Review of Valuation Studies for Coastal and Ocean Resources in Latin America and the Caribbean

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EXECUTIVE SUMMARY

In February 2003, the Environment Network of the Regional Policy Dialogue determined that one of the issues to be discussed as part of its III Environmental Dialogue would be the economic valuation of costs and benefits associated with the sustainable management of coastal and ocean resources. This report and the presentations by Professors Lee G. Anderson and George R. Parsons of the University of Delaware scheduled for a meeting 9th and 10th of March 2004 are responsive to a request to lead that dialogue.

Introduction and Theory

This report is not intended to be a handbook for how to do valuation techniques or to be exhaustive on all the applications done in Latin America and the Caribbean. Rather, it is intended to be a statement, as free of economic jargon as possible, about how and why economists value environmental goods, and in particular coastal and ocean resources. It includes a discussion of how these analyses are used, several examples of studies that have been done in the region, and some thoughts on information systems for gathering future data used in these analyses.

We begin with a brief discussion of why valuation studies are important. The short answer is that it will allow for more informed policy analysis and decision-making. In the jargon of economists, it will help decision-makers manage resources in such a way that they yield the highest value to society. We discuss a few examples of how and why more informed decision-making using valuation studies is good for society.

Following this section is a discussion of some of the approaches used to value coastal and ocean resources. Goods traded in markets, like fish sold by commercial fisheries, oil sold from an off shore oil well, or transit of commodities from one port to another are usually easier to value because there is market information an economist can use. Sometimes it is possible to value environmental resources by noting their linkages to market based products. For example, one of the case studies shows how the loss of a small percentage of a mangrove estuary will affect the net returns to a shrimp fishery.

Goods not traded in markets like clean water or trips to the beach are bit more difficult but approaches have been developed to estimate these values as well. We discuss two basic approaches for the latter type of goods: "revealed preference" and "stated preference." Revealed preference approaches estimate values using information from a market related to the environmental good of interest. For example, by examining how far and where people travel on recreation trips, economists have designed techniques to estimate the value of recreation sites (eg. a beach) and characteristics of recreation sites (eg. width or cleanliness of a beach).

Stated preference approaches estimate values using surveys in which people are asked to report their willingness to pay for environmental goods in a hypothetical but realistic context, like a vote for a tax or bond program. There are numerous formats for a stated

preference survey. One approach essentially mimics a vote: would you vote for a project that improved water quality by a certain amount if it meant your taxes would rise by $X? Yes or No? Other stated preference formats ask people for behavioral responses: would you continue diving at this reef if the visibility were to drop a certain amount? Using data from surveys like these economists can infer values of environmental goods.

The Case Studies

This section is followed by a review of 10 case studies applying valuation techniques. These are short discussions to give a sense of what was done and what its policy implications were. Seven are applications within the Caribbean/Latin America region and 3 are outside the region. These three were included in part to expand the coverage of the resources considered and in part because of a lack of applications within the region. Indeed, one of our findings is that there are extremely few published studies and the quality of many of the studies is lacking. The table below provides a summary of the case studies for quick reference.

The cases cover all of the approaches described in the section on valuation approaches: market-based, market-linked, non-market, and transfer. The setting for these studies include an analysis of the Galapagos marine reserve, Ecuador; development of a sewerage project to control land based pollution in Barbados; valuing mangrove-fishery linkages in Campeche, Mexico; replacement value of wetlands in Sweden; setting fees on tourists to finance environmental projects in the Bay Islands, Honduras; and valuing of recreational diving in Bonaire, Dutch West Indies. While far from exhaustive, this is representative of the issues facing the region.

In almost all cases the analyses did not offer specific policy recommendations. Instead, they provided pieces of information that along with other information (economic and otherwise) could be useful in formulating policy.

A Summary of Case Studies

Case Study	Location	Resources Valued	Approach(es)	Policy Implications
#1 Galapogos Marine Reserve	Ecuador	Fisheries & Recreation	Market based & Nonmarket	Predicts benefits of establishing a marine park exceed costs. Suggests that an increase in a user fee could be used to finance the park and capture value for home country.
#2 Reef Fishery	Gulf of Mexico	Fisheries	Market based	Shows large economic gains to changing existing management regime to a rights based regime.
				Develops a model Barbados can use to

#3 Sewerage Project	Barbados	Sewerage Project	Nonmarket	design a sewerage plant favorable to citizens.
#4 Mangrove Deforestation and Mariculture	Ecudaor	None	None	Makes a case that there is an excess supply of shrimp ponds. Identifies analyses needed to confirm above case.
#5 Dive Tourism	Belize	Recreation	Market linked	Show that user fee could be increased modestly to finance park with little loss in visitation.
#6 Dive Tourism	Bay Islands	Recreation	Nonmarket Transfer	Show that user fee could be increased modestly to finance park with little loss in visitation.
#7 Dive Tourism	Bonaire	Recreation	Nonmarket	Estimates the costs associated with reduced environmental quality of reefs – value could be used in damage assessment or benefit-cost analysis of park. Show that user fee could increased to finance park with little loss in visitation.
#8 Mangrove-Fishery Linkage	Campeche	Mangrove Forests & Fisheries	Market linked	Suggests policies to decrease fleet size. Provides a model officials may use to decide whether or not to protect mangrove forests.
#9 Wetlands	Sweden	Wetlands	Market linked	Shows that the most economical approach for reducing nitrogen emissions involved the loss of some wetlands.
#10 Coastal Wetlands	North Carolina	Wetlands	Market Linked	Develops model that allows policy makers to decide when, where, and if to develop wetlands.

Information requirements

Economic valuation of the environment may be done by primary or secondary analysis. By a 'primary' analysis we mean a study that generates a new data set to analyze a specific policy need. These use the market-based, market-linked, and non-market approaches mentioned above. By a 'secondary' analysis we mean a study that essentially uses the results from other primary analyzes. These are benefits transfers -- the results

from primary studies at other locations and from other time periods are said to be 'transferred' to a new site for policy analysis. Sometimes a study will employ primary and secondary analyses together. Primary studies are generally more accurate but also more costly. Time and other resource constraints often require analysts to apply secondary analyses. How can the Caribbean/Latin American region prepare itself for future valuation applications, primary and secondary? What data should be collected now? What type of information system is needed?

For the primary analyses, analysts use a variety of different types of data. Some should be gathered routinely as a matter of policy. For example, primary data on all sectors with a marine component such as fishing, mining and mineral sectors (off-shore oil and others if any), transport services and so on should be collected. While the nature of the data varies from sector to sector, the essential needs are output quantities and prices; input quantities and prices; and consistency across the region. It is important to have these data overtime and again collected in a consistent way over the region. Other obvious data along these lines include visitation rates to beaches and resort areas, land use in coastal areas, property value data, and even rental rates in coastal regions.

For other primary analyses, like the reveal preference and stated preference approaches, advanced routine collection of data is not ideal. It is too expensive and is likely to result in data sets that poorly fit policy needs. By their very nature, these applications are best designed to fit specific policy needs as they arise. Then surveys and other data collection efforts can be tailored to the specific purposes. For example, the Barbados sewerage project was designed in response to specific policy need.

For secondary analyses it is useful to maintain a database (extended bibliography) of existing studies and how they have been used. In our effort to identify existing studies of economic valuation of the environment in Latin America and the Caribbean, we were struck by how few studies were readily accessible from a convention library/internet/agency search. Published work is easy to identify. Unpublished work and data sets often sit in an analyst's or policy maker's computer files, their existence unknown to future would-be analysts. No doubt we have missed studies in our search, perhaps many, but our effort highlights that there appears to be little systematic collection of existing studies and data sets in the region.

The report closes with some comments on data collection and a bibliography of valuation studies which is preceded by a statement of how we searched for and identified these studies.

Review of Valuation Studies for Coastal and Ocean Resources in Latin America and the Caribbean

INTRODUCTION

During the Second Environmental Dialogue (25th-26th February 2003), it was determined that one of the issues to be discussed at the Third Environmental Dialogue will be the economic valuation of costs and benefits associated with the sustainable management of costal and ocean resources. It was determined that it would be useful to frame the discussion in the context of a review of case studies of experiences with economic valuations of marine and costal resources in the Caribbean and Latin America.

The purpose of this document to is discuss the results of this review. It is important to note that the purpose here is not to provide a handbook of the theory and techniques of economic valuation of the environment and resources. There are several handbooks on the market for non-economists.[1]

The discussion will proceed as follows. The first section will describe why valuation studies are important for policy analysis. The next section summarizes some key aspects of the economic approach to valuation. The section that follows contains short reviews of many of the identified valuation studies. There is a short discussion on data needs for the future. And finally there is a bibliography.

WHY ARE VALUATION STUDIES IMPORTANT?

Why is it important to be able to evaluate the benefits and costs of environmental and natural resources use? The short answer is because it will allow for better informed policy analysis and decision making. Economic policy is concerned with the size and distribution of economic output, both of goods and services. Because economic output consists of so many different items, it is not very useful to describe its size in terms of the number of physical units. Rather we look at the net economic value of output which is measured in terms of money. "Output" is all of the goods and services a society consumes. The amount of each unit of output is multiplied by its market price to get the gross value in monetary terms. The net value is obtained by subtracting the market value of all of the inputs used in its production. The result of adding the net values of all types of production is the total net value of the production of an economy.

A quick example can show the policy relevance of the concept of total net value of production. If a nation is considering building a dam to supply water for irrigation, a main concern, from an economic point of view, is the effect it will have on the net value

[1] Two we recommend are **Economic Valuation of Natural Resources: A Handbook for Coastal Resource Policymakers** by Douglas Lipton and Katherine Wellman and **Revealing the Economic Value of Protecting the Great Lakes** edited by Allegra Cangelosi. Both of the works are published by the National Oceanic and Atmospheric Administration of the United States Government.

of output. Building the dam requires the use of land for the site and other inputs to undertake the construction. Since these inputs will no longer be available for their current use, this will cause a reduction in the net value of output. In addition, if the new irrigation water allows for the increase in farming opportunities, other inputs will be transferred from their current use and this will also cause a decrease in the value of output. These reductions in the net value of output are the costs of building the dam, while the additional value of agricultural output that results are the benefits.

One important criterion for determining whether the dam should be built is whether the benefits are greater than the costs. If the project's benefits are greater than its costs, there is an overall increase in the net value of output and an improvement in general welfare. Of course the distribution of the benefits and costs can be as important as their relative size. To take an extreme example, if the increase in agricultural production is in high priced items that can only be purchased by the rich and the decrease in production comes from sectors that sell to or are sources of employment for those on the lower end of the income scale, the size of the gain in the net value of output may not be that important to policy makers. But in order determine the changes in the amount and the distribution of the net value of output, it is necessary to be able to evaluate the benefits and costs of using various inputs in the economy.

Viewed in this light, we can look again at the question motivating this paper. Why is it important to be able to evaluate the benefits and costs of environmental and natural resources use? The answer is that they are inputs (directly or indirectly) into the production of economic output. And it is important to know how the use of environmental and natural resources will affect the net value of output in an economy. Valuation of environmental and natural resource use is just an extension of basic economic policy analysis.

For example, while many would consider the main output of a forest to be wood products, it can also be an input into the production of other outputs as well. To take a simple case, assume that a forest is located on a hill above some very fertile farming land. As such, it helps to control run off every spring or in the case of severe storms. If the forest is removed the water will come in too fast and it may wash away plants as well as the soil. Therefore one of the costs of cutting timber is the expected loss in agriculture production as a result of increased runoff. A forest can assist in the production of other services as well. It can be a site for various types of outdoor activities including hiking, bird and animal watching, and hunting. These are services that people value in the same way that they value market based recreation such as going to a movie.

So, the benefits of cutting down the forest are the value of the wood products that are produced. The costs are the costs of the inputs to remove the trees and process them into the final products, the lost agricultural output, and the lost recreation.

In some cases, the policy relevance involves more than just determining which course of action to take. For example, in many countries current laws stipulate that individuals are liable for any damages that occur as a result of environmental accidents for which they

are responsible. The case of oil spills is a common example. Because of ecological linkages, a spill can affect the net returns to a commercial fishery. The oil can kill fish, and can damage breeding and nursery grounds. As a result there will be a reduction in the output of the fishery. Similarly, the spill can affect recreational services. If the oil settles on a coral reef, the number and the quality of visits by scuba divers will likely decrease. In either case, there will be a decrease in the net value of goods and services produced. This decrease in value is at least part of the damage for which the responsible party is liable.

Incidentally, such laws make good economic sense, because individuals will be motivated to take precautions such that such accidents do not occur. They will know that in the case of an accident, they will not only lose the value of the ship and the cargo (which is some incentive to be safe) but they will also be responsible for the other economics losses which result (which will add to the incentives).

If the responsible firms or individuals are going to receive the proper incentives to prevent accidents, and if society is going to be properly compensated for any accidents that do occur, it is important that the losses in economic values that do occur are properly measured. While exactly what individuals should be responsible for may vary according to the particular law, logic demands that at a minimum it include the value of the loss of natural resource services from the time of the spill until the services are fully restored to their baseline condition. In addition, there are good arguments that the liability should also include the cost of cleaning up and restoring the environment and the cost of doing the economic valuation used to determine losses.

Sometimes valuations can have even more down to earth relevance. For example, sometimes it is necessary to implement user fees related to natural resource use. To use a marine example, consider a big game fishery. The availability of the stock may attract visitors and this can increase national income. However, to maintain the fishery it is necessary to initiate research and regulation programs. User fees can help raise funds to cover these costs. But how high should the fee be set? If it is set too high, it may drive off too many visiting fishers. Non-market valuation approaches can estimate the value that people ascribe to recreational fishing. They can be used to find out how high the fees can go before there will be an appreciable drop off in participation.

Knowing why these measurements should be made is one thing; actually doing them is quite another. However, economic theory and empirical methods have improved significantly over the past few decades. The next section is a short discussion of the approaches used in valuation.

APPROACHS TO VALUATION

Economists have developed a variety of approaches for valuation. They vary by the type of good being valued. There are market goods, like fish and offshore oil, in which market-based data are used to estimate values. There are cases where environmental

goods are "linked" to markets and market data still can be used, but the approach is more indirect. And finally, there are cases where there are simply no market data or links to markets and non-market survey data are used. We will refer to these three approaches as *market-based*, *market-linked*, and *non-market*. The table at the end of this section summarizes the three approaches.

As the label suggests, market-based approaches use market data directly in the analysis. Market data are the prices and quantities of goods and services traded in a society. The value of a harvest fishery is a good example. It is possible to measure the value of the fish produced and the cost of the inputs necessary to produce them using price and quantities (and changes in either) from market data. The same is true for market goods and services such as offshore oil production or ocean transportation. Some times variation in prices and quantities is needed in the analysis and researches will use data over time or across regions to estimate values.

Next is the market-linked approach. These approaches can take a variety of forms. In all cases the analyst attempts to find a market where the value of an environmental good or service can be captured in a market. In some cases, marine or ocean resources are important inputs into the production of goods that are sold on the market and it is possible to use changes in the market values to get a measure of the service value of the inputs. For example, one effect of a program to reduce the discharge of certain material into rivers, could be a reduction in the operation costs and maintenance requirements of water treatment plants. These market prices could be used in the valuation of the program benefits. In this way, the goods to be valued use "links" to a market in valuation.

Another market-linked approach often used in valuation is called "revealed preference". In this approach one tries to find a market where environmental goods are implicitly traded and then use statistical analyses of market data to "tease out" the implicit values. We say that the values are revealed in these markets. For example, environmental goods are often implicitly traded in housing markets. Housing prices are higher for houses near environmental amenities such as open spaces, parks, beaches, and forested land. They will also be higher for houses with beautiful natural vistas, cleaner air, and quieter neighborhoods. Likewise, prices will be lower for house near hazardous waste sites, next to major roadways, and near industrialized areas. We say that the property values capitalize amenities and disamenities – their values are embedded in housing prices.

Individuals also reveal something about their value for recreational uses of an environment in how far they travel to use a site. Think about a trip for swimming, hiking, viewing, or fishing. People are willing to travel further (pay a higher price) to visit better recreation sites. The more amenities and more unique the site is, the broader the geographic range of the users at the site – compare a grand national park with unique natural landscape to a local park or compare a fishing area that offers catch of a variety of fish species with high success versus a local fishing pond with a one species and limited success of catch. Again, there are values for environmental goods implicit in these "markets" or travel choices.

Finally, there are non-market approaches to valuation. These are also referred to as "stated preference" approaches. In these analyses, one attempts to value environmental goods by asking individuals to state their value for an environmental good in a survey. The survey may be by mail, phone, in-person, or Internet. In a carefully crafted questionnaire, people are asked to state their valuation (willingness to pay) for a change in or use of an environmental good.

The typical format for a willingness to pay question asks people to vote for or against a hypothetical project. For example, here is a willingness to pay question from stated preference survey concerned with valuing the restoration of a segment of a polluted river. After a detailed description of the river and what the restoration would entail, individuals were asked

> If the South Platte River Restoration Fund was on the ballot in the next election, and it cost your household $50 each month in a higher bill would you vote in favor or against?

The amount ($50 in the above sentence) was varied across the respondents over the range $1 to $100.

Using responses to questions like this, economists can estimate the value of restoring the river. In some cases respondents are asked multiple willingness to pay questions, in other cases they are asked how their use of the environment might change if there were a change in circumstances of use. For example, people may be asked how their number of trips to the beach might change if the beach were cleaner or wider or had regular government inspections for water quality.

There are difficulties in using all the approaches mentioned here. And, it is important to keep in mind that which approach one uses depends on the resource being valued. Market-based approaches are limited to resources traded in markets (egs. fish and offshore oil). A difficulty with approaches using market data is that data are sometimes missing or spotty. There are also circumstances where time series or cross sectional data are needed to do a supporting statistical analysis and the variation needed in the data does not exist. Also, when policies being analyzed call for changes in the environment beyond what is actually observed (eg. a fish catch rate never realized in a given fishery), the analyst is forced to extrapolate, and this entails some loss in accuracy. Put differently, it is sometimes difficult to tailor the analyses to fit the specific needs of a policy question. Still, market approaches have the advantage of being based on "hard" data and actual (not hypothetical) behavior.

Market-linked approaches are limited to those where some, albeit indirect, linkage can made between an environmental good and a market. Economists have had most success here with recreation (in travel cost), amenities like visibility and open spaces (in housing or property markets), risks of death or injury (in job markets), and cases where environmental goods serve as inputs in production processes (clean water as an input into production of agriculture crops). These approaches share many of the same difficulties that the market data approaches have. When policies extend outside the realm of observation, some extrapolation is necessary. In the housing and labor market studies where existing market information is used, the researcher is at the mercy of the existing

market data. Again, this can sometimes be missing or spotty. With the travel cost information, the researcher needs to develop a survey and go into the field to gather the data. The surveys can be expensive. Like the approaches for market data, these approaches have the advantage of being based on "hard" data and observed behavior. In some instances, the data may be considered somewhat softer since is constructed by survey.

Non-market approaches are usually reserved for goods not traded in markets and for which there are not obvious market data that can be used (egs., improved scenic vistas, reduced health risk due to improved drinking water, or a decline in the health of a coral reef system). In principle, however, they can be used to value any good or service. These techniques have the advantage of being easily tailored to specific policy questions. The questionnaire is designed to fit the exact setting of the valuation needed. At the same time, stated preference techniques are controversial because they rely on individuals' responses to hypothetical questions in a survey which may or may not being valuing the good the analyst intended.

It is worth noting that the current trend is toward combining the methods mentioned above to suit the needs of specific benefit-cost analyses, damage assessments, or other policy questions. This is particularly true of revealed preference studies (market linked) and stated preference studies (non-market), wherein one attempts to draw on the strengths of the different approaches. Also, in many applications to actual policies, analysts do not have the luxury of designing a study from the ground up to address their specific needs. Instead, they rely on what has been learned in existing studies. This approach is known as "benefits transfer" and involves an analyst matching existing studies to the needs a specific policy. For example, an analyst may use beach use values in Florida Keys to value beaches in Barbados, or value the improvements in coral reef environment in Belize using results from a study in Bonaire. While imperfect, analysts often have no other choice – at least until more locally developed valuation information is available.

Now, lets turn to the case studies to see how some of these approaches are used in practice.

A Summary of Valuation Approaches

Approach	Examples of Resource	Requirements	Data Needs	Cost of valuation	Dis-advantages	Advant ages
Market-based	Fish, off-shore oil, marine transportation	Good or service is traded in a market	Market data on prices and quantities, sometimes needed over time and regions, often published	Medium	Data maybe unavailable or the needed variation in data may not exist. Difficulty fitting with specific policy needs	Based on "hard" data and observed behavior
Market-linked	Recreation, view amenities, environmental good as inputs into production processes, some health risks	Good or service can be 'linked' to a market	Market dat a on transactions linked to environmental good, sometimes need a survey, usually have to combined different data sources	High		
Non-market	View amenities, ecological values, existence values	Any good or service but usually reserved for goods not traded or linked to a market	Need to design and conduct own survey	High	Based on hypothetical behavior from survey. Costly if survey is done well	Can be tailored to fit almost any policy need and resource type
Transfer	Any resource	An existing study matching the resource to be valued		Low	Existing studies maybe unavailable. Reduced accuracy.	Can be done quickly at low cost

REVIEW OF CASE STUDIES

This section presents a brief overview of 10 case studies. Seven are applications within the Caribbean/Latin America region and three are outside the region. These three were included in part to expand the coverage of the resources considered and in part because of a lack of applications within the region. Indeed, one of our findings is that there are extremely few published studies and the quality of many of the studies is lacking. The table below provides a summary of the case studies for quick reference.

The cases cover all of the approaches mentioned above: market-based, market-linked, non-market, and transfer. The market-linked studies include a case where an environmental good serves as an input to a market good and a case using a revealed preference application for recreation.

The setting for these studies include an analysis of the Galapagos marine reserve, Ecuador; development of a sewerage project to control land based pollution in Barbados valuing mangrove-fishery linkages in Campeche, Mexico; replacement value of wetlands in Sweden; setting fees on tourists to finance environmental projects in the Bay Islands, Honduras; and valuing of recreational diving in Bonaire, Netherlands Antilles. While far from exhaustive, this is representative of the issues facing the region.

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#10 Coastal Wetlands	North Carolina	Wetlands	Market Linked	Develops model that allows policy makers to decide when, where, and if to develop wetlands.

Case Study #1

Wilen, James. E., Micki Stewart, and David F. Layton 2000 **Economic Analysis of the Galapagos Marine Reserve Resources Management Plan.** Final report of study funded by IADB.

Background.

The government of Ecuador is considering a proposal to close off about 20% of the internal waters in the Galapagos Archipelago as a marine reserve where no fishing would be allowed. Marine reserves are purported to have whole range of ecological benefits even in quite mundane fishing areas, and given the special nature of the Galapagos, the potential benefits could be even more significant. While the ecological ramifications of the introducing a reserve to the system are immense and largely unknown, some of the basic policy issues are easy to identify.

First, the commercial fishers whose activities will be constrained by the reserve will suffer losses at least in the short run. Also the tourists may have greater satisfaction from their visits due to the increased biomass or species diversity or from simply knowing that the reserves are in place.

Valuation techniques and results.

This study is interesting because it was necessary to use market techniques to estimate the effect of the marine reserves on local fishermen, and non-market techniques to estimate the effects on tourists.

There will be both short-run and long-run effects of the closure on the commercial fishery. In the short-run, net returns will be reduced because of the constraints. The individual participants will likely change their behavior in response to the closure. They may well fish harder in other areas. The short run effect will be the changes in net returns taking into account the smaller fishable area and any changes in fishing behavior. In the long run, the short-run losses can be mitigated if any of the predicted increase in biomass in the reserve spills over into the fishable area and results in higher catches.

Given the scarcity of information on both the activities of the commercial fishermen and on the long term population dynamics and migration patterns of the affected stocks, the analysts could only make a rough estimate of the short run effects. They were able conclude that there are about 500 fishing households with an average income from fishing equal to US$4,375. In the worst case, they will lose about 10% of that due to the closure. At US$437 per houshold, this amounts to a short term annual lose of about US$220,000.

Given the absolute absence of any data on the long term effects of the reserves on commercial fishing in the fishable zone, the analysts elected to ignore them completely, although they acknowledged that these short term losses will likely be reduced overtime

and may even turn into positive gains. Although this does not do much for the accuracy of the actual effects, it can make sense for policy analysis. If costs are estimated on a worst case basis, and the benefits are still larger than the estimated costs, the policy implications are quite clear.

In order to estimate the benefits, the analysts designed and implemented a valuation survey in order to get some idea of the possible magnitudes that tourists might place on the added value associated with marine reserves. Their results indicated that Ecuadorian resident visitors would be willing to pay US$6.37 extra per trip knowing that the reserves were in place. That is each of the approximately 15,000 resident tourist would enjoy a consumer surplus equal to US$6.36 as a result of instituting the marine reserves. The results indicated that these values were generated just be putting the reserves in place; it was not conditional on waiting to see what the actual effects were. The numbers for the foreign tourist visitors was US$53. There are approximately 50,000 foreign visitors.

Policy implications

The results of these valuations can be summarized as follows:

	Costs		**Benefits**
Number of affected fishing households	500	Number of affected (National visitors)	15,000
Value of reduction in net income per household	US$437	Value increase in individual user benefit	US$6.37
		Annual national total benefits	US$95,400
		Number of affected (foreign visitors)	50,000
		Value increase in individual user benefit	US$53
		Annual total foreign	US$2,650,000
Annual Total Loss	**US$220,000**	**Annual Total Benefits**	**US$2,745,000**

From a simple comparison of the benefits and costs, building the marine reserves seems to make sense in terms of the overall changes in the values of goods and services produced. However, the Ecuadorian government would want to take a closer look. From a national point of view, the simple introduction of the marine reserves with no other changes will result in a loss to its citizens. The fishing community in the Galapagos would lose US$220,000 and resident tourists would only gain US$95,400. However, since the consumer surplus of foreign visitors represents a willingness to pay over and above what they are already paying, some of the gains to foreign visitors could be captured and used help run the park and to compensate the fishermen. A policy to advertise the marine reserves and their likely effects combined with an increase in the entrance fee of US$4.20 would raise enough money to compensate the fishermen for their worst case losses. And given the size of the estimated consumer surplus to foreign

visitors, the fee could be raised well above that amount will little expected effect on the number of visitors.

It is interesting to note, that even though the analysts were not able to estimate the actual biological effects of initiating the marine reserve program due the lack of data, they were able to provide enough information to policy makers that suggest that the policy may very well make sense. Any other benefits which follow from the long terms effects of the reserves are just gravy.

Case Study #2

Weninger, Quinn and James R. Waters 2003 **Economic Benefits of Management Reform in the Northern Gulf of Mexico Reef Fish Fishery.** Journal of Environmental Economics and Management 46:207-230.

Background

At the time of the study, there were 387 vessels harvesting red snapper in the US reef fishery. In order to keep harvest within a biologically determined safe total allowable catch, the fleet is subject to severe restrictions. Fishing for red snapper is only allowed during specified open seasons. During the period of study, the open season was 95 days per year. The length of the season is set such that the expected catch of the active boats will equal the total allowable catch. Further, vessels can only harvest a limited amount of red snapper on any trip.

While the regulation appears to be biologically effective, there are serious economic consequences. For one thing, because all of the fish has to be harvested over such a short period, the glut on the market lowers the price. This is bad for the fishermen, but it also indicates that consumers are not being well served. They may get lower prices over the short season, but they do not have access to fresh red snapper for about three fourths of the year.

In addition, the costs of harvesting the total allowable catch (TAC) are higher than the need be. In the first place, the fleet could be reduced in the harvest were spread over the full year. In addition, costs are higher than necessary because more trips are required to take the TAC given the restrictions on the amount that can be harvest on any trip.

The managers are considering adopting a rights based fishery management program, where the TAC is broken in to smaller units and allocated as a property right to current participants. They will then be able to harvest it in any way they please. In addition, it will be permissible to buy and sell these harvest rights, making it possible for the more efficient boats, which are now only operating part of the year, to purchase enough harvest rights that they can become full time red snapper boats.

Before implementing such a program, the managers would like to get some idea of how this scheme would affect the operation of the fishery. What is the amount of the extra value that could be extracted from the fishery?

Valuation Techniques and Results.

To try to see the effect of the closed season on the price of red snapper, the analysts used standard econometric techniques to estimate the relationship between price, the size of the TAC, and the length of the open season. Using the results they estimated that if the closed season were removed, the average price would increase from US$1.94 to $2.88. Given the size of the TAC, the actual revenue at the time of the study was US$6.598

million. With the same TAC, but a higher price, revenue would increase to US$9.805 million, indicating a gain of US$3.208 million on the revenue side alone.

Estimating the likely cost savings involved some slightly more complex econometric analysis of the cost structure of the existing fleet. Without going into the details, the analysts estimated that the same harvest could be obtained over 12 month season with a fleet of around 70 rather than 387 vessels. In addition taking into account the savings that could be obtained by using the more efficient vessels in the fleet and dropping the trip catch limits, they estimated that harvesting costs could be reduced by some where between US$7.860 million and US$8.416 million.

Policy Implications

Taking the total of the revenue and the cost effects, the analysts predict that as a result of instituting a rights based fishery management program, the net value from the red snapper fishery can be increased by somewhere between US$11.068 million and US$11.624 million per year. Judging from the size of gross revenues under the current regulation program this is a significant increase.

Policy makers would also want to consider how the gains would be distributed among the existing participants and this would be related to formula for the initial allocation of the harvest rights. In addition, they may be concerned about the effects of removing around 300 vessels from the fishery. What effects would these have on employment opportunities? Would the boats merely move on to cause over-fishing in other fisheries?

Case Study #3

Swallow, Stephen K. and Michael McGongale, 1996**. Resident's Preferences for Design of Barbados' West Coast Sewerage Project,** report submitted to Stanley International Group, Inc.

Background

The government of Barbados (in cooperation with the Inter-American Development Bank) had plans for a new sewage collection and treatment system to serve the residents of the west coast of Barbados. Several different designs for the system were being considered. The government and the IADB were interested in knowing which of the designs had the highest net economic value.

The costs of the different designs were estimated by an engineering firm separately from the analysis here. The charge for this study was to rank different design alternatives according to the preferences of residents and to estimate the economic benefits of different design types.

The benefits of the new system to households were: more convenient disposal of waste, elimination of waste seepage into beach water and reef systems, and a new source of clean water for irrigation and aquifer recharge.

The benefits to residents were measured using stated preference techniques. More specifically, a contingent behavior analysis was conducted.

Valuation Techniques and Results

Two separate in-person surveys were administered on the island. Each posed questions that allowed the researchers to rank different designs according to the preferences of Barbados' residents and to value the different design options. One survey was for residents living on the west coast where the new sewage treatment system would have its largest impact. The second was for residents living elsewhere on the island.

A considerable amount of effort was devoted to developing a credible survey instrument. A focus group was conducted, the surveys were pre-tested, and local administrators and academics were included in the design. Over 700 surveys were administered to west coast residents, and 500 were administered to residents living elsewhere.

There were two valuation questions in the in-person survey. After some discussion of what the treatment projects were about and what they accomplished, respondents were asked to consider three options and choose which they preferred. The options were:

- No new system
- New system #1
- New system #2

The no new system option came at no additional cost and maintained the status quo. New system #1 and new system #2 came at some additional cost to residents but afforded them some degree of the economic benefits mentioned above. Residents were told that the added cost would come in the form of a higher water bill. The new system options varied by (i) location, (ii) whether the outfall waste was reused or disposed at sea, (iii) whether the reused water was for households or agriculture, and (iv) whether the existing facility at Emmerton was also expanded or not. These were the lines along which different designs were actually being considered and residents had different opinions about the efficacy of the designs.

The survey allowed the researchers to consider 32 different types of system designs. These were varied over the respondents. This study design allowed the researchers to report the rank and value of numerous system designs prior to the actual choice of a system. In this way, the analysis could be used in the design of the system itself.

The analysts' report the valuation results from four scenarios and, as mentioned earlier, never reported the cost in this study. All numbers were reported per household per year in 1996 dollars. The mean household willingness to pay for specific systems was

Scenario	West Coast Residents	Other Residents
Expand Emmerton, Locate in South, Off-shore disposal, No reuse	$306.39	$163.23
Expand Emmerton, Locate in South, Off-shore disposal, Reuse for agriculture	448.81	171.49
No change at Emmerton, Locate in West, No off-shore disposal, Reuse for residents	277.75	71.02
Reduce Emmerton, Locate in South, No off-shore disposal, Reuse for residents	176.89	123.94

As shown the west coast residents have a higher willingness to pay than other residents. The preferred approach appeared to locate the system in the south, expand the facility at Emmerton, and used a mix of reuse and off-shore disposal.

Policy Implications

We contacted the authors to see if the final analysis was used in decision making. We received the following response.

> Stanley International did use it in the next stage to rank alternatives for the government. They applied it to about a half-dozen configurations (not all of which were distinct on the available variables. I don't know whether the government adopted or modified final recommendations (which would have been mixed with any engineering or construction cost implications, not just the benefit analysis).

He also indicated the model may have been modified further for some later applications.

Case Study #4

Parks, Peter J., and Manuel Bonifaz 1994 **Nonsustainable Use of Renewable Resources: Mangrove Deforestation and Mariculture in Ecuador.** Marine Resource Economics 9:1-18

Background

This article provides a different type of case study because it contains no actual valuation work. However, it does describe a real world example where it is obvious that valuation studies are critical in order to determine proper policy. In addition, because it is similar to, but more complicated than, previous cases, discussing it will provide a better understanding of the types and uses of various valuation procedures.

The shrimp aquaculture industry in Ecuador has developed over that last 30 years, with the number of hectares of pond increasing from 5,146 in 1979 to 146,000 in 1991 (the last year discussed in the paper).

There are several linkages that need to be understood to understand how the shrimp industry works. In the first place, the mangrove forests help to provide for a healthy wild shrimp stock by providing nutrients and maintaining salinity. The more mangroves that are put into shrimp ponds, all else equal, the higher will be the aquaculture output. However, all else is not equal, because the shrimp ponds rely upon wild harvest post larvae shrimp to stock their ponds. In one sense, as more shrimp ponds are built, the more difficult it is to obtain post larvae shrimp. There is reason to believe that private individuals will not make the right decision with respect to building new shrimp ponds because they do not consider the full costs of their actions.

There are other problems as well. First, just as in the Campeche case study, there will be a tendency for the shrimp fishermen to take so much harvest that the stock declines and the long term sustainable harvest decreases. In this case, the problem is more complicated because there are two sources of commercial harvest. First, there is the artisinal fishery which captures the post larva shrimp to supply the shrimp ponds. In addition, there is the (potential) for a wild harvest fishery.

The potential problems with respect to the artisinal fishery are somewhat more complicated than in the Campeche case. In the first place, every post larvae that is taken in the artisinal fishery is technically not available for harvest in the wild fishery. An important valuation issue is the effect that different levels of post larvae fishing will have on the actual catch and earnings in the wild fishery. It is important to know the trade-offs in terms of value gained in the aquaculture sector versus value lost in the wild harvest sector.

In addition, however, the tendency for the artisinal fleet to take more fish in the short run than can be sustained can have two harmful long term effects. As in other fisheries, it will reduce the stock size and lower the sustainable harvest. In addition, the immediate

abundance of post larvae shrimp can provide incentives to build more aquaculture ponds, which will likely exacerbate the problem of stock declines.

Valuation Techniques and Results

The valuation questions that need to be answered are:

What is effect of reducing mangrove areas on stock size and the economics of both harvest sectors?

What is the effect of current harvest in the two sectors on the long term productivity of the stock?

What is the relative value of harvesting grown shrimp for direct market consumption and harvesting post larvae shrimp to use in shrimp ponds?

Policy Implications

The authors of this paper believe that the tendency ignore the full cost of building shrimp ponds has resulted an improper combination of mangrove estuary and shrimp ponds. The stock has been adversely affected. They also believe that the tendency for the artisinal fishery to supply too much output has given further incentives to over produce shrimp ponds. Their evidence for this is that in recent years there have not been enough post larvae to supply all of the existing ponds.

Answers to the above questions can guide policy on:

Mangrove utilization: Should more mangroves be converted to ponds or should there be an effort to rebuild forests?

Annual shrimp harvest: How much should be caught each year and how much should go to each sector?

Case Study # 5

Dharmaratne, Gerard. 2002. "Economic Value of Belize Barrier Reef: Evidence from Dive Tourism and Commercial Fisheries" UWI Centre for Environment and Development, The University of the West Indies.

Background

Belize has one of the largest and most magnificent barrier reef systems in the world. The reef and its surrounding coastal environs support a vibrant and growing tourism industry which (accoding to Dharmaratne) accounts for approximately 20% the country's GDP. This industry is the focus of the analysis.

The purpose of the analysis is to estimate the economic value of diving and snorkeling, recreational fishing, and commercial fishing due to the barrier reef. The study was motivated by the Bureau of Tourism and resource managers who wanted to document the economic importance the reef and to develop a capacity in environmental valuation for future management of the reef and tourism. In part, the Bureau wanted to justify its intentions to further develop dive tourism. This analysis provides a first pass at establishing baseline values for the most important use values of the reef system.

Valuation Techniques and Results

The recreation values were derived using statistical techniques applied to data on observed recreational travel decisions (revealed prefence), and using a valuation survey. An in-person survey was conducted at three major recreation destinations in Belize. The survey included detailed information on where people traveled from, trip costs, and how long they stayed. Using variation in actual travel related costs borne by USA versus UK residents, they estimated the individual net benefit of a vacation trip to Belize at US$527 per US resident and at US$219 per UK resident. The annual aggregate value of trips was, in turn, estimated at US$34.16 million.

The analysts argued that these values represented total recreation use values. Since there was an interest in how much of this was due to diving, they preformed a separate valuation survey analysis to estimate this piece of the total. Individuals were asked their willingness to pay based on an annual pass and a dive-by-dive pass to go diving. Using these results and result from the trip component of the survey they estimated the value of diving at somewhere between 12 and 57% of the total recreation use value.

One interesting aspect of their analysis from the perspective of resource managers and policy makers is the demographic, attitudinal, and resource use questions which were also answered. These type of data are commonly gathered as part of the economic survey and give the policy maker a useful profile of who is using the resource, how they are using it, and what they like and dislike about it. It can be useful information for planning purposes.

Circumstances prevented the analysts from completing the valuation of the recreation fishery and their valuation effort on the commercial was simply a reporting on the rate of return on the industry and revenues generated by the industry in recent years. They make a conservative estimate that reef fishery is worth US$2 million but provide little evidence in support.

Policy Implications

The policy implications appear to be rather limited. The Tourist Bureau indeed gets some values it can use to argue its case for more attention to reef-based tourism. There is evidence that the dive population is willing to pay a dive fee that may generate as much as $3 million per year in revenue. And finally, the study does provide a set of values which may be useful as in secondary analyses such as benefit-cost analyses or damage assessments which may be of relevance in the development of environmental policies in Belize.

Case Study # 6

J. Edward Taylor, George Dyer, and Micki Stewart, 2002, **Economic Study of the Bay Islands**. Environmental Management Program (EMPBI) for the Bay Islands funded by the Inter-American Development Bank (IDB: HO-0198)

Background

The Bay Islands, located 50 kilometers north of Honduras, rely on three primary economic sectors: tourism, real estate, and fishing. The recent growth in the tourism industry has put the island under considerable environmental stress prompting this EMPBI-IDB study.

The study provides an overview and a model of the island economy. The primary uses of the model are to (1) help design alternative environmental management projects, (2) explore alternative financial mechanisms for environmental projects, and (3) identify impacts of the growth on the different sectors of the economy. We will focus our attention on the use their use of economic valuation techniques to help in developing a tax on tourists to finance environmental projects – an element in item (3) above.

A tax on tourists has the advantage of drawing on resources from outside their own economy but has the disadvantage of possibly driving tourists away from the island thereby shrinking the tourism base.

To explore the feasibility of a tax the authors conducted a valuation survey of 300 island tourists in 2002. The purpose was to establish whether or not a tax would be tolerated and, if so, how large a tax would be possible. The results were used to estimate potential revenue and to predict the number of tourists that such a tax might discourage from visiting the island.

Valuation Techniques and Results

The valuation survey was not random but did include a mix of people arriving by boat and air. The survey was done in-person. The valuation question was as follows:

> The Bay Islands are located in one of the most remarkable coral reef systems in the world, and are a world-famous diving destination. As a consequence, the archipelago has drawn growing numbers of people, both temporary tourists as well as permanent residents. New management and environmental protection programs, such as water and sewage treatment systems are being developed in order to maintain the **current** condition of the Bay Islands under continuing pressures from tourism and local residents.
>
> 1. These environmental protection programs could be funded **in part** through the establishment of user fees, such as a visitor fee or a diving permit. Keeping in mind the experience you just had, what is the most that you would be willing to pay for such a permit or entry fee, and still take this trip to the Bay Islands? (You may answer in the currency you are most familiar with, just tell us which currency you are using.)
>
> I would be willing to pay _____.

(Which currency? _____)

If not willing to pay anything, the visitor was then asked:

2. If you would not be willing to pay any more than what you actually did pay to visit the Bay Islands on this trip, please tell us why:

   I don't believe people should be asked to pay more.

   It's just not worth it.

   I don't have enough income.

   I don't believe additional fees would be applied to the program.

   Other (Please tell us: _____)

The researchers deliberately tied the tax to environmental policies on the islands so the visitors would understand that their money would be buying a better environment. The question above pertains to a fee needed to maintain the current condition of the islands. The average willingness to pay over the sample to maintain current conditions was US$75 per trip.

This questioned was followed by another in the same format that asked people how much they would be willing to pay to for a program that improved the conditions to islands. The average willingness to pay for increased protection was US$103.

The authors note two things in particular about these results. First, there were two or three tourists willing to pay in the thousands of dollars for both programs. This tended to inflate the mean values somewhat. Second, in follow up questions, respondents indicated a concern about whether or not the government could be trusted to actually deliver on such a promise. This probably tended to push the numbers downward somewhat.

Policy Implications

The authors show that a tax of near $8.50 per person to maintain current conditions would reduce visitation by only 10% and that an annual revenue stream of $300,300 would be generated. At the same time, a tax of near just over $20 per person to improve conditions would reduce visitation by only 10% and generate a revenue stream of $712,950.

Case Study # 7

Thur, Steve. 2003. **Valuing Recreational Benefits in Coral Reef Marine Protected Areas: An Application to the Bonaire National Marine Park.** PhD Dissertation, University of Delaware.

Background

Bonaire is one of five islands that comprise the Netherlands Antilles located in the southern Caribbean. The Bonaire National Marine Park encircles the island and is known as an international scuba diving location. The coral reefs surrounding Bonaire are considered to be among the most pristine in the Caribbean.

The purpose of this study three fold: (1) to value the recreation uses of the marine park, (2) to inform policy makers about the impact of increased user fees on the park, and (3) to provide policy makers with data of interest on the demographics of divers and usage of the park.

The BNMP is believed to contribute, at least in part, to maintaining the current high quality of coral reefs on Bonaire. The researcher was particularly interested in valuing the potential economic loss associated with a hypothetical decline in quality – something that may happen if the park were to cease to exist.

Valuation Technique and Results

To dive in the BNMP one must register and purchase a dive tag. Over 27,000 people purchased tags in 2002. This analysis uses a random draw of 300 of these divers.

Divers names and addresses were obtained from the BNMP. A survey was mailed to each diver at their home shortly after their dive vacation. Individuals were asked to questions about length of stay, expenses, sites visited, and then a set of four stated preference questions for the purpose of valuing the recreation use of the park.

The first question asked people their maximum willingness to pay for a dive tag. The last three questions posed hypothetical choices intended to infer the value of the environmental quality of the coral reef system at the park. The latter question took the following form

> Suppose that prior to your most recent trip to Bonaire you were offered two dive vacations: one to Bonaire and another to a similar Caribbean Island. Assume that the cost of each vacation, excluding the dive tag, was the same as the cost of your recent Bonaire trip. Suppose that the two destinations varied only by dive tag price, average coral cover, diversity of fish and coral species, and average visibility. If the characteristics of each island varied as shown below:

	Bonaire	Other Island	Neither
Dive Tag Price	$100	$0	Stay Home Or Take Some Other Dive or Nondive Vacation
Coral Cover	35%	5%	
Species' Diversity	300 fish 45 corals	50 fish 10 corals	
Visibility	100 ft.	20 ft.	

… which option would you have chosen? (check one)

? Bonaire

? Other Island

? Neither

The question was intended to force individuals to trade off tag price with coral reef quality and thereby allow researchers to infer values of potential declines in coral reef quality.

The survey was designed such that values could be inferred for declines in reef quality from current conditions on Bonaire to three different levels: poor, medium, and good. These were defined in terms of coral cover, species diversity, and visibility. In the example above, the person is offered an "other island" option with poor conditions. After answering this question they were offered islands in medium and good condition. The definitions of the different levels are shown below. Bonaire conditions are shown for comparison purposes.

	Poor	***Medium***	***Good***	***Bonaire***
Coral Cover	5%	20%	30%	35%
Species Diversity	50 fish 10 corals	125 fish 25 corals	225 fish 40 corals	300 fish 45 corals
Visibility	20 feet	50 feet	75 feet	100 feet

Policy Implications

Thur finds that divers were willing to pay on average $47 to avoid a decline in quality to "good" conditions, $101 to avoid a decline in quality to "medium" conditions, and $115 to avoid a decline to "poor" conditions. These numbers translate to annual aggregate losses of $1.5 million for a decline to "good" conditions, $3.0 million for decline to "medium" conditions, and $3.4 million for a decline to "poor" conditions.

The BNMP is financed entirely from the sale of dive fees. As the budget seems to grow increasingly tight, park authorities have expressed an interest in the potential of raising the fee level to increase revenues. Understandably, there is a concern that higher fees may lead to lower visitation. Thur's analysis shows that revenues would be maximized at a dive tag price of $50 (current price is $10). Total annual revenues would be $760,000, an increase of over ½ million dollars. Visitation, however, is projected to drop by 40% at a fee level of $50. This would no doubt be a considerable drain on the economy.

A $30 dive tag, on the other hand, would raise revenues to $600,000 with a decline of only 25% in participation. And, a tag price of $20 would raise $500,000 with a decline of only 6%. The modest increase to $20 nearly doubles revenues with almost no loss in revenues.

Case Study #8

Barbier, Edward B. and Ivar Strand 1998 **Valuing Mangrove-Fishery Linkages: A Case Study of Campeche, Mexico.** Environmental and Resource Economics 12:151-166.

Background

Campeche is located on the west side of the Yucatan Peninsula in Mexico. There are very productive shrimp stocks in the surrounding gulf waters. They support a large fishery that produces valuable food for national consumption and export. In 1991 it employed 13% of Campeche's total labor force. Campeche also contains Laguna de Terminos, one of the largest and most productive mangrove areas in the Gulf of Mexico. Mangroves are known to provide a nursery area for shrimp and other species. They also provide a home for many other types of birds and animals. The area is also a potential site for urban expansion and aquaculture facilities.

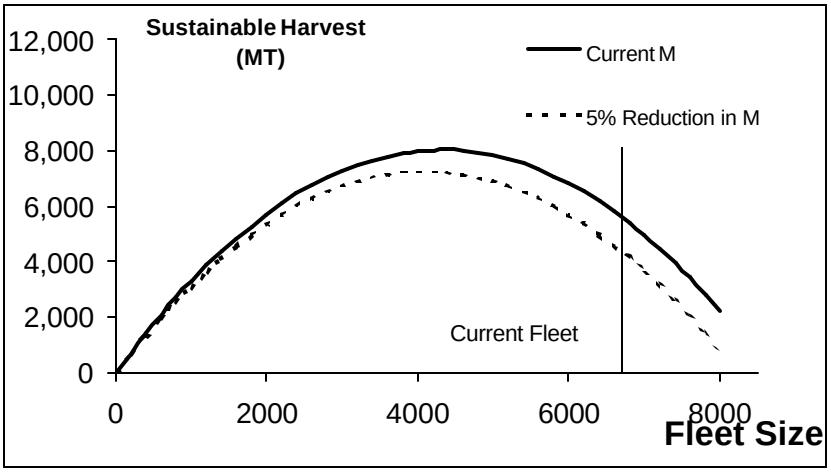
There are two important policy issues concerning the wise use of the shrimp stock and the mangrove estuary. *How large should the shrimp fleet be? How much of the mangrove area should be developed for other purposes?*
Why are these relevant questions for government policy? First, because the full cost of adding another boat to the fleet is not considered by individual fishermen. There is a tendency for unregulated fisheries to be over-exploited. The cumulative effect of too many boats will reduce the stock size and potential yields. Second, because the full cost of developing a unit of the mangrove estuary is not considered by individual property owners, there can be a tendency to develop too much of the estuary.

In order to answer these questions it is necessary to find a way to value the contribution of the Laguna de Terminos mangrove estuary to the commercial shrimp fishery?

Before reviewing the valuation process used by the analysts, it is interesting to note that in the 10 years prior to the study, there was a considerable decrease in catch (-38%) despite a large increase in fleet size (+40%). Over the same period, the size of mangrove estuary decreased slightly (-3%). Is it possible to explain what caused the decrease in catch? Did it fall because the decrease in size of the estuary has damaged the stock such that catch has fallen in spite of fleet increase? Or did it fall because the cumulative catch from the increased fleet has damaged the stock such that catch has fallen?
Valuation Techniques and Results

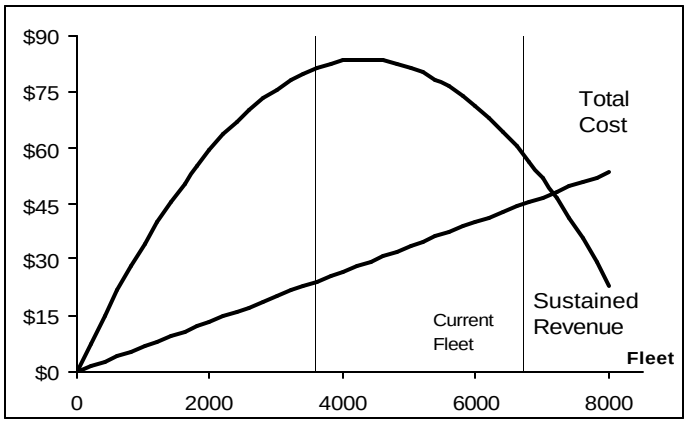
The authors of this study linked the productive capacity of the mangroves to the fish stock by modifying the standard bioeconomic analysis and were able to estimate a relationship between sustainable harvest and both fleet size and estuary size.

Their results can be summarized in the following graph, where the graph for the current



sized mangrove area is pictured as a solid line, while the sustainable yield with a 5% loss in mangroves is pictured as a dotted line. The interpretation of these curves is as follows. First, for any estuary size, the sustainable yield will fall after the fleet reaches a certain level. With the 1990 estuary size, sustainable yield increases until fleet reaches 3,575. Since the current fleet is 6,700, decreases in fleet size will actually increase sustainable harvest. Second, a decrease in estuary size will decrease sustainable harvest for all fleet sizes. The percentage decrease will increase with fleet size. Given the current fleet size the reduction in mangroves will reduce sustainable harvest by 1,224 metric tons. In response to the above questions, these results suggest that while the loss in mangroves has affected harvest, the long term effect of too many boats seems to be more important.**Policy Implications**

The sustainable yield curve can be used to construct a total revenue curve, which when used with a total cost curve can be useful in analyzing the health of the fishery. Using 1990 shrimp price and estimated vessel costs, the curves are pictured in the following graph.

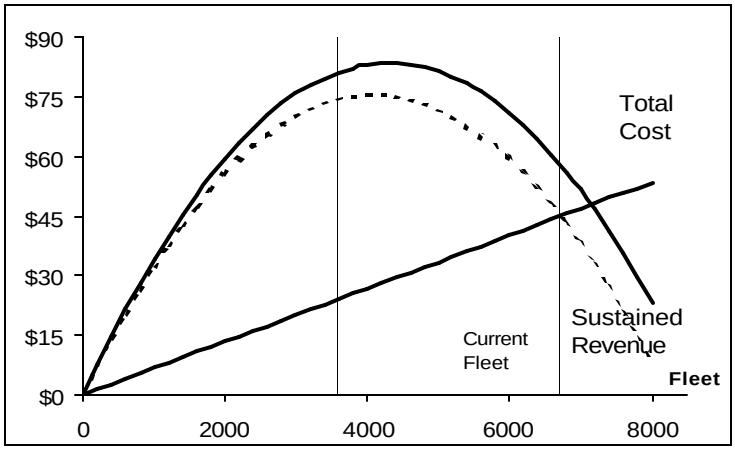


Given the current fleet size, the industry is making a profit. Two policy implications follow. First, since industry profits will likely attract other participants, profits will likely

decrease in the future. Therefore it would be wise to consider policies to restrict increases in fleet size or utilization. Second, it might be wise to consider reducing the fleet size in order to increase the sustainable harvest and net returns. By reducing the fleet to about 3,500 units the net returns could be maximized at about US$57 million.

There are two caveats, however. First, profits will not increase instantly. They will do so only as the fish stock grows and this will take time. Second, the reduction in fleet size will reduce employment opportunities. This is a double-edged sword. It may take time for the released workers to find new employment. But when they do, the increase in shrimp output will be complimented by an increase in production elsewhere in the economy.

Consider another policy question. Should a development project which will reduce the size of the mangrove estuary by 5% be approved? How can the linkages between the project and the fishery be demonstrated. As noted above a decrease in estuary size will shift the sustainable yield curve down. The net effects on harvest and profits are shown in the graph below.



The existing US$13.52 million dollar profit will be almost eliminated because of the decrease in sustainable harvest. In those cases where the fleet has expanded to where total revenue equals total cost, as might be expected, the reduction in the revenue curve will force a fleet reduction and harvest will fall even more.

This information can be useful in considering the approval of the development project. If the annual value of production from development is less than the US$12.94 million reduction in the net value of shrimp output, then the project would not make sense on economic grounds. There would be a net decrease in the value of production in the economy. There would be gains in one area but larger losses in another. If the project results in losses in other parts of the economy, the argument for non-approval is even more compelling.

But if the value of annual production from the project is more than US$12.94 million,

the answer is not quite as clear. Based on the losses in the shrimp fishery along, the project could be approved. But if losses in other areas are expected, the difference between gains to the project and losses to the shrimp fishery will have to be large enough to cover them.

Case Study #9

Brystrom, Olof 2000 **The Replacement Value of Wetlands in Sweden.** Envirionmental and Resource Economics 16:347-362.

Background.

Wetlands have the capacity to reduce non-point source pollution Because of denitrification, sedimentation, and assimilation, nitrogen concentration can be reduced in rivers and streams by maintaining existing wetlands or building new ones. The value of wetlands can be measured by taking into account the cost savings that are possible by using them as part of a pollution reduction program.

Valuation Techniques and Results

This study measured the value of wetlands by comparing two efficient programs to reduce nitrogen emissions in Sweden by 50%, which was the amount mandated by a regional environmental agreement. There are many ways to reduce nitrogen emissions in addition to using wetlands. They include reducing the amounts of organic and inorganic fertilizer. It is also possible to change land use patterns including extended use of winter crops, switching to forestry, using cover crops or letting the land lie fallow. The costs of using them are the net loss in the value of output.

Taking into account the natural levels of nitrogen leakages from various types and locations of land, and the amount of nitrogen retention in rivers and oceanic waters, the analysts used linear programming techniques to find the least expensive combination of methods to achieve the reduction goal. In one study they considered all types, including building new wetland, and in another they considered all methods except using wetlands. The derivation of the equations and obtaining the solution to the programming problem was quite complex, but the results where interesting. The most efficient program which did not use wetlands had a cost of 753 million Swedish Kroner, while the one that used wetlands had a cost of 540 million Swedish Kroner

Policy Implications

The value of the wetlands in Sweden is at least equal to 213 million Swedish Kroner. This of course is an underestimate because it does not consider the other productive services they provide.

Case Study #10

Swallow, Stephen K. 1994 **Renewable and Nonrenewable Resource Theory Applied to Coastal Agriculture, Forest, Wetland, and Fishery Linkages.** Marine Resource Economics 9:291-310.

Background

Pamlico Sound in North Carolina supports a valuable shrimp fishery, which produces 25% of the dockside revenues from all fisheries in the area. The juvenile fish stock annually arrive via on-shore currents. The currents carry the juveniles from off shore breeding grounds and estuarine nurseries. The wetlands surrounding the sound help support the stock by moderating the salinity levels by filtering fresh water runoff. At the same time however, the wetlands can be converted to other productive uses, the most common of which is agriculture or forestry.

The economic/ecological linkages can be stated as follows. First, the returns to the shrimp fishery depend upon the average size of the fish stock. Second, the average size of the fish stock depends upon the salinity in the surrounding water. Third, the salinity depends upon the particular use of the shoreline at various points around the sound.

The basic policy question is: When does it make economic sense to transform wetlands for other uses. An important issue is whether the location of the wetland or the use to which it will be put is a relevant consideration.

Valuation Techniques and Results

In order to answer the question it is necessary to estimate an equation for each of the three relationships stated above and to find out the values that will be generated by the agriculture or forestry production from the transformed wetlands.

Using standard econometric techniques with data on catch, effort, price and cost, in combination with a juvenile stock index, the analyst estimated a profit function for the shrimp fishery. The results showed that for every unit increase in the stock index the annual profits for the fishery would increase by $131,952.

Then using data on catch rates, salinity, and temperature, the analyst was able to estimate an equation that showed how the juvenile stock index varied with salinity. The results showed that if salinity went up by one point, the stock index would go up by .8635. Combining this with the previous result, it follows that if salinity goes up by one point, the annual profits in the fishery would go up by .8638*$131,952 or $113,941.

Then using data on salinity and land use by location, the analyst was able to show how runoff affected salinity. Without going into the complex details, the results showed that forest lands prevented more runoff that did agriculture lands and, as such, did not reduce the salinity as much as agricultural land. Further they found that converted wetlands near the entrance to the sound did not have as much negative effects on salinity as

converted wetland further to the west. This was due to the amount of undiluted seawater near the entrance.

The bottom line is that taking into account the effect that developing each acre will have on overall salinity and then using the relationship between changes in salinity and changes in industry profit, the analyst came up with the following values.

Developing one acre near the entrance for forestry will not affect the profit.
Developing one acre near the entrance for agriculture will reduce profit by $0.28.
Developing one acre in the west for forestry will reduce profit by $1.85
Developing one acre in the west for agriculture will reduce profit by $3.37.

Unfortunately, the analyst was not able to get any information on the returns to development for forestry. He was able to show that the difference between the selling price per acre of developed agricultural land and the development and acquisition costs was $160 for land near the entrance to the sound and $127 for land toward the west. Since the selling price of the developed land is the expected present value of net proceeds of using the land, these values represent the change in the value of output that results from developing the wetlands.

Given a discount rate of 8% the annual benefit of developing the two types of land are $12.80 and $10.16 respectively.

Policy Implications

The policy implications of this study are very interesting because it shows that it is necessary to consider both location of the land that is to be developed and the use to which the land will be put in order to set appropriate policy for wetland development. Ideally it would be useful to compare the total costs and benefits of developing land for the two different purposes in the different areas. Unfortunately, the analyst was only able to estimate the costs inflicted on the shrimp fishery and was not able to estimate any of the benefits from developing the land for forestry. However, some conclusions may be possible.

The table below summarizes the known information.

	Benefits	Costs	Net Gain
Land Near Entrance	Agriculture $10.16	$1.12	Initially $9.04
	Forestry ???	$0	
Western Lands	Agriculture $12.80	$13.48	Negative
	Forestry ???	$6.80	

The known benefits of development are shown in the first column. If the total costs in terms of total fishery use are in proportion to dockside value of harvest, then the actual

costs will be four times those estimated for shrimp and these values are listed in the second column. The initial net benefits are shown in the third column.

Even though the benefits of developing for agriculture are higher in the western area, it does not make sense to develop there because the gains are less than the costs. It does make sense to develop for agriculture near the inlet because there are positive gains. The increase in the annual value of agriculture output is higher than the decrease in value to the fishery. However this does not mean that there should be a blanket approval to develop all of the wetlands near the inlet. As more and more acres are developed, the benefits will likely decrease, due to increased development costs and lower productivity, and the costs will increase, due to the diminished amount of remaining wetlands to prevent runoff. Further work will be necessary to show how the benefits and costs will change with the number of acres developed.

What can be said about the possibility of development for forestry? First, unless the benefits are greater than $6.80 per acre in the west, it will not make sense. Second, even though the cost of development are lower near the entrance, the benefits will have to be higher than $9.04 initially because that is how much can be made by developing for agriculture. Based on this information, if development is to take place in this area, it should be in agriculture.

INFORMATION SYSTEMS

Economic valuation of the environment may be done by primary or secondary analysis. By a 'primary' analysis we mean a study that generates a new data set to analyze a specific policy need. These use the market-based, market-linked, and non-market approaches mentioned above. By a 'secondary' analysis we mean a study that essentially uses the results from other primary analyzes. These are benefits transfers -- the results from primary studies at other locations and from other time periods are said to be 'transferred' to a new site for policy analysis. Sometimes a study will employ primary and secondary analyses together. Primary studies are generally more accurate but also more costly. Time and other resource constraints often require analysts to apply secondary analyses. How can the Caribbean/Latin American region prepare itself for future valuation applications, primary and secondary? What data should be collected now? What type of information system is needed?

For the primary analyses, analysts use a variety of different types of data. Some should be gathered routinely as a matter of policy. These apply largely to data used in market-based studies, but may include market linked studies as well. For example, primary data on all sectors with a marine component such as fishing, mining and mineral sectors (off-shore oil and others if any), transport services and so on should be collected. While the nature of the data varies from sector to sector, the essential needs are output quantities and prices; input quantities and prices; and consistency across the region. Output can take the form of landings of fish or tonnage of specific freight delivery and so forth. Inputs are units of energy consumed, number of people employed, units for capital and equipment (eg., boats). It is important to have these data overtime and again collected in a consistent way over the region. Other obvious data along these lines include visitation rates to beaches and resort areas, land use in coastal areas, property value data, and even rental rates in coastal regions.

For other primary analyses, like the reveal preference and stated preference approaches, advanced routine collection of data is not ideal. It is too expensive and is likely to result in data sets that poorly fit policy needs. By their very nature, these applications are best designed to fit specific policy needs as they arise. Then surveys and other data collection efforts can be tailored to the specific purposes. For example, the Barbados sewerage project was designed in response to specific policy need. The exception here would be resources of significant value and subject to on going policy issues. For example, where beach use is a major industry in an island state, routine collection of data on a random sample of individuals suitable for valuation may make sense. The survey could be tailor for specific needs at different times. Otherwise primary studies are best commissioned on a case by case basis according to the priorities and policy needs of the region.

For secondary analyses it is useful to maintain a database (extended bibliography) of existing studies and how they have been used. In our effort to identify existing studies of economic valuation of the environment in Latin America and the Caribbean, we were struck by how few studies were readily accessible from a convention library/internet/agency search. Published work is easy to identify. Unpublished work

and data sets often sit in an analyst's or policy maker's computer files, their existence unknown to future would-be analysts. No doubt we have missed studies in our search, perhaps many, but our effort highlights that there appears to be little systematic collection of existing studies and data sets in the region.

ANNEX: BASIC ECONOMIC PRINCIPLES RELEVANT TO VALUATION

One of the most fundamental concepts in economics is the notion of a demand curve. A demand curve shows the relationship between amounts of a good purchased (by an individual or a group) at different prices all else equal. See Figure 1. For example at a price of P_1 the amount purchased will be Q_1. However, if for whatever reason, the price falls to P_2, the amount purchased will increase to Q_2. Looked at from the other way around, the demand curves shows how the marginal willingness to pay for (or the value of) a particular good will change as the amount purchased changes, all else equal. When the Q_1 units are consumed the willingness to pay for the last unit is P_1, whereas when Q_2 units are consumed the willingness to pay for the last unit is P_2.

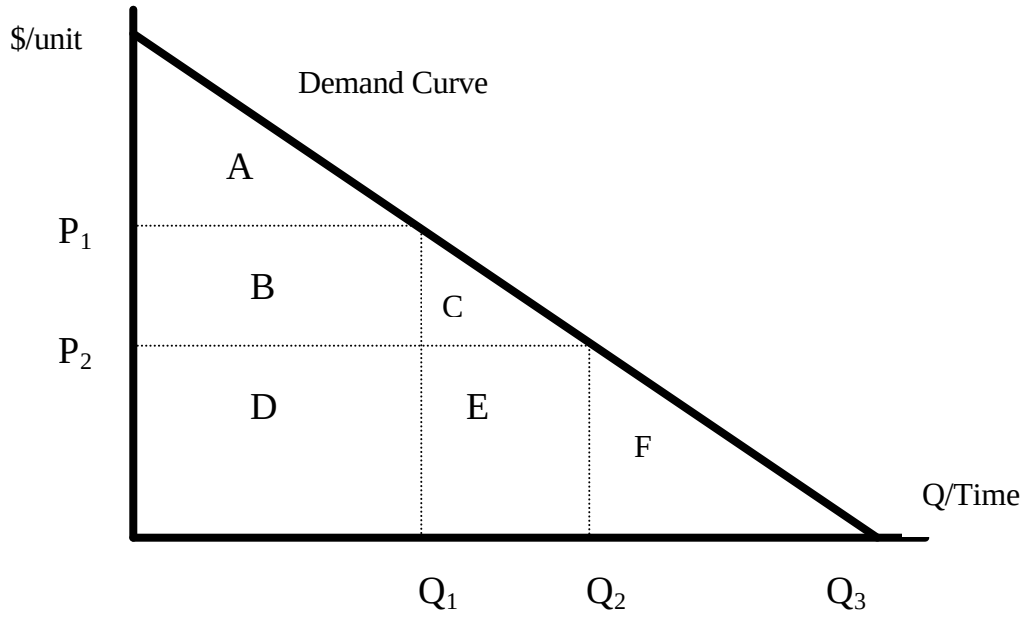


Figure 1

The demand curve is also fundamental to the notion of value and valuation. In modern welfare economics, the value of a good or a service is the amount people are willing to pay for it. If the price is P_1 then consumers will purchase Q_1 units for a total expenditure of P_1 times Q_1. In the diagram, this is represented by areas B+D. However, P_1 is the willingness to pay for last unit consumed. It is the marginal willingness to pay. Intra-marginal units will have a higher value as specified by the demand curve. Therefore, the total willingness to pay for Q_1 units per period of time is equal to areas A+B+D. Area A is known as consumer surplus. It is the amount that consumers would be willing to pay for a certain amount of a good, over and above what they have to pay on the market.

Turning to the question of valuation, the demand curve is a useful tool for answering questions about how to value extra units of a certain good. The important points to consider are how much is currently available and how much is being provided. Assume that the current situation is that there are Q_1 units being provided at a price of P_1. If the amount provided is very small relative the status quo amount, the output can be evaluated at the current marginal willingness to pay of P_1. However, if there is a non-marginal change in output, the change in marginal willingness to pay must be considered. For example, if the extra output were such that total output were to expand to Q_2, then the gross value of $(Q_2 - Q_1)$ units of output would be equal to areas C+E.

While it is relatively easy to think of a demand curve for goods and services bought and sold on the market (like washing machines, hamburgers, and movie tickets), it may be more difficult to think in terms of environmental goods and services that are not readily traded in a market. These are sometimes called non-market goods and services. However, the same concepts apply. Consider a demand curve for recreational fishing trips for a particular species at a particular location. Presumably if individuals had to pay an entrance fee every time they took a fishing trip, the number of trips they took per year would vary inversely with the price. There is no reason to believe that the law of demand would not apply here just as it does with movie admissions. Since individuals do not (for the most part) have to pay a fee, the effective price is zero. Given the demand curve in Figure 1, with a zero price, the number of trips would be Q_3. No money would change hands on the market, but there would still be a consumer surplus equal to the sum of areas A+B+C+D+E+F. The same principles apply for many other services provided by environmental and natural resources such as scuba diving, walking along the beach etc.. The notion of value is not so much a price times quantity as it is with market goods. Rather it is the notion of consumer surplus. How much would participants be willing to pay rather than do without the service?

Prior to the 1970's economists made few attempts at valuing environmental goods. In benefit-cost analyses, for example, economists would value the obvious market goods for a government project and treat any environmental good as an intangible that could not be valued. Its value was left to the good judgment of policy makers.

Then, in the 1970's as the environmental movement took hold and major environmental regulations at the national level were passed, economists began exploring ways to value the environment. The efforts constituted a major research initiative for environmental and resource economists and continues to this day.

Most universities and colleges and environmental protection agencies have economists working on economic valuation of the environment. The US Environmental Protection Agency (EPA), for example, employs over 100 economists working on valuation in some capacity.[2] The National Atmospheric and Oceanic Administration (NOAA), employs

2 Charles Griffiths, an economist with the US EPA, tells us that "The US EPA employs approximately 112 economists. Most of these economists work on economic valuation of environmental goods in some capacity. About one quarter of these economists are in the National Center for Environmental Economics.

approximately a half dozen economist working on valuation of the environment in damage assessment cases.[3]

Economists have developed techniques for estimating the value of environmental goods implicit in housing markets using housing transaction data. The technique is called the *hedonic price method* and it has been used widely to value clean air, proximity to hazardous waste sites, odor, noise, and open space. The hedonic price method is also used in other markets. For example, it is used in labor markets to value the risk of death and injury. It has also been used in the market for farms to value crop damage due to air pollutants and in the market for foods to estimate the implicit value of naturally grown food items.

Economists have developed a technique called the *travel cost method* for valuing recreational uses of the environment using site visitation data. The technique has been used to value many types of recreation. The most common applications are to water based sports such as fishing, boating, swimming, and beach use. It has also been applied to hunting, hiking, and even mountain climbing. The method is quite flexible. For example, it can be used the value the closure of a beach due to an oil spill or closure of lake due to a fish consumption advisory. And, it can be used to value the improvement of water quality at a fishing site or the widening of a beach for beach use. We say it can be used to value either the "access to a site" (closing or opening a site) or to value the "change in characteristics of a site".

They focus on some of the larger theoretical and practical issues of economic valuation. The remainder are dispersed throughout the Agency, primarily in the "program offices" (Office of Air; Office of Water; Office of Solid Waste and Emergency Response; and Office of Prevention, Pesticides, and Toxic Substances). These economists generally focus on specific rules and the practical exercise of applying the economic values to rule making efforts. To do this, they very often rely on the assistance of private consulting groups that hire their own economists. EPA economists work almost exclusively in Washington, D.C.. The regional offices tend to focus more on compliance assistance, enforcement, and information provision, and hire very few economists."

[3] Like the US EPA, NOAA relies on private consults for much of it actual valuation work. Probably the most famous valuation study was the effort to estimate the economic damages associated with the Exxon Valdez oil spill in Alaska. This effort actually had a profound influence on the research agenda for future valuation studies and involves studied funded by NOAA and Exxon.

THE BIBLIOGRAPHIC SEARCH

The bibliographic search for marine-related resource valuation studies in the Latin America/Caribbean region was composed of four strategies. First, a request for citations was placed on the *ResEcon* and the Fishfolk listserves. The message informed listserve members of the project and requested assistance in gathering appropriate studies. Approximately one dozen researchers responded to the listserve request, providing references for about fifteen studies. Many of these took the form of project reports, and, as such, were un-refereed publications that would likely have been missed by other bibliographic search strategies.

Second, searches were conducted on the *Expanded Academic ASAP Plus* and *EconLit* electronic databases. Both economic methods (eg: travel cost, contingent valuation, hedonic, etc) and resource types (eg: shrimp, aquaculture, recreation, mangrove, etc) were used as keywords in the process. This strategy provided the greatest number of relevant references. In addition, several studies conducted outside the Latin America/Caribbean region, but using applicable methods on closely related resources were found with this strategy. These references have been incorporated at the end of the bibliography to provide examples of specific methods when none could be found for studies within the region.

Third, the tables of contents of several leading economic journals were searched to identify any relevant studies that were missed in the electronic database search. The *Journal of Environmental Economics and Management*, *Land Economics*, and *Marine Resource Economics* were the targets of this strategy. Approximately one-half dozen studies were identified in this manner.

Fourth, the reference sections of those papers collected via the first three strategies were scanned for relevant sources. A handful of appropriate studies were collected in this process. While numerous references were available in the papers collected, very few were related to valuation studies conducted in the region.

There were two concerns discussed prior to beginning the bibliographic search. First, it was recognized that a substantial portion of the marine-resource related valuation studies in the region might take the form of unpublished project reports, and thus would be part of the gray literature. It was acknowledged that identifying such sources would prove difficult. The primary purpose of appealing to the listserve members was to uncover these references.

Second, it was discussed that many of the valuation studies in the region may have been published in Spanish or Portuguese journals. Searches in English-language journals or databases would be insufficient to identify such articles. This difficulty was not overcome during the search process.

The citations are listed in alphabetical order by author. Where possible an abstract is included. Further, articles which apply to IADB countries are so marked.

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Barbier, Edward B., and Ivar Strand 1998. "Valuing mangrove-fishery linkages- A case study of Campeche, Mexico". *Env. and Res. Econ.* 12(2):151-66. **[Mexico]**

This paper explores the value of mangrove systems as a breeding and nursery habitat for off-shore fisheries, focusing on mangrove-shrimp production linkages in Campeche State, Mexico. We develop an open access fishery model to account explicitly for the effect of mangrove area on carrying capacity and thus production. From the long-run equilibrium conditions of the model we are able to establish the key parameters determining the comparative static effects of a change in mangrove area on this equilibrium. We then estimate empirically the effects of changes in mangrove area in the Laguna de Terminos on the production and value of shrimp harvests in Campeche over 1980–90. Our findings suggest that mangroves are an important and essential input into the Campeche shrimp fishery, but that the low levels of deforestation between 1980 and 1990 mean that the resulting losses to the shrimp fishery are still comparatively small. Over-exploitation of the fishery due to open access conditions remains the more pervasive threat, and without better management any long-run benefits of protecting mangrove habitat are likely to be dissipated.

Barbier, Edward B. 2000 "Valuing the environment as input: Review of applications to mangrove-fishery linkages". *Ecological Economics* 35(1):47-61. **[Mexico]**

The following paper reviews recent developments in the methodology for valuing the role of wetlands in supporting economic activity. The main focus will be on mangroves serving as a breeding ground and nursery habitat in support of coastal and marine fisheries. As this particular ecological function of mangrove system means that it is effectively an unpriced `environmental' input into fisheries, then it is possible to value this contribution through applying the production function approach. The first half of the paper overviews the procedure for valuing the environment as an input, applied to the case of a wetland supporting a fishery. Both the `static' Ellis–Fisher–Freeman approach and the `dynamic' approach developed by Barbier and Strand, incorporating the intertemporal bioeconomic fishing problem, are reviewed. The second half of the paper discusses briefly two recent case studies of mangrove-fishery valuation. An application in South Thailand, which is based on the static Ellis–Fisher–Freeman model, and an application in Campeche, Mexico, which is based on the dynamic approach.

Barbier, Edward B., Ivar Strand and Suthawan Sathirathai 2002 "Do open acess conditions affect the valuation of an externality? Estimating the welfare effects of mangrove-fishery linkages in Thailand". *Env. and Res. Econ.* 21(4):343-67.

Mangroves are considered ecologically important due to their role as breeding grounds and nursery habitats for off-shore fisheries. However, mangrove deforestation through conversion to shrimp aquaculture threatens this valuable function. This paper develops a `dynamic' production function approach to analyze the influence of habitat changes on an open access fishery that faces a finite elasticity of demand. The basic model is applied to a case study of the impacts of mangrove deforestation on the artisanal marine demersal and shellfish fisheries in Thailand. By

estimating parameters through pooled time-series and cross-sectional data over the 1983–1993 period for the five coastal zones of Southern Thailand, the welfare impacts of mangrove deforestation are estimated under different elasticity of demand assumptions. Under pure open access, the welfare losses estimated for mangrove deforestation in Thailand of 30 km^2 annually ranged from $12,000 to $408,000 depending on the elasticity of demand.

Barbier, Edward. B. 2003 "Habitat-Fishery Linkages and Mangrove Loss in Thailand." *Contemporary Economic Policy* 21(1):59-77.

Barton, David 2002 "The Transferability of Benefit Transfer: Contingent Valuation of Water Quality Improvements in Costa Rica." *Ecological Economics*. 42:147-164 **[Costa Rica]**

Bell, Frederick W. 1997. "The economic valuation of saltwater marsh supporting marine recreational fishing in the Southeastern United States". *Ecological Economics* 21(3):243-54.

This paper is concerned with placing an economic value on the contribution of wetlands in supporting recreational fishing in the southeastern United States. A production function first links the recreational catch to angler fishing effort and wetlands. The parameters of the recreational fisheries production function are estimated using cross-sectional data by states. To simplify the mathematics, the estimated elasticities are substituted into a Cobb-Douglas production function. For simplicity, a linear demand curve for recreational fishing is postulated which shifts when there is an increase or decrease in the catch (success rate). Therefore, incremental changes in wetlands will via the production function provide incremental changes in the catch which will in turn shift the recreational demand curve, thereby increasing or decreasing consumer surplus. Using a discount rate of 8.125%, the perpetual flow of consumer surplus per incremental acre of wetlands has an estimated asset value of $6,471 and $981 on the East and West Coast of Florida respectively in 1984 dollars. If commercial fisheries and other economically useful functions of wetlands are *added* to recreational fisheries, it may be more efficient for the State of Florida to acquire more coastal land for preservation from development.

Bell, Kathleen P. and Ivar E. Strand 2003 "Reconciling models of recreational route and site choices". *Land Econ.* 79(3):440-454.

When employing travel cost models, the unit cost of the essential input (travel) in the household's production of a recreation experience is central to obtaining the preference structure for the recreational good. However, little attention has been given to the choice of the route although the route defines the monetary and time costs used to compute travel costs. Conventional wisdom considers time and money costs in determining the cost per mile in the estimation of site choices but does not use both in determining the route choices and mileages. This paper investigates whether models of recreational site and route choices can be reconciled.

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This paper outlines an approach to natural resource management that incorporates multiple objectives for protected area management within a decision-making framework. Both regulators and other major stakeholders are directly incorporated into the approach to enhance decision-making processes. We call this approach trade-off analysis. The approach uses a framework based on multi-criteria analysis (MCA) but involves stakeholders at all stages. This holistic approach is appropriate for multiple use, complex systems such as marine protected areas (MPAs), where many different users are apparently in conflict and where linkages and feedbacks between different aspects of the ecosystem and economy exist. The paper applies trade-off analysis to the case of Buccoo Reef Marine Park (BRMP) in Tobago. Stakeholder analysis is undertaken, and social, economic and ecological criteria identified. The impacts of four different development scenarios are evaluated for these criteria. Stakeholders are asked to weight different criteria and then the outcomes of different stakeholder weightings in the MCA are used to explore different management options. For BRMP, the MCA suggests consensus around development options characterised as limited tourism development for the area surrounding the park in association with the implementation of complementary environmental management. The approach has been used to enhance stakeholder involvement in decision-making and develop consensus-based approaches to management of the MPA.

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Wetlands, in Sweden and elsewhere, have been suggested as effective and low-cost sinks for agricultural pollution. This paper estimates the value of using wetlands for abatement of agricultural nitrogen load on the Baltic Sea. A replacement value of wetlands is estimated for Sweden. The replacement value is defined and estimated as the difference between two cost-effective reductions of agricultural nitrogen pollution: one that uses wetlands for nitrogen abatement, and one that does not. It is shown that the use of wetlands as nitrogen sinks can reduce the total abatement costs of nitrogen emissions by 30% for Swedish agricultural sources of nitrogen pollution.

Carson, Richard T., Robert C. Mitchell, Michael Hanemann, Raymond J. Kopp, Stanley Presser, and Paul A. Ruud Jul 2003 "Contingent valuation and lost passive use: Damages from the Exxon Valdez oil spill". *Env. and Res. Econ.* 25(3):257-86.

We report on the results of a large-scale contingent valuation (CV) study conducted after the Exxon Valdez oil spill to assess the harm caused by it. Among the issues considered are the design features of the CV survey, its administration to a national sample of U.S. households, estimation of household willingness to pay to prevent another Exxon Valdez type oil spill, and issues related to reliability and validity of the estimates obtained. Events influenced by the study's release are also briefly discussed.

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Dharmaratne, Gerard. 2002. "Economic Value of Belize Barrier Reef: Evidence from Dive Tourism and Commercial Fisheries" UWI Centre for Environment and Development, The University of the West Indies. **[Belize]**

The extent of economic impact/activity associated with BBR is directly dependent on its economic value. It is the economic value of diving/snorkeling and other reef based activities that attract visitors to Belize. The economic value is simply the value of the satisfaction that the visitors get from their experience over and above their expenditure to visit Belize. Therefore, it is clear that the quality or the uniqueness of the experience is the major determinant of its value. The high quality of the diving/snorkeling experience is evident in the assessment of the condition of the reef by the divers as mentioned above. Also, lower the expenditure to come to Belize, higher the value derived for the diving and snorkeling.

Value of a trip to Belize is about US$527 for a visitor from the USA and about US$219 for a visitor from the UK. The reason for lower value for an UK visitor is the higher travel cost. Accordingly, Belize is a popular dive destination for divers from USA. Based on their indication of the importance of diving/snorkeling to undertake the trip, the value of diving/snorkeling is about US$337 and US$149 respectively, for an USA and UK visitor, respectively. Willingness to pay directly for diving differs depending on how the fee is collected. If collected on a per dive basis, diver is willing to pay about US$ 6.45 per dive. On the average they make about 3 dives during a visit. This implies that the willingness to pay is about US$19 on a per dive basis for all dives. However, if they were offered a dive passport for unlimited dives during a trip, they are willing to pay about US$36. This comes to about US$12 per dive. Therefore, willingness to pay for diving on a per dive basis is about 6% and 13% of value of diving for USA and UK visitors. On a dive passport basis, USA divers are willing to pay about 11% of the value of diving and UK visitors are willing to pay about 24%.

If a diving fee is implemented on a per dive basis, US$1.67 million can be collected. If a dive passport system were implemented, this would lead to a direct income of about US$3 million, on a yearly basis with the current visitor numbers. This is an indication of how economic value could be directly transferred to real income. Needless to say any degradation of BBR will lead to a loss

of economic value. For example, divers who ranked water clarity and visibility to be good or excellent are willing to pay $7 more than the divers who ranked water clarity and visibility to be just satisfactory.

Value of Commercial Reef Fishery

Besides a vibrant tourism industry, BBR also supports a highly productive commercial reef fishery. Fishing contributes about 3% to the GDP. In 2000 total exports were about US$36 million. There are 2600 registered fishermen. Total capital investment in the fishery is about US$9 million. The lobster and conch fishery, the two most important, have grown significantly in quantity and value during the past 10 years. Based on 1998 figures the net value of the reef fishery was about US$ 2 million. Lobster fishery in particular appears to generate much higher as compared to the general productivity of the country.

Diaz-de-Leon, AJ and JC Seijo 1992 "A multi-criteria non-linear optimization model for the control and management of a tropical fishery". *Mar. Res. Econ.* 7(1):23-40. **[Mexico]**

One of the principal problems when dealing with fishery resource management is to estimate strategies that satisfy biological, economic, and social objectives simultaneously. As a contribution to solving this problem in the Yucatan Shelf Octopus (Octopus maya) fishery, a multi-criteria non-linear optimization procedure was applied to a dynamic bioeconomic model of the fishery. The procedure copied simultaneously with non linearities and system stochasticity. The min-max optimization, iteratively minimized the difference between the manager's objectives and model output values for the bioeconomic variables in a Pareto-optimal way. Results showed that is was possible to achieve explicit managerial objectives under different scenarios, such as those that simulate the normal 1988 fishing season, the impact of natural phenomena (hurricane Gilbert) and the reaction to such phenomena. Implications fot the results are discussed.

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The demand for Galapagos vacations by ecotourists was estimated using hedonic demand analysis, a technique being developed by environmental economists. In turn, the demand model was used to explore how a fiscal policy of maximizing tax revenues could help to satisfy the alleged incompatible goals of wilderness preservation and economic growth. Constrained to a carrying capacity of 125,000 visitor days, there is potential to raise about $30 million (U.S.) by substantially increasing the entrance fee charged to ecotourists. This tax revenue could be used to finance both conservation of the Galapagos wilderness and investment in Ecuador's economy.

Freeman III, A. Myrick 1995 "The benefits of water quality improvements for marine recreation: A review of the empirical evidence". *Mar. Res. Econ.* 10(4):385-406.

Gillig, Dhazn, Teofilo Ozuna Jr, and Wade L. Griffin 2000 "The value of the Gulf of Mexico recreational red snapper fishery". *Mar. Res. Econ.* 15(2):127-39.

This study estimates the value of recreational red snapper fishing in the Gulf of Mexico. Additionally, the study shows how to decompose the estimated red snapper recreation demand function into changes: (i) due to recreationists who were not taking recreational red snapper fishing trips but were induced to take a trip in response to changes in catch rates and (ii) due to recreationists already taking trips and responding to changes in catch rates. The decomposition allows us to also decompose the estimated elasticities and consumer surplus. The results indicate that an improvement in expected fishing quality will increase consumer surplus and that most of the increase is contributed by recreationists who initially do not take recreational red snapper

fishing trips, but later take a positive number of trips. This finding has important policy implications for managing the red snapper fishery in the Gulf of Mexico.

Greene, Gretchen, Charles B. Moss, and Thomas H. Spreen 1997 "Demand for recreational fishing in Tampa Bay, Florida: A random utility approach". *Mar. Res. Econ.* 12(4):293-305.

An estimation of demand for recreational fishing in Tampa Bay, Florida, can facilitate the environmnetla management of the bay. A nested random utility travel cost model is used to estimate access values. Results suggest that average annual values for the bay alone are $18.14 and $0.048 for participants and nonparticipants, respectively.

Hall, Darwin C., Jane V. Hall, and Steven N. Murray 2002 "Contingent valuation of marine protected areas: Southern California rocky intertidal ecosystems". *Nat. Res. Modeling* 15(3):335-68.

Hanley, Nick, David Bell, and Begona Alvarez-Farzio 2003 "Valuing the benefits of coastal water quality improvement using contingent and real behaviour". *Env. and Res. Econ.* 24(3):273-85.

Recent moves in the European Union have been made towards a toughening of legislation on bathing water quality. This has focussed policy-makers thoughts on the welfare benefits resulting from such improvements, especially given their cost. Our paper uses a combined stated and revealed preference approach to value coastal water quality improvements, focussing on an area of Scotland which has consistently failed to meet standards under the Bathing Waters Directive. We combine data on real behaviour with data on contingent behaviour using a random effects negative binomial panel model. This allows us to predict both the change in participation (trips) should water quality be improved, and the welfare increase per trip. Our model includes allowance for the existence of substitute sites, and for changes in recreational behaviour during a beach visit.

Hannesson, Rognvaldur 2002 "The economics of marine reserves". *Nat. Res. Modeling* 15(3):273-90.

Hayes, Karen M., Timothy J. Tyrrell, and Glen Anderson 1992 "Estimating the benefits of water quality improvements in the Upper Narragansett Bay". *Mar. Res. Econ.* 7(1):75-85.

Holland, Daniel S., and RJ Brazee 1996 "Marine reserves for fisheries management". *Mar.Res.Econ.* 11: 157-71.

Conventional methods of regulating commercial fisheries restrict catch by limiting either the quantity or efficiency of fishing efforts, or by putting direct limits on catch. These regulatory practices are neither feasible nor desirable for many fisheries, and have failed to conserve fishery stocks in other fisheries. Marine reserves may be an effective alternative management strategy for some fisheries. Here we develop a dynamic model of marine reserves applicable to inshore fisheries. In contrast to previous models of reserves, the model is fully dynamic and provides information on both equilibrium conditions and the path to equilibrium. A simulation model based on red snapper data from the Gulf of Mexico is presented. The simulation results suggest that marine reserves can sustain or increase yields for moderate to heavily fished fisheries but will probably not improve yields for lightly fished fisheries.

Holland, Daniel S. Fall 2002. "Integrating marine protect areas into models for fishery assessment and management". *Nat. Res. Modeling* 15(3):369-86.

Huppert, Daniel D. 1989 "Measuring the value of fish to anglers: Application to central California anadromous species". *Mar. Res. Econ.* 6(2):89-107.

This article reports estimates of economic value associated with recreational fishing for anadromous species (Chinook salmon and striped bass) in central California based upon two methods: a simple travel cost model (TCM) and the contingent valuation method (CVM). Alternative model specifications for the TCM yield estimates of ordinary consumer surplus (OCS) per fishing day ranging from $61 to $296. The CVM approach directly yields Hicksian compensating and equivalent surpluses per angler. Average CVM values are (1) $49.2 for willingness to pay (WTP) for a doubling of catch rate (2) $38.2 for WTP to avoid a 50% decrease in catch rate, and (3) $98.2 willingness to accept compensation (WTA) for a 50% drop in catch rate. To compare the TCM and CVM results, we compute Hicksian surpluses from the TCM models based upon the indirect utility function as previously demonstrated by Hanemann (1980. Land Economics 56(4):482-490) and Hausman (1981. American Economic Review 71(4):662-676). Although the resulting TCM-based Hicksian surpluses differ from the CVM values, a t-test for differences between means fails to reject equality of means for the WTP values. The t-test does reject equivalence of CVM and TCM values for WTA. A more rigorous chi-square test of the hypothesis that CVM and TCM observations are drawn from the same underlying population rejects equivalence of the estimates for all three measures of economic surplus.

Ibanz, Anna Maria 2001 Beach Use Values in Cartagena, Colombia. Ph.D. Dissertation University of Maryland **[Colombia]**

James, Alexander, Sam Kanyamibwa, and Michael J. B. Green 2001 "Sustainable financing for protected areas in Sub-Saharan Africa and the Caribbean". In The Politics and Economics of Park Management (Political Economy Forum Series). Rowman and Littlefield: Lanham, MD and Oxford. p69-87.

Janssen, Ron, and Jose E. Padilla Oct 1999 "Preservation or conservation? Valuation and evaluation of a mangrove forest in the Philippines". *Env. and Res. Econ.* 14(3):297-331.

Mangrove ecosystems are rapidly declining in many parts of the world. This has resulted in the loss of important environmental and economic products and services including forest products, flood mitigation and nursery grounds for fish. The aquaculture industry was the single biggest threat to mangroves in the Philippines until 1981 when conversion of the remaining mangrove stands was prohibited by law. However, the decreasing yield from capture fisheries is putting pressure for the re-examination of this policy. To understand the importance of mangroves, insight is needed into the ***value*** of products and services provided is needed. This article compares the costs and benefits of mangrove preservation with those generated by alternative uses such as aquaculture and forestry. Equity and sustainability objectives are taken into account, in addition to economic efficiency and analyzed according to the perspectives of the different types of decision makers involved.

Kahn, J. R. 1987 "Measuring the economic damages associated with terrestrial pollution of marine ecosystems. *Marine Resource Economics* 4(3):193-209.

Kahn, J. R. and W. M. Kemp 1985 "Economic losses associated with the degradation of an ecosystem: the case of submerged aquatic vegetation in Chesapeake Bay". *Journal of Environmental Economics and Management* 12(3):246-263.

Kaplowitz, MD (2001 "Uncovering economic benefits of Chivita (Melongena melongena Linnaeus, 1758 & Melongena corona bispinosa Philippi, 1844)". *J. of Shellfish Research* 20(1):295-299. **[Mexico]**

Kaplowitz, MD and J Hoehn Feb 2001 "Do focus groups and personal interviews reveal the same information for natural resource valuation?". *Ecological Economics* 36:237-247. **[Mexico]**

Kaplowitz, MD Aug 2001 "Assessing mangrove products and services at the local level: The use of focus groups and individual interviews" *Landscape and Urban Planning* 56(1-2):53-60. **[Mexico]**

Lynne, Gary D., Patricia Conroy, and Frederick J. Prochaska (June 1981). "Economic valuation of marsh areas for marine production processes". *J. of Env. Econ. and Mgmt* 8(2):175-86.

Loomis, John B. and Douglas Larson 1992 "Total economic values of increasing gray whale populations: Results from a contingent valuation survey of visitors and households". *Mar. Res. Econ.* 9(3):275-86.

Lutz, Ernst, Stefano Pagiola, and Carlos Reiche 1998. "The costs and benefits of soil conservation in Central America and the Caribbean." In Agriculture and the Environment: Perspectives on Sustainable Rural Development". With assistance from Hans P. Binswanger, Peter Hazell, and Alexander McCalla. World Bank: Washington, D.C. p215-29.

Mathieu, Laurence F., Ian H. Langford, and Wendy Kenyon 2003 "Valuing marine parks in a developing country: A case study of the Seychelles". *Env. and Dev. Econ.* 8(2):373-90.

McConnell, Kenneth E. (1979). "Values of marine recreational fishing: Measurement and impact of measurement". *American J. of Ag. Econ.* 61(5):921-25.

McConnell, K.E. and J.H. Ducci 1989 "Valuing environmental quality in developing countries: Two case studies". Prepared for AERE Session on Contingent Valuation Surveys in Developing Countries. AEA Meetings, Atlanta, Georgia, December 29, 1989.

This paper reports on studies in two countries in Latin America using the referendum form of contingent valuation methods to measure the value of improvements in water quality. These studies were originally designed to evaluate projects, not to do research on contingent valuation. This paper is concerned with the kinds of problems that arise in doing contingent valuation on environmental problems in developing countries, and not with specific research issues of contingent valuation, and in the Whittington et al. (1989) paper.

Niklitschek, Mario, and Javier León 1996 "Intended Demand and Yes/No Responses in the Estimation of Contingent Valuation Models". *J. of Env. Econ. and* Mgmt 31:3 p. 387-402.

The contingent valuation method (CVM) has limitations arising from the lack of a direct link between estimated willingness to pay and consumer behavior regarding the use of the good being evaluated. To estimate the total value of a resource under a capacity constraint, information on intended use is introduced as an integral part of the CVM. This combined approach allows use and non-use values to be distinguished for a sample of users and non-users. The econometric specification is applied to estimate the benefits of reducing water pollution on beaches located near an important metropolitan area of South America.

Parks, RJ, and M Bonifaz 1994 "Nonsustainable use of renewable resources: Mangrove deforestation and mariculture in Ecuador". *Mar. Res. Econ.* 9(1):1-18. **[Ecuador]**

The paper provides a conceptual model that examines (i) open-access exploitation and (ii) mangrove deforestation as two potential causes for the scarcity of post-larval shrimp inputs to shrimp mariculture in Ecuador. Results indicate that conversion of mangrove ecosystems to shrimp ponds may have obtained short-term profit at the expense of long-term productivity. Open-access collection of post-larval shrimp may also have contributed to dwindling stock levels. Specific policy recommendations are presented and future empirical studies are proposed.

Parsons, George R., D. Matthew Massey, and Ted Tomasi 1999 "Familiar and favorite sites in a random utility model of beach recreation". *Mar. Res. Econ.* 14(4):299-315.

Pezzey, John C.V., Callum M. Roberts, and Bjorn T. Urdal (Apr 2000). "A simple bioeconomic model of a marine reserve". *Ecological Economics* 33(1):77-91.

We model the effect of a no-take reserve in a marine fishery management area, such as on a coral reef. Implicitly, eggs and larvae are mobile but adults are not; and there is open access fishing outside the reserve. A reserve is found to increase equilibrium catch if the prior ratio of stock to carrying capacity is less than a half, and the catch-maximising reserve proportion rises towards a half as this ratio falls towards zero. After initial adjustment, long-run stability is improved by a reserve. We estimate that coral reef reserves could increase world wide annual catches by about a billion dollars.

Ramdial, DS 1975 "The social and economic importance of Caroni Swamp, Trinidad". Ph.D. Dissertation. University of Michigan. (**[Trinidad]**

Ronnback, Patrick 1999. "The ecological basis for economic value of seafood production supported by mangrove ecosystems". *Ecological Economics* 29(2):235-252.

The undervaluation of natural products and ecological services generated by mangrove ecosystems is a major driving force behind the conversion of this system into alternative uses. This trend of undervaluation is partly due to the difficulty involved in placing a monetary value on all relevant factors, but lack of ecological knowledge and a holistic approach among those performing the evaluation may be even more important determinants. This article identifies and synthesizes ecological and biophysical links of mangroves that sustain capture fisheries and aquaculture production. Fish, crustacean and mollusc species associated with mangroves are presented and the ecology of their direct use of this system is reviewed. Through a coastal seascape perspective, biophysical interactions among mangroves, seagrass beds and coral reefs are illustrated. The life-

support functions of mangrove ecosystems also set the framework for sustainable aquaculture in these environments. Estimates of the annual market value of capture fisheries supported by mangroves ranges from US$750 to 16750 per hectare, which illustrates the potential support value of mangroves. The value of mangroves in seafood production would further increase by additional research on subsistence fisheries, biophysical support to other ecosystems, and the mechanisms which sustain aquaculture production.

Rosenthal, Donald H., Marshall B. Rose, and Lawrence J. Slaski 1988 "Economic value of the oil and gas resources on the outer continental shelf". *Mar. Res. Econ.* 5(3):171-89.

Samples, Karl C. and Richard C. Bishop 1985 "Estimating the value of variations in anglers' success rate: An application of the Multiple-site travel cost method". *Mar. Res. Econ.* 2(1):55-74.

An estimation method is presented to measure sport fishermen's valuation of exogenous changes in fishing quality (catch rates). A theoretical model is initially presented to show how variations in prevailing catch rates influence an angler's valuation of recreational fishing. A two-stage estimation approach is ssuggested that capitalizes on the notion that angler consumer surplus is sensitive to changes in success rates. The procedure entails first estimating sport fishing values at qualitatively different fishing sites using a multiple-site travel cost approach. Afterward, the sensitivity of estimated values to different success rate levels is measured using a separate regression procedure. An empirical application of this two-stage regression method to Lake Michigan sportfishing is given. It is estimated that for Lake Michigan anglers who fish for trout and salmon, a 10% increase in success rates will increase average trip values by $US 0.30.

Seroa da Motta, Ronaldo, Richard M. Ruitenbeek, and H. Jack 1999 "Market based instruments for environmental policymaking in Latin America and the Caribbean: Lessons learned from eleven countries". *Environment and Development Economics* 4(2):177-201.

Shultz, Steve Dec 1997 "Non-market valuation of natural and environmental resources in Central American and the Caribbean". *CEPAL Review* 0(63):65-76.

Shyamsundar, Priya, and Randall A. Kramer 1996 "Tropical Forest Protection: An Empirical Analysis of the Costs Borne by Local People". *J. of Env. Econ. and Mgmt* 31(2):129-144.

Contingent valuation is used to value tropical forest resources for a rural population in Africa. Welfare losses from land-use restrictions associated with a newly established national park in Madagascar are estimated with a willingness-to-accept format. Because of a limited local cash economy, the contingent valuation question is denominated in baskets of rice. The analysis indicates that contingent valuation can be successfully applied to rural households within the developing country context. The econometric analysis undertaken reveals a systematic association between various socioeconomic variables of interest and the expressed willingness-to-accept compensation for foregone land use.

Smith, V. Kerry, Xiaolong Zhang, and Raymond B. Palmquist 1997 "Marine debris, beach quality and non-market values". *Env. and Res. Economics* 10(3):223-47.

This paper reports the first attempt to measure the importance of controlling marine debris as an aesthetic characteristic of beaches and coastal area. The results are based on a contingent valuation survey designed to estimate the economic value people would place on controlling marine debris on recreational beaches in New Jersey and North Carolina. A Weibull survival model was estimated treating for and against votes as defining censoring points for an unknown willingness to pay distribution. The findings suggest: (1) people do distinguish situations with differing amounts of debris when they are described using color photographs; (2) the pilot survey implies measures of people's willingness to pay (WTP) for debris control are consistent with a scope test in that larger WTP is associated with programs intended to address situations for more serious background levels of debris; and (3) local beach conditions seem to influence how people interpreted the plans describing beach conditions without the proposed control programs.

Smith, Martin D., and James E. Wilen 2003 "Economic impacts of marine reserves: the importance of spatial behavior". *J. of Env. Econ. and Mgmt* 46(2):183-206.

Marine biologists have shown virtually unqualified support for managing fisheries with marine reserves, signifying a new resource management paradigm that recognizes the importance of spatial processes in exploited systems. Most modeling of reserves employs simplifying assumptions about the behavior of fishermen in response to spatial closures. We show that a realistic depiction of fishermen behavior dramatically alters the conclusions about reserves. We develop, estimate, and calibrate an integrated bioeconomic model of the sea urchin fishery in northern California and use it to simulate reserve policies. Our behavioral model shows how economic incentives determine both participation and location choices of fishermen. We compare simulations with behavioral response to biological modeling that presumes that effort is spatially uniform and unresponsive to economic incentives. We demonstrate that optimistic conclusions about reserves may be an artifact of simplifying assumptions that ignore economic behavior.

Spash, Cline L. 2002 "Informing and forming preferences in environmental valuation: Coral reef biodiversity". *J. of Economic Psychology* 23(5):665-87.

Swallow, Stephen K. 1994 "Renewable and Nonrenewable resource theory applied to coastal agriculture, forest, wetland, and fishery linkages". *Mar. Res. Econ.* 9(4):291-310.

This paper addresses tradeoffs in wetland development using a framework that integrates econoic theory of renewable and nonrenewable resources. The theory treats wetland development as use of a nonrenewable resource, while wetland preservation protects critical fishery habitat. The framework recognizes that wetland quality may vary for either development or fisheries. An illustrative application assesses tradeoffs in converting pocosin wetlands to agriculture rather than maintaining wetlands to protect salinity in estuarine nursery areas. Reults reveal the marginal value of salinity protection may be substantial, while location may affect a wetland's value to an estuarine shrimp fishery. Comparisons between agricultural and forestry land-uses show that ecological links may cause wetland values to depend upon the land-use chosen for the developed state. Future assessments of other development may reveal additional impacts through impacts on salinity.

Swallow, Stephen K. and Michael McGonagle (28 Oct 1996). "Residents' preferences for design of Barbados' west coast sewerage project". Working Paper. **[Barbados]**

Tai, Shzee Yew, Kusairi Mohd Noh, and Nik Mustapha Raja Abdullah 2000 "Valuing fisheries depreciation in natural resource accounting: The pelagic fisheries in Northeast Peninsular Malaysia". *Env. and Res. Econ.* 15(3):227-241.

In this paper, an approach based on the net present value method is used to account for the changes in the value of fisheries resources. Changes in the value of fisheries resources can occur between successive years' catch as well as between current and optimal levels of catch. These changes need to be accounted for in the national accounting system to reflect the `true' net national income that is sustainable. The approach outlined in this paper is desirable as it allows the estimation of the depreciation value of fisheries resource with limited biological information. The application of the approach to the pelagic fisheries in Northeast Peninsular Malaysia (NEPM) showed that the resource depreciated in value over most years from 1982 to 1993. These depreciations correspond to increased fishing effort. In addition, pelagic catches in NEPM from 1982 to 1993 were lower than the optimal levels of catch due to overfishing. Thus policies aimed at reducing fishing effort can provide improvement in both the potentially higher capital values of the fishery resource and the earning potentials of the fishing industry in NEPM.

Taylor, J. Edward, George Dyer, Micki Stewart, and Antonio Yúnez-Naude 2002 "Economic Study of the Bay Islands Final Report". IADB Working Paper. **[Honduras]**

Our modeling and analysis have three major objectives. The first is to provide a comprehensive diagnostic of how the Bay Islands economy works, including income linkages among production sectors, households, government, and outside markets. The second is to create economic instruments that can be used to facilitate the design of alternative environmental management projects and identify financing mechanisms. The third is to explore and quantify likely economic and fiscal impacts of changes in key economic activities, especially those related to the islands' unique marine ecosystems.

This Report presents findings from the Bay Islands economic surveys, model estimation, policy experiments, and identification of sustainable financing mechanisms for the environmental body and marine protected area. It is organized as follows. Part I presents an overview of the Bay Islands economic and socio-demographic landscape, drawing from our survey data and existing information sources. Part II describes the island economywide modeling framework, based on a Roatan Island Social Accounting Matrix (SAM). Parts III and IV describe the survey instruments and sample design, respectively. Findings on the structure of the Roatan Island economy, policy experiments quantifying likely economy-wide impacts of environmental decline and changes in key industries, and our analysis of factors explaining migration and population growth are presented in Part V. Part VI identifies and analyzes mechanisms to finance environmental programs, particularly a visitor tax, and it explores the likely island economywide impacts of environmental management programs. Part VII summarizes key conclusions.

Taylor, Timothy G. and Brian Francis 2003 "Agricultural export diversification in Latin America and the Caribbean". *J. of Ag. and Applied Econ.* 35(Supplement):77-87.

Teisl, Mario F., Brian Roe and Robert L. Hicks 2002 "Can Eco-Labels Tune a Market? Evidence from Dolphin-Safe Labeling". *J. of Env. Econ. and Mgmt* 43(3):339-359.

In this paper we test whether the dolphin-safe labels altered consumer purchases of tuna. We also provide a partial measure of the total welfare effects of the dolphin-safe labeling policy. The results confirm our hypothesis that the dolphin–tuna controversy and the subsequent implementation of dolphin-safe labeling affected consumer behavior. Further, the paper provides market-based evidence that consumers can respond to eco-labels; the dolphin-safe label increased the market share of canned tuna. The welfare analysis provides a partial measure of society's willingness to pay to avoid personally contributing to dolphin mortality as a result of tuna fishing.

Thomas, Michael, and Nicholas Stratis 2002 "Compensation variation for recreational policy: A random utility approach to boating in Florida". *Mar. Res. Econ.* 17(1):23-33.

A nested logit random utility travel cost model is developed for recreational boating is southwest Florida. Using data from a survey of recreational boaters, the model estimates site choice probabilities and compensating variation for changes in boating speed limits. Behavior is modeled as a two-step, discrete-choice process, where boaters first select a launch point for their trailered boats, then select a boating destination based on site characteristics. The results of this particular model are currently being used in policy applications in Florida.

Thur, Steve 2003 "Valuing Recreational Benefits in Coral Reef Marine Protected Parks: An Application to the Bonaire National Marine Park." Ph. D. Dissertation University of Delaware.

Weninger, Quinn and James R. Waters 2003 "Economic benefits of management reform in the northern Gulf of Mexico reef fish fishery". *J. of Env. Econ. and* Mgmt 46:2. p.183-206.

Controlled access management in the northern Gulf of Mexico commercial reef fish fishery has not achieved key management objectives. We estimate the economic benefits of replacing controlled access with tradable harvest permits. Results suggest that eliminating market gluts caused by periodic seasonal closures could have raised revenues by $3.206m in 1993, the year of our data. Eliminating per-trip catch limits and seasonal closures could have reduced harvest costs by $8.078m. The total 1993 potential benefits, at $11.284m, suggest property rights-based management is an attractive alternative for the northern Gulf reef fish fishery.

Wielgus, J, NE Chadwick-Furman, N Zeitouni, and M Schechter 2003 "Effects of coral reef attribute damage on recreational welfare". *Mar. Res. Econ.* 18:225-37.

This paper presents the results of an economic valuation of coral reef degradation at Eilat, Israeli Red Sea. We estimate the marginal prices of coral and fish diversity and water visibility at US$2.60 and US$1.20 per dive, respectively. From the standpoint of recreational diving welfare, the annual social costs of activities contributing to coral reef degradation are approximately US$2.86 million. To our knowledge, this is the first economic valuation of individual coral reef attributes and the first application of a choice experiment to coral reef valuation.

Whitehead, John C., William B. Clifford, and Thomas J. Hoban 2001 "Willingness to pay for a saltwater recreational fishing license: A comparison of angler groups". *Mar. Res. Econ.* 16(3):177-94.

Whittington, D, J Briscoe and X Mu (1990). "Estimating the willingness to pay for water services in developing countries: A case study of contingent valuation surveys in southern Haiti". *Economic Development and Cultural Change*. January 1990 issue. **[Haiti]**