

Executive Summary

Investment in and maintenance of public resources is a prime function of government. Artificial and natural reefs are public resources that provide recreational benefits to reef users and income to local economies. This study determined, in a comprehensive manner, the net economic value of southeast Florida's natural and artificial reef resources to the local economies and the reef users. Southeast Florida is defined as the counties of Palm Beach, Broward, Miami-Dade and Monroe. This study area includes, from north to south, the cities of West Palm Beach, Fort Lauderdale, and Miami, and the Florida Keys.

This study employed extensive survey research to measure the economic contribution and the use values of artificial and natural reefs over the twelve-month period of June 2000 to May 2001. The reef users surveyed were boaters who are recreational fishers (commercial fishers were not included), reef divers, reef snorkelers and/or visitors viewing the reefs on glass-bottom boats. This study estimated the following values:

- Use of artificial and natural reefs by residents and visitors in each of the four counties over a twelve-month period as measured in terms of person-days
- Economic contribution of the artificial reefs as residents and visitors spend money in each of the four counties to participate in reef-related recreation
- Economic contribution of the natural reefs as residents and visitors spend money in each of the four counties to participate in reef-related recreation
- Willingness of reef users to pay to maintain the natural reefs of southeast Florida in their existing conditions
- Willingness of reef users to pay to maintain the artificial reefs of southeast Florida in their existing conditions
- Willingness of reef users to pay for investment in and maintenance of additional artificial reefs in southeast Florida
- Socioeconomic characteristics of reef users

Economic contribution is measured by total sales, income, employment and tax revenues generated within each county. In addition, the opinions of resident reef-using boat owners regarding the existence or establishment of "no-take" zones as a tool to protect existing artificial and natural reefs are presented.

This study was funded by each of the four counties, the Florida Fish and Wildlife Conservation Commission through the use of Federal Aid in Sport Fish Restoration funds, and the National Oceanic and Atmospheric Administration through the Socioeconomic Monitoring Program for the Florida Keys National Marine Sanctuary.

Study Methods. This study conducted four surveys as follows:

- Resident boaters – mail survey conducted in the Fall of 2000
- General visitors – intercept survey conducted in the Summer of 2000 and the Winter of 2001
- Visitor boaters – intercept survey conducted in the Summer of 2000 and the Winter of 2001
- Charter / Party boats – mail survey conducted in the Spring of 2001

Visitors are defined as nonresidents of the county that they are visiting. Residents are those who live within the county.

The purpose of the resident boater survey and the visitor boater survey was to collect information to estimate the following characteristics:

- Percentage of all boaters who fish, dive and / or snorkel on the reefs;
- Itemized expenditures in the county related to using the reefs (lodging, food, gas, equipment, etc.);
- Number of person-trips and person-days of reef use by type of reef and activity;
- Willingness of reef users to pay to protect southeast Florida’s natural and artificial reefs in their existing condition;
- Willingness of reef users to pay for additional artificial reefs in southeast Florida; and,
- Socioeconomic characteristics of reef users.

In addition, at the request of the counties, the resident survey also included questions regarding “no-take” zones in southeast Florida and in their counties of residence.

The purpose of the general visitor survey was to obtain estimates of the total number of visitors to each county and the percentage of visitors who boat. This information was necessary to estimate reef use.

The charter/party boat survey was a survey of for-hire operations that take out passengers for recreational fishing, snorkeling, scuba diving and glass-bottom boat rides in saltwater off the coasts of the four counties. The primary purpose of this survey was to estimate the proportion of charter / party service activity that takes place on the artificial versus the natural reefs in each county. The results of this survey were used to allocate charter/party boat fishing days between artificial and natural reefs.

The results of this study are based on the responses to these surveys. The resident mail survey resulted in 2,543 completed surveys. The general visitor intercept survey resulted in 3,855 completed surveys. The visitor boater intercept survey resulted in 2,473 completed surveys. These completed surveys provided sufficient information to estimate the economic value of the reefs to reef users and the economies of each of the southeast Florida counties.

Definitions. Certain terminology is used in this report to represent units of recreational activity. These terms are person-trip and person-day. A person-trip is defined as one person making one trip to a county. That trip may last one day to many days. On any given day, the number of visitor person-trips and the number of visitors are the same. For resident boaters, a person-trip is one day's outing on a boat to participate in saltwater recreation activities. A person-day is defined as one person participating in an activity for a portion or all of a day.

Number of Days People Participated in Recreational Use of the Reefs. The number of person-days of reef use by county and by reef type is presented in Table ES-1. Visitors and residents spent 28 million person-days using artificial and natural reefs in southeast Florida during the 12-month period from June 2000 to May 2001. Reef users spent 10 million person-days using artificial reefs and 18 million person-days using natural reefs. The breakdown of reef use by residents and visitors is provided in Table ES-2. Overall, residents and visitors each spent about 14 million person-days using the reefs of southeast Florida but the proportions vary by county.

A summary of reef use by type of activity is provided in Table ES-3. Overall, fishing activity on the reefs appears to dominate when snorkeling and scuba diving are compared separately. When snorkeling and scuba diving are considered together as diving activities, diving and fishing contribute about equally to total reef use in southeast Florida. In Palm Beach County, diving is a bit more prevalent than fishing while in Miami-Dade County, fishing is more prevalent than diving. In Broward and Monroe counties, the levels of diving and fishing are about equal.

**Table ES-1
Number of Person-Days Spent on Artificial and Natural Reefs in
Southeast Florida
Residents and Visitors by County
June 2000 to May 2001**

County	Number of Person-Days (in millions)		
	Artificial Reefs	Natural Reefs	All Reefs
Palm Beach	1.41	2.83	4.24
Broward	3.98	5.46	9.44
Miami-Dade	2.95	6.22	9.17
Monroe	1.47	3.64	5.11
Total	9.81	18.15	27.96

Table ES-2
Number of Person-Days Spent on All Reefs
Comparison of Visitor Versus Resident Use in Southeast Florida
June 2000 to May 2001

County	Number of Person-Days (in millions)		
	Residents	Visitors	All Users
Palm Beach	2.98	1.26	4.24
Broward	3.72	5.72	9.44
Miami-Dade	4.51	4.66	9.17
Monroe	3.03	2.08	5.11
Total	14.24	13.72	27.96

Table ES-3
Number of Person-Days on All Reefs by Recreational Activity
June 2000 to May 2001 – Residents and Visitors (in millions)

Activity	Palm Beach County	Broward County	Miami-Dade County	Monroe County	Total – Southeast Florida
Snorkeling	0.74	1.09	2.11	1.75	5.69
Scuba Diving	1.73	3.85	1.14	0.83	7.55
Fishing	1.76	4.45	5.90	2.45	14.56
Glass Bottom Boats	0	0.05	0.02	0.08	0.15
Total	4.23	9.44	9.17	5.11	27.95
<i>a Residents were not asked about their participation in glass bottom boat sightseeing. Therefore, glass bottom boats include only visitors.</i> <i>Note: Difference in Total – Southeast Florida between Tables ES-2 and ES-3 is due to rounding (27.96 versus 27.95).</i>					

Glass bottom boat sightseeing is available in Broward, Miami-Dade and Monroe counties. The reported number of person-days associated with viewing the reefs using glass bottom boats applies to visitors, not residents. Resident boaters were not asked for their level of activity on glass bottom boats. Visitors spent about 150,000 person days on glass bottom boats in southeast Florida.

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

The economic contributions of the reefs to each of the counties are provided in Table ES-4. The sales contribution is defined as the value of the additional output produced in the county due to the reef-related expenditures. The total income contribution is defined as the sum of employee compensation, proprietor's income, interest, rents, and profits generated as a result of the reef-related expenditures. Income is the amount of money that remains in the economy. The employment contribution is the number of full-time and part-time jobs created due to the reef-related expenditures.

Table ES-4
Economic Contribution of Reef-Related Expenditures to Each County¹
June 2000 to May 2001 – Residents and Visitors

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

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

¹ *The economic contributions cannot be summed over the four counties to get the total economic contribution of the reefs to southeast Florida. This is because the concept of economic contribution looks at the economy of the individual geographic area as a separate entity from its neighbors. In this study, visitors were asked how much they spent in the county they were visiting. They were not asked how much they spent in the other three counties. Also, visitors to a county can come from one of the other three southeast Florida counties. When looking at southeast Florida as a whole, only the indirect and induced contribution of visitors from outside the four counties can be considered as 100 percent reef-related. To get the economic contribution of the reefs to all of southeast Florida, the southeast Florida expenditures of visitor reef users to southeast Florida would have to be estimated wherein a visitor lives outside the four county area.*

expenditures provided 6,300 jobs in Palm Beach County, 36,000 jobs in Broward County, 19,000 jobs in Miami-Dade County and 10,000 jobs in Monroe County.

In Palm Beach and Miami-Dade counties, artificial reef-related expenditures comprised about a third and natural reef-related expenditures comprised about two-thirds of the economic contribution associated with the reef system. In Broward County, artificial and natural reef-related expenditures contributed equally to the economic contribution of the reef system. In Monroe County, artificial reef-related expenditures comprised about 25 percent of the economic contribution associated with the reef system.

Value that Reef Users Place on the Reefs. In this study, four types of use values were estimated: (1) the value to natural reef users of maintaining the natural reefs in their existing condition; (2) the value to artificial reef users of maintaining the artificial reefs in their existing condition; (3) the value to artificial and natural reef users of maintaining both the artificial and natural reefs in their existing condition; and (4) the value of adding and maintaining additional artificial reefs. In general, use value is the maximum amount of money that reef users are willing to pay to maintain the reefs in their existing condition and to add more artificial reefs to the system. Use value was measured in terms of per party per trip for existing natural and artificial reefs and per party per year for new artificial reefs. For presentation, values were normalized to values per person-day of reef-related activity so that the use values can be compared to use values estimated in other studies. Use value is also presented in aggregate for all users of the reef system.

The reef user values associated with maintaining the reefs in their existing conditions for each county are provided in Table ES-5. Use value per person-day means the value per person-day of artificial, natural or all reef use, as specified in the table. Values for all reefs were taken from statistical analysis of responses to Question 38 of the Visitor Boater Survey: “Suppose that both of the above plans to maintain the natural and artificial reefs in southeast Florida were put together into a combined program...If your total costs for this trip would have been \$___ higher, would you have been willing to pay this amount to maintain the artificial and natural reefs?” The dollar values provided to the respondents were rotated from respondent to respondent and were \$20, \$100, \$200, \$400, \$1,000 and \$2,000. The responses were then statistically analyzed to calculate average values. Values for artificial reefs were taken from statistical analysis of responses to Question 36 pertaining only to a program to maintain the existing artificial reefs in their current condition. Values for natural reefs were taken from statistical analysis of responses to Question 34 pertaining only to a program to maintain the natural reefs in their current condition. For the individual reef types (artificial or natural), the dollar values provided to the respondents were rotated and were \$10, \$50, \$100, \$200, \$500, and \$1,000.

Table ES-5
Annual Use Value From June 2000 to May 2001 and Capitalized Value associated With Reef Use
Southeast Florida – Residents and Visitors

Item	Palm Beach County	Broward County	Miami-Dade County	Monroe County	Total^a
All Reefs - Artificial and Natural					
Person-Days of Reef Use (in millions)	4.24	9.44	9.17	5.11	27.96
Use Value Per Person-Day	\$7.34	\$13.35	\$5.12	\$9.87	\$9.10
Annual Use Value in million dollars	\$31.30	\$126.02	\$46.95	\$50.44	\$254.51
Capitalized Value @ 3 percent Discount Rate in billion dollars	\$1.0	\$4.2	\$1.6	\$1.7	\$8.5
Artificial Reefs					
Person-Days of Reef Use (in millions)	1.41	3.97	2.95	1.47	9.80
Use Value Per Person-Day	\$6.47	\$14.07	\$3.50	\$6.36	\$8.63
Annual Use Value in million dollars	\$9.09	\$55.86	\$10.33	\$9.35	\$84.63
Capitalized Value @ 3 percent Discount Rate in billion dollars	\$0.3	\$1.9	\$0.3	\$0.3	\$2.8
Natural Reefs					
Person-Days of Reef Use (in millions)	2.83	5.47	6.22	3.64	18.15
Use Value Per Person-Day	\$14.86	\$15.16	\$7.54	\$16.34	\$12.74
Annual Use Value in million dollars	\$42.12	\$83.60	\$46.71	\$55.22	\$227.65
Capitalized Value @ 3 percent Discount Rate in billion dollars	\$1.4	\$2.8	\$1.6	\$1.8	\$7.6

^a Use Value per Person per Day is the average among the counties.

Note: Use value per person day means per person day of artificial, natural or all reef use. Values for all reefs taken from statistical analysis of responses to Question 38 of Visitor Boater Survey: Suppose that both of the above plans to maintain the natural and artificial reefs in southeast Florida were put together into a combined program...If your total costs for this trip would have been \$___ higher, would you have been willing to pay this amount to maintain the artificial and natural reefs. Values for artificial reefs taken from statistical analysis of responses to Question 36 pertaining only to a program to maintain the existing artificial reefs in their current condition. Values for natural reefs taken from statistical analysis of responses to Question 34 pertaining only to a program to maintain the natural reefs in their current condition. Therefore, the sum of the values for the individual reef programs may be different from the value for both programs. These results were estimated using the logit model. Alternate methods of estimation are provided in the Technical Appendix to this report.

Visitor and resident reef users in Palm Beach County are willing to pay \$31 million per year to maintain both the artificial reefs and the natural reefs in their current condition by maintaining water quality, limiting damage to reefs from anchoring, and preventing overuse of the reefs. When the projects to protect the artificial and natural reefs are considered separately, visitor and resident reef users are willing to pay \$9 million to protect the artificial reefs and \$42 million to protect the natural reefs.

Visitor and resident reef users in Broward County are willing to pay \$126 million per year to maintain both the artificial reefs and the natural reefs in their current condition by maintaining water quality, limiting damage to reefs from anchoring, and preventing overuse of the reefs. When the projects to protect the artificial and natural reefs are considered separately, visitor and resident reef users are willing to pay \$56 million to protect the artificial reefs and \$84 million to protect the natural reefs.

Visitor and resident reef users in Miami-Dade County are willing to pay \$47 million per year to maintain both the artificial reefs and the natural reefs in their current condition by maintaining water quality, limiting damage to reefs from anchoring, and preventing overuse of the reefs. When the projects to protect the artificial and natural reefs are considered separately, visitor and resident reef users are willing to pay \$10 million to protect the artificial reefs and \$47 million to protect the natural reefs.

Visitor and resident reef users in Monroe County are willing to pay \$50 million per year to maintain both the artificial reefs and the natural reefs in their current condition by maintaining water quality, limiting damage to reefs from anchoring, and preventing overuse of the reefs. When the projects to protect the artificial and natural reefs are considered separately, visitor and resident reef users are willing to pay \$9 million to protect the artificial reefs and \$55 million to protect the natural reefs.

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

The sum of the values for the individual reef programs can be different from the value for the combined programs. This result is not inconsistent with the literature on embedded values. Randall and Hoehn (1992) have shown that this type of result is consistent with economic theory. The combined programs have exceeded the income constraints of many respondents and/or many respondents had value for only one of the programs. So we conclude that our estimated values for the natural and artificial reefs valued separately and together are valid estimates. Bear in mind that willingness to pay for the combined programs is a different scenario from willingness to pay for the individual programs.

The capitalized value of the reef user values is equal to the present value of the annual values calculated at three percent discount rate. It represents the “stock” value analogous to land market values. The capitalized reef user value for all southeast Florida reefs is \$8.5 billion. Bear in mind that this value only includes the value that reef users place on the reefs and does not include the values that non-reef-users place on the reefs or the economic contribution of the reefs. The estimation of the value of the reefs to non-reef users was not part of this study.

Visitor and resident reef users’ willingness to pay to invest in and maintain “new” artificial reefs is provided in Table ES-6. The use value per person-day is the value per day or a portion of a day of artificial reef use. In Palm Beach County, reef users are willing to pay \$4.8 million annually for this program in Palm Beach County. Broward County reef users are willing to pay \$16 million per year while Miami-Dade County reef users are willing to pay \$4.1 million per year. Monroe County reef users are willing to pay \$2.1 million annually per year to fund this program in Monroe County. These values are those that are appropriate to use in a benefit-cost analysis of providing new artificial reefs.

Table ES-6
Estimated Use Value of Investing in and Maintaining "New" Artificial Reefs
Southeast Florida – Residents and Visitors

Item	Palm Beach County	Broward County	Miami-Dade County	Monroe County	Total ^a
Person-Days of Artificial Reef Use (in millions)	1.40	3.97	2.95	1.47	9.80
Use Value Per Person-Day for "New" Artificial Reefs	\$3.37	\$3.95	\$1.38	\$1.46	\$2.72
Annual Use Values for "New" Artificial Reefs in million dollars	\$4.78	\$15.70	\$4.07	\$2.14	\$26.69
Capitalized Value @ 3 percent Discount Rate in million dollars	\$158.0	\$523.5	\$135.4	\$71.5	\$888.4

^a Use Value per Person per Day is the average among the counties.

Note: Use value per person-day is a day or portion of a day of artificial reef use.

Resident Opinions of “No Take” Zones. Both the economic contribution and the use value of the reef system are based upon its management or lack thereof. In each of the four counties, resident reef-users were asked questions regarding “no take” zones. A “no take” zone is a designated area of the reef system in which nothing is to be taken from this area including fish and shellfish.

Because the reefs play a vital role in the entire oceanic ecosystem by providing habitat and protection for young fish and other creatures, it is argued that “no-take” zones would actually increase recreational, commercial, and natural resource benefits even though takings would be banned in certain areas. No one knows exactly where and to what degree “no-take” zones must be employed to increase net benefits. As a result, “no-take” zones have become a controversial issue. Therefore, as part of this study, resident respondents were asked their opinions regarding the establishment of “no-take” zones as a management tool for artificial and natural reefs in southeast Florida.

These opinions are summarized in Table ES-7. It is apparent from this table that a majority of resident reef-users endorse the idea of “no-take” zones in their county and in the other southeast Florida counties. A majority of residents would support “no take” zones on 20 to 25 percent of the existing natural reefs. About 75 percent of respondents in all counties supported the existing “no take” zones in the Florida Keys. About 60 percent of respondents supported “no take” zones in their own counties and about the same percentage supported “no take” zones on some of the reefs in Palm Beach, Broward and Miami-Dade counties. Such a result provides public officials with information important to the management of the reef system from Palm Beach County to Monroe County.

Table ES-7
A Summary of the Opinion of Resident Reef-Users on
"No Take" Zones in Southeast Florida, 2000

Question: "Support Existing "No Take" Zones in the Florida Keys"			
County	Percentage of Respondents Answering "Yes"	Percentage of Respondents Answering "No"	Percentage of Respondents Answering "Don't Know"
Palm Beach	76%	15%	9%
Broward	75%	18%	7%
Miami- Dade	74%	19%	7%
Monroe	78%	18%	4%
Question: "Support "No Take" Zones on Some Reefs in Your County"			
County	Percentage of Respondents Answering "Yes"	Percentage of Respondents Answering "No"	Percentage of Respondents Answering "Don't Know"
Palm Beach	65%	23%	12%
Broward	63%	27%	10%
Miami- Dade	61%	28%	11%
Monroe ¹	57%	21%	22%
Question: "Support "No Take" Zones on Some Reefs off Palm Beach, Miami-Dade and Broward Counties"			
County	Percentage of Respondents Answering "Yes"	Percentage of Respondents Answering "No"	Percentage of Respondents Answering "Don't Know"
Palm Beach	65%	21%	14%
Broward	64%	24%	12%
Miami- Dade	61%	28%	11%
Monroe	44%	39%	17%
Question: "What Percentage of Coral or Natural Reefs in Your County Would Be Reasonable to Protect Using "No Take" Zones?"			
County	Average Percentage	Median Percentage	
Palm Beach	30%	20%	
Broward	35%	25%	
Miami- Dade	30%	20%	
Monroe	32%	20%	

¹ Since Monroe County already has "no take" zones, the word "additional" was inserted into this question for Monroe County surveys.

Demographic Characteristics of Reef Users. Demographic characteristics were obtained from the resident boater survey and the visitor boater survey. They are summarized in Tables ES-8 and ES-9. The typical reef user is a non-Hispanic white male, in his forties, with an annual household income from \$55,000 to \$90,000. However, the demographic picture provided in Table ES-8 also shows that females, non-whites and Hispanic persons also use the reefs. Visitor reef-users tend to be younger than resident reef users. Also, larger proportions of visitors than residents are women and/or non-white.

Table ES-8
Demographic Characteristics of Resident and Visitor Reef-Users in Southeast Florida, 2000

Median Age of Respondent	Resident Reef-Users			Visitor Reef-Users		
Palm Beach	48			41		
Broward	48			39		
Miami-Dade	46			41		
Monroe	54			44		
Sex Of Respondent	Resident Reef-Users			Visitor Reef-Users		
	Male	Female		Male	Female	
Palm Beach	91%	9%		79%	21%	
Broward	92%	8%		77%	23%	
Miami-Dade	93%	7%		75%	25%	
Monroe	86%	14%		70%	30%	
Race Of Respondent	Resident Reef-Users			Visitor Reef-Users		
	White	Black	Other	White	Black	Other
Palm Beach	97%	0%	3%	94%	2%	4%
Broward	93%	2%	5%	89%	7%	4%
Miami-Dade	88%	1%	11%	83%	7%	10%
Monroe	94%	0.2%	5.8%	95%	2%	3%
Percent Hispanic/Latino	Resident Reef-Users			Visitor Reef-Users		
Palm Beach	4%			5%		
Broward	5%			13%		
Miami-Dade	33%			29%		
Monroe	7%			8%		
Median Household Income	Resident Reef-Users			Visitor Reef-Users		
Palm Beach	\$71,695			\$87,500		
Broward	\$72,310			\$87,500		
Miami-Dade	\$69,722			\$55,000		
Monroe	\$56,393			\$87,500		

From Table ES-9, it is clear that residents have been boating in southeast Florida for a significantly longer period of time than visitors – about 22 years versus 7 years. Overall, visitor and resident boat owners have similar sized boats and both resident and visitor reef users have about the same probability of belonging to a fishing or diving club.

**Table ES-9
Boater Profile of Resident and Visitor Reef-Users in Southeast Florida, 2000**

Average Years Boating in South Florida		
County	Residents	Visitors
Palm Beach	21	9
Broward	22	7
Miami-Dade	25	7
Monroe	22	7

Average Length of Boat Used for Salt Water Activities in Feet		
County	Residents	Visitors
Palm Beach	25	25
Broward	25	27
Miami-Dade	23	26
Monroe	24	22

Percentage of Respondents Who Belong to Fishing and/or Diving Clubs		
County	Residents	Visitors
Palm Beach	20%	24%
Broward	19%	12%
Miami-Dade	18%	6%
Monroe	15%	11%