Chapter 6: Social and Economic Effects of Ecological Reserves on Commercial Fisheries in Dry Tortugas

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INTRODUCTION AND BACKGROUND

This chapter describes and characterizes the human dimensions of Dry Tortugas before and after the implementation of the Tortugas Ecological Reserves (TER). A major goal of this integrated assessment was to determine social and economic consequences, and more specifically, if short-term economic losses occurred to fishers displaced by the reserves. The locations of the no-take reserves in Dry Tortugas were selected to minimize adverse socioeconomic effects, but short-term economic losses to consumptive users still were hypothesized to occur because 391-km^2 of marine waters was closed to commercial and recreational fishing. Two complementary approaches were used by separate teams of social scientists[A] to determine socioeconomic impacts of TER implementation. One team focused on commercial fisheries and conducted statistical analyses of catch landings and revenues reported by fishers before and after TER implementation, as well as the use of *in situ* surveys and monitoring with pre and post spatial distributions of catch. The second team focused on recreational industry and conducted *in situ* surveys of tour guides operating in the Tortugas region before and after TER implementation. Assessments of social and economic impacts of the TER on recreational fisheries are summarized in Chapter 7 of this report.

Although the two teams of social scientists used the findings of Leeworthy and Wiley (2000) as the baseline to determine pre versus post TER impacts, the teams evaluated the commercial and recreational industries differently. The commercial fisheries team took a more quantitative approach that supplemented the baseline data found in Leeworthy and Wiley (2000) with data from several other sources and used five-year pre and post data periods to determine trends in fisheries landings and revenues. Additionally, other factors, including assessments of the biophysical trends, were used to explain observed trends in commercial fisheries. In contrast, the recreation industry team qualitatively evaluated the effects of the TER on recreational activities and purposely did not use quantitative information for pre to post TER comparisons. The recreational team argued that there were too many factors that could explain observed changes in recreational activity and that the quantitative measures could be misinterpreted. Instead, the recreational team conducted *in situ* surveys of charter boat captains that operate in the Tortugas area to determine whether or not the TER affected their businesses.

Marine reserves can have varying levels of socioeconomic impacts on a region depending on the overall condition of the economy. Thus, macroeconomic conditions that determine the overall demand for goods and services should be considered when conducting assessments of the socioeconomic impacts of marine reserves. This chapter (1) summarizes and describes the overall condition of the economy of South Florida and its effect on the demand for goods and services before and after the implementation of the TER; and (2) presents detailed analyses of (a) commercial landings and revenues to fishers reported for Dry Tortugas area between 1997 and 2006, (b) macroeconomic conditions that may have affected revenue streams from commercial fisheries, and (c) the knowledge, perceptions, and attitudes of commercial fishers before and after TER implementation. Analyses of commercial fisheries data excluded areas inside Dry Tortugas National Park (DRTO) because commercial fishing has been prohibited within park boundaries since 1992.

1. NOAA/NOS/Office of National Marine Sanctuaries
2. NOAA/NOS/NCCOS/CCMA Biogeography Branch
3. Consolidated Safety Services, Inc.

A. Socioeconomic team was divided into two sub-teams. The Commercial Fisheries Team includes Bob Leeworthy from NOAA's Office of National Marine Sanctuaries, Thomas J. Murray of Thomas J. Murray & Associates, Inc. and the Virginia Institute of Marine Sciences, and Manoj Shivlani from the University of Miami Rosenstiel School of Atmospheric and Marine Sciences. The Recreation Industry Team included David K. Loomis and Christopher Hawkins from the University of Massachusetts Amherst, Douglas Lipton from the University of Maryland, and Robert B. Ditton from Texas A & M University.

MACROECONOMIC CONDITIONS AFFECTING REVENUES FROM DRY TORTUGAS COMMERCIAL FISHERIES AND IMPLICATIONS FOR THE TORTUGAS ECOLOGICAL RESERVES

Condition of Overall Economy

A key factor in assessing the socioeconomic impacts of the TER pre to post establishment is the general condition of the economy. Referred to as macroeconomic conditions, these economic measures could be important factors in determining the demand for goods and services from the Tortugas area and the Florida Keys in general both for the recreation-tourist industry and the commercial fisheries. Sources of demand include both local, state and national areas as well as international areas. Here, a simple look at the macroeconomic conditions in the local Monroe County economy, the state of Florida's economy and the U.S. economy is presented. The changes in real per capita income and real average wages per job (real meaning adjusted for inflation and converted to 2006 dollars) were evaluated. Additionally, changes in unemployment rates were examined; and because the Tortugas is a remote location, diesel fuel prices were also a focus. The pre and post TER periods were defined as two, five-year periods with pre TER including years 1997-2001 and post TER including years 2002-2006. At the time of this assessment, some of the data were not available for 2006.

Measures of Macroeconomic Condition

Real Per Capita Income

The demand for recreation-tourist activities and commercial fishing products may be a function of real per capita income. Real per capita income increased pre to post TER in the U.S., Florida and Monroe County. Real per capita income was higher in Monroe County than either in the entire state of Florida or in the U.S., and increased faster over the entire 1997-2006 period in Monroe County versus the state and the U.S. (Table 6.1). Looking at annual changes, real per capita income declined in 2001, 2002 and 2003 in the U.S. and the state of Florida. Real per capita income declined in 2001 and 2002 in Monroe County, but rebounded in 2003. Given these declines in real per capita income, declines in recreation-tourism demand and the demand for some commercial fishing products like spiny lobsters or shrimp for these years might be expected, holding all other factors constant. Increases in total population, for example, could offset the impact from the decline in real per capita income, and as seen with the commercial shrimp fishery, real prices for shrimp collapsed due largely to increases in imports of shrimp.

Table 6.1. Real per capita income for the U.S., Florida and Monroe County 1997 - 2006.[1]

Year	U.S. (2006 $/Person)	Florida (2006 $/Person)	Monroe County (2006 $/Person)
1997	$31,823	$30,778	$37,267
1998	$33,250	$32,142	$40,317
1999	$33,808	$32,544	$40,439
2000	$34,937	$33,373	$43,321
2001	$34,789	$33,314	$42,287
Pre TER Ave.	**$33,721**	**$32,430**	**$40,726**
2002	$34,508	$33,283	$41,463
2003	$34,476	$33,187	$42,003
2004	$35,315	$34,721	$46,077
2005	$35,581	$35,096	$47,426
2006	$36,272	$35,798	N/A
Post TER Ave.	**$35,230**	**$34,417**	**$44,242**
Post - Pre	**$1,509**	**$1,987**	**$3,516**
Post - Pre % Change	**4.47**	**6.13**	**8.63**

1. Real per capita income is adjusted for inflation using the Consumer Price Index for All Urban Consumers. Per capita income is converted to 2006 dollars.

Real Average Wages Per Job

Over the past two decades, the distribution of income has changed with a marked increase towards those who are in the upper five percent of the income distribution. Trends in real per capita income may have lost some of their meaning for explaining the general demand for goods and services. An alternative measure is the real average wage per job. As with real per capita income, real average wage per job also increased from pre to post TER in the U.S., Florida and Monroe County (Table 6.2). The real average wage per job also increased faster in Monroe County than in the state of Florida or the U.S. However, unlike real per capita income, real average wage per job is lower in Monroe County than in the state of Florida or the U.S. reflecting the lower wage recreation-tourist service sector jobs (see Table 6.2). The general declines in real per capita income

for years 2001, 2002 and 2003 were not as evident in the real average wage per job. The real average wage per job declined in 2001 and 2002 in the U.S. and declined in 2001 in Monroe County, but steadily increased from 1997 to 2006 for the state of Florida.

Unemployment Rates

Another measure for looking at the general state of the macro economy is unemployment rates. The trend in unemployment rates tells a story somewhere between that of real per capita income and real average wage per job. Unemployment rates increased in 2001, 2002 and 2003 corresponding to the declines in real per capita income for the U.S. Unemployment rates increased in 2001 and 2002 for both the state of Florida and Monroe County (Table 6.3).

Diesel Fuel Prices

Much of the for hire recreation industry and the commercial fisheries depend on diesel fuel as a key input of production. The Tortugas area is generally a long way from the home ports of suppliers in both industries. The real prices for diesel fuel increased significantly from pre to post TER. This may have had an impact in the decision to go out to the Tortugas area for both the for-hire recreation-tourist industry operators and the commercial fishing operations. The average real price per gallon of diesel increased 2.0% during the pre TER period and 16.9% over the post TER period (Table 6.4).

Summary of Macroeconomic Conditions

Generally, there was an overall improvement in macro economic conditions pre to post TER. However, the individual years of 2001 and 2002 and sometimes extending into 2003 were generally relatively poor economic times and may have had an impact on recreation-tourist demand and the demand for commercial seafood products.

Table 6.2. Real average wages per job for the U.S., Florida and Monroe County 1997 - 2006.[1]

Year	U.S. (2006 $/Job)	Florida (2006 $/Job)	Monroe County (2006 $/Job)
1997	$37,505	$33,336	$28,510
1998	$38,851	$34,617	$29,911
1999	$39,659	$34,746	$30,379
2000	$40,644	$35,467	$31,261
2001	$40,503	$35,625	$30,764
Pre TER Ave.	**$39,432**	**$34,758**	**$30,165**
2002	$40,509	$36,146	$31,682
2003	$40,724	$36,551	$32,379
2004	$41,400	$37,333	$33,465
2005	$41,439	$37,761	$34,713
2006	N/A.	N/A	N/A
Post TER Ave.	**$41,018**	**$36,948**	**$33,060**
Post - Pre	**$1,586**	**$2,189**	**$2,895**
Post - Pre % Change	**4.02**	**6.30**	**9.60**

1. Real average wage per job is adjusted for inflation using the Consumer Price Index for All Urban Consumers. Average wage per job is converted to 2006 dollars.

Table 6.3. Unemployment rates for the U.S., Florida and Monroe County, 1997-2006.

Year	U.S. Percent	Florida Percent	Monroe County Percent
1997	4.9	5.0	2.4
1998	4.5	4.5	2.7
1999	4.2	4.0	2.3
2000	4.0	3.8	2.9
2001	4.7	4.7	3.4
Pre TER Average	**4.5**	**4.4**	**2.7**
2002	5.8	5.7	3.9
2003	6.0	5.3	3.3
2004	5.5	4.7	3.0
2005	5.1	3.8	2.7
2006	4.6	3.3	2.5
Post TER Average	**5.4**	**4.6**	**3.1**
Post - Pre	**0.9**	**0.2**	**0.3**

Socioeconomic Analysis of Commercial Fisheries in Dry Tortugas

Data Collection, Definition of Study Areas and Statistical Analyses

To assess the impacts of reserves on commercial fisheries, information on fishing effort, costs (fuel prices), landings and ex-vessel revenues were compiled from a variety of sources for the entire Dry Tortugas, Tortugas Ecological Reserve Study Area (TERSA), Monroe County, Florida and the state of Florida. The Dry Tortugas area comprises grid areas 2.0, 2.8 and 2.9 as defined by Florida's Marine Fisheries Institute (FMRI, but hereaf-

ter referred to as FWRI)[B] for data collection. The TERSA encompasses a 3,503-km^2 (1,020 square mile) area in Dry Tortugas selected by the Florida Keys National Marine Sanctuary (FKNMS) for analyzing five different alternatives, one of which became the TER (Leeworthy et al., 2001). The TERSA excludes the DRTO where commercial fishing has been banned since 1992.

Socioeconomic data for commercial fisheries were compiled at a spatial resolution of 1 nm^2 for reef fishes, spiny lobster (*Panulirus argus*), shrimp, King Mackerel (*Scomberomorus cavalla)* and stone crabs. All data were entered into a GIS and were linked to economic models to estimate the socioeconomic impacts of various no-take area boundaries. In 2000, these data and models were used to predict future potential socioeconomic impacts of various alternatives that were being considered for the no-take areas (Leeworthy and Wiley, 2000).

Table 6.4. Diesel prices, retail prices for the lower Atlantic 1997 - 2006.[1]

Year	CPI: 1982-1984=100[2]	CPI: 2006=1.00	Nominal Price[3]	Real Price[4]	Annual % Increase
1997	160.5	0.7961	112.7	141.6	N/A
1998	163.0	0.8085	101.1	125.0	-11.7
1999	166.6	0.8264	106.8	129.2	3.4
2000	172.2	0.8542	145.0	169.8	31.4
2001	177.1	0.8785	137.1	156.1	-8.1
Pre TER Avg.	**167.9**	**0.8327**	**120.5**	**144.8**	**2.0**
2002	179.9	0.8924	128.0	143.4	-0.9
2003	184.0	0.9127	147.5	161.6	12.7
2004	188.9	0.9370	175.7	187.5	16.0
2005	195.3	0.9688	236.2	243.8	30.0
2006	201.6	1.0000	265.0	265.0	8.7
Post TER Avg.	**189.9**	**0.9422**	**190.5**	**202.2**	**16.9**

1. U.S. Department of Energy, Energy Information Administration. http://www.eia.doe.gov.
2. Consumer Price Index (CPI), All Urban Consumers, U.S. City Average, U.S. Department of Labor, Bureau of Labor Statistics. http://www.bls.gov.
3. Nominal price is not adjusted for inflation. Price is cents per gallon.
4. Real price is adjusted for inflation using the CPI and converting to 2006 dollars. Price is cents per gallon.

Sources of Information

Commercial Fishing Panels: An important source of information for this assessment was the Socioeconomic Research and Monitoring Program for the FKNMS (http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/commercial_fishing/fishing_panels.html). Prior to the implementation of the FKNMS in 1998, the program began collecting baseline socioeconomic data to assess the status of commercial fisheries in the Florida Keys through in-person surveys of commercial fishers organized into four panels, one of which included Dry Tortugas (Table 6.5). The goal of the study was to monitor the impacts of sanctuary regulations on commercial fishers and to assess impacts of the proposed reserves on their fisheries catch and financial performance. Selected participants were representative of the commercial fishers in each location and provided information on total weight of catch by species and grid location, total revenue generated by species, cost of fishing, net earnings from fishing and other related socioeconomic information. Interview surveys were conducted through

Table 6.5. Description of commercial fisher panels surveyed by the Socioeconomic Research and Monitoring Program for the Florida Keys National Marine Sanctuary (FKNMS, http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/commercial_fishing/fishing_panels.html). Survey data were collected through a contract with Thomas J. Murray & Associates, Inc. and a sub-contract with Manoj Shivlani from the University of Miami, Rosenstiel School of Marine and Atmospheric Sciences (UMRSMAS).

Survey Panel	Description
General Fishermen	Fishermen with active saltwater product licenses (SPLs) who did not fish in the Sanctuary Preservation Areas (SPAs) or the Sambos Ecological Reserve (ER) within the FKNMS. Fishermen that fished in Dry Tortugas were excluded from this group because no-take reserves were being considered for that area.
Sambos Fishermen	Fishermen with active SPLs who fished in the Sambos ER prior to July 1997 when the Sambos ER's no-take regulations went into effect.
Tortugas Fishermen	Fishermen with active SPLs who fished in the area generally known as Dry Tortugas (as geographically defined by the Florida Wildlife Research Institute (FWRI) statistical grids 2.0 and 2.9 for gathering information through the trip ticket program).
Marine Life Collectors	Fishermen with active SPLs who report collecting marine species for the aquarium trade.

B. The Florida Marine Research Institute (FMRI) was renamed Florida Fish and Wildlife Research Institute (FWRI) on July 1, 2004.

a contract with Thomas J. Murray & Associates, Inc. and a sub-contract with Manoj Shivlani from the University of Miami, Rosenstiel School of Marine and Atmospheric Sciences (UMRSMAS). A total of eight years of data from fisher interviews (1998-1999 through 2005-2006) were available for this assessment.

Socioeconomic data from the commercial fishing panels for the TERSA hereafter is referred to as microeconomic data. Microeconomic data were collected within two time strata: baseline or pre TER versus post TER to provide detailed synoptic views on individual fishing operations that occurred before the TER, but then were displaced after the reserves were implemented. The baseline microeconomic data were collected for the year July 1, 1998 to June 30, 1999 (1998-1999) while the post TER microeconomic data were collected for the year July 1, 2004 through June 30, 2005.

In contrast, socioeconomic data from commercial fishing panels and other sources for the Tortugas area, Monroe County and state of Florida hereafter are referred to as macroeconomic data. Macroeconomic data are reported in calendar years (January 1 through December 31), thus exact comparisons between macroeconomic and microeconomic data for a given year were not possible.

Additionally, the commercial fishing panels were resurveyed by Thomas Murray and Associates, Inc. and Manoj Shivlani through a Marine Fisheries Initiative grant from the NOAA National Marine Fisheries Service (NMFS).The study included year six of the commercial fishing panels plus a pre versus post comparison of commercial fisheries in the Tortugas region (Thomas J. Murray & Associates, Inc., 2006). Thomas Murray and Manoj Shivlani also replicated a 1995-1996 study on the knowledge, attitudes, and perceptions of regulations and management strategies of the FKNMS (Shivlani et al., 2008). A summary of the data obtained from these studies were also included in this chapter.

State of Florida Trip Ticket Information System: Data on harvest (measured in pounds), exvessel value of landings, and number of fishing trips for total landings by species and area of catch for both Monroe County and the state were obtained from the state of Florida's Trip Ticket Information System on an annual basis.[C] Since 1984, FWRI has been collecting data on commercial fisheries landings and fishing effort. Florida law (Chapters 370.021, .06(2)(a), 370.07(6)(a), and Administrative Code 68E-5.002):

> "...require that all sales of seafood products from the waters of Florida must be reported on a Marine Fisheries Trip Ticket at the time of sale. Trip tickets include information about the harvester, the dealer purchasing the product, the date of the transaction, the county in which the species was landed, time fished and pounds of each species landed for each trip. Completed tickets are mailed to the Florida Fish and Wildlife Conservation Commission, where the data are processed and stored" (http://research.myfwc.com/features/view_article.asp?id=23423).

NMFS Commercial Landings Database: Macroeconomic data on commercial landings and imports of shrimp were obtained from NFMS database of annual commercial landing statistics (NMFS, 2007a,b) to determine overall trends in shrimp landings and imports in the U.S., Gulf of Mexico and Florida (http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html). Data obtained included annual weight and ex-vessel dollar value of landings identified by species. This information was included to help explain annual changes in prices and total revenues received by fishers in the Tortugas during the years before and after implementation of the TER.

Published Studies: Several published reports were reviewed to obtain information on temporal trends in socioeconomic data for the study areas covered by this assessment. The studies reviewed are listed in Table 6.6. The macroeconomic data from Florida's Trip Ticket information for all saltwater product license holders (SPLs) is considered reliable, with only a small subset unreported by area of catch (Leeworthy and Wiley, 2000). Unlike the approach used in the baseline assessment (Leeworthy and Wiley, 2000), the macroeconomic data were used to provide a broader spatial view of the Tortugas area, rather than limiting the analysis to the

C. Catch by area from the FMRI includes statistical grids: 1.0, 1.1, 1.9, 2.0, 2.9, 3.0, 3.1, 3.2, 3.9, 748, 748.1, and 748.9 for Monroe County. The quality of this data has varied over time and improved over the recent past. Most recent data on landings includes 99% of the commercial catch being identified by reporting grid.

Table 6.6. Sources of macroeconomic[1] and microeconomic[2] information used for Tortugas Integrated Assessment.

Fisheries databases
[1] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute Trip Ticket database. Data summaries were obtained through personal communications with Jim Waters at the NOAA Fisheries, Southeast Fisheries Science Center. This was required because we were not allowed access directly to the "trip ticket" database because of rules to protect the proprietary nature of the data.
[1] National Marine Fisheries Service (NMFS). 2007b on-line database of commercial fishing statistics. http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html.
Published Reports
[1,2] Leeworthy, Vernon R. and Wiley, Peter C. 2000. Proposed Tortugas 2000 Ecological Reserve: Final Socioeconomic Impact of Alternatives. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects, Silver Spring, MD. October 2000, pp.157. http://coastalsocioeconomics.noaa.gov/core/reserves/tortugas.pdf.
[1] National Marine Fisheries Service (NMFS). 2007a. Fisheries of the United States, 2006. Current Fishery Statistics No. 2006. Office of Science and Technology, Fisheries Statistics Division, Silver Spring, MD. July 2007, pp. 119.
[2] Shivlani, Manoj and Tonioli, Flavia. 2007. 2003-04 and 2004-05 Florida Keys National Marine Sanctuary Commercial Fishing Panels' Spatial Fishery Profiles. April 4, 2007, pp.36. http://data.nodc.noaa.gov/coris/library/NOAA/CRCP/project/1812/fknms_commercial_fish_panel_spatial_profile_2003-05.pdf.
[2] Thomas J. Murray & Associates, Inc. 2006. Tortugas 2000 – A Post Mortem: Evaluation of Actual versus Projected Socioeconomic Impacts of the Dry Tortugas Ecological Reserve, Final Report. Report under MARFIN Grant NA04NMF4330079, December 31, 2005, Revised May 2006, pp.31. http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/tortugasmarfin.pdf
[2] Thomas J. Murray & Associates, Inc. 2007. Socio-economic Baseline Development Florida Keys National Marine Sanctuary: Years 1998-2006. Commercial Fishing Panels. June 30, 2007, pp27. http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/commfishpan7and8.pdf.
[2] Shivlani, M., Leeworthy, V.R., Murray, T.J., Suman, D.O., and Tonioli, F. 2008. Knowledge, Attitudes and Perceptions of Management Strategies and Regulations of the Florida Keys National Marine Sanctuary by Commercial Fishers, Dive Operators and Environmental Group Members: A Baseline Characterization and 10-year Comparison. Marine Sactuaries Conservation Series ONMS-08-06. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. 170 pp. http://sanctuaries.noaa.gov/science/conservation/pdfs/kap2.pdf
1. Source of macroeconomic data; 2. Source of microeconomic data

TERSA. This broader perspective allowed assessment of any shifts in fishing grounds used by fishers and any substitution across the species occurred.

The original baseline study, which was based on data from 1997, predicted several potential socioeconomic impacts of the TER (Leeworthy and Wiley, 2000). A longer time series would have been preferable, but that was not possible because catch data reported in the Florida Trip Ticket database prior to 1997 contained incomplete information about the grid-location of catch. In 1994, only about one-third of all catch was reported by grid area. Reporting of catch by area improved to about 63% in 1995, to 96.3% in 1996 and to 99.9% in 1997. Overall, 1997 was a relatively good year for the commercial fisheries in Florida. Thus it was expected that any projections of impact might be overestimated.

The macroeconomic data were also used to track individual SPLs to determine the distributions of economic impact among fishers and to assess dependency of fishers on the Tortugas fishing grounds relative to other fishing grounds. This approach addressed both spatial and inter-species substitution by fishers in the region, who mostly fish for multiple species in multiple fishing grounds.

The macroeconomic data were supported with the microeconomic data from several of the surveys noted above to provide additional details about the economic impacts on individual fishing operations that were displaced by the TER. The microeconomic dataset included detailed information on harvest; costs-and-earnings; investment in boats and equipment, spatial distribution of catch, and demographic profiles of the fishermen. It also contained information fishers' knowledge, attitudes, and perceptions of regulations and management strategies in the FKNMS. Full citations for the publications used in the analysis of the microeconomic data are listed in Table 6.6.

Results and Discussion

Overall Characterization of Commercial Fisheries

Number of Fishing Operations or SPLs: The total number of fishing operations, as measured by the number of SPLs, fishing in the Tortugas areas (FWRI areas 2.0, 2.8 and 2.9) has fluctuated over the 1997-2006 period, but overall there has been a downward trend. This is consistent with the trends in the entire state of Florida. The average number of SPLs fishing in the Tortugas region declined by about 12% from 601 SPLs during the pre TER period to 531 SPLs during the post TER period. The decline in the number of SPLs was less during the post TER period than during the pre TER period. During the pre TER period, the number of SPLS declined by 37%, while during the post TER period, the decline was 2.18% (Table 6.7).

Table 6.7. Number of saltwater product licenses (SPLs) pre versus post TER.

Year	SPLs	Change in SPLs	% Change in SPLs
1997	657	-	-
1998	665	8	1.22
1999	597	-68	-10.23
2000	529	-68	-11.39
2001	556	27	5.10
Pre TER Average	**601**	**-101**	**-15.37**
2002	504	-52	-9.35
2003	543	39	7.74
2004	567	24	4.42
2005	546	-21	-3.70
2006	493	-53	-9.71
Post TER Average	**531**	**-11**	**-2.18**

Dependence on the Tortugas Area: Fishing in the Tortugas area appeared to be opportunistic. Many of SPLs holders, who entered and exited the commercial fishery, caught very little within the Tortugas and may not have been heavily dependent on that area for their fishing revenues. In the pre TER period, 1,436 different SPL holders fished the Tortugas area during 1997 to 2001 (Table 6.8). Twenty-six percent of these SPLs received 79% of the total ex-vessel revenues from the Tortugas area (Table 6.8). This ratio is very close to the 20-80 rule of thumb found to characterize most commercial fisheries, i.e. that 20% of the fishermen catch 80% of the fish.

Table 6.8. Distribution of average revenues for all Tortugas fishermen: pre TER (1997-2001).

Ex-vessel Value of Catch	Number of SPLs	% of SPLs	Sum of Avg. Revenues	Percent of Revenues
GT $0	1,436	100.0	$62,677,154	100.0
GE $250,000	38	2.6	$11,660,897	18.6
GE $100,000	190	13.2	$36,493,437	58.2
GE $50,000	373	26.0	$49,567,073	79.1
GE $20,000	622	43.3	$57,806,282	92.2
LT $20,000	814	56.7	$3,967,282	6.3
LT $5,000	530	36.9	$805,508	1.3
LT $1,000	257	17.9	$98,509	0.2

NOTE: GT=Greater than, GE=Greater than or Equal to, LT=Less than; Average ex-vessel revenue was $43,019.

Table 6.8 shows the distribution of revenues received by SPLs across all species caught in the Tortugas areas for the pre TER period. Almost 57% of the SPLs accounted for only 6.3% of the revenues and each of these SPLs received less than $20,000 in total revenue per year over the pre TER period from their catch in the Tortugas area. Almost 18% of SPLs caught less than $1,000 worth of fish and shellfish from the Tortugas area, which represents only a fraction of one percent of the total revenues received by SPLs from catch in the Tortugas area. Only 26% of SPLs received more than $50,000 per year and only 13.2% received $100,000 per year, so the overwhelming majority of SPLs are not highly dependent on the Tortugas area alone for their fishing revenues.

In the post TER period, the number of SPLs fishing in the Tortugas area declined by 299 (21%) from a pre TER level of 1,436 to 1,137 in the post TER period. The distribution of revenues received by SPLs was not much different between pre and post TER, but there was slightly more dependency in the post TER period with a greater proportion of SPL holders having received $50,000 to $100,000 or more in fishing revenues from the Tortugas area (Table 6.9). The overall average ex-vessel revenue received by SPL holders increased from $43,019 in the pre TER period to $47,733 in the post TER period or about a 10% increase. This increase was not adjusted for inflation.

Another way of measuring a change in the dependence of SPL holders on the Tortugas area is to determine whether any change occurred in the spatial distribution of fishing revenues for SPL holders that fished in the Tortugas. Before implementation of the TER, SPL holders that fished in the Tortugas area derived 28.87% of their total fishing revenues from the area (Table 6.10). These fishers increased the proportion of their revenues derived from the Tortugas region to 31.04% after the TER was implemented. The increase in revenues from the Tortugas was accompanied by a decrease in fishing revenues from other areas such as Key West and "other Florida" areas. The spatial shift toward increased dependence on the Tortugas for additional fishing revenues was true across all species and for each species/species group for which fishing was prohibited. The King Mackerel fishery experienced the largest spatial shift in revenue after the TER was implemented. During the pre TER period, SPL holders received only 26.41% of their King Mackerel fishing revenues from the Tortugas compared with 56.77% during the post TER period. Thus, SPL holders that fished the Tortugas subsequently became more dependent on that area for their fishing revenues after implementation of the reserve.

Table 6.9. Distribution of average ex-vessel revenues for all Tortugas fishermen: post TER (2002-2006).

Ex-vessel Value of Catch	Number of SPLs	% of SPLs	Percent of Revenues
GT $0	1,137	100.0	100.0
GE $250,000	27	2.2	15.4
GE $100,000	176	15.4	57.4
GE $50,000	348	30.5	80.0
GE $20,000	579	50.8	94.0
LT $20,000	558	49.2	6.0
LT $5,000	319	28.2	1.0
LT $1,000	120	10.5	0.1

NOTE: GT=Greater than, GE=Greater than or Equal to, LT=Less than; Average ex-vessel revenue was $43,019.

Table 6.10. Distributions of revenues of catch by species/species groups and waterbodies: pre versus post TER.

Species/ Period	Waterbodies (Percent of Catch)									
	Tortugas	Key West	Marathon	Everglades	Miami	Ft. Myers	Tampa	Other FL	Other States	Unknown
Reef Fish										
Pre	17.10	12.85	0.83	7.95	2.14	13.98	31.01	13.25	0.12	0.76
Post	18.69	7.76	1.39	8.99	1.79	18.50	27.90	14.65	0.13	0.20
Spiny Lobster										
Pre	39.84	44.92	7.72	3.65	1.98	1.31	0.02	0.45	0.00	0.10
Post	48.91	35.30	10.51	2.57	2.04	0.27	0.02	0.38	0.00	0.00
Shrimp										
Pre	37.78	3.75	0.03	3.36	0.02	9.02	7.23	37.22	1.58	0.01
Post	39.87	1.70	0.01	2.24	0.03	13.72	8.79	31.89	1.74	0.001
King Mackerel										
Pre	26.41	42.57	0.60	11.51	0.66	0.07	0.19	17.92	0.06	0.002
Post	56.77	21.07	0.24	7.00	0.52	0.57	0.04	13.72	0.08	0.00
Stone Crab										
Pre	2.99	29.27	8.43	44.86	1.37	4.79	0.90	0.86	0.00	0.05
Post	6.63	26.97	11.04	49.86	0.52	2.76	1.02	1.20	0.00	0.01
Non Reef Fish[1]										
Pre	10.77	14.72	1.33	6.32	1.95	2.81	5.77	51.82	2.20	2.30
Post	24.49	8.61	3.29	3.93	0.99	4.61	8.30	34.71	6.61	4.46
All Species										
Pre	28.87	14.38	2.18	7.64	0.89	7.54	8.79	28.33	1.03	0.34
Post	31.04	10.97	3.26	9.13	0.84	10.82	10.86	21.09	1.47	0.51

1. Non reef fish include all non reef fish, excluding King Mackerel.

The shift demonstrates the spatial substitution referenced in Leeworthy and Wiley (2000) in their baseline assessment and projection of the potential socioeconomic impact of the TER. Even in the face of displacement from the TER, a higher proportion of fishing revenues were derived from the Tortugas area not less as would have been expected if the TER had a negative short-term impact on the commercial fisheries. This issue will be examined further to determine what happened to the total amount of revenues derived from the Tortugas pre versus post TER.

Changes in Total Ex-vessel Revenues Pre and Post TER: The amount of revenues that fishermen receive for their catch is called ex-vessel revenues. Ex-vessel revenues are equal to the pounds of fish and/or shellfish landed multiplied by the price per pound. Total ex-vessel revenues from all catch in the Tortugas area declined from pre to post TER. Almost the entire decline was due to the decline in the price of shrimp, which accounted for, on average, 67% of total ex-vessel revenues from catch in the Tortugas area in the pre TER period and 55% in the post TER period (Table 6.11). There was an increase in revenues from reef fish, King Mackerel, stone crabs and all other species. Declines were experienced in spiny lobster as well (Table 6.12).

Table 6.11. Total ex-vessel value of landings Tortugas areas 1997-2006.

Year	All Species Nominal Value (Millions $)	All Shrimp $ Nominal Value (Millions $)	% Shrimp of Total	All Species Real Value (Millions 2006 $)	All Shrimp Real Value (Millions 2006 $)
1997	$32.5	$24.2	74.5	$40.82	$30.40
1998	$32.5	$23.8	73.2	$40.20	$29.44
1999	$25.1	$14.9	59.4	$30.37	$18.03
2000	$22.2	$12.8	57.7	$25.99	$14.99
2001	$24.6	$16.1	65.4	$28.00	$18.33
1997-2001	**$137.0**	**$91.8**	**67.0**	**$164.52**	**$110.24**
2002	$19.9	$12.6	63.3	$22.30	$14.12
2003	$21.4	$13.1	61.2	$23.45	$14.35
2004	$25.8	$14.3	55.4	$27.53	$15.26
2005	$22.9	$11.5	50.2	$23.64	$11.87
2006	$28.7	$13.9	48.4	$28.70	$13.90
2002-2006	**$118.7**	**$65.4**	**55.1**	**$125.99**	**$69.41**

The decline in shrimp prices explains almost all the decline in ex-vessel revenues received from catch from the Tortugas. Prices received for Tortugas-caught shrimp declined from an average real price (adjusted for inflation to 2006 dollars) of $4.30 per pound pre TER to $2.36 per pound post TER (Table 6.12). Although shrimp caught in the Tortugas fetched higher real prices per pound than shrimp caught commercially in the Gulf of Mexico and elsewhere in U.S., the same pattern of declines were evident for the entire shrimp commercial fishery in the U.S.

Table 6.12. Total ex-vessel revenues by species/species group for pre and post TER for all tortugas areas.

	Pre TER Ex-vessel Revenues	Post TER Ex-vessel Revenues	Post - Pre Ex-vessel Revenues
Species/Species Groups	2006 $	2006 $	2006 $
All Species	$164,542,407	$126,008,487	-$38,533,920
Reef Fish	$14,086,203	$16,527,873	$2,441,670
Spiny Lobster	$31,201,871	$25,681,579	-$5,520,292
King Mackerel	$1,714,706	$3,588,489	$1,873,783
Shrimp	$110,231,017	$69,466,015	-$40,765,002
Stone Crab	$1,386,932	$2,949,013	$1,562,081
All Other	$5,939,880	$7,691,057	$1,751,177
NOTE: Pre TER (1997-2001) and post TER (2002-2006).			

The declines in shrimp prices may have been caused by an increase in the supply of imported shrimp. In 1997, U.S. commercial landings of shrimp were a little over 179 million pounds, while imports were about 811 million pounds. By 2006, U.S. commercial landings had only increased to 182 million pounds, while imports increased to over 1.7 billion pounds (NMFS, 2007a).

It will become evident in the report as each fishery is addressed that even though ex-vessel revenues from shrimp caught in the Tortugas decline pre to post TER, actual pounds of shrimp catch increased pre to post TER.

As noted above, not all fisheries in the Tortugas area were characterized by declines in total ex-vessel revenues from pre to post TER periods. Many SPL holders that fish in the Tortugas fish for multiple species/species groups, and it is possible that losses from targeting one fishery species could have been off-set by gains from another fishery species. The changes in total ex-vessel revenues received by each SPL holder that fished in the Tortugas area during the pre and post TER periods were calculated. Overall 558 SPL holders fished in the Tortugas area in both the pre and post TER periods (Table 6.12). Of these, 303 SPL holders (54.3%) lost revenues, while 255 (44.7%) increased revenues after the TER was implemented. On average, SPL holders suffered an overall decline in total ex-vessel revenues of $7,931 with a median loss of $580 from their catch in the Tortugas. The largest loss was $344,719 by a shrimper. However, there were SPL holders that also experienced increases in ex-vessel revenues; one shrimper gained $369,243 after the reserve was implemented (Table 6.13).

Table 6.13. Distribution of the change in ex-vessel revenues able for all Tortugas fishermen for all species post - pre TER.

Change in Ex-vessel Revenue[1]	Number of SPLs	Percent of SPLs
Decreases in Revenues		
$300,000 +	2	0.4
$200,000 - $299,999	11	2.0
$100,000 - $199,999	36	6.4
$50,000 - $99,999	60	10.8
$25,000 - $49,999	47	8.4
$10,000 - $24,999	52	9.3
$5,000 - $9,999	27	4.8
$1 - $4,999	68	12.2
Greater than $0	303	54.3
Increases in Revenues		
Greater than $0	255	45.7
$1 - $4,999	66	11.6
$5,000 - $9,999	29	5.1
$10,000 - $24,999	46	8.1
$25,000 - $49,999	41	7.1
$50,000 - $99,999	44	7.7
$100,000 - $199,999	21	3.8
$200,000 - $299,999	7	1.1
$300,000 +	1	0.2

1. Mean= -$7,931; Median=-$580; Min=-$344,719; Max=+$369,243; Standard error=+ $3,161; N=558.

Essentially for every fisher that lost revenue, one gained revenue. Excluding the losses in the shrimp fishery, there was an overall increase in ex-vessel revenues from catch in the Tortugas area during the post TER relative to the pre TER period. Thus, from this perspective it appears there were no short-term losses to the commercial fisheries caused by establishing the TER. In addition, some hypothesized that fishing congestion would result from displaced fishermen crowding into the remaining open areas in the Tortugas region. The overall decline in the number of SPL holders in the Tortugas region and other parts of Florida, however, suggests that congestion effect did not occur. A reduction in the number of SPLs may overestimate the loss in fishing effort because the microeconomic data on species-specific fishing effort indicate that vessels and equipment may have been consolidated among the remaining SPL holders in the fishery. However, even with this consolidation, total effort has decreased, and the macroeconomic data did not reveal congestion effects except in the spiny lobster fishery.

The remaining sections of this chapter will address this in more detail with focus on each species/species group and will incorporate the microeconomic data. The species/species group macro and microeconomic data were used to examine the pounds of catch, as well as vessel revenues. As a result, it was possible to integrate the assessment results with the physical science data on how stocks of fish and invertebrates have fared in the pre and post TER periods.

Reef Fish Fishery

Leeworthy and Wiley (2000) predicted that reef fisheries in the Tortugas would likely suffer short-term losses caused by congestion effect. However, a comparison of data on reef fish catch and fishing effort before and after implementation of the TER does not support this prediction.

Reef Fish Fishery Macroeconomic Data: Overall, the total catch of reef fish from the Tortugas areas increased from about 5.9 million pounds during the pre-TER period to over 6.8 million pounds during the post-TER period (Table 6.14). The best three years between 1997 and 2006 occurred in the post TER period from 2004-2006. In addition, the real value (adjusted for inflation) of ex-vessel revenues increased as real prices increased slightly from pre to post TER.

Table 6.14. Catch, landings, ex-vessel value and prices for Tortugas Reef.

Year	Caught/Landed	Pounds	Nominal[1] Value ($)	Nominal Price ($/lb)	Real Value[2] (2006 $)	Real Price (2006 $/lb.)
1997-2006	**All Tortugas-Catch**	**12,686,493**	**$27,378,622**	**$2.16**	**$30,614,076**	**$2.41**
1997-2006	**Monroe County Landed**	**10,121,587**	**$21,784,834**	**$2.15**		
1997	All Tortugas	1,160,087	$2,243,965	$1.93	$2,818,697	$2.43
1998	All Tortugas	1,202,454	$2,401,786	$2.00	$2,970,669	$2.47
1999	All Tortugas	1,324,467	$2,632,637	$1.99	$3,185,669	$2.41
2000	All Tortugas	1,011,549	$2,058,732	$2.04	$2,410,129	$2.38
2001	All Tortugas	1,158,311	$2,372,862	$2.05	$2,701,038	$2.33
5-year	**Pre- Total**	**5,856,868**	**$11,709,982**	**$2.00**	**$14,086,203**	**$2.40**
2002	All Tortugas	1,115,238	$2,300,651	$2.06	$2,578,049	$2.31
2003	All Tortugas	1,187,959	$2,479,014	$2.09	$2,716,132	$2.29
2004	All Tortugas	1,637,791	$3,610,665	$2.20	$3,853,431	$2.35
2005	All Tortugas	1,355,518	$3,165,661	$2.34	$3,267,610	$2.41
2006	All Tortugas	1,533,119	$4,112,650	$2.68	$4,112,650	$2.68
5-year	**Post - Total**	**6,829,625**	**$15,668,641**	**$2.29**	**$16,527,873**	**$2.44**
	Post - Pre	**972,757**	**$3,958,659**	**$0.29**	**$2,441,670**	**$0.04**
3 years	**Best Three Years - Pre**	**3,687,008**	**$7,278,388**	**$1.97**	**$8,975,036**	**$2.43**
3 years	**Best Three Years - Post**	**4,526,428**	**$10,888,976**	**$2.41**	**$11,233,692**	**$2.48**
	Post - Pre (Best 3 Years)	**839,420**	**$3,610,588**	**$0.43**	**$2,258,656**	**$0.05**

1. Nominal ex-vessel value and prices are not adjusted for inflation.
2. Real ex-vessel value and prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers. Ex-vessel value and prices are converted to 2006 dollars.

Dependence on the Tortugas Areas: During the pre TER period, 608 SPLs fished in the Tortugas areas. That number declined to 471 SPLs during the post TER period. In the pre TER period only four SPLs (0.5%) caught 50,000 or more pounds in the Tortugas areas (Table 6.15), while nine SPLs (1.7%) caught 50,000 or more pounds in the post TER period (Table 6.16). In the pre TER period, 22.5% of the SPLs that fished in the Tortugas areas caught 80.8% of the catch. This is close to the 20-80 rule often cited in other fisheries throughout the country. In the post TER period, 20.4% of the SPLs that fished in the Tortugas areas caught 77.9% of the total catch. The average pounds of catch per SPL were 4,414 pre TER and increased to 6,564 post TER. Generally, fewer SPL holders were catching more reef fish per SPL pre to post TER.

Table 6.15. Distribution of average pounds of catch for all Tortugas reef fish fishermen: pre TER (1997-2001).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	608	100.0	100.0
GE 50,000	4	0.5	9.5
GE 25,000	23	3.6	32.8
GE 10,000	80	13.0	65.1
GE 5,000	138	22.5	80.8
LT 5,000	470	77.5	19.2
LT 1,000	310	51.0	3.6
LT 500	231	38.0	1.4
LT 100	100	16.4	0.20

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 4,414, with min=6 and max=86,996.

Table 6.16. Distribution of average pounds of catch for all Tortugas reef fish fishermen: post TER (2002-2006).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	471	100.0	100.0
GE 50,000	9	1.7	20.0
GE 25,000	34	7.0	47.5
GE 10,000	97	20.4	77.9
GE 5,000	141	29.7	88.3
LT 5,000	330	70.3	11.7
LT 1,000	204	43.3	2.0
LT 100	63	13.4	0.1

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 6,564 with min=1.0 and max=113,678.

The distribution of ex-vessel revenues tells the same story as the distribution of pounds of catch. Few would seem to rely on reef fish catch from the Tortugas. In the commercial fishing panels (Thomas J. Murray & Associates, Inc., 2007), full-time fishermen had total fishing revenues ranging from $80,000 to $215,000 per year. Very few reef fish fishermen in the Tortugas earned enough from fish caught in the Tortugas to be full-time fishermen (Tables 6.17 and 6.18). Only 0.5% of SPLs received $100,000 or more in revenue from reef fish catch in the Tortugas in the pre TER period, while 1.7% of SPLs received $100,000 or more from their reef fish catch in the Tortugas in the post TER period. Overall, average revenues per SPL from reef fish in the Tortugas increased from $8,974 during the pre TER period to $15,125 during the post TER period.

Table 6.17. Distribution of average revenues for all Tortugas reef fish fishermen: pre TER(1997-2001).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	608	100	100
GE $100,000	4	0.5	9.5
GE $50,000	25	4.9	34.8
GE $20,000	81	13.3	65.9
LT $20,000	527	86.7	34.1
LT $5,000	398	65.5	9.1
LT $1,000	236	38.8	1.4
LT $500	169	27.8	0.5
LT $100	67	11	0.06
LT 100	63	13.4	0.1

1. GT=Greater than; GE=Greater than of Equal to; LT=Less than
2. Average revenues per SPL was equal to $8,974 with min=$10 and max=$155,951.

The spatial distribution of reef fish catch by species groups across South Florida also supports the hypothesis that there were no short-term losses as a result of the TER. Reef fishermen that fished in the Tortugas areas caught 18.14% of their reef fish in the Tortugas areas in the pre TER period and 18.84% in the post TER period (Table 6.19).

All the macroeconomic data shows that reef fish fishers have become more dependent on the Tortugas areas pre to post TER. Fewer SPLs catching both more per SPL and more in aggregate (total pounds of catch) would also indicate that the congestion effect was not experienced as projected in Leeworthy and Wiley (2000). Thus, from the macroeconomic data, there is no evidence that short-term losses have occurred as a result of the TER.

Table 6.18. Distribution of average revenues for all Tortugas reef fish fishermen: post TER (2002-2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	471	100.0	100.0
GE $100,000	9	1.7	21.5
GE $50,000	41	8.3	54.0
GE $20,000	99	21.0	79.9
LT $20,000	372	79.0	20.1
LT $5,000	279	59.2	5.4
LT $1,000	152	32.3	0.7
LT $500	103	21.9	0.3
LT $100	34	7.2	0.03

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average Revenue per SPL was equal to $15,125 with min=$2.20 and max=$317,334.

Reef Fishery Microeconomic Data: The microeconomic data from Thomas J. Murray & Associates, Inc. (2006) reports snap shot pictures of the Tortugas fishery for years 1998-1999 (pre TER) and 2004-2005 (post TER). The TERSA is used for the Tortugas area which is more limited than that used in the macroeconomic data, but it does include the wider area of the FKNMS and the Gulf of Mexico. The microeconomic data show that fewer SPLs were fishing in the TERSA pre to post TER. This is consistent with the macroeconomic data for the larger Tortugas areas. Also, the microeconomic data show that there has been a consolidation of vessels and equipment with a smaller number of SPLs with a lot more vessels and equipment per SPL pre to post TER. Average trip days put on an SPL and vessel basis both declined as well, indicating an overall effort declined. With both the decline in number of SPLs and trip days per SPL, total reef fishery effort declined. Average landings increased from 21,705 lbs per SPL in 1998-1999 (pre TER) to 23,700 pounds per SPL in 2004-2005 (post TER). This again is consistent with the macroeconomic data for all the Tortugas area.

Table 6.19. Distributions of pounds of catch by species/species groups and waterbodies: pre versus post TER.

Species/ Period	Waterbodies (Percent of Catch)									
	Tortugas	Key West	Marathon	Everglades	Miami	Ft. Myers	Tampa	Other FL	Other States	Unknown
Reef Fish										
Pre	18.14	13.81	0.78	7.77	2.87	13.04	29.66	13.06	0.11	0.77
Post	18.84	8.50	1.76	8.62	2.39	17.91	27.04	14.59	0.14	0.20
Spiny Lobster										
Pre	38.80	46.52	7.42	3.60	1.87	1.31	0.01	0.37	0.00	0.11
Post	49.04	35.78	10.04	2.53	1.93	0.29	0.02	0.36	0.00	0.00
Shrimp										
Pre	34.04	4.28	0.05	2.48	0.04	6.56	5.88	45.12	1.52	0.02
Post	40.77	2.30	0.02	1.83	0.07	10.13	5.58	37.76	1.54	0.002
King Mackerel										
Pre	30.56	43.84	0.75	13.44	0.49	0.05	0.15	10.69	0.03	0.002
Post	64.99	18.29	0.19	7.66	0.40	0.29	0.03	8.09	0.06	0.00
Stone Crab										
Pre	3.46	35.07	8.64	44.70	1.12	5.00	0.91	1.04	0.00	0.05
Post	5.97	26.58	10.81	51.19	0.46	2.71	1.09	1.18	0.00	0.01
Non Reef Fish										
Pre	13.14	16.85	0.99	10.12	1.51	3.16	6.48	45.23	1.50	1.04
Post	22.84	9.79	1.88	5.67	2.13	4.57	7.32	40.77	3.07	1.96

On the issue of dependence on the Tortugas, with the limited definition of the Tortugas, dependence on the TERSA declined from 48.1% of reef fish catch in 1998-1999 (pre TER) to 42.9% of reef fish catch in 2004-2005 (post TER). This is not consistent with the macroeconomic data for the Tortugas areas. For capturing spatial substitution, a wider view, as in the macroeconomic data is required.

The microeconomic data also show that fuel expenditures increased significantly, which would have decreased net earnings. Average costs of fuel per trip more than doubled from 1998-1999 (pre TER) to 2004-2005 (post TER) for reef fish fishermen who fished in the TERSA. The real price of diesel fuel for the lower Atlantic increased from a pre TER average of $1.448 per gallon to $2.022 per gallon post TER (U.S. Dept. of Energy, 1997-2006). The distribution of reef fish catch shows that reef fishermen moved to fishing waters closer to the port of Key West in the proportion of their total reef fish catch. This was probably in response to the higher fuels costs.

As with the macroeconomic data, there is no evidence that there were short-term losses to the reef fish fishermen that fished in the Tortugas because of the TER. Even though the macro and microeconomic data show increases in catch and revenues to Tortugas fishermen, it cannot be concluded that the TER was a benefit in the short-term. As was maintained by the biologists in their assessment of the TER, reef fish are too slow growing for the TER to have an effect in the short pre-post comparison presented here. The microeconomic data would seem to supply an explanation.

Thomas J. Murray & Associates, Inc. (2006), developed detailed maps of the distributions of reef fish catch both pre and post TER. When the TIA team of social scientists and biologists met to compare information, the biologists noted that the maps of commercial catch generated by Thomas J. Murray & Associates, Inc. showed that fishermen had shifted to areas that were not being sampled by reef fish biologists. These maps showed that the displacement from the TER had resulted in fishermen visiting areas they never fished before. This explains the discrepancy between the biological assessment of overfishing for reef fish and the macro and microeconomic data showing increases in reef fish catch. What the macro and microeconomic data are showing is the “expansionary phase” of a new fishery. Again, spatial substitution has resulted in mitigating/off-setting any losses from displacement from the TER for the reef fish fishery.

Spiny Lobster Fishery

Leeworthy and Wiley (2000), projected that there would be no short-term negative impact of the TER on the spiny lobster fishery. One of the key factors behind this assessment was the spiny lobster trap reduction program, which intended to reduce the number of lobster traps by 10% per year. A 10% reduction in traps would have made it possible for those who were displaced from the TER to relocate to other fishing spots and avoid the congestion effects of displacement. However, the trap reduction program was put on hold. In addition, hurricanes and disease negatively affected spiny lobster stocks (Ehrhardt, 2005; Johnson et al., 2007) and caused a lagged effect on catch between 2001 and 2003, just before the TER went into effect and for two years after the TER went into effect (Table 6.20).

Spiny Lobster Fishery Macroeconomic Data: Spiny lobster catch from all the Tortugas areas declined from about 5.8 million pounds during the pre-TER years to about 5.1 million pounds during post TER years. As mentioned above, the decline started in the last year pre TER and continued through 2003 (Table 6.20). The spiny lobster fishery in the Tortugas areas began to recover in 2004. A comparison of the best three years of catch before and after TER was implemented show that the losses in catch were about 176,000 lbs. Additionally, overall catch and real value of spiny lobster have been increasing since 2002, with 2006 being the best year since 1997.

When looking at overall ex-vessel revenues received by Tortugas fishers who fished for lobsters, the losses were magnified because real prices received for spiny lobster declined between 1999 and 2005 (Table 6.20). The increase in fuel prices coupled with decreased prices for spiny lobsters, synergistically reduced net revenues for fishers in the Tortugas region.

*Table 6.20. Catch, landings, ex-vessel value, and prices for Tortugas spiny lobster (*Panulirus argus*): pre versus post TER.*

Year	Caught/Landed	Pounds	Nominal[1] Value ($)	Nominal Price ($/lb)	Real Value[2] (2006 $)	Real Price (2006 $/lb.)
1997-2006	**All Tortugas-Catch**	**10,933,392**	**$50,178,468**	**$4.59**	**$56,883,450**	**$5.20**
1997-2006	**Monroe County Landed**	**10,861,224**	**$49,801,406**	**$4.59**		
1997	All Tortugas	1,186,567	$4,724,318	$3.98	$5,934,327	$5.00
1998	All Tortugas	1,080,453	$4,272,516	$3.95	$5,284,497	$4.89
1999	All Tortugas	1,281,549	$5,819,367	$4.54	$7,041,828	$5.49
2000	All Tortugas	1,343,910	$6,632,576	$4.94	$7,764,664	$5.78
2001	All Tortugas	934,243	$4,533,021	$4.85	$5,159,956	$5.52
5-year	**Pre- Total**	**5,826,722**	**$25,981,798**	**$4.46**	**$31,201,871**	**$5.35**
2002	All Tortugas	716,121	$3,352,111	$4.68	$3,756,288	$5.25
2003	All Tortugas	754,142	$3,204,614	$4.25	$3,511,136	$4.66
2004	All Tortugas	1,171,245	$5,012,086	$4.28	$5,349,078	$4.57
2005	All Tortugas	1,047,312	$4,951,460	$4.73	$5,110,921	$4.88
2006	All Tortugas	1,417,850	$7,676,399	$5.41	$7,676,399	$5.41
5-year	**Post - Total**	**5,106,670**	**$24,196,670**	**$4.74**	**$25,681,579**	**$5.03**
	Post - Pre	**-720,052**	**-$1,785,128**	**$0.28**	**-$5,520,292**	**-$0.33**
3 years	**Best Three Years - Pre**	**3,812,026**	**$17,176,261**	**$4.51**	**$20,740,820**	**$5.44**
3 years	**Best Three Years - Post**	**3,636,407**	**$17,639,945**	**$4.85**	**$18,136,398**	**$4.99**
	Post - Pre (Best 3 Years)	**-175,619**	**$463,684**	**$0.35**	**-$2,604,422**	**-$0.45**

1. Nominal ex-vessel value and prices are not adjusted for inflation.
2. Real ex-vessel value and prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers. Ex-vessel value and prices are converted to 2006 dollars.

Dependence on the Tortugas Areas: The number of SPLs fishing for spiny lobsters in the Tortugas areas declined from 332 in the pre TER period to 316 in the post TER period. This follows the trends throughout Florida and Monroe County (Thomas J. Murray & Associates, Inc., 2007). Again, the 20-80 rule seems to characterize the Tortugas spiny lobster fishery, with 19.9 of the SPLs accounting for 78.9% of the catch in the pre TER period and 20.3% of the SPLs accounting for 78.2% of the catch in the post TER period. Eight SPLs caught 50,000 lbs or more in the pre TER period and this declined to seven SPLs in the post TER period (Tables 6.21 and 6.22). The average catch per SPL was 6,829 lbs in the pre TER period and 6,760 lbs in the post TER period.

Table 6.21. Distribution of average pounds of catch for all tortugas spiny lobster fishermen: pre TER (1997 - 2001).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	332	100.0	100.0
GE 50,000	8	2.1	22.7
GE 25,000	33	9.6	61.9
GE 15,000	51	15.1	78.3
GE 10,000	65	19.9	78.9
GE 5,000	84	25.0	92.5
LT 5,000	248	75.0	7.5
LT 1,000	195	58.7	1.6
LT 500	168	50.6	0.8
LT 100	106	31.9	0.2

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 6,829 with min=1.0 and max=94,319.

The distributions on ex-vessel revenues tell a similar story as catch. Using the $100,000 in revenue as defining a full-time fisherman, in the pre TER period 10.8% of SPLs were full-time fishermen, while this declined to 9.8% in the post TER period. The average SPL received $30,518 in the pre TER period and $32,449 in the post TER period. This latter result seems odd, suggesting that the revenue situation improved, but this is a result of

changes in the lower end of the distribution (those who earn less than $20,000 from spiny lobster catch in the Tortugas) declined from 72.9% pre TER to 66.6% post TER (Tables 6.23 and 6.24).

At the same time, those who had revenues between $100,000 and $200,000 declined pre to post TER.

Another way to look at dependence is the overall percent of total spiny lobster catch from the Tortugas areas versus other areas where the fishermen who fish for spiny lobster made their catches pre to post TER. In the pre TER period, Tortugas spiny lobster fishermen made 38.8% of their spiny lobster catch from the Tortugas and this increased to 49% in the post TER period (Table 6.19). Most of the shift seems to be from the Key West area to the Tortugas areas. This seems opposite of what one might have expected given the increases in fuel prices, since the Key West areas are closer to port. However, the microeconomic data from Thomas J. Murray & Associates, Inc. (2006; 2007) shows more refined spatial fishing patterns with their Key West Region defined to include parts of the FWRI Tortugas areas. The microeconomic data show a consistent change in pattern of fishing moving closer to port. Thus, while overall spiny lobster catches declined in the Tortugas and other areas of Florida, for fishermen that fish in the Tortugas areas, they have become more dependent on the Tortugas areas pre to post TER.

Table 6.22. Distribution of average pounds of catch for all Tortugas Spiny lobster fishermen: post TER (2002 - 2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT 0	316	100.0	100.0
GE 50,000	7	1.9	20.5
GE 25,000	25	7.6	49.3
GE 15,000	42	13.0	64.7
GE 10,000	65	20.3	78.2
GE 5,000	100	31.3	89.9
LT 5,000	216	68.7	10.1
LT 1,000	145	45.9	1.6
LT 500	120	38.0	0.7
LT 100	68	21.5	0.1

1. GT=Greater than; GE=Greater than of Equal to; LT=Less than
2. Average pounds per SPL was equal to 6,760, with min=3.0 and max=77,156.

Table 6.23. Distribution of average revenues for all Tortugas spiny lobster fishermen: pre TER (1997 - 2001).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	332	100.0	100.0
GE $300,000	2	0.6	8.0
GE $200,000	12	3.6	32.7
GE $150,000	21	6.3	47.3
GE $100,000	36	10.8	65.3
GE $50,000	63	19.0	84.6
GE $20,000	90	27.1	93.6
LT $20,000	242	72.9	6.4
LT $10,000	222	66.9	3.8
LT $5,000	197	59.3	1.9
LT $1,000	130	39.2	0.4

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $30,518, with a min=$3.74 and max=$446,640.

The macroeconomic data provide a mixed message and the explanation would seem to be that the declines experienced in the spiny lobster fishery from 2001-2004 were the results of hurricanes and disease, which recent trends in catch show that the spiny lobster fishery is now recovering. Therefore, it appears there is no evidence that spiny lobster fishermen suffered from short run losses due to the TER.

Spiny Lobster Fishery Microeconomic Data: The microeconomic data from Thomas J. Murray & Associates, Inc. (2006) shows that in 1998-1999 there were 36 SPLs, who fished for spiny lobster in the TERSA and were sampled versus 21 SPLs in 2004-2005. This decline in number of SPLs is consistent with the macroeconomic data. The average sampled SPL caught 36,153 lbs of spiny lobster pre TER and 27,000 lbs post TER. This decline in the averages is not consistent with the macroeconomic data averages, but is consistent with the overall decline in aggregate catch pre to post TER. Again, as explained above, the macroeconomic data increase in average catch was a statistical artifact influenced by a movement of a large proportion of fishermen, who caught less than $20,000 worth of spiny lobsters in the Tortugas areas in the pre TER period, who started catching more than $20,000 worth of spiny lobsters from the Tortugas areas post TER. Even though there were declines at the upper end of the distribution consistent with the microeconomic data, the movements up from

the lower distribution resulted in higher mean revenues post versus pre TER.

Table 6.24. Distribution of average revenues for all Tortugas spiny lobster fishermen: pre TER(2002 - 2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	316	100.0	100.0
GE $300,000	2	0.6	7.1
GE $200,000	11	3.5	28.4
GE $150,000	15	4.7	34.9
GE $100,000	31	9.8	54.9
GE $50,000	65	20.6	77.7
GE $20,000	106	33.5	91.0
LT $20,000	210	66.5	9.0
LT $10,000	174	55.1	3.9
LT $5,000	142	44.9	1.7
LT $1,000	90	28.5	0.3

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $32,449, with a min=$19.40 and max=$366,776.

The microeconomic data also showed that the average sampled fishermen increased the number of traps they fished with from 1,528 traps in the pre TER period to 1,746 traps in the post TER period. Fishers also increased their average trip days of fishing the traps from 105.8 days to 106.4 days, respectively. Since some SPLs own more than one vessel, average days per vessel were also estimated. The average days per vessel increased from 82.8 pre TER to 85.9 post TER. For the sample, overall catch per unit of effort (CPUE) has declined pre to post TER. However, given the overall decline in the number of SPLs, it is not clear in aggregate whether total effort increased or decreased.

In Thomas J. Murray & Associates, Inc. (2007), an attempt was made to look at CPUE for the aggregate Tortugas areas spiny lobster fishery pre and post TER. Generally, CPUE was lower pre TER to post TER. However, for 2006, CPUE in federal waters was higher than all years in the pre TER period except 1999.

Average trip costs increased significantly from pre TER to post TER, largely because fuel costs more than doubled during that time. With declining CPUE, rising costs per trip and lower prices per pound, spiny lobster fishermen were being squeezed financially from both ends (i.e., receiving less per pound for a lower amount of product and paying higher costs to produce the product).

The microeconomic data also show that fishing has moved closer to the port of Key West. Prior to the TER, 67.1% of reported catch came from the TERSA. After the TER was implemented, 47.0% of reported catch came from the TERSA region. Most of the change in distribution resulted because of increased catch in region two or the Key West region (Thomas J. Murray & Associates, Inc., 2006; 2007). Although region two of the Thomas J. Murray & Associates, Inc., 2006 and 2007 studies are smaller than the FWRI Tortugas areas, it includes some of the FWRI Tortugas areas between Dry Tortugas and Key West. Thus the micro and macroeconomic data on spatial distributions of catch concur and show a movement of fishing closer to the Key West port after the TER was implemented. Alternatively, that movement in fishing effort and catch could be explained by higher fuel prices as well as displacement of fishers by the TER.

With hurricanes, disease, fuel price increase, declines in the price of spiny lobsters, general declines in the number of SPL, and the lobster trap reduction program, it is difficult to assess whether or not the spiny lobster fishery suffered net losses due to displacement from the TER. But with inter-species substitution, spiny lobster fishermen may have been able to mitigate or completely offset any losses by substituting to stone crabs and King Mackerel.

Shrimp Fishery

Leeworthy and Wiley (2000) estimated that only about 1% of the catch by shrimp fishermen that fished in the TERSA would be affected negatively by displacement from the TER. Furthermore, they asserted that shrimp fishers would have no short-term losses if the displaced fishers relocated to other fishing grounds. These conclusions were supported by the macroeconomic data for the Tortugas areas. Total catch of shrimp from all Tortugas areas increased from during the post TER period relative to pre TER catch. Total ex-vessel revenues received from this catch, however, declined significantly from pre to post TER. The decrease in revenues was caused most likely by the collapse in the price of shrimp nationally, which probably resulted from increased

importation of shrimp. Therefore, the shrimp fishery apparently did not suffer any short-term losses due to the TER; and existing data support the original assessment in Leeworthy and Wiley (2000).

Shrimp Fishery Macroeconomic Data: Shrimp catch, primarily pink shrimp, from all Tortugas areas increased from 21.5 million pounds pre TER to almost 26.3 million pounds in the post TER period (Table 6.25). A comparison of the "best" three years in both the pre and post TER periods indicates the post TER catch in the post TER period again exceeds that in the pre TER period, but there the difference is much smaller.

Table 6.25. Catch, landings, ex-vessel value, and prices for Tortugas shrimp: pre versus post TER.

Year	Caught/Landed	Pounds	Nominal[1] Value ($)	Nominal Price ($/lb)	Real Value[2] (2006 $)	Real Price (2006 $/lb.)
1997-2006	**All Tortugas-Catch**	**55,813,771**	**$157,238,858**	**$2.82**	**$179,697,032**	**$3.22**
1997-2006	**Monroe County Landed**	**21,544,889**	**$50,927,248**	**$2.36**		
1997	All Tortugas	5,609,391	$24,200,018	$4.31	$30,398,214	$5.42
1998	All Tortugas	7,833,789	$23,772,591	$3.03	$29,403,328	$3.75
1999	All Tortugas	4,085,844	$14,905,925	$3.65	$18,037,179	$4.41
2000	All Tortugas	3,463,408	$12,825,019	$3.70	$15,014,070	$4.34
2001	All Tortugas	5,267,895	$16,085,815	$3.05	$18,310,546	$3.48
5-year	**Pre- Total**	**26,260,327**	**$91,789,368**	**$3.50**	**$110,231,017**	**$4.20**
2002	All Tortugas	5,438,599	$12,558,524	$2.31	$14,072,752	$2.59
2003	All Tortugas	6,613,754	$13,154,908	$1.99	$14,413,178	$2.18
2004	All Tortugas	6,804,029	$14,268,542	$2.10	$15,227,900	$2.24
2005	All Tortugas	5,343,984	$11,542,466	$2.16	$11,914,189	$2.23
2006	All Tortugas	5,353,078	$13,925,050	$2.60	$13,925,050	$2.60
5-year	**Post - Total**	**29,553,444**	**$65,449,490**	**$2.21**	**$69,466,015**	**$2.35**
	Post - Pre	**3,293,117**	**-$26,339,878**	**-$1.28**	**-$40,765,002**	**-$1.85**
3 years	**Best 3 Years - Pre**	**18,711,075**	**$64,058,424**	**$3.42**	**$78,112,089**	**$4.17**
3 years	**Best 3 Years - Post**	**18,856,382**	**$39,981,974**	**$2.12**	**$43,713,830**	**$2.32**
	Post - Pre (Best 3 Years)	**145,307**	**-$24,076,450**	**-$1.30**	**-$34,398,258**	**-$1.86**

1. Nominal ex-vessel value and prices are not adjusted for inflation.
2. Real ex-vessel value and prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers. Ex-vessel value and prices are converted to 2006 dollars.

The real story from the macroeconomic data is the collapse in shrimp prices from pre TER to post TER. The real price of shrimp received by fishermen declined from an average real price (adjusted for inflation) of $4.20 per pound in the pre TER period to $2.35 per pound in the post TER period. The decline in prices is a national phenomenon. The pre TER average real price for pink shrimp was $4.30 per pound and this declined to $2.36 per pound in the post TER period. Prices for pink shrimp received by fishermen for shrimp from the Tortugas were higher than those received for pink shrimp from the entire Gulf of Mexico or the U.S. However, pink shrimp prices generally plummeted throughout the nation (Table 6.26). The most likely explanation is the rise in imports. Total U.S. commercial fisheries landing for all shrimp were about 179.1 million pounds (heads-off weight) in 1997, while imports were about 810.7 million pounds. By 2006 commercial landings increased slightly to 182.3 million pounds, while imports increased to over 1.7 billion pounds (NMFS, 2007a).

Because of the collapse in prices, total ex-vessel revenues declined significantly from pre to post TER. For the five-year pre TER period shrimp fishermen received over $110 million for their shrimp catch from the Tortugas areas and this declined to about $69.5 million for the five-year period post TER. This is an extremely large loss in revenues and this coupled with the increases in fuel prices have squeezed shrimp fishermen financially from both ends (i.e., receiving less for their total product while paying higher prices for inputs of production).

Table 6.26. Ex-vessel shrimp landings and prices, U.S., Gulf and Tortugas 1997 - 2006.[1]

Year	U.S.		Gulf of Mexico		Tortugas	
	Landings (millions lbs.)	Real Price (2006 $/lb.)	Landings (millions lbs.)	Real Price (2006 $/lb.)	Landings (millions lbs.)	Real Price (2006 $/lb.)
1997	20.65	$3.33	20.05	$3.36	5.57	$5.43
1998	27.65	$2.77	27.11	$2.78	7.81	$3.76
1999	13.50	$3.14	12.70	$3.17	4.02	$4.44
2000	12.75	$3.23	11.69	$3.31	3.42	$4.35
2001	15.98	$2.91	15.21	$2.93	5.16	$3.49
Pre TER Avg.	**18.11**	**$3.08**	**17.35**	**$3.11**	**5.20**	**$4.30**
2002	18.36	$2.08	16.88	$2.10	5.43	$2.59
2003	15.28	$2.02	14.83	$2.01	6.54	$2.18
2004	15.91	$1.93	15.26	$1.94	6.76	$2.23
2005	13.50	$1.97	13.05	$2.00	5.32	$2.23
2006	N/A	N/A	N/A	N/A	5.33	$2.60
Post TER Avg.	**15.76**	**$2.00**	**15.01**	**$2.01**	**5.88**	**$2.36**

NOTE: Real prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers, converted to 2006 dollars. Prices are for pink shrimp.

Dependence on the Tortugas Areas: The number of SPLs that operated in the Tortugas areas declined significantly from 628 pre TER to 436 post TER, about a 30% drop. Shrimping in the Tortugas areas does not follow the 20-80 rule as in other fisheries in the Tortugas. In the pre TER period, 36.5% of the SPLs caught 79.5% of the catch (Table 6.27), while in the post TER period 51.1% of the SPLs caught 86.3% of the catch (Table 6.28). The SPLs caught, on average, 20,612 lbs pre TER and 32,661 lbs post TER. There were 14 SPLs that caught 100,000 or more pounds pre TER and this doubled to 28 SPLs in the post TER period.

Table 6.27. Distribution of average pounds of catch for all Tortugas shrimp fishermen: pre TER(1997 - 2001).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Total Pounds
GT 0	628	100.0	100.0
GE 100,000	14	2.1	12.0
GE 50,000	66	10.4	40.3
GE 20,000	229	36.5	79.5
LT 20,000	399	63.5	20.5
LT 10,000	302	48.1	10.0
LT 5,000	178	28.3	2.9
LT 1,000	59	9.4	0.2

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 20,612 with min=21.0 and max=177,444.

Table 6.28. Distribution of average pounds of catch for all Tortugas shrimp fishermen: post TER (2002 - 2006).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Total Pounds
GT 0	436	100.0	100.0
GE 100,000	28	6.2	24.7
GE 50,000	90	20.4	56.0
GE 20,000	224	51.1	86.3
LT 20,000	212	48.9	13.7
LT 10,000	117	26.8	3.9
LT 5,000	64	14.7	1.2
LT 1,000	8	1.8	0.02

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 32,661 with min=47.0 and max=243,386.

Because of the collapse in shrimp prices discussed above, dependence viewed from a revenue perspective tells a more mixed story. The number of SPLs receiving over $50,000 for their shrimp catch from the Tortugas areas declined from 264 to 222; however, there was a significant move from those who were receiving less than $20,000 to those who received more than $20,000 pre to post TER (Table 6.29 and 6.30). As with the spiny lobster fishery, this change in the distribution of revenues resulted in an increase in the average revenue received by SPLs from $69,537 pre TER to $73,418 post TER. But as noted above, the overall decline in shrimp prices combined with increasing fuel costs probably explains the

consolidation of the shrimp fishery to much fewer SPLs catching more of the shrimp.

Another way to look at fishers' dependence on the Tortugas is to determine temporal changes in the overall percent of total shrimp caught from the Tortugas areas versus other areas where shrimp fishers made their catches. In the pre TER period, Tortugas shrimp fishermen made 34% of their catch from the Tortugas and this increased to almost 41% in the post TER period (Table 6.29 and 6.30). Most of the declines in share of catch were in the aggregate "other Florida" areas, which are north of Tampa in the Gulf of Mexico. A higher proportion of catch was made in the Ft. Myers region pre versus post TER. This trend indirectly suggests that there was a consolidation of the remaining SPLs in the fisheries due to price declines and increasing fuel costs. This consolidation resulted in shrimping activities being based closer to Ft. Myers and Key West, which are close to the Tortugas. Pre to post TER, shrimp fishermen have become more dependent on the Tortugas areas.

From the macroeconomic data, there was no evidence that shrimp fishermen suffered short-term losses from displacement from the TER.

Table 6.29. Distribution of average revenues for all Tortugas shrimp fishermen: pre TER (1997-2001).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	628	100.0	100.0
GE $300,000	11	1.6	8.6
GE $200,000	60	9.4	35.5
GE $100,000	146	23.1	64.5
GE $50,000	264	41.9	84.3
GE $20,000	410	65.1	95.7
LT $20,000	218	34.9	4.3
LT $10,000	126	20.1	1.2
LT $5,000	79	12.5	0.4

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $69,537, with a min=$50.65 and max=$385,905.

Table 6.30. Distribution of average revenues for all Tortugas shrimp fishermen: post TER (2002-2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	436	100.0	100.0
GE $300,000	2	0.2	2.5
GE $200,000	29	6.4	22.5
GE $100,000	117	26.6	61.6
GE $50,000	222	50.7	85.2
GE $20,000	332	75.9	96.7
LT $20,000	104	24.1	3.3
LT $10,000	52	11.9	0.8
LT $5,000	27	6.2	0.2

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $73,418, with a min=$157.45 and max=$427,380.

Shrimp Fishery Microeconomic Data: The microeconomic data from Thomas J. Murray & Associates, Inc. (2006) showed that in 1998-1999 there were 19 SPLs, who fished for shrimp in the TERSA and were sampled versus nine SPLs in 2004-2005. This decline in number of SPLs is consistent with the macroeconomic data. The average sampled SPL caught 192,895 lbs of shrimp pre TER and 119,556 lbs post TER. This decline in the averages is not consistent with the macroeconomic data averages. The sampled shrimp fishermen were from the upper end of the distribution of shrimp fishermen(i.e., the ones that catch relatively large amounts of shrimp). As the macroeconomic data show, there was a significant decline in the number of SPLs from the upper distribution, while overall catch increased pre to post TER.

The microeconomic data also show differences on dependence with a shift of SPLs catching 18% of their catch from the TERSA pre TER to 10% of their catch post TER. Again, the Thomas J. Murray & Associates, Inc. (2006; 2007) spatial area definitions for the Tortugas is more limited. The Thomas J. Murray & Associates, Inc. definition of the Gulf of Mexico region includes FWRI Tortugas area, and they show most of the change in distribution of catch coming from the Gulf of Mexico region. This would make the macro and microeconomic data consistent.

The microeconomic data also confirm the rising costs of fuel and the declining prices received by fishermen for their catch, and its effects on shrimp fishermen's decisions. Thomas J. Murray & Associates, Inc. (2006) illustrates this point with the following excerpt from an interview with an area fisherman:

> "...a September 2005 interview conducted with a shrimp fisher in Key West, Florida. The respondent stated that he had not taken a trip since the fuel price spike following Hurricane Katrina in late August 2005, and that he did not plan to go out until those prices declined or shrimp ex-vessel values increased. At the time, he argued, he would simply be losing income if he were to take a trip."

Based on both the macro and microeconomic data on the shrimp fishery, there were no short-term losses to the shrimp fishery because of the TER.

Inter-Species Substitution

Leeworthy and Wiley (2000) characterized the Tortugas fishery as a multiple-species fishery, one in which many fishermen depended on multiple species/species groups for their livelihoods. Reef fish and spiny lobster fishermen also depended on King Mackerel and stone crabs. Stone crabs were not caught in the TERSA before the TER was implemented. Thus, there was no displacement of stone crab fishing by the TER. King Mackerel, a pelagic species, was caught in the TERSA but also could be caught outside the TER. In addition, King Mackerel caught inside the TERSA (before the TER) were attracted there most likely by discards from the shrimp fishery. Fisheries for stone crabs and King Mackerel were opportunistic and were not directly affected by the TER. However, these fisheries were impacted indirectly because fishermen displaced by the TER increasingly targeted these two species to compensate for losses in catch of reef fish and spiny lobster that resulted from the displacement. Both the macro and microeconomic data show that spiny lobster fishermen that fish the Tortugas areas have become more dependent on stone crabs and King Mackerel, and revenues from these two species have mitigated losses in revenues that may have resulted from displacement by the TER.

King Mackerel Fishery

King Mackerel Macroeconomic Data: King Mackerel catch by SPLs fishing in the Tortugas areas more than doubled from 1.6 million pounds pre TER to almost 3.7 million pounds post TER (Table 6.31). The number of

Table 6.31. Catch, landings, ex-vessel value, and prices for Tortugas King Mackerel: pre versus post TER.

Year	Caught/Landed	Pounds	Nominal[1] Value ($)	Nominal Price ($/lb)	Real Value[2] (2006 $)	Real Price (2006 $/lb.)
1997-2006	**All Tortugas-Catch**	**5,302,515**	**$4,808,840**	**$0.91**	**$5,303,196**	**$1.00**
1997-2006	**Monroe County Landed**	**5,065,128**	**$4,621,363**	**$0.91**		
1997	All Tortugas	248,725	$205,632	$0.83	$258,299	$1.04
1998	All Tortugas	229,262	$222,708	$0.97	$275,458	$1.20
1999	All Tortugas	361,102	$320,598	$0.89	$387,945	$1.07
2000	All Tortugas	166,866	$130,455	$0.78	$152,722	$0.92
2001	All Tortugas	621,429	$548,443	$0.88	$624,295	$1.00
5-year	**Pre- Total**	**1,627,384**	**$1,427,836**	**$0.88**	**$1,714,706**	**$1.05**
2002	All Tortugas	630,437	$558,912	$0.89	$626,302	$0.99
2003	All Tortugas	788,303	$672,224	$0.85	$736,522	$0.93
2004	All Tortugas	731,085	$673,385	$0.92	$718,661	$0.98
2005	All Tortugas	876,315	$829,656	$0.95	$856,375	$0.98
2006	All Tortugas	648,971	$646,826	$1.00	$646,826	$1.00
5-year	**Post - Total**	**3,675,111**	**$3,381,003**	**$0.92**	**$3,588,489**	**$0.98**
	Post - Pre	**2,047,727**	**$1,953,167**	**$0.04**	**$1,873,783**	**-$0.08**
3 years	**Best 3 Years - Pre**	**1,231,256**	**$1,074,673**	**$0.87**	**$1,270,539**	**$1.03**
3 years	**Best 3 Years - Post**	**2,395,703**	**$2,175,265**	**$0.91**	**$2,311,558**	**$0.96**
	Post - Pre (Best 3 Years)	**1,164,447**	**$1,100,592**	**$0.04**	**$1,041,019**	**-$0.07**

1. Nominal ex-vessel value and prices are not adjusted for inflation.
2. Real ex-vessel value and prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers. Ex-vessel value and prices are converted to 2006 dollars.

SPLs catching King Mackerel in the Tortugas increased from 307 SPLs pre TER to 326 SPLs post TER. This is counter to the general trends of declining SPLs in each fishery throughout the state of Florida and Gulf of Mexico region.

Even though nominal prices increased from $0.88 to $0.92 per pound pre to post TER, real prices (adjusted for inflation to 2006 dollars) declined from $1.05 to $0.98 per pound pre to post TER. Total ex-vessel revenues still more than doubled in real terms from $1.7 million to almost $3.6 million mirroring the overall increase in catch (Table 6.31).

As with many fisheries, the distributions of catch by SPLs is close to the 20-80 rule in both the pre and post TER periods with 19.5% of the SPLs having caught 80% of the catch in the pre TER period and 24.2% of the SPLs having caught 84.3% of the catch in the post TER period. On average, SPLs caught 2,992 lbs pre TER and 6,180 lbs post TER (Tables 6.32 and 6.33).

On average, SPLs fishing for King Mackerel in the Tortugas received more ex-vessel revenues pre to post TER. In the pre TER period the average revenue received was $2,620 and this increased to $5,477 in the post TER period. With maximum revenue in the pre TER period of $64,620, very few if any fishermen depend on King Mackerel from the Tortugas to provide full-time employment. Only two SPLs earned$40,000 or more pre TER. This expanded slightly in the post TER period with five SPLs earning $40,000 or more and the maximum was $140,791 (Tables 6.34 and 6.35).

Table 6.32. Distribution of average pounds of catch for all Tortugas King Mackerel: pre TER (1997 - 2001).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	307	100.0	100.0
GE 50,000	4	1.3	27.4
GE 25,000	11	3.6	49.3
GE 10,000	18	5.9	61.1
GE 5,000	29	9.4	69.1
GE 2,000	60	19.5	80.0
LT 2,000	247	80.5	20.0
LT 1,000	200	65.1	4.9
LT 100	96	31.3	0.4

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 2,992 with min=2.0 and max=83,845.

Table 6.33. Distribution of average pounds of catch for all Tortugas King Mackerel fishermen: post TER (2002 - 2006).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Total Pounds
GT 0	326	100.0	100.0
GE 50,000	4	1.2	21.6
GE 25,000	22	6.7	56.2
GE 10,000	44	13.5	72.5
GE 5,000	79	24.2	84.3
GE 2,000	141	42.9	94.6
LT 2,000	185	57.1	5.4
LT 1,000	138	42.3	1.8
LT 100	65	19.9	0.1

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 6,180 with min=2.0 and max=196,062.

Table 6.34. Distribution of average revenues for all Tortugas King Mackerel: pre TER (1997-2001).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	307	100.0	100.0
GE $40,000	2	0.7	13.9
GE $20,000	13	4.2	47.1
GE $10,000	17	6.5	54.3
GE $5,000	35	11.4	70.3
GE $2,500	60	19.5	82.5
LT $2,500	247	80.5	17.5
LT $1,000	191	62.2	6.3
LT $100	87	28.3	0.4

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $2,620, with a min=$1.50 and max=$64,620.

King Mackerel Microeconomic Data: The microeconomic data from Thomas J. Murray & Associates, Inc. (2006) is not completely consistent with the macroeconomic data. The number of SPLs sampled in the post TER period was less than the pre TER period, with 24 SPLs sampled in the pre TER period and only 13 sampled in the post TER period. The average catches pre to post are consistent with respect to the upwards direction of catch pre to post TER, but the magnitudes of change are not as great as in the macroeconomic data. The average catch was 22,481 lbs pre TER and 23,692 post TER. The distributions of where SPLs catch their King Mack-

erel are in agreement with a higher proportion coming from the TERSA (16.4% pre TER and 29.3% post TER) and from the FWRI Tortugas areas (30.56% pre TER and 64.99% post TER). As with other species/species groups, average trip fuel cost almost doubled pre to post TER.

The overall evidence is that the King Mackerel fishery serves as mitigating and/or offsetting factor to the TER displacement for spiny lobster and reef fish fishermen.

Table 6.35. Distribution of average revenues for all Tortugas King Mackerel fishermen: post TER (2002-2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	326	100.0	100.0
GE $40,000	5	1.5	19.7
GE $20,000	23	7.1	46.2
GE $10,000	45	13.8	63.6
GE $5,000	103	31.6	85.3
GE $2,500	141	43.3	92.9
LT $2,500	185	56.7	7.1
LT $1,000	131	40.2	2.1
LT $100	57	17.5	0.1

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $5,477, with a min=$2.50 and max=$140,791.

Stone Crab Fishery

Probably the most important shift in catch was the shift from spiny lobster to stone crabs by spiny lobster fishermen. Previously stone crabs were not caught in the TERSA and so stone crab fishermen were not displaced from the TER. Instead, with spiny lobster stocks down from the impacts of hurricanes and disease, spiny lobster fishermen responded by shifting to stone crabs.

Stone Crab Macroeconomic Data: Stone crabs were not caught west of the Marquesas before the TER was implemented. The Marquesas area was not included in the TERSA, but they are part of the FWRI Tortugas study areas. Stone crab catch increased from 204,622 lbs pre TER to 281,085 lbs post TER (Table 6.36). Besides displacement from the TER and declining spiny lobster stocks, fishermen shifted effort from spiny lobster

Table 6.36. Catch, landings, ex-vessel value, and prices for Tortugas stone crab: pre versus post TER.

Year	Caught/Landed	Pounds	Nominal[1] Value ($)	Nominal Price ($/lb)	Real Value[2] (2006 $)	Real Price (2006 $/lb.)
1997-2006	**All Tortugas-Catch**	**485,707**	**$3,933,389**	**$8.10**	**$4,335,945**	**$8.93**
1997-2006	**Monroe County Landed**	**482,506**	**$3,907,630**	**$8.10**		
1997	All Tortugas	76,000	$202,657	$2.67	$254,562	$3.35
1998	All Tortugas	56,408	$371,640	$6.59	$459,666	$8.15
1999	All Tortugas	34,898	$293,894	$8.42	$355,632	$10.19
2000	All Tortugas	23,274	$202,607	$8.71	$237,189	$10.19
2001	All Tortugas	14,042	$84,100	$5.99	$95,731	$6.82
5-year	**Pre- Total**	**204,622**	**$1,154,898**	**$5.64**	**$1,386,932**	**$6.78**
2002	All Tortugas	10,757	$74,945	$6.97	$83,981	$7.81
2003	All Tortugas	35,603	$322,348	$9.05	$353,181	$9.92
2004	All Tortugas	58,659	$574,277	$9.79	$612,889	$10.45
2005	All Tortugas	72,650	$686,897	$9.45	$709,018	$9.76
2006	All Tortugas	103,416	$1,120,034	$10.83	$1,120,034	$10.83
5-year	**Post - Total**	**281,085**	**$2,778,501**	**$9.88**	**$2,949,013**	**$10.49**
	Post - Pre	**76,463**	**$1,623,603**	**$4.24**	**$1,562,081**	**$3.71**
3 years	**Best 3 Years - Pre**	**167,306**	**$868,191**	**$5.19**	**$1,069,860**	**$6.39**
3 years	**Best 3Years - Post**	**234,725**	**$2,381,208**	**$10.14**	**$2,441,941**	**$10.40**
	Post - Pre (Best 3 Years)	**67,419**	**$1,513,017**	**$4.96**	**$1,372,081**	**$4.01**

1. Nominal ex-vessel value and prices are not adjusted for inflation.
2. Real ex-vessel value and prices are adjusted for inflation using the Consumer Price Index for All Urban Consumers. Ex-vessel value and prices are converted to 2006 dollars.

to stone crabs because of an increase in the real prices (adjusted for inflation) of stone crabs. Real prices for stone crabs increased on average from $6.78 per pound pre TER to $10.49 per pound post TER. Although catch increased a little over 37%, total ex-vessel revenues more than doubled (Table 6.36). The year 2006 was the highest year catch and ex-vessel revenue of stone crabs with ex-vessel revenue topping $1.1 million.

The number of SPLs fishing for stone crabs declined, similar to the trend in the number of SPLs observed in most fisheries throughout Florida and the Gulf of Mexico. There were 121 SPLs fishing for stone crabs in the Tortugas areas pre TER and this declined to 113 SPLs post TER. The stone crab fishery is characterized as being close to the 20-80 rule for catch. Pre TER 25.6% of SPLs caught 80.8% of the stone crabs, while in the post TER period 24.8% of the SPLs caught 76.4% of the catch. Only two SPLs caught 10,000 lbs or more both pre and post TER, but two more SPLs caught 5,000 or more pounds post TER than pre TER. On average, an SPL caught 1,082 lbs pre TER and 1,306 lbs post TER (Tables 6.37 and 6.38).

The distribution of ex-vessel revenues generally mirrors that of catch except one can see the influence of the increases in prices. Pre TER, the maximum ex-vessel revenue received was $65,479, while in the post TER period three SPLs received $100,000 or more with a maximum of $137,928 (Tables 6.39 and 6.40).

Stone Crab Microeconomic Data: The microeconomic data and the macroeconomic data are generally consistent. SPLs fishing for stone crabs declined pre to post TER, though the interpretation is a bit different than for other species because stone crabs are not caught in the TERSA. In the microeconomic data the stone crabs caught are those caught by TERSA fishermen who also fish for stone crabs. The microeconomic data reveal that spiny lobster fishermen that fish in the TERSA increased their number of stone crab traps from

Table 6.37. Distribution of average pounds of catch for all Tortugas stone crab fisherman: pre TER (1997 - 2001).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	121	100.0	100.0
GE 10,000	2	1.7	16.4
GE 5,000	5	4.1	29.7
GE 2,500	16	13.2	61.7
GE 1,500	27	22.3	78.1
GE 1,000	31	25.6	80.8
LT 1,000	90	74.4	19.2
LT 500	75	62.0	11.2
LT 100	24	19.8	0.9

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2. Average pounds per SPL was equal to 1,082, with min=2.0 and max=11,088.

Table 6.38. Distribution of average pounds of catch for all Tortugas stone crab fishermen: post TER (2002 - 2006).

Average Pounds/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Pounds
GT 0	113	100.0	100.0
GE 10,000	2	1.8	16.6
GE 5,000	7	6.2	40.7
GE 2,500	16	14.2	61.4
GE 1,500	28	24.8	76.4
GE 1,000	37	32.7	83.9
LT 1,000	76	67.3	16.1
LT 500	58	51.3	6.6
LT 100	26	23.0	0.9

1. GT=Greater than, GE=Greater than or Equal to, LT=Less than.
2.Average pounds per SPL was equal to 1,306, with min=8.0 and max=14,074.

Table 6.39. Distribution of average revenues for all Tortugas stone crab: pre TER(1997-2001).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	121	100.0	100.0
GE $40,000	3	2.5	23.3
GE $20,000	10	8.3	51.3
GE $10,000	18	14.9	67.2
GE $7,500	26	21.7	75.6
GE $5,000	33	27.3	82.7
LT $5,000	88	72.7	17.3
LT $2,500	71	58.7	8.7
LT $1,000	45	37.2	3.2
LT $500	20	16.5	0.6

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $5,853, with a min=$3.75 and max=$65,479.

1,189 traps pre TER to 1,699 post TER or a 42.9% increase. They also fished those traps more days. Average days of stone crab fishing increased from 37.7 days pre TER to 61.7 days post TER or about a 64% increase. This increase in traps and days fished resulted in average catches increasing from 5,263 lbs to 9,171 lbs. With the increase in real prices, ex-vessel revenues increased as well. As with other fisheries, average trip fuel costs doubled. Curiously, bait costs declined, while crew costs increased, but only slightly. On the whole, stone crabs seemed to have mitigated and/or offset any losses suffered by spiny lobster fishermen due to the hurricanes, diseases and displacement from the TER.

Table 6.40. Distribution of average revenues for all Tortugas stone crab fishermen: post TER (2002-2006).

Average Revenues/SPL[1,2]	Number of SPLs	Percent of SPLs	Percent of Revenues
GT $0	113	100.0	100.0
GE $100,000	3	2.1	23.6
GE $40,000	8	7.1	43.1
GE $20,000	20	17.7	67.3
GE $10,000	38	33.6	84.8
GE $7,500	48	41.5	90.7
GE $5,000	53	46.9	92.6
LT $5,000	60	53.1	7.4
LT $2,500	42	37.2	2.7
LT $1,000	27	23.9	1.0
LT $500	12	10.6	0.2

1. GT=Greater than; GE=Greater than or Equal to; LT=Less than.
2. Average revenue per SPL was equal to $12,941, with a min=$84 and max=$137,928.

ASSESSMENT OF FISHERS' KNOWLEDGE, ATTITUDES, AND PERCEPTIONS OF TORTUGAS ECOLOGICAL RESERVES AND FLORIDA KEYS NATIONAL MARINE SANCTUARY

This section presents assessments of the knowledge, attitudes and perceptions of Tortugas fishermen about marine protected areas and no-take reserves. The information was summarized from Thomas J. Murray & Associates, Inc. (2006) and Shivlani et al (2008) on a 10-year replication of a study on knowledge, attitudes and perceptions of FKNMS management strategies and regulations, with particular focus on no-take zones. For details on survey methodology and discussion please see Thomas J. Murray & Associates (2006).

Table 6.41. Tortugas fishermen's knowledge and sources of information for TER.[1]

Item	Percent
Participated in the TER process	57.1
Sources of Information	
1. TER meetinga and workshops	49.2
2. Reading TER newsletters	36.5
3. Media	34.9
Knowledge of TER boundaries and regulations	100.0
Sources of Information	
1. Literature provided by FKNMS, Gulf of Mexico Fishery Management Council and other agencies	60.3
2. Other fishers and/or fish houses	36.5
3. Media	12.7

1. From Shivlani et al (2008).

Fishers Knowledge

There was a fairly high participation rate among sampled Tortugas fishermen in the TER development process with attendance at meetings and workshops being the number one source of information (49.2%). One hundred percent of the sampled Tortugas fishermen had knowledge of the TER boundaries and regulations with the number one source of information being literature provided by the various management agencies (60.3%). Results are summarized in Table 6.41.

Fisher Attitudes and Perceptions of the TER Process

- The majority (67%) of sampled Tortugas fishermen did not consider the process in developing the TER as fair nor did they think that individual fishermen/citizens or local government concerns were considered in the process (Table 6.42).
- The majority (71%) of sampled fishermen did not think their fishing grounds and the impacts of the TER on them were considered in establishing the TER boundaries and regulations (Table 6.42).

- There were mixed results on whether the TER process was fairer than the original FKNMS development process.

Discussion: Tortugas Fisher's Perceptions of the TER Process

The perceptions of the majority of sampled Tortugas fishermen would seem to be inconsistent with several facts. First, the TER process included detailed maps of all the major commercial fisheries catch, which the Sanctuary Advisory Council Working Group (SACWG) used in attempting to minimize impacts on the fishermen, while achieving ecosystem protection goals. This information was further supplemented with information from individual fishermen who attended the SACWG meetings/workshops where fishermen pointed out areas they needed to remain open under various weather conditions.

Second, 12 alternatives were developed by the SACWG in their meetings. Several commercial fishermen served on the SACWG. At the SACWG meeting to select the preferred alternative, the commercial fishermen presented a 13th alternative that was adopted by consensus.

Third, the Governor and Cabinet of Florida and the Gulf of Mexico Fishery Management Council voted unanimously for the SACWG's preferred alternative (the fishermen's alternative).

Thomas J. Murray & Associates, Inc. (2006) offer a possible explanation for this seeming inconsistency. They hypothesize that the commercial fishermen on the SACWG did not represent all commercial fishermen with a particular bias against shrimp fishermen.

However, this again does not seem consistent with the facts. First, the data on catch distributions provided to the SACWG in GIS maps were obtained from 86% of the known fishermen that fished in the TERSA, and these fishermen accounted for over 90% of the catch from the TERSA (Leeworthy and Wiley, 2000). So commercial fishermen were broadly represented in the process. Second, it was determined that shrimp fishermen only depended on 18% of their catch from the TERSA and the preferred alternative only potentially impacted 1% of the shrimp fishermen total catch (Leeworthy and Wiley, 2000). This was the lowest impact across all commercial fisheries. So it would seem that the SACWG commercial fishermen did a good job of representing the shrimp fishermen.

Table 6.42. Tortugas fishermen's perceptions of the TER development process.[1]

Question	N	Mean	Percent Distribution (%)					
			Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5	Don't Know
NOAA considered my fishing grounds in developing boundaries and regulations for the TER and reduced impacts to my fishing grounds.	63	4.22	11.3	4.8	6.5	1.6	71	4.8
The process NOAA used to develop the TER was open and fair to all groups.	63	4.15	11.1	7.9	3.2	4.8	66.7	6.3
Participation didn't matter as the average person had no influence on the final decisions.	63	1.72	69.8	4.8	1.6	0	14.3	9.5
NOAA did not consider local government concerns in the TER designation process.	63	2.01	57.1	3.2	9.5	3.2	14.3	12.7
NOAA did not consider individual citizen concerns in the TER designation process.	63	1.93	65.1	1.6	4.8	3.2	17.4	7.9
The average person has been able to voice their opinion on the usefulness of the TER boundaries and regulations.	63	4.51	7.9	3.2	1.6	3.2	80.9	3.2
The TER development process was fairer than the FKNMS development process.	63	3.19	15.9	3.2	23.8	3.2	22.2	31.7

1. Replication of Table 12 on page 25 of Thomas J. Murrary & Asscociates, Inc. (2006).

Thomas J. Murray & Associates, Inc. (2006) did also offer an alternative explanation for this inconsistency in perceptions and facts. Simply, fishermen did not like the outcome. But as was noted above, it was the fishermen's alternative that was adopted by consensus by the SACWG, the governor and Cabinet of Florida, and the Gulf of Mexico Fishery Management Council. Further, a key element of the adopted alternative was TER South, which totally protected Riley's Hump. Riley's Hump was widely recognized by fishermen as being an important spawning site for some reef fish and fishermen wanted this area protected from all fishing, including recreational fishing, which was done.

One explanation for this inconsistency between perceptions and facts would seem to be that the majority of fishermen didn't want any no-take areas and what they proposed, and got, was the best deal they thought they could get. Below in the discussions about the attitudes and perceptions of outcomes, another explanation is offered that focuses on the institutional situation in fishery management.

Attitudes and Perceptions of Outcomes and Support of the TER and FKNMS

Sampled Tortugas fishermen were also asked eight questions on various outcomes of the TER as well as support for the TER and the FKNMS (Table. 6.43).

- The majority of sampled Tortugas fishermen did not think that they benefited from the TER or that the TER was a benefit to the Florida Keys economy.

- In contrast, a near majority to a majority did think that the TER protections improved natural resource conditions within the protected areas and that nonconsumptive users, who were not displaced from Tortugas North, were the primary beneficiaries of the TER.
- The majority of sampled Tortugas fishermen did not support establishment of the TER (60.3 to 61.9%), nor did a majority support establishment of the FKNMS (57.4%).

- However, Thomas J. Murray & Associates, Inc. (2006) point out that the lack of support has significantly improved since the 1995-1996 assessment (Milon et al., 1997) and the one they had done in the baseline TERSA study in 1998-1999.

Table 6.43. Tortugas fishermen's attitudes and perceptions of TER outcomes and support of TER and FKNMS.[1]

Question	N	Mean	Percent Distribution (%)					
			Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5	Don't Know
The TER has replenished stocks in the region.	63	4.02	14.3	3.2	4.8	4.8	55.6	17.5
The TER has improved stocks within the reserve boundaries.	63	2.71	34.9	7.9	1.6	0.0	28.6	27.0
The TER has conserved and protected corals, fish, and other marine life within the reserve boundaries.	63	2.2	44.4	11.1	4.8	1.6	17.5	20.6
My catch within the TER region has increased since the implementation of the TER.	61	4.47	3.3	0.0	18.0	1.6	73.8	3.3
The TER is the most effective way to protect and restore coral reefs in the region.	61	3.33	27.9	6.6	8.2	0.0	45.9	11.5
The long-term effects of the TER on the economy of the Florida Keys (region) have been positive.	63	4.04	20.6	1.6	0.0	0.0	68.3	9.5
I favor establishment of the TER.	63	3.81	19.0	3.2	15.9	0.0	60.3	1.6
- TER North	63	3.87	15.8	6.3	14.3	0.0	61.9	1.6
- TER South	63	3.77	23.8	1.6	7.9	4.8	60.3	1.6
I favor establishment of the FKNMS.	61	3.76	16.4	11.5	8.2	4.9	57.4	1.6

1. From Thomas J. Murray & Associates, Inc. (2006) pages 26-27.

- From the 1995-1996 study, 70% and 78.1% of the sampled respondents did not support the establishment of no-take zones in the Lower Keys and Dry Tortugas and the FKNMS, respectively.

- From the 1998-1999 study, 77.9% were against a reserve being established in the Dry Tortugas region and 70.5% were against establishment of the FKNMS.

Discussion - Tortugas Fishermen's Attitudes and Perceptions of TER Outcomes and Support for the TER and FKNMS

Perceptions on increased catch from the sampled Tortugas fishermen are not consistent with the pre and post TER quantitative information presented in this assessment. Catch increased pre to post TER for reef fish, shrimp, King Mackerel and stone crabs. Only small declines for spiny lobster were detected, but the declines started before the TER closure and persisted through 2003, but since 2004 have been on an upward trend, with 2006 being the highest year of catch for the 1997-2006 period. Part of the explanation here for this inconsistency between perceptions and facts is the timing of the survey. The survey was largely about what had taken place up through 2003 and there was not much of a change in reef fish catch for years 2000-2003 (Table 6.14), while spiny lobster catch declined from 2001 to 2003. In addition, biologists did not expect there would be replenishment effects in the short-run so one would not expect that fishermen to have experienced increased catches. As shown, the increases in reef fish were the result of fishing new fishing grounds previously not exploited, but this did not happen until 2004.

Measures taken on attitude and perceptions in both the 1995-1996 and 1998-1999 studies were done under conditions of great uncertainty. Fishermen were being asked to give up fishing grounds with high uncertainty of whether they would benefit from such actions. The existing fishery management institutional arrangement is still characterized as an open access, common property fishery despite the lobster trap reduction program and other regulations that partially limit effort. Under such an institutional arrangement, fishermen cannot be assured they will personally benefit from any investment in improving the fisheries, and therefore a majority of fishermen might not support (i.e., sacrifice by giving up fishing grounds) any regulation or management strategy that purports to yield future returns if an investment is made. However, Johnson and Libecap (1982) demonstrated that some fishermen might support such investments, even under open access, common property conditions, because they have superior knowledge and skills, and can thus capture the benefits of such investments. This explains why anywhere from 21-36% of fishermen support both the TER and FKNMS.

As to the improvement in support for the TER and FKNMS, as noted the baseline measures were taken in 1995-1996 and 1998-1999. The FKNMS management plan and regulations, including the original 22 sanctuary preservation areas and the first ecological reserve (Sambos) did not go into effect until July 1, 1997, and the TER did not go into effect until 2001. By the 2004-2005 survey, the fishermen had time to experience the effects of the FKNMS management plan and regulations and many of the fears generated by uncertainty were reduced. As this chapter shows, short-term economic losses due to the TER did not occur, and as shown in Leeworthy (2001), short-term losses did not occur for Sambos fishermen.

SUMMARY AND CONCLUSIONS

There have been many reports and journal articles addressing the social and economic (socioeconomic) impacts of marine protected areas (MPAs) and the special class of MPAs, marine reserves (MRs) or no-take areas (Berman et al., 2008; Holland, 2000; Mascia, 2003; Sanchirico et al., 2007). However, all of these efforts have not addressed the question of what actually happens. Past efforts have focused on expected possible outcomes based on either theory and/or have modeled behavior based on reasonable assumptions. To actually determine what happens, in most cases, requires a pre-post implementation assessment requiring monitoring data.[D]

D. Most cases involve marginal or small changes in the total amount of activity affected. In cases where large changes occur (New England Groundfish Closure) economic and social impacts are clear and real. In the New England Groundfish Closure, it was projected that even after stock recovery, 50% of fishermen would not get their jobs back. The federal government moved to set up compensation and assistance programs to help fishermen transition to new livelihoods.

Here the results of the first pre-post integrated assessment of the socioeconomic impacts of a MR, the TER in the FKNMS, are reported (results are summarized in Table 6.44 at the end of this section). At the time of its creation (July 2001), it was the largest MR in the U.S. (151 nm^2). Five-year pre implementation and five-year post implementation periods were used for the assessment with five years serving as the period for determining short-run impacts.

Most of the literature assumes that for those who are displaced from MRs, there will be short-run losses, which economists refer to as opportunity costs. The findings stated here run counter to all of the theoretical papers and modeling efforts that assume there will be short-run opportunity costs associated with MRs. The data indicate in the short-run neither those who participate in the commercial fisheries, nor the recreational fisheries experienced any financial losses due to implementation of the TER (Table 6.7). And, given that there were no financial losses, it can be concluded that there were no wider social costs. There were no major disruptions that could lead to family and community problems as indicated by unemployment, general crime rates, domestic violence and substance abuse.

In the recreational fisheries, effort did shift to other areas away from the larger Tortugas area closer to home ports, but this was due to rising fuel costs and new grouper regulations that made the trip to the Tortugas area a less preferred choice. It was simply not worth the cost to go all the way out to the Tortugas area for a couple of grouper. None of the charter fishing guides thought that the TER affected their business.

For the commercial fisheries, there was also a shift in effort away from the Tortugas area towards fishing grounds closer to home ports due to fuel price increases. But, the actual changes in catch and revenues received by fishermen from the Tortugas area pre to post varied considerably by fishery.

Table 6.44. Summary of major findings from assessment of socioeconomic impacts from no-take reserves in Tortugas.

	Initial Assessment Projections[1]		
	Step 1	**Step 2**	**Current Assessment**
Commercial fisheries[2]	--	--	--
Reef Fish	116,642 (20.3%)	Projected losses highly likely to occur since reef fish are considered overfished throughout the region. Thus, fishermen not expected to be able to relocate and make up lost catch.	No losses due to closed areas. Reef fish catch increased from pre to post establishment of the TER. This was opposite of expectations. Reason was that displaced fishermen found new areas previously not fished and these areas were not sampled by biologist and were not included in stock assessments.
Spiny Lobster	108,639 (11.6%)	Projected losses not likely to occur because lobster trap reduction program will allow for relocating traps and fishermen are knowledgeable and fish other locations throughout the Florida Keys.	No losses due to closed areas. Spiny lobster declined from 2001 through 2003 due to hurricanes and disease. Spiny lobster catch recovered 2004 through 2006 reaching record levels. Short-run losses in 2001-2003 offset by fishing for stone crabs and king mackerel.
Shrimp	58,374 (8.2%)	Projected losses not likely to occur. Shrimp fishermen catch only 10% of their total catch from the Tortugas Area and displacement will impact only 8% of catch from the Tortugas Area and only 1% of total catch from all areas. Should be able to relocate and make up catch from other areas.	No losses due to closed areas. Shrimp catch increased from pre to post establishment of TER. However, prices declined due to large increases in imported shrimp and total revenues received by fishermen declined.
King Mackerel	13,489 (14.0%)	Projected losses not likely to occur. King mackerel is a pelagic species and are thus highly mobile and there are no special features in closed areas. Expect fishermen can relocate to other areas and make up lost catch from closed area.	No losses due to closed areas. Catch increased pre to post establishment of the TER.

1. Initial projections of losses from Leeworthy and Wiley (2000). The approach used a two-step analysis. Step 1 was quantitative and simply assumes all commercial catch or recreational activity would be lost from area closed. This represents “maximum potential loss”. Step 2 looks at all mitigating and off-setting factors and provides qualitative assessments of how likely step 1 losses are to occur.
2. Pounds of catch from closed area.
3. Person-days of displaced activity.

The most interesting finding was that for the reef fish fishery. During the design and evaluation phase of the TER (initial assessment), the biophysical scientists had concluded that reef fish in the Tortugas area, as well as in the rest of the Florida Keys, were overfished. This assessment led the socioeconomic team to conclude that there would be losses to the reef fishermen since they would not be able to relocate to other fishing grounds and make up for lost catch from the TER. However, reef fish catch from the Tortugas area actually increased pre to post TER and is on an increasing trend. The reason for this disparity was that displaced fishermen found new areas previously unfished and these areas were not sampled by biophysical scientists, and were therefore not in their stock assessment. Based on the data, the current upward trend in reef fish catch from the Tortugas area reflects the expansionary phase of a new fishery. The projection of losses in the initial assessment was based on the assumption of perfect knowledge by both the scientists and the fishermen. For the fishermen, it is assumed they knew all the available fishing grounds and the fishing choices made in the pre TER period were the profit maximizing choices. In reality, fishermen did not have perfect knowledge and displacement from the TER led them to discover new fishing grounds (necessity is the mother of invention).[E]

For the shrimp fishery, the initial assessment concluded that losses would not likely occur because of the low dependence of shrimping operations on the TER for their total catch. In the post TER period, total catch from the Tortugas area actually increased, but revenues for that catch significantly declined due to large reductions in shrimp prices resulting from large increases in imported shrimp.

For the King Mackerel fishery, the initial assessment projected no losses because King Mackerel is a pelagic species and therefore is highly mobile. In addition, there were no special features in the TER which attracted or aggregated them. Catch lost from displacement from the TER could be made up by relocating to fishing grounds outside the TER. In the post TER period, King Mackerel catch increased as did revenues received from the catch.

The spiny lobster fishery highlighted why an integrated assessment is important and also illustrated the importance of accounting for interspecies substitution. In the pre TER period, spiny lobster catch was in decline in the Tortugas area. The decline continued through the first two years of the post TER period, then started to increase with a record year in the 5th year of the post TER period. The biophysical scientists were able to explain the decline in the spiny lobster catch as being the result of hurricanes and a larval disease. The upward trend in catch at the end of the post TER period indicates the fishery has recovered from these effects and is now meeting or exceeding catches experienced in the beginning of the pre TER period. So again, the data indicate there were no losses attributable to the TER.

Evaluation at the fishing operation level across all fishing catch and revenues revealed that spiny lobstermen also participate in multiple fisheries and were able to increase their catch of King Mackerel and stone crabs to offset any losses from the reductions in spiny lobster catch (interspecies substitution) during the years when spiny lobster were in decline.

E. A caveat is that if fishermen are taking bigger risks in fishing new fishing grounds they did not fish in the past because oceanographic and weather conditions rendered them more dangerous to fish. Regulations often have unintended consequences (Pendleton et al., 2001) .

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Chapter 7: Social and Economic Effects of Tortugas Ecological Reserve to Recreation Businesses that Utilize the Dry Tortugas Area

David K. Loomis[1], Christopher Hawkins[1], Douglas Lipton[2] and Robert B. Ditton[3]

INTRODUCTION AND BACKGROUND

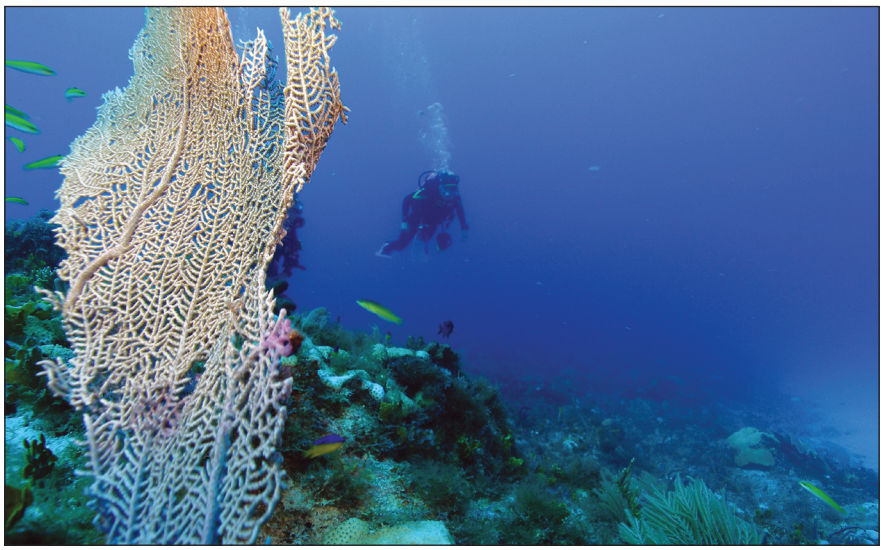

Figure 7.1. Purple sea fan and diver. Photo: NOAA Center for Coastal Fisheries and Habitat Research (CCFHR).

Recreational activities represent a prominent use of natural resources in the Tortugas region (Figure 7.1). To complement the analysis of commercial fisheries data to determine short-term socioeconomic impacts, data on recreational activities were also analyzed to evaluate short-term effects of the Tortugas Ecological Reserve (TER) on recreational businesses operating in the Tortugas region. A study published in 2000 entitled *Socioeconomic Impact Analysis of Alternatives* (SIA; Leeworthy and Wiley, 2000) outlined potential economic and social impacts of the TER on recreational businesses based on five proposed alternative scenarios for TER implementation. At the time, few private boaters made the 140 mile roundtrip from Key West to the Tortugas area. Therefore, the impact analysis primarily collected qualitative data on the for-hire recreation industry (dive boats and fishing charters), although quantitative approaches were also used to understand private recreational use of the TER study area.

The purpose of this study is to provide follow-up data with regard to the for-hire recreation sample to understand any social and economic impacts to these groups as a result of the creation of the TER. The current trends in private recreational fishing in the Tortugas region are discussed here. The first half of this chapter describes the methods and results of the 2000 SIA to provide context and to serve as a baseline for data on recreational activities collected during 2006. The second half presents data obtained through telephone and in-person surveys and describes social and economic impacts of the TER to recreational businesses that were operating in the Tortugas region during 2006.

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3. Texas A&M University

RESULTS OF THE 2000 SOCIOECONOMIC IMPACT ANALYSIS

The 2000 SIA identified a list of potential operators through three primary means: (1) a Dry Tortugas National Park (DRTO) listing of permitted for-hire operators; (2) "snowballing," in which these operators were asked to identify additional relevant individuals; and (3) commercial (non-charter/non-recreational) fishermen, who were asked about boats they saw consistently in the study area (very few). From this research, a list of 23 potentially relevant operations was developed. Of these 23, seven could not be contacted, despite repeated attempts. Thus, the final list was set at 16 boats (12 businesses) and was considered a census. Individuals were then interviewed by telephone and in person (Table 7.1).

Table 7.1. Final list of operators in the 2000 study.

Charter boats	Party boats
Playmate	*Yankee Capts*
Katmandu	
Andy Griffiths Charters	
Ultimate Getaway	
Tiburon	
Lisa B	
Triple Time	
Captain Marvel	
Miss Rene	
Whisker Charters	
Dennis Smith (boat name not known)	

Data Collection

The data collected by Leeworthy and Wiley (2000) included the following: person-days of activity, revenue, cost and profit by activity. These variables were quantified by month, and across four activities (non-consumptive diving, diving for lobster, spear fishing, and hook and line fishing). These activities were identified as being all of the recreational activities occurring in the study area. In addition, participation within these activities was found to be limited because of the time and expense one must invest in making the lengthy trip to the Tortugas area, as well as the lack of lodging in the small islands that comprise the Dry Tortugas. While many people do make the trip to the DRTO, (approximately 72,000 visitors in 1998) few of these people were found to leave the park boundaries to undertake side trips to the study area.

The 2000 study focused on potential non-market and market economic losses that could result from displacement of consumptive recreational activities. The market economic values were identified as revenues from the party and charter boat operations that catered to the consumptive segment of the study area users. These revenues were then analyzed further in terms of the impact of total output/sales, income, and employment on the Monroe County economy. These impacts included multiplier effects. Non-market values were assessed in terms of consumer's surplus and producer's surplus. Activities in these categories included spear fishing, and fishing and diving for lobsters (Figure 7.2).

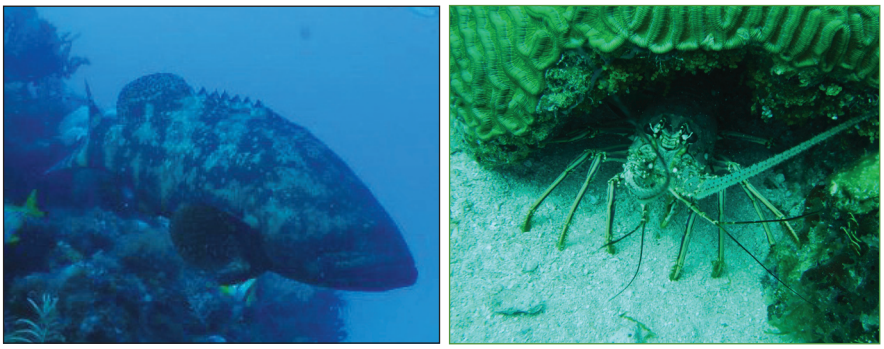

*Figure 7.2. Goliath Grouper (*Epinephelus itajara*; left) and Caribbean spiny lobster (*Panulirus argus*; right) in the Dry Tortugas National Park (DRTO). Photos: NOAA CCFHR.*

The SIA used the data capture technique of snowball sampling by asking Tortugas charter operators if they had seen or were aware of other similar businesses operating in the study area and if they had seen private fishing and diving boats outside of the DRTO boundaries. All answered that they had seen only the other boats identified in the sample and had not seen any private recreational boats in the study area. Finally, the SIA included contacting all the known fishing clubs in South Florida to ascertain whether their members regularly went to the study area (not including the DRTO). The information gathered from the clubs confirmed that only on rare occasions do their members make this trip.

Results of Leeworthy and Wiley (2000)

Survey results showed that these firms supplied 21,027 person-days of recreation, mostly within the FKNMS boundaries. The activities were: fishing (78%), spear fishing (9%), diving for lobsters (8%) and non-consumptive diving (5%). The net benefit to recreators (consumer surplus) as calculated by applying a person-day value was $1,665,643. Profits for these firms, used as a relative indicator of producer surplus, amounted to just over $400,000.

Potential impacts of reserve designation were reported across five alternatives proposed for the TER. Alternative III, the current reserve boundary, was identified by the Tortugas Working Group as the preferred option. With regard to non-market values, NOAA reported that under Alternative III approximately 26% of the total person days of diving for lobster, approximately 26% of the total person days of spear fishing and just over 3% of the total person days of fishing would be displaced. In total, a little more than 7% of person days across all three activities would be negatively impacted by reserve designation. The monetary estimate for this impact was that $125,163 of the consumer surplus could be displaced by the reserve and $55,786 of the operator profits could be lost.

Alternative III analysis suggested that nine of 12 charter operations would potentially incur market value impacts. Economic losses in the form of direct business revenue were projected to be 26.6% for diving for lobster, 20% for spear fishing and 6.3% for fishing. Across all three activities, 11.7% of revenue could be potentially impacted. The report concluded that these potential losses, though noticeable to the individual charter operations, would likely not be felt by the greater Monroe County economy, as they represented only a fraction of 1% of the revenue generated by recreating visitors to the Florida Keys.

The figures presented in the SIA are termed “maximum total potential losses.” It is made clear that these estimates are only valid if the operators were to completely abandon those components of their business that occurred inside of what was proposed to be and is now the TER. However, if these operators were to shift their activities geographically to accommodate the new reserve boundaries, it was reported as unlikely that the maximum losses would be realized. This shift is known as substitution. Substitution is one response to the displacement that occurs after an area is closed to previously-allowed activities. Substitution, together with the potential of long term benefits from the hoped for fishery replenishment effects of creating the reserve, are defined by Leeworthy and Wiley (2000) as mitigating factors.

POST TER SOCIAL AND ECONOMIC IMPACTS TO RECREATIONAL BUSINESSES – 2006

Background

In 2005, the University of Massachusetts Amherst's Human Dimensions of Marine and Coastal Ecosystems Program was contracted to examine the social and economic impacts, if any, on the 12 businesses reported in the 2000 SIA, and to understand what, if any, wider effects reserve designation has had on the Tortugas for-hire fishing and dive industry. Specific themes of interest in the present research are: (1) understanding the economic impacts of reserve designation; (2) determining relevant social and economic factors that have/are contributing to the use or non-use of the Tortugas for for-hire fishing and diving; (3) obtaining a picture of private recreational fishing in the Tortugas area; (4) presenting attitudes towards the reserve and of the current quality of fishing and diving near there; (5) determining if there has been a switch to non-consumptive uses as a result of Tortugas implementation; and (6) whether operators are using the TER as a selling point in their advertising.

One goal of this research was to demonstrate a long-term commitment to understand those stakeholders potentially affected by the TER designation. A second goal was to continue to build on existing knowledge regarding the social and economic effects of reserving fishing areas in order to make the best possible predictions in similar cases in the future. Presented here is a shortened version of the analysis of the recreation industry. For the full report see Loomis et al. (2007).

The current project used an interdisciplinary social and biophysical science approach. In December 2005, a meeting was held at the Southeast Fisheries Science Center in Miami, which provided an opportunity for relevant individuals to meet and discuss the history and goals of this effort, especially in terms of the integrated assessment approach utilized by NOAA. Following this meeting, an initial assessment of the Tortugas for-hire fishing and diving universe (locations of boats, numbers of operators, etc.) was conducted in Key West.

Methods

To initiate the data collection, 61 charter vessels in the Key West area were contacted by telephone and in person from a wider list developed by an extensive search of various sites (e.g., the phone directory, Internet, Florida Keys Tourist Development Council). Time and logistical constraints did not allow the team to contact all charter operators on this list, and in many cases operators were clearly not appropriate, due to the nature of their business or boat size. The sample of 61 was based primarily on boat size and range. Of the 12 businesses identified by Leeworthy and Wiley (2000), researchers were able to find seven, and these were included in this sample. Additionally, methods ensured that those who were identified as new Tortugas area operators were captured in the sample. With regard to new operators, the only new individuals identified were captains who have been hired to work for an existing Tortugas charter company. While they represent new additions as captains, the business they work for, Andy Griffiths Charters, is not new to the Tortugas area. This study also found four individuals not listed in the 2000 survey, but that identified themselves as having previously been engaged in for-hire Tortugas trips. Finally, the president of the Keys Area Dive Operators Association indicated that, to his knowledge, no additional dive business had begun regular Tortugas operations.

The rationale for starting with a greater number of operators was to ensure that any boats that may have entered the Tortugas for-hire fishery since 2000 would be captured and it was hoped that contacting a larger group of people would assist with this goal. It was found in speaking with these captains that many of the same names were mentioned repeatedly. The final list of relevant businesses was narrowed to 21 (fishing=19, diving=2). This was considered a census (Table 7.2).

Initial telephone and personal contacts with operators indicated that a simple re-creation of the 2000 SIA was going to be of little value in understanding how reserve designation has impacted for-hire fishing and diving operators utilizing the Tortugas area. This is primarily because the data generated would offer little in understanding the complex issues involved in the Tortugas for-hire recreation industry. Events since the creation of the TER have altered the operational climate. Factors such as fuel and insurance costs, as well as changes in fishing regulations and drops in tourism are important and relevant factors in how people might or might not use the TER. Changes in activity level in and around the TER may have much more to do with these fac-

tors than with the creation of the TER itself. Thus, it is not possible to make a simple and straight-forward comparison of the before and after TER for-hire activity. To do so would likely result in erroneous conclusions. In other words, a report illustrating the current economic status of those operators who still or no longer make regular trips to the Tortugas area to fish and dive would ignore various intervening variables inherent in determining the economic feasibility of Tortugas operations. Therefore, this research concentrated on a particular set of variables (discussed below), in order to present a fuller picture of the current attitudes and issues of Tortugas operators.

Table 7.2. Final list of operators in re-study.

Charter Boats	Party Boats
Andy Griffiths Charters	Florida Fish Finder
Andy Too	Yankee Capts
Mean Green	
Ultimate Getaway	
Leathal Weapon	
Tiburon	
Ultra Grand Slam	
Tortuga Hooker	
Playmate	
Triple Time	
Captain Marvel	
Conch Too†	
Cha-Cha†	
Miss Kasey†	
John Weinhofer (boat name not known)†	
Miss Rene*	
Whister Charters*	
Lisa B*	
Dennis Smith (boat name not known)*	

†Indicates individuals not on the 2000 Socioeconomic Impact Analysis of Alternatives (SIA) list that claim to have gone to the Tortugas area prior to reserve designation but who no longer do.

* Indicates charger operators on the 2000 SIA that we could not find in 2006.

In late February 2006, interviews were conducted with charter owners, captains, and mates from the above list of 21 relevant operator businesses. During our initial conversations with Tortugas and other operators, it became apparent that there were a variety of factors that were relevant to whether fishing and diving businesses made the 140-mile roundtrip to the Dry Tortugas area, and that these factors were independent of the establishment of the reserve. This finding prompted a change in our approach to data collection and analysis.

Given that many operators stated that either (a) other (non reserve) factors were at work; or (b) sustainable fishing and diving locations were readily available due to the sheer size of the Tortugas area, a survey instrument was developed to examine, among other things the range of possible reasons for not making Tortugas area fishing and diving trips, as well to collect information about previous and current Tortugas activity, and attitudes about the quality of fish and diving pre and post reserve implementation. Two survey instruments were developed and administered onsite or mailed to 23 individuals associated with these 21 for-hire businesses to address the main questions of who is using the area, how often, why, and their views of the quality of fishing and diving in the Tortugas, as well as their views on private fishing, non consumptive use and advertising (see Appendix III).

While in Key West, and in subsequent phone calls and mailings from the university, 23 surveys were administered. Twenty of these were completed by individuals associated with Tortugas fishing charters and two were completed by individuals associated with dive charter operators. Of these individuals, 10 were operators, five were owners, four were owner/operators and one was a mate. All but two listed their vessels as charter boats, and one considered himself both a charter and a party boat because of capacity. It should be noted that the dive charters are different from the more typical head boats found operating on the Florida Keys reefs. The two dive charters in this sample run different, more intimate boats.

In June 2007 a third trip to Key West was made to interview knowledgeable respondents regarding three questions pertinent to recreational use in the Tortugas area. The first question concerned the numbers of personal recreational boats fishing between Rebecca Shoal and the Tortugas area. This question is related to the number of fish being removed (potentially) from the ecosystem, and the impact of that removal to the effectiveness

of the reserve. The second question concerned whether operators previously going to the area that is now the TER have switched from consumptive activities to non-consumptive activities. The third question was whether or not Tortugas-based operations are using the reserve as a component in their advertising. For example, dive operators might conceivably point out that a large no-take area will provide for larger fish and better reef conditions, while charter anglers might point to more and larger fish "spilling over" from the closed areas. Findings related to these three questions can be found in the Results section under "Private Fishing, Non Consumptive Use and Advertising."

Results

Intervening Variables

As stated previously, the survey instrument was developed to understand a more comprehensive, and seemingly more important, range of factors that have affected or may affect Tortugas activity. These factors are termed "intervening variables," because they interfere (or can interfere) with the ability to attribute longer and shorter term economic changes in the Tortugas-based for-hire recreational diving and fishing industry. As such, data about these variables allows for a better picture of the social and economic factors that may be related to the for-hire activity in and around the TER. Discussions with operators of what socio-economic variables might be important resulted in several questions regarding fuel prices, number of clients desiring to go fishing in the Tortugas, and availability of fish. Two additional themes were encountered during data collection: the effects of fishing regulations and the interplay between sanctuary and park rules and administration. In addition, Florida tourism trends are addressed.

Fuel Prices

Fuel is a constant concern for charter boat operators who routinely fish or dive long distances from their home port. Additionally, as fuel prices climb, so do the prices of associated products, such as lube oil. Therefore, a factor that has apparently affected trips to the Dry Tortugas area is that fuel prices have risen 133% in South Florida since 1999 (U.S. Department of Labor). Thirteen individuals answered the fuel component of question seven, which asked respondents to rank how important each of nine items was as a current reason not to make trips to the Tortugas. Of these, five ranked the issue as "extremely important," six ranked it as "very important" and two ranked it as "somewhat important."

Clients

A shortage of customers willing to pay for and expend the time on a Tortugas trip will certainly have a negative impact on business. There are two trends to consider here: the trend in overall tourism in Florida and customer interest in Tortugas trips. With regard to general trends, data that were generated in the original SIA were related in part to booming tourism. Person trips to Florida increased from 50 million annually in 1998 to approximately 74 million annually in 2000, a bump of almost 150% in just two years. However, tourism visits to Florida fell approximately four million person trips in 2001, and have been erratic since (Visit Florida Research, 2006; http://media.visitflorida.org/research.php). There are several probable reasons for this decline, including the 2001 terrorist attacks on the United States, increased hurricane activity, red tides, transportation issues and changing tourist behavior patterns (Visit Florida Research, 2006). However, for Tortugas operators, this does not appear to be an issue. Twelve individuals answered the client component of question seven. Of these, only three ranked too few clients as a current reason for not making trips. A majority of the remainder ranked this issue as currently "not at all important." Three ranked it as "somewhat important" and one person ranked it as "slightly important."

Availability of Fish in the Tortugas

If a fishery experiences drastic stock declines, then the potential exists for recreational and commercial operations to exit, because there will not be enough fish to sustain the business. However, this did not appear to be a concern among the Tortugas operators. In fact, most spoken with indicated the fishing was excellent in the Tortugas area. Thirteen individuals answered the fish component of question seven. Of these, 10 ranked too few fish as "not at all important" for not making trips. One ranked it as "somewhat important" and two people ranked it as "slightly important." Regardless of the results of biological studies of fish stocks in the Tortugas area, the perception clearly exists among charter operators that the region has experienced no significant losses in fish biomass.

Fishing Regulations

Many operators cited recent and historical fisheries management decisions as harmful to their business. Specifically mentioned were the Red Grouper (*Epinephelus morio*) limit of one fish per person (and per vessel) on the Atlantic side, the Black Grouper (*Mycteroperca bonaci*) bag limit of two fish per person, and the total bag limit of five grouper (Florida Fish and Wildlife Conservation Commission, 2007). Several operators mentioned that the small grouper limit was worrisome.

Grouper is an important fish to Tortugas-based fishing operations (Figure 7.3). All of those who answered question five and question 12 listed grouper as desired species to catch. In fact, over half listed grouper first on the survey and only two people did not list grouper at all. Clearly, changes to the grouper regulations are watched closely by and have ramifications for Tortugas fishing charters. Qualitatively, many operators were quite excited about changes to grouper regulations. A common theme was that recent changes to the red and black grouper bag limits were perceived as damaging to business. In the words of one operator, "who wants to go all that way to keep one grouper?"

*Figure 7.3. Changes to grouper catch regulations include red grouper (*Epinephelus morio*). Photo: NOAA CCFHR.*

Reserve and Park Rules

Both fishing and diving charter operators raised the issue of not being able to anchor or tie up anywhere overnight. To reach the Tortugas by sea mandates at least a seven hour boat ride (one way), so charter trips are, by necessity, multi-day excursions. However, while private boats can easily obtain permission via radio to tie up overnight to a mooring buoy in the TER or can run into national park waters to anchor, captains of charter boats with clients on board believe they are required to have a permit to anchor. Discussions with operators illustrated a perception that National Park Service (NPS) permits are difficult to obtain and the paperwork required to do so is cumbersome. There was definitely a sense that for-hire boats were being treated differently and less fairly than private boats with regard to tying up and anchoring. This complaint was separate from "safe harbor" issues, in which strong winds or other dangerous conditions requiring immediate anchorage. Interviews with park staff in June 2007 indicated some confusion as to the rules for charter operators wishing to enter park waters without a permit. These two factors were mentioned several times by operators as both an upsetting issue and a reason not to go the Tortugas.

Private Fishing, Non Consumptive Use and Advertising

To answer the question regarding fishing pressure associated with personal boats, meetings were held during the week of June 10, 2007, with one Tortugas ferry service captain and two ferry service employees, three DRTO rangers, one Key West dockmaster with Tortugas fishing experience, and the captain of the Florida Fish Finder, a 35 m party fishing vessels that makes multi-day trips to the Tortugas area. These individuals were asked to comment on the amount of boats they saw at any one time during their transit to or while in the Tortugas area. All respondents answered that they see few private fishing boats during the course of their voyages. A typical view was expressed by the ferry captain, who remarked that he sees "five to 10" private boats per week on his route. While more specific quantified results would be gained from an aerial survey that spans the four seasons, the findings reveal very light recreational fishing pressure occurring in the area near the TER and mirrors the findings of the 2000 SIA.

To answer the second and third questions (switching to non-consumptive uses and reserve-based marketing), two approaches were used. First, all of the above operators, as well as the president of the Keys Area Dive Association, were asked about businesses switching to non-consumptive use in the TER. Only two business operations, the Ultimate Getaway out of Ft. Meyers and the research vessel *Tiburon* out of Key West, were mentioned in these discussions. The second approach, a directory and online search, yielded the same businesses. However, while the owner of *Tiburon* does seem to have transitioned to research-only activities, Ultimate Getaway appears to still conduct some consumptive activities (although not in the TER), such as lobstering. With regard to using the reserve as an enticement to customers, it appears that Tortugas-based or associated businesses have yet to gear their messages towards the fact that they operate in the backyard of a relatively large marine reserve. Web sites and brochures only reference the DRTO and the history of the area. The words no-take, reserve, or protected area were not mentioned in any reviewed business literature.

Attitudes Towards the Reserve

The study of attitudes has been used in a variety of natural resource management situations, such as restoring wildlife (Brooks et al., 1999; Enck and Brown, 2002), and wildlife management activities (Bright, 1993; Bright and Barro, 2000; Teel et al., 2002; Lee and Miller, 2003; Koval and Mertig, 2004). However, McCleery et al. (2006) contend that many of the authors of natural resource management studies that utilize the attitude do not understand or have failed to properly communicate attitudes, attitudinal measurement, and the social psychological frameworks of attitudes, especially when examining attitude-behavior linkages.

Eagly and Chaiken (1993) define an attitude as, “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor.” This definition has been supported by various investigators (e.g., Ajzen and Fishbein, 1980). Most attitudes studied by social psychologists, such as the ones presented in the present research, are probably learned (Eagly and Chaiken, 1993).

Attitudes towards the impact of the reserve were assessed directly and indirectly via several survey questions. Question 13 asked, “to what extent do you feel the creation of the TER has improved or harmed the quality of fishing in that area?” Seventeen people responded to this question. Seven individuals answered that they believe the reserve has “somewhat improved” the quality of fishing in the area. Five believe that there has been no change. Two believe that the reserve has “somewhat harmed” fishing in the area. Finally, one “did not know” for sure whether the reserve has had a positive or negative impact.

Respondents were about evenly split as to whether they fished near the boundaries of the reserve. Given examples from elsewhere of the “boundary effect,” where anglers and commercial fishing operators fish near the edge of a reserve’s borders in hopes of catching any bigger fish in the reserve, it seemed logical that the majority of respondents would have indicated they fished near the boundaries of the TER. However, there are reasons why some people would not answer this question truthfully, especially if they feel it will draw attention to them in the future or if there is uncertainty about whether this practice is illegal.

Finally, when responses to Question 4 (for each of the following, how would you rate the quality of fishing in or around the TER prior to its creation?) were compared to responses to Question 8 (for each of the following, how would you rate the quality of fishing near the TER today?), major differences were not indicated or observed. Several individuals stated that they feel the fishing is as good now as it always has been.

Economic Impacts

From the above summary, Leeworthy and Wiley (2000) expected that the maximum economic impacts of the reserve boundary designation to be small, and more likely negligible. Because of the small number of firms identified as operating in the proposed reserve area, and the small total impact of the reserve, any error in terms of having not included an operator in the original estimate is potentially large. For example, they found that only two operators provided lobster dive trips, so finding a single additional operator would increase the estimated number of participants by 50%.

Nine of the 12 businesses that were originally surveyed in the 2000 SIA were located. Of these nine, seven were contacted successfully. Without the ability to contact the additional five operators to see if they are still running operations in the area, it is presumptuous to conclude that they are out of business, and specifically

out of business due to the reserve. This makes comparison of current conditions to the pre-reserve designation conditions problematic. Interestingly, four operators that claimed to have run operations in the Tortugas area prior to the establishment of the reserve, but were not surveyed in 2000.

Of the fishing operations surveyed for this report, two did not operate in the Tortugas area prior to the reserve designation and do not do so now. Of the remaining operations, 10 operated prior to the designation and continue to operate today outside the reserve. Five that operated in the Tortugas area prior to the reserve no longer operate in the area, but these are almost completely replaced by the four operations that indicate that they are now operating in the Tortugas where they had not operated prior to the reserve designation.

The 2000 SIA found that potential economic losses would be small and that substitution rather than business closures would be the likely behavioral response to the TER. The 2006 discussions with these operators confirmed that this has indeed been the case. This finding, along with the findings discussed above, argued conclusively against a full recreation of the 2000 SIA.

DISCUSSION AND RECOMMENDATIONS

A re-analysis of the economic attributes of the Tortugas for-hire diving and fishing industry would provide little useful data to coastal marine resource managers in terms of understanding the consequences of creating the TER. Moreover, any new figures indicating a change pre and post TER would likely be misrepresented as being a result of the creation of the reserve when such a conclusion is not able to be drawn because of a lack of data on a wider range of socially-relevant variables. Data on many of these variables, discussed above, were not collected in the 2000 SIA. However, this information is important because it represents the social and economic drivers of resource use and provides the basis from which to understand and predict behavioral responses to economic, social and environmental changes.

This report finds that in 2006 the recreational economic impacts of reserve designation were minimal and had been offset by behavioral adjustments of operators and their clients. There is no indication that there was a major net change in the number of operators in the Dry Tortugas area, although some individual firms may have gone out of business. Even so, it would be difficult to state that the cause of this was the establishment of the reserve. Although many existing operators indicated in their response to the questionnaires that they would have preferred that the reserve was not created, they also indicate that the distance and remoteness of the reserve area is a major factor limiting activity in that area.

The results of this study point to a need to operate with a broader scope when conducting baseline human dimensions impact analyses of marine reserves. In addition to the issue of intervening variables, recent statutory changes, such as those to the Magnuson-Stevens Fishery Conservation Act that provide for (a) better inclusion of sport fishing data in decision making, and (b) mechanisms to reverse no-take zones if the objectives of the closure are achieved illustrate a changing paradigm in marine reserve designation and management processes. However, while the biological science underpinning marine reserve theory is still being debated (e.g., Jones, 2007; Tupper et al., 2002), the potential benefits of marine fishery reserves are being touted by managers and scientists (Murray et al., 1999; Roberts et al., 2001; Halpern and Warner, 2002) and it therefore appears likely that marine reserves will have a place in fishery and marine sanctuary management for the foreseeable future.

This continued use of marine reserves necessitates the creation of a framework that institutionalizes the collection of information regarding a broader suite of factors and issues that pertain to the for-hire and private recreational sectors. Such information will enable marine resource managers to better analyze and learn from marine reserve implementations. The issues of intervening variables, attitudes towards the effectiveness of the TER, user norms, and beliefs about reserve theory in general suggest that an analysis with a fairly strict economic focus is perhaps too limited in scope to use as a primary baseline for evaluating the impacts of designating marine reserves. While the 2000 SIA was comprehensive and well done in terms of economics, it ultimately proved of little value in understanding the changing nature of fishing and diving in the area that is now the TER. This is due to the unanticipated effects of the intervening variables noted.

For this reason, it is recommend that future social impact analyses be based on an interdisciplinary framework that includes both an economic component and a social component, and that this social component include a broad range of disciplines, such as sociology, social psychology, anthropology and recreation. This is especially important in cases where behavioral adjustments, such as substitution, are likely to confound a follow-up economic analysis. This framework could include pertinent elements of the National Marine Fisheries Service (NMFS) Social Impact Analysis assessment procedures (NOAA, 2007).

A combination of the traditional economic analysis and the NMFS assessment approach serves as a good model for quantifying and qualifying social conditions at the time of a reserve's designation because the interdisciplinary nature of such a framework will most probably be more responsive to and inclusive of a variety of factors that will likely prove important when evaluating impacts in the future. Specifically, the NMFS approach serves to gauge the social and cultural consequences of alternative fishery management actions or policies, determines social and cultural conditions likely to be affected by the regulatory action or policy, and project future social and cultural effects of continuing the status quo. Additionally, it considers the effects of:

1. Changes in resource availability;
2. Changes in fishing practices on fishermen, communities, fishing-related businesses;
3. Families and other social institutions;
4. Regulations and social norms of behavior; and
5. Social and cultural values

Furthermore, NMFS guidelines state that while descriptions of effects should be quantitative probabilities, this is not always possible. In these cases, conclusions should be discussed qualitatively rather than simply ignored because they are not easily enumerated or understood.

SUMMARY AND CONCLUSIONS

While a general distrust of government on the part of the fishing operators was observed, this study benefited from a high degree of cooperation among the sample. As the survey instrument illustrates, operators were asked about their past and recent trips to the Tortugas, what constraints exist for them with regard to making such trips, and what, if any, impacts the TER has had on their economic and social well-being.

There are three important findings from this study. The first is that there is little evidence to suggest that (a) there has been either a negative or positive economic impact of reserve designation on charter fishing and diving operations that operated in the study area prior to its creation, or (b) the reserve has been an economic barrier to business. Participation was extremely low, by any measure, prior to establishment of the reserve, and by all indicators remains low today. The issue of quantifying change in participation is not whether to express change in absolute numbers or percentages, but the fact that accurately measuring change and then attributing that change to the reserve is extremely difficult given the above described circumstances.

The surveys and interviews suggest that operators feel that diving and fishing is still as good as ever (but not significantly better) in the Tortugas region, and the operators who went to the study area prior to its designation as an ecological reserve have adapted to the closure via substitution. However, there was variance on the issue of general support for no-take fishery reserves. For example, while some stated that closing an area "must have some positive impact to the fish stocks," there were at least two people who found this idea baseless. In one case, it was termed "ridiculous."

The second important finding from this study is that in cases where substitution is an available option for operators, and where there are multiple economic and social variables that are unaccounted for, a straightforward before and after economic comparison will likely show little evidence of positive or negative impact due to a marine closure. Therefore, it is recommended future social impact analyses undertaken by NOAA include an interdisciplinary social science team. Such a team would be in a better position to build an analysis framework that would include collecting data on study area specific potentially intervening variables. This will allow for a

more detailed, holistic and meaningful comparison later. This study suggests several variables that may generalize to other geographic locations.

Thirdly, while marine resource managers hope that establishing marine reserves will have benefits, such as increased fish to catch and observe, to those who use and rely on the surrounding marine environment, the complexity of ecological systems and social variables, and the interplay between the two, can make quantifying such benefits difficult. For example, were fish biomass to increase substantially from the creation of the reserve, the local dispersal patterns of such biomass may not be well understood. How do storms and climate shifts factor in? How can benefits to the few private recreational anglers be quantified? If fish biomass increases but fuel prices or fewer customers force charter operators to stay closer to Key West, how will more fish in the Tortugas help them? A main problem here is that the reserve is so remote and difficult to access that it limits the ability to suggest that biophysical improvements in conditions within the reserve have led to more non-consumptive recreational use or benefits within the reserve boundaries. One of the goals in establishing the reserve was that it would (hopefully) improve abundance and diversity of stocks in the broader Florida Keys. It is even more difficult to prove that this has occurred, and then, a completely different scope of study is necessary to determine what the economic benefits and impacts of those improvements are.

It takes the right kind of business model, knowledge of the waters, the right business atmosphere, and the right regulatory conditions to make for-profit recreational fishing in the Tortugas feasible. Because of this, the number of for-hire dive and fishing operators utilizing the Tortugas area was small in 2000, and remains so today. There has been no large movement of operators into or out of this community. The reserve does not appear to have created any large-scale positive or negative impacts on for-hire recreational businesses that used the Tortugas area. This study relied on both quantitative and qualitative methods, but did not recreate the detailed economic analysis conducted as part of the 2000 SIA. While scale of activity and the net change in economic terms are important measures in marine reserve research, in the case of the TER these numbers are small and knowing the change in number of operations, as well as understanding the attitudes and beliefs of charter operators and the intervening variables noted, is sufficient. Conclusions and recommendations would not be changed by conducting a detailed economic analysis. For the reasons stated elsewhere, collecting and analyzing such information, stating that this actually represented a real change, and then attributing that change to the establishment of the reserve would go far beyond the ability of the data to draw those conclusions.

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