Appendix 6. Net present value (PhP million)

Year	Fisheries	Tourism	Research	Carbon Sequestration	Coastal Protection	Biodiversity	Discounted Benefits Stream
1	563	115	35	417	1,160	348	2,637
2	512	104	31	379	1,055	317	2,398
3	465	95	29	345	959	288	2,180
4	423	86	26	314	872	262	1,981
5	384	78	24	285	792	238	1,801
6	349	71	21	259	720	216	1,638
7	318	65	20	236	655	197	1,489
8	289	59	18	214	595	179	1,353
9	263	53	16	195	541	162	1,230
10	239	49	15	177	492	148	1,118
11	217	44	13	161	447	134	1,017
12	197	40	12	146	407	122	924
13	179	36	11	133	370	111	840
14	163	33	10	121	336	101	764
15	148	30	9	110	305	92	694
16	135	27	8	100	278	83	631
17	122	25	8	91	252	76	574
18	111	23	7	83	229	69	522
19	101	21	6	75	209	63	474
20	92	19	6	68	190	57	431
Total	**5,270**	**1,073**	**324**	**3,908**	**10,863**	**3,261**	**24,698**

Economic Valuation of Philippine Coral Reefs in the South China Sea Biogeographic Region

by

Giselle Samonte-Tan and Ma. Celeste Armedilla

UNEP
United Nations Environment Programme

SCS
UNEP/GEF South China Sea Project

GEF
Global Environment Facility

Appendix 5. Total economic value (PhP million)

Location of Reef	Fisheries	Tourism	Research	Net Market Value[a]	Carbon Sequestration	Coastal Protection	Biodiversity	Non-market Value[b]	Total Economic Value[c]
1. Lingayen Gulf	12.7	0.0	18.0	30.7	9.5	26.3	7.9	43.6	74.4
2. North Luzon-Babuyan Islands-Batanes Islands	2.7	20.8	10.3	33.8	2.0	5.6	1.7	9.4	43.2
3. South Luzon-Marinduque-Eastern Mindoro-	30.6	57.0	0.0	87.5	22.7	63.1	18.9	104.7	192.2
4. Northwestern Palawan	206.6	47.4	0.0	254.0	153.4	426.1	127.8	707.3	961.2
5. Kalayaan Island Group, Palawan	366.2	0.4	10.0	376.6	271.9	755.2	226.6	1,253.7	1,630.3
Total	**618.8**	**125.6**	**38.3**	**782.7**	**459.5**	**1,276.3**	**382.9**	**2,118.6**	**2,901.2**

[a]Net market value from fisheries, tourism and research.

[b]Non-market value including carbon sequestration and shoreline protection and option value

[c]Net market value plus non-market value

First published in the Philippines in June 2004 by the United Nations Environment Programme

UNEP/GEF
Project Co-ordinating Unit,
United Nations Environment Programme,
UN Building, 9th Floor Block A, Rajdamnern Avenue,
Bangkok 10200, Thailand
Tel. +66 2 288 1886
Fax. +66 2 288 1094; 281 2428
http://www.unepscs.org

Prepared for publication by: Porfirio M. Aliño (National Focal Point-Coral reefs Philippines), Miledel Christine C. Quibilan, Ma. Vanessa B. Baria, Ma. Gregoria Joanne P. Tiquio

Lay-out: Ma. Gregoria Joanne P. Tiquio
Cover design: Rex Flores
Cover picture: XXX
Printed and bound in the Philippines: XXX

For citation purposes this document may be cited as:

Samonte-Tan, G. and Armedilla, M. C. 2004. Economic Valuation of Philippine Coral Reefs in the South China Sea Biogeographic Region. National Coral Reef Review Series No. 3. UNEP.

Appendix 3. (Cont'd)

Valuation Study	Methodology	Valuation Results
Cesar H, van Beukering P, Pintz S, Dierking J (2002) Economic valuation of the coral reefs of Hawaii. National Oceanic and Atmospheric Administration, Coastal Ocean Program. 67-75pp	Simple Coral Reef Ecological Economic Model	Recreation Tourism -$ 325 million/year Amenity Property- $ 40.05 million/year Biodiversity- $ 17 million/year Fisheries- $ 2.5 million/year Education Spill Over - - - Total Annual Benefits- $ 384.55 million/year NPV @ 3% - $ 10,279 million

Appendix 4. Literature on economic valuation of coral reefs: books

Valuation Study	Valuation Results
Burke, L., E. Selig, and M. Spalding. 2002. Reefs at risk in Southeast Asia. Washington, D.C.: World Resources Institute.	Tourism and recreation were assumed to have annual net benefits of US$330 for coral reefs with low tourism potential (beyond 10 km from current identified tourism development) and US$56,000 for areas with good tourism potential (within 10 km of current tourism development). Only 3 percent of Indonesia's reefs and 7 percent of Philippine reefs were identified as having high tourism potential. Coastal protection assumed annual net benefits of US $110,000 for reefs near high development areas, US $5,600 near medium development areas, and US$90 for reefs in low development areas or more than 4 km from the coastline. Sustainable fisheries production was assumed to yield 15 mt per kilometer squared per year (McAllister 1988), annual net benefits of US$24,000 per kilometer squared, and reef area estimates of 50,875 kilometer squared and 25,819 kilometer squared for Indonesia and the Philippines, respectively. Aesthetic / biodiversity value was evaluated only for reefs with high tourism potential and was assumed to have annual net benefits of US$5,700 per kilometer squared.

TABLE OF CONTENTS

List of Tables

List of Figures

Appendix 3. (Cont'd)

Valuation Study	Methodology	Valuation Results
Johns GM, Leeworthy VR, Bell FW, Bonn MA (2001). Socioeconomic study of reefs in Southeast Florida. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects, and Tallahassee, Fl: Florida State University, Department of Economics and Department of Business, School of Hospitality Administration. pp.255	User Value. Contingent Valuation using discrete choice logit model. Randomly assigned dollar amounts for residents were $10, $50, $100, $500 and $1,000 per trip. Many trips for visitors were multiple day trips. Data was pooled across counties and logit model was used. Although the question asked about the willingness to pay per trip for all Southeast Florida natural reefs, estimates by County were derived by first normalizing to value per person-day for each individual. Sample means by County/ Activity/Boat Mode were used when the logit model identified significant differences and sample means were significantly different. Annual values by County/Activity/Boat Mode is derived as total person-days of natural reef use in the County (by Activity/Boat Mode) times the mean value per person-day (by Activity/Boat Mode). Economic Impact/Contribution For visitors to Palm Beach, Broward and Miami-Dade counties the IMPLAN input-output model was used. For Monroe County, a model using wages to sales ratios and wages to employment ratios by industry was used to derive direct impacts on income and employment. Keynsian regional multipliers for income and employment were then used to calculate total income and employment impacts.	*Revenue* Sales/Output (millions 2001 $): $697.072 Income (millions 2001 $): $393.087 Employment (# full and part-time): 11,211 *Welfare Estimate* Per Person Per Day: Fishing $6.73; Scuba diving $9.81; Snorkeling $7.25; Glass-bottom Boat Rides $7.01; All $7.09
Stoll JR, Ditton RB 2002. Sport diving and it's economic value: Are artificial reefs different? Green Bay, WI: University of Wisconsin, Public and Environmental Affairs Dept. and College Station, TX: Texas A & M University, Dept. of Wildlife and fisheries Science	Contingent valuation	Consumer's surplus per person per trip: $141.62 Sport divers Flower Gardens National Marine Sanctuary Consumer's surplus per person per trip: $109.19 Sport divers Artificial Reefs in Gulf of Mexico

Appendix 3. (Cont'd)

Valuation Study	Methodology	Valuation Results
Gustavson KR (1998) Values associated with the local use of the Montego Bay Marine Park. Marine system valuation: An application to coral reef systems in the developing tropics. World Bank Research Committee Project # RPO 681-05/ World Bank pp. 42	Estimation of net present value using production function theoretical context. In other words, contribution of resource as input to production to value of output in produced good or service.	Welfare Estimate: $65 million associated with the coastal protection function based on the average value of land, this translates to $428,000 per acre. Ranges of net present values for fishing of -$1.66 to $7.49 million at the 5% discount rate (the range is based on a range of operating revenues from a previous study) and -$741 thousand to $2.37 million at the 15% discount rate. These estimates can be normalized to a (non-weighted) average per fisher of $7,410 to $33,437 for i= 5% and $3,308 to $10,580 for i=15%. A net present value range of $210 to $630 million associated with tourism (with a 15% and 5% discount rate, respectively). This translates to a per person-day NPV of $56 to $318.
Hundloe TA, Vanclay FM, Carter M (1987) Economic and socio-economic impacts of the crown of thorns starfish on the Great Barrier Reef.	Reef Valuation: Travel Cost Method, Contingent Valuation (convergent bidding approach); Crown of Thorn Starfish Trust Fund/Reef Management: Contingent Valuation.	VALUE OF REEF: Travel-Cost Method: Total consumer surplus for all Australian visitors to the reef: $117,455,988 per annum; $26,737,219 for foreign visitors. Contingent Valuation: $5,652,056 for surveyed visitors (or sample mean entrance fee per adult of $11.00), $45,386,664 for vicarious users when weighted to the Australian population (or mean maximum WTP of $4.13). Mean consumer surplus for crown of thorns starfish reef management (over and above entry fee): $9.77 ($8.69 weighted) (all respondents); Mean consumer surplus for crown of thorns starfish research and control: $2.66 ($2.36 weighted).

List of Appendices

List of Acronyms

UNEP	United Nations Environment Programme
PhilReefs	Coral Reef Information Network of the Philippines
UNEP/GEF	United Nations Environment Programme - Global Environment Fund
NSCB	Philippine National Statistics Coordination Board
GNP	Gross National Product
R&D	Research and Development
KIG	Kalayaan Group of Islands

EXECUTIVE SUMMARY

This paper is an initial investigation of the economic value (use and preservation values) of Philippine coral reefs in the South China Sea biogeographic region. The approach for estimating the economic value of coral reefs used the valuation framework agreed by the UNEP's Regional Task Force on valuation. The concept of total economic valuation highlights the significant economic values that can accrue from use values and non-use values. Adding the above market (direct) and non-market values (indirect and option values) gives an estimate of the total quantifiable economic value of PhP 2,901 million ($ 53 million). Fisheries, tourism and research values account for about 27 percent of the total net economic value. Calculated over 20 years, with a discount rate of 10%, the net present value of benefits of Philippine coral reefs in the South China Sea basin is estimated at PhP 24,700 million (US$ 449 million) translates to approximately PhP 5.3 million/km^2 net present value, or PhP 266,112/km^2/yr on an annualized basis. This is based on an estimated Philippine coral reef area within the South China Sea basin of 4,640.94 km^2.

Coral reef areas in the Philippines are major fishery resources and popular recreational attractions for domestic and foreign tourists. Current financing of coral reef management is insufficient considering the threats of land-based and marine-based human activities that cause irreversible damage to the coral reef resources. The results of this study may guide policy makers in evaluating/ updating pricing policies (user fees, general tax revenues, fines, etc.) and in developing appropriate financing mechanisms.

Appendix 3. (Cont'd)

Valuation Study	Methodology	Valuation Results
Drimil, S (1994) Protection for profit: Economic and financial values of the Great Barrier Reef World Heritage Area and other protected areas. Great Barrier Reef Marine Park Authority; Townsville, QLD		Tourism consumer surplus for Great Barrier Reef estimated by Hundloe et al. (1987) to be in the range of $23-$357 million (1991-92 dollars).
English DBK, Kriesel W, Leeworthy VR, Wiley PC (1996) Economic contribution of recreation visitors to the Florida Keys/Key West. Athens, GA: USDA Forest Service, Outdoor Recreation and Wilderness Assessment Group and University of Georgia, Department of Agricultural and Applied Economics, Silver Spring, MD: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division. 1-22 pp.	For South Florida (Broward, Miami-Dade and Monroe counties), the IMPLAN input-output model was used. For Monroe County, wages-to-sales ratios and wages-to-employment ratios by industry were used to derive direct wages and salaries and direct employment estimates. These ratios were from the 1992 Economic Censuses for Monroe County by the U.S. Department of Commerce, Bureau of the Census. Total Direct income and employment were derived by using the ratio of wages and salaries to total income to derive proprietor's income and the ratio of proprietor's income to proprietor's employment to dervive proprietor's employment. These ratios were from the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System for Monroe County (1998). Total direct output, income and employment were then converted to total output, income and employment using Keynesian local multipliers derived from a study by Bell (1991) for Monroe County.	Visitor Spending: $1.67 billion

Appendix 3. (Cont'd)

Valuation Study	Methodology	Valuation Results
Dixon JA, Scura LF, van't Hof, T. Meeting ecological and economic goals: The case of marine parks in the Caribbean. Washington, DC: The World Bank. Prepared for the Second Conference on the Ecology and Biodiversity Loss of the Beijer Institute. 21 p.	Contingent Valuation question using user fees as the payment vehicle. Respondent first asked if they think $10 per diver per year fee being proposed is reasonable and if so, were they willing to pay it. 92 percent were willing to pay the $10 per diver per year fee. Respondent were then asked at what level they would find the admission fee to be unreasonable. Values were $20, $30, $50 and $100. 80 percent were willing to pay $20, 48 percent were willing to pay $30, and 16 percent were willing to pay $50. The report doesn't say what percent were willing to pay $100. The sample average willingness to pay was $27.40. The difference between the average willingness to pay and the $10 fee to be charged was interpreted as consumer's surplus.	Per diver per year: Average Willingness to Pay User Fee $27.40 minus $10 user fee charged or $17.40 in consumer's surplus per diver per year. Annual Consumer's Surplus: 18,700 divers times $17.40 per diver or $325,000
Drimil, S. (1999) Dollar values and trends of major direct uses of the Great Barrier Reef Marine Park. Great Barrier Reef Marine Park Authority Townsville, QLD		Gross financial value of commercial tourism 1995-1996: Reef trips $167.4 million; Mainland accommodation: $236.3 million; Island resorts, $243.3 million; TOTAL = $647 million for a total of 1.2 million visitor nights. Gross financial value of commercial fishing: $143 million. Gross expenditures by recreational anglers in 1995 = $122.5 million. Total gross financial value of the three direct uses of the Great Barrier Reef Marine Park in 1995 is $912.5 million.

I. Valuation of Coral Reefs and the Socio-economic Context

Net primary production for coral reefs (1,000 g/m^2/year) is highly correlated with the value of services ($6,075/ha/year) that reefs provide (Costanza, et al., 1998). In the Philippines, it is estimated that the 27,000 km^2 of reef in their degraded condition still contribute at least US$ 1.35 billion annually to the economy (White, et. al., 2000). The coral reefs found west of the Philippines cover approximately 4,641 km^2 or 17 percent of the total coral reef area of the Philippines (Table 1). Major reef areas are found in the the Batanes group of islands and along coastlines of Luzon Island, the bays of Batangas and Mindoro provinces, the Calamianes group of Islands along the main island of Palawan though the Balabac islands, and the Kalayaan Island Group (KIG) (Coral Reef Information Network of the Philippines (Philreefs) 2003 and Aliño, et al., 2002).

The importance of socio-economic considerations in the management of coral reefs is recognized. Important values provided by coral reefs include marine fishery, recreational and tourism benefits, research, and natural protection for the shoreline. Correct management of coral reefs maintains sustainable use and benefits to the community. Externalities should be 'costed' and internalized by users.

The United Nations Environment Programme (UNEP) Regional Working Group on coral reefs has agreed on a two tier process for evaluating coral reefs in the South China Sea biogeographic region based on environmental and socio-economic indicators (UNEP, 2003a). Identified indicators for socio-economic consideration include national significance (identified as national priority and socio-economic value); level of stakeholder/community involvement in management; and threats (fishing impact, development impact, coral mining land-based pollution, natural impact such as typhoon, bleaching, and crown of thorns star fish).

Table 1. Estimated area of Philippine coral reefs in the South China Sea biogeographic region

Location	Area[a] (km^2)
1. Lingayen Gulf	95.6
2. North Luzon-Babuyan Islands-Batanes Islands	20.5
3. South Luzon-Marinduque-Eastern Mindoro-Northwest Tablas	229.3
4. Northwestern Palawan	1,549.3
5. Kalayaan Island Group, Palawan	2,746.3
Total	**4,640.9**

[a]World Resources Institute (2002)

The economic value of coral reefs shall help decision-makers understand the contribution of the goods and services that coral reefs provide to the various stakeholders and sectors of the economy. Determining the value of coral reefs is a 'first step' to protecting and managing coral reef ecosystems. From the estimated economic value of coral reefs, the discounted future benefits can be compared with current and future costs of various protection/management options thus, providing critical information on the impact of marine protection. In addition, the recognized economic value of coral reefs will generate the political will essential for sustaining coral reef management processes, thus, safeguarding the productivity of coral reefs. This paper is an initial investigation of the economic value (use and preservation values) of Philippine coral reefs in the South China Sea biogeographic region.

Appendix 3. Literature on economic valuation of coral reefs: reports

Valuation Study	Methodology	Valuation Results
Bunce LL, Gustavson KR (1998) Coral reef valuation: A rapid socioeconomic assessment of fishing, watersports, and hotel operations in the Montego Bay Marine Park, Jamaica & an analysis of reef management implications. Environmentally and socially Sustainable Development Sector Department, Latin America and the Caribbean Region (LCSES)/World Bank, Washington, DC. 369-380 p.	This incorporated a "Rapid Rural Appraisal (RRA)" methodology. This study did not purport to estimate market or non-market economic values.	Fishers (subsistence or small scale commercial) average yearly individual net income US$3,000 To US$4,500. Translates to total net income of US $1,134,000 TO US$1,701,000. No information was presented on watersports operators income in this study. This information cannot be easily separated from hotel revenue. The same is true of the hotel industry.
Cesar, HJ (1996) Economic analysis of Indonesian coral reefs. Working Paper Series. Work in Progress. World Bank Washington, DC 97 p	Benefits transfer. Use of existing studies for threats and destruction of reefs and existing studies and government data for different reef uses. All uses are converted to thousands of U.S. dollars per square kilometer of coral reef. Net Losses to Society are calculated as estimated losses in square kilometers of coral reefs times the value of Net Losses to Society for each use dependent on the cooral reefs per square kilometer of coral reef.	Poison Fishing. Total Net Benefits to Individuals $33.3; Net Losses to Society a) Fishery $40.2, b) Coastal Protection $0, c) Tourism $2.6 - $435.6; Total Net Losses $42.8 - $475.6 Riopelle (1982) studied reef-related tourism on West Lombok (coastline of around 40-50 km), and found a total net present value of benefit from divers and snorkelers of US$ 23.5 million at a 10% discount rate xiii . This would mean a present value of direct total net benefit of around US $500,000 per km of coastline. With the tourism-multiplier of 2, this gives a net present value of US $ 1 million per km of coastline. For West Lombok (NTT, Indonesia) this is calculated by Riopelle (1995), who estimated the total economic value vi of coral reefs as high as US$ 58.2 million for West Lombok, which corresponds to more than US$ 1 million per km 2 of reef.

Appendix 2. Literature on economic valuation of coral reefs: unpublished studies

Valuation Study	Methodology	Valuation Results
Arin, T (1998) Estimating the Tourist Demand for International Dive Vacations: A Pretest Phillipines (Anilao, Batangas; Mactan Island, Cebu; Panglao Island, Bohol) Master of Science Thesis, Nicholas School of the Environment, Duke University	Contingent valuation and travel cost methodologies	· Average WTP as a daily entrance fee to a marine sanctuary: $4.20 (average for the three sites). · Average WTP as an annual donation for coral reef boat mooring maintenance: $6 (average for the three sites)
Christiernsson, A (2003) An Economic Valuation of the Coral Reefs at Phi Phi Island: A Travel Cost Approach. Masteral Thesis. Lulea University of Technology. 40 p.	Consumer surplus measures how much visitors of the coral reefs at Phi Phi are willing to pay, in addition to what is already paid, for recreation at the site using the travel cost method/ revealed preference method.	· The total consumer surplus is approximately US $ 110 million.
Wright, MG (1994) An Economic Analysis of Coral Reef Protection in Negril, Jamaica. College Senior Thesis. Williams College	Contingent valuation- and travel cost method-based surveys.	· Visitor willingness-to-pay estimated at $31 annually (in addition to current costs) to preserve coral reefs as they are; $49 annually to improve them to a quality level where over 90% of the reef's coral are alive and healthy. If the quality was improved, they would receive approximately $8 million in benefits. Consumer surplus using travel cost method is $121 with annual consumer surplus at $19,602,000.
Subade, RF (2003). Economic Valuation for Biodiversity Conservation of a World Heritage Site: Citizens' Non-use values of Tubbataha Reef National Marine Park, Sulu Sea, Philippines. Dissertation Research, University of the Philippines at Los Baños.	Contingent valuation.	· Social willingness-to-pay or social benefit from conserving Tubbataha marine park ranges from PhP 187 million ($3.44 million) to PhP 6.02 billion ($110.7 million). · Mean WTP was computed at PhP 394/individual/year.

II. Economic Framework

Resources including coral reefs have use and non-use values. Use value refers to consumer surplus benefit from actual use, while non-use value refers to benefits from preservation. The Regional Task Force[1] agreed on the valuation framework presented in Figure 1. The concept of total economic valuation highlights the significant economic values that can accrue from use values (direct, indirect and option) and non-use values (existence, bequest). Option value is the willingness-to-pay for retaining the use of the coral reefs for possible future use. Existence value is the willingness-to-pay for the knowledge that the coral reefs are preserved. Bequest value is the willingness-to-pay for the satisfaction derived from endowing future generations with the coral reef resources.

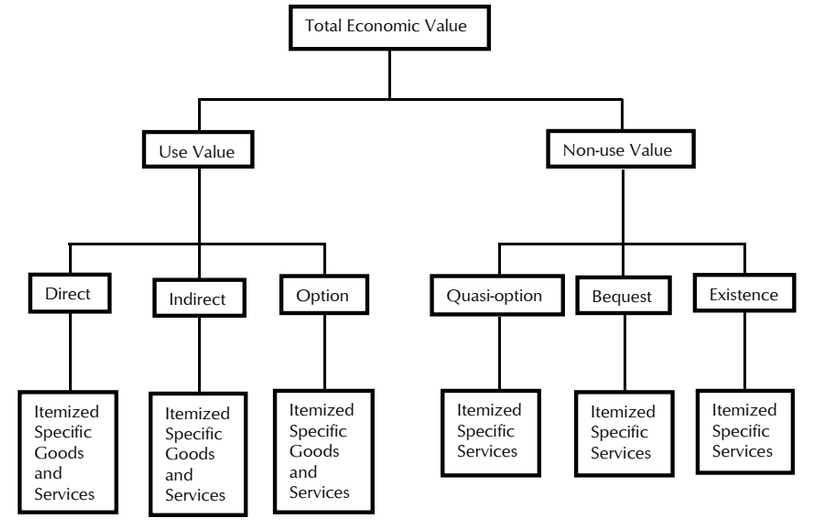

Fig. 1. Economic valuation approach (UNEP, 2003b)

[1]The Regional Task Force on Economic Valuation was established, under the UNEP/GEF Project on Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand, with the primary objective of advising and providing expertise and assistance in completing economic valuations and cost-benefit analyses.

The estimation of the economic value of coral reefs in west Philippines, South China Sea basin, includes the market value of the direct use values such as fisheries, tourism and research values (Table 2). Other marine products such as coral rock and sand also provide value as construction materials.[2] The non-market values include indirect use values such as carbon sequestration and shoreline protection, and option values.

Table 2. Uses of Philippine coral reefs in the South China Sea biogeographic region[3]

Location of Reef	Use Values					Non-use Values
	Direct Use Values			Indirect Use Values	Option Value	
	Fisheries	Recreation/ Tourism	Research/ Education			
Pasuquin, Ilocos Norte	✓	✓	✓	✓	✓	✓
Bolinao, Pangasinan	✓	✓	✓	✓	✓	✓
Anda, Pangasinan	✓	✓	✓	✓	✓	✓
Alaminos, Pangasinan	✓	✓	✓	✓	✓	✓
Balingasay, Pangasinan	✓		✓	✓	✓	✓
Masinloc, Zambales	✓	✓	✓	✓	✓	✓
Cabangan, Zambales	✓		✓	✓	✓	✓
Mabini and Tingloy, Batangas	✓	✓	✓	✓	✓	✓
Puerto Galera, Mindoro	✓	✓	✓	✓	✓	✓
Sablayan, Mindoro	✓		✓	✓	✓	✓
El Nido	✓	✓	✓	✓	✓	✓
San Vincente, Palawan	✓	✓	✓	✓	✓	✓
Kalayaan Island Group, Palawan	✓		✓	✓	✓	✓

[2]No data is available to derive the value of raw materials from coral reefs.
[3]Derived from Aliño, et. al. (2002) and Coral Reef Information Network of the Philippines (Philreefs) (2003).

Appendix 1. (Cont'd)

Valuation Study	Methodology	Valuation Results
Pet-Soede C, Cesar HSJ, Pet JS (1999) An economic analysis of blast fishing on Indonesian coral reefs. *Environmental Conservation* 26: 83-93	The cost-benefit balance at the society level was calculated with an economic model.	This analysis showed a net loss after 20 years of blast fishing of US$306,800 per square km of coral reef where there is a high potential value of tourism and coastal protection, and US $33,900 per square km of coral reef where there is a low potential value.
Polunin NVC, Roberts CM (1993) Greater biomass and value of target coral reef fishes in two small Caribbean marine reserves. *Marine Ecology Progress Series* 100: 167-176	Average price by range of fish size and species of fish multiplied by count in fish size range by species.	Mean for the two fished sites was B$1.85/count (Belize dollars). Mean for the Hol Chan Marine Reserve was B$4.08/count. The mean value for fish caught at the Basil Jones Cut was B$2.96/ count. The mean value of fish in families showing significant differences at Saba (snapper, grunt, grouper and parrotfish was B$1.48/count in fished areas and B$5.30/ count in the no fishing zone of the marine park.
White AT, Barker V, Tantrigama, G (1997) Using integrated coastal management and economics to conserve coastal tourism resources in Sri Lanka. *Ambio* 26	Contingent valuation	*Revenue:* Average tourist expenditure is $32/day. With an estimated 311,726 tourist guest nights per year, total gross tourism expenditure is approximately $10 million. *Welfare Estimate*: Reef access WTP estimate: $5.12; Beach access WTP estimate: $0.75; Aggregrate 1994 consumer surplus for Hikkaduwa beach and reef ranges from $54,000-$167,000.

Appendix 1. (Cont'd)

Valuation Study	Methodology	Valuation Results
Dixon JA, Scura LF, van't Hof T (1993) Economic benefits of Marine Protected Areas. *Oceanus* Fall: 35-40	Report provides a review of the literature for the Caribbean and discusses the theoretically correct measures needed for assessing the economics of marine protected areas or parks.	· *Revenue:* 1992 18,700 divers per year at $10/diver/year or $187,000 in user fee revenue · *Welfare Estimate:* Per diver per year: Average Willingness to Pay User Fee $27.40 minus $10 user fee charged or $17.40 in consumer's surplus per diver per year. · *Annual Consumer's Surplus*: 18,700 divers times $17.40 per diver or $325,000
Hundloe T (1990) Measuring the value of the Great Barrier Reef. *Australian Parks and Recreation* 26:11-13	Travel cost; contingent valuation	· *Revenue:* Total expenditure by visitors to the reef region per annum is estimated at $653.7 million, of which $44.4 million is directly associated with visits to coral sites. · *Welfare Estimate:* Total consumer surplus as calculated through a travel-cost methodology for visits to the coral reef region by Australian and international tourists is $144.2 million, and for visits to coral sites $105.6 million. Using a contingent valuation survey of visitors to the reef region visiting coral sites, the willingness to pay amount is $6 million per year or $8 per adult visitor.
McAllister DE (1988) Environmental, economic and social costs of coral reef destruction in the Philippines. *Galaxea* 7:161 – 178	Benefits transfer. Use estimates from other studies on coral reef fish production per square kilometer of coral reef for reefs in various conditions (e. g., poor, fair, good, excellent).	· Using the good condition, sustainable yield per year was calculated. This yield minus the actual yields equals the losses in potential fish production. Fish are valued at 10 pesos per kilogram to yield approximately $80 million U.S. A multiplier of 2 is used to derive an estimate of $160 million U.S. in lost fishery production per year. · For number of jobs lost, catch per small-scale fisherman is used with lost production to derive number of lost fishing jobs. An average of fisher's household size of four was used to derive an estimate of the number of family members impacted. Again using multiplier analysis, over a million persons are affected by the loss in employment. Lost jobs to small-scale Fishermen: 127,000.

III. Valuation Method

The total economic value of coral reefs is the sum of all net benefits from all compatible uses and non-use values. The total economic value (TEV) for Philippine coral reefs in the South China Sea biogeographic region is computed as follows:

$$TEV = \text{use value} + \text{non-use value}$$
$$= (DUV + IUV + OV) + (XV + BV)$$

where,

DUV = Direct Use Value
IUV = Indirect Use Value
OV = Option Value
XV = Existence Value
BV = Bequest Value

Only a few studies on valuation of coral reefs in this region have been conducted. The benefits transfer method, wherein the values derived in various studies are transferred and adjusted, is adopted to estimate the total economic benefits provided by Philippine coral reefs in the South China Sea biogeographic region. The total economic benefits include both direct benefits as indicated by fishers and tourism revenues as well as non-marketed benefits such as potential benefits to be gained by maintaining these resources. This approach involves taking an estimate of the economic value of a similar environmental impact form an existing study, and transferring it to a new context, assuming that the existing value can be used as an approximation. The following steps were undertaken in applying the benefit transfer method: (1) identification of existing studies where the benefit has been estimated; (2) identification of the relevant values to be applied for the Philippine reef areas; (3) substitution of the values to calculate the benefits of the reef area; and, (4) calculation of the total discounted value. Benefit transfer included value transfers of single point estimates.

Benefit transfer method was used for the estimation of indirect, option and non-use values to present the indicative potential net benefits, which may be used as inputs for management decisions.

As natural assets, coral reefs provide a stream of valuable services to society over time. Total economic benefits derived from Philippine coral reefs was calculated as the sum of the present value of the stream of revenues (NPV) over a 20-year period. That is,

$$NPV = \left(\sum_{t=0}^{T} B_i - \sum_{t=0}^{T} C_i \right) / (1 + r)^t$$

where, *NPV* = net present value, *B* = benefits of each sector, *C* = costs of each sector, *i* = sector, *t* is the year, and *r* is the social discount rate. A discount rate of 10% was used in this study. Low values of the discount rate will make the sum of present values large and high values of the discount rate will make the sum of present values small.

Appendix 1. (Cont'd)

Valuation Study	Methodology	Valuation Results
Bunce L, Gustavson K, Williams J, Miller M. 1999. The human side of reef management: a case study analysis of the socioeconomic framework of Montego Bay Marine Park. *Coral Reefs* 1999: 369-380	The author estimates option and existence values (inspiration and spiritual values (based on expenditures) and option value), direct use values (productive use values based on harvest and recreation use values), education and research values, and indirect use values (organic waste treatment, biodiversity maintenance, nature protection, and habitat/ refugia) , per hectare per year in Galapagos National Park.	• *Existence value*: $0.20/ha/year for cultural/ artistic inspirational use, based on sales of books and films, $0.52/ha/hr for spiritual use based on donations. • *Option value*: US$120/ha/yr which is equal to the total value of all the Park's conservation and productive use values combined. • *Direct use value*: ➤ Productive use values: productivity change- global aquarium trade attributable to the Philippine Coral Reefs: $10 million in 1988 could be increased by 50% with sustainable production practices. ➤ Recreation: productivity change: $45/ha/yr for the total protected area; based on maximum carrying capacity of 40,000 visitors/yr, and average expenditures per visit of $1300. • *Education and research*: $2.73/ha/hr based on research expenditures, and expenditures on field courses, fellowships, training courses, education facilities and materials. • *Indirect use value:* ➤ Organic waste treatment: replacement cost - $58/ha/year based on the costs of artificial purification technology; ➤ Biodiversity maintenance: shadow price - $49/ha/yr which equals 10% of the market value of any activity reliant on biodiversity maintenance. ➤ Nature protection: $0.55/ha/yr; based on the park budget and the idea that money invested in conservation management should be seen as productive captial because of the environmental functions and socioeconomic beneftis provided by conservation. ➤ Habitat/Refugia: Benefit transfer - $7/ha/yr; based on the similarities of the Dutch Wadden Sea and Galapagos estuarine areas. It was assumed that 10% of fishery in Galapagos depends on the nursery function provided by inlets and mangrove lagoons.

Appendix 1. Literature on economic valuation of coral reefs: published studies

Valuation Study	Methodology	Valuation Results
Arin T, Kramer RA (2002) Divers' willingness to pay to visit marine sanctuaries: an exploratory study. *Ocean and Coastal Management* 45: 171-183.	WTP questions were in the payment card format in which respondents were asked to choose a value among an ordered set of threshold values or specify another value.	· WTP to enter a marine sanctuary for one day: $3.70 in Anilo; $5.50 on Mactan; and $3.40 on Panglao. Tourists in all three resort areas preferred that an Environmental NGO be the organization to manage the entrance fee revenues. · College education = higher WTP. Youth = higher WTP.
Berg, H, Ohman, MC, Troeng S, Linden O (1998) Environmental economics of coral reef destruction in Sri Lanka. *Ambio* 27: 627-634	Fish-habitat function was estimated with the effect-on-production approach (EOP). The tourist-attraction function was estimated using both the financial-revenue approach (FR) and the contingent valuation (CV) approach. The physical structure function was estimated using the preventive-expenditure approach (PE) and the loss of property-value approach (PV). Total quantifiable economic value was calculated over twenty years using a discount rate of 9%.	· Net value of coral reef fish-habitat function (EOP): $7800-$9800 km^2 reef yr.; · Net value of reef as tourist attraction: $150,000(FR)-$214,000(CV) km^2 reef yr1; · Cost of coastal erosion resulting from loss of reef: $160-$172,000 (PV) km^2 reef yr.-1; · Cost of replacing the coastal protection function of a degraded reef: $1,230,000-$4,180,000 (PE) km-^{2} reef yr-1 depending on the type of coastal protection structures used; · Total quantifiable economic value of reef: $13,000-$4,404,000 km-^{2} reef yr.-1; · Total net present value of 1 km2 over 20 years with 9% discount rate: $142,000-$7,504,000; · Annual direct cost of coral mining: $192,000-$430,000 km-^{2} reef yr.-1; Accumulated net present benefits of coral mining over 20 years: $749,000-$1,671,000 per km^2; Accumulated net present costs of coral mining over 20 years: $111,000-$7,364,000.

IV. VALUE OF PHILIPPINE CORAL REEFS IN THE SOUTH CHINA SEA BIOGEOGRAPHIC REGION

A. DIRECT USE VALUES

1. Fisheries

Reefs are used by coastal communities as traditional fishing grounds. Municipal as well as commercial fishers are dependent on the various reef areas for fish food (subsistence) and commercial exchange. Several reef areas are declared marine sanctuaries[4] as an effort of the government and communities to protect coral reefs and sustain the fisheries. Annual fish harvest of 15 mt/km^2 can be obtained from coral reef ecosystems (McAllister, 1988).

The annual fishery benefits from the Philippine coral reefs in the South China Sea biogeographic region are shown in Table 3. The value of fish catch from coral reefs is estimated to be PhP 773 million. This comprises 11 percent of the value of fish production in the Philippines in 2002.

Net revenues from fisheries were adjusted to reflect costs such as variable (fuel, ice and salt, maintenance and repair, supplies), fixed (depreciation and overhead). Overhead costs consisted of labor, rent, and other miscellaneous expenses. Assuming 80% net return for coral reef fishery, the net revenue is PhP 619 million (US$ 11.3 million)

[4]For example, Carot Fish Sanctuary and Balingasay Marine Protected Replacement Area in Pangasinan; San Salvador Marine Sanctuary and Reservation Area in Zambales; Arthur's Rock, Cathedral Rock and Twin Rocks Fish Sanctuaries in Batangas; Puerto Galera Biosphere Reserve and Apo Reef Marine Reserve in Mindoro; El Nido-Taytay Managed Resource and Protected Area/El Nido Marine Reserve in Palawan.

Table 3. Net benefits from fisheries

Location of reef	Area of reef (km^2)	Estimated Annual Fish Production[a] (mt/km^2)	Annual Revenue from Fisheries[b] (PhP)	Net Revenue from Fisheries[c] (PhP)
1. Lingayen Gulf	95.6	319	15,933,333	12,746,667
2. North Luzon-Babuyan Islands	20.5	68	3,415,000	2,732,000
3. South Luzon-Marinduque-Eastern	229.3	764	38,215,000	30,572,000
4. Northwestern Palawan	1,549.3	5,164	258,215,000	206,572,000
5. Kalayaan Island Group, Palawan	2,746.3	9,154	457,711,667	366,169,333
Total	**4,640.9**	**15,470**	**773,490,000**	**618,792,000**

[a]Based on average biomass of target species of 5 tons/km^2/yr and fish production/biomass ratio of 1.5 for coral reef fishes

[b]Average ex-vessel price of PhP 50/kg.

[c]Production costs estimated at 20% of gross revenue

2. Tourism/Recreation

Many tourist activities take place on coral reefs. These activities are mainly SCUBA diving, swimming, snorkeling, beach combing, boating, jet skiing, sun bathing and fishing (recreational/sport) and visiting fishing villages. Tourism contributes to the economy of many coastal communities. The coral reef areas are diving destinations by domestic and foreign tourists. In 2002, about 331,000 domestic travelers (80% of total travelers) visited tourists destinations in Batangas, Mindoro and Palawan (NSCB Factsheet, 2002).

Vogt, H.P. (1997) The economic benefits of tourism in the marine reserve of Apo Island, Philippines. In 8th International Coral Reef Symposium 24-29 June 1996. pp. 2101-2104. Panama.

Westmacott, S., Cesar, H. Pet-Soede, L. (2000) Socio-economic Assessment of the Impacts of the 1998 Coral Reef Bleaching in the Indian Ocean: A Summary. *In*: Coral Reef Degradation in the Indian Ocean: Status Report 2000. Souter, D., Obura, D. and Linden, O. (eds.). CORDIO, SAREC Marine Science Program, Sweden.

White, A.T., Vogt, H.P., and Arin, T. (2000) Philippine coral reefs under threat: The economic losses caused by reef destruction. *Marine Pollution Bulletin* 40 (7): 598-605.

Whittaker, R.H. and Likens, G.E. (1973) Carbon in the Biota. *In*: Carbon and the Biosphere. Woofwell, E.M. and Pecan, E.V. (eds.). Washington, D.

Dr. Giselle Samonte-Tan has worked as an economist for SEAFDEC, ICLARM (now the WorldFish Center) and PEMSEA on aquaculture economics, community-based fisheries management, marketing and distribution of fish commodities, socio-economic analysis and benefits of integrated coastal management. She is currently a member of the Resource and Environmental Economists Association of the Philippines. She obtained both her Bachelor of Science (cum laude) and Masters degrees from the University of the Philippines at Los Baños. For her dissertation she worked on the by-catch reduction and turtle excluder devices on the Gulf of Mexico shrimp fishery using bio-economic modeling at Texas A&M University.

Ms. Ma. Celeste Armedilla is an Instructor in Economics and Management at the Palawan State University. She completed her Bachelor of Science in Agribusiness from the College of Economics and Management at the University of the Philippines at Los Baños. She has worked on seaweed economics and financial analysis of marine parks in the Philippines. She is currently pursuing her Masters degree at the University of the Philippines Open University.

26 (2), 119-131.

Pet-Soede, C., Cesar, H.S.J. and Pet, J.S. (1999) An economic analysis of blast fishing on Indonesian coral reefs. *Environmental Conservation* 26 (2), 83-93.

Samonte-Tan, G.PB, Pido, M.D., and Armedilla, M.C. (2004) Sustaining the Benefits of Tubbataha Reef National Marine Park: A 10-Year Business Plan. Palawan State University, Center for Strategic Policy and Governance.

Sasekumar, A., Chong, V.C., and Phang,S.M. (1998) Marine and Coastal Resource Valuation for the Straits of Malacca. University of Malaya. Report for the GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas.

Spurgeon, J. (1998) The Socio-Economic Costs and Benefits of Coastal Habitat Rehabilitation and Creation. *Marine Pollution Bulletin* 37 (8): 373-382.

Subade, RF (2003). Economic Valuation for Biodiversity Conservation of a World Heritage Site: Citizens' Non-use values of Tubbataha Reef National Marine Park, Sulu Sea, Philippines. Dissertation Research, University of the Philippines at Los Baños.

UNEP (2003a) Reversing environmental degradation trends in the South China Sea and the Gulf of Thailand, Report of the Third Meeting of the Regional Working Group on Coral Reefs. UNEP/GEF/SCS/RWG-CR. 3/3.

UNEP (2003b) Reversing environmental degradation trends in the South China Sea and the Gulf of Thailand, Report of the First Meeting of the Regional Task Force on Economic Valuation. UNEP/GEF/SCS/RTF-E.1/3.

Uychiaoco, A.J., Cassstrence, Jr., F.I., and Aliño, P.M. (2003) Bolinao, Pangasinan. *In*: Philippine Coral Reefs through Time: Workshop Proceedings. Second of the Atlas of Philippine Coral Reefs Series. Coral Reef Information Network of the Philippines (Philreefs), University of the Philippines Marine Science Institute, Quezon City, Philippines and the Marine Parks Center, Tokyo, Japan.

Tourism revenues include direct revenues such as diver fees and park entrance fees, and indirect (private sector) revenues such as hotels (rooms/meals), dive operation and restaurants. The net return from tourism is about 60% of revenues (Cesar, 1996). The estimated net revenue from coral reef-related tourism is PhP 126 million (US$ 2.3 million) (Table 4). Tourism revenues are high for the South Luzon-Mindoro reef area because of the proximity and accessibility of the reefs to travelers compared to the Palawan and KIG reefs, although the coral reefs in these areas are more extensive.

For the Great Barrier Reef, willingness to pay was estimated from a survey of visitors to the reef region visiting coral sites at $6 million per year or $8 per adult visitor (Hundloe, 1990) using the contingent valuation method. For this study, Arin and Kramer's (2002) divers' willingness to pay, estimated to range from PhP 190-300/person/day ($3.40-5.50), to visit marine sanctuaries in the Philippines, specifically in Eastern Visayas region is adopted to reflect consumer surplus.

Table 4. Tourism revenues

	Location of reef	Area of Reef (km^2)	Estimated On-Site Visitor Arrivals[a]	Visitor Receipts[b] (PhP)	Net Tourism Revenue[c] (PhP)
1	Lingayen Gulf; North Luzon-	95.6	-	-	-
2	Babuyan Islands-Batanes Islands	20.5	5,000	34,650,000	20,790,000
3	South Luzon-Marinduque-Eastern Mindoro	229.3	13,700	94,941,000	56,964,600
4	Northwestern Palawan	1,549.3	11,400	79,002,000	47,401,200
5	Kalayaan Island Group, Palawan	2,746.3	100	693,000	415,800
	Total	**4,640.9**	**30,200**	**209,286,00**	**125,571,60**

[a]Except fpr Lingayen and KIG, assumes 10 percent of total tourists will visit coastal and marine areas. Total tourists arrivals include domestic, foreign and overseas Filipino travelers (Department of Tourism, 2002)

[b]Based on $126 average daily expenditure(Department of Tourism, 2001)

[c]60% net revenue (Cesar, 1996)

Consumer surplus measures how much visitors of the coral reefs are willing to pay, in addition to what is already paid for recreation at the site. Consumer surplus has been estimated for Thailand at approximately US $110 million (Christiernsson, 2003). The consumer surplus per diver per year in the Caribbean is estimated at $17.40 or $325,000 annual consumer's surplus (Dixon, et al., 1993). Using a similar approach, annual user fee revenue is PhP 5.4 million assuming 36,000 dives/year at PhP 150 user fee per diver. Average willingness-to-pay user fee of PhP 220 minus PhP 150 user fee charged results in consumer's surplus per diver of PhP 70 for an annual consumer's surplus of PhP 2.5 million ($ 46,000).

3. Research

Expenditures for research and development in the fisheries sector was PhP 222.3 million in 1998, constituting 0.008 % of the gross national product (GNP) in 1998 and 0.04 % of national government expenditure (Pabuayon and Yorro, 2001). The research and development (R&D) expenditure for coral reef ecosystems was not determined. In Malaysia, annual research expenditure for coral reef studies amount to $ 120,000 (Sasekumar, et al., 1998).

Scientific research provides the basis for establishing monitoring programs, raising public awareness and providing education to stakeholders for effective management of coral reef areas. From the 1980's to the present, various types of research were undertaken in Bolinao, Telbang Reef, Batong Ungot (Zambales), Batangas Bay, Puerto Galera, and KIG. Research expeditions are funded by national government institutions and through collaboration with international organizations.

Expenditures on research provide a minimum research value or the willingness-to-pay for access to reef areas with research value. For example, education and research value is estimated at $2.73/ha/hr based on research expenditures, and expenditures on field courses, fellowships, training courses, education facilities and materials (Bruce, et al., 1999). The research value of Philippine coral reefs in the South China Sea is about PhP 38.3 million (US$ 0.7 million) (Table 5).

(Goodwill Bookstore), Quezon city, Philippines. xvi + 264 pp.

Nañola, C.L., Jr., Aliño, P.M., Dantis, A.L., Rañola, M.C., Hilomen, V., Cabansag, J. (2002) Understanding Philippine Reef Fishes: A Key to Fisheries Management and Marine Biodiversity Conservation. *In:* Atlas of Philippine Coral Reefs. Aliño, P.M., Miclat, E.F.B., Nañola, C.L., Jr., Roa-Quiaoit, H.A., and Camos, R.T. (eds.) Philippine Coral Reef Informaiton (Philreefs). Goodwill Trading Co., Inc. (Goodwill Bookstore), Quezon city, Philippines. xvi + 264 pp.

National Statistical Coordination Board (2002). Factsheet, Region IV.

National Economic Economic Development Authority (2001) The Medium-Term Philippine Development Plan 2001-2004.

Orallo, C.A., Calpito, M.C., Pagan, J.C., Anacta, F., Domingo, Jr., C., Nacar II, C., Acosta, E., and Milan D. (2003a) Davila, Pasuguin, Ilocos Norte. *In*: Philippine Coral Reefs through Time: Workshop Proceedings. Second of the Atlas of Philippine Coral Reefs Series. Coral Reef Information Network of the Philippines (Philreefs), University of the Philippines Marine Science Institute, Quezon City, Philippines and the Marine Parks Center, Tokyo, Japan.

Orallo, C.A., Calpito, M.C., Pagan, J.C., Anacta, F., Domingo, Jr., C., Nacar II, C., Acosta, E., and Milan D. (2003b) Telbang, Alaminos, Pangasinan. *In*: Philippine Coral Reefs through Time: Workshop Proceedings. Second of the Atlas of Philippine Coral Reefs Series. Coral Reef Information Network of the Philippines (Philreefs), University of the Philippines Marine Science Institute, Quezon City, Philippines and the Marine Parks Center, Tokyo, Japan.

Pabuayon, I.M. and Yorro, B.M. (2001) Evaluation of Fisheries Research and Development. Research Project under the Research Program, 'Evaluation of Fisheries Research and Development Extension Programs and Socio-economic Impact Assessment of Technologies' funded by Philippine Council for Aquatic and Marine Research and Development. 53 p.

Philippine Council for Aquatic and Marine Research and Development (1996) An analysis of the R&D investment in the fisheries sector. LosBaños, Laguna.

Pendleton, L.H. (1995) Valuing coral reef protection. *Ocean & Coastal Management*

Institute, Quezon City, Philippines and the Marine Parks Center, Tokyo, Japan.

Costanza, R., d'Arge, R., de Groot, R., Farber, S. Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van de Belt, M. (1998) The value of ecosystem services: putting the issues in perspective. *Ecological Economics* 25, 67-72.

Cumpio, J.R. and Orallo, C.A. (2002) Telbang Reef. *In:* Atlas of Philippine Coral Reefs. Aliño, P.M., Miclat, E.F.B., Nañola, C.L., Jr., Roa-Quiaoit, H.A., and Camos, R.T. (eds.) Philippine Coral Reef Informaiton (Philreefs). Goodwill Trading Co., Inc. (Goodwill Bookstore), Quezon city, Philippines. xvi + 264 pp.

Dixon, J.A, Fallon Scura, L., Van't Hof, T. (1993) Meeting ecological and economic goals: Marine parks in the Caribbean *Ambio* 22, 117-125.

Fankhauser, S. (1994) Evaluating the Social Costs of Greenhouse Gas Emissions. CSERGE Working Paper GEC 94-1. CSERGE, University College, London,

Hawkins, J.P., Roberts, C. M., Van't Hof. T., De Meyer, K., Tratalos J. and Aldam, C. (1999) Effects of recreational scuba diving on Caribbean coral and fish communities. *Conservation Biology* 13 (4), 888-897.

Hodgson, G. and Dixon, J.A. (2000) El Nido Revisited: Ecotourism, Logging and Fisheries. *In*: Collected Essays on the Economics of Coral Reefs. Cesar, H. (ed.) CORDIO, Department of Biology and Environmental Sciences, Kalmar University, Kalmar, Sweden.

Hundloe T (1990) Measuring the value of the Great Barrier Reef. *Australian Parks and Recreation* 26:11-13.

McAllister, D.E. (1988) Environmental, economic and social costs of coral reef destruction in the Philippines *Galaxea* 7, 161-178.

MPP EAS 1998. Benefit cost analysis of habitat conservation in the Malacca Straits. MPPEAS Technical Report 18. GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas, Quezon City, Philippines.

Nañola, C.L., Jr. (2002) Bolinao. *In:* Atlas of Philippine Coral Reefs. Aliño, P.M., Miclat, E.F.B., Nañola, C.L., Jr., Roa-Quiaoit, H.A., and Camos, R.T. (eds.) Philippine Coral Reef Informaiton (Philreefs). Goodwill Trading Co., Inc.

Table 5. Research value

	Location of reef	Area of reef (km^2)	Research/ Education Value (PhP)
1.	Lingayen Gulf	95.6	18,000,000
2.	North Luzon-Babuyan Islands-Batanes Islands;	20.5	
3.	South Luzon-Marinduque-Eastern Mindoro-Tablas;	229.3	
4.	Northwestern Palawan[a]	1,549.3	10,294,500
5.	Kalayaan Island Group, Palawan	2,746.3	10,000,000
	Total	**4,640.9**	**38,294,500**

[a]Assumes 30 percent of 1993-1996 average R&D expenditures on environment in the fisheries sector (PCAMRD, 1996)

B. Indirect Use Values

The main indirect benefits to be derived from coral reefs in this area are carbon sequestration and shoreline protection. Other indirect use values, not estimated in this report include organic waste treatment and habitat/refuge. These have been estimated on a per hectare per year in Galapagos National Park:

- Organic waste treatment: replacement cost - $58/ha/year based on the costs of artificial purification technology; applies to marine area only;
- Habitat/Refugia: Benefit transfer - $7/ha/yr; based on the similarities of the Dutch Wadden Sea and Galapagos estuarine areas. It was assumed that 10% of fishery in Galapagos depends on the nursery function provided by inlets and mangrove lagoons.

1. Carbon Sequestration

Coral reefs have already been affected by climate change (global warming). Reef Check, an international monitoring program reported that in 1998 alone, 10 percent of the world's reefs died from higher temperatures associated with global warming. Regardless of the debate between the coral reefs being a source or sink, estimated carbon storage value of coral reefs is PhP 459.5 million ($8.4 million) (Table 6).

Table 6. Carbon sequestration value

Location of reef	**Area of reef (km^2)**	**Carbon Sequestration Value[a,b] (PhP)**
1. Lingayen Gulf	95.6	9,464,400
2. North Luzon-Babuyan Islands-Batanes Islands	20.5	2,028,510
3. South Luzon-Marinduque-Eastern Mindoro-Northwest Tablas	229.3	22,699,710
4. Northwestern Palawan	1,549.3	153,379,710
5. Kalayaan Island Group, Palawan	2,746.3	271,880,730
Total	**4,640.9**	**459,453,060**

[a]Based on 10% of 9 tonnes-carbon/ha/yr productivity of coral reefs (Whittaker and Likens, 1973).

[b]Based on $20/tonne-carbon of avoided future cost of climate change (Fankhauser, 1994).

2. Coastal Protection

Islands and beachfront properties are protected by coral reefs structures. Nature protection was estimated by Bruce, et al. (1999) at $0.55/ha/yr; based on the park budget and the idea that money invested in conservation management should be seen as productive capital because of the environmental functions and socioeconomic benefits provided by conservation. In Bolinao, damage was estimated at PhP10 million (excluding rehabilitation cost) for a 75 m^2 area. In Indonesia and Malaysia, coastal

REFERENCES

reefs- sustainable fishery, food security, biodiversity, coastal protection and tourism of coral reefs.

Aliño, P.M., Miclat, E.F.B., Nañola, Jr., C.L., Roa-Quiaoit, H.A., and Campos, R.T. (eds.). (2002) Atlas of Philippine Coral Reefs. Philippine Coral Reef Information (Philreefs). Goodwill Trading Co., Inc. (Goodwill Bookstore), Quezon City, Philippines xvi + 264 pp.

Arin T, Kramer RA (2002) Divers' willingness to pay to visit marine sanctuaries: an exploratory study. *Ocean and Coastal Management* 45: 171-183.

Berg, H, Ohman, MC, Troeng S, Linden O (1998) Environmental economics of coral reef destruction in Sri Lanka. *Ambio* 27: 627-634

Bunce L, Gustavson K, Williams J, Miller M. (1999). The human side of reef management: a case study analysis of the socioeconomic framework of Montego Bay Marine Park. *Coral Reefs* 1999: 369-380

Burke, L., Selig, E, and Spalding M. (2002) Reefs at Risk in Southeast Asia. World Resources Institute.

Cesar, HJ (1996) Economic analysis of Indonesian coral reefs. World Bank Washington, DC. 97 p.

Cesar, H., Lundin, C.G., Bettencourt, S. and Dixon, J. (1997) Indonesian coral reefs - An economic analysis of a precious but threatened resource *Ambio* 26 (6), 345-358.

Christiernsson, A (2003) An Economic Valuation of the Coral Reefs at Phi Phi Island: A Travel Cost Approach. Masteral Thesis. Lulea University of Technology. 40 p.

Coral Reef Information Network of the Philippines (Philreefs) (2003) Philippine Coral Reefs through Time: Workshop Proceedings. Second of the Atlas of Philippine Coral Reefs Series. Coral Reef Information Network of the Philippines (Philreefs), University of the Philippines Marine Science

benefits from logging. This implies that resource management decisions by one industry can have serious ecological and economic impacts on other industries. For example, the benefit-cost analysis in El Nido, Palawan showed that foregone revenue from the fisheries and tourism industry due to logging impacts could amount to $6.2 million and 13.9 million, respectively (Hodgson and Dixon, 2000). The policy response would differ with the type of threat. In addition, different sectors would require different management approaches.

The willingness to pay for reef conservation is directly related to the state of the reef. From a management perspective, this has implications for the type of information that the tourists are receiving on the state of the reefs. To gain support for reef conservation from visitors, management efforts need to be visible through public information, brochures, active rangers and patrols. Willingness to pay is approximately 2%-3% of the total vacation expenditure (Westmacott, et al., 2000). This information can be used when establishing protected areas and generating revenue through user fees.

Social willingness-to-pay or social benefit from conserving Tubbataha marine park ranges from PhP 187 million ($3.44 million) to PhP 6.02 billion ($110.7 million) (Subade, 2003). The study showed that there is a substantial amount of voluntary contribution potentially available for conservation. Capturing a portion of the social willingness-to-pay through taxes, which will eventually be remitted to respective local governments, can meet the costs of conservation and park management for coral reefs in the Philippine South China Sea.

The benefits derived from coral reef ecosystems in the Philippine South China Sea area provide substantial use and non-use values for the general public and society as a whole. Stakeholders and policy-makers must develop and implement strategic economic policies and market-based regulations to sustain these benefits. These policies will more than likely result in increased direct use benefits from fishing and tourism owing appropriate management interventions and efficient pricing of the resources. Second, if the tourism sector continues to expand, then it is expected that revenues in terms of direct (diver fees) and indirect (private sector) revenues will further increase. Third, it is expected that as government and stakeholder support is enhanced, the fisheries sector will continue to flourish. In sum, the total economic value of Philippine coral reefs in the South China Sea is around PhP 2,901 million ($53 million) of which net market value and non-market values account for 27% and 73%, respectively. Costs of a policy of inaction are the losses in the value of the functions of coral

protection benefit from coral reefs is valued at US$ 19,000 and 34,000 per hectare per year (MPP EAS, 1998). The coastal protection value for reefs in the South China Sea region is estimated at PhP 1,276 million ($ 23 million) (Table 7).

Table 7. Coastal protection value

Location of reef	**Area of reef (km^2)**	**Coastal protection value[a] (PhP)**
1. Lingayen Gulf	95.6	26,290,000
2. North Luzon-Babuyan Islands-Batanes Islands	20.5	5,634,750
3. South Luzon-Marinduque-Eastern Mindoro-Northwest Tablas	229.3	63,054,750
4. Northwestern Palawan	1,549.3	426,054,750
5. Kalayaan Island Group, Palawan	2,746.3	755,224,250
Total	**4,640.9**	**1,276,258,500**

[a]Based on US$5,000/$km^2$/year (White et. al, 2000)

C. Option Value

Option value is the value individuals place on expected future use and indirect use of the coral reefs. Bruce, et al. (1999) estimated option value at $120/ha/yr for the Montego Bay Marine Park. The biodiversity value of Philippine coral reefs in the South China Sea region is estimated at PhP 382.9 million (US$ 7 million) (Table 8).

D. Total Economic Value

Adding the above market (direct) and non-market values (indirect and option values) gives an estimate of the total quantifiable economic value of PhP 2,901 million (US$ 52.7 million). Table 9 shows the net market values and non-market values of coral reef ecosystems in the five reef areas in west

Table 8. Biodiversity value

Location of reef	Area of reef (km^2)	Biodiversity Value[a] (PhP)
1. Lingayen Gulf	95.6	7,887,000
2. North Luzon-Babuyan Islands-Batanes Islands	20.5	1,690,425
3. South Luzon-Marinduque-Eastern Mindoro-Northwest Tablas	229.3	18,916,425
4. Northwestern Palawan	1,549.3	127,816,425
5. Kalayaan Island Group, Palawan	2,746.3	226,567,275
Total	**4,640.9**	**382,877,550**

[a]Based on US$15/ha/year (Sasekumar et al, 1998) or PhP 82,500/km^2/year

Table 9. Total economic value (TEV)

Location of reef	Net Market Value [a] (PhP million)	Non-market Value[b] (PhP million)	Total Economic Value (PhP million)
1. Lingayen Gulf	30.7	43.6	74.4
2. North Luzon-Babuyan Islands-Batanes Islands	33.8	9.4	43.2
3. South Luzon-Marinduque-Eastern Mindoro-Northwest Tablas	87.5	104.7	192.2
4. Northwestern Palawan	254.0	707.3	961.2
5. Kalayaan Island Group, Palawan	376.6	1,253.7	1,630.3
Total	**782.7**	**2,118.6**	**2,901.2**

[a]Net market value from fisheries, tourism and research

[b]Non-market alue including carbon sequestration and shoreline protection and option values

VI. Policy Implications

Economic valuation of coral reefs as an environmental asset has implications on policy-decisions. As the preliminary results indicate, the coral reefs in the Philippine South China Sea generate substantial benefits from fisheries and marine tourism. The economic value provides a basis for formulating policies and strategies, developing user fees and charges, and in undertaking benefit-cost analysis of conservation measures for coral reef protection, zonation, and marine park management. The estimated economic value of the Philippine reefs in the South China Sea area also provides good reason for government support and private sector investment in the protection and management of coral reefs to maintain their quality and productivity.

Tourism is a major dollar-earner with snorkeling and diving being the most important coral reef-related activities of tourists. Maintenance of the quality of coral reefs should be enhanced to ensure the sustainability of the reef-based tourism sector. In the Caribbean, there was a significant decline in the proportion of old colonies of massive coral species within dive sites (19.2% loss), compared to a smaller loss in reserves (6.7%) (Hawkins et al., 1999). Despite close management of reefs, the impact of background stresses on massive corals seems to have been greater in the presence of diving. Policies on zoning including limitation on the number of divers as indicated by coral reef carrying capacity or threshold levels that can be allowed per coral reef site per year, should be considered.

Major threats to the conservation and protection of coral reefs are well documented and include: (1) destructive fishing practices including blast and poison fishing; (2) overfishing; (3) land-based and water-based pollution; (4) sedimentation and siltation caused by mangrove cutting and deforestation; (5) anchor damage; and (6) natural calamities. Total net costs to society are estimated for Indonesian coral reefs to be 7.5 times higher than the net benefits to individuals for coral mining and 6 times as high as the short-term gains from blast fishing (Cesar, et al., 1997). In the Philippines, logging induced sedimentation damage to coral reefs was 2.8 times higher than the associated

The costs of managing reef areas are justified in economic terms if the annual benefits from the reefs generate much more than the associated costs. For example, the annual costs required to maintain the condition of the Tubbataha reefs is estimated at PhP 10 million (Samonte-Tan, et al, 2004). The benefit/cost returns of about 8:1 from Tubbataha reefs imply that the annual benefits give good reason for management costs. A recent study of the 40 sq km coral reef, mangrove and wetland habitats around Olango Island showed they contributed from $1.53-$2.9 million a year to the local economy. "Improved reef quality and wetland stewardship on Olango," an estimated $100,000 a year investment, "could easily mean a 60 percent ($ 1.4 million) increase in annual net revenues from reef and mangrove fisheries and tourism expenditures" (White et al., 1999).

Philippines. For coral reefs west of the Philippines this total economic value corresponds to PhP 625,142 per km^2 of reef ($11,300). Fisheries and tourism values account for about 62 % of the total net economic value of Philippine coral reefs in the South China Sea basin (Figures 2 and 3). Important non-market benefits are shoreline protection and carbon storage and they account 33 % of the total economic value of the Philippine coral reefs in the South China Sea biogeographic region.

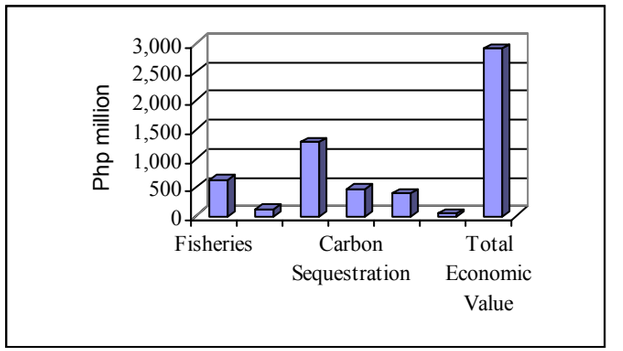

Fig. 2. Use and non-use values of Philippine coral reefs in the South China Sea.

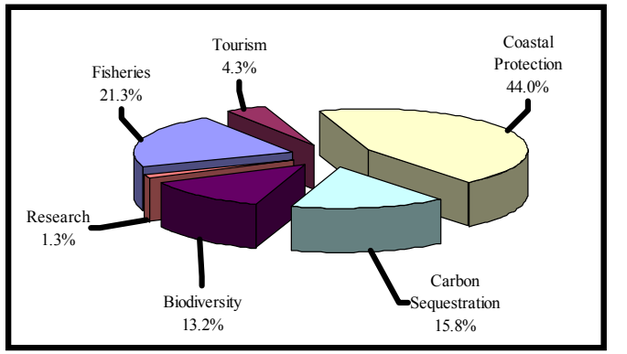

Fig. 3. Annual direct and indirect benefits

V. Discussion

This study shows that 1 km^2 of coral reef can generate PhP 625,142 ($11,366) direct and indirect-use values. For the South China Sea biogeographic region, which is approximately 3.4 million km^2, the value of the products and ecological services provided by the coral reef systems in this region is estimated at $13,792 million/year (Philreefs, 2003). Philippine coral reefs have an estimated value of PhP 1,064 million ($19.3 million) (Table 10).

Table 10. Potential annual economic net benefits

Resource Use (Direct and Indirect)	Philippines[a] ($ million)	Philippines-South China Sea Basin ($ million)
Fisheries	620.0	11.3
Tourism	108.0	2.3
Carbon Sequestration		8.4
Coastal Protection	326.0	23.2
Biodiversity	10.0	7.0
Research		0.7
Total Net Annual Benefits	1,064.0	52.7
Net Present Value[b]	9,063.0	449.1
Reef Area (km^2)	27,000.0	4,640.9

[a]Burke et al, 2002

[b]Stream of annual benefits over 20 years at 10% discount rate

Calculated over 20 years, with a discount rate of 10%, the net present value of benefits of Philippine coral reefs in the South China Sea basin is estimated for identified local uses using benefit transfer method and production valuation approaches. These values provide a benchmark value for comparative purposes. Values estimated included net present values for fisheries, tourism, research and indirect use values. The total NPV of PhP 24,700 million (US$ 449 million) translates to approximately PhP 5.3 million/km^2 net present value, or PhP 266,112/km^2/yr on an annualized basis. This is based on an estimated Philippine coral reef area within the South China Sea basin of 4,640.94 km^2.

In Sri Lanka, the total quantifiable economic value of reef ranges from $13,000-$4,404,000/km^2 reef /year. The total net present value of 1 km^2 over 20 years with 9% discount rate ranges from $142,000-$7,504,000 (Berg, et al. 1998).

McAllister (1988) estimated economic and social costs of coral reef destruction in the Philippines at $160 million in lost fishery production per year and 127,000 lost jobs to small-scale fishers. The potential losses to the Philippines as coral reefs are destroyed are about PhP 1 billion/year and the losses are expected to increase if investments in conservation are not made (White, et al., 2000). Costs for rehabilitation of coral reefs is high ranging from $10,000/ha to $6.5 million/ha (Spurgeon, 1998). On the other hand, the present value of costs of protection would be approximately 0.7% of the net benefits that come from reef tourism (Pendleton, 1995).

A recent analysis of blast fishing in Indonesia estimated the cost of the practice over a 20 year time span, in terms of forgone benefits from fishing, coastal protection and tourism, to be in the range of $ 33,900 to $ 306,800/km^2 (Pet-Soede et. al., 1999). Although discussed here as an economic factor, the authors of this study considered the inability to eradicate blast fishing to be a problem closely connected to politics–specifically a lack of political will and interest at the national government level. Instead of being focused on management that increases fishery yields through protection and conservation, the Indonesian government is generally focused on increasing and diversifying fishing effort. The cost of coastal erosion resulting from loss of reef: $160-$172,000 (PV)/km^2 reef/year (Berg, et al., 1998).