ReefFix Phase 1: Cost-Effective Valuation Tools for Coral Reef Managers

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ABSTRACT

ReefFix is an Integrated Coastal Zone Management (ICZM) tool that aims to build capacity within marine management agencies by promoting cost-effective economic valuation methodologies which can be used by managers to get a better understanding of the value of coastal ecosystems and build public awareness. This program, supported by the government of Chile, is currently being implemented by the Organization of American States' Inter-American Biodiversity Information Network (IABIN) program at sites around the region.

As part of Phase I, the Barbados and St. Vincent and the Grenadines exercises were conducted between the months of October 2009 to May 2010 with the aim of valuing some of the ecological goods and services provided by coastal ecosystems within the Folkestone Park and Marine Reserve and the Tobago Cays Marine Park. It utilizes three methodologies, two developed by the World Resource Institute (WRI) which focuses on direct use values (fisheries, tourism and recreation) based on market prices and a benefits transfer technique using a habitat typology developed by Troy and Wilson (2006). Results from the Tobago Cays exercise indicated that reefs could be contributing over US$11.7 million in benefits in the Tobago Cays and as much as US$66.1 million in Folkestone. The results are based on data gathered from key informants and available local and national statistics and are therefore limited by the quantity and quality of data available during the short study periods. Differences between methodologies increase the versatility of ReefFix however assumptions in both techniques must be acknowledged.

KEY WORDS: Economic valuation, management tools, ecosystem services

ReefFix Fase 1: Herramientas Costo-efectivas de Valuración para los Responsables de la Gestión de Arrecifes Coralinos

PALABRAS CLAVE: Valuación económica, herramientas de gestión, servicios del ecosistema

ReefFix Phase 1: Outils Coût-Efficaces de Valorisation pour les Responsables de la Gestion de Récifs Coralliens

MOTS CLÉS: Coût-efficaces, responsables de la gestion, récifs coralliens

INTRODUCTION

Project Background

The Inter-American Biodiversity Information Network (IABIN) is a web based forum that seeks to promote greater use and sharing of existing biodiversity information in order to improve decision-making and education amongst countries of the Western Hemisphere (Department of Sustainable Development 2009). The main output for IABIN is to strengthen coastal management frameworks and develop a climate change adaptation plan for coral reefs and mangroves. As a component of IABIN, ReefFix falls under the ICZM Capacity Building Program. This exercise, supported by the government of Chile is an ICZM tool that trains participating countries in ecosystem valuation methodologies and management techniques in order to better enable them to conserve marine ecosystems and the associated watersheds.

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Study Sites

The Folkestone Park and Marine Reserve (FPMR) lies on the sheltered West Coast of Barbados and spans the settlement of Holetown (Figure 1). The marine reserve (2.1km^2) is the only legislated Marine Protected Area (MPA) in Barbados (Cumberbatch 2001). Reef fish caught around the reserve can be purchased on shore at landing sites within and outside of the reserve boundaries (AXYS

et al. 2000). Only cast net fishing is allowed within the reserve. Holetown and Folkestone are a hive of tourist activities with numerous hotels, resorts, guest houses, restaurants and retail facilities in the area. Much of the development in the area is geared towards the high-end market exemplified by villas such as those at Sandy Lane renting for up to US$25,000 per night (BHTA 2009). Many of the business owners in the area have acknowledged that the reserve has been beneficial to their business and have used it for promoting their enterprise (AXYS et al. 2000).

The Tobago Cays are located in the Southern Vincentian Grenadines about 50 km south of the island of St Vincent. The marine park encompasses an area of 14 km^2 and includes five uninhabited islands (Petit Rameau, Petit Bateau, Jamesby, Baradal and Petit Tabac) and the inhabited island of Mayreau (~250 residents) (Pena 2006). The Tobago Cays is also a hub for yachting tourism and is the port of call for around three small cruise ships each with a capacity of around 500-600 passengers (ECLAC 2004, TCMP 2009). As a result, the Tobago Cays contribute significantly to the St. Vincent tourism economy with over 50,000 annual visitors to the park (TCMP 2009). Legitimate fishing is permitted for locals along the western corridor of the park however there have been some reports of occasional illegal fishing within the park though significantly less than when the park was first introduced (TCMP 2010).

METHODS

ReefFix employs the use of three methodologies, two developed by the World Resources Institute and one using a direct value transfer method.

World Resources Institute (WRI) Valuation Methodologies

Coral reef valuation involves the estimation of the economic benefits that are gained from the presence of reefs and can be derived from examining the use and non-use value. Less tangible benefits such as indirect use from shoreline protection and non-use/existence value are much more difficult to quantify as non-market forces determine their values. The WRI Valuation Tools (available at http://www.wri.org/project/valuation-caribbean-reefs) as used in this study only account for estimates of revenues that are generated from the direct use of coral reefs, and hence value is based on current market prices. As a result, the methodology will underestimate the overall value of goods and services provided by coral reefs, focusing solely on consumptive use from fishing and non-consumptive use associated with tourism and recreation.

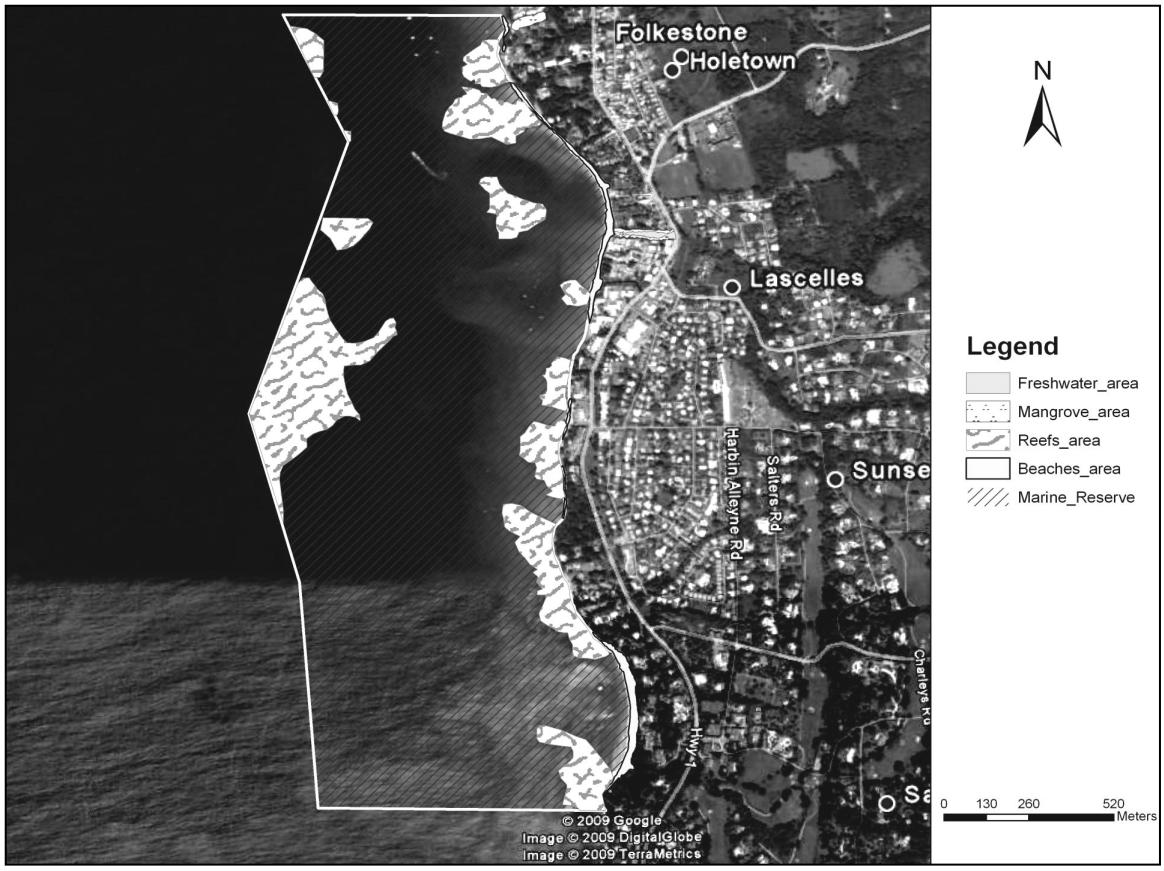

Figure 1. GIS land cover map of the Folkestone Marine Reserve

Data were gathered through information received from a wide variety of sources, namely the marine park staff, statistical departments, hotel and tourism government bodies and associations, fisheries divisions and resource users. This comprised of a combination of statistical data, field observations and expert opinion. Additional research was employed to supplement this data so as to fill information gaps where possible. To account for errors in the data and the assumptions made in the study, the sensitivity analysis was employed using a range of ± 20% for the more uncertain values (Burke et al. 2008, Cooper et al. 2009) thus providing a range of values instead of a single metric. Some of the calculated estimates and extrapolations (e.g. number of annual snorkelers, annual landings) were rounded off to the nearest hundred to discourage the illusion of precision as many of these values are based on daily or weekly estimates of use or catch.

Tourism and Recreation (Non-consumptive Use Value)

The tourism data were compiled and analyzed using the World Resources Institute's (WRI) Coral Reef Valuation Tool (v2.0): *A Tool to Guide the Economic Valuation of Goods and Services from Coral Reefs (Tourism and Recreation Component)* which utilizes the Microsoft Excel® platform. This creates an estimate of the direct economic impacts from the reef-based accommodation and recreation (snorkeling, diving, local reef and coralline beach use) sectors using existing data, personal interviews and expert opinion. As data were limited, assumptions were made in the analysis so that the necessary data requirements for the tool could be met. Some variables such as occupancy rates and operating expenses were difficult to acquire and thus ranges based on expert opinion were used for those businesses where no data were available.

Fisheries (Consumptive Use Value)

Similarly, fisheries data were compiled and analyzed using the other WRI's Coral Reef Valuation Tool (v2.1): *A Tool to Guide the Economic Valuation of Goods and Services from Coral Reefs (Fisheries Component)* which also utilizes the Microsoft Excel® platform. This section focuses on the contributions to the economy derived from reef-associated fishing as well as other added value (e.g. local fishing for enjoyment and consumption). Fishing is restricted within the majority of the reserves but this component was included based on the assumption that the reefs within the parks will be providing supporting services to the surrounding areas. The fisheries data were derived from a number of sources including official landings data from the government. The remainder of the data were garnered from previous reports and informal interviews with fishers in the area. This resulted in disparate landings values and therefore wide ranges were reported in the results.

Value Transfer: Spatial Distribution of Ecosystem Service Values

The third methodology utilizes a benefits transfer technique that relies on per-unit values from "heavily-studied" reefs (e.g. $US/m^2 reef /year) in other areas and applying them to the similar sites (Department of Sustainable Development 2009). For the purposes of this study, land cover will be classified into a unique typology developed by Troy, Austin and Matthew A. Wilson in "Practical challenges and opportunities in linking GIS and value transfer" (Ecological Economics 60 (2006) 435-449). Categories of land cover types include coral reef environs, mangroves, beaches, freshwater herbaceous swamp grasslands and coastal forests (Tables 3 and 6). This method, unlike the WRI Valuation Tool, includes indirect use values such as shoreline protection.

For this study, the desired land cover types were identified and outlined using Google Earth^{TM} satellite data and exported into ArcMap 9.2 to calculate surface areas. Additional marine data were derived from basic dive maps outlining the general area of the deeper reefs not visible by satellite and from previous habitat mapping studies (Baldwin 2009). It must be noted that these values are also estimates as the accuracy of the surface areas were dependant on the quality and resolution of the available maps.

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RESULTS

Tobago Cays Marine Park (TCMP)

The results of the WRI valuation tools indicate that the reefs within the TCMP could be contributing US$466,801 - US$980,282 to fisheries and US$11,207,956 - US$35,066,989 to tourism and recreation each year. Table 1 and 2 summarizes the output from the WRI Tools with Table 3 outlining the results of the value transfer method.

Key Points

Listed below are some key points from the Tobago Cays exercise as full details can not be provided in this document. For more information, the project report is available at http://www.oas.org/dsd/IABIN/Component1/ReefFix/ReefFix.htm.

Table 1. Summary of total economic impact of reef-related fisheries around the Tobago Cays Marine Park using averaged values (WRI Fisheries Tool)

Category	Value (US Dollars)
1. Commercial Fisheries	
Gross Revenue	$1,046,544
Net Revenue	$366,290
Transfers to the economy (Wages)	$261,636
Total Commercial Fishing Value	**$627,926**
2. Fish Processing and Cleaning	**$0**
3. Local Fishing	**$227,574**
4. Multipliers	**$0**
TOTAL ECONOMIC IMPACTS OF FISHING IN AND AROUND THE TCMP	**$953,303**

Table 2. Summary of total economic impact of reef-related tourism and recreation in the Tobago Cays Marine Park using averaged values (WRI Tourism and Recreation Tool)

Category	Value (US Dollars)
1. Accommodation	$20,033,750
2. Diving	$271,000
3. Snorkeling and Boating	$1,327,507
4. Marine Parks	$221,048
5. Other Direct Expenditures (Vending, food sales) - Total Value	$28,680
TOTAL DIRECT AND INDIRECT IMPACTS	**$21,881,985**
Local Use of Coralline Beaches	**$772,209**
Local Use from reef recreation	**$3,089**
TOTAL ECONOMIC IMPACTS OF REEF-RELATED TOURISM AND RECREATION IN THE TCMP	**$22,657,283**

i) The large disparity in the results between the WRI methodologies and the Value Transfer methodology could be due to the fact that the WRI tool only assesses the direct use value of the park. Other values such as shoreline protection are quite significant and this value may be even higher than reported for the Tobago Cays where most of activities in the area depend almost 100% on the presence of the windward reefs.

ii) The Total Economic Impact of fisheries is unclear due to uncertainties in the commercial landings data (landings value: US$113,893 - US$8,250,412).

iii) In the WRI Tool results, the accommodation component generates the most revenue (75 - 85%) however significant leakages (# of foreign owned rooms) exist in this sector.

iv) There is extremely low use of the park by locals (< 1% of visitors).

Table 3. Ecosystem service values by cover type for the Tobago Cays Marine Park

Ecosystem Type	$US/ha/yr	Total Hectares	Total Contribution (US Dollars)
Beach	$88,000	8.7	$767,174
Coastal & Riperian Forest	$1,826	165.6	$302,312
Grassland/Pasture	$118	1	$116
Freshwater Herbaceous Swamp*	$72,787	5.4	$390,300
Near shore Aquatic Habitat (Seagrass*)	$16,283	365.2	$5,946,552
Mangrove*	$37,500	4.3	$162,749
Coral Reef Environ*	$100,000	1335.7	$133,569,406
TOTAL TCMP ECOSYSTEM SERVICE VALUE			**$141,138,608**

Table 4. Summary of total economic impact of reef-related fisheries around the Folkestone Park and Marine Reserve using averaged values (WRI Fisheries Tool)

Category	Low Value (US Dollars)	High Value (US Dollars)
1. Commercial Fisheries		
Gross Revenue	$104,112	$156,168
Net Revenue	$67,673	$101,509
Transfers to the economy (Wages)	$26,028	$39,042
Total Commercial Fishing Value	**$93,701**	**$140,552**
2. Fish Processing and Cleaning	**$8,135**	**$12,202**
3. Local Fishing	**$151,829**	**$190,303**
4. Multipliers	**$232,170**	**$348,256**
TOTAL ECONOMIC IMPACTS OF FISHING FROM AROUND THE FPMR	**$485,835**	**$691,313**

Table 5. Summary of total economic impact of reef-related tourism and recreation within the Folkestone Park and Marine Reserve using averaged values (WRI Tourism and Recreation Tool)

Category	Low Value (US Dollars)	High Value (US Dollars)
1. Accommodation	$25,798,902	$56,534,883
2. Diving	$592,875	$640,925
3. Snorkeling and Boating	$2,786,000	$8,476,800
4. Marine Parks	-	-
5. Other Direct Expenditures (Vending, food sales) - Total Value	$33,131	$33,131
TOTAL DIRECT AND INDIRECT IMPACTS	**$29,210,908**	**$65,685,739**
Local Use of Coralline Beaches	**$112,050**	**$303,750**
Local Use from reef recreation	**$5,603**	**$60,750**
TOTAL ECONOMIC IMPACTS OF REEF-RELATED TOURISM AND RECREATION IN FPMR	**$29,328,561**	**$66,050,239**

v) Based on current tax rates, an estimated US$4.1 million in annual tax revenue and fees is garnered from tourism and recreational activities in the park and its immediate environs.
vi) The informal sector (watertaxis) is well integrated into the tourism plant and transfers into the local economy appear to be considerable.
vii) Significant revenue is generated by the park (entry fees) which could eventually lead to its self-sustainability.

Folkestone Park and Marine Reserve (FPMR)

The results of the WRI valuation tools indicate that the reefs within the FPMR could be contributing US$29,328,561 - US$66,050,239 to fisheries and US$29,328,561 - US$66,050,239 to tourism and recreation annually. Table 4 and 5 summarizes the results from the WRI Tools for the FPMR. Figure 1 reveals the outline of the marine reserve highlighting the various habitat/land cover types of interest and Table 6 summarizes the corresponding value estimates.

Key Points

i) The accommodation sector accounted for approximately 87% of the combined WRI revenue values however a potential underestimation of high operating costs may affect this result and the total revenue lost as a result of economic leakages is uncertain.
ii) Fishing accounted for >2% of the WRI total but this is expected as no major fishing is allowed within the reserve.
iii) When compared to visitor usage, there is low use of the area by locals. Non-commercial fishing and local recreation accounted for less than 1% of the WRI total.
iv) The large variation in the results between the WRI methodologies and the Value Transfer methodology could be attributed to the high room rates from premium properties in the area and the comparably low value assigned for coral reefs in the Value Transfer method ($100,000/ha/year).
v) Based on the current tax rates, over US$6 million in tax revenue is estimated to be garnered from reef-related tourism and recreation in and around the reserve each year.
vi) Between 1950-1991, Barbados might have lost over US$88,000-US$528,000 in annual benefits due to the degradation of some of the reefs in the reserve.
vii) The Folkestone Reserve could generate over US$0.5 million in annual revenue with the introduction of snorkelling and diving user fees. However, implementation must be done in close collaboration with the resource users.

DISCUSSION

Analysis of Methods

The differences in data requirements, analysis and presentation of results all contribute to the many differences in the strengths and weaknesses of each tool. The WRI tools require variable amounts of revenue and use data which can be continuously modified and updated with a sensitivity analysis in cases of uncertainty. It incorporates local use value and the results improve with the quantity and quality of data. One shortcoming of the WRI methodology is that significant effort is needed by the data collector to liaise with and acquire data from several agencies. Data acquisition from multiple departments can be an onerous task and many times the quality of data is variable. The results also focus primarily on direct-use values although there is an option to input consumer surplus data from other studies. The Value Transfer methodology however may not require any external data sources as most of the data (i.e. maps) could be available via the internet. Results can be easily incorporated into existing spatial datasets and can be an excellent visual communication tool. This method, however, usually involves using static data which would not account for natural and anthropogenic changes to ecological features such as beach transformation or recent deforestation. Satellite imagery also is variable as cloud cover and limited resolution will affect precision. Another weakness to the methodology is the fact that values attributed to each land

Table 6. Ecosystem service values by cover type for the Folkestone Park and Marine Reserve

Ecosystem Type	$US/ha/yr	Total Hectares	Total Contribution (US Dollars)
Beach Near Dwelling	$117,000	2.5	$295,980
Freshwater Herbaceous Swamp	$72,787	0.2	$17,115
Coral Reef Environ	$100,000	32.3	$3,226,522
Mangrove	$37,500	0.3	$11,396
TOTAL FPMR ECOSYSTEM SERVICE VALUE			**$3,551,014**

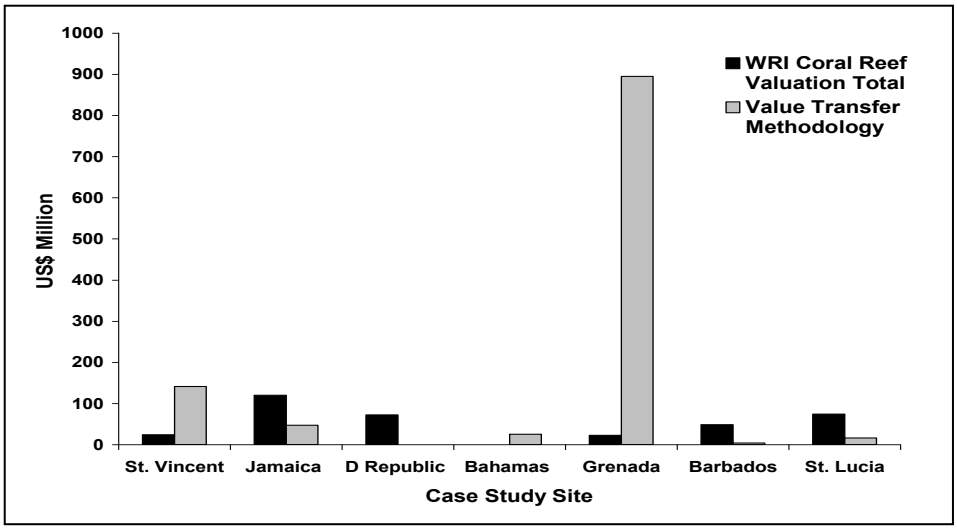

Figure 2. Comparison of the ReefFix results from seven countries highlighting the differences between the results of the WRI and Value Transfer methodology

cover type were not developed in the Caribbean and its applicability to the region has not been thoroughly tested. This value can be very site-specific as was evident in the Barbados case study site where the value of the reef was dependant on the altered natural and built environment on the shoreline (i.e. luxury hotels). The Value Transfer methodology also may require knowledge of mapping software (e.g. ArcMap, Coral Point) which may be lacking in the organizations that are seeking to carry out the valuation.

Comparison Between Study Sites

A comparison of the values derived from the other ReefFix exercises in the region highlight the variations in results between study sites (Figure 2). It also underscores the differences in the two methodologies. Disparity in results could be attributed to variations in the sizes of the study areas, local population demographics, number of fishers and tourists and the type and size of accommodation and recreational operations at the sites.

CONCLUSION

The methodologies used in this study have the potential to communicate the benefits of marine ecosystems to policy makers who relate more readily to economic values than to conservation theory and data. Managers can use these cost-effective techniques to analyze and create economic output that can be presented both numerically and graphically, building a bridge between scientific research and policy making. However, users should always be aware of their limitations and proceed cautiously, using ranges of values instead of single metrics. Where possible, results of this project should be supplemented with detailed primary valuation studies, especially those that can estimate the shoreline protection and non-use value of the resource.

LITERATURE CITED

AXYS Environmental Consulting (Barbados) Inc., Environmental Planning Group, Gillespie and Steel Associates and Bellairs Research Institute. 2000. Feasibility studies of Harrison's Cave and associated sites, Carlisle Bay, and Folkestone Park and Marine Reserve: Baseline Report. Folkestone Marine Management Area. Prepared for the Ministry Environment, Energy and Natural Resources, Environmental Special Projects Unit, Barbados. March 2000. 164 pp.

Baldwin, K. 2009. *A Marine Space-Use Information System for the Grenadine Islands: A Basis for Collaborative Planning and Management.* PhD Dissertation. Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies, Cave Hill Campus, Barbados.

Barbados Hotel and Tourism Association (BHTA). 2009. Personal communication. Barbados Hotel and Tourism Association, St. Michael, Barbados. December 2009.

Burke, L., S. Greenhalgh, D. Prager, and E. Cooper. 2008. *Coastal Capital: Economic Valuation of Coral Reefs in Tobago and St. Lucia.* World Resources Institute, Washington DC, USA. 76 pp.

Conservation International. 2008. Economic values of coral reefs, mangroves, and seagrasses: a global compilation. Center for Applied Biodiversity Science, Conservation International, Arlington, Virginia USA. 35 pp.

Cooper, E., L. Burke, and N. Bood. 2009. *Coastal Capital: Belize. The Economic Contribution of Belize's Coral Reefs and Mangroves.* WRI Working Paper. World Resources Institute, Washington DC, USA. 53 pp.

Cumberbatch, J. 2001. Case study of the Folkestone marine park and reserve, Barbados. Caribbean Natural Resources Institute (CANARI) Technical Report no. 281. 11 pp.

Department of Sustainable Development. 2009. ReefFix: An ICZM coral reef restoration, watershed management and capacity building demonstration project for the Caribbean. Organization of American States & Inter-American Biodiversity Information Network (IABIN). Washington DC, USA. Retrieved December 28, 2009, from http://www.oas.org/dsd/IABIN/Component1/ReefFix/ReefFix.htm.

Economic Commission for Latin America and the Caribbean (ECLAC). 2004. *Yachting in the Eastern Caribbean.* Economic Commission for Latin America and the Caribbean (ECLAC) Technical Report LC/CAR/R.75. 286 pp.

Pena, M. 2006. Report on evaluating management effectiveness at the Tobago Cays Marine Park (TCMP), St. Vincent and the Grenadines. CERMES Regional Project on Enhancing Management Effectiveness at Three Marine Protected Areas in St. Vincent and the Grenadines, Jamaica and Belize. Centre for Resource Management and Environmental Studies. University of the West Indies, Cave Hill Campus, Barbados. Technical Report No. 5. 69 pp.

Tobago Cays Marine Park (TCMP). 2009. Personal communication. Tobago Cays Marine Park Office, Clifton, Union Island, St. Vincent and the Grenadines. November-December 2009.

Tobago Cays Marine Park (TCMP). 2010. Personal communication. Tobago Cays Marine Park Office, Clifton, Union Island, St. Vincent and the Grenadines. January 2010.

Troy, A., and M.A. Wilson. 2006. Mapping ecosystem services: practical challenges and opportunities in linking GIS and value transfer. *Ecological Economics* **60**:435–449.