Policy White Paper

on

Socioeconomic Study of Reefs in

Southeast Florida

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INTRODUCTION

In October 2001, Hazen and Sawyer, Inc. of Hollywood, Florida issued a report entitled Socioeconomic Study of Reefs in Southeast Florida sponsored by Broward, Palm Beach, Miami-Dade, and Monroe Counties, Florida; the Florida Fish and Wildlife Commission, and the National Oceanic and Atmospheric Administration (NOAA). Hazen and Sawyer did the visitor economic analyses, but contracted to Florida State University to survey the resident population of reef users in the counties under study. In part, the use of Florida State University was dictated by their expertise in an earlier study of artificial reefs in Northwest Florida (1998) plus the availability of their Survey Research Center. Dr. Grace M. Johns was the project manager and an economist, while Dr. Frederick W. Bell from Florida State University and Dr.Vernon R. (Bob) Leeworthy of NOAA served as associate economists on the project. Finally, Dr. Mark A. Bonn headed the resident survey project at the university.

The purpose of this study was to quantify the economic significance of both the artificial and natural reefs off the coast of four Southeastern Florida Counties. The decision to fund such a study was prompted by a magnitude of problems impacting the reef system off the coasts. For example, natural reefs were being damaged by both freighters running a ground in Monroe County, while historical beach renourishment had silted many reefs to a point where they ceased to function as they had for centuries. With the growing population in this area, pollution or lower water quality has also threatened the natural reefs. In addition, the use of natural reefs became intense, thereby increasing the demand for artificial reefs to supply needed recreational opportunities for diving, snorkeling, and fishing. For ease of exposition, we shall refer to this economics study of reefs as the H/S Report from this point on.

Except for an earlier study by Bell, Leeworthy and Bonn (1998) in Northwest Florida and a study of use value of new artificial reefs off Miami-Dade by Milon (1988), no economic studies have been done to give policy makers an idea of the economic consequences of increasing problems with the artificial and natural reef resources off the coast of four counties mentioned above. The initial intent of the first study cited above was to establish a baseline on the economic status of the reef system. Much as a fishery resource is studied for the size of the biomass or the age structure of the population to establish a "supply baseline", *natural resources should also be studied to establish a "demand baseline"*. When these two efforts are put together, it is possible to address policy issues such as proper fishery management or settlement of inadvertent damages to valuable natural resources, which has been a continuing issue in the Florida Keys of Monroe County.

The supply and demand baselines involved biologists on one side and economists on the other with the users of the natural resource or general public often confused over the implications of the "baseline findings" when policy issues emerged in one's own backyard. For example, a recent finding by the U.S. Army Corps of Engineers (USACE)

that the renourishment or augmentation of present saltwater beaches off Broward County would provide $8 in "economic benefits" for each $1 in "economic cost" prompted those using reefs to point out that such renourishment may impair the functioning of parts of the natural reef system due to silt from dredging operations associated with the planned expansion of the beach resource. Many environmentalists rushed to the H/S Report to demonstrate that reefs also provide economic value not directly considered by the USACE. Even though the H/S Report was written in relatively simplified terms, the lay reader found it difficult to bring the reef baseline data to bear on the policy issue at hand.

In England, many technical reports are produced in the social and natural sciences, but are not easily comprehended by the lay person seeking an answer to a particular question. To solve this problem, the English have developed the concept of a White Paper, which integrates many disciplines in an attempt to bring to bear all the theories, data, and conclusions relating to a single (multiple) policy issue(s). These White Papers are written with black ink on white paper and are widely read by those interested in a particular policy issue. Although embracing material on the "cutting edge" of many disciplines, the purpose of the White Paper is to inform the taxpayer on what is known by the government in solving major and minor pubic issues. In this report, we shall follow this White Paper model. To a degree, this is an experiment to bring the H/S Report to bear on dealing with various policy issues, which were never addressed in the H/S baseline report. Quite simply, this is a user's guide to how one can bring the baseline information to bear on current policy issues. In doing this, we shall also look at government budget support for developing and maintaining data, which can be used in baseline studies such as the H/S Report.

This White Paper effort is, of course, limited in scope since it is an experiment to further communication between government research and policy issues. We shall look at various policy issues and ask whether the H/S Report, with a little bit of tweaking, could be used to shed light on problems with the reef system. We approach the formulation of the White Paper by first surveying, on a face-to-face basis, government officials on their reaction to the H/S Report. The purpose here was to see how non-economists reacted to concepts in the report and it's usefulness for policy issues. It is true that many of these same officials "signed off" on the final report, but it is not quite clear as to how it was received, what it was currently being used for, and what policy issues with which these officials are presently dealing.

The survey took place in June 2002, approximately 8 months after delivery of the report. Second, from the interviews and other inquiries, we formulated a list of policy issues for which the H/S Report might be used and how, in simple language, a public official could combine data from this report and possibly other reports to arrive at an insight into the policy issue in question. Third, it was quite apparent that respondents to our survey were having some problems with concepts in economics, which were apparently not thoroughly explained in the H/S Report. For example, the concept of "use value" was questioned by public official as to its importance in looking at the demand for a natural reef. The White Paper will attempt to shed light on this critical concept so that the user can employ this concept and quantitative estimates in guiding policy issues.

Fourth, it is often said that a report is too old or applies to another area. In addition, the H/S Report is for the visitor year 2000-2001 (June 2000 – May 2001). In five or ten years, one may need an update. In effect, this is a forecast of activity and economic value of the reef system in the future. Or, one may ask the usefulness, if any, of the results to other areas than those studied. We shall give the users some idea of simple tools and data forecasts that are readily available and can be used to forecast "future" baselines in the study. Lastly, we shall give our conclusions and recommendations to the reader and those involved in producing the report as to how to be more effective in the future in developing a baseline economics report.

Before we discuss the essence of the White Paper, we shall briefly summarize the H/S Report for the reader unfamiliar with this study. We urge everyone involved in the administration of regulations and policies involving artificial and natural reefs to review the Executive Summary of the H/S Report at a minimum and the entire report if possible. Hopefully, this White Paper will stimulate greater interest in the parent report. The H/S Report may be obtained from the website http://marineeconomics.noaa.gov.

A SUMMARY OF THE H/S REPORT

The main thrust of the H/S Report was to identify the nature of demand for both artificial and natural reefs in each of four counties in Southeast Florida. These counties are Palm Beach, Broward, Miami-Dade, and Monroe, the latter of which contains the Florida Keys National Marine Sanctuary. The demand by users of artificial and natural reefs evidences itself in what economist call the economic impact created by spending associated with getting to, staying, and returning from the location of the reef resource. This is the overt market spending that shows up in hotel and restaurant revenues and has the further effect of creating jobs and wages and profits (income) in the economic sectors serving reef users consisting of both local residents and visitors to an area. The H/S Report was able to identify the following economic activity directly associated with artificial and natural reefs off the coast of the four counties under study for the year 2001:

Table 1. Direct Impact of Expenditures by Residents and Visitors
(Excludes Multiplier Impacts)

County	Expenditures/Sales (Millions $)	Employment (Full and Part-time)
Palm Beach	379.2	4,792
Broward	1,289.2	25,443
Miami-Dade	847.8	13,103
Monroe	466.0	9,984

Source: Johns et al (2001), Table 2.3.2-3 and Table 2.3.2-9.

For example, in Broward County, it was estimated that residents and visitors to that County spent nearly $1.3 billion on reef-related services and commodities, which in turn created 25,443 jobs in that county. This is known as the direct economic impact since it does not include multiplier effects produced by visitors. When multiplier impacts of visitors is included, the total impacts are over $2 billion in sales/output and over $1 billion in income, which supports 35,473 full and part-time jobs.

The spending on reef-related products and services is dependent on the supply of both artificial and natural reefs. This "supply" could be measured not only in terms of acres of reefs, but the quality of the reef system. The quantity and quality of the reef system is the providence of biologists and other scientists, but it is fair to say that environmental deterioration such as diminished water quality or damage/destruction of parts of the reef system is what economist call a "leading economic indicator". As Leeworthy and Bowker (1997) have pointed out, monitoring the state of the resource is critical since a deterioration in a resource usually precedes or "leads" a decline or diminished growth in users of a resource, which eventually shows up in market variables such as sales and employment shown above.

A mystery concept to those first encountering it and even to some economists is what is called "use value". Although quite real, it does not show up in traditional market statistics such as sales, income, and employment. It does not show up in GDP or gross domestic product so familiar to those following the stock market. The reason is that many resources are "used" by consumers and quite simply not paid for. Fish in the ocean, air around the planet, and natural reefs off our shores are "used" by everyone, but no direct charges are made for their use, since they are in a class of resource designated by the term "common property". Decades ago, land in the Western part of the U.S. was claimed by the government, but owned by no private individuals. In the oceans within 200 miles of the U.S., fish are claimed by the U.S., but except for a few shellfish licenses are owned by no private individual.

Assume that some benefactor supplied Disney Land outside Orlando, Florida under the conditions that no admission charges could be made and that the government should pick up any expenses (e.g., wages of Disney employees) out of general taxes. All our State, County, and National Parks were run on this basis until an economist named Hotelling estimated the use value of natural resources that are common property. Earlier in our history, users did not pay for the use of these resources. But, resources such as natural reefs, with great biodiversity, obviously provide "use value" to the user. Even more simply, use value is the willingness of users to pay or value to them from natural resources, which suffer from ill-defined (i.e., common property) property rights. It is a problem ranging from the atmosphere around us to the deepest of ocean resources. In terms of animal life, this problem ranges from eagles to manatees.

In the H/S Report, the researchers conducted experiments with users to determine their willingness to pay for the use of artificial and natural reefs, which have ill-defined property rights. In the fisheries, property rights have been shifting from common property to private property as aquaculture has emerged. In the four county area, it was estimated

from users' responses to willingness to pay questions that they, after paying for all expenses to get to a reef (i.e., economic impact discussed above), users would be willing to pay an additional $9.05 per person day for the "right" to fish, dive, and snorkel on any kind of reef. Put differently, if the author "owned" or had the private property right over all the reefs off Southeast Florida, I could charge each person about $9.05 per day. You might call this an "admission fee", while economist call it use value.

In the four county area, it was estimated that nearly 28 million person-visits were made per year, amounting to a collection of nearly $256 million per year if a private market in "reef use" emerged. As long as the reef existed, this gross revenue would flow for years and perhaps increase as users are willing to pay more as their income increase, but the reef resource remains fixed. As we would do with a private business, the discounted value of a flow of income over time would be an estimate of the value of the business on the open market. We can do the same thing with a reef system and derive the value of the "business" or in our case the reef resource. If this is done, the asset value of the reef resource is worth a little over $8.5 billion ($256 Million/.03) in the four counties off Southeast Florida. If a hurricane chopped 10% off the reef system, then the public would lose about $850 million. If an oil tanker or ship carrying a caustic substance did the same thing, then we know the lost asset value upon which to base a lawsuit. Use value is used every day by the USACE in adding beaches and thereby creating natural resources or suing for damages to fish and wildlife in the case of oil spills. The concept of "use value" is widely used in resource economics, but not well understood by those entrusted with maintaining the supply of so many common property resources. This was one purpose of the H/S Report. As we did for the economic impact discussed above, we can summarize the use value estimates for the four counties under study:

Table 2. Use Value for Southeast Florida Reefs

County	Use Value Per Person-day (All Reefs $)	Number of Person-Days on Reefs (Millions)	Total Annual Use Value (Millions $)	Asset Value (Billions $)
Palm Beach	$7.34	4.24	$31.3	$1.0
Broward	$13.35	9.44	$126.0	$4.2
Miami-Dade	$5.12	9.17	$46.9	$1.6
Monroe	$9.48	5.46	$51.8	$1.7
Total	$9.05	28.31	$256.0	$8.5

Source: Johns et al (2001), Table ES-5. Monroe County estimates revised.

The above results can be found in Table ES-5 in the Executive Summary of the H/S Report. The results in the full Table ES-5 require further explanation. Table ES-5 presents results for "All Reefs-Artificial and Natural" (that presented above), "Artificial reefs Only", and "Natural Reefs Only". The addition of artificial only and natural reefs only is not equal to the value of "All Reefs-Artificial and Natural". The reason for this is that reef users were first asked to value each type of reef separately, then asked to value them together.

When people were asked to value artificial reefs only, they were presented with a program designed to protect and maintain the current artificial reefs and were given a randomly assigned dollar amount and asked if they were willing to pay the amount for this program. Respondents were also reminded that if the artificial reefs were not protected and maintained, they could still use the natural reefs in the area, the artificial and natural reefs in other areas, or could spend their money on something else. In other words, respondents were given a choice just like they would face if there were a market for selling the right to use the artificial reefs.

The same procedure was used for natural reefs only, then the programs were combined into one program protecting both the artificial and natural reefs. The price was doubled for the combined programs. So if the artificial and natural reef protection programs were both offered for $10 each, the combined programs were offered for $20.

Many reef users were willing to pay the amounts offered for the artificial and natural reefs when offered separately. Many also were willing to pay for the combined programs when the offered price was doubled, but even though some were willing to pay for both programs, when offered separately, they were not willing to pay the doubled price offered. Therefore, the combined programs were of less value than the sum of the two programs separately.

This completes our review of the core economic concepts from the H/S Report. Now we turn to a discussion of the survey of those public officials that received the H/S Report and how effective this report has been accomplishing its objective of aiding in formulating public policy since its publication in November 2001.

A SURVEY OF USERS OF THE REEF REPORT

State and Local Government Officials: People Contacted

A formal survey instrument was designed for a face- to- face interview of those government employees and officials that directly deal with artificial and natural reefs as part of their job. The author interviewed a total of eight individuals. The survey instrument is in Appendix A of this report, while the list of government officials is contained in Appendix B for the reader. Finally, Appendix C contains a concise tabulation of the responses obtained by those surveyed, which will be discussed below.

There was one official from each county and two individuals at the state level representing research and monitoring of natural and artificial reefs, respectively. Finally, two individuals were interviewed from the Florida Keys National Marine Sanctuary (FKNMS). The purpose was to obtain an impression of the effectiveness of the H/S Report from those recognizing the need from such a report. The typical respondent has a high degree of responsibility in recommending natural and artificial reef policy to both heads of departments and elected officials in their particular area. Such individuals said that they supervised staff, served as point-of-contact on natural and artificial reef issues for their agency and the public, as well as supervising staff conducting reef-related activities conducted in-house. These people had extensive training in the natural sciences ranging from marine biology to oceanography. Although trained in the "natural sciences", many respondents said they found themselves increasingly dealing with socioeconomic matters. In Broward and Monroe Counties, respondent felt that at least 50% of their time involved dealing with socioeconomic matters, but such matters fluctuated with the ebb and flow of public projects, damage to resources, and pressure from environmental groups to adopt various policies. All persons contacted had heard of the H/S Report and read at a minimum the Executive Summary and the chapter corresponding to their particular county. But, what has this group been doing with the report?

Expectations, Use and Dissemination of the H/S Report

None of the above respondents were professional economist or had specialized training skills in this discipline; therefore, all but one had no idea of the magnitude of the economic impact or the use value of the reef resource in the region. Also, representatives from three of the four counties never heard of "use value" before the advent of this report. For example, it came as a complete surprise that slightly less than 26,000 jobs in Broward County were directly tied to products (e.g., gas and oil) and services (e.g., dive boat operators) consumed by resident and visitor reef users. When multiplier effects were considered, through injection of money into the local economy by visitors, the total jobs attributable to the reef resource swelled considerably (See pages 2-61 to 2-64 of the H/S Report for details). Thus, the magnitude of the economic impact of the reefs system was much greater than expected. Only the persons in Monroe County and those associated with the FKNMS were not surprised by the large magnitude of employment created by the existence of reef resources. According to them, this was directly attributable to the economic analysis of English et al (1996) and Leeworthy and Wiley (1996, 1997) of NOAA done earlier on Monroe County. But how would these results be used?

The respondents were asked whether the economic impact in the H/S Report would be used for new budget requests, almost all of those surveyed felt that the economic impact numbers would be used to ask for more money to (1) build more artificial reefs; (2) enhance natural reefs by one time projects; (3) cover recurring expenses such a salaries, supplies and overhead; (4) encourage more State and Federal support through grants, etc. Apparently, this would be the primary use of the H/S Report; however, such

data in the report would also be used in specific policy issues as revealed by other questions in the survey.

Finally, we asked the respondents what key variables elected officials might look at from the H/S Report in coming to decisions regarding reef funding. Opinions were split. Palm Beach, Broward, and Monroe felt that economic considerations, such as sales and employment and even use value would contribute to budget formulations, whereas the representative from Miami-Dade felt that non-economic criteria such as just the popularity in general of reef use would govern budget making.

To disseminate the H/S Report, all counties issued press releases to local media except Monroe County, which thought this would be a duplication of the earlier work by English et al (1996) and Leeworthy and Wiley (1996, 1997). Almost all of the relevant elected/appointed government officials were briefed on the results of this study, since they appropriated the money for its funding. However, the FKNMS did put out a press release on the H/S Report. Although dealing with natural reefs, the Florida Marine Research Institute, which falls under the Florida Fish and Wildlife Conservation Commission, did not issue a press release since they felt that the information would be better disseminated by the counties studied.

To communicate with the public and specific user groups, the counties put out an attractive one-page report in color summarizing the economic results for each of the four counties. These are Exhibits 1-4 in this report. As the reader can see, the counties agreed that the number of person-days spent on artificial and natural reefs was important, since this demonstrated the popularity of fishing, diving, and snorkeling on this resource. In addition, the economic impact of visitor and resident spending was included on the "one-pager" including the indirect or multiplier effect of visitors. Thus, the numbers in Exhibits 1-4 for sales and employment are higher than the direct effects presented earlier in the last section. Finally, the sometimes-illusive concept of "use value" was presented by the counties in their one page summary describing this concept as the willingness of reef users to pay for the use of reef resource. This was an attempt to give the causal reader some idea of the recreational value generated by the reef resource. The numbers for Monroe County that appear on the fact sheet (Exhibit 4) have been revised slightly, since the original H/S Report. Estimates of use for residents were revised upwards by about ten percent. This then impacted the original estimates for spending, income, employment, and total user value.

Some Specific Policy Issues Addressed by the H/S Report

There were several policy issues known to us at the time the H/S Report was being prepared. Others evolved during the preparation of the White Paper. For example, the issue of "No-Take Zones" had been addressed in the FKNMS and now was under consideration in the other three counties. Having the opportunity to query reef users about a variety of things, we asked them about their support or lack thereof of such zones. Well over one-half of resident reef users supported "No-Take Zones" in Palm Beach, Broward, and Miami-Dade Counties as a tool in fishery management and preservation. All

respondents to our management agency survey also supported the implementation of "No-Take Zones" similar to those instituted in the FKNMS in 1997. Another important policy issue was the potential damage to natural reefs during the process of beach renourishment. This is a contentious issue in Broward County and promises to be one in the future for other counties. Except for the Broward County representative, all respondents felt that the H/S Report might make a valuable contribution to shedding some light on this important issue.

Respondents were asked whether there were other economic studies on reefs that were needed. Most respondents agreed that there was needed economic research in the following areas: (l) "No-Take Zones; (2) deployment of artificial reefs; (2) reef damage assessment; (3) global climate changes and (4) water quality. The last issue was particularly important in the FKNMS, where the effects of man (i.e., pollution) is degrading many natural resources, such as the natural reefs.

We also obtained some idea of the budget or sums of money allocated for maintenance, research, enforcement, and deployment and preservation of artificial and natural reefs for the last fiscal year. At the State of Florida level, we obtained the average annual transfer of money to the counties to support construction, monitoring, planning, and researching artificial reefs over the 1995-2001 period for the four counties under study. On the natural reef side, we obtained expenditures involving the same categories, which applied to the natural reef program for the latest fiscal year. Expenditures on natural reefs are subject to great year-to-year fluctuations as those for artificial reefs.

We obtained data on recurring and non-recurring expenditures from the counties and the FKNMS, which are related to the reef program. Many of these expenditures were direct transfers and are supported in part by overhead at the county level. Thus, we added 50% for overhead. It was estimated that the annual budget for natural and artificial reefs averaged $2.754 million per county or about $11.014 million per year to enhance, enforce, research, and plan for the artificial and natural reefs off the four-county coast. The average is heavily skewed to Monroe County and it natural reefs, since its economy and natural resources are tied in with the FKNMS. For example, Monroe County gets little for artificial reefs, but quite a bit from other sources (e.g., FMRI) to protect its natural reefs. Detailed estimates on a county-by-county basis are included in Appendix C. The main policy issue addressed here is the cost of reef preservation versus the recreational benefits to the public. To test the versatility of the H/S Report, we have added several policy issues in the latter part of this report to serve as a sort of "user's guide" to the report.

Finally, the respondents reported that there are 398 functioning artificial reefs in the four county area. Natural reefs are usually not counted by discrete units, but possibly acres or some other measure of area. We shall address this issue later in the report. We asked for criticisms of the H/S Report by the respondents. They pointed to the difficulty in reading by non-economist and that the Executive Summary was difficult to read. Also, the section on use value and the various combinations of questions regarding use value made an already difficult concept more difficult to comprehend. As the respondents did

for the each county, they felt that the most prominent results could have been displayed in 1-3 pages and no more. In effect, the purpose of this White Paper is to better explain the H/S Report. Unfortunately, the issues with which we are dealing demand a somewhat lengthy White Paper.

Others Contacted

Because of many developing issues surrounding the reefs, it was not possible to ignore individuals involved in environmental concerns. This was especially true of a project proposed by Broward County to renourish their beach resource. In the process of adding beach, the dredging might destroy many hard bottom communities near shore. The public's knowledge of the H/S Report drew the attention of "Cry of the Water" and other environmental groups to ask how this report could be used to demonstrate not only beach versus reef recreation, but how the report could be used in damage assessment. This will be one of the policy topics discussed below.

POLICY ISSUES AND THE USE OF THE REEF REPORT

Use in Benefit-Cost Analysis

From beach renourishment to oil spills, government is required by Federal law to engage in a benefit-cost analysis to either justify a proposed project, collect damages, or justify a program. As will be discussed below, the USACE must demonstrate that the economic benefits exceed the cost in order to renourish a beach. With respect to the recreational use of an artificial or natural reef, any increase in the quantitative and/or qualitative use of that resource with public money should be measured by "use value" with respect to economic benefits. This is why the H/S Report contained estimates of the use value of reefs.

Why must use value be the measure of economic value created rather than the economic impact of the resource? This is the crux of this policy issue, which leads to misunderstanding. Quite simply, if expenditures of public money <u>increase</u> the supply of artificial reefs, for example, then this additional resource will be available to public at usually no charge. Tax money does, of course, fund not only the deployment of the artificial reefs, but annual cost such as enforcement. Many natural resources such as natural reefs are inherited (or taken) as nations develop. In both cases, these reef resources provide recreational activities that are not measured directly by the organized market. Thus, taxes in most cases are an investment in a resource so it will yield recreational value. The user or recreationalist receives this "use value" since they directly use the resource without direct payment for its use. Since the price to use an artificial reef is not published in the newspaper, as is the price of ground beef, we do not have use value conveniently available to those proposing government programs, for example, to increase the supply of such natural resources. Economists have developed, however, techniques of approximating the use value derived by recreationalists. The nature of these

techniques was explained in the H/S Report and the H/S Technical Appendix (2003). In essence, it is use value that is the measure of the value to the recreationalist of a resource such as natural and artificial reefs. A destruction of these resources would be evaluated**,** as we shall see below, in terms of the loss in use value. Efforts should be made to add use value to GDP or gross domestic product, since use value among a variety of natural resources should be included in our overall estimate of value of domestic production. This effort is generally referred to as "Green Accounting".

But why are sales, income, and employment not measures of output for a natural resource such as artificial and natural reefs? Such measures are well understood and tend to be those data, which are pointed to in terms of the economic impact on an area such as a state or county. There are really two forceful answers. First, sales of hotel and motel rooms, steak dinners, or even dive boats to a reef resource are just for those items and not for the use of the reef. Second, it is true that reefs attract dollars to a community such as Monroe County. There is no doubt that Monroe County benefits because of its natural reefs compared to no such reefs off the coast of Northwest Florida. But, if the natural reefs were eliminated tomorrow, then the recreationalist may choose the beaches of Panama City and his or her dollar in spending is merely diverted from one area to another. Although simplified, spending is really not increased or decreased, but reallocated based upon the regional distribution of recreational sites. This is why sales, income, and employment are measures of the economic impact on a region of natural resources, but not the value paid for the use of these reef resources. Therefore, any change in expenditures by government or measure taken to effect the supply of reefs must be measured by the change in use value. As Leeworthy and Bowker (1997) have pointed out, there is a relationship between use value and the variables characterizing the economic impact (e.g., sales, income and employment). If resources are allowed to deteriorate, such as through a decline in water quality, then users will be less attracted to the area containing these resources. Use value will decline first and then will be followed by a decline in economic activity. That is why use value per recreationalist is called a "leading economic indicator" in that it most often precedes the decline in the variables associated with the economic vitality of a region.

Benefit-cost analysis is the tool by which we evaluate policy issues related to the reef resource itself. It asks the question as to how use value will be impacted by a change in government policy and activities, as well, of the private sector. Good examples of this are beach renourishments, or ship groundings, which destroy natural reefs. Use value as benefits and government expenditures as costs usually forms the following ratio:

$$\frac{\text{Economic Benefits}}{\text{Government Spending}} = \frac{\text{Use Value}}{\text{Economic Costs}}$$

A value greater than one for the benefit-cost ratio means simply that the net economic benefits (i.e., Economic Benefits less Government Spending) are positive and there will be an increase in national output. The government calls this the NED or the national economic development. This means that the project or activity will contribute to a rising GDP. If negative, the opposite may be true and such activities should be avoided.

Finally, the benefits from many government projects may flow over many years so one may have a stream of economic benefits over time. To put all the flow of benefits on the same basis (i.e., current dollars), future benefits must be discounted back to the present using a discount rate. Costs are usually heavier in earlier periods, as the project is undertaken, then lower in future periods, which usually entail maintenance costs. The discounting of the flow of future costs must also be discounted back to present dollars using the discount rate.

The purpose of this section was to outline how the material in the H/S Report can be used for benefit-cost analysis. Now we turn to some specific policy issues to illustrate some practical use of the baseline economic values on reefs provided by the H/S Report.

Damage Assessment Using the Reef Report

The Damage Assessment Center of NOAA usually takes the lead in evaluating the damage done to reefs. For example, this office assessed the economic damage resulting from the physical/biological injury to the Looe Key reef ecosystem caused by the *R/V Columbus Iselin* grounding in the Florida Keys in 1994. It was estimated that complete recovery would take 30 years, but partial recovery occurring each year was incorporated into the calculations. The baseline number of person-days to this reef was estimated at 15,764 in 1994 and the use value per person-day was $387. The use value per person-day or user day was estimated by Leeworthy (1991) for John Pennekamp Coral Reef State Park[1]. The economists multiplied the use value per person-day by the number of person-days to derive the flow of use value without the damage. In the H/S Report, use value for natural reefs in Monroe County was estimated at $14.82 per person-day. This estimate is far short of the $387 estimated by Leeworthy (1991), which is expressed in 1989 dollars and would be even higher in 2001 dollars. One explanation for the difference in values is that the estimates for John Pennekamp Coral Reef State Park are for some of the 'best reefs" in the entire Florida Keys, while the H/S Report numbers represent an average value for all reefs in the entire Florida Keys. The second explanation is that the John Pennekamp estimates were based on travel cost models, which provide values of the entire trip. All the value of the trip was assigned to the coral reefs. It is likely that a good portion of the value of the trip is associated with other natural resources (e.g. sea grass beds, beaches, etc.).

There is one important advantage that the report on the *R/V Columbus Iselin* had over the possible use of the H/S Report had it been available in the 1990's. When the damaged area can be matched up with user to that area and their use value is available, when such users go fishing, diving, and snorkeling on that reef, the damage estimates become, in theory, more reliable. However, the H/S Report merely gives the use value for the entire natural reef system off a particular county. In this case, one must hope that any damage to a particular area matches up or is close to the average use value per person-day for the entire area. It is possible, of course, to calculate use value for various reef systems or a smaller area than approached in the H/S Report, but this was well beyond the time and monetary constraints of this study. For a more intensive discussion of this case, see Meade (1996).

NOAA did build in a recovery factor for the reef system. It was assumed that the reef would recover gradually reaching nearly 100% of its previous "productivity" in 30 years. As discussed in the previous section, the flow of money (i.e., losses) over time makes it necessary to introduce a discount rate. NOAA used a real interest rate of 3%. In present dollars (1994), the damage inflicted by the grounding to the reef was estimated at $747,389. NOAA felt that the 30-year recovery period was a conservative assumption after restoration of the broken reef structure and replanting with live coral. See Hudson (1995). In damage cases, NOAA would also ask for the reef construction costs, monitoring over at least 30 years, and other incidental costs (including the cost of the damage assessment).

In the *M/V Miss Beholden* grounding, NOAA used what is called the HEA method or habitat equivalency analysis as a substitute for use value arguing that the later term only considers recreational value and that reef resources provide other ecological functions that must be measured. This is certainly true, and use value, as the sole element of loss, is very conservative. HEA represents one of the few methodologies that can be used to quantify resource losses when the site uses are primarily ecological/biological, and the direct human use for recreation is small or difficult to determine. More specifically, HEA determines the quantity of equivalent habitat necessary to be restored and/ or created beyond the restoration of the injured resources to baseline, such that the total services provided by the compensatory habitat over its life span equals the total services lost due to the natural resource damage.

In the H/S Report, it was found that the number of person-days spent on natural reefs per year ranged from a low of 1.9 million in Palm Beach County to 2.9 million in Miami-Dade County. If we assume relatively uniform use per acre of the natural reef system, then we can estimate reef activity and consequently total annual use value flowing from this segment of the resource. Of course, the larger the chunk of the resource is of the total reef system, the greater the probability that this simplifying assumption will be correct. The assumption of the HEA approach is that the primary category of lost on-site services pertains to the biological functions of the area and that recreational losses are small.

It is of interest to compare the use of the H/S Report in terms of outcome to the HEA techniques to see how divergent damage estimates can be. Using the HEA technique damage estimates for the *M/V Miss Beholden* grounding were about $1.7 million excluding monitoring costs. Using the outer reefs in Monroe County, there is an estimated 57.49 million dollars in use value created annually for about 52,456 acres or $1,096 per acre. The reader should notice that we have expressed use value in Monroe County on a per acre basis. This is one of the alternatives when little is known as to the use value and number of visitor days per site. It was reported that about 643 square meters of natural reef was destroyed or just about .16 acres. Thus, the annual loss was but $175 with an asset value of about $5,845. The HEA yielded damages expressed in restoration cost of $1.67 million. Thus, the reader must use caution in using each of the two approaches, since they yield very divergent values. This caveat will extend to the

policy issues expressed below. For a more extensive discussion of this case, see Julius (1993).

Resource Conflicts: Beach versus Reefs

In an attempt to enhance or expand valuable natural resources, such efforts conflict with other resources. The USACE and Broward County are proposing a beach renourishment project that may provide three economic benefits. First, by expanding the beach area it is argued that storm damage will be reduced. Second, loss of land to the sea will be avoided. Third, beach recreational areas will be expanded and those additional beach users will obtain use value of which we have been discussing throughout this report. The latter is the same concept estimated for reef users in the H/S Report. Unfortunately, the renourishment of the beach on the shores of Broward County threatens to destroy the natural reefs near the shore. The dredge and fill operation will produce silt, which will cover hard bottom communities off shore. The added effects of localized, short-term turbidity and sedimentation upon stony corals adjacent to borrow sites may cumulatively impact a number of stony corals, which already exhibit signs of disease or bioerosion, resulting in decreased reproduction and increased mortality.

Depending on the source, it is estimated that from 13.6 acres (USACE, 2002) to 40 acres (Reefguardian, 2002) of reef area will be destroyed off Broward County, thereby reducing the magnitude of the recreational use value estimated in the H/S Report. The USACE recognizes that some reefs will be lost in the process of augmenting the beach resource and proposes a mitigation program by adding boulders in non-reef areas to offset the anticipated destruction of reefs by their project. Even though estimates vary as to the extent of the damage, there seems to be no clear statement or finding as to when the mitigation will become fully effective, if ever. As with the *R/V Columbus Iselin* case of damage assessment discussed above, the recovery function was basically unknown and 30 years was selected with partial restoration building each year. Hudson (1995) has estimated that pre-incident baseline coral recovery will be 60 to 100 years. Thus, the crux of this cases is to be found in the assumption by the USACE that mitigation will be completely effective in offsetting the admitted damage to the reef system no matter what the estimate is of the damaged area. Of course, mitigation cost will be less if the damaged areas are at the low end of estimates and this is what the USACE is assuming. In contrast to the *R/V Columbus Iselin* case discussed above, the USACE is not going to clean or rebuild the damaged reefs, but rely on the effectiveness of mitigation. Using the USACE data, mitigation cost will run about 14% of total project cost over a 50-year period. The USACE has had a mixed track record with wetland mitigation as a tool and there is some question as to how effective natural reef mitigation may be. If mitigation is not very effective or not effective at all, then the reef resource will be permanently damaged. Although a different resource, the USACE's record on wetland mitigation has met with at best mix reviews from the National Academy of Sciences (2001).

To illustrate the potential applicability of the H/S Report to the beach/reef conflict, we looked at various scenarios, which could alter the benefit-cost ratio for the beach project under consideration in Broward County. In the proposed project, construction would take

two years, with Segment II beginning in August of 2002 and Segment III beginning approximately 12 months later. Since the proposed project is still under review, these dates will obviously be moved into the future. To simply our analysis, we shall combine the two phases of the project (i.e., Segments 1I and III) into one project. They may be combined as follows:

	Segment II	Segment III	Total Project
Annualized Benefits	$34.7 Million	$26 Million	$60.7 Million
Annualized Cost	$ 4.2 Million	$ 3.2 Million	$ 7.4 Million
Benefit/Cost Ratio	8.26:1	8.13:1	8.2:1

About $22 million (36%) of the total annualized economic benefits are a direct result of the increase in the use value derived by beach users according to the USACE's calculation. All annualized benefits and cost above are based upon a 50-year time horizon. According to the DEIS (2002) there will be a loss of 13.6 acres of hard bottom reefs off Broward County as a direct result of the total project. The USACE and Broward County recommend that mitigation be used to offset this loss. We have discussed some of the problems with mitigation above. This would be accomplished by using limestone boulders as compensation for nearshore resource losses. A two-year time frame in which 6.1 acres of mitigation boulder reefs will be deployed in the first year with 7.5 acres in the second year. This is called a 1:1 mitigation, since the mitigation boulders deployed will be placed on a "nearby" 13.6 acres to offset the loss due to, in part, the expansion of the beach. Thus, we have a resource conflict between beaches (in part) and existing reef systems used, in part, for recreation. Both have use value as discussed above.

Beach advocates will take sides against those engaged in reef diving, each arguing for expansion of her resource at the potential expense of the other. For Broward County, the H/S report indicates that the use value per person day of a natural reef resource is $15.16 (Table 2.3.3-1, page 2-67). The USACE estimates that a person-day at the beach has a use value of $3.91. This is a starting point for the discussion since both camps are employing the proper measure of the value of these two resources – use value of which we have been discussing at length above.

There will no doubt be readers on both sides of this issue, so what we should do in this White Paper is to give the proper economic framework in which to insert various assumptions. Many of these assumptions are based upon biology and oceanography so it would not be proper for an economics report to jump into these disciplines. We would argue that it is proper for the writer to use the H/S Report, if possible, to arrive at the economic outcome of using various assumptions**.** It would appear that there are three assumptions in dispute as follows: (1) mitigation as proposed by the USACE will be a complete success with no loss of recreational value; (2) mitigation as proposed by the USACE will take quite some time (i.e., recovery period is lengthy such as 20 years); (3) the level of mitigation (i.e., ratio of acres replaced by limestone rocks to acres of hard

bottom destroyed by beach renourishment) to achieve complete compensation will vary from 1:1 assumed by the USACE to something much higher. That is, the USACE would argue that their mitigation would offset any reef losses in terms of biological/ecological function at approximately the start of project. We shall call these the three Scenarios, which shall be examined as follows:

Scenario 1: Mitigation Will Be Successful at the Beginning of the Project;
Scenario 2: Mitigation Will Be Successful in 20 Years With Two Recovery Factors;
Scenario 3: Mitigation Will Not Be Successful, but the Ratio Must be 10:1

Scenario 1 is currently the baseline scenario proposed by the USACE. The cost of nearshore hard bottom mitigation is $300,000 per acre according to the USACE and there will be 13.6 acres destroyed by the beach renourishment amounting to a total cost of $4,080,000 not including, to the author's knowledge, monitoring, contingency, and other costs. The replacement of 13.6 acres with limestone boulders will result in no recreational losses according to the USACE. To annualize this total cost of mitigation at a 1:1 ratio, we must multiply by a capital recovery factor of .064554 to arrive at $263,380. The reader is referred to Appendix D, which discusses discounting, present value, and annualizing present value. We put this in the White Paper for those needing a primer on finance, but is not necessary to read. All we are doing is looking at the annual benefits and cost of this beach renourishment project so total cost over a period of time (e.g., 50 years) of doing the project must be annualized. It is instructive to note that the annualized cost shown above for the total project is $7.4 million according to the USACE including the cost of mitigation. Thus, mitigation in Scenario 1 would be about 3.6% of annual cost ($263,380/ $7.4 Million).

In Scenario 2, it is assumed that the mitigation cost the same, but requires time to be completely effective taking up to 20 or even more years. During this period, there will be damage to reef users that are not included in the costs presented in the present proposal by the USACE. To address this issue, we can use the H/S Report as we did in the damage assessment case discussed above.

As with some of the damage assessment cases discussed above, we do not know how many reef users visit the reef site, which will be destroyed as a result of the beach renourishment discussed in Scenario 2 above. We only know that Broward County reef users spend about 5.47 million days on natural reefs off the entire county (See page 2-67). These natural reefs generated $83.6 million in total user value or $15.16 per person-day. The flow of use value to a resource could be placed on a different basis, which is to express the flow on a per acre of natural reef basis. Personal communication with Fletcher (2002) revealed that there are 6, 205 acres of hard bottom corresponding to reef areas, with a use value generated per year of $13,376 per acre ($83.6 million divided by 6,205). The H/S Report does not tell us how use value per person-day may vary with distance from shore, size of boat, or other variables that might enable us to adjust upward or downward the value of $13,376 per acre. If the reader feels that the 13.6 acres of destroyed hard bottom has a greater or lesser value, then this can be introduced into the simple model discussed below. Since there is recreational damage and thereby cost

added to the project, the loss or cost of the project in the first year will increase by an estimated $181,914 (13.6 times $13,376) and continue as long as mitigation has no positive impact. This leads us to Scenario 2.

Within Scenario 2, let us assume two extremes and call them "A" and "B". The first or "A" assumes there are no significantly positive impacts from mitigation for 20 years and in the 21st year mitigation is completely effective. This exact projected chain of events is probably unrealistic, but does show a long lag between mitigation and positive results. If this happens, the 50-year project will experience annualized recreational losses of $133,338.

Next, let us deal with Scenario 2 B and give mitigation some effectiveness over the first 20 years of the project by assuming a "5% recovery function" where the level of mitigation effectiveness increases by 5% per year reaching 100% (i.e., no further recreational losses since mitigation has replaced the natural functions of the hard bottom communities) in 20 years. In this case, recreational reef use value losses will be reduced to an annualized figure of $76,201.

Lastly, Scenario 3 assumes that mitigation of 10:1, but this money is ill spent because mitigation is never effective. This is kind of a worst case scenario where reef users impose 10 acres of mitigation by the USACE, but mitigation replaces none of the hard bottom communities in terms of the ecological functions needed to provide use value to the reef users. Thus, the annualized mitigation cost increases by 10 fold (i.e., 10 times $263,380 to $2.634 million) and annualized recreational losses of $181,914. The science behind replacing hard bottom communities with boulders of any kind is not highly developed and the outcome is subject to considerable debate between engineers and biologists. In Scenario 3, costs of the project are escalated by increased recreational losses coupled with higher mitigation cost. We can now summarize the impact of our three Scenarios on the project of beach renourishment proposed by the USACE for Broward County, Florida as follows:

Benefits/Cost=Benefits/ (Construction Cost + Added Mitigation + Recreational Losses)

Scenario 1: Baseline: Mitigation at 1:1 and No Recreational Reef Damages

8.2 = $60.7 Million/ ($7.4 Million + 0 + 0)

Scenario 2A: Mitigation at 1:1 and Recreational Losses Per Year Same for 20 Years

8.06 =$60.7 Million/($7.4 Million + 0 + $.134 Million)

Scenarios 2B: Mitigation at 1:1 and Recreational Losses Fall As Reefs Recover

8.12 =$60.7 Million/($7.4 Million + 0 + $.076 Million)

Scenario 3: Mitigation at 10:1 and Recreational Losses for 50 Years

5.94 =$60.7 Million/($7.4 Million + $2.634 Million + $.182 Million)

In Scenario 1, the mitigation of 13.6 acres of covered hard bottom is completely effective in mitigating any recreational losses to those using artificial reefs in any area off Broward County. This is the one proposed by the USACE in their GDM and DEIS (2002). Scenario 2A assumes that the USACE spends the same on mitigation as in Scenario 1, but there is a significant lag of 20 years before mitigation is in any way effective resulting in an annualized recreational loss to reef users of about $134,000. Note that the benefit-cost ratio falls from the baseline of 8.2 to 8.06 with the introduction of recreational damages or only 2%. As assumed in many reef damage studies discussed above, Scenario 2B projects the same mitigation cost by the USACE, but there is a annual recovery of the reef system adversely impacted by the beach renourishment by 5% per year and culminating in complete effectiveness in 20 years. Note that the earlier effectiveness of the mitigation decreases the benefit-cost ratio from 8.2 to 8.12 or only 1%. Finally, if the USACE were pushed by reef users to a much higher mitigation ratio of 10:1 and this failed to replace the natural functions of the reef system, then the benefit/cost ratio would fall from 8.2 to 5.94 or about 28%. Although the benefit-cost ratio would drop 28% from Scenario 1 supported by the USACE, the ratio would greatly exceed unity. Thus, the project would be justified on economic grounds. It would appear that a number of factors are at work in this debate with the added cost of mitigation (i.e., a higher mitigation ratio of 1:1) and the potential recreational losses to reef users not yet considered by the USACE.

The estimated economic benefits are enormous compared to construction and other costs. The area of impact of 13.6 acres out of 2,045 acres (i.e., inner reef area) is less than 1% (Fletcher, personal correspondence, 2002). The reef use value per acre of a little less than $13.4 thousand per year yields a relatively small loss to reef users.

All of this may be quite confusing to the lay reader so we have added Appendix E to the White Paper to give a better idea of the impact of a rising mitigation ratio and recreational losses separately and then combined. For simplicity, we have assumed that 13.6 acres of mitigation will be the starting point or what the USACE calls the baseline benefit-cost scenario. Thus, the benefit-cost ratio for one-to-one mitigation will be 8.2 without any recreational losses.

If there is an increase in mitigation cost from 1:1, then what will be the impact of this variable alone on the benefit-cost ratio? In Appendix E, we see that as we go from 1:1 under mitigation to 20:1, the benefit-cost ratio falls to 4.79. Of interest, the reader may pick any mitigation ratio and compute the associated benefit-cost ratio. For example, say that environmental groups negotiate with the USACE for a 2.5:1 mitigation ratio. Then, the reader can go to Appendix E and multiply 2.5 times the annualized mitigation cost of $263,380 to obtain $658,450 less $263,380, which is already in the $7.4 million of

project cost, to arrive at $395,070 additional project cost. Thus, the new benefit/cost ratio not shown in Appendix E is derived as follows:

{$60.7 million/ ($7.4 million+$.395070)}=7.79.

As expected, the new benefit-cost ratio falls between a 2:1 and 3:1 mitigation ratio. The next column in Appendix E shows the impact of only environmental damage or reef destruction of 13.6 acres on the benefit-cost ratio. We have assumed for convenience of the reader that the baseline benefit-cost ratio includes losses to reef users for these acres declining at 5% per year for twenty years. The baseline benefit-cost ratio does include the 1:1 assumption about mitigation, which allows the recreational damages to decline gradually over time.

From Appendix E, the benefit-cost ratio falls from 8.12 to 6.81 as we increase the damages on the same scale or "multiple" as we increased mitigation. That is, assume that environmentalists would ague that the estimate of use value loss per acre to reef users is underestimated at $13,376 per year because the 13.6 acres are prime hard bottom appreciated much more by reef users than the overall average of the reef system. This was discussed above. The real value should be at least three times the H/S Report estimate. The reader can go to Appendix E and look at 3:1 under cost from recreational loss and see that the benefit-cost ratio would be 7.96 as a result of this adjustment with a mitigation ratio of 1:1. The reader may find that the decline in the benefit-cost ratio is very gradual as recreational losses increase from 1:1 to 20:1 primarily because the annualized cost of recreational losses at 1:1 was only $76,213 to begin with.

As with mitigation, the reader can use his own ratio for recreational losses by multiplying by how much greater the losses might be (i.e., a multiple) by $76,213 and add this to baseline cost ($7.4+$.076213=$7.476 million). Let us argue that recreational reef use losses are four times the original annualized estimate of $76,213. This would add $.2287 million to baseline cost or $7.7046 million. The new benefit-cost ratio at 4:1 for recreational cost alone would be 7.88 as shown in Appendix E.

Finally, what if the mitigation ratio and recreational value both went up together as shown in the bottom of Appendix E. This impact would drop the benefit-cost ratio from 8.12 to 4.28 assuming that mitigation and recreational values both increase from 1:1 to as much as 20:1. The reader may calculate any combination of mitigation and recreational losses using the annualized value for each and adding this to the annualized baseline cost of the project. The annualized benefits of $60.7 as the numerator of the benefit/cost ratio will always be the same.

Since we are dealing with the interaction of reef and beach resources, we would be remiss if we did not mention the potential harmful effect of beach alteration to the endangered green turtle. The green turtle is not "used" as a beach or reef, but nevertheless has value to the community. This is expressed by environmental groups and national and state legislation to protect or preserve the green turtle. As with beaches and reefs, there is no organized market in which green turtle preservation is bought and sold. There may a

bit of use value associated with the green turtle by observing them on a beach; however, the probability is as low as observing a key deer on the streets of Key West. So, how do economist handle this problem?

There are two other "values" which have been accepted by both the economics profession and the court system. These are "option" and "existence value". In option value, people are asked their willingness to pay for the preservation of a species with the option to actually observe the animal some day. That is, how much would consumers be willing to pay for the option of seeing, maybe not today, but tomorrow or the next day a green turtle? The last concept in this murky arrangement of nonmarket measures is "existence value". Yes, what would you be willing to pay to know that an animal is insured existence or preservation of the known biomass? In this case, we can shed some light on the beach/reef conflict in Broward County by citing an obscure study by Bendle and Bell (1995). Although this study's main purpose was to obtain existence value for the endangered West Indian Manatee in Florida, the study also asked about the green turtle.

A Florida household was willing to pay $2.98 per year to ensure the existence of the green turtle. This may not sound like much. However, there are 654,445 households in Broward County alone and 6.338 million households in Florida. The rather amazing thing about existence value is that it calls for the willingness to pay for the existence for not one, two or ten million of a species, but the preservation of all the creatures with this designation. This is why Federal and Florida agencies are charged with protecting such species in total and not allow any diminution of the biomass. Thus, annual existence value for the green turtle could run from $1.95 million in Broward County ($2.98 times 654,445) to $18.9 million per year for the entire State of Florida ($2.98 times 6.339 million) since this an annual willingness to pay.

When these figures are brought into the picture with the benefit-cost ratio, the economics of this beach renourishment changes considerably. If this kind of cost were integrated into the benefit-cost ratio for the beach project discussed above, it could render the project less feasible than if they were not considered. The author knows of no case where existence value has been used by the USACE to account for environmental cost of a project. Also, it does require that we justify whether we look at the County or the State of Florida as to that group having existence value in a part of the state. But, it does render a picture that beaches, reefs, and turtles must coexist and additions to one that impacts the other must be subject to economic analysis to see what the net economic value is to the nation.

A Benefit-Cost Analysis of the Government Reef Management

In an earlier analysis by Bell, Leeworthy and Bonn (1998) of the artificial reefs deployed in Northwest Florida (i.e., Bay through Escambia counties), one of the purposes of the analysis was to justify the State and local program of placing artificial reefs in coastal areas for the recreational benefit of fishers, snorkelers, and divers. Much of the money supporting the artificial reef budget at the state level comes from the Federal government. This money is raised from a national sales tax on fishing and hunting

equipment. The intention of this tax is to simulate a user fee, where those that engage in this kind of outdoor recreation pay for investments by the State and Federal governments. The taxes (user fees) pay for everything from boat ramps to deployment of artificial reefs. There is intense competition among various geographical locals in the U.S. for these Federal funds. To make your case for funding, it is useful to present what the recreational benefits are compared to the investment cost in the program. Of course, the benefits of recreation are measured by use value, which we have discussed at length above. This is but another arena where use value can be used properly rather than the elements such sales, employment and income, which are elements of the economic impact on the region from the recreational activity.

In Northwest Florida, it was found that the benefit-cost ratio for the reef deployment program measured in use value was 131. That is, for every dollar spent on artificial reefs, the program returned $131 in user value of recreation received by artificial reef users. Artificial reefs are made of discards or what many people call junk. The cost of acquiring this "junk" is small, but the cost of deployment, management, and monitoring may make the project somewhat more expensive.

In the earlier part of this White Paper, we indicated that budget figures for all reefs were obtained from State and local agencies that have the responsibilities for things like deploying artificial reefs and caring for natural reefs. Many of these budgets are murky since they omit the time personnel spend on other recreational resources (e.g., beaches) and lump sum grants for a variety of purposes. Thus, it is not always easy to get the actual amount of money spent by government on just the artificial and natural reefs. We asked the State and local officials for their best estimate. One thing often omitted from government budgets is overhead, which would appear as fixed cost on a private firm's income statement. Insurance premiums, rent, security, and cleaning are often paid for at a higher level of government and constitute overhead. Thus, we increased the cost given to us for the "management" of artificial and natural reefs by 50% to cover overhead.

Management would include the acquisition of capital items such as artificial reefs or boats needed to accomplish the role of government, which is to make sure that common property natural resources, such as reefs, are provided to the citizens of the local area or county. This is justified by the fact that the market cannot make these decisions for resources that are free to everyone. If we could buy and sell in an open market the "right" to use natural reefs, for example, then government would have no real role. We buy cars, trucks, and pizza every day and government has no role in this process since the market is not only more capable, but is more efficient when property rights to factories and pizza parlors are well defined. This is private property and the market generally works very efficiently for such goods. Thus, because of repeated market failure in the fisheries and air (i.e., common property resources), the government does have a role to manage these resources so that recreational users obtain a greater use value than the government cost of providing the use of the resource. More than we would like, government fails in their mission to deal or come to grips with the " tragedy of the commons". Commercial fisheries have been overfished to virtual extinction (e.g., New England Groundfish) while "managed" by the government. Generally, when the use

value greatly exceeds the cost of government intervention with a common property resource, this is a reasonable indication that government policies are working in the right direction.

For Palm Beach, Broward, Miami-Dade, and Monroe Counties in Southeast Florida, the author estimates that the government cost of managing artificial and natural reefs is about $11 million per year. This will vary from year to year depending on, for one thing, capital costs (e.g., deploying an artificial reef) which tend to be lumpy (i.e., fluctuate greatly over time). From the H/S Report, we have estimated that the annual use value for all four counties for artificial and natural reefs is $256.05 million. Thus, the benefit-cost ratio for the management of these resources would be 23.3 ($256.05/$11). Thus, for every dollar spent on the management of all reef activities by government in Southeast Florida, about $23 are generated in use value flowing from artificial and natural reefs directly to reef users. Thus, the net value added to GDP or gross domestic product would be $245 ($256-$11 million) million. This does not actually show up the GDP, since national income accounting has not advanced to this level of sophistication, but the reef management program adds to national output via the natural and artificial reef resources. The implicit assumption is that without government intervention that these resources might soon vanish or seriously diminish in quality where the $256.05 million in use value might fall to zero. It may be a bit bold in giving government at all levels credit for the maintenance or even enhancement of the use value of these reef resources. But, the benefit-cost ratio serves as a yardstick by which budgets can be allocated. For example, if the benefit-cost ratio is higher in the Southeast Florida for reef projects than those off Jacksonville, Florida, money is more wisely spent in the former than the latter given a fixed budget.

Marine Protected Areas and Fishery Management

As part of the H/S Report, resident reef users were asked their opinion on "no-take" zones as a management tool for artificial and natural reefs in Southeast Florida. In Monroe County, the FKNMS has created 24 of these zones (164.37 square miles) since 1997 so the implementation of this tool is not new to the general area and especially to resident reef users of the area. Such designated areas are used throughout the world and are usually called marine protected areas or MPAs[2].

On average, nearly 59% of resident reef users supported "no-take" zones on some reefs of Palm Beach, Broward, Miami-Dade and Monroe Counties. To our knowledge, this is the first referendum on MPA's. The economist's interpretation of this result is that MPA are quite possibly increasing use value per day for resident reef users. As discussed above, this is potentially a government program that would change use value and therefore the benefit-cost ratio for reef management.

We should remember that reef use involves diving, snorkeling and fishing. In this trinity of uses, usually only fishing is really what economist call consumptive use in that the resource is harvested. However, many users harvest marine resources while diving and snorkeling (e.g. spearfishing, gathering lobster, scallops, etc.). An MPA would

exclude the extraction of any of the resources in that area and would adversely impact the recreational fishermen the most.

Leeworthy (2002) has taken the H/S Report, or more precisely the data generated by this report, one step further in analyzing this issue. Leeworthy found that those that were predominately resident recreational fishermen shared about the same opinion regarding MPAs as their diving and snorkeling counterparts, which is that well over 70% supported MPAs off the four counties. Resident reef users were also asked, "What percentage of coral or natural reefs in your county would be reasonable to protect using "no-take" zones? The respondents felt that nearly 32% of natural reefs should be designated as MPAs. The more the area caters to those interested in nonconsumptive use, the greater one would expect this percentage to be. This working hypothesis is contradicted by Leeworthy, who finds statistically the same results when just fishermen are compared to just snorkelers and divers.

The use of reefs by fishermen is consumptive recreation as discussed above. However, the literature has generally shown a low response of use value to catch rates. This means that fishing recreational experience is less influenced by how many fish are caught on reefs. And, this finding in the literature is consistent with Leeworthy's finding, after further analyses of the H/S data, that there is really no difference between fishers and others, such as snorkelers and divers, in their opinions regarding an MPA program. Again, the data collected by Florida State University (i.e., sub-contractor to H/S) is extremely useful for policy purposes. If four heavily populated counties in Florida feel that MPAs in existence and proposed will apparently enhance their use value, this is important since this policy issue has produced much controversy throughout the U.S. and even the world (e.g., See NOAA (2002)).

In the beach/reef conflict discussed above, it has been proposed by the Greater Fort Lauderdale Marine Protected Area Committee that two MPAs be designated off Broward County. This would be a further effort to provide mitigation against the potential destruction of hard bottom communities in the process of renourishing the beach. The first MPA would be 300 feet north of the Lauderdale-By-The-Sea fishing pier, while the second would begin 300 feet north of Dania fishing pier. The Committee states that "The coral reefs off Broward County are easily accessible from shore or with a small boat". Thus, the Committee argues that MPA's would be easily reached for nonconsumptive recreation by a large group of individuals.

In a review of the existing literature on MPAs, the Committee argues that the withdrawal of fishing effort in an MPA will create an enlarged biomass, which will spill over into other areas that can be fished. This contention is certainly true since this would be predicted by traditional population dynamics, which is well established in theory and in practice. Also, migratory fish would, depending on their life and migratory cycles, would potentially escape the MPA with greater size and maturity thereby increasing the biomass external to the MPA. When an MPA plan is initially implemented, the results may be astounding. For example, Rowely (1992) reports that in a study of the Saba Marine Park in the Netherlands Antilles illustrates the increase in the biomass. The Saba

Marine Park was established as a MPA in 1987. Between 1991 and 1993, scientists noted a 60 percent increase in commercially important species, including an increase in snapper of over 200%. Given that fishing effort is not increasing dramatically throughout the entire area, which is dotted with MPAs, it is very probable that the entire biomass will increase for the area with respect to most, if not all, species.

Of course, both recreational and commercial fishermen usually predict economic losses as a result of MPAs, since they are precluded from some productive areas of fishing. During the growth of the biomass, losses in profits may occur for commercial fishermen as catch rates fall and the cost of fishing rises due to altered trips to account for the MPAs, etc. For recreational fishermen, they may have to go further out in the Atlantic Ocean for Broward County, since the MPAs will be just 300 feet from shore. How the winners compensate the losers is really beyond this White Paper. However, there is a larger question to the MPA issue. That is, the areas outside the MPAs are still populated by common property resources. After a short period of time, catch rates for both commercial and recreational fishermen may rise in areas adjacent to MPAs. In the case of Broward County, if MPAs did all they were expected to do, which is to (1) provide mitigation for beach renourishment destruction; (2) increase catch rates outside the MPAs and (3) provide more recreational areas for nonconsumptive use such as diving and snorkeling and (4) provide minimum problems to the existing commercial and recreational fishing industry, we still have not come to grips with the "tragedy of the commons" outside of the MPAs.

Thus, the White Paper would be remiss if it did not include the "rest of the story", as Paul Harvey would utter. One attractant to fishermen is a rise in catch rates for both recreational and commercial use. There would possibly be three phases. In the first phase until catch rates rise, fishermen might have losses in profits and use value for commercial and recreational fishers, respectively. Both kinds of fishermen might avoid the area, go elsewhere such as out of business, or just ride out the process. Phase two would witness the rise in catch rates as the abundance from the MPAs spills over to adjacent or contiguous areas. Those that stayed the course would be amply rewarded as super profits emerge for commercial fishing and use value rises due to favorable fishing outside MPAs. The problem is with phase three. The super profits and high use value would attract more and more individuals into the fishery with the ultimate result of overfishing. Thus, MPAs could work only if phase three is avoided. From regulated inefficiency to overall quotas, traditional fishery management schemes have experienced abysmal failure in preventing over capacity in the fisheries. See Bell (1978).

The only approach that has shown concrete results is ITQs or individual transferable quotas that would function outside the MPA. In essence, this system transfers the common property to private hands. This as old as the hills, but considered new by those in fishery management. Douglas North was even given the Nobel Price in Economics for identifying the basis of economic development as the transfer of commons into private property hands. The U.S. government via the Homestead Act gave away land in the Western part of the U.S. or put the land in private hands. The principle is simple. Those that hold private property will not only conserve it, prize it, tend it, and defend it, but can

capture the fruits of utilizing it within the free market system. ITQs have been sweeping the world, except in the U.S., with few reports of failure.

How would ITQs work with MPAs? For fishing areas outside the MPAs, a fisherman would be given an individual quota per year or quarter to either sell to another fisherman, not so fortunate, or utilize herself. If one sells her quota, she can exit the fishery with what is called the rental value of the fishery. If one sees that she is going to exceed her quota, she may buy a part or the entire quota from someone else. Eventually, the quota expressed in pounds of fish will have a market value in its own right. In Iceland for example, pound/tones of cod are listed in the daily paper in terms of "bid" and "ask" as would a share of stock in IBM. Thus, the individual quota given or transferred to the fishermen would be available to other fishermen that are more productive.

In both theory and the studies of individual cases, ITQs prevent overfishing and induce the most productive individuals to remain in the fishery, and those that are less productive exit to another occupation with the value of their initial quota that might be several hundreds or thousands of dollars. Thus, the MPAs combined with ITQs is a better tandem for economic efficiency and the welfare of recreational and commercial fishermen than the partial, but possibly short lives success of the MPAs alone.

Finally, recreational fishermen obtain their rewards from ITQs since commercial fishing effort is limited and catch rates are higher than under free entry. They may share a fishery with commercial fishers that have every incentive to not overfish, since the sum of the ITQs is limited to the sustainability of the biomass, such as maximum sustainable yield. Sports fishermen will start out with high bag limits, which as more recreational fishermen enter the fray will probably fall. This fall may not be to unacceptable limits due to the low elasticity of use value for sports fishers to catch rates (i.e., sport fishers are insensitive in terms of their use value to falls in the catch rates)[3]. In Scotland, salmon anglers pay a privately owned firm to provide fishing for a week or a day. The transfer of fishing rights to private enterprises (i.e., privatization of the resource) in foreign countries helps us learn more about efficient use of the resource.

Use Value of Natural versus Artificial Reefs

We have seen how use value is critical to many policy decisions as discussed above (e.g., beaches versus reefs). The H/S Report contains many use value figures and it may be helpful to the reader to see if there is any pattern to these estimates and reasons why the authors obtained varying results. In addition, are there any additional policy implications of the various estimates of use value? In Table 2.3.3-1 (Residents and Visitors) on page 2-67 of Chapter 2 of the H/S Report, we have various use values per person-day by both kind of reef and county. The statistic that is most meaningful is use value per person-day, since it standardizes the willingness to pay by one user for one day.

Would a reef user prefer a natural reef to an artificial reef if she had to make the choice of allocating one day to one or the other? On intuitive grounds, one might jump to the conclusion that natural reefs are preferred to the artificial variety. For residents and

visitors, the average user value for natural reefs is $12.50 per person-day compared to only $8.65 for artificial reefs. This is about a 1.45 to 1 ratio, which soundly confirms intuition. This means that the combination of fishing, diving, and snorkeling as recreational pursuits are vastly enhanced by natural as opposed to artificial reefs.

The stock of natural reefs is relatively fixed compared to artificial reefs. However, natural reefs can be restored to some degree, as we have seen in the infamous vessel grounding cases discussed earlier in the White Paper. It should be further noticed that the 1.45:1 ratio in use value per person-day for natural over artificial reefs varies between a low of 1.08:1 for Broward County to a high of 2.40:1 for Monroe County. All things being equal, restoration of natural reefs would supply the reef user with more use per person-day than deploying additional artificial reefs. Thus, we might be lead to conclude that supplying 5 acres of natural reefs (if possible) to an area might be a more efficient policy than 5 acres of artificial reefs. Of course, this would be incorrect, as we have learned above, since the cost of doing this must enter this conclusion in the form of a benefit-cost ratio. But, it is a valuable start to know the use value for these two different kinds of reefs.

Assuming the same activity (i.e., user person-days) at each kind of reef, the cost of supplying (i.e., restoring) natural reefs as opposed to artificial reefs would have to exceed a 1.45:1 ratio for the artificial reef to be more efficient. Because artificial reefs are based on relatively low cost material, it could easily be that artificial reefs are more economically efficient than restoring natural reefs given the latter is relatively high cost. However, the assumption of the same amount of activity at each kind of reef is not correct. Remember that annual use value is equal to the user value per person-days times the number of person-days of use. Natural reefs are preferred to artificial reefs not only in terms of user value per person-day, but also in terms of annual person-days of use. Across the four counties, the ratio of natural reef person-days to artificial reef person-days is 1.87:1 and varies by county from a low of 1.08:1 in Broward County to a high of 2.4:1 in Monroe County. Thus, the government's choice between artificial and natural reefs, if available, would greatly be justified with the results from the H/S Report.

What do economists know about use value? The determinants of the level of use value for a commodity or service are usually based upon the user's income, the availability of suitable substitutes, and the attributes of the commodity/service in question. Little has been done on use value for reefs, but we do have an abundance of studies on beach use and recreational fishing.

In the case of beach use value, higher incomes usually increase use value because the individual has higher purchasing power. The availability of <u>many</u> substitute beaches will lower the user value for a particular beach. Of course, lifeguards, accessibility, width of the beach, and quality of the sand are just a few of the "attributes" that will change use value. In the case of recreational fishing for a particular species, use value may depend on the catch rate. This is an attribute of the recreational experience and higher catch rates, as a rule, increase use value for fishing. Remember that use value has two components, the use value per unit of use (per person-day in recreation) and total amount of use (total

number of person-days in recreation). Higher catch rates could change one or both components of use value.

Since the use of the reef is multi-dimensional in terms of activities, this is clearly a factor in determining the use value of a reef. The use value we have been discussing is for three distinct activities: (l) fishing, (2) diving, and (3) snorkeling. Earlier, we said that the use value of a natural reef by residents/visitors is $12.50 per person-day. However, we do not know at this point how that use value might change if the natural reef became less useful to fishing through the adoption, for example, of MPAs. That is, MPAs would exclude consumptive recreation, such fishing, and encourage nonconsumptive recreation, such as diving and snorkeling within an MPA. We do not know the effect of such a policy move on the $12.50. For each County, the H/S Report contains detailed tables of user values by type of reef, activity and resident status. The user values vary by all these factors across counties. No generalizations can be made about user value per person-day across the four counties. To do this would require additional research relating user value to both user and reef characteristics.

Of great policy interest and the last items considered in this section of the White Paper is the user value for reefs for residents as opposed to visitors. For the four counties combined, we have the following result of use value per person-day by class of user as follows:

Kind of User	Artificial Reef	Natural Reef
Resident	$2.99	$8.52
Visitor	$14.26	$16.85

On a per person-day basis, the ratio of natural reef valuation to artificial reef valuation for residents is similar across counties ranging from 2.7:1 in Monroe County to 2.9:1 in Broward County. For visitors, the ratios are lower and range from 1.08:1 in Broward County to 1.83:1 in Monroe County.

Again, natural reefs are also used more than artificial reefs by both residents and visitors and thus the ratios of total annual use value of natural reefs to artificial reefs are even higher than those on a per person-day basis. Residents have higher natural reef value to artificial reef value ratios than visitors do in all counties, except Monroe County.

There is no one ratio of natural reef to artificial reef value. It varies by county, resident and visitor status of the user, and by activity of the users (e.g. snorkeling, scuba diving or fishing).

Finally, reef users were asked about their willingness to pay to invest in and maintain "new" artificial reefs. This gives us some insight into one policy issue and that is the intensity of reef use. We could express intensity as the number of reef-related user person-days per acre of artificial reefs. This would not be meaningful as an indicator of

intensity of reef use, since it would vary between weekends and weekdays for example. This would not answer the critical question and policy issue of the carrying capacity of a given reef.

Carrying capacity might be defined as the point where congestion renders the change in total use value as zero or a negative value for one unit of use (person-day). Two things are happening in this process. First, user value per person-day starts declining with additional use as a site becomes more crowded, but total use is increasing and total use value is still increasing. As use continues to increase, per person-day values will decline to the point where total additional use value is zero or declines. What does this mean? It means that the last boat load of reef users crowd the others to a point where their utility from the recreational experience begins to decline. We have often seen congestion at boat ramps on Saturday morning as people attempt to get their boat in the water without a long wait. In the State Comprehensive Outdoor Recreational Plan or SCORP (2002), capacity guidelines are set up for such resources as boat ramps, piers, and beaches based primarily upon expert opinion as to the point of carrying capacity. Thus, if reefs were "overutilized", one would be willing to pay for additions to capacity. But, what does all of this have to do with new artificial reefs added to the existing stock of artificial and natural reefs?

Congestion is only one factor that might reduce use value; however, if it is significant, use value or the amount reef users are willing to pay for the recreational experience might be lowered from some number without congestion. The use value per recreational day for "new" reef use was as follows:

Table 3. Use Value Per Person-day for New Artificial Reefs

County	Visitors ($/Person-day)	Residents ($/Person-day)	Residents & Visitors ($/Person-day)
Palm Beach	$12.01	$0.72	$3.37
Broward	$5.55	$0.60	$3.95
Miami-Dade	$2.57	$0.28	$1.38
Monroe	$3.60	$0.42	$1.46
All (Weighted Average)	$4.94	$0.49	$2.72

Source: Johns et al (2001), Tables 2.1.3-3 (Residents), 2.2.3-2 (Visitors) and 2.3.3-2 (Residents and Visitors)

For visitors, "new" artificial reefs among all the counties is only about 35% of the use value per person-day expressed by visitors using the existing artificial reefs

($4.94/$14.26). And for residents, "new" artificial reef among all counties is about 16% of the value obtained from the existing stock of artificial reefs ($0.49/$2.99).

There may be psychology that additional artificial reefs are for someone else and the respondents do not want to finance the recreation of others. Or, it may represent the difference between no crowding or congestion and the advent of some congestion. It does raise a significant policy issue, which is what use value to use in making benefit-cost analyses for deploying new artificial reefs.

Fortunately, the Bell, Leeworthy and Bonn (1998) study can provide some light on this issue since it dealt with artificial reefs only and restricted the willingness to pay questions to "new" artificial reefs. Depending on the method used, use value in Northwest Florida for new artificial reefs ran from $4.53 to $7.18 per person day, with an average of $5.75 in 1998 dollars. In 2001 dollars, the finding from Northwest Florida would be about $6.27 or well within the findings or "new" reefs for Southeast Florida. This would tend to reduce the benefit-cost ratio for the artificial reef program.

In this four county area, 9.83 million days were spent on existing artificial reefs, but this does not tell us how many additional days the existing users and new users would expend. If we assume that crowding/congestion is the main issue, then possibly we could obtain $26.7 million (9.83 million times $2.72) in use value per year for new artificial reefs.

Adding new artificial reefs would not be as costly as the nearly $27 million dollars received as reef benefits. Over the 1995-2001 period, the four counties received an average of $191,284 per year each from the Florida Department of Environmental Protection to help build artificial reefs. Monroe County received no funding from the State. Assuming that matching money and other expenditures related to artificial reef is as high as 5:1, this still would be about $1.14 million per county and even counting Monroe would only be about $4.6 million for the entire area rendering a benefit-cost ratio of nearly 5.8 ($26.7 million divided by $4.6 million).

Thus, this exercise under the most conservative assumption still arrives at a benefit-cost ratio of 5.8:1 for the artificial reef program in Southeast Florida. A matching program of 2:1 would yield a benefit-cost ratio of over 11.6:1. Also, in much less densely populated area of Northwest Florida compared to Southeast Florida, the Bell, Leeworthy and Bonn (1998) report revealed that 38% of visitors and residents felt the artificial reefs were too crowded. This question was not included in the H/S survey. It would appear that the only two reef studies known to the author are consistent in their results. This is gratifying that results may be reasonably interchangeable within a state or another area since the ability to transfer general results will be discussed as a policy issue below.

Finally, does use value have anything to do with demographics. Within certain classes such as resident artificial or natural reef users, there is generally a positive relation between willingness to pay and household income. We would expect that those with a higher ability to pay would be willing to pay more for a recreational trip to an artificial or

natural reef. This was true for both artificial and natural reefs in the H/ST Report for visitors and residents studied separately. Since there is no actual payment made for the use of a reef (i.e., common property resource discussed above), it may be inferred that higher income groups probably benefit more from these natural resources than lower income groups. Visitors have median family income of about $79,375 compared to $67,531 for residents of all the counties combined, and derive somewhat higher use value from both artificial and natural reefs in this area.

We will end on an ominous note from Leeworthy and Bowker (1997) which is quoted as follows:

"But one thing that seems to be common among all definitions of sustainable development… is the idea of increasing or maintaining the natural capital stock. By this we mean the environmental quality and abundance and diversity of natural resources as presented in our simple conceptual model of how the economy and environment are linked. That is, the environment is able to assimilate the amount of waste without declining environmental quality. Fish harvest does not exceed the population's ability to replenish itself. Damage to other resources like sea grasses and coral are at a rate not exceeding the replenishment rate of these resources" (p.10).

They go on to say "a decline in natural capital is a leading economic indicator of a decline eventually in traditional economic indicators such as sales, income, and employment. The best indicator of the state of the environment is use value, since it indicates the value of resources. In monitoring the health of natural resources, the decline in use value, should it occur, is a sign that there may certainly be lagged declines in the "measured economy".

Below, we shall get an idea of how much of the economy depends on reefs alone. A decline in the number of reefs and/or the quality of reefs will certainly be followed by lost visitors and residents disserting the local economy elsewhere. This is why a better understanding of use value and how to estimate this statistic is a priority for monitoring an area such as a MPA or protected sanctuaries as well as those resources which are more exposed to use, especially within a common property setting.

Monitoring Marine Sanctuaries and Other Resources

One of the most vexing problems in resource management is keeping on top of what is happening in the dynamics of resource change due to natural and man-made activities. Marine sanctuaries have recently been established to protect valuable marine resources. Other resources such as whale and tuna resources have had their own specific management programs, which started much earlier than the recent 13 National Marine Sanctuaries in the United States. The H/S Reef Report has great implications as discussed above for the FKNMS, as well as similar resources off the coast of Palm Beach, Broward and Miami-Dade Counties (e.g., used in resource conflict between reefs and beaches). To effectively use this report, it must be placed in the context of the resource management.

As a useful delineation, resource management can be divided into the familiar chants of the economist, which is that so much can be understood in terms of supply and demand. Scientific studies can tell us, for example, the abundance of fish and the maximum sustainable yield from a biomass. The same science can tell us about the sustainability of an artificial reef for recreation in certain places in the ocean. The vast information base on marine resources tells us something about the supply of that resource to man. Such a supply can be characterized by the availability of the resource for food consumption all the way to just knowing that the resource is preserved. But, the driving influence that makes supply meaningful is for what purpose the resource is to be "used".

If used for food or as an input into other commodities (e.g., coral displays in museums; fish meal for chickens), there are organized markets that govern extraction, although imperfect (i.e., commercial fishing has an overt market for the fish even though the resource is common property, while recreational fishing as no price for daily use of the resource). Most marine resources such as fish and reefs for recreation fall into the category of nonmarket value, which we extensively discussed above under use value.

We think that marine sanctuaries, for example, must be monitored in terms of both supply and demand to arrive at a sustainable use of many renewable resources in the ocean. For example, how many people will want to use a particular reef system in 10 years? To answer this question, we must determine the baseline use of the reef system today. The State Comprehensive Outdoor Recreational Plan, called SCORP, is an excellent illustration of blending demand and supply of recreation resources, including many of these resources from marine sanctuaries and other marine areas. The thrust of this monitoring is to see what are the needs of man-made resources, such as boat ramps, piers, beaches, and docks today, and in the future for an increasing number of users. Both the demand and supply side are both needed to arrive at an outcome that will enable managers to make the marine resources available for present and future consumption.

The H/S Report acts as a baseline for the four counties in terms of the demand side of monitoring resources. For example, we ran into the problem of the carrying capacity of various kinds of reefs. Conceptually, carrying capacity may be reached when incremental use value drops to zero. Although not presently available, the H/S Report did ask respondents about their evaluation of resources in the FKNMS, which, when analyzed, will lead to some idea of the state of the resource. We also said that use value might be a leading economic indicator for market variables such as sales, income, and employment. If use value declines from some base level, this may be followed by declines in jobs and income tied directly and indirectly to these resources. Thus, there is an interaction or link between the use value of these resources as discussed in earlier sections and the economic impact of these resources on the local community. We shall extend the H/S Report to include a summation of the economic impact and importance of this impact to the four counties in a section below.

Thus, demand monitoring of marine natural resources within a marine sanctuary or elsewhere is absolutely indispensable in planning for the present availability of the resource in question and the future demand that will bring further pressure on such

resources. For example, what is the future demand for artificial reefs off Miami-Dade County? We know that residents and visitors use this resource and by how much thanks to the H/S Report. In addition, we also know some of the factors that determine present demand for artificial reefs (e.g., household income), but where is this demand likely to be in 2010 given no change in the supply of artificial reefs? This depends on carrying capacity, which we do not presently know, but the H/S Report has given us a start. Use value through existence value may be tapped to give us the answers to many of these questions. As fish are quite correctly monitored in terms of abundance, consumers must be monitored in terms of their use value. Use value can be monitored indirectly by many statistics such as the percent of visitors returning for repeat trips to the FKNMS, for example. If this percent is declining, then this could indicate a decline in use value or at least a relative decline to other marine resources elsewhere in the world. This is something that can be monitored by quarter through the usual visitor survey conducted by many large counties throughout Florida and the Nation. Below, we shall attempt to extend the H/S Report to outline what kind of information is available upon which to make long term projections of the reef resource use in the various counties under study.

In monitoring a sanctuary or other areas under some degree of government management, it is necessary to consider that monitoring within a demand and supply context, each element vital to those using the resource from food to just the knowledge that it exists.

Economic Importance of Reefs to Counties

The H/S Report does not fully give the reader an idea of the relative economic importance of reef resources to the individual counties under study. The loss of reef resources through pollution, damage, or other factors will impact those businesses directly and indirectly dependent on reef use in the county. Thus, we should have some idea of the baseline economic impact of the present natural and artificial reefs off each county under study.

Although one may think of spending first when considering the economic impact of the reefs on a county, it is what this spending does that is more important. Spending produces wages for employees and profits for investors in the county. We can get at the creation of wages and employment by reefs, since such statistics can be developed through the use of published data. Obtaining profits at this level is not feasible, since data are not readily available for small businesses, many of which cater to those using the reef system. Using the data in the H/S Report along with data published elsewhere, we were able to estimate the employment and wages generated by the reef industry for each county as follows:

Table 4. Employment and Wages Generated by Reef Activities

User Type/County	Employment	% of Total Employment	Wages[1] (Millions $)	% of Total Wages
Visitors:				
Palm Beach	4,796	6.8	104.0	6.9
Broward	32,999	46.9	680.8	45.1
Miami-Dade	16,477	23.4	393.7	26.1
Monroe	8,653	12.3	214.6	14.2
Sub-total	62,925	89.5	1,393.1	92.2
Residents:				
Palm Beach	1,504	2.1	22.4	1.5
Broward	2,474	3.5	37.7	2.5
Miami-Dade	2,109	3.0	38.9	2.6
Monroe[2]	1,331	1.9	19.1	1.3
Sub-total	7,418	10.5	118.1	7.8
Grand Total	70,343	100.0	1,511.2	100.0

1. Wages for visitors do not include proprietor's income.
2. Monroe County resident estimates revised from Oct. 15, 2001 report.

Source: Johns et al (2001) Table 2.1.2-1 for residents and Tables 2.2.2-9 to 2.2.2-12 for visitors.

One thing about the above statistics is the overwhelming economic impact of visitors as opposed to residents. In the case of employment, this was taken directly from Chapter 2 of the H/S Report (i.e., Table 2.1.2-1 for residents and Tables 2.2.2-9 to 2.2.2-12 for visitors). For residents, all jobs are directly dependent upon providing products and services directly to reef users. There are no additional economic impacts, since residents are a result of exporting goods and services from a county. They do not have well known multiplier effects, since they are viewed by economists as living on income generated by sales outside the county. However, visitors are viewed quite different. They inject money into the local economy, which is passed on from businesses and employees to other businesses and employees until the money leaks out of the economy in the form of exports.

For example, in Palm Beach, there were an estimated 1,504 jobs (full and part-time) directly created by resident spending on commodities and services related to reef recreation; however, 4,796 jobs in total created by reef using visitors. Of these 4,796 jobs, only 3,288 jobs were directly related to serving reef-using visitors. The remaining

1,508 jobs were created by multiplier effects related to the initial injection of money by reef using visitors into Palm Beach County. We would say that the multiplier is 1.46 (1.46 times 3,288) for Palm Beach County. Thus, we reach the rather startling conclusion that 89.5% of all reef-related employment is related to reef-using visitors.

Wages follow the same general pattern, as expected, as employment. Unfortunately, the H/S Report does not breakout wages created by visitors, but gives total income, which includes wages, capital income and proprietor's income. We were able to estimate what wages would be of total income by multiplying direct employment by the average wage of those providing goods and services to the reef sector from data on residents. For indirect employment (i.e., that created by the multiplier), we used the average wage paid to all employees in the county from the U.S. Department of Commerce (2002). For all of the counties under study by H/S Report, reef using visitor's effect on wages and employment was about nine times that of residents. What are the reasons behind this finding?

The reader may infer that there are just more visitors than residents to explain this differential impact. A review of the H/S Report reveals that in 2001, person-days associated with visitors were 13.2 million compared to 14.2 million for residents. Thus, the visitors and residents spent about an equal amount of time using both natural and artificial reefs. The question of resident versus visitor use often comes up within the context of crowding, which we discussed above.

On further analysis, two factors explained the higher economic impact as measured by wages and employment related to reefs in the four counties. First, visitors have a multiplier effect as they inject money into the local economy. This creates numerous indirect jobs. Second, the visitors spend considerably more per person-day than the residents. From the H/S Report, we estimate that residents spend about $62 per person-day compared to $153 per person-day for the visitors for the approximately equal number of days spent engaging in recreational activity on artificial and natural reefs. In terms of economic policy, a county may be better off adopting policies that favor the visitors over the residents based upon this analysis.

Visitors are often associated with higher government cost for police, highways, and even medical cost for emergencies. Most studies indicate that such cost are greatly offset by one tax on visitors, for which they get no services. Visitors pay indirectly for school taxes on hotels and motels and other accommodation modes, but have no children in schools. The one drawback to visitors is that the industry jobs they directly support (i.e., jobs in industries directly serving reef uses from party/charter boats to hotel accommodations) are low skilled and highly part-time. For example, the average wage in the reef-related industry pays about $15 to $18 thousand per year compared to a county average of $26 to $37 thousand per year.

The figures developed above are of use for policy issues such as the economic impact of attracting reef users. We can see that attracting visitor reef users has a much larger impact on each county than that added by resident reef users. Of course, visitors do not

vote, while residents do. So, government may stress the economic importance of preserving the reefs for residents. One of the economic aspects of the creation of wages and jobs is relative importance the reef industry is to the economy under study. This was not discussed in the H/S Report. Using the numbers developed above, we can see how important the reef industry is within the context of each county studied as follows:

Table 5. Employment and Wages Generated by Reef Activities as a Percent of the Total County Economies

County	Reef-Related Employment	% of Total County[1]	Reef-Related Wages (Millions $)[2]	% of Total County
Palm Beach	6,300	1.0	126.4	0.5
Broward	35,473	4.2	718.5	2.6
Miami-Dade	18,586	1.5	432.6	1.0
Monroe[3]	9,984	18.4	233.8	16.1
Total	70,343	2.5	1,511.3	1.6

1. Total Employment: Palm Beach (636,441); Broward (846,511); Miami-Dade (1,264,050); Monroe (54,200) from U.S. Dept. of Commerce (full and part-time employment.
2. Total Wages and Salaries: Palm Beach ($23,417.2 million); Broward ($28,063.7 million); Miami-Dade ($44,110.3 million); Monroe ($1,451.9 million) from U.S. Dept. of Commerce, Bureau of Economic Analysis (nonfarm earnings).
3. Monroe County estimates revised from Oct. 15, 2001 report.

In absolute terms, the reef-related employment looks large. For example, the over 35,000 jobs created by the existence of artificial and natural reefs in Broward County may make this one of the larger industries in the county. But, each of the counties, except Monroe, has a massive amount of employment compared to other counties in Florida. The third column in the above data presentation shows what percent the reef-related industry is of total employment in the county. This varies from a low of only 1% in Palm Beach to a high of 18.4% in Monroe County. As Monroe County and the Florida Keys depend on their natural resources such as attractive coral reefs, this is hardly surprising. Overall, the reef-industry as we have defined it accounts for 2.5% of all employment in the four-county area. If these resources were to vanish tomorrow, employment would drop by 2.5%, which would constitute a recession when added to the existing unemployment rate in these counties. ***Thus, the failure to protect these reef resources could, at the margin, create an unacceptable unemployment problem among a great diversity of businesses ranging from dive shops to fancy hotels.***

Notice that in every county, wages are a lower percent of total wages than is the case with employment. Generally, recreational industries based on natural resources tend to have support industries that are relatively low skilled with a lot of part-time employees.

We see these two factors at work in the above presentation. Even so, the reef-related industry among the four counties under study account for 1.6% of all wages generated. This addition to the H/S Report gives the user of the report a better idea of the relative economic importance of natural and artificial reefs to the economies of these counties.

Formulating a Multi-County Reef Management Plan

The White Paper has added some additional information to the H/S Report on the demand side for reef resources. As we stated above, the formulation of management and monitoring plans is really not possible unless both "Demand" and "Supply" is taken into consideration. Those officials in the four counties under study have already outlined the ingredients or elements needed to be considered in managing the reef resource. The first step is to deal with the question of managing the artificial reefs. Already, St. Lucie and Martin County to the north have been added as additional members of the multi-county management group. There are so many common issues such as reef/beach conflicts, water pollution, and MPAs that no one county can really "go it alone". The management plan considers the following elements: (l) Public Involvement; (2) Agency Coordination; (3) Funding; (4) Liability; (5) Research Needs; (6) Program Review; (7) Materials; (8) Design Criteria; (9) Sitting; (10) Permitting; (11) Monitoring and Maintenance; (12) Reef enhancement; (13) Volunteers and (14) User groups. Hopefully, the H/S Report will contribute to each of the elements of the management plan.

The fourteen areas are treated in the management plan on a county by county basis. For example, funding can not only come from the State of Florida for artificial reefs or from Sport Fishing Clubs, but also from ad valorem taxes and the county budgets. In St. Lucie County ad valorem and general county revenues are used, while Palm Beach is stressing FWCC grants and local estuary partnership fund grants. It is clear that this multi-county management plan is just in its infancy, but the plan is down on paper and regular meetings between counties are taking place. The plan does seem to lack a clear identification of the user groups or the "Demand" side as discussed above. The H/S Report contains such information. User groups should be identified to see that their needs are being met and for purposes of revenue raising, such as financing artificial reefs through reef decals or adding different kinds of fishing licenses. In the final section of this report, we shall look at how to use the H/S Report to see what the needs will be in the future, which is really the basis on any management plan.

FORECASTING REEF USE WITH THE REEF REPORT

The Future of Resident Use of the Reef Resources

The management plan discussed above can only be effective if the planners have some idea not only of the present demand for artificial and natural reefs, but the future demand for recreation using these resources off each county. The unit of consumption of recreation is usually defined in terms of the recreational day. For example, in Miami-Dade County, the H/S Report estimated that in 2001 there were 9.2 million person-days

of use on the reefs off this county, consisting of about 33% residents and 67% visitors respectively. It is important to make a distinction between residents and visitors because of different expenditure per person-day and multiplier effects discussed above. Thus, we shall consider the demand for residents first.

In Miami-Dade, residents spent 2.95 million person-days in 2001 on artificial reefs. The forecaster of demand should breakdown the demand into the most homogenous products that are possible, such as distance from shore and/or age of artificial reefs, for example. So, it would be wise to further breakdown the reef use. The question is as follows: How much will the demand for artificial reefs increase from the 2.95 million person-days of use in 2001 to the year 2010? To examine this question, let us write the following expression:

ArtPerDays = (Y/POP; POP; Pn/Pa) (Miami-Dade County-Residents)

Where, ArtPerDay = person-days spent on artificial reefs per year;
Y/POP = income divided by population in reef area or
Per capita income;
POP = population in Miami-Dade
Pn/Pa = price (cost) for an recreating on an natural (n) reefs
relative to the price(cost) for recreating on a artificial (a)
reef.

The hypothesis is that the number of artificial resident reef person-days (i.e., demand for artificial reefs) positively depends on (1) per capital income; (2) population and the (3) the ratio of the cost of recreating on a natural as opposed to an artificial reef. The logic of all this is fairly simple. As per capita income rises, those engaging in recreation will have more money to devote to leisure activities. Of course, even if per capita income remains constant, increases in population will, all other things remaining constant, increase the number of artificial reef participants and therefore person-days. Finally, if recreating on a natural reef becomes more costly than doing the same thing on an artificial reef, the recreationalist may switch or substitute artificial reef fishing, diving, and snorkeling days for that on a natural reef to keep cost down.

To make a forecast, we must know the variables on the right hand side of the demand equation. Thus, in most cases, we must have a forecast to make another forecast. If we wish to forecast over the period 2001 to 2010, we may require the three variables on the right hand side of the demand equation. It will also be necessary to engage in extensive statistical analysis to find out the empirical relation between artificial reef person-days and any independent variable such as per capita income. This kind of analysis is possible with the data set gathered by H/S Report. It would be preferable to do a separate survey to gather the precise variables required.

Let us assume that, over the period of the forecast, we expect that population is the only variable to change. This would mean that there will be no change in personal income per capita and the relative cost of natural versus artificial reefs for recreation. For

residents, population projections are available from the Florida Statistical Abstract (2001). These indicate the following for Miami-Dade County:

Year	Population (Thousands)
2001	2,253.4
2010	2,557.1

The projection would indicate that population in Miami-Dade County would rise by about 13.5% over the 2001-2010 period. A safe assumption is that every thing else remains constant, that resident person-days on artificial reefs would rise in the same proportion that population in the county rises. By the year 2010, we would forecast that artificial reef person-days would rise to 3.35 million (1.135 times 2.95 million). Thus, if the carrying capacity of the artificial reefs were at their limit in 2001, then we must find artificial reefs for 400 thousand additional person-days by 2010. Although very simplified, this forecast would be a useful "Demand" side tool to guide any management program as discussed above. Such a forecast would be useful in budgeting, since it would outline the dollar needs or investment required to have a sustainable use of the artificial reef resource.

The Future of Visitor Use of Reef Resources

Visitor demand tends to be much more volatile than resident demand. The theory does not change behind the demand equation, but travel cost to the reef site and alternatives become more numerous, especially for visitors coming from long distances. For example, a visit by someone or party from Ohio to the Florida Keys to go snorkeling on natural reefs has many more uncertainties than a drive down the road from one's house in Key West to a dock to snorkel a morning away. Yet, for planning and budgeting purposes, we should know something about the magnitude of visitation to the Keys for the use of natural reefs in the future.

The same demand equation can be used as was used for residents. Of course, U.S. population and per capita income would replace that used for the county since visitors can come from anywhere including over seas or Canada. Exchange rates or other such variables that have been very reliable in the past may predict foreign visitors. However, the forecasting of variables on the right hand side of the equation is difficult for visitors.

In Monroe County, there were 1.598 million person-days spent by visitors to that county on natural reefs or about 3.3 times the number using artificial reefs. All of these counties under study made a baseline study of the total number of person-visits for tourists. However, few make forecasts of future tourism. The State of Florida makes short-run forecasts of visitors from out of state, but even these suffer from too short a time period of forecast and not including visitors from other areas of the state. We require a forecast for a sub-area or county within the State of Florida. So, the researcher may have to make her own forecast of visitors to the area over the long-run to guide in

making a forecast of visitors likely to use natural reefs in the future by employing a range of increases in use. But, the H/S Report gives the researcher a good start at the baseline needed and even some of the data that could be used, but remain unpublished.

Benefits Transfer for Other Reef Areas

The H/S Report was prepared at a cost of several hundred thousand dollars. Even though there has never been a report on the "Demand Side" for the four counties studied, with respect to the rich and valuable reef resources, this is still considered quite a lot of money allocated to the social sciences. Many smaller areas simply do not have the resources to do such a study. As stressed above, the main output of a reef is the user value to those that engage in recreation. Can these benefits (i.e., use value) calculated in the H/S Report be transferred to other areas as estimates of reef values?

Other studies have found that use value is positively associated with income per capita and the various attributes of a natural resource. Thus, to reduce the cost of these studies, can one, for example, use the use value per person-day found in the four-county area for Collier or Lee County on the West Coast of Florida? This would be the thrust of benefits transfer. However, we may not know the person-days spent on the new area to which the use value per person-day has been transferred. One could assume that the ratio of person-days to population in one area would be the same as that in the area to which the study is being applied.

Generally, the use value part of a natural resource study is the most expensive because of the expertise needed to make these calculations once the willingness to pay data are collected. Such techniques are, of course, readily available from NOAA, but also need a seasoned researcher to implement them for specific areas that have not been studied. Benefits transfer is also useful in resource damage cases where only a few studies on use value are available in the general area where such damage has taken place. This does not mean that one estimate cannot be transferred thousands of miles or halfway across the world. However, the greater the distance from the initial study and the greater the physical difference between the areas, the more cautious one must be in using "benefits transfer" as a way of getting an inexpensive estimate.

We can test the accuracy of benefits transfer here in Florida by comparing the results obtain from the H/S Report for Southeast Florida with the Bell et al (1998) report done for Northwest Florida or Milon (1988). The latter study restricted the analysis to only "new" artificial reefs off the Miami-Dade coast, so we can only compare the use value for this kind of reef. In addition, the willingness to pay question in Northwest Florida was for a "new" artificial reef, which is only one of several questions asked in Southeast Florida. After adjusting the Bell et al (1998) use value per person-day numbers to 2001 dollars, we have the following results:

A Comparison of Use Value Per Day for New Artificial Reefs

Kind of User	H/S Report	Bell et al Report	Milon
Residents	$0.49	$2.11	N/A
Visitors	$4.94	$3.71	$2.13

Thus, if one used the H/S Report for Northwest Florida (i.e., benefits transfer), one would underestimate resident use value and overestimate visitor use value for "new" artificial reefs. Although the percent differential is very significant for these numbers, it is questionable whether the estimates for visitors are statistically different from each other given the wide statistical error range found in the literature on use value.

If one were very conservative and wished to transfer the use value numbers from Southeast Florida via the H/S Report to Northwest Florida, the researcher might use a range of statistical estimates for the area from which the estimates are transferred. The actual estimates that just happened to be available are most probably within this range.

Also, one could argue that the warmer water combined with richer natural reefs would be attributes of the Southeast reefs that would make adding artificial reefs in Northwest Florida of less user value per person-day than in the Southeast Florida for visitors. And, lacking information on Northwest Florida that the former estimates be reduced by 25-50% by the researcher. For residents, the use value per person-day for new artificial reefs in Northwest Florida may be higher than that for Southeast Florida because Southeast Florida has abundant supplies of both artificial and natural reefs, while Northwest Florida only has artificial reefs. Again, we see the value of intensive studies to see what variables influence use value. Also, we can see how both supply and demand factors determine willingness to pay. For example, on the demand side, we mentioned per capita income, which is much higher in Southeast Florida than in Northwest Florida. This might be an additional reason for lowering the value of our "benefits transfer". However, on the supply side, there would be reason to increase the resident's value. Until studies are done on the relation, if any, between use value per person-day for reefs and the supply of reefs and per capita income, we will not know how much to modify an estimate in one area that is transferred to another where there is a considerable supply or income differences. The seasoned economist would make such adjustments for supply and income.

If we assume for illustrative purposes that user value for "new" artificial reefs rise in proportion to income, then we can look at the income difference and make an adjustment. In 2001, personal income per capita was $31,600 in Southeast Florida compared to only $21, 300 in Northwest Florida, a 32.6% income difference. Since this only applies to residents, our benefit transfer number of $0.49 would fall to $0.33 when the difference in per capita income is taken into consideration compared to an actual number of $2.11. This demonstrates that there are either significant other demand factors or supply factors that explain the differences in willingness to pay for new artificial reefs in Southeast versus Northwest Florida.

Applying this same procedure and percent differential to visitors would drop user willingness to pay by visitors to $3.33, which is somewhat below the Bell et al (1998) estimate for Northwest Florida (i.e., $3.71). Finally, in 1984, Milon (1988) made a limited study of funding "new" artificial reefs for just residents off Miami-Dade County. Adjusted for inflation, Milon found user value per day of $2.13, which was below the $4.94 estimated by the H/S Report, but still, depending on the techniques used, not too far from other estimates. The consistency in the range of results reinforces the case for the use of "benefits transfer".

In the hands of a specialized economist, "benefits transfer" can be a powerful tool, while relatively inexpensive to use for areas where studies presently do not exist. In our illustration above, we see that with some thought the H/S Report for Southeast Florida could be easily used for Northwest Florida, if the Bell et al (1998) had not existed. For Martin and St. Lucie Counties to the north of our H/S Study area, we would have great confidence in "benefits transfer" since income and environmental conditions are so similar. Thus, the H/S Report plays a key role in focusing on the use value per person-day estimates and how they might vary if applied elsewhere for a variety of purposes (e.g., reef damage cases).

We Need an Updated Report: How Do We Do It?

In all likelihood, the H/S Report will not be replicated for several years. Although there should be quarterly monitoring of visitor statistics for evidence of resource decline, we shall not have a new database for several years, if ever. As mentioned, the H/S Report represents the "Demand" side of monitoring the reef resources in Southeast Florida. Hopefully, all disciplines will rely on this report for some time to come and that the White Paper has become a User's Guide for the report in terms of dealing with a variety of issues. From time to time in the near future, a user may want an updated version of the H/S Report that is relevant for that time. In effect, we might be asking for a forecast of what this report would say in 5 years. There will certainly be miscalculations where vessels destroy natural reefs and damage assessment is necessary in the future. So, how do we update the H/S Report? There are several steps that will be outlined below.

First, the H/S Report must be brought up to current dollars. The dollar values for user value or expenditures are in 2001 dollars. Assume it is the year 2006 and we wish to express use value per person-day in 2006 dollars. One can simply go to the web for the multiplier used to update such numbers. Just search for CPI Calculation Machine. This is a product of the Minneapolis Federal Reserve Bank. The researcher can plug in 2001 and get a multiplier for 2006 in terms of the increase in the consumer price index (CPI). Thus, we have made an adjustment in the report for inflation.

Second, examine all per capita values such as user value per person-day. This already will have been adjusted for inflation in the first step. Following our demand equation discussed above, we should look at whether real per capita income (i.e., income in the area adjusted for inflation has risen since 2001). This is the basis for raising the per capita values on user value person-day, for example. Generally, the real willingness to pay will

go up with increases in real per capita income. Make sure to adjust per capita values upward first and then by the CPI Calculation Machine. This will give you per capita indicators in both 2001 and 2006 dollars. Then, you can see how much is due first to increases in real income and then to increases in prices. How much of a real per capita adjustment will depend on the availability of additional studies, the existing literature, or a selection based upon theory. Our section above dealing with "benefits transfer" indicated, perhaps, proportional increases in use value per person-day to that of income (e.g., economist would call this a unitary elasticity of income).

Third, dollar per capita amounts can be approached as we have outlined above, but what about real variables such as person-days. The change in resident person-days on artificial reefs will be governed by increases in population. Thus, we take the ratio of resident person-days on artificial reefs to population for the county subject to the update in 2001 and assuming this ratio is fixed, we can derive the 2006 resident person-days for artificial reefs. This can be done for all other sectors as well. All other things constant, there is usually a one-to-one relationship between population and person-days to make the update for 2006. Of course, since we are in the year 2006, as assumed above, we shall have this population for updating a whole array of real per capita numbers.

Fourth, there are some variables that are more difficult to update, such as employment. As we go from 2001 to 2006, less labor will probably be used because of capital-labor substitution and technological change. Adjustments can be made for employment as well as wages by using 2006 money wages and sales-to-employment ratios in the industries that support directly spending by reef users. For example, if sales-to-employment in the charter boat industry goes up over the 2001-2006 period, then we would not expect employment to grow as fast. Comparing the ratio of inflation adjusted sales-to-employment in 2006 to that in 2001 will tell the researcher how much to adjust employment downward from a one-to-one or proportional relationship.

No doubt all of the above steps will require the 2001 basic spreadsheets upon which to update the H/S Report. Spreadsheets can be programmed with appropriate sources (e.g., CPI Calculation Machine) to periodically update the 2001 results. This is a form of monitoring and comes in handy when numbers must reflect 2003 or 2006 values. Notice that these steps not only deal with dollars, but real variables such as employment that is subject to other real variables, such as technological change. Remember that the update is not a forecast! The reason is that you are in the year of update where normally forecasted variables are actual variables that have already been tabulated (e.g., population; change in sales-to-employment; etc). At some point, the study must be replicated since many assumptions are still used for the update. ***We would recommend an update of the study for reef management purposes to occur every 2-4 years.*** The State Comprehensive Outdoor Recreational Plan or SCORP is updated about every 3-4 years. This plan is used for recreational resource management of especially man-made resources such as docks, boat ramps, beaches and piers, etc.

Government agencies, such as those commissioning the initial H/S Study, would be well advised to do minor revisions in-house, such as expressing 2001 dollars in 2003

dollars, since the time period is short. However, a time period over 3 years would really require someone knowledgeable about the modeling, such as an economist. This is why H/S has provided a technical appendix, which will be available shortly.

We have referred to the Technical Appendix as the H/ST Report, which should be available on NOAA's website in early 2003. It is further recommended that the entire study be completely redone about every 6-7 years since the H/S Report will become less easily updated as time progresses away from the initial study.

ENDNOTES

1. Leeworthy (1991) actually included a number of travel cost model specifications, including different functional forms of the equations, different assumptions about the value of time, and different methods of calculating consumer's surplus (user value per person-day). The report stated that the "best" model estimates ranged from $130.62 to $454.48 in 1989 dollars. In 2002 dollars, this range would be $186.52 to $649.00.

2. The term marine protected areas (MPAs) has now taken on a formal definition. MPAs now apply to any marine area receiving special protections by law or regulation. The 13 National Marine Sanctuaries are considered MPAs by this definition as are National Parks, National Seashores, National Wildlife Refuges as well as many State and local agency managed marine parks and areas. The term "marine reserves" has now become more popular for "no take zones", which often exist within an MPA. The Florida Keys National Marine Sanctuary (FKNMS) is an MPA and there are currently 24 "no take areas" within the FKNMS. In the FKNMS, there are two types of no take areas; 1) Ecological Reserves (ERs) and 2) Sanctuary Preservation Areas (SPAs). ERs attempt to capture an ecosystem, while SPAs are relatively small and don't capture an entire ecosystem, but instead primarily resolve conflicts between user groups. In this report, we use MPAs in referring to no take areas.

3. Sports fishers have been found to be very sensitive to changes in catch rates in cases where the stocks of particular species are in extremely limited supply. See Leeworthy (1990) for the case of King Mackerel in the Gulf of Mexico.

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Socioeconomic Study of Reefs in Southeast Florida - Palm Beach County

BY HAZEN AND SAWYER, P.C. IN ASSOCIATION WITH FLORIDA STATE UNIVERSITY AND NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

This study used extensive survey research over the twelve-month period from June 2000 to May 2001 to measure the economic contribution and the use values of artificial and natural reefs to the economies and the reef users of southeast Florida.

This study was co-funded by the four southeast Florida counties (Palm Beach, Broward, Miami-Dade and Monroe), the Florida Fish and Wildlife Conservation Commission, and the National Oceanic and Atmospheric Administration.

In all of southeast Florida, residents and visitors spent 28 million person-days using artificial and natural reefs during the 12-month period. Of this amount, residents and visitors spent about 4.2 million person-days using the reefs in Palm Beach County, or about 15 percent of the regional total. A person-day is one person participating in an activity for a portion or all of a day.

Artificial and Natural Reef Use in Millions of Person-Days Palm Beach County, Florida - June 2000 to May 2001			
Reef Use by Reef Type	**Artificial Reefs**	**Natural Reefs**	**All Reefs**
	1.41	2.83	4.24
Reef Use by User Type	**Residents**	**Visitors**	**All Users**
	2.98	1.26	4.24
Reef Use by Recreation Type	**Snorkeling**	**SCUBA Diving**	**Fishing**
	0.74	1.73	1.76

Reef-related expenditures generated $194 million in income to Palm Beach County over the 12-month period and created 6,300 jobs.

Economic Contribution of Reefs to Palm Beach County, Florida June 2000 to May 2001 (Generated from Reef-Related Expenditures)		
Sales ($ million)	**Income ($ million)**	**Employment (FT and PT Jobs)**
$505	$194	6,300

Recreational fishers, divers and snorkelers who use Palm Beach County's reefs are willing to pay $31 million per year to maintain these reefs in their existing condition.

Natural reef users are willing to pay $42 million per year to maintain the natural reefs in Palm Beach County. Artificial reef users are willing to pay $9 million per year to maintain the existing artificial reefs and $4.8 million per year to add new artificial reefs to the Palm Beach County system.

Annual User Value to Maintain Reefs in Their Existing Condition - Palm Beach County (million dollars)		
Artificial Reefs	**Natural Reefs**	**All Reefs**
$9	$42	$31

A majority of Palm Beach County resident reef users would support "no take" zones on 20 percent of the natural reef system.

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Socioeconomic Study of Reefs in Southeast Florida - Broward County

BY HAZEN AND SAWYER, P.C. IN ASSOCIATION WITH FLORIDA STATE UNIVERSITY AND NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

This study used extensive survey research over the twelve-month period from June 2000 to May 2001 to measure the economic contribution and the use values of artificial and natural reefs to the economies and the reef users of southeast Florida.

This study was co-funded by the four southeast Florida counties (Palm Beach, Broward, Miami-Dade and Monroe), the Florida Fish and Wildlife Conservation Commission, and the National Oceanic and Atmospheric Administration.

In all of southeast Florida, residents and visitors spent 28 million person-days using artificial and natural reefs during the 12-month period. Of this amount, residents and visitors spent about 9.4 million person-days using the reefs in Broward County, or about 34 percent of the regional total. A person-day is one person participating in an activity for a portion or all of a day.

Artificial and Natural Reef Use in Millions of Person-Days Broward County, Florida - June 2000 to May 2001			
Reef Use by Reef Type	**Artificial Reefs**	**Natural Reefs**	**All Reefs**
	3.98	5.46	9.44
Reef Use by User Type	**Residents**	**Visitors**	**All Users**
	3.72	5.72	9.44
Reef Use by Recreation Type	**Snorkeling**	**SCUBA Diving**	**Fishing**
	1.09	3.85	4.45

Reef-related expenditures generated $1 billion in income to Broward County over the 12-month period and created 36,000 jobs.

Economic Contribution of Reefs to Broward County, Florida June 2000 to May 2001 (Generated from Reef-Related Expenditures)		
Sales ($ million)	**Income ($ million)**	**Employment (FT and PT Jobs)**
$2,069	$1,049	36,000

Recreational fishers, divers and snorkelers who use Broward County's reefs are willing to pay $126 million per year to maintain these reefs in their existing condition.

Natural reef users are willing to pay $83.6 million per year to maintain the natural reefs in Broward County. Artificial reef users are willing to pay $55.9 million per year to maintain the existing artificial reefs and $15.7 million per year to add new artificial reefs to the Broward County system.

Annual User Value to Maintain Reefs in Their Existing Condition - Broward County (million dollars)		
Artificial Reefs	**Natural Reefs**	**All Reefs**
$55.9	$83.6	$126.0

A majority of Broward County resident reef users would support "no take" zones on 25 percent of the natural reef system.

For more information contact:

Pamela Fletcher
Broward County Biological Resources Division
Marine Resources Section
218 S.W. 1st Avenue,
Fort Lauderdale, Florida 33301
(954) 519-1218, phone
pfletcher@broward.org

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Hazen and Sawyer, P.C.
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Socioeconomic Study of Reefs in Southeast Florida : Miami-Dade County

BY HAZEN AND SAWYER, P.C. IN ASSOCIATION WITH FLORIDA STATE UNIVERSITY AND NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

This study used extensive survey research over the twelve-month period from June 2000 to May 2001 to measure the economic contribution and the use values of artificial and natural reefs to the economies and the reef users of southeast Florida.

This study was co-funded by the four southeast Florida counties (Palm Beach, Broward, Miami-Dade and Monroe), the Florida Fish and Wildlife Conservation Commission, and the National Oceanic and Atmospheric Administration.

In all of southeast Florida, residents and visitors spent 28 million person-days using artificial and natural reefs during the 12-month period. Of this amount, residents and visitors spent about 9.2 million person-days using the reefs in Miami-Dade County, or about 33 percent of the regional total. A person-day is one person participating in an activity for a portion or all of a day.

Artificial and Natural Reef Use in Millions of Person-Days Miami-Dade County, Florida - June 2000 to May 2001			
Reef Use by Reef Type	**Artificial Reefs**	**Natural Reefs**	**All Reefs**
	2.95	6.22	9.17
Reef Use by User Type	**Residents**	**Visitors**	**All Users**
	4.51	4.66	9.17
Reef Use by Recreation Type	**Snorkeling**	**SCUBA Diving**	**Fishing**
	2.11	1.14	5.90

Reef-related expenditures generated $614 million in income to Miami-Dade County over the 12-month period and created 19,000 jobs.

Economic Contribution of Reefs to Miami-Dade County, Florida June 2000 to May 2001 (Generated from Reef-Related Expenditures)		
Sales ($ million)	**Income ($ million)**	**Employment (FT and PT Jobs)**
$1,297	$614	19,000

Recreational fishers, divers and snorkelers who use Miami-Dade County's reefs are willing to pay $47 million per year to maintain these reefs in their existing condition.

Natural reef users are willing to pay $47 million per year to maintain the natural reefs in Miami-Dade County. Artificial reef users are willing to pay $10 million per year to maintain the existing artificial reefs and $4.1 million per year to add new artificial reefs to the Miami-Dade County system.

Annual User Value to Maintain Reefs in Their Existing Condition - Miami-Dade County (million dollars)		
Artificial Reefs	**Natural Reefs**	**All Reefs**
$10.3	$46.7	$47.0

A majority of Miami-Dade County resident reef users would support "no take" zones on 20 percent of the natural reef system.

For more information contact:

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Socioeconomic Study of Reefs in Southeast Florida - Monroe County

BY HAZEN AND SAWYER, P.C. IN ASSOCIATION WITH FLORIDA STATE UNIVERSITY AND NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

This study used extensive survey research over the twelve-month period from June 2000 to May 2001 to measure the economic contribution and the use values of artificial and natural reefs to the economies and the reef users of southeast Florida.

This study was co-funded by the four southeast Florida counties (Palm Beach, Broward, Miami-Dade and Monroe), the Florida Fish and Wildlife Conservation Commission, and the National Oceanic and Atmospheric Administration. In all of southeast Florida, residents and visitors spent 28.3 million person-days using artificial and natural reefs during the 12-month period. Of this amount, residents and visitors spent about 5.46 million person-days using the reefs in Monroe County, or about 18 percent of the regional total. A person-day is one person participating in an activity for a portion or all of a day.

Artificial and Natural Reef Use in Millions of Person-Days Monroe County, Florida - June 2000 to May 2001			
Reef Use by Reef Type	Artificial Reefs	Natural Reefs	All Reefs
	1.58	3.88	5.46
Reef Use by User Type	Residents	Visitors	All Users
	3.38	2.08	5.46
Reef Use by Recreation Type	Snorkeling	SCUBA Diving	Fishing
	1.87	0.89	2.62

Reef-related expenditures generated $140 million in income to Monroe County over the 12-month period and created almost 10,000 jobs.

Economic Contribution of Reefs to Monroe County , FL June 2000 to May 2001 (Generated from Reef Related Expenditures)		
Sales ($ million)	Income ($ million)	Employment (FT and PT Jobs)
504	140	10,000

When willingness to pay for each type of reef is considered separately, natural reef users are willing to pay $57.5 million per year to maintain the natural reefs in Monroe County. Artificial reef users are willing to pay $9.75 million per year to maintain the existing artificial reefs and $2.2 million per year to add new artificial reefs to the Monroe County system.

When both types of reefs are considered together, willingness to pay is reduced to $52 million for maintaining existing reefs in there existing condition. This is significantly less than the value of the reefs considered separately.

Annual User Value to Maintain Reefs in Their Existing Condition - Monroe County (Million Dollars)		
Artificial Reefs	Natural Reefs	All Reefs
9.75	57.49	51.78

A majority of Monroe County Resident reef users would support “no take: zones on 20 percent of the natural reef system.

For more information contact:

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Monroe County Marine Resources
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Marathon, Florida 33050
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APPENDICES

APPENDIX A

SURVEY OF POLICY MAKER RESPONSIBLE FOR NATURAL AND ARTIFICIAL REEFS IN THEIR COUNTIES

PURPOSE OF SURVEY:

Recently, the reef system of Southeast Florida has been given increased visibility by economic information generated to show how important the reef system is to the economy. Hazen and Sawyer in Fort Lauderdale prepared this research report containing economic data on the reef system. We shall refer to it in short as the H/S Report. In an effort to see how this information has been received and potentially utilized, NOAA has funded a contract to prepare a White Paper to analyze the reef data and suggest ways to get the community (i.e., government; business and taxpayers) to make the necessary investment to ensure sustainability of outdoor recreation using man-made and natural reef systems. From this analysis, we intend on recommending suggestions on how a bridge may be formed between socioeconomic data and its utilization by resource managers in Palm Beach; Broward; Miami-Dade and Monroe Counties. We have asked Dr. Frederick W. Bell, Professor Emeritus, from Florida State University to prepare the White Paper, which will be provided to user groups with these recommendations. So often, research reports are completed with no directions on how to use the results in practical policy decision making. We hope that this White Paper will be a user's guide to the H/S Report. We ask you to participate in this project by doing two things. First, please fill out the short survey below and send back to Dr. Bell in the enclosed envelop. Second, as a follow-up, meet with Dr. Bell for about one hour in your county within the next several weeks. Dr. Bell will be in contact with you to arrange the on-site discussion. If you have any questions, you may reach Dr. Bell at 850-523-9349 (Tallahassee) or 863-701-9114 (Lakeland). You may e-mail at fwbell@garnet.acns.fsu.edu or FWELLBELL@aol.com for questions and comments. Thank you for your help and cooperation.

Sincerely,

Bob Leeworthy, Chief Economist
NOAA/NOS/Special Projects
1305 East West Highway, SSMC4, 9th floor
Silver Spring, MD 20910
Telephone: (301) 713-3000 ext. 138
Fax: (301) 713-4384
e-mail: Bob.Leeworthy@noaa.gov

SURVEY QUESTIONNAIRE

1. Would you briefly outline your three main responsibilities with respect to the natural and artificial reefs in your marine coastal zones?
   (1) _____
   (2) _____
   (3) _____

2. About how much of your time is spent on physical science as opposed to the socioeconomic areas related to the reef system, including both natural and artificial reefs? _____% Physical Science _____% Socioeconomic

3. We are interested in the amount of financial support which is provided to maintain and support the reef system of your county. By financial support, we are referring to all funding from Federal, State and County sources. For the 2000-2001 Fiscal Year, would you give us the expenditures (e.g., labor; materials; contracts; and sundry other expenses) on the following categories:

   Recurring Cost to Maintain the reef system: $_____K
   What percentage goes toward natural as opposed to artificial reefs? %_____Natural

   Single/Non-Recurring Cost for Special Projects: $ _____K
   What percentage goes toward natural as opposed to artificial reefs? %_____Natural

4. How many natural and man-made or artificial reefs does your county presently have the responsibility for maintaining and enhancing?

   Number of Natural Reefs: _____
   Number of Man-Made or Artificial Reefs _____

5. Late last fall, a report entitled Socioeconomic Study of Reefs in Southeast Florida, which included your county, was produced by Hazen and Sawyer(H/S), a Consultant in Fort Lauderdale. Have you heard of this report? YES_____ NO_____. If "Yes" did you have a chance to read this report? YES___ NO_____?

6. The H/S report estimated that Broward County provided residents with reefs that generated over $270 million in spending and supported 2,474 part and full time jobs in the county.(p. 2-8) Reef-related visitors to your county produced direct and indirect spending of $1.8 billion, which supported 32,999 jobs.(p. 2-48) Thus, all kinds of reefs supported 36,668 full and part-time jobs in Broward County.

Did you have an idea of the magnitude of spending and employment generated by reef resources in Broward County before the H/S report?
(**Circle One**) YES NO

Do you expect to use these measures of economic impact of the reef system for the following areas (**Circle YES or No**)?

YES or NO: Justify more money for building more artificial reefs
YES or NO: Justify more money for enhancing natural reefs by a one-time project
YES or NO: Justify more money for recurring expenses related to both artificial and natural reefs
YES or NO: Do you believe that the H/S report will lead to a greater investment in both artificial and natural reefs in your county from the Federal; State and County governments? If "NO", please explain the rationale for your answer

_____

_____

7. Did you or your county issue a press release to illustrate to the general public economic results of the H/S Report? (**Circle One**) YES NO

8. Was a Broward County elected or appointed official briefed as to the economic results contained in the H/S Report? (**Circle Below**)

YES NO Elected Official (e.g., county commissioner)
YES NO Appointed Official (e.g., county/city manager)

9. The H/S Report covered "**NO-TAKE ZONES**". Among resident reef users in the county, 63.4% said they favored such zones.(p. 2-18) With this knowledge, will you be more favorably inclined to recommend such zones for your county? (**Circle One**) YES NO

10. Before the H/S study, did you know what economist call "**use value**" of a natural resource used for outdoor recreation such as artificial reef or natural reefs? (**Circle One**) YES NO

11. For residents and visitors using the reef system of Broward County, the H/S Report indicated that a reef user received $24 per day in recreational value for uses such as fishing, snorkeling and diving. The reef users spent about 9.4 million days in Broward County and, according to the H/S Report received a grand total annually of $229 million in "**use value**".(p.2-65) Do you think these economic considerations will be taken in account in preparing and adopting future budgets for managing the reef system? (**Circle One**) YES NO.

12. Do you think that elected officials that pass reef budget consider the following when making their determinations? (**Circle One**)

YES NO Support of reef system based upon how much **employment** they generate in the county;

YES NO Support the reef system based upon **overall spending** of those using the reef system;

YES NO Support the reef system based upon annual "**use value**" derived from the natural resource reef system

YES NO Support the reef system based upon **popularity of recreating** on artificial and natural reefs by residents and visitors.
OTHER CONSIDERATIONS (PLEASE SPECIFY)_____

---

13. Do you think other economic studies than the H/S Report are needed to help look at the socioeconomic importance of reef systems? (**Circle One**) YES NO, If "YES", check which kind of economic study you think is needed

_____(1) Economics of "**NO-TAKE ZONES**"

_____(2) Economics of **Deploying Individual Artificial Reefs**
_____(3) Economics of **Businesses Supported** by Spending on the Reef System.
_____(4) Other Economic Studies (Please Indicate Nature in a Brief Statement)
_____
_____
_____

---

14. Sometimes there are conflicts in natural resource use. For example, beach renourishment may conflict with a healthy reef system due to silt and other particle build up. Do you think that the H/S Report can be used as an aid in evaluating the economic damage to the reef system from such renourishment? (**Circle One**) YES NO

15. At present, what is the most prominent policy issue related to the reef system,which is supported by funding from all sources (e.g., deployment of more artificial reefs; adoption of "NO-TAKE ZONES"; repairing damage to natural reefs; enforcement of boating laws related to reef use, etc.)

Description of Policy_____
_____
_____

Annual Appropriations for this policy last fiscal Year $_____K
% of Appropriations Recurring:_____%

16. Do you have any criticisms or problems with the H/S Report? If so, please list them below:
    1._____
    2._____
    3._____
    4._____

17. If you would be so kind, please send any literature, brochures and/or other material to help us better understand your reef programs and expenditures on the reef program. Send information and material to Dr. Frederick W. Bell, 1903 Sherwood Drive, Tallahassee, Fl. 32303 or give this information when Dr. Bell conducts his interview.

THANK YOU FOR YOUR COOPERATION

Survey for Broward County

Signature of Respondent: _____

APPENDIX B

LIST OF GOVERNMENT OFFICIALS INTERVIEWED

Counties:

Broward:

Pamela Fletcher, Broward County Biological Resources Division
Marine Resources Section

Palm Beach:

Julie Bishop, Palm Beach County, Department of Environmental Resources Management

Miami-Dade:

Brian Flynn, Miami-Dade County, Department of Environmental Resources Management

Monroe:

George Garrett
Director-Marine Resources
Monroe County Marine Resources

State of Florida:

Jon Dodrill
Bureau of Marine Fisheries Management
Division of Marine Fisheries
Florida Fish and Wildlife Conservation Commission

Walter Japp
Florida Marine Research Institute
Florida Fish and Wildlife Conservation Commission

Federal Government:

William (Billy) Causey
Brian Keller
Florida Key National Marine Sanctuary
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

APPENDIX C: TABULATION OF SURVEY RESULTS FOR WHITE PAPER

	SOUTHEAST FLORIDA COUNTIES				STATE	STATE	FKNMS
QUESTION ASKED:	P.BEACH	BROW	MIAMI-D	MONROE	ARTIFIC'L	NATURAL	NATURAL & ART.
1.DUTIES OF THE RESPONDENT ADMINISTRATORS	A.REEFS N.REEFS MONITOR	A.REEFS A.CONST MONITOR	A.REEFS N.REEFS MONITOR	A.REEFS N.REEFS MONITOR	A.REEFS ONLY	N.REEF RESTORE N.REEF	IMPLEM'T MGMT PLAN
2.PERCENT OF TIME SOCIOECON	5%	75%	10%	50%	10%	5%	55%
3.ANNUAL BUDGET RECURRING	$25K	$30K	$50K	$200K	$300K	$820K	$480K
% NAT	25%	50%	0%	90%	0%	100%	90%
NONRECURRING	$150K	DK	$30K	DK	DK	$500K	DK
%NAT	0%	DK	0%	DK	100%	100%	SMALL
STATE ART FUND (1995-2001)	$213K	$421K	$132 K	None	$3756K	DK	$480K
4.NUMBER REEFS NATURAL	0	3	?	23SPAS	N/A	N/A	100+
ARTIFICIAL	75	105	160	56	364	N/A	20
5.HEARD OF H/S	YES	YES	YES	YES	YES	YES	YES
READ H/S REPT	YES	YES	YES	YES	YES	YES	YES/NO
6.KNOW ECON IMPACT OF REEFS BEFORE H/S REPT	NO	NO	NO	YES	NO	NO	YES
USE REPORT FOR BUILD'G A.REEF	YES	YES	YES	YES	YES	YES	YES/NO
USE ENHANCE NATURAL REEF	YES	YES	NO	YES	N/A	YES	YES
USE FOR RECURR-ART+NAT	YES	YES	YES	YES	YES	YES	YES
H/S REPT FOR GREATER INVEST	YES	YES	YES	YES	YES	YES	YES
7.PRESS RELEASE	YES	YES	YES	NO	YES	N/A	YES
8.ELECTED BRIEF	YES	NO	YES	YES	NO	N/A	YES
APPOINT BRIEF	YES	NO	YES	YES	YES	N/A	YES
9.RECOMMEND "NO TAKE ZONE"	YES	YES	YES	YES	YES	MAYBE	YES

10.KNOW MEANING OF USE VALUE	NO	NO	NO	YES	YES	YES	YES
11.USE VALUE FOR FUTURE BUDGETS	YES	YES	NO	NO	YES	NO	YES
12.CONSIDER FOR REEF BUDGETS							
EMPLOYMENT	YES	YES	NO	YES	YES	YES	YES
SPENDING	YES	YES	NO	YES	YES	YES	NO
USE VALUE	YES	YES	NO	YES	NO	NO	NO
POPULARITY	YES	YES	YES	YES	YES	YES	YES
13.OTHER ECON STUDIES NEEDED							
NO TAKE ZONES	YES	YES	YES	YES	YES	YES	YES
DEPLOY REEFS	NO	YES	YES	NO	YES	YES	YES
BUS SUPPORTED	NO	YES	DK	NO	DK	YES	YES
MORE ON NAT R	DK	YES	DK	YES	DK	YES	YES
14.USE H/S REPT FOR REEF DAMAGE	YES	NO	YES	YES	YES	YES	YES
15.MOST IMPORT POLICY ISSUE	NO TAKE	DEPLOY A.REEFS	REEF DAMAGE	NO TAKE	REEF DEGRADE	GLOBAL CLIMATE	WATER QUALITY;
ANNUAL $ FOR IMPORT ISSUE	0$K; 0%	$50K;100%	$50k;30%	0$K;0%	0$K;0%	0$K;0$	$1800K; 100%
16.CRITICISMS OF H/S REPORT	NONE	DIFFICULT READING BY NON-ECON	NONE	NONE	REDUCED TO 1-3 PAGES	NONE	CLEARER EXECUT SUMMARY

Appendix D
Discounting, Compounding and Annualizing
In Resource Economics

Discounting:

From time to time, society wishes to make investments in natural resources such as artificial reefs and beach renourishment. By law, many of these decisions must be made using the financial criterion that economic benefits must exceed the economic cost of the investment. It just makes good sense that society should not invest in some asset where the benefits are meager compared to the cost. To illustrate this procedure, let us consider an investment in an artificial reef. The cost of this investment is usually incurred in the year it is deployed; however, there will be maintenance cost over time.

As discussed in the main text of this White Paper, economic benefits from many outdoor recreational resources such as reefs, both natural and artificial, are measured by "use value" which accrues this year, next year and into the future for the recreational user. But, a one dollar return in 3 years, for example, is not equal to a one dollar return this year. Since the recreational user must "wait" for the benefits accruing in 3 years using our example, this distant benefits are not worth their full future value today. Thus, returns "in the future" must be discounted back to the present. Let us say that the deployment of an artificial reef will bring $1 million in user value each year over the next three years. For simplicity, assume the artificial reef must be replaced (i.e., has no more use value) at the end of the three year period. For reefs, beaches and other natural resources, period are much longer, but three will illustrate the principle without using a lot a space.

Now, we must obtained what is called the "present value" of the deployed artificial reef by discounting back to the present. Present value is often called the asset value of the artificial reef since it generates use value (or just economic returns) over the three years used in our example. To discount, we use the following formula:

$$(1) \qquad \text{Economic Benefits/ Use Value (UV)} = \sum_{t=1}^{3} UV(t) \,/\, (1+r)^{t}$$

where,

UV = use value per year
r = discount or interest rate
t = time

All equation one says is that the use value (UV) accruing over the three years must be discounted by the discount or interest rate for each period and then summed to arrive at the present value of the artificial reef. This may be derived by the following calculations using a discount rate in our example of 3%.

(1') Present Value of Artificial Reef = $\frac{(\$1\ mil)}{(1+.03)^1} + \frac{(\$1\ Mil)}{(1+.03)^2} + \frac{(\$1\ Mil)}{(1+.03)^3}$

Notice that in the first year we have t = 1 or that we obtain economic benefit starting at the very beginning of the year . Thus, the calculations would looks as follows:

$2.829 = $.971 Mil + $.943Mil + $.915 Mil

Thus, the present value (PV) or the asset value of the artificial reef is $2.829 Million.

Compounding:

Compounding should be mentioned here since it is the opposite of discounting. Your own savings account with a local bank is a good example of compound since you receive interest as it accrues over time. For example, in the above example, if we invested $2.829 million today at 3% interest, it would be worth $3 Million at the end of three years. Compounding is not often used in making decisions about natural resources; however, it is a more familiar concept to readers than the process of discounting.

Annualizing:

The USACE prefers to annualize the benefits and cost over the during of the policy. For example, in the absence of the discount rate (i.e., r=0), the $1 million at the end of the of the first year, $ 1 million at the end of the second year and $1 million at the end of the third year can be said to have annualized benefits of $1 million over the three years. This may be more familiar to the reader as the monthly payment you make on the mortgage of a house which includes principal and interest. Using our example above, the annualized benefits can be computed using the following formula:

(2) Annualized Benefits $= \{r * (1+r)^t\} / \{(1+r)^t - 1\} * PV$

$1.035 Million $= \{ .03 * (1.03)^3 / (1.03)^3 - 1 \} * \$2.829$ Million

The annualized benefits or user value are $1.035 Million since such economic benefits are equal to what occurs in each year plus interest. If we go through the same procedure for the cost of an artificial reef, then we can express either present value of economic benefits divided by the present value of the economic cost to obtained the benefit/cost ratio. Or, we can annualized. In this case, we merely divided the annualized economic benefits by the annualized economic cost to derive the same benefit/cost ratio. Annualizing gives the analyst an better idea of the returns and cost on an annual basis. This procedure, as mentioned above, is used by the USACE in all of their beach renourishment projects. This may aid the reader in understanding the section of the White Paper dealing with beach renourishment conflicts with reef viability.

APPENDIX E

DEMONSTRATION OF HOW MITIGATION AND RECREATIONAL COST WILL IMPACT THE BENEFIT/COST RATIO FOR BEACH PROJECT IN BROWARD COUNTY, FLORIDA

BASELINE INFORMATION:	MILL $
ANNUALIZED BENEFITS	60.7
ANNUALIZED COST*	7.4
ANNUALIZED MITIGATION COST	0.26338
ANNUALIZED RECREATIONAL LOSSES**	0.076213

IMPACT OF VARIOUS SCENARIOS ON BENEFIT/COST RATIO

INCREASED MITIGATION COST FROM ONE TO ONE		INCREASE RECREATIONAL COST FROM INCLUSION IN BENEFIT/COST RATIO***
ONE TO ONE	8.2 (BASELINE USACE)	8.12 (BASELINE LESS 20 YR. RECOVERY)
TWO TO ONE	7.92	8.04
THREE TO ONE	7.66	7.96
FOUR TO ONE	7.41	7.88
FIVE TO ONE	7.18	7.81
TEN TO ONE	6.05	7.44
FIFTEEN TO ONE	5.35	7.11
TWENTY TO ONE	4.79	6.81

INCREASE IN MITIGATION AND RECREATIONAL COST COMBINED FROM BASELINE

ONE TO ONE	8.12 (BASELINE WITH MITIGATION AND RECREATIONAL COST INCLUDED)
TWO TO ONE	7.84
THREE TO ONE	7.51
FOUR TO ONE	7.21
FIVE TO ONE	6.67
TEN TO ONE	5.62
FIFTEEN TO ONE	4.86
TWENTY TO ONE	4.28

* Includes $.26338 million annualized for mitigation of 13.6 acres of reef; **Assumes 20 years for recovery after mitigation to fully functioning reef; *** Recreational losses added to initial B/C ratio.