Economic Impact Analysis of Coastal Ocean Observing Systems In the Gulf Coast Region

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Table of Content

INTRODUCTION **4**

SUMMARY OF ECONOMIC ACTIVITIES AND ESTIMATES **15**

- CONSTRUCTION 15
- RECREATION 17
- RECREATION RELATED BUSINESS 19
- CROP AGRICULTURE 25
- MILITARY (NAVY) OPERATIONS 28
- OIL AND GAS DISTRIBUTION 30
- POLLUTION MANAGEMENT AND PREVENTION 32
- MARITIME TRANSPORTATION 37
- STORM DAMAGE MITIGATION AND REPAIR 39
- COMMERCIAL SHIPPING 41
- OFFSHORE ENERGY PRODUCTION 45
- FISHERIES: COMMERCIAL 48
- FISHERIES: RECREATION 50
- MARINE SEARCH AND RESCUE (SAR) 52
- MARINE WATER QUALITY MANAGEMENT 53
- FRESHWATER SUPPLY MANAGEMENT 55

RESULTS AND DISCUSSION **57**

ECONOMIC ANALYSIS OF COOS IN THE GULF OF MEXICO REGION, USING THE IMPLAN MODEL **60**

- IMPLAN RESULTS 63

FINAL CONCLUSIONS **68**

REFERENCES **69**

Tables

Table 1. Summary of Economic Activities and Estimates and ENSO Events, 2001. 10
Table 2. Value of Residential Construction in States by Construction Contract, 2001.... 15
Table 3. Value of Non-residential Construction in States by Construction Contract, 2001 16
Table 4. Value of Residential and Non-residential Construction in States by Construction Contract, 2001........ 16
Table 5. Participation in Coastal Recreation by the Gulf Coast States........ 18
Table 6. Expenditure by the Coastal Recreation Participants in the Gulf States........ 18
Table 7. Hotel and Motel Sales Volumes and Employment in the Gulf States........ 19
Table 8. Marinas Sales Volumes and Employment in the Gulf States........ 20
Table 9. Amusement Parks Sales Volumes and Employment in the Gulf States........ 21
Table 10. Amusement and Recreation, NEC Volumes and Employment in the Gulf States 21
Table 11. Coin Operating Instruments Business Sales Volumes and Employment in the Gulf States........ 22
Table 12. Museum Sales Volumes and Employment in the Gulf States........ 23
Table 13. Botanical Garden and Zoo Sales Volumes and Employment in the Gulf States 23
Table 14. Total Recreational Sales Volume and Employment in the Gulf States........ 24
Table 15. Agricultural Production by Gulf State for 2002. 25
Table 16. Top Five Agricultural Commodities for 2002 by Gulf State........ 26
Table 17. Navy Annual Expenditures in the Gulf Region........ 29
Table 18. Petroleum and Natural Gas Production Expenditures by State, 2000 31
Table 19. Oil spill trends in Gulf of Mexico, 1973-2000. 33
Table 20. Oil Spill Trends in Florida, Alabama, Mississippi, Louisiana and Texas. 1973-2000........ 34
Table 21. The cost of Oil Spills 36
Table 22. Shipping costs........ 37
Table 23. Estimated Operating Costs Of Maritime Transportation In The Gulf Of Mexico States, Assuming Average Total Transit Time Of Two Days. 38
Table 24. Storm Damage by State, 2002 39
Table 25. Storm Damage by State in Millions, 1998-2002, Five-Year Average........ 40
Table 26. Largest Gulf Seaports, Millions of Short Tons........ 41
Table 27. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Imports by Millions of Metric Tons........ 42
Table 28. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Imports by Millions of Dollars........ 42
Table 29. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Exports by Millions of Metric Tons........ 43
Table 30. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Exports by Millions of Dollars........ 43
Table 31. Average Direct Operating Costs per 12-Slot and 18-Slot Platform for the Gulf of Mexico from 1986-2002........ 46
Table 32. Commercial Finfish and Shellfish Weight, Dollar Value,and Estimated Average Value Added per Fishing Day for the Gulf of Mexico, By State, for 2002 48

Table 33. Marine Recreational Anglers, Angler Trips and Estimated Willingness to Pay for Fishing, in the Gulf of Mexico, by State, for 2002 51
Table 34. USCG Gulf Area SAR Program Lives Saves Performance Measures 52
Table 35. Percent of Bodies of Water Near Coast Judged Good Water Quality for Intended Use, 2000 53
Table 36. Clean Water State Revolving Fund 54
Table 37. Water Supply Revenues for the Gulf of Mexico 56
Table 38. Summary of Economic Activities for Gulf States (Florida, Alabama, Mississippi, Louisiana and Texas) 58
Table 39. Summary of Economic Activities by Sector for Gulf States (Florida, Alabama, Mississippi, Louisiana and Texas) 59
Table 40. IMPLAN Direct, Indirect, and Induced Economic Impact Results for Gulf of Mexico States 66

Introduction

The Gulf Coast States of Florida, Alabama, Mississippi, Louisiana and Texas

The Gulf of Mexico is a major asset to three surrounding countries, in terms of fisheries, tourism, agriculture, oil, infrastructure, trade and shipping (Cato and Adams, 1999). Population along the Gulf coast increased by 52% between 1970 and 1990, to 15.2 million people in 1990. The infrastructure for oil and gas production in the Gulf of Mexico (oil refineries, petrochemical and gas processing plants, supply and service bases for offshore oil and gas production units, platform construction yards and pipeline yards) is concentrated in coastal Louisiana and eastern Texas. Oil production has a tremendous impact on the economy and other environmental and economic resources. Commercial fishing is an important component of the Gulf of Mexico's economy, contributing $707 million in 2002. The Gulf region contains one-fourth of the U.S. seafood processing and wholesale establishments. Marine sportfishing is another industry of regional importance, providing jobs and recreational activities. The Gulf of Mexico contains major shipping lanes. Port facilities contribute to important sources of employment.

The Gulf of Mexico encompasses an area of about 600,000 square miles, and is almost completely surrounded by the United States, Mexico and Cuba. The watershed area of the Gulf of Mexico is approximately two million square miles. About 33 major rivers drain into the Gulf, in addition to smaller creeks and streams. The Mississippi River is the largest of these rivers, draining 40% of the continental United States. The major estuaries along the Gulf coast comprise 24% of all estuarine areas in the continental U.S., and 55% of the marshes. The importance of these estuaries is underscored by the fact that 98% of the fish and shellfish caught in the Gulf depend on estuarine and marsh habitats.

About $16 billion in yearly spending is generated by the millions of people who inhabit the coast in addition to 25 million annual visitors. Many of the people living near the Gulf of Mexico coast are gainfully employed in such areas as fishing, oil and gas, maritime shipping, marine resources or the tourism industry.

The Gulf of Mexico is a hotbed for recreational activities including beach-related recreation, birdwatching, diving and snorkeling, among others. Fishery resources comprise approximately 40 percent of the total U.S. fisheries landings, 80 percent of the national total of shrimp and more than 60 percent of the national total of oysters. The dockside value of commercial landings of fish and shellfish was $705 million (or 1.7 billion pounds) for 2002. Commercial fisheries support other important gulf industries such as ship construction and fish processing, among others. Recreational fisheries supports boat building, sport and bait shops, charter boats, and gear manufacturing. The Gulf of Mexico leads the nation in the level of recreational fishing.

The Gulf of Mexico is a host to a multitude of oil and gas industries. There are nearly 1,600 outer continental shelf leases in production in the Gulf, comprising 97 percent of offshore production in the U.S. The primary area of offshore mineral, oil and gas production occurs in Louisiana, and as of November, 2003 there were 272 exploration wells and 4,219 (4,011 are active) producing platforms operating in the Gulf. There are numerous industries that directly serve the oil and gas operations. Some of these include large facilities such as platform fabrication yards and shipyards, chemical production, oil field equipment dealers, cement suppliers, drilling tool and equipment suppliers, helicopter services, caterers, and divers.

Agricultural production totaled approximately $31.4 billion in 2002. In Florida, citrus farming and greenhouse/nursery revenues top the list more than any other product. In Louisiana, sugarcane and cotton are primary agricultural products. In Alabama, broilers and cattle are the main agricultural commodities, and in Mississippi, broilers and cotton top the list for agricultural production. Interestingly, aquaculture ranked fourth on the "Top 5" agricultural products for Mississippi. Lastly, in Texas, beef cattle, calves and greenhouse/nursery are the primary agricultural industry.

Of the major seven ports in the world, two are located in the Gulf of Mexico – New Orleans and Houston. Seven of the ten busiest ports in the U.S are located on the Gulf Coast. Shipping tonnage is approximately 734 million tons (1999). The most widely shipped product is petroleum, with coal, grains, chemicals, fertilizers, and metal (iron and steel) as primary shipping products.

Coastal Ocean Observing System (COOS)

The National Oceanographic Partnership Program (NOPP) encompasses fourteen Federal agencies with a goal to provide leadership and coordination of national research and education programs. NOPP fosters new collaborations among federal agencies, academia and industry with an objective to highlight those efforts and accomplishments across the oceanographic community. NOPP promotes joint sharing of resources and innovative advances in ocean science, technology, and education. The focus of NOPP is the development of an integrated, sustained ocean observing system for the United States (NOPP, 2002).

NOPP's objective is the development and successful launch and operation of an Integrated Coastal Ocean Observing System (ISOOS) system. For the purpose of this study, we will be referring to the system, as the Coastal Ocean Observing System or COOS. Currently, there are five investment areas (operational/routine observation, research observatories, observational technique development, "commons" for ocean information, and education and outreach. The economic benefit-cost study of the Gulf Coast COOS is a project included in the operational/routine observations category. The quantification of benefits and costs is a critical and important stage in the COOS planning process. The results will provide a baseline for future research and policy decisions regarding the long-term focus to guide the success of the COOS for the United States.

The current ocean observation system exists in varied sections throughout the regions of the United States. Observations are often taken from platforms, which could be ships or old lighthouses. The observations taken by ship are not continuous, whereas the observations taken from lighthouses might not be in geographically important or desired locations. In addition, the data from all the observations systems were rarely compiled into a single consistent large dataset. Lastly, there is a large reserve of ocean that remains an untapped source of data collection. Thus, the COOS was created, that would organize ocean data collection in a systematic and continuous methodology.

The Global Ocean Observing System (GOOS) is a collaborative effort of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the World Meteorological Organization (WMO) and the United Nations Environmental program (UNEP). GOOS provides long-term ocean data based on a globally coordinated strategy and is used for climate forecasting. The system will be built to the extent possible, on existing global, regional and national systems through an integrating process. It will consist of a number of modules to examine specific objectives such as climate assessment and prediction, evaluation of marine living resources, coastal zone management and development, health of the ocean, marine meteorological and oceanographic operation services. It will offer a comprehensive description of the current state of the ocean, and will serve as an input to a variety of operations, such as coastal protection, marine resource exploitation, safety, monitoring the marine environment, and pollution control (Stel and Mannix, 1996).

ISOOS, or for the purpose of this study, COOS, is the U.S. counterpart to the GOOS. COOS is to be an integrated ocean observing system that would routinely gather ocean information similar to the information gathered for atmospheric weather forecasting. Most regional observing systems are likely to evolve as a combination of existing and expanded observing stations. Some of the expanded observing stations will be fixed buoys deployed to supplement existing infrastructure such as the National Weather Service weather buoys (Kite-Powell and Colgan, 2001). It is a significant undertaking, but of vital importance since ocean data collection in the past has been of great value, but was not compiled or organized in a global systems approach manner. The data that COOS assembles will serve seven vital activities: 1) detecting and forecasting oceanic components of climate variability 2) facilitating safe and efficient marine operations 3) ensuring national security 4) managing living resources for sustainable use 5) preserving and restoring healthy marine ecosystems 6) mitigating natural hazards, and 7) ensuring public health (Nowlin and Malone, 1999).

Rodney Weiher and Hauke Kite-Powell (2000) have estimated that nearly 15 percent of GDP originates in climate sensitive industries, such as agriculture, recreation, construction, energy distribution, and water supply management. In addition, climate forecasts are becoming increasingly needed in industries, such as agribusiness, motor and rail freight, and air transportation. Forecasts of climate, weather, coastal and marine conditions create economic value, as producers and consumers can use the forecasts to improve the outcome of their decisions. Agriculture producers use temperature and precipitation forecasts to project approximately six months to a year as a decision tool for what crop varieties and fertilizers to apply, and investments decisions to make. Forecasts of natural marine hazards such as red tide and detrimental algal blooms can reduce losses in recreation and offset health risks. Another example of applying economic analysis to ENSO forecasts was conducted by Lynch and O'Brien, in 1992, who concluded that the economic benefits of ENSO forecasts holds the potential to yield annual discounted savings (or benefits) for the U.S. alone of $130 million annually with a NPV of benefits exceeding $1.56 billion over a 12 year period.

In August 2000, a publication was launched entitled "The Economics of Sustained Ocean Observations: Benefits and Rationale for Public Funding" that reported the results of a group of economic experts with the purpose of assessing the economics of the proposed COOS. Overall conclusions were that quite substantial benefits would be derived from the COOS. These were partially based on previous studies underscoring the large economic benefits already captured from ocean data. The authors were able to categorize and quantify a considerable amount of data and economic estimates that are presented in Table 1. The cost of COOS is estimated to be approximately $0.667 billion,

Table 1. Summary of Economic Activities and Estimates and ENSO Events, 2001.

Economic Activity	Economic Scale of Activity	Effect of Weather Fluctuations	How Forecasts can be Used	Effects of the 1997/98 ENSO Event	Estimates of Forecast Value (perfect forecast)
Construction	$528 billion (1992 construction industries	Temperature and precipitation affect whether construction can proceed	Construction managers can better schedule projects	Increased seasonal home construction in mid-Atlantic region; more working days for carpenters, painter, etc.	?
Recreation	$100 billion (1992 hotels and recreational amusement centers) $10 billion (1991 rec. boating and fishing expenditures)	Temperature and snowfall affect winter sports conditions; rainfall affects other outdoor recreation; severe weather causes accidents at sea and in marinas	Vacationers can improve their vacation experience by better planning their travel and sports activities; decisions about going to sea or securing marinas are based on forecasts	Better than average recreational fishing in California, Florida, mid-Atlantic states	$10s of millions/year from improved recreational fishing and boating planning and safety
Crop Agriculture	$109 billion (1996 cash receipts, all US)	Temperature and rainfall affect crop yields	Farmers can select crop varieties appropriate to expected temperature and rainfall conditions; distributors can reduce commodity storage if uncertainty about future yields is reduced.	$3 billion losses to producers and consumers	$300 million/year for US agriculture $300 million/year for corn storage industry
Military	$87 billion (2000 Budget for Navy and Marines)	Weather and marine conditions affect military operations	Improved safety and efficiency of military operations	?	?
Oil and Gas Distribution	$76 billion (1992 natural gas production and distribution) $7 billion (residential and commercial heating gas and fuel oil, average)	Temperature affects demand for heating fuels	Energy suppliers can adjust fuel stores and better time drawdown of stored fuel	$2 billion reduced expenditures for heating fuels due to mild winter	?

Table 1. Summary of Economic Activities and Estimates and ENSO Events, 2001, Cont.

Economic Activity	Economic Scale of Activity	Effect of Weather Fluctuations	How Forecasts can be Used	Effects of the 1997/98 ENSO Event	Estimates of Forecast Value (perfect forecast)
Maritime Transportation	$25 billion (1987 revenues)	Visibility, wind and water levels affect ships schedules	Better marine conditions forecasts lead to better routing and scheduling	---	<$10 million/year from improved water level forecasts in ports
Storm Damage Mitigation and Repair	$16.7 billion (1992 value of roofing/siding construction work)	Storms (wind and precipitation) cause damage to buildings and other infrastructure	Homeowners can take measures to minimize storm damage (preemptive repairs) municipalities can prepare for possible floods (clearing drainage canals, etc.)	$500 million in property damage in California $275 million FEMA obligations for storm and flooding damage sales of roofing materials etc. up 20% in California	?
Offshore energy	$16.4 billion (1987 revenues)	Hurricanes and strong currents affect operations	Improved storm and current predictions can enhance safety and efficiency	---	?
Fisheries	$3.5 billion (1996 landings, all US)	Water temperature and streamflow affect fish abundance and reproductive behavior	Fishery managers can adjust harvesting to ensure adequate spawning; fishers can use wind and temperature forecasts to improve safety and efficiency	Decreased output of fishmeal in South America	$1 million/year for one northwestern coho salmon fishery
Marine search and rescue (SAR)	$700 million in property saved by USCG SAR per year (1993)	Wind/waves, currents, and visibility affect SAR operations	Better current models can target SAR efforts more effectively	---	>$100 million/year from 1% improvement in search success
Marine water quality management	?	Coastal water quality affects recreational and other marine resources	Improved information about water quality will enable coastal managers to make better decisions	?	?
Freshwater supply management	?	Precipitation affects the amount of water entering reservoirs and the demand for irrigation	Water supply managers can improve reservoir management by anticipating future inflows	Fall precipitation was late, but spring flows tracked forecast	?

and the estimated additional cost of implementing COOS is expected to grow from $30 million to about $100 million on an annual basis. As the name implies, the immediate output of COOS will be ocean observations; new and real time data on the physical, chemical, and biological characteristics of marine waters and the ocean/atmospheric boundary. Some economic benefits derived from COOS include marine conditions reports, and weather and climate forecasts, among others. In addition, some of the potential benefits of the information gathered from COOS can influence national policy since decision-making would have a national perspective. For the private sectors, the creation of new firms and new employment will be generated from the information provided by COOS. In the final conclusions, the authors stress the importance of public support of COOS, for the following reasons: COOS generates network externalities (the value of the system will be much greater than the sum of the values of the individual parts), uncertainty about the magnitude of benefits impedes the private sector contract negotiations, and lastly, the information that COOS provides has the characteristics of a public good. The property of information is such that for distribution purposes, it is relatively low in cost.

Prior to investing in public sector projects, decision makers must be confident that the project will serve the public interest, based on results where economic benefits exceed economic costs. A previous study, conducted by the late Peter Sassone and Rodney Weiher (1997) examined a benefit-cost analysis of the recently complete Tropical Ocean Global Atmosphere (TOGA) program. The first ten years of TOGA was devoted to being a research program. It has evolved into an operational program for collecting data and making ENSO forecasts, and would be the main contribution of the U.S. to the

GOOS and GCOS programs. As the authors note, even though benefit-cost analysis is a widely accepted tool used by economists to determine project worthiness, there are characteristics of climate prediction investments that make the analysis more difficult to employ. Some of these characteristics include: 1) uncertainty about the actual costs of the programs. 2) uncertainty about the nature of precision of the proposed research (projects to develop climate prediction models). 3) benefits of a correct climate forecast will be contingent on the actual climate that occurs. 4) benefit-cost analysis (BCA) compares a baseline forecast to an actual forecast, but often, with climate prediction investments, this presupposes that the baseline contains a forecast, which is difficult to project with climate prediction investments. 5) The behavioral responses to climate forecasts would have to be specified for both the baseline and project scenarios, and the affected economic sectors, and that information (to date) is incomplete.

The general format for performing benefit-cost analysis involves comparison among alternative scenarios. First, one identifies the program or policy to be examined. One must also determine a baseline program. The next stage is to qualitatively identify the benefits and costs associated with each program scenario. Then one must quantify the program components associated with benefits and costs, and assign monetary values to those units. Lastly, the monetary effects must be aggregated over time using present value analysis, to perform sensitivity analysis, and to summarize results and conclusions. There are two primary methods for dealing with uncertainty in BCA; one involves conducting sensitivity analysis (by varying discount rate, period of analysis, and so forth and then examining changes in net present value over time) and the other involves creating conservative estimates of costs and benefits such that the final calculations result in the most conservative estimate of the net benefits of the program. The internal rate of return (IRR), or aggregation of the costs and benefits using present value analysis, is calculated. The IRR is a common summary value used to determine the economic value of a project investment. The Office of Management and Budget (OMB, 1992) recommends IRR values to be greater than seven percent in order for a project to be considered. The authors concluded that investments in TOGA provide an economic return on investment to the U.S. of 13 – 26 percent, annually.

The objective of this report was to identify and quantify the expected economic benefits of sustained coastal ocean observing systems in the gulf coast region. To date, given that the benefits of COOS have not been quantified and perfect information is not available, our study made an assumption that for each economic activity, that enhanced forecasts through COOS would result in a 1% savings for that particular economic activity. Economic benefits were separated in three categories: private sector activities, non-market activities, and public sector activities. Lastly, the analysis aggregated benefits across sectors to yield total systems benefits. The ultimate end goal of this project will be to aggregate economic benefits and costs for all the regions (to be performed by NOAA and ONR), as an effort to calculate a benefit cost ratio for COOS in the United States.

Summary of Economic Activities and Estimates

Construction

A potential benefit of having COOS in the Gulf of Mexico is that forecasts from such a system would allow construction managers to better schedule projects around adverse weather events. Since construction takes place outside, temperature and precipitation can affect whether construction can proceed and at what pace. Construction delays from the weather usually result in higher costs for the project. However, if such an ocean observing system could provide more accurate and timely weather information, then construction managers could better schedule work crews to minimize any additional costs, due to the weather, that the project may encounter. The table below displays the costs of residential construction for the Gulf States. Florida and Texas have a large amount of construction projects due the large size and economic activity of each state.

Table 2. Value of Residential Construction in States by Construction Contract, 2001

State	Residential Construction (in millions of dollars)
Florida	$21,415
Alabama	$2,557
Louisiana	$1,544
Mississippi	$1,296
Texas	$18,549
Total	$45,361

Source: U.S. Census Bureau, Statistical Abstract of the United States: 2002

The Gulf States could also benefit from better scheduling of non-residential construction. The tables below illustrate the magnitude of non-residential construction costs in Florida, Alabama, Louisiana, Mississippi, and Texas. Assuming that forecasts

Table 3. Value of Non-residential Construction in States by Construction Contract, 2001

State	Non-residential Construction (in millions of dollars)
Florida	$10,831
Alabama	$2,728
Louisiana	$1,785
Mississippi	$1,293
Texas	$14,687
Total	$31,324

Source: U.S. Census Bureau, Statistical Abstract of the United States: 2002

Table 4. Value of Residential and Non-residential Construction in States by Construction Contract, 2001.

State	Residential and Non-residential Construction (in millions of dollars)
Florida	$32,246
Alabama	$5,285
Louisiana	$3,329
Mississippi	$2,589
Texas	$33,236
Total	$76,685

Source: U.S. Census Bureau, Statistical Abstract of the United States: 2002

from the ocean observing system would allow construction managers to better plan projects and thereby lower construction costs by 1%, then the total benefits to construction would be $766.85 million.

Coastal Recreation Activities

The more accurate weather and currents information generated from COOS positively affects on the recreation activity. We analyze the influence of the COOS information on the outdoor recreation activities and on the recreation business respectively.

According to the 1999-2000 National Survey on Recreation and the Environment (NSRE) that was started in 1960 by the Outdoor Recreation Resources Review Commission (ORRRC), 80 million (over 16 years) population participated in coastal recreation in the Gulf area during 2000.[1] Among the five states in the Gulf of Mexico, Florida is the number one state in which 52 million participated in outdoor leisure activities. The 18 activities encompassed swimming to fishing; visiting beaches and swimming are the most favored activities. Forty-one million, more than 50% of all participants, enjoy only these two activities. Also, it should be noted that 36% of all the people, 29 million out of the total 80 million, that selected the "Visit Beaches" and "Swimming" category, were located in Florida. When people enjoy coastal recreation, they are assumed to spend money on their recreation, and this expenditure affects the regional economy directly and indirectly. According to the Visitors Study by Florida and Texas, assuming that participants enjoy just a day-trip, average expenditures per person per day, which includes "food," "shopping," and "miscellaneous" categories, ranges from $47.7 to $51.3 in 2002.[2] The other recreation related activities and businesses are described below.

1 NOAA, Current Participation Patterns in Marine Recreation, 2001.
2 Texas Office of Economic Development, 2002 Travel to Texas Report, 2002; Visit Florida, Florida Visitor Study, 2002.

Table 5. Participation in Coastal Recreation by the Gulf Coast States

Activities	Number of Participants (Millions)					
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
Visit Beaches	1.249	15.246	0.629	1.042	3.851	22.017
Swimming	1.022	14.033	0.398	0.563	3.076	19.092
Snokeling	0.107	2.866	0.016	0.025	0.165	3.179
Scuba Diving	0.018	0.802	0.011	0.004	0.070	0.905
Surfing	0.045	0.583	0.009	0.000	0.124	0.761
Wind Surfing	0.027	0.109	0.008	0.008	0.101	0.253
Fishing	0.615	4.698	0.975	0.312	1.695	8.295
Motorboating	0.272	3.337	0.382	0.228	0.820	5.039
Sailing	0.103	0.926	0.203	0.047	0.195	1.474
Personal Watercraft	0.139	1.626	0.136	0.070	0.272	2.243
Canoeing	0.019	0.276	0.019	0.010	0.046	0.37
Kayaking	0.022	0.338	0.000	0.005	0.021	0.386
Rowing	0.013	0.153	0.015	0.000	0.020	0.201
Water-Skiing	0.071	0.613	0.095	0.039	0.144	0.962
Bird watching	0.351	0.373	0.888	0.317	0.805	2.734
Viewing Other Wildlife	0.364	2.846	0.385	0.235	0.745	4.575
Photographing Scenery	0.441	3.920	0.596	1.324	1.193	7.474
Hunting Waterfowl	0.062	0.072	0.083	0.006	0.075	0.298
Total	**4.94**	**52.817**	**4.848**	**4.235**	**13.418**	**80.258**

Source: NOAA, Current Participant Patterns in Marine Recreation, 2001.

Table 6. Expenditure by the Coastal Recreation Participants in the Gulf States

Category	Participants and Expenditures (Millions)					
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
Participants	4.94	52.817	4.848	4.235	13.418	80.258
MIN Expend.	$235.64	$2,519.37	$231.25	$202.01	$640.04	$3,828.31
MAX Expend.	$253.42	$2,709.51	$248.70	$217.26	$688.34	$4,117.24

We assume that expenditures by the outdoor recreation participants range from $47.7 to $51.3, per day, and annual total expenditures range from $3.8 billion to $4.1 billion. Therefore, if we assume the enhanced information from COOS contributes an increase of 1% expenditures spent in the outdoor recreation area, it is estimated that recreational benefits will range from $38 million to $41 million, or an average of $39.73 million.

Recreation Related Business

Regarding the recreation activities in coastal areas, we considered other related businesses such as accommodations, marinas, amusement parks, and so forth. The CACI business directory supported by the ARCView geographic information system (GIS) provides payroll and employment data of the Gulf States by NAICS[3]. Because the CACI data provides the range of the payroll and employment rather than the exact value, we estimated the range and average of the recreation related businesses for the coastal counties (Appendix A) of the five Gulf states:

Hotel and Motel

One of the major recreation-related businesses are accommodations such as hotels and motels. The annual sales volume of the hotel and motel business ranged from $136 million in Louisiana to $5.5 billion in Florida. Also, as presented in Table 7, the assumed total average sales volume of the five Gulf States was estimated as $5.3 billion (minimum = $3.1 billion and maximum = $8.2 billion) in 2001.

In addition, the employment of the hotel and motel businesses in the Gulf States ranges from 2,760 (in Mississippi) to 72,522 (in Florida). Average of the total employment of the hotel and motel industry for the Gulf area was estimated at 75,946.

Table 7. Hotel and Motel Sales Volumes and Employment in the Gulf States

	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	$152,090,000	$2,166,330,000	$136,440,000	$215,110,000	$468,370,000	$3,138,340,000
MAX	$510,000,000	$5,499,500,000	$482,000,000	$426,000,000	$1,281,000,000	$8,198,500,000
AVG	$255,750,000	$3,751,500,000	$233,750,000	$295,250,000	$798,250,000	$5,334,500,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	3,416	38,405	2,831	2,760	7,293	54,705
MAX	6,092	72,522	5,243	4,716	14,071	102,644
AVG	4,454	53,648	3,840	3,639	10,365	75,946

3 CACI Business Directory for Coastal Counties of Gulf Coast States provided by Dave Sobush, Center for Economic Development Research (CEDR), University of South Florida

Marinas

The annual sales volume for marinas (as estimated by the CACI data in 2001) ranged from $22.1 million in Mississippi to $907 million in Florida. In addition, as depicted in Table 8, the assumed total average sales volumes of the five Gulf States was estimated as $1.0 billion, in 2001.

The employment of the marina business in the Gulf area ranges from 97 to 5,145. Average of the total employment of marinas in the Gulf States was estimated as 6,332.

Table 8. Marinas Sales Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	$35,290,000	$366,820,000	$66,360,000	$22,160,000	$99,710,000	$590,340,000
MAX	$89,500,000	$907,000,000	$163,500,000	$52,500,000	$250,500,000	$1,463,000,000
AVG	$62,250,000	$635,500,000	$114,750,000	$37,250,000	$174,750,000	$1,024,500,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	192	2,089	462	97	586	3,426
MAX	492	5,145	1,185	262	1,357	8,441
AVG	369	3,876	857	195	1,035	6,332

Amusement Park

The annual sales volume of the amusement park falls into the range from $7.5 million in Mississippi to $372 million in Florida. In addition, as shown in Table 9, the assumed total average sales volumes of five Gulf States was estimated as $386 million in 2001.

In addition, the employment of amusement parks in the Gulf area ranged from 50 to 3,145. When we assume maximum employment in the amusement park, Florida was assumed to employ 3,145. Also, the average of the total employment of amusement park in the five Gulf States was estimated as 3,487, in 2001.

Table 9. Amusement Parks Sales Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	$23,520,000	$201,760,000	$21,050,000	$7,500,000	$27,110,000	$280,940,000
MAX	$48,500,000	$372,500,000	$45,500,000	$15,000,000	$60,000,000	$541,500,000
AVG	$36,000,000	$262,000,000	$33,250,000	$11,250,000	$43,500,000	$386,000,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	215	1,711	119	50	215	2,310
MAX	503	3,145	268	114	487	4,517
AVG	364	2,470	202	85	366	3,487

Amusement and Recreation, NEC

All other businesses, which were not included in the NAICS specific amusement category, but do business in amusement and recreation industry, are classified into this category. The annual sales volume of the NEC business ranged from $22 million in Mississippi to $2.6 billion in Florida. In addition, as presented in Table 10, the assumed total average sales volumes of the five Gulf States was estimated as $2.9 billion, in 2001.

The employment of the amusement and recreation business in the Gulf area ranged from 309 to 23,586. Average of the total employment of the amusement and recreation business in the Gulf States was estimated at 30,091, in 2001.

Table 10. Amusement and Recreation, NEC Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	$98,970,000	$804,880,000	$223,430,000	$22,840,000	$253,810,000	$1,403,930,000
MAX	$294,500,000	$2,603,000,000	$614,500,000	$89,000,000	$774,000,000	$4,375,000,000
AVG	$196,000,000	$1,694,750,000	$417,750,000	$55,500,000	$511,500,000	$2,875,500,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	1,210	9,653	2,530	309	3,010	16,712
MAX	2,826	23,586	5,858	790	7,168	40,228
AVG	2,103	17,670	4,352	596	5,370	30,091

Coin Operated Device Amusement

In this analysis, we assumed that coin device players are one category of recreation. The annual sales volume of the coin operated devices ranges from $1.5 million in Texas to $1.3 billion in Mississippi. In addition, as depicted in Table 11, the assumed total average sales volumes of five Gulf States was estimated as $1.5 billion, in 2001.

Compared to the sales volume, the number of employees seemed to be small. The employment of the coin device business in the Gulf area ranged from 8 to 11,180. There are huge variances in this business. The average total employment of the coin device business in the Gulf area was estimated at 13,739.

Table 11. Coin Operating Instruments Business Sales Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	$4,520,000	$81,200,000	$237,080,000	$808,050,000	$1,550,000	$1,132,400,000
MAX	$11,000,000	$183,500,000	$384,000,000	$1,268,500,000	$5,500,000	$1,852,500,000
AVG	$7,750,000	$132,250,000	$310,500,000	$1,038,250,000	$3,500,000	$1,492,250,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	35	837	773	8,609	8	10,262
MAX	76	1,719	1,564	13,730	32	17,121
AVG	59	1,294	1,182	11,180	24	13,739

Museums

Unfortunately, we could not get possible sales volume for the museum business, except Florida. The annual sales volume of the museum ranged from $1.5 million to $3.5 million in Florida. In addition, as shown in Table 12, the assumed total average sales volume in Florida was estimated as $2.5 million in 2001.

However, the employment of museums in the Gulf area ranged from 33 to 1,829. Average of the total employment of museum in the Gulf area was estimated as 2,422, for 2001.

Table 12. Museum Sales Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	NA	$1,500,000	NA	NA	NA	$1,500,000
MAX	NA	$3,500,000	NA	NA	NA	$3,500,000
AVG	NA	$2,500,000	NA	NA	NA	$2,500,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	86	790	33	66	450	1,425
MAX	184	1,829	89	149	1,004	3,255
AVG	140	1,351	68	110	753	2,422

Botanical Garden and Zoo

We could not obtain sufficient data for the sales volume for the botanical garden and zoo category. The annual sales volume of the garden and zoo ranged from $1.0 million to $2.0 million in Texas. In addition, as depicted in Table 13, the assumed total average sales volume in Texas was estimated as $1.5 million, in 2001.

The employment of the gardens and zoos in the Gulf area ranged from 1 to 521. Employee numbers vary greatly among the five Gulf states. Average of the total employment of Botanical Garden and Zoo category in the Gulf area was estimated as 786.

Table 13. Botanical Garden and Zoo Sales Volumes and Employment in the Gulf States

Sales Volume						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	NA	NA	NA	NA	$10,000,000	$10,000,000
MAX	NA	NA	NA	NA	$20,000,000	$20,000,000
AVG	NA	NA	NA	NA	$15,000,000	$15,000,000
Employee Size						
	AL	**FL**	**LA**	**MS**	**TX**	**Total**
MIN	29	304	1	20	101	455
MAX	63	729	4	49	253	1,098
AVG	49	521	3	35	178	786

Based on the total sales volume and employment in the five Gulf States, the range of the sales volume was from \$6.5 billion to \$16.5 billion, and the range of employment was from 89,295 to 177,304. On average, the total sales volume and total employment were \$11.1 billion and 132,803, respectively (Table 14).

Table 14. Total Recreational Sales Volume and Employment in the Gulf States

	Total Sales Volume	**Total Employment**
MIN	\$6,557,450,000	89,295
MAX	\$16,454,000,000	177,304
AVG	\$11,130,250,000	132,803

Therefore, if the information from the COOS enhances 1% of the sales volume, the sales volume will be increased from a minimum of \$65 million to a maximum of \$164 million, and \$111 million on average, respectively.

Crop Agriculture

It is believed that many agriculture decisions will be improved with the implementation of the Coastal Ocean Observing System (COOS) in the gulf coast region. Due to the fact that different crops have different water requirements, temperature requirements and growing seasons, crop selection is a key decision that is dependent to weather forecasts. For any given gulf crop, decisions regarding planting and harvesting timing and methods of pest control and fertilization will possibly be improved with an enhanced weather forecast.[4] Tables 15 and 16 depict the total agricultural production and top five agricultural commodities by gulf state.

Table 15. Agricultural Production by Gulf State for 2002.

State	(in millions of dollars)
Florida	$7,207.465
Alabama	$3,745.922
Louisiana	$2,019.221
Mississippi	$3,382.857
Texas	$15,076.181
Total	$31,431.646

Source: State Fact Sheets; Economic Research Service (ERS) 2002

4 Adams, R., M. Brown, C. Colgan, N. Flemming, H. Kite-Powell, B. McCarl, J. Mjelde, A. Solow, T. Teisburg, and R. Weiher. "The Economics of Sustained Ocean Observations: Benefits and Rationale for Public Funding." A Joint Publication of National Oceanic Atmospheric Administration and the Office of Naval Research, August 2000.

Table 16. Top Five Agricultural Commodities for 2002 by Gulf State

State/Commodity	Value of Receipts (in millions of dollars)
Florida **Greenhouse/Nursery**	$1,629.993
Oranges	1,168.211
Cane for Sugar	517.925
Tomatoes	508.320
Dairy Products	356.184
Alabama **Broilers**	$1,608.480
Cattle and calves	304.698
Chicken eggs	296.530
Greenhouse/nursery	243.234
Cotton	128.718
Louisiana **Cane for Sugar**	$368.924
Cotton	158.666
Cattle and calves	157.153
Corn	152.095
Soybeans	123.687
Mississippi **Broilers**	$1,223.520
Cotton	376.905
Soybeans	260.438
Aquaculture	245.326
Cattle and calves	193.110
Texas **Cattle and calves**	$5,862.734
Greenhouse/nursery	1,348.136
Cotton	974.367
Broilers	893.327
Dairy products	680.604

Current studies show that the use of weather forecasts will increase society's overall welfare. For example, one study (Nicholls 1996) found that costs could be reduced by nearly $500,000 per year if 50 percent of cotton farmers in Missouri used agricultural weather data to reduce replanting. In Nebraska, weather information could reduce the need for irrigation enough to save $100,000 per season.

Research performed by Solow et al. 1998, found that by integrating the National Oceanic and Atmospheric Administration's (NOAA) ENSO forecasts into planting decisions, farmers in the United States could increase agricultural output and produce benefits to the U.S. economy of up to $300 million per year. Another study (Chen and McCarl, 2000) which factors in uncertainty about ENSO raises this value to $400 million.

Assuming that a $300 million per year increase in agricultural output and benefits to the U.S. economy were consistent within literature, a considerable percentage of this improvement could be attributed to agricultural production in the gulf states. In 2002, the U.S. generated $271.2 billion in agricultural products. $31.4 billion (14.47%) corresponded to agricultural production in the gulf states. If a one percent increase in improved weather forecasting were to be applied to the gulf state agricultural production for 2002, as suggested, yearly agricultural production would increase by a total of $314 million.

Military (Navy) Operations

One of the important potential benefits of the Coastal Ocean Observing System (COOS) information is that contribution to the military operation capability in the Gulf area. For example, during Hurricane Floyd in 1999, the Command's early warning gave the Atlantic Fleet sailors time to move 82 ships and submarines out of harms way. The sortie cost the Navy over $17 million, but a decision not to sortie may have resulted in billions of dollars in damages. [5]

There are eight Naval Bases including Navy Air Stations in the Gulf region encompassing Texas, Florida, Mississippi, and Louisiana. These bases are located on the seashore and thus are affected by the accurate weather and currents information from the COOS.

As assumed, military purview in the region is different from the state jurisdiction, thus estimating their benefits in terms of state level is not so plausible. However, estimating their benefits in the Gulf region per se seems to be possible, and helps us to understand the COOS benefit could even be accrued to military operations.

In the Gulf region, for the full readiness ability against expected or unexpected war, the Navy has to keep their war fighting capability at all times, and even in peace time, the Navy has to prepare for any natural disaster. This preparation lead time due to improved weather forecasting for natural and human disasters will increase the readiness of the Navy. Military readiness, especially after 9.11, has become increasingly more important. Thus, the benefit of the COOS to military is more than just an economic value. It is directly related to improved Naval readiness capabilities.

5 NOAA. Economic Statistics for NOAA, 2003, p.31.

As depicted in Table 17, in the Gulf region, the eight naval bases have spent $1.8 billion for the 2002 fiscal year. The range is from $27 million in Ingleside, Texas to $935 million in Pensacola, Florida. Therefore, if we assume the information from the COOS would contribute 1% increase of the readiness of the Navy, then we could assume the economic benefit of the COOS to be approximately $18 million. However, as already mentioned, improvement of the military readiness for the warfighting effort against any possible factor in this era of terror is more than just an economic benefit.

Table 17. Navy Annual Expenditures in the Gulf Region

Base	2002	2001
Key West, FL	$179,855,858	$171,078,745
Gulfport, MS	$239,592,606	$187,499,977
Pascagoula, MS	$76,091,003	$84,085,419
Pensacola, FL	$935,524,659	*NA
Corpus Christi, TX	$182,116,600	$187,778,800
Ingleside, TX	$27,811,000	$27,228,000
Kingsville, TX	$68,296,000	$63,855,000
New Orleans, LA	$74,614,800	$73,928,300
Total	$1,783,904,528	$352,790,100

Source: Navy, Comptroller's Office of Each Base and Regional Public Affairs Offices
* Data for Pensacola was unavailable for 2001.

Oil and Gas Distribution

Space heating requirements change with the outside temperature. Seasonal forecasts of temperature are therefore useful in managing the production and delivery of energy products for heating and cooling. There are two activities involved here: managing storage and managing refinery product runs.

Storage in a typical natural gas delivery system makes underground sites such as salt domes for large-scale storage. Gas is set-aside during the summer months to augment flowing gas provided during the winter heating months. This gas might be drawn down over periods of weeks or months. Once the winter peak demand period has passed, the potential capital gain from storing gas will disappear. As a result, delaying the sale of any gas remaining in storage becomes very expensive, and it makes increasing sense to use this gas. The exact timing of the decision to use remaining stored gas will be driven by the weather forecast for the remainder of the winter.

Storage of fuel has traditionally occurred at refineries. However, the amount of such storage capacity has fallen relative to fuel oil use in recent years, due to a dearth of new refinery construction. This is particularly a problem in the fuel oil dependent Northeast region of the United States. In response to the sharp rise in fuel oil prices in the winter of 1999-2000, the President has proposed the creation of a Regional Home Heating Oil Reserve for the Northeast United States. When such a reserve becomes operational, seasonal weather forecasts will play a role similar to their role in managing natural gas storage. That is, once the storage capacity is in place, it will normally make sense to fill it completely, prior to the heating season. Then, as the season progresses and nears its end, it will make sense to use any remaining inventory. The timing of the decision to use remaining inventory will be primarily determined by the weather forecast for the remainder of the winter.

Typically, refineries in the US increase the fraction of output in the form of heating fuels in the winter, and increase the fraction of transportation fuels in the summer. The output proportions are charged partly by altering the refinery process parameters, and partly by changing the types of crude oils that are used in the refinery. Changes in the output process can typically be made fairly quickly, and thus would not necessarily benefit from seasonal temperature forecasts. Changing the types of crude oils used as input to refineries, however, has a lead-time due to the shipping time required getting crude oil from overseas producers. This implies that there is a value to seasonal temperature forecasts in deciding on the time to shift from production of transportation fuels to heating fuels and back again. Table 18 below displays oil and natural gas production expenditures for each of the Gulf States.

Table 18. Petroleum and Natural Gas Production Expenditures by State, 2000

State	Oil (in millions)	Natural Gas (in millions)
Texas	43,536	15,373
Florida	17,476	2,803
Louisiana	11,753	4,986
Alabama	5,787	1,550
Mississippi	4,091	1,148

Source: Energy Information Administration

If we assume that that forecasts from coastal ocean observing systems would result in a 1% decline in oil and natural gas production expenditures because energy suppliers can adjust fuel stores and better time draw down of stored fuel, then the benefits would be $1.085 billion less petroleum and natural gas production expenditures in the Gulf region.

Pollution Management and Prevention

Improved understanding of the fate and effects of marine pollutants is likely to have major economic benefits. The prediction and management of oil spills from the Gulf of Mexico and the Gulf of Mexico states (Florida, Alabama, Mississippi, Louisiana and Texas) illustrate the potential benefits that may be derived. The risks of oil spills have, fortunately, declined over the past thirty years. The volume of oil spilled has dropped significantly in the Gulf of Mexico and in the neighboring states. The trend in the frequency of spill incidents is different for the Gulf and the states. For instance, in Florida, it has in Florida, Alabama, and Texas the number of incidents has dropped for last decade with few exceptions. Although the frequency has increased in the Gulf Mexico, Mississippi, and Louisiana, the volume of oil spilled has dropped. The data in Tables 19-20 indicate that the number and magnitude of “routine” spills has declined, but the risks of large scale catastrophic spills will never be eliminated entirely.

Table 19. Oil spill trends in Gulf of Mexico, 1973-2000.

Gulf of Mexico		
Year	**Number of Spills**	**Spill Volume (in gallons)**
1973	38	8,553
1974	218	157,926
1975	727	1,418,791
1976	936	850,660
1977	731	933,106
1978	656	402,392
1979	867	386,281
1980	473	437,069
1981	857	99,120
1982	1061	121,889
1983	1290	295,736
1984	1583	2,897,179
1985	951	116,969
1986	431	97,221
1987	218	91,524
1988	372	1,076,986
1989	1063	108,519
1990	1834	4,115,264
1991	1977	100,702
1992	1974	363,279
1993	1763	53,265
1994	1350	205,151
1995	1485	253,040
1996	2403	45,145
1997	2341	105,462
1998	2190	181,372
1999	1756	45,786
2000	1838	112,069

Source: US Coast Guard.

Table 20. Oil Spill Trends in Florida, Alabama, Mississippi, Louisiana and Texas. 1973-2000.

	Alabama		Florida		Louisiana		Mississippi		Texas	
Year	**#**	**Volume (gallons)**	**#**	**Volume (gallons)**	**#**	**Volume (in gallons)**	**#**	**Volume (gallons)**	**#**	**Volume (gallons)**
1973	63	49,006	335	49,765	2119	2,310,781	44	860,646	600	1,447,605
1974	77	33,128	376	90,102	1698	3,646,213	44	186,791	1154	4,851,211
1975	95	68,630	357	83,536	1305	3,103,161	62	2,837,809	1122	1,228,566
1976	75	21,911	468	34,484	1556	751,770	70	64,108	1012	969,471
1977	164	193,646	621	192,786	1669	785,129	82	639,559	937	1,646,852
1978	157	196,257	649	162,681	1770	2,294,153	52	34,444	1053	490,233
1979	151	137,536	683	163,410	1528	700,206	62	68,282	1191	2,767,410
1980	124	45,316	577	304,582	1239	2,610,520	49	24,821	935	1,432,125
1981	150	100,477	467	47,195	1054	4,126,560	75	52,063	794	1,697,685
1982	148	13,316	373	49,048	921	1,746,599	66	106,772	644	1,854,251
1983	132	35,911	574	43,078	781	2,607,478	74	860,745	706	399,513
1984	125	11,470	529	176,631	837	3,537,751	74	49,845	656	788,929
1985	83	6,335	298	28,830	555	423,433	38	13,949	606	2,983,274
1986	88	4,279	453	46,476	105	326,433	45	12,844	648	307,691
1987	38	6,424	463	142,590	122	80,968	36	3,090	575	185,488
1988	62	24,093	136	177,220	217	26,974	57	305,569	595	1,361,975
1989	129	10,142	674	34,358	332	74,427	104	56,794	721	559,576
1990	108	14,765	972	51,965	532	407,031	67	34,723	759	258,762
1991	131	6,610	1093	31,772	744	191,839	64	127,298	815	193,745
1992	106	13,538	837	170,473	1218	542,871	77	2,065	759	322,930
1993	100	16,240	800	432,489	1255	411,125	87	4,751	763	165,327
1994	85	6,450	894	34,284	1594	146,110	90	11,710	735	598,176
1995	100	17,481	976	68,992	1848	439,502	104	845,694	629	125,216
1996	179	45,251	861	23,083	2468	342,533	174	7,546	672	309,831
1997	263	7,363	798	16,424	2034	505,526	217	3,313	715	27,470
1998	147	10,982	804	25,896	1985	311,714	135	2,741	730	62,212
1999	129	8,443	716	13,664	1595	309,515	128	3,318	814	57,689
2000	174	1,092	674	23,302	1704	701,995	156	4,188	1055	161,365

More importantly, however, the cost of oil spills has risen dramatically. Strict liability standards in the Oil Pollution Act of 1990; increased requirements for training, preparedness, and mitigation; and provisions for recovery of damages to natural resources from oil spills have pushed the cost of oil spills up by over 700% according to one industry estimate. British Petroleum estimates the total cost of an oil spill to be $10,000 per barrel spilled. The table below provides a list of the types of costs involved in oil spills.

Direct Expenses	Indirect Expenses
· cost of personnel and their expenses during cleanup · cost of contractors and other direct cleanup · reimbursed cost for USCG and USCG fines · fees and fines from state agencies · cost of litigation and litigation defense · costs associated with residual damages · economic losses · environmental damage · mitigation expense · loss of sale of products	· increased attention by regulators · permits for new activities cost more and take longer · more drills and exercises · increased cost of new equipment and other preparation costs · new local, state, and federal laws · new local, state, and federal taxes and fees · business cost from diverting key personnel to spill control · stock price and stockholder pressure · higher insurance costs

Oil spill cost categories.
Source: Gandhi and Chennoju.

All major oil handling ports must have an oil spill response plan in place. That plan varies in detail from port to port, but each plan includes deployment of oil spill containment and clean-up equipment. Oil spill containment and cleanup remains a poor substitute for prevention; once a spill has occurred, adverse effects can be generally be reduced by only five to fifteen percent. One potential key to improving the effectiveness of containment and cleanup operations is to deploy the appropriate equipment in a timely manner. Spill response coordinators often rely on fate and effects models based on models of currents, which are in turn derived from the best available data. While good data on tidal currents are usually available, larger regional circulation patterns may be imperfectly predictable because of a lack of observations. Regional ocean observing systems are likely to develop significantly improved data bases from which new models can be estimated. The result may be significant improvements in spill response time and effectiveness.

Table 21 presents the total oil spill cost based on the clean-up cost of $10,000 per barrel spilled in the year 2000.

Table 21. The cost of Oil Spills

	Oil Spill Volume		
	in Gallons	in Barrels	Estimated Total Cost
Gulf of Mexico	112,069	2,668	26,683,095
Alabama	1,092	26	260,000
Florida	23,302	555	5,548,095
Louisiana	701,995	16,714	167,141,667
Mississippi	4,188	100	997,143
Texas	161,365	3,842	38,420,238
Total (five states)	891,942	21,237	212,367,143

If we assume that the improved forecasts from COOS would result in a 1% decline in oil spills, then the results would be estimated at a savings of $266,830 for the Gulf of Mexico and $2.1 million for the five states.

Maritime Transportation

Ships within the Gulf of Mexico can make use of more timely and accurate information from ocean observing weather systems to better plan their routes for minimal transit time and exposure to severe weather. Part of the cost of delays in ocean transport can be seen in representative daily operating costs shown in Table 22.

Table 22. Shipping costs for Dry and Liquid Bulk, and General Cargo Ships

cargo type	ship type	representative size	typical charter rate ($/day)	typical operating costs ($/day, 2002)*
	handysize	27,000 dwt	6,500	22,118
dry bulk	handymax	43,000 dwt	8,000	24,239
	Panamax	59,000 dwt	9,500	27,258
	Cape	150,000 dwt	14,000	40,193
	product	45,000 dwt	12,000	33,043
liquid bulk	Aframax	90,000 dwt	13,000	40,593
	Suezmax	140,000 dwt	16,500	51,112
	VLCC	280,000 dwt	22,000	72,122
general cargo	container	400 TEU	5,000	3,144
	container	1,000 TEU	9,000	3,470

Sources: Kite-Powell (2000) and Kite-Powell Shipping Costs spreadsheet (2002)
*average of domestic and foreign ships typical operating costs.

Table 23 provides an estimate of total operating costs for marine transportation in the Gulf of Mexico. Because there are no data to match vessel types in the Gulf of Mexico precisely with the operating costs shown in Table 23, we use the following assumptions. (1) The lowest cost in Table 22 is used for each vessel type. (2) Each transit (round trip) of the Gulf of Mexico takes 2 days. Based on these assumptions, a 1% improvement of transit times would yield benefits of about $32,272,145 per year.

Table 23. Estimated Operating Costs Of Maritime Transportation In The Gulf Of Mexico States, Assuming Average Total Transit Time Of Two Days.

	transits/ year (2001)	operating cost estimate ($/day)*	annual operating cost ($/year)
foreign dry cargo and passenger	3,676	10,884	80,019,168
foreign flag tanker	1,422	15,905	45,233,820
domestic dry cargo and passenger	60,856	25,272	3,075,905,664
domestic flag tanker	346	37,653	26,055,876
Total			3,227,214,528

Sources: US Army Corps of Engineers Waterborne Commerce of the United States 2001 and Kite-Powell Shipping Costs spreadsheet (2002)
*lowest cost for each ship type was used.

Storm Damage Mitigation and Repair

Another potential benefit of having COOS in the Gulf of Mexico is that forecasts from such a system would allow homeowners and municipalities to prepare for and take measures that minimize the affects of storm damage. Storms cause damage to buildings and infrastructure, which later have to be rebuilt. However, if such an ocean observing system could provide more accurate and timely weather information, then decision makers could take preemptive measures to deal with upcoming storms. Such preparations could include making repairs or additions to the house where it can withstand the forecasted wind and precipitation levels that the storm is expected to bring. Municipalities, on the other hand, could make better decisions with the more accurate and timely information about whether to clear drainage canals or have evacuations, for example.

Storm damage is by no means a trivial matter. Storms can cause millions of dollars of property damage in state each year. The National Weather Service's Division of U.S. Natural Hazard Statistics provides statistical information on damages caused by weather related hazards. Table 24 displays the large magnitude of storm damage in the Gulf States (Florida, Alabama, Louisiana, Mississippi, and Texas) in 2002.

Table 24. Storm Damage by State, 2002

State	Storm Damage (in millions)
Florida	$43.0
Alabama	$36.8
Louisiana	$660.3
Mississippi	$118.3
Texas	$282.4
Total	$1,140.80

Source: National Weather Service

Louisiana, in 2002, had a particular bad year with respect to property damage because of storms. Since a state can experience more severe weather in some years and not in others, it is preferable to look at the average amount of property damage done over the course of several years. Table 25 shows that dollar value of property damage each year from 1998 – 2002 and the five-year average. The property damage done within a

Table 25. Storm Damage by State in Millions, 1998-2002, Five-Year Average

State	1998	1999	2000	2001	2002	5 Year Average
Florida	$1,691.3	$653.2	$485.8	$106.5	$43	$595.9
Alabama	$760.1	$11.7	$53.4	$26.8	$36.8	$177.8
Louisiana	$136.6	$33.3	$244	$39.3	$660.3	$222.7
Mississippi	$739.9	$15.5	$11.1	$126.3	$118.3	$202.2
Texas	$1,098.9	$372.8	$296	$5,511.9	$282.4	$1,512.4
Total	$4,426.80	$1086.50	$1090.30	$5,810.80	$1140.80	$2,716.00

Source: National Weather Service

given state fluctuates quite a bit over the years. However, it is clear that the storm damage is costly and any improvements in weather forecasts that would allow decision makers to better prepare for storms and minimize damage would be desirable. If we assume that that forecasts from such a system would result in a 1% decline in storm damage because homeowners and municipalities would be able to better prepare for and take measures that minimize the affects of storm damage, then the results would be $27.1 million dollars worth of less storm damage in the Gulf region.

Commercial Shipping

Gulf Ports

Table 26 lists the largest ports, in millions of short tons, for the Gulf States – Florida, Alabama, Louisiana, Mississippi, and Texas for 2001.

Table 26. Largest Gulf Seaports, Millions of Short Tons

Port Name	U.S. Rank	Total	Foreign Total	Foreign Inbound	Foreign Outbound	Domestic
South Louisiana, LA, Port of	1	212.6	95.7	32.5	63.1	116.9
Houston, TX	2	185.1	120.6	85.5	35.1	64.5
New Orleans, LA	4	85.6	50.3	27.1	23.2	35.3
Beaumont, TX	5	79.1	62.0	56.7	5.3	17.1
Corpus Christi, TX	6	77.6	53.9	45.0	8.9	23.7
Texas City, TX	9	62.3	44.1	40.3	3.8	18.1
Baton Rouge, LA	10	61.4	20.7	14.2	6.4	40.8
Plaquemines, LA, Port of	11	60.7	23.4	14.9	8.4	37.3
Lake Charles, LA	13	52.8	31.9	27.7	4.2	20.9
Mobile, AL	16	48.1	28.0	17.7	10.3	20.1

Source: U.S. Corps of Engineers: Waterborne Commerce of the United States, 2001

Commerce going through the Gulf's ports may be classified into various types. One common classification of vessel type are tankers, which transport large volumes of valuable liquid materials, tramps, which carry other types of cargo, and liners, which represent the cruise ship industry and carry people. The tables below present data on the largest Gulf ports by type of vessel, measured in millions of metric tons and millions of dollars, for U.S. Imports within those ports. The metric tons for each vessel type are aggregated into a total and then each port is ranked by that total.

Table 27. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Imports by Millions of Metric Tons

Name of Port	Total	Liner	Tanker	Tramp
(Millions of Metric Tons)				
Houston, TX	88.65	4.26	75.74	8.65
Morgan City, LA	47.66	0.01	47.64	0.01
Corpus Christie, TX	42.27	0.01	38.35	3.91
Beaumont, TX	36.97	0.16	36.36	0.45
New Orleans, LA	32.73	2.40	16.14	14.19
Lake Charles, LA	27.10	0.01	25.24	1.85
Port of South LA	25.38	0.07	16.45	8.86
Port Arthur, TX	20.90	0.07	19.98	0.85
Freeport, TX	19.85	0.01	19.45	0.39
Gramercy, LA	18.71	0.07	10.28	8.36

Source: U.S. Army Corps of Engineers and the Maritime Administration Office of Statistical & Economic Analysis, U.S. Port Totals by Type Service, 2001

When looking at the largest Gulf ports by type of vessel, measured in millions of dollars, for U.S. Imports within those ports, the ranking of ports change slightly as can be seen by the table below.

Table 28. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Imports by Millions of Dollars

Name of Port	Total	Liner	Tanker	Tramp
(Millions of Dollars)				
Houston, TX	24,967	8,988	12,622	12,622
New Orleans, LA	8,842	3,580	2,786	2,786
Jacksonville, FL	8,817	2,572	594	594
Miami, FL	8,113	7,637	90	90
Morgan City, LA	7,687	33	7,648	7,648
Beaumont, TX	6,845	773	6,040	6,040
Corpus Christie, TX	6,452	25	6,098	6,098
Port Everglades, FL	5,851	4,839	679	679
Lake Charles, LA	3,537	7	3,372	3,372
Port of South LA	3,455	25	2,643	2,643

Source: U.S. Army Corps of Engineers and the Maritime Administration Office of Statistical & Economic Analysis, U.S. Port Totals by Type Service, 2001

In addition to imports going through the Gulf's ports, U.S. exports are also an integral part of foreign waterborne commerce in the Gulf. Tables 29 and 30 present data on the largest Gulf ports by type of vessel, measured in millions of metric tons and millions of dollars, for U.S. Exports within those ports. The metric tons for each vessel type are aggregated into a total and then each port is ranked by that total.

Table 29. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Exports by Millions of Metric Tons

Name of Port	Total	Liner	Tanker	Tramp
(Millions of Metric Tons)				
Port of South LA	50.00	0.15	4.98	44.87
Gramercy, LA	36.85	0.08	3.48	33.28
New Orleans, LA	32.52	2.39	4.36	25.77
Houston, TX	29.59	5.01	14.77	9.81
Destrehan, LA	9.46	0.07	0.10	9.30
Mobile, AL	8.98	1.17	0.16	7.65
Corpus Christie, TX	6.54	0.03	3.16	3.35
Baton Rouge, LA	5.80	0.11	1.33	4.36
Beaumont, TX	4.18	0.01	2.88	1.30
Lake Charles, LA	3.76	0.08	1.46	2.22

Source: U.S. Army Corps of Engineers and the Maritime Administration Office of Statistical & Economic Analysis, U.S. Port Totals by Type Service, 2001

Table 30. 2001 Waterborne Foreign Commerce: Largest Gulf Ports' U.S. Exports by Millions of Dollars

Name of Port	Total	Liner	Tanker	Tramp
(Millions of Dollars)				
Houston, TX	19,522	12,569	4,333	2,621
Miami, FL	8,487	7,978	6	503
New Orleans, LA	8,134	3,583	957	3,594
Port of South LA	6,539	40	831	5,667
Gramercy, LA	4,712	28	499	4,186
Port Everglades, FL	4,433	4,046	10	377
Jacksonville, FL	1,991	1,215	3	773
Tampa, FL	1,573	84	661	828
Mobile, AL	1,458	606	94	758
Gulfport, MS	1,321	894	-	427

Source: U.S. Army Corps of Engineers and the Maritime Administration Office of Statistical & Economic Analysis, U.S. Port Totals by Type Service, 2001

Since the tables only show ports ranked the largest in terms of millions of metric tons or millions of dollars of value, an appendix is attached showing other Gulf ports. If we assume that forecasts from a coastal ocean observing system would result in a 1% increase in the dollar value of goods commercially shipped from the Gulf states, then the benefits to commercial shipping exports would be $468.01 million dollars in the Gulf region.

Offshore Energy Production

Hurricanes pose risks to life and property for offshore oil and gas operations. There are high costs both of failing to anticipate a hurricane that occurs and of preparing for a hurricane that fails to occur. For these reasons, accurate forecasts of hurricanes and their expected tracks are valuable to offshore oil and gas platform operators.

Loop Current eddies in the Gulf of Mexico are also of concern to offshore oil and gas operators, because they can cause significant disruptions of exploratory drilling operations. Loop Current eddies are powerful and deep localized currents that can damage drill strings deployed below drilling vessels. Forecasts of Loop Current eddies have value to offshore oil and gas operators because they make it possible to set more efficient drilling schedules (WHOI 1993).

Other kinds of offshore operations are sensitive to weather and/or surface and subsurface ocean conditions. These include operations of heavy lifts, pipe-laying, pipe-trenching, tie-ins, remotely operated vehicle (ROV) operations, and deep-water pile driving. For example, crane barges capable of lifting 10,000 tons at a single lift are required regularly to lift the deck module structures onto the legs or "jackets" of oil platforms after they have been installed. These operations are highly sensitive to wind and waves, and need forecasts of 10 to 20 days if possible. Pipelaying barges are required to lay many miles of steel and concrete pipes in water depths of up to 1000 feet. The pipe hangs from the stern of the barge during laying, and the operation is sensitive to sub-surface currents, surface waves, winds. ROV's fitted with hydraulic power tools are used for many operations on deep water oil and gas production. These machines operate with long cables and power lines exposed in the water, and are sensitive to current profiles and to wind-wave forces on surface support vessels.

Table 31 summarizes the direct annual operating costs per platform for the Gulf of Mexico, for 1986 - 2002. The annual operating costs measure the change in direct costs implicit to the production of oil and gas and exclude changes in indirect costs such as depreciation and ad valorem and severance taxes. The overall average for both the 12 and 18-Slot Platforms, for 2002, was $5.4 million.

Table 31. Average Direct Operating Costs per 12-Slot and 18-Slot Platform for the Gulf of Mexico from 1986-2002

Platform Type	**Average Platform Costs/Year***
12-slot Platform	$4,674,100
18-slot Platform	$5,888,800
Aggregate Average	$5,402,900**

* 2002 dollars
** Aggregate average 1986-2002
Source: Energy Information Administration, Office of Oil and Gas

The current number (as of November, 2003) of operating platforms in the Gulf of Mexico total 4,011 active and 208 inactive, or a grand total of 4,219 platforms, in 2003[6]. For 2002, there were 4,015 active, and 204 inactive platforms. If the assumption is made that COOS will result in improved weather forecasting of 1% or $54,029 per platform, which translates to a total of $216,710,319 per year for all the operating platforms.

Forecasts of weather and conditions are valuable to offshore operators because they make it possible to schedule these kinds of operations to avoid either risks to equipment or expensive interruptions of operations. As offshore operations move into

6 http://www.gomr.mms.gov/homepg/fastfacts/borehole/master.asp

deeper waters, knowledge and forecasts of sub-surface conditions are becoming increasingly important.

Fisheries: Commercial

The commercial fishing industry represents an important part of the overall U.S fisheries industry. The dockside value of commercial landings of fish and shellfish was $705 million (or 1.7 billion pounds) for 2002. In addition, commercial fisheries support other important gulf industries such as ship construction and fish processing, among others.

As depicted in Table 32, the total commercial (finfish and shellfish) fisheries landings for the Gulf states was 704,764,195 pounds for 2002. Economic benefits that may result from implementation of the COOS system may be viewed as a function of the value of a day at sea.[7] As Kite-Powell and Colgan mentioned, this is viewed as an

Table 32. Commercial Finfish and Shellfish Weight, Dollar Value,and Estimated Average Value Added per Fishing Day for the Gulf of Mexico, By State, for 2002

State	Pounds	Dollars	Estimated Average Value Added per Fishing Day
Finfish			**(in dollars)**
West Florida	43,369,547	51,297,681	854,961
Alabama	5,356,621	3,076,983	51,283
Mississippi	197,690,946	12,627,365	210,456
Louisiana	1,118,376,725	96,303,421	1,605,057
Texas	6,064,809	9,595,737	159,929
Gulf of Mexico	1,370,858,648	172,901,187	2,881,686
Shellfish			
West Florida	37,915,385	91,158,517	759,654
Alabama	17,799,719	31,899,389	265,828
Mississippi	20,268,770	34,920,053	291,000
Louisiana	190,154,262	209,231,072	1,743,592
Texas	87,418,789	164,653,977	1,372,116
Gulf of Mexico	353,556,925	531,863,008	4,432,190
Gulf of Mexico Total	**1,724,415,573**	**704,764,195**	**7,313,876**

Source: National Marine Fisheries Database, 2002
*Assumes a 60 day finfish season and 120 day shellfish season.

[7] H.L. Kite-Powell and C.S. Colgan. "The Potential Economic Benefits of Coastal Ocean Observing Systems: The Gulf of Maine as an Example."

approximation, since the real value of benefits must be the marginal rather than average value. Assuming that the COOS system improves commercial fishing by allowing for an average of an additional day of fishing, benefits would be \$2.9 million and \$4.4 million for finfish and shellfish, respectively, for a Gulf of Mexico commercial landings total of \$7.3 million.

Fisheries: Recreation

The Gulf of Mexico leads the nation in the level of recreational fishing. In addition, recreational fisheries supports other industries such as boat building, sport and bait shops, charter boats, and gear manufacturing.

The National Marine Fisheries Service has been instrumental in conducting numerous marine recreational economics studies. In addition, NMFS also collects data and has many databases (including SAS datasets) that provide creel census, demographic, and economic data for Florida (inland and open water). The latest NMFS economic impact study, conducted in 1999, relating to the Southeast area, was *Marine Angler Expenditures in the Southeast Region* by Gentner, Price, and Steinback. Their report summarized the results of the expenditure survey, and provided state-level estimates of direct sales resulting from anglers' expenditures in 1999. The Marine Recreational Fishing Statistics Survey (MRFSS) database is a system of surveys that target recreational fishermen to obtain socioeconomic data, catch estimates, expenditures data and other data, using phone and intercept, and mail survey methodology.

Table 33 depicts number of angler trips and number of marine recreational anglers for the Gulf of Mexico region, by state. It should be noted that Texas is not included in the Marine Recreational Survey that the National Marine Fisheries Service conducts, as the perform their own annual marine recreational survey. For the Gulf of Mexico, it is

Table 33. Marine Recreational Anglers, Angler Trips and Estimated Willingness to Pay for Fishing, in the Gulf of Mexico, by State, for 2002

	Angler Trips* 2002	Number of Marine Recreational Anglers				Estimated Total Willingness to Pay** ($$ M for 2002)	Value of 1% Increase in Trips ($)
		Coastal	Non-Coastal	Non-Residents	Total		
West Florida	14,418,275	1,685,575	0	1,664,373	3,349,948	$1,874	$18,743,758
Alabama	1,190,004	121,305	80,046	154,264	355,615	$155	$1,547,005
Mississippi	1,038,353	174,237	49,206	41,275	264,718	$135	$1,349,859
Louisiana	3,018,946	478,812	65,880	98,115	642,807	$392	$3,924,630
Texas* **	497,128				0	$65	$646,266
Gulf of Mexico	20,162,706	2,459,929	195,132	1,958,027	4,613,088	$2,621	$26,211,518

* Includes all modes (charter, private and shore) and all areas (state, federal, etc. waters)
Source: NMFS data 2002
http://www.st.nmfs.gov/st1/recreational/queries/participation/par_time_series.html
**Detailed willingness to pay measures have not been summarized with a standardized methodology for
the
Gulf of Mexico states by NMFS, so other studies were used.
For Florida: Florida Coastal Environmental Resources: A Guide to Economic Valuation and Impact Analysis 2002.
Used McConnell and Strandt study using RUM (random utility method for both residents and non-residents)
Note: adjusted from 1994 dollars to 2003 dollars.
*** Data was obtained from Mark Fisher, Dir. Of Research, Coastal Fisheries Division, Texas Parks and Wildlife, for 2001

estimated that a total of 20.2 million angler trips were conducted in 2002. For all the Gulf states, excluding Texas, there were a total of 4.6 million anglers. Given that detailed willingness to pay studies have not been performed for the Gulf of Mexico, other studies were examined and an average of $132 (adjusted from 1994 to 2002 dollars) for all marine species was used to approximate an angler's willingness to pay on a daily basis. Thus, if an assumption of a 1% improvement were made due to implementation of the COOS system, a total value of $26.1 million would be realized.

Marine Search and Rescue (SAR)

The US Coast Guard conducted some 7,000 SAR missions and saved more than 590 lives in the Gulf of Mexico region during the periods of 1997-2001 (Table 34). This represents about 18% of the Coast Guard's total SAR activity and 15% of life-saving achievement compared to the total USCG accomplishment in 2001. However, significantly, some 24 lives are lost each year in the Gulf of Mexico region after the Coast Guard has been notified that they are at risk. Perhaps the most critical factor determining the success of SAR is the time it takes the Coast Guard to get to the person at risk. The SAR success rate is only about 4% when this time exceeds 2 hours.

Table 34. USCG Gulf Area SAR Program Lives Saves Performance Measures

	1997	1998	1999	2000	2001	Average
Cases	7,659	7,470	7,337	6,331	5,914	6,942
Lives Saved	720	467	680	521	578	593
Lives Lost	88	90	95	87	123	97
Live Lost Before CG Notification	67	70	76	64	87	73
Live Lost After CG Notification	21	20	19	23	36	24
SAR Lives Saved Goal (93%)	97.2%	95.9%	97.3%	95.8%	94.1%	96.0%
CG Lives Saved Goal (85%)	89.1%	83.8%	87.7%	85.7%	82.5%	85.8%

Source: United States Coast Guard (USCG), 7th District and 8th District

Understanding the currents and winds in the vicinity of the SAR target is critical to locating and reaching the person quickly. Improved forecasts of these parameters can improve SAR effectiveness. For example, a 1% improvement in SAR effectiveness (e.g. 1% increase from lives saved) in the Gulf of Mexico would result in an additional 6 lives saved per year, with an economic value of some $24 million (assuming a conservative value for a human life of $4 million; see Viscusi, 1993). At the same time, additional benefits can be realized from reduced SAR costs and reduced risk to SAR personnel.

Marine Water Quality Management

Another potential benefit of having a COOS System in the Gulf of Mexico is that forecasts from such a system would allow water quality managers to make better decisions, which would lead to improved coastal water quality. Improved coastal water quality would affect aquatic life support. If water quality is improved, then habitat for protection of and propagation of fish is improved as well. This would also mean less human health risk for eating fish from contaminated waters. Improved water quality, also means people can pursue water recreational activities without worrying about adverse health effects from waterborne illnesses.

The Clean Water Act requires states to assess their water quality and report the results to the Environmental Protection Agency. Table 35 displays the percent of bodies of water near the coast judged good water quality for intended use.

Table 35. Percent of Bodies of Water Near Coast Judged Good Water Quality for Intended Use, 2000

State	Aquatic Life Support	Fish Consumption	Recreation
Alabama	90	87	96
Florida	79	79	79
Louisiana	80	93	70
Mississippi	100	100	82
Texas	83	95	100

Source: The National Water Quality Inventory Report to Congress, 2000

To improve water quality in states, the Clean Water State Revolving Fund (CWSRF) was established. Through the CWSRF program, each state maintains revolving funds to provide sources of financing for water quality projects. Table 36 presents the funding levels to improve water quality for each state in the Gulf of Mexico region.

Table 36. Clean Water State Revolving Fund

State	1999	2000	2001	2002	2003
Alabama	$15,210,500	$15,158,900	$15,024,200	$15,057,600	$14,959,800
Florida	$45,916,700	$45,760,900	$45,354,200	$45,455,200	$45,159,700
Louisiana	$14,953,600	$14,902,900	$14,770,400	$14,803,300	$14,707,100
Mississippi	$12,255,600	$12,214,000	$12,105,400	$12,132,400	$12,053,500
Texas	$62,173,600	$61,962,700	$61,411,900	$61,548,700	$61,148,700
Total	$150,510,000	$149,999,400	$148,666,100	$148,997,200	$148,028,800

Source: Environmental Protection Agency.
http://www.epa.gov/owmitnet/cwfinance/cwsrf/cwsrfallots.pdf 2003.

The data was unavailable regarding the breakout of dollar amounts spent on marine and freshwater clean water quality improvement projects, thus, if we assume that forecasts from coastal ocean observing systems would allow water quality managers to make better decisions and thereby lower the costs of water quality improvement projects by an amount of 1%, then the benefits to water quality management would be $1.48 million.

Freshwater Supply Management

The importance of understanding, monitoring and accurately forecasting variations in the Gulf of Mexico would also have impact on the freshwater supply. An improved forecasting through COOS in the Gulf of Mexico would affect the quality and availability of the freshwater supply because the system would provide information to respond to environmental stressors such as severe storms and seasonal and inter-annual changes in fresh water conservation. The improvement in forecasting would also reduce the cost of freshwater supply management by providing more accurate information about weather conditions to the supplier, thus allowing them to prepare for severe weather conditions such as freezing. Finally, the accurate weather forecasting would also improve the accuracy of fresh water supply projections for the future and therefore help the water supply planning.

According to U.S. Geological Survey, in 1995, about 341,000 million gallons per day of freshwater was withdrawn from surface and ground water sources, such as rivers, lakes, reservoirs, and wells. The breakdown by water-use category for the same year is as follows: irrigation (39 percent), thermoelectric power (39 percent), public supply (12 percent), industry (6 percent), livestock (1 percent), domestic (1 percent), mining (1 percent), and commercial (1 percent). Due to the large number of different freshwater suppliers and their pricing policy based on the water-use category, it is a challenge to portray an accurate estimation of the water supply management cost. As presented in Table 37, the Economic Census data for 1997, regarding the total revenues of water supply establishments, is used as a proxy to estimate the water supply cost.

Table 37. Water Supply Revenues for the Gulf of Mexico

	Establishments (number)		Revenues ($1,000)
Florida			
Water, sewage, & other systems	235		299,662
Water supply & irrigation systems	146		201,317
Water supply	129		192,661
Louisiana			
Water, sewage, & other systems	214		108,647
Water supply & irrigation systems*	193		81,482
Water supply*	192		79,709
Mississippi			
Water, sewage, & other systems	350		75,466
Water supply & irrigation systems	335		64,932
Water supply	332		64,277
Texas			
Water, sewage, & other systems	659		347,629
Water supply & irrigation systems	618		249,489
Water supply	601		245,528
Alabama			
Water, sewage, & other systems*	111		112,332
Water supply & irrigation systems*	98		84,237
Water supply*	96		82,406
Total Water Supply (five states)			664,581

Source: U.S. Census Bureau, 1997 Economic Census.
*The revenue is an estimated value. The original values were not disclosed by the Census. The estimation was made based on the percentage of the relevant items in the total revenues from the other states.

If we assume that that forecasts from such a system would result in a 1% decline in freshwater supply management because the water suppliers would be able to better prepare for and take measures that minimize the affects of severe weather conditions and increase the water conservation and make better projections of water supply, then the results would be worth a savings of $6.6 million, based on 1997 Economic Census data.

Results and Discussion

This project concerning the economic benefit-cost study of the Coastal Ocean Observing System (COOS) in the Gulf Coast Region serves to dovetail effectively with the NOPP project goals of data accessibility, education, and communication. In our data collection process, we aimed to target data that would be publicly available. One of our primary goals was to provide high quality data, and ease of accessibility of data, to the public. In addition, the data sources allow one to not only duplicate the studies, but to enhance one's global perspective through use of a standardized and consistent database. The results provided from this study will facilitate the presentation of the economic benefits of COOS to academia and to the public, thus adhering to the stated NOPP goals of education and communication.

Regarding the economic activities that would benefit greatly from improved weather forecasting due to COOS, the private sector benefits tremendously. Ninety-five percent of all COOS benefits are contained in the private sector, totaling $2.961 Billion (Table 39), in 2002 Dollars. The oil and gas distribution, and the commercial shipping industries will benefit the greatest, based on the annual expenditures. For the non-market sector, benefits total $66.46 Million. Recreation-based activities contribute 60% of benefits to the non-market sector. The results of the benefits accruing to the recreation related businesses located along the coastal counties of the gulf states, using CACI data, were estimated to be $111 Million. The public sector, including search and rescue, military, marine and freshwater management, and stormwater damage mitigation will benefit by a savings of $83.86 Million, due to the improved weather forecasts provided by COOS. For the three sectors, the benefits total $3.111 Billion.

Table 38. Summary of Economic Activities for Gulf States (Florida, Alabama, Mississippi, Louisiana and Texas)

Economic Activity	Economic Activity Classification	Annual Estimates of Forecast Value in Dollars	Annual Estimates of Forecast Value in 2002 Dollars
Construction	Private	\$766.85 Million	\$778.97 Million
Recreation	Non-Market	\$39.73 Million	\$40.36 Million
Crop Agriculture	Private	\$314 Million	\$314 Million
Military	Public	\$18 Million	\$18 Million
Oil and Gas Distribution	Private	\$1.085 Billion	\$1.134 Billion
Maritime Transportation		\$32 Million	\$32 Million
Commercial Shipping	Private	\$468.01 Million	\$475.41 Million
Pollution Abatement (Oil Spill)	Private	\$2.1 Million	\$2.19 Million
Storm Damage Mitigation and Repair	Public	\$27.1 Million	\$27.1 Million
Offshore energy	Private	\$216.7 Million	\$216.7 Million
Fisheries			
Commercial	Private	\$7.3 Million	\$7.3 Million
Recreation	Non-market	\$26.1 Million	\$26.1 Million
Marine search and rescue (SAR)	Public	\$24 Million	\$29.88 Million
Marine water quality management	Public	\$1.48 Million	\$1.48 Million
Freshwater supply management	Public	\$6.6 Million	\$7.4 Million
Total		\$3.035 Billion	\$3.111 Billion

Table 39. Summary of Economic Activities by Sector for Gulf States (Florida, Alabama, Mississippi, Louisiana and Texas)

Economic Activity Sector	Annual Estimates of Forecast Value in 2002 Dollars
Private Sector	
Construction	$778.97 Million
Crop Agriculture	$314 Million
Oil and Gas Distribution	$1.134 Billion
Maritime Transportation	$32 Million
Commercial Shipping	$475.41 Million
Pollution Abatement (Oil Spill)	$2.19 Million
Fisheries Commercial	$7.3 Million
Offshore energy	$216.7 Million
Total	**$2.961 Billion**
Non-Market Sector	
Recreation	$40.36 Million
Fisheries Recreation	$26.1 Million
Total	**$66.46 Million**
Public Sector	
Military	$18 Million
Storm Damage Mitigation and Repair	$27.1 Million
Marine search and rescue (SAR)	$29.88 Million
Marine water quality management	$1.48 Million
Freshwater supply management	$7.4 Million
Total	**$83.86 Million**
Grand Total	**$3.111 Billion**

Economic Analysis of COOS in the Gulf of Mexico Region, Using the IMPLAN Model

Economists use a method called input-output analysis to trace the effects a given expenditure on the regional economy. Input-Output (I-O) models show how various sectors of an economy are interrelated by examining sales and purchases made in various sectors and industries of the economy, and how they result in changes in incomes and employment in those sectors and for the overall regional economy. The models describe the labor and economic relationships and interactions between industries, and reveal the ways in which the various sectors of the economy interact with each other and how these productive activities affect incomes and final demand for goods and services.

IMPLAN is exclusively an input-output model. It is non-survey based, and its structure typifies that of input-output models found in the regional science literature. IMPLAN assumes a uniform national production technology and uses the regional purchase coefficient approach to regionalize the technical coefficients.

IMPLAN first creates a descriptive model, using data on employment and expenditures from over 500 sectors in the economy. The descriptive model provides data on expenditures and transactions within and between the various sectors and industries of the economy. Data from these interactions can be used to characterize and describe economic activity within the region. The IMPLAN data set also provides information on goods and services brought into the area from other regions (imports) and goods and services produced in the area for sale elsewhere (exports). These transactions include purchases and sales of productive resources, raw materials and intermediate good from one industry to another, and it is possible to understand the effect of changes in a supplying industry on another industry or sector that produces goods and services for final sale.

In addition to it's descriptive capabilities, the I-O model can also be used to examine the likely effects resulting from a change in the structure of an economy. The analyst can model particular changes in an economy by identifying the sectors of the economy most likely to be affected and estimating the initial expenditure this change represents. For example, suppose a new theme park is to be built in Orlando. An analyst would estimate attendance to the park and expenditures of visitors to the park, and then I-O analysis to model the effects of those expenditures on the surrounding economy (Thomas and Stratis, 2001).

The model generates two types of multipliers: the difference between the multipliers is an induced consumption effect. Multipliers are generated for employment, output, value added, personal income, and total income.

IMPLAN builds its data from top to bottom. National data serve as control totals for state data. In turn, state data serve as control totals for county data. The primary sources of employment and earnings data are County Business Patterns data and Bureau of Economic Analysis (BEA) data. IMPLAN estimates output at the state level by using value added reported by BEA as proxies to allocate U.S. total gross output. Also, IMPLAN allocates state total gross output to counties based on county employment and earnings. IMPLAN uses the BEA Gross State Product series for states, and implicit assumption of uniform value added-to-earnings ratios across counties within a state (Rickman and Schwer, 1993).

IMPLAN uses the classical definition of economic impacts – direct, indirect and induced. Direct impacts are those that result from the expenditure on a particular good or service. Aggregated over a community or region, it reflects the change in total expenditures made for a particular industry, product, or activity, and focuses on the receiving industries and businesses. The indirect and induced effects are sometimes referred to as the "multiplier effects". The indirect effect measures the business growth/decline resulting from changes in sales for suppliers to the directly affected businesses (including trade and services at the retail, wholesale, and producer levels). Essentially, they reflect purchases made by those industries on local suppliers. The induced impacts capture further shifts in spending on food, clothing, shelter and other consumer goods and services, as a consequence of the change in workers and payroll of directly and indirectly affected businesses. This leads to further business growth/decline throughout the local economy.

The impact analysis for this study used the latest version of IMPLAN (v. 2.0) Professional, a software package designed to analyze economic impacts and the latest available data for the gulf coast, 2000 data.

IMPLAN Results

Summary Of Potential Economic Impact To The Gulf of Mexico State Economies From Improved Accuracy Of COOS Weather Systems Predictions

Table 40 provides the profile of the estimated value to each of the Gulf Coast States economies from the presumed increases in accuracy regarding weather systems observations. This evaluation assumes that more accurate observations could induce a 1% increase in productivity from weather sensitive economic activities across this region. The economic impact results were generated by initially examining the output of each of IMPLAN's industrial sectors. The assumption was made that these sectors are operating suboptimum and with better weather information provided to the weather sensitive sectors (for example commercial and recreational fishing) that other sectors (for example transportation, boating, hotels/motels, restaurants and so forth) would all benefit by increasing productivity and would generate an approximate 1% higher productivity yield. This higher productivity (assuming an increase in the sector's output by 1%) across all sectors of the economy was then entered into the economic impact assessment model as a "new" direct stimulus to each state's economy. The resulting output of total (direct, indirect and induced) generated output reported in Table 40 provides the magnitudes of total output, value added, employment and income generated from this stimulus. Each state has a unique mix of economic sectors and therefore was modeled separately. Therefore, the total reflects a summation of each of the Gulf States stimulus. The economic impact of these increasingly accurate weather predicting observations results in increased economic impact of the output, value added, level of employment and income received by employees for a single year across all weather sensitive economic sectors of each Gulf Coast states. The summary of these potential impacts are profiled for each of the Gulf States and subsequently summed at the end in Table 40.

The input-output model, IMPLAN, was used to examine these potential economic impacts. This analysis section models the improvements in the productivity of goods and services brought into and those generated within the region from more than 500 sectors of the economy favorably affected by gains in productivity from those weather sensitive industries within the region described previously. Aggregated together over the entire coastal region, the sum of these activities reflect the change in total expenditures, productivity, output, employment, value added, and employment across this region of the U.S. In total, due to increased precision in weather predicting related economic activity, the estimated 1% increase in economic activity for all Gulf States could translate into improvements of $59.8 billion in output, $34.7 billion in value added, 637,009 jobs and $22.3 billion of income annually.

Table 40 also provides a summary of the two major economic sectors of the economy representing the primary economic beneficiaries from this increased weather prediction accuracy across the five Gulf Coast states. The first economic sector is the private sector weather sensitive activity such as gas distribution, marine transportation, offshore energy, construction, commercial fishing and other private-sector economic activities such as tourism-related activities. The second important economic sector that is a potential beneficiary are the public-sector activities such as search and rescue, marine water quality management, storm damage addition and repair, and environmental protection (e.g. oil spill response). Another economic sector, including non-market activities such as coastal recreation, boating and fishing and other measures of consumer surplus, were estimated earlier in the report.

Table 40 provides a summary of the total, private sector, and public sector increases in output, value added, employment, and income associate with increased weather accuracy prediction values of 1% across the Gulf Coast state economies. Public sector output constitutes 8 % of total productivity across the region while 12 % of value-added, 14 % of employment and 16 % percent of total income for the region. As a result, the potential impact of improvement in weather predictability in the public sector constitutes potential increases of \$4.8 billion of output, \$4.3 billion of value-added and 89,363 jobs, and \$3.5 billion of income across the region. Comparatively, the larger private sector constitutes considerably higher potential benefits from the improved weather predictability, and 1% improvements in productivity would yield increases of \$54.9 billion in output, \$30.5 billion in value-added, 547,647 jobs and \$18.8 billion in income across the region. As described earlier, total potential private and public economic impacts are estimated at. \$59.8 billion in output, \$34.7 billion in value- added, 637,009 jobs and \$22.3 billion in income across the region.

In summary, the application of IMPLAN economic impact input-output simulation modeling suggests substantial potential gains in productivity from improvements in weather predictability to the states of the U.S. Gulf Coast in enhancements to weather sensitive private and public economic sectors and potential improvements in productivity gains in output, value added, employment and income.

Table 40. IMPLAN Direct, Indirect, and Induced Economic Impact Results for Gulf of Mexico States

TEXAS POTENTIAL ECONOMIC GAINS !% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 14,060,753,109	$ 5,635,828,129	$ 15,285,470,880	$ 34,982,051,940
Value Added	$ 7,858,874,054	$ 3,146,070,587	$ 9,324,895,827	$ 20,329,840,494
Employment	125,080	43,938	171,408	340,427
Income	$ 4,866,812,332	$ 1,979,161,700	$ 6,128,663,668	$ 12,974,637,619

LOUISIANA POTENTIAL ECONOMIC GAINS 1% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 2,373,643,470	$ 803,879,564	$ 1,754,390,871	$ 4,931,913,929
Value Added	$ 1,210,022,816	$ 396,544,796	$ 1,115,957,550	$ 2,722,525,185
Employment	24,921	7,347	25,977	58,245
Income	$ 776,571,761	$ 241,418,744	$ 746,084,979	$ 1,764,075,487

MISSISSIPPI POTENTIAL ECONOMIC GAINS !% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 1,247,162,580	$ 347,954,875	$ 774,874,696	$ 2,369,992,158
Value Added	$ 636,340,851	$ 160,247,977	$ 484,749,388	$ 1,281,338,205
Employment	15,181	3,846	11,666	30,693
Income	$ 417,610,118	$ 103,541,427	$ 316,394,681	$ 837,546,224

ALABAMA POTENTIAL ECONOMIC GAINS !% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 2,201,749,856	$ 653,517,318	$ 1,606,609,328	$ 4,461,876,493
Value Added	$ 1,170,760,735	$ 333,516,337	$ 1,008,778,833	$ 2,513,055,910
Employment	24,477	7,065	22,835	54,378
Income	$ 761,101,795	$ 224,587,647	$ 667,745,485	$ 1,653,434,937

FLORIDA POTENTIAL ECONOMIC GAINS !% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 7,727,224,629	$ 2,323,099,056	$ 2,963,596,049	$ 13,013,919,735
Value Added	$ 4,667,093,204	$ 1,360,681,504	$ 1,896,287,452	$ 7,924,062,130
Employment	89,838	25,556	37,873	153,267
Income	$ 2,989,991,124	$ 948,252,178	$ 1,138,139,029	$ 5,076,382,305

TOTAL POTENTIAL ECONOMIC GAINS !% IMPROVEMENT IN PRODUCTIVITY (2000 DOLLARS)				
	Direct	Indirect	Induced	
	Totals	Totals	Totals	Totals
Output	$ 27,610,533,644	$ 9,764,278,942	$ 22,384,941,824	$ 59,759,754,254
Value Added	$ 15,543,091,659	$ 5,397,061,202	$ 13,830,669,051	$ 34,770,821,924
Employment	$ 279,497	$ 87,753	$ 269,760	$ 637,009
Income	$ 9,812,087,130	$ 3,496,961,695	$ 8,997,027,843	$ 22,306,076,572

IMPLAN Results	TOTAL PUBLIC SECTOR IMPACTS	TOTAL PRIVATE SECTOR IMPACTS	PUBLIC SECTOR	TOTAL OF ALL SECTOR IMPACTS
Output	$ 4,817,741,188	$ 54,942,013,065	8%	$ 59,759,754,254
Value Added	$ 4,282,881,320	$ 30,487,940,604	12%	$ 34,770,821,924
Employment	89,363	547,647	14%	637,009
Income	$ 3,495,389,758	$ 18,810,686,814	16%	$ 22,306,076,572

Final Conclusions

The higher productivity (assuming an increase in the sector's output by 1%) across all sectors of the economy was entered into the economic impact assessment model (IMPLAN) as a "new" direct stimulus to each state's economy. The economic impact of these increasingly accurate weather predicting observations results in increased economic impact of the output, value added, level of employment and income received by employees for a single year across all weather sensitive economic sectors of each Gulf Coast states. The economic impacts resulting from a 1% total potential private and public economic impacts are estimated at $59.8 billion in output, $34.7 billion in value-added, 637,009 jobs and $22.3 billion in income across the region.

Regarding the economic activities that would benefit greatly from improved weather forecasting due to COOS, the private sector benefits tremendously. Ninety-five percent of all COOS benefits are contained in the private sector, totaling $2.961 Billion (Table 39), in 2002 Dollars. The oil and gas distribution, and the commercial shipping industries benefit the greatest, based on the annual expenditures data. For the non-market sector, benefits total $66.46 Million. Recreation-based activities contribute 60% of benefits to the non-market sector. The results of the benefits accruing to the recreation related businesses located along the coastal counties of the Gulf states, using CACI data, were estimated to be $111 Million. The public sector, including search and rescue, military, marine and freshwater management, and stormwater damage mitigation will benefit by a savings of $83.86 Million, due to the improved weather forecasts provided by COOS. For the three sectors, the benefits total $3.111 Billion.

References

Adams, R., M. Brown, C. Colgan, N. Flemming, H. Kite-Powell, B. McCarl, J. Mjelde, A. Solow, T. Teisburg, and R. Weiher. "The Economics of Sustained Ocean Observations: Benefits and Rationale for Public Funding. " A Joint Publication of National Oceanic Atmospheric Administration and the Office of Naval Research, August 2000.

Energy Information Administration, 2000. http://www.eia.doe.gov/emeu/states/sep_sum/html/rank_pr_pa_ng.html#footnotes 2000

H.L. Kite-Powell and C.S. Colgan. "The Potential Economic Benefits of Coastal Ocean Observing Systems: The Gulf of Maine as an Example." NOAA and ONR Publication, Woods Hole Oceanographic Institution, December, 2001.

Lynch, T., and J. O'Brien. Proceedings of Workshop on the Economic Impact of ENSO Forecasts on the American Australian and Asian Continents, hosted on August 11-13, 1992, at Florida State University.

National Marine Fisheries Service. 1991. Marine Recreational Fishery Statistics Survey: Atlantic and Gulf Coasts. US Department Of Commerce, Washington, D.C.

National Oceanographic Oceanic Atmospheric. Current Participation Patterns in Marine Recreation, 2001.

National Oceanographic Partnership Program: Promoting Partnerships for the Future of Oceanography. NOPP Web site: http://www.coreocean.org

National Oceanographic Partnership Program. Sol: 02-011. http://www.onr.nay.mil/02/baa/02_011.htm

National Weather Service. Natural Hazard Statistics. http://www.nws.noaa.gov/om/hazstats.shtml 2002.

Nowlin, W. and T. Malone. Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System. http://core.cast.msstate.edu/NOPPobsplan.html 1999.

Office of Research. FY2001 Annual Report. Florida State University, Tallahassee, Florida.

OMB Circular A-94. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." 1992.

Rickman, D. and R. Keith Schwer "A Systematic Comparison of the REMI and IMPLAN Models: The Case of Southern Nevada," The Review of Regional Studies, Fall 1993, pp. 148-149.

Sassone, P. and R. Weiher. "Cost Benefit Analysis of TOGA and the ENSO Observing System." Operational Oceanography: The Challenge for European Cooperation. Elsevier Press 62: 1997 pp 36-50.

Stel, J. and B. Mannix. "A Benefit-Cost Analysis of a Regional Global Ocean Observing System: Seawatch Europe." Marine Policy. Elsevier Press 20: 1996 pp. 357-376.

Texas Office of Economic Development, 2002 Travel to Texas Report, 2002.

Thomas, M. and N. Stratis "Assessing the Economic Impact and Value of Florida's Public Piers and Boat Ramps" Report to the Florida Fish and Wildlife Conservation Commission, March, 2001.

U.S. Army Corps of Engineers and the Maritime Administration Office of Statistical & Economic Analysis. U.S. Port Totals by Type Service. http://www.iwr.usace.army.mil/ndc/usforeign/index.htm 2001.

Visit Florida, Florida Visitor Study, 2002.

Weiher, R., and H. Kite-Powell. "Assessing the Economic Benefits of El Niño and the Benefits of Improved Forecasts," in *Improving El Niño Forecasting: The Potential Economic Benefits*. Aug. 2000.

Appendices

Appendix A

Coastal Counties of the Gulf of Mexico Region

MS (3)	AL(2)	LA(9)	TX(15)	FL(24)
Hancock	Mobile	Jefferson	Jefferson	Escambia
Harrison	Baldwin	St.Bernard	Chambers	Santa Rosa
Jackson		Plaquemines	Galveston	Okaloosa
		Lafourche	Brazoria	Walton
		Terrebonne	Matagorda	Bay
		St.Mary	Calhoun	Gulf
		Iberia	Jackson	Franklin
		Vermilion	Refugio	Wakulla
		Cameron	Aransas	Jefferson
			San Patricio	Taylor
			Nueces	Dixie
			Kleberg	Levy
			Kennedy	Citrus
			Willacy	Hernando
			Cameron	Pasco
				Pinellas
				Hillsborough
				Manatee
				Sarasota
				Charlotte
				Lee
				Collier
				Monroe
				Miami-Dade

Appendix B

U.S Exports in Millions of Metric Tons for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

Port Name	TOTAL (Metric Tons)	LINER (Metric Tons)	TANKER (Metric Tons)	TRAMP (Metric Tons)
TAMPA, FL*	1.16	0.62	0.01	0.53
Jacksonville, FL	0.74	0.49	0.00	0.25
Fernandina Beach, FL	0.23	0.11	na	0.11
Port Canaveral, FL	0.19	0.02	0.01	0.16
MIAMI, FL*	4.13	3.30	0.26	0.58
Miami, FL	2.23	1.92	0.01	0.30
Port Everglades, FL	1.31	1.09	0.03	0.19
West Palm Beach, FL	0.59	0.28	0.21	0.09
Fort Pierce, FL	0.01	0.00	na	0.00
Gulf Total:	154.59	10.46	39.83	104.31
TAMPA, FL	1.71	0.29	0.14	1.28
Tampa, FL	1.09	0.11	0.14	0.84
Panama City, FL	0.30	0.15	0.00	0.14
Pensacola, FL	0.23	0.02	na	0.21
Port Manatee, FL	0.10	0.01	na	0.09
MOBILE, AL	12.18	1.74	0.86	9.58
Mobile, AL	8.98	1.17	0.16	7.65
Gulfport, MS	0.92	0.54	na	0.39
Pascagoula, MS	2.27	0.04	0.70	1.54
NEW ORLEANS, LA	92.26	2.73	12.25	77.28
Morgan City, LA	0.05	0.01	na	0.05
New Orleans, LA	32.52	2.39	4.36	25.77
Baton Rouge, LA	5.80	0.11	1.33	4.36
Destrehan, LA	9.46	0.07	0.10	9.30
Gramercy, LA	36.85	0.08	3.48	33.28
Avondale, LA	0.14	0.00	0.12	0.01
St. Rose, LA	2.88	0.00	0.59	2.29
Good Hope, LA	0.81	0.00	0.81	na
Lake Charles, LA	3.76	0.08	1.46	2.22
Port of South LA	50.00	0.15	4.98	44.87
PORT ARTHUR, TX	6.31	0.03	4.36	1.92
Port Arthur, TX	2.07	0.02	1.47	0.59
Sabine, TX	0.05	0.01	0.01	0.03
Orange, TX	0.00	0.00	na	na
Beaumont, TX	4.18	0.01	2.88	1.30
LAREDO, TX	0.20	0.01	0.20	0.00

U.S Exports in Millions of Metric Tons for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

Port Name, Cont.	TOTAL	LINER	TANKER	TRAMP
	(Metric Tons)	(Metric Tons)	(Metric Tons)	(Metric Tons)
Brownsville, TX	0.20	0.01	0.20	0.00
MIAMI, FL	0.00	0.00	na	0.00
Key West, FL	0.00	0.00	na	0.00
HOUSTON, TX	41.92	5.65	22.02	14.25
Houston, TX	29.59	5.01	14.77	9.81
Texas City, TX	2.65	0.06	2.14	0.44
Galveston, TX	0.87	0.22	0.26	0.39
Freeport, TX	1.88	0.31	1.33	0.24
Corpus Christie, TX	6.54	0.03	3.16	3.35
Port Lavaca, TX	0.40	0.01	0.35	0.03

U.S Exports in Millions of Dollars for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

PORTNAME	TOTAL (US DOLLARS)	LINER (US DOLLARS)	TANKER (US DOLLARS)	TRAMP (US DOLLARS)
TAMPA, FL	2376.94	1390.11	10.57	976.26
Jacksonville, FL	1990.53	1214.82	2.94	772.77
Fernandina Beach, FL	230.01	160.08	na	69.93
Port Canaveral, FL	156.39	15.21	7.63	133.56
MIAMI, FL	13800.06	12861.79	27.31	910.96
Miami, FL	8486.72	7977.64	6.21	502.87
Port Everglades, FL	4432.96	4045.64	9.82	377.49
West Palm Beach, FL	874.00	836.04	11.28	26.69
Fort Pierce, FL	6.37	2.47	na	3.91
Gulf Total:	46,801.00	19,153.93	10,678.63	16968.44
TAMPA, FL	1886.77	177.26	661.55	1047.97
Tampa, FL	1572.70	83.82	660.91	827.96
Panama City, FL	128.92	66.53	0.63	61.75
Pensacola, FL	144.19	22.03	na	122.16
Port Manatee, FL	40.97	4.87	na	36.10
MOBILE, AL	3461.05	1552.08	208.33	1700.64
Mobile, AL	1457.97	605.52	94.50	757.95
Gulfport, MS	1321.19	894.01	na	427.18
Pascagoula, MS	681.89	52.55	113.83	515.50
NEW ORLEANS,	16667.54	3723.80	2455.77	10487.97

U.S Exports in Millions of Dollars for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

PORTNAME Continued…	TOTAL (US DOLLARS)	LINER (US DOLLARS)	TANKER (US DOLLARS)	TRAMP (US DOLLARS)
Morgan City, LA	143.91	30.80	na	113.11
New Orleans, LA	8133.62	3583.01	956.82	3593.79
Baton Rouge, LA	1235.02	43.76	358.21	833.05
Destrehan, LA	1203.07	11.73	17.97	1173.37
Gramercy, LA	4712.50	28.04	498.65	4185.81
Avondale, LA	49.32	0.14	45.67	3.51
St. Rose, LA	448.05	0.48	139.60	307.97
Good Hope, LA	175.17	0.01	175.15	na
Lake Charles, LA	566.88	25.81	263.71	277.37
Port of South LA	6538.78	40.27	831.37	5667.14
PORT ARTHUR, TX	1045.55	96.00	631.72	317.84
Port Arthur, TX	210.28	13.54	73.31	123.44
Sabine, TX	6.43	1.35	1.51	3.57
Orange, TX	5.01	5.01	na	na
Beaumont, TX	823.84	76.11	556.90	190.83
LAREDO, TX	30.37	11.69	18.53	0.15
Brownsville, TX	30.37	11.69	18.53	0.15
MIAMI, FL	16.37	13.68	na	2.69
Key West, FL	16.37	13.68	na	2.69
HOUSTON, TX	23693.34	13579.42	6702.73	3411.18
Houston, TX	19521.67	12568.52	4332.63	2620.52
Texas City, TX	962.27	52.87	826.46	82.94
Galveston, TX	832.04	603.68	75.49	152.86
Freeport, TX	979.07	264.44	553.47	161.16
Corpus Christie, TX	1227.20	78.58	765.53	383.08
Port Lavaca, TX	171.10	11.33	149.16	10.62

U.S Imports in Millions of Metric Tons for U.S. Customs Districts and Ports in The Gulf Region - 2001

Port Name	TOTAL	LINER	TANKER	TRAMP
	(Metric Tons)	(Metric Tons)	(Metric Tons)	(Metric Tons)
TAMPA, FL	10.78	0.70	4.34	5.75
Jacksonville, FL	8.60	0.59	3.41	4.59
Fernandina Beach, FL	0.13	0.08	na	0.06
Port Canaveral,	2.05	0.03	0.92	1.09
MIAMI, FL	10.42	3.47	4.18	2.77
Miami, FL	3.40	2.45	0.67	0.27
Port Everglades, FL	6.46	0.90	3.24	2.32
West Palm Beach, FL	0.49	0.10	0.27	0.12
Fort Pierce, FL	0.08	0.01	na	0.06
Gulf Total:	428.57	8.11	350.65	69.81
TAMPA, FL	10.34	0.21	3.92	6.21
Tampa, FL	8.28	0.13	3.58	4.57
St. Petersburg, FL	0.00	0.00	na	na
Panama City, FL	0.44	0.05	0.02	0.37
Pensacola, FL	0.12	0.00	na	0.12
Port Manatee, FL	1.50	0.03	0.31	1.15
MOBILE, AL	34.81	0.64	21.05	13.12
Mobile, AL	16.19	0.44	4.89	10.86
Gulfport, MS	1.15	0.19	0.04	0.92
Pascagoula, MS	17.47	0.01	16.12	1.34
NEW ORLEANS, LA	149.54	2.59	115.01	31.94
Morgan City, LA	47.66	0.01	47.64	0.01
New Orleans, LA	32.73	2.40	16.14	14.19
Baton Rouge, LA	16.59	0.10	9.46	7.02
Destrehan, LA	0.01	na	na	0.01
Gramercy, LA	18.71	0.07	10.28	8.36
Avondale, LA	0.08	na	0.08	0.00

U.S Imports in Millions of Metric Tons for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

Port Name	**TOTAL**	**LINER**	**TANKER**	**TRAMP**
	(Metric Tons)	**(Metric Tons)**	**(Metric Tons)**	**(Metric Tons)**
St. Rose, LA	3.45	na	2.95	0.50
Good Hope, LA	3.21	na	3.21	na
Lake Charles, LA	27.10	0.01	25.24	1.85
Port of South LA	25.38	0.07	16.45	8.86
PORT ARTHUR, TX	58.15	0.23	56.62	1.30
Port Arthur, TX	20.90	0.07	19.98	0.85
Sabine, TX	0.28	0.00	0.28	na
Beaumont, TX	36.97	0.16	36.36	0.45
Port Name	TOTAL	LINER	TANKER	TRAMP
	(Metric Tons)	(Metric Tons)	(Metric Tons)	(Metric Tons)
LAREDO, TX	0.45	0.01	0.05	0.39
Brownsville, TX	0.45	0.01	0.05	0.39
MIAMI, FL	0.00	0.00	na	0.00
Key West, FL	0.00	0.00	na	0.00
HOUSTON, TX	175.28	4.42	154.01	16.85
Houston, TX	88.65	4.26	75.74	8.65
Texas City, TX	16.35	0.00	16.34	0.01
Galveston, TX	4.08	0.14	3.30	0.63
Freeport, TX	19.85	0.01	19.45	0.39
Corpus Christie, TX	42.27	0.01	38.35	3.91
Port Lavaca, TX	4.08	0.00	0.82	3.25

U.S Imports in Millions of Dollars for U.S. Customs Districts and Ports in The Gulf Region - 2001. Cont.

Port Name	TOTAL (US DOLLARS)	LINER (US DOLLARS)	TANKER (US DOLLARS)	TRAMP (US DOLLARS)
TAMPA, FL	9283.57	2680.47	770.61	770.61
Jacksonville, FL	8816.53	2572.25	594.36	594.36
Fernandina Beach, FL	123.03	98.01	na	na
Port Canaveral, FL	344.02	10.20	176.25	176.25
MIAMI, FL	14788.57	13227.06	809.03	809.03
Miami, FL	8113.10	7637.07	90.11	90.11
Port Everglades, FL	5850.51	4839.33	678.87	678.87
West Palm Beach, FL	803.52	744.29	40.04	40.04
Fort Pierce, FL	21.45	6.37	na	na
Gulf Total:	82504.34	15914.02	55404.89	55404.89
TAMPA, FL	1544.72	337.58	580.47	580.47
Tampa, FL	1109.82	275.82	515.14	515.14
St. Petersburg, FL	0.12	0.12	na	na
Panama City, FL	129.98	36.24	3.20	3.20
Pensacola, FL	31.20	8.35	na	na
Port Manatee, FL	273.60	17.05	62.13	62.13

U.S Imports in Millions of Dollars for U.S. Customs Districts and Ports in The Gulf Region - 2001, Cont.

Port Name	TOTAL (US DOLLARS)	LINER (US DOLLARS)	TANKER (US DOLLARS)	TRAMP (US DOLLARS)
MOBILE, AL	6038.91	1555.92	2867.60	2867.60
Mobile, AL	2187.57	424.75	805.19	805.19
Gulfport, MS	1735.50	1108.13	10.35	10.35
Pascagoula, MS	2115.84	23.04	2052.06	2052.06
NEW ORLEANS, LA	25827.69	3692.73	17867.36	17867.36
Morgan City, LA	7686.52	33.14	7647.91	7647.91
New Orleans, LA	8842.27	3579.87	2785.70	2785.70
Baton Rouge, LA	2278.62	47.98	1394.29	1394.29
Destrehan, LA	0.04	na	na	na
Gramercy, LA	2357.03	25.01	1591.08	1591.08
Avondale, LA	28.83	na	24.97	24.97
St. Rose, LA	548.79	na	503.07	503.07
Good Hope, LA	548.77	na	548.77	548.77
Lake Charles, LA	3536.81	6.72	3371.57	3371.57
Port of South LA	3454.64	25.01	2642.93	2642.93
PORT ARTHUR, TX	10058.69	808.36	9046.13	9046.13
Port Arthur, TX	3161.38	34.99	2954.07	2954.07
Sabine, TX	52.26	0.31	51.95	51.95
Beaumont, TX	6845.04	773.06	6040.10	6040.10
LAREDO, TX	81.21	9.11	24.58	24.58
Brownsville, TX	81.21	9.11	24.58	24.58
MIAMI, FL	1.53	0.10	na	na
Key West, FL	1.53	0.10	na	na
HOUSTON, TX	38951.60	9510.23	25018.74	25018.74
Houston, TX	24966.89	8988.45	12621.59	12621.59
Texas City, TX	2699.01	0.83	2695.73	2695.73
Galveston, TX	1426.90	473.15	523.93	523.93
Freeport, TX	3176.74	22.89	2936.50	2936.50
Corpus Christie, TX	6451.66	24.91	6097.89	6097.89
Port Lavaca, TX	230.40	0.01	143.11	143.11

*The Customs Management areas of Miami Fl. and Tampa Fl. have ports in both the Atlantic and Gulf Coastal Region.

The ports in capital letters represent the customs district office for that area and the totals represented by each customs district office are the aggregate total for each individual port in that district which is listed below the district office in normal font.