentially worthwhile interventions;
3. Evaluate the economic benefits and financial costs associated with these interventions, and;
4. Find sustainable sources of funding for management interventions.

For more details go to:

ftp://data.nodc.noaa.gov/pub/data.nodc/coris/library/NOAA/CRCP/project/1029/econ_value_guam_coral_reefs.pdf



Economic Assessment of Eastern Puerto Rico's Coral Reefs and Associated Environments (2008)

Estudios Técnicos Inc

The Puerto Rican Department of Natural and Environmental Resources hired the consulting firm Estudios Técnicos Inc., to carry out an economic assessment of the coral reefs and associated environments of eastern Puerto Rico, namely Fajardo, the Cordillera reef system, Vieques and Culebra. The objective of the study was to calculate the total economic value of the coral reefs and associated resources in this part of eastern Puerto Rico.

Approach

The report calculated total economic value on the basis of goods, roles, and services provided by this ecosystem. Using the TEV approach they arrive at this value by adding the use values (value of goods and services) and passive values (future value, legacy value, existential value, and biodiversity value).

Findings

The non-use values for the Puerto Rican population are estimated through the application of the contingent valuation method and again show that these types of values, when estimated, dominate the total economic value of coral reefs. The total annual values for each service are summarized in Table 9.

Table 9 Total coral reef values for Puerto Rico (millions US\$/year; 2007 prices)

Ecosystem service	Valuation method	Total value (millions, US\$)
Small-scale fishing	Gross revenue	1
Recreation and tourism	Travel cost	192
Coastal protection	Value transfer	1
Education and research	Gross revenue	1
Existence value	Contingent valuation	306
Future value	Contingent valuation	193
Bequest value	Contingent valuation	210
Biodiversity	Contingent valuation	191
Total Economic Value		1,093

Coral reef resources, however, continue to deteriorate, mostly due to poor land use practices and improperly regulated tourist/recreational activities. Over the course of this study, factors were identified that have the potential to impact the effective management of these resources, including the following:

1. A lack of understanding on the part of the general population of the importance of coral reefs and their interconnectedness with other coastal resources;
2. A lack of understanding on the part of the general population of what types of tourism/recreational activities are harmful to the resources;
3. The extension and condition of these resources are unknown;
4. Information on research and researchers of these resources is scattered; and
5. The Commonwealth has laws and regulations on the books to protect the reefs, but their enforcement has been inadequate.

Based on the analysis of uses, users, and threats uncovered in the economic assessment exercise, a number of recommendations were put forward. They were roughly grouped under Management and Financing Recommendations.

The management recommendations were:

- Establishment of areas where fishing is permanently banned
- Significantly increase penalties for violations of environmental law
- Implement a study that details the characteristics and demarcation of the zone
- Engage in ecosystem surveillance and supervision
- Limit access to the most sensitive areas
- Buoy placement
- Promotion of sustainable tourism
- Ongoing restoration and monitoring programs
- Implementation of a system for boat access to the area
- Visitor information program

While the suggested financing recommendations were:

- Impose an environmental tax to finance a small fund for maintaining the natural resources of eastern Puerto Rico
- Include tourists and users in the protection and management of the area



The Economic Value of the Coral Reef Ecosystems of the United States Virgin Islands (2011)

van Beukering, Brander, van Zanten, Verbrugge and Lems

The objective of this study was to provide a quantitative measure of how important the reefs are to the USVI in monetary terms and also to generate a reference point with which to compare possible alternative development/conservation plans. The assumption being that information on the Total Economic Value (TEV) of reefs should provide a basis for advocating the preservation of the coral reefs in USVI, establishing damage compensation, setting fees for permit applications or determining potential user fees for residents and tourists.

Approach

The approach for this study was to focus on valuing the six main uses of coral reefs and adjacent habitats in selected sites on the USVI: (1) fishery value; (2) tourism value; (3) recreational and cultural value; (4) real estate value; (5) shoreline protection; and (6) education/research values. Based on the overall approach mentioned, the study involved a wide range of research activities. These include the following:

1. An elaborate local resident survey aimed at estimating the local cultural and recreation attachment to the marine environment;
2. An extensive tourist survey with the objective to get a comprehensive insight into the importance of the marine environment for visitors to the USVI;
3. A thorough analysis of the coastal protection function of reefs thereby revealing the role of coral reefs in avoiding storm damage to properties and infrastructure;

4. A hedonic pricing analysis based on real estate transactions which demonstrated the positive impact of healthy reefs on house prices;
5. A spatial analysis aimed at preparing value maps of the coral reefs of the USVI.
6. An aggregation exercise combined with a rapid scenario analysis leading to the estimation of the TEV of coral reefs of the USVI.

Findings

The above activities resulted in the estimation of the main ecosystem services provided by coral reefs in the USVI. However estimation of the various ecosystem service values involved a large number of assumptions that simplify the underlying dynamics and complexity of coral reefs in the USVI. The authors of this study presented lower and upper bound estimates determined for each ecosystem service, recognizing the uncertainty surrounding the economic analysis. In the case of coastal protection, for example, the different storm frequencies available in the literature were used to create a range of values. In the case of the fishery values, the wide range of financial cost estimates was used to set the upper and lower bound of the value. The ranges estimated for each ecosystem service is presented in Table 10 below.

With an average estimate of US\$ 202 million per year, the lower bound estimate is determined at almost US\$100 million per year while the upper bound is set at US\$273 million per year. The authors suggest that further study could allow for the reduction of uncertainties and thus the narrowing of the value range.

Table 10 Upper and lower bound estimates of the annual benefits of coral reefs in the USVI (2010US\$ million/year)

Ecosystem Service	Lower bound	Average	Upper bound
Tourism	64.7	102.9	141.0
Recreation & Cultural	17.5	51.1	66.7
Amenity	9.7	37.1	47.2
Coastal protection	3.4	6.7	13.4
Fishery	3.1	3.3	3.4
Research & Education	0.5	1.0	1.5
Total annual economic value	98.9	202.1	273.2

The study provides various insights that may be used to develop policy measures which directly contribute to more sustainable management of coral reefs in the USVI. It also provided a clear perspective of who benefits most from healthy coral reefs. Those who stand to gain the most may be ideal contributors to the preservation of the USVI coral reefs. The study shows that next to tourists, the second most important beneficiary of the coral reefs is the local community, who benefits from the reef in various ways (e.g. recreation, culture, coastal protection). Through stronger engagement of the local public in marine management, decision makers may build more local support for conservation oriented measures while at the same time enhancing the awareness of local communities.

For further details see full study:

http://www.ivm.vu.nl/en/Images/The%20Economic%20Value%20of%20the%20Coral%20Reefs%20of%20the%20USVI_tcm53-232341.pdf

Conclusion

This document presents a brief summary of seven NOAA Coral Reef Conservation Program funded studies. Other valuation studies were conducted in some of the same jurisdictions over this period. For the purposes of this summary report, we have focused only on these seven studies. However, Brander et al (2013) present a detailed analysis of US coral reef valuation studies in which they include the seven studies discussed here as well as a few others. As part of their summary report, Brander et al conducted a meta-analysis of valuation data. They combined the data from all studies and ran multiple regression models that allowed them to examine relationships between variables, for example the statistical relationships between people and their demand (willingness to pay) for particular coral reef attributes. For example, they found that bundles of tourism/recreation activities were more highly valued than individual activities and non-use values for coral reefs were found to be substantially higher than other values.

Brander et al have estimated total economic value of coral reef services for all US coral reef jurisdictions at just over **US\$ 3.4 billion** per year. The authors consider this value to be a partial estimate due to (1) the limited geographical coverage of some state/territory level TEV estimates and (2) the limited set of services that are valued for some states and territories. They have recommended that in order to develop a full picture of the TEV of US coral reefs it is necessary to fill the information gaps on non-use values for the remaining coral reef regions.

Like the report discussed above (Brander et al 2013), this report also comes to a similar conclusion. **Coral reefs contribute significant economic value to the US public.** These studies also confirm that **in order to continue to address the management needs and to build public support for conservation of these resources, economic values must be considered.**

Better consideration of these economic values should lead to more efficient decision making that balances the needs of development and conservation. The findings summarized here demonstrate a need for new valuation studies in order to update some of the more dated coral reef valuation estimates. In some cases, these studies are over 10 years old and would benefit from advances in valuation approaches and econometric techniques. New valuation studies should incorporate attribute based choice experiment survey approaches as well as the use of cutting edge hedonic analyses.

The results from new studies should not only contribute to increased awareness of coral reef values but also could provide useful information that can lead to improvements in policy and decision-making.

Total Economic Value of US Reefs by Jurisdiction (2012\$)

Location	Study Year	Present Value (2012\$ Million/Year)
Florida	2001	324
Hawaii	2002	455
American Samoa	2004	11
CNMI – Saipan	2006	68
Guam	2007	150
Puerto Rico	2008	1,161
US Virgin Islands	2011	210

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