University of Miami
Rosenstiel School of Marine and Atmospheric Science

Efforts to Create a Sustainable Environment within the Florida Keys; Requirements for the Future

by

Kimberly A. Cohen

An Internship Report

[Restored and transferred to electronic form by M. J. Bello (NOAA) and Jabari Capp (RSMAS) in 2001 as part of the Coastal and Estuarine Data/Document Archeology and Rescue (CEDAR) for South Florida. Sponsored by the South Florida Ecosystem Restoration Prediction and Modeling Program. Original stored at the Library, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Minor editorial changes were made.]

Submitted to the Faculty of the University of Miami
Rosenstiel School of Marine and Atmospheric Science
in partial fulfillment of the requirements for the
degree of Master of Arts

Miami, Florida

4/01/99

Cohen, Kimberly A. M.A., Marine Affairs

Efforts to Create a Sustainable Environment within the Florida Keys; Requirements for the Future May 1, 1999

Abstract of a master's internship thesis at the University of Miami, Rosenstiel School of Marine and Atmospheric Science. Thesis supervised by Dr. Fernando Moreno. Number of pages in text: 41

The natural environment of South Florida has been affected by many anthropogenic disturbances, such as nutrient enrichment, soil erosion, pesticide contamination, and algal blooms. Efforts to divert freshwater resources to sustain the more populated areas have had devastating effects on the state's wetland areas. Coastal and benthic ecosystems have also been subject to many stressors as a result of runoff and groundwater contamination. Legislators have begun to consider the impact of ecosystem destruction not only ecologically but economically and have responded with increased funding and protective legislation designed to preserve the area.

In the last decade, several baseline studies and long-term monitoring projects have been conducted to ensure that conservation and restoration projects are patterned specifically to the needs of the South Florida ecosystem. The Florida Keys have been designated as an area in need of protection and, as such, has been the subject of many of these research/conservation projects. My internship consisted required that I participate in one such project designed to characterize the sedimentation and nutrient patterns within the Florida Keys reef tract. Modelers will then use this data as one parameter which will can combined with concurrent biological, physical, and chemical data for an accurate estimation of system health.

Table of Contents

List of Figures

1.0 INTRODUCTION

The natural environment of South Florida is uniquely diverse yet fragile, containing such productive habitats as coral reefs, wetlands, and mangroves. Each of these delicate ecosystems is very sensitive to changes in the ambient environment and has been subject to degradation as a result of the dramatic increase in development over the past century. The natural environment of South Florida has been affected by many anthropogenic disturbances, such as nutrient enrichment, soil erosion, pesticide contamination, and algal blooms. The direction, quantity, and quality of freshwater flow within the wetland areas have been altered considerably through the use of canals, dikes, and agricultural development in order to meet the needs of a growing population.

Researchers agree that the wetland ecosystem should be restored to its natural condition. However, a steady water supply is necessary to sustain not only the animal life but the many plants species which inhabit South Florida. For this reason, scientists must first complete a water budget to determine the annual water usage and availability within South Florida to pattern a restoration and/or conservation project which will address the specific needs of the area (Fig. 1). It is important that they express this water supply not only in terms of quantity but quality. Certainly, the maintenance of an uncontaminated supply of drinking water is necessary. However, other systems such as the Florida Keys reef tract also depend on a very high level of water quality in order to maintain productivity and are negatively affected by nutrient enriched runoff.

The biological diversity of the Florida Keys reef tract makes the ecosystem "ecologically, economically, aesthetically, and biogeographically unique within the U.S."[1] and, consequently, a popular vacation destination.

[1]Crosby, M., 1997. South Florida Ecosystem Success Indicator-11: Improvement of Coral Reef Conditions. National Oceanic and Atmospheric Administration, p. 2.

With tourism being the leading industry in the state of Florida, legislators must consider the impact of ecosystem destruction both ecologically and economically.

The degraded condition of local resources can result in lost revenue not only for the tourism industry but for the many industries augmented by tourism such as transportation, various service industries, and commercial fishing.

Each of these would be negatively impacted if South Florida were to no longer possess the aesthetic quality which attracts millions of tourists each year.

Tourism accounts for over half of the gross revenue generated within the Florida Keys and water related activities account for about 61 % of all visitor recreation. The $1.6 billion economy of the Florida Keys is "dependent on the maintenance of a high quality marine environment"[2].

The need for further study and restoration of the area has been recognized by both federal and local authorities and, in the Florida Keys alone, over 230 million dollars is currently allocated for such efforts. The Florida Keys Carrying Capacity Study, Sanitary Wastewater Management Plan, Multi-Species Habitat Conservation Plan, and Florida Keys National Marine Sanctuary (FKNMS) Water Quality Protection Plan are just a few of the many projects currently being conducted (Fig.2). The task of restoring the Florida Keys to a "sustainable" state is a very large undertaking which requires the expertise of scientists from many different fields. For this reason, studies are being conducted by the National Oceanic and Atmospheric Administration (NOAA), Florida Department of Environmental Protection (FDEP), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS), among others. In addition to the Federal and state agencies listed, many scientists conduct their research within the Florida Keys on behalf of Florida universities. With so many agencies and laboratories working concurrently in a small area, coordination efforts are essential in order to communicate findings and to ensure that efforts are not duplicated.

[2] National Oceanic and Atmospheric Administration, 1995. Florida Keys National Marine Sanctuary Draft Management Plan/ Environmental Impact Statement. Vol. 2, p. 179.

BACKGROUND:

2.1 The Everglades:

The Everglades watershed has been subject to drainage since the early 1880's and, in 1948, Congress authorized the Central and Southern Florida Project for Flood Control in order to decrease the possibility of flooding while providing a source of water for both agricultural and urban areas. This "flood control" was accomplished through the use of levees, canals, and pumps which diverted the natural flow of groundwater in order to conserve water during the wet season and dispense it during the dry season when supplies become scarce. These drainage efforts succeeded in converting portions of the former wetland area to a terrestrial environment with resulting habitat loss for both wading birds and aquatic species.

In addition to the ecological changes associated with the South Florida flood control provisions, the natural condition of the Everglades was further altered when some 800,000 acres of the northern portion were allocated for agriculture. This conversion from a natural state to the "Everglades Agricultural Area" (EAA) has had devastating effects on the system. The use of pesticides and fertilizers, while making the area more suitable and productive for farming, continues to be detrimental to the many other systems within South Florida. Pesticides, although they vary in toxicity, residence time, and in their ability to be transported through the system, can have very severe effects on the system and on non-target species. In addition, the fertilizers used in the farming process alter the nutrient dynamic of the system causing high concentrations of nitrogen and phosphorus to be deposited into the surrounding areas such as Florida Bay (Lapointe and Clark, 1992; Fourqurean *et al*., 1993).

As a result of the altered hydrology, the vegetation in these areas has changed dramatically and the nutrient-filtering capacity of the wetland has been compromised. In a natural condition, the Everglades have the ability to act as a "filtration" system for inorganic nutrients. As groundwater flows through the system, nutrients are assimilated into the marsh vegetation and nutrients return to background levels (Jones and Amador, 1992). Historically, the Everglades existed as a relatively low nutrient system so the uptake capacity of native algal and vascular plant species was not very high. Sawgrass had been the predominant marsh species of the area but, as a result of the enriched nutrient regime, it has been replaced by cattails which have a higher assimilation capacity (Davis, 1991).

2.2 The Florida Keys Reef Tract:

Because the Florida Keys reef tract already exists at its upper latitudinal limit in terms of temperature stress (Crossland, 1988), other physical and biological factors must be closely monitored in order to maintain system health and productivity. As a result of such stressors as runoff, nutrient enrichment from groundwater contamination, and high amounts of sedimentation, coral diversity and the amount of sea floor inhabited by corals has declined in the northern Florida Keys (Porter and Meier, 1992) .

Two environmental factors known to affect the health and viability of coral reefs are high levels of nutrients and sedimentation. Elevated levels of these factors may be natural to an area and, along with other environmental factors, determine the extent of reef development in a given location. Elevated levels may also be the more recent result of anthropogenic disturbances such as polluted groundwater, surface discharge, and storm water runoff. Increases in nutrients and/or sedimentation due to anthropogenic activity have been shown to cause coral reef decline in other parts of the world (Rogers, 1990) and there is concern that nutrient enrichment and higher sediment deposition rates may also be having a negative effect on Florida coral reefs. High sedimentation rates have been associated with fewer coral species, lower calcification and growth rates, morphological changes, and decreased net productivity (Rogers, 1990, Cortes and Risk, 1985), and can be the result of poor land use patterns and dredging operations.

The nutrient concentration in sediments reflects the longer-term nutrient supply and productivity of an area as opposed to water column nutrients which are much more temporally variable (Parsons *et al.* 1984). Sediments will also better reflect an influx of nutrients by groundwater seepage and can serve as a mechanism for these nutrients to be resuspended and transported to the offshore areas during wind events.

Evidence suggests that domestic wastewater is the main source of increased nutrient levels in the nearshore area (EPA, 1993). For this reason, the issue of wastewater treatment facilities in the Keys is of particular importance. The Florida Keys lack the infrastructure to properly dispose of all potentially damaging waste produced at the current level of development and tourism. The City of Key West is currently the only area in the county to operate both centralized sewage and stormwater treatment facilities and, even for those areas which are equipped with the proper facilities, outfalls occur very near to shore concentrating elevated levels of nutrients in these areas. Moreover, only eight marinas in the Keys have pump-out facilities causing the majority of boats to pump their waste directly into the water (FKNMS Final Management Plan, 1996).

Proposed changes to address these issues include the on-site disposal of wastewater, establishment of standards for acceptable nutrient loadings, and a method for inspection and enforcement. Additionally, improved containment facilities are proposed in order to properly treat the large volume of stormwater which is deposited during the rainy season. Each would contribute to decreased nutrient levels throughout the Florida Keys reef tract and would preserve the area for future tourism and development.

ASSESSING THE ECOLOGICAL CONDITION OF THE FLORIDA KEYS

3.1 The South Florida Initiative and the National Water Quality Assessment Program (NAWQA)

One of the largest multi-agency, multidisciplinary projects within the Keys has been the "South Florida Initiative", a collaborative effort by the USGS and other Federal and State agencies to provide scientific insight into the current land use demands and water supply issues in South Florida. In 1991, the USGS implemented the National Water Quality Assessment Program

(NAWQA) in order to "define long term trends in water quality and to identify, describe, and explain the major factors that affect observed water quality conditions and trends"[3]. This initiative, combined with the many other smaller-scale projects, comprised one of the largest efforts of its kind in the United States and targeted both the terrestrial as well as the marine and coastal environments. Because a large portion of the state of Florida lies either at or below sea level, its terrestrial and coastal ecosystems are very closely interrelated and should be considered in conjunction with one another.

The South Florida NAWQA and the South Florida Ecosystem Program overlap to provide some of the most comprehensive information regarding the effectiveness of both water-quality management and restoration programs (Fig. 3). The South Florida NAWQA Study began in 1993 to address the water quality degradation, which has occurred as a result of the urban and agricultural development. Scientists intend to analyze historical hydrologic data, collect surface and groundwater samples, and conduct ecological studies in order to create a restoration program designed specifically for South Florida.

Some of the scientific objectives of the project are the characterization of sediment patterns within Florida Bay, the determination natural hydrologic conditions for the area, and the estimation of water availability through the use of a water transport model.

The USGS established seven sites for a surface water quality assessment program and chose 30 shallow wells for groundwater sampling. Also, using the most recent Landsat satellite technology, scientists generated images of the entire Bay for both turbidity and topographic analysis.

[3]McPherson, B.F., and R. Halley, 1996. The South Florida Environment- A Region under stress. U.S. Geological Survey Circular 1134. United States Government Printing Office, p.5

3.2 Determination of Groundwater-Flow Direction and Rate

Significant changes in water quality have occurred within the Florida Keys due, in part, to the seepage of sewage in marine groundwater (Shinn *et al.* 1994). In order to address this problem, the USGS conducted a project designed to determine both the flow rate and direction of groundwater flow within the Keys region to better predict the fate of waste water. Prior to the initiation of this project, scientists had not widely addressed wastewater containment and treatment issues even though many agreed that groundwater contamination is a major threat to the marine system. In addition, the State of Florida had placed few restrictions on wastewater disposal within the Florida Keys.

In order to measure not only how much but how quickly wastewater reaches the reef area, scientists measured its flow through the use of both dye and radioactive tracers. They injected "tracers" into more than 80 wells, septic tanks, and sewage systems throughout the Keys so that their progression to open water could be closely monitored.

In addition to flow measurements, scientists continue to sample the groundwater for salinity, nutrient, dissolved oxygen, and fecal coliform bacteria analysis. Project managers intend to use this data to establish a baseline from which to gauge the effects of future development as well as the success or failure of restoration projects.

Preliminary results have shown that the direction of flow is perpendicular to the Florida Keys toward the offshore area and that "...wastewater ...injected into the subsurface environment of the Florida Keys can rapidly enter into surface waters."[4] Mean sea level in Florida Bay is 10-20 cm. above mean Atlantic sea level so, although the direction of flow is dependent on the tide net lateral flow is towards the Atlantic (Shinn *et al.,* 1996).

[4]J.H. Paul et al. 1997. Evidence for groundwater and surface marine water contamination by waste disposal wells in the Florida Keys. Wat. Res.31(6): 1448-1454

During periods of strong easterly winds, groundwater flow was mainly toward the west in Florida Bay. Regardless of lateral direction, however, water transport was always upward toward the surface layers. These results suggest that the organic material which leaks from septic tanks within the Keys will eventually contaminate the reef tract and could contribute to its degradation.

Improvements in the existing wastewater practices and policies for the Florida Keys are essential for ecosystem restoration. About 9,000 unpermitted cesspits still remain within the Keys, delivering untreated sewage to the groundwater system. As a result of this study, legislators have already modified State regulations for the installation of sewage wells. The House of Representatives passed General Bill hb2391: Sewage Treatment/ Disposal System which was to amend Florida Statute 381.0065, titled "Onsite Sewage Treatment and Disposal". The House Bill amends standards for placement of sewage treatment and disposal systems, provides for system compliance, and establishes both standards for design criteria and deadlines for review. (Appendix #1)

3.3 Florida Keys Carrying Capacity Study.

The Keys Carrying Capacity Study, being conducted under the direction of the Florida Department of Community Affairs (DCA), is focused on all of Monroe County ranging from Key Largo to the Dry Tortugas. The Florida Keys, under the authority of the Florida Environmental Land and Water Management Act of 1972, have been identified as anArea of Critical State Concern since 1975. The legislative intent of Florida Statute sec. 308.055 (2) (c): Florida Keys Area; Protection and Designation as an Area of Critical State Concern is to "establish a land use management system that promotes orderly and balanced growth in accordance with the capacity of available and planned public facilities and services"[5]. State officials recognized the need for a study designed to specifically address the problems of biodiversity loss, decreases in water quality, and pressure on infrastructure caused by the continued development in the Florida Keys.The

[5]Florida Statutes 380.005 (2) (d) 1993

proposed project would "determine the density of human life and activity that the Florida Keys ecosystem is able to sustain without ...adverse impacts to natural resources and to identify, where appropriate, areas requiring restoration efforts and additional infrastructure investment to restore ecosystem integrity (wastewater and stormwater facilities)[6]".

From a management perspective, this is one of the most important studies currently being conducted within the Florida Keys. With the use of collected information, a model can be produced which would identify a sustainable rate of development, as well as a theoretical "threshold" beyond which resource degradation would occur. This model would then become an integral part in the decision making process where water/land resource allocation and management decisions are concerned. The information generated from this project will allow decision makers not only to determine which are the most pressing ecological problems within the Florida Keys but to project the effect of future regulations and standards on these problems.

3.4 The Florida Keys National Marine Sanctuary:

The Florida Keys National Marine Sanctuary (FKNMS) was created with the Florida Keys National Marine Sanctuary and Protection Act of 1990. This legislation directed the EPA and the State of Florida, in conjunction with NOAA, to develop a Water Quality Protection Plan (WQPP) for the Sanctuary. The purpose is to recommend compliance schedules as well as corrective action for both point and non-point sources within the FKNMS. Before the WQPP could be implemented, several studies were required in order to better understand the "cause and effect relationships among pollutants, transport pathways, and the biological communities of the Sanctuary"[7].

The Final Management Plan contains a completed Water Quality Action plan which is divided into 9 categories: Florida Bay/External Influence, Domestic Wastewater, Stormwater, Marinas and

[6]U.S. Army Corp of Engineers, 1998. Central and Southern Florida Ecosystem Restoration Critical Project Letter Report, p. 3

[7]http://www.epa.gov.docs/gumpo/florida-announcement.html

Live-Aboards, Landfill, Hazardous Material, Mosquito Spraying, Canals, and Research and Monitoring. Sanctuary managers ranked, in order of ecological importance, each of 37 water quality "strategies" within the 9 categories (Fig. 4). The FKNMS projects the cost for the completion of the Water Quality Action Plan to near $495 million, so, in order to ensure that funds were allocated in the appropriate manner, officials established priority levels for each task. As a result of this ranking, managers and other Sanctuary officials gave the Florida Bay, Domestic Wastewater, Mosquito Spraying, and Research and Monitoring categories the highest overall priority.

The South Florida Water Management District (SFWMD) and the National Park Service (NPS) will conduct a historical assessment of the natural hydrology of the Florida Bay in order to establish a baseline from which to pattern other projects.

In addition, the EPA and FDEP will conduct circulation studies to examine the degree to which Sanctuary waters are exchanged with Florida Bay as well as several ecological studies to determine the extent to which this exchange will impact Sanctuary communities.

The Domestic Wastewater Strategies seek to reduce pollutant loadings from cesspits (untreated sewage), onsite disposal systems (OSDS), package plants, and municipal treatment plants. Those given high priority are the OSDS Project, the Wastewater Management System and Wastewater Disposal Strategies (Key West). The goals of the OSDS project are to select alternate locations for septic systems in the Florida Keys and to determine their nutrient-removal efficiency. The Wastewater Management Systems strategy seeks to establish an inspection/compliance program to both identify and replace all cesspits and to enforce all existing standards for OSDS and package plants. Also, once evaluated for cost-effectiveness and nutrient reduction efficiency, the FKNMS will implement a Sanitary Wastewater Treatment Program to upgrade existing systems to current standards, upgrade package plants to advanced water treatment (AWT), and construct AWT plants which will service the most densely existing wastewater disposal in the area using current nutrient reduction technology. Because this plan also discontinues ocean outfall of sewage effluent, the scientific panel will investigate re-use options including irrigation and possible potable re-use of the wastewater.

Sanctuary officials list the Mosquito Spraying Strategy as a high priority simply because so little data exists regarding the concentrations of pesticides within the Sanctuary or their effects on Sanctuary resources. The major goals of the strategy are to investigate alternative pest control measures and to refine the existing Mosquito Control Program so that the amount of pesticides which enter Sanctuary waters is reduced. The FKNMS will not suggest any major changes in the Mosquito Control Program until more data can be collected regarding possible impacts.

Monroe County recently allocated over 7 million dollars for the completion of the Florida Keys Stormwater Master Plan, the Florida Keys Wastewater Master Plan, and the Florida Keys Cesspit Identification and Elimination Program. These projects are not yet complete but Sanctuary managers expect nutrient levels within the nearshore areas to decrease as a result of these and other water quality restoration efforts.

In addition to the Water Quality Plan, the EPA and NOAA have issued a Zoning Action Plan which addresses wildlife and habitat preservation in addition to the water quality issues. The plan establishes "zones" intended to "protect areas from resource degradation , separate incompatible uses, and facilitate research and education by establishing special areas for these activities"[8] (Fig. 5). Also, the FKNMS Management Plan establishes regulations governing many issues ranging from nutrient input to boat traffic and describes the major anthropogenic factors contributing to the degraded condition of some Florida reefs.

[8] National Oceanic and Atmospheric Administration, 1996. Florida Keys National Marine Sanctuary Final Management Plan/Environmental Impact Statement.

4.0 SEDIMENTATION PATTERNS WITHIN THE FLORIDA KEYS

4.1 Project Overview

The *NOAA Coastal Oceans Project: Cumulative Effects of Multiple Stressors on Coastal Ecosystems* is a 6 year, multi-disciplinary project whose main focus is to characterize the effects of both natural and anthropogenic stressors on the South Florida coastal ecosystem. Dr. Alina Szmant is one of several co-principal investigators on the project and, as her Research Associate, I was assigned to address Subtask 1b of this project, titled *Characterization of the Stress Regime caused by Turbidity and Nutrients*.

The overall goal of the project is to develop a model which may be used by managers and policy makers when conducting ecological risk assessments or making management decisions. Because this is a long-term monitoring project, the principal investigators (PIs) can gather information regarding natural seasonal differences and the temporal and spatial variability associated with storm frequency. The project involves the collaboration of several physical, chemical, geological and biological oceanographers, so it has the ability to generate a more accurate view of system health, using data from the concurrent study of many system parameters. Once scientists are able to estimate general system health, they will combine all accumulated data to form an ecological model intended to predict the possible synergistic effects of many ecological stressors on the system. The South Florida environment is rather complex with closely interrelated systems, so to look at each parameter or stressor separately might not accurately depict their ecological effect. A characterization of the local stress regime requires the consideration of the physical variability and the temporal or spatial patterns of both natural and anthropogenic stressors within the area. This information is essential when making decisions about system management and sustainability.[8]National Oceanic and Atmospheric Administration, 1996. Florida Keys National Marine Sanctuary Final Management Plan/ Environmental Impact Statement.

The sedimentation subtask of this project is designed to characterize the patterns of sedimentation within the Florida Keys, as well as the levels of nutrients associated with the resuspended sediments. It is important to understand the role of resuspension in the redistribution of nutrients within the Florida Keys since scientists believe that increases in one or both factors have caused coral reef decline in other parts of the world. Both are contributing factors to the cumulative physiological stress which corals and other species must endure in order to survive in South Florida. A data set which accurately describes the sedimentation and nutrient patterns within the Florida Keys is essential to the creation of a model for the system.

4.2 Methods

Cynthia Yeung, Beth Orlando and myself placed three sediment traps at each of 24 stations along 9 transects distributed from the northern limits of Biscayne National Park (BNP) to Long Key with 2-3 stations per transect (Fig. 6). Dr. Alina Szmant established all transects in an inshore to offshore direction in order to sample expected differences in both and sediment nutrient content and sedimentation rates when distance from shore increases. We conducted nine trap deployments from October 1996 to December 1997, each with a 3-4 week interval. In addition to the sediment trap samples, we sampled the surrounding sediments both at the beginning and at the end of the project. I, then, analyzed these sediment grab samples for both nutrient and particle size composition.

We constructed the sediment traps of 7.5 cm diameter PVC tubing with a layer of 63 μm mesh nitex placed 2 cm from the bottom. As sediments were deposited into the trap, those with a grain size of <63 μm (fine) would fall through the mesh and be trapped separately from coarse sediments (>63 μm) in order to facilitate the processing of each fraction. After we retrieved the traps, I extracted the coarse sediment from the trap so that it may be dried and weighed. I also filtered a subsample of the water which was trapped below the nitex mesh onto a Whatman GF/A filter. I placed the filters in an oven at 60° C and, once dried, I weighed the filters in order to quantify the trapped fine sediment.

After drying and homogenizing the coarse sediment subsamples, I placed them into vials for total nitrogen (TN) and total phosphorus (TP) analysis. In order to analyze the sediment for total nitrogen composition, myself and an undergraduate student weighed 25-30 mg of sediment into replicate tin sample cups to be combusted at 1020 °C in a Carlo Erba CHN Elemental Analyzer (EA 1108). We weighed an additional subsample of 25-30 mg into replicate borosilicate tubes for total phosphorus composition. I added 200 ml of $MgN0_3$ to each vial and ashed them at 400 °C for 24 hours. Once I retrieved them from the furnace, I added 10 ml of 1M HCl and vortexed the samples. Finally, I filtered the solution through a Whatman #1 filter, and analyzed it for phosphorus content using the TRAACS 2000 autoanalyzer.

4.3 Results

Although rates of resuspension and deposition of fine sediments (<63 µm particle size) were quite variable, both a N-S and an E-W trend in deposition rates was discernable within the study area. Rates of deposition were generally higher at the inshore stations than at the offshore stations and tended to increase toward the more southern transects at all distances from shore (Fig. 7). There was not a clear inshore to offshore trend for the deposition of coarser sediments (>63, µm particle size), although we were able to measure slightly greater deposition rates in both the northernmost and southernmost transects of the study area.

Total deposition rates were highest at all distances from shore along the 3 southernmost transects (Crocker to Long Key Viaduct). Average total deposition (coarse + fine) rates were between 100 to 200 $g/m^2/day$, often well above the 100 $g/m^2/day$ (Rogers, 1996) considered to be stressful to reef corals. While the BNP and Key Largo Transects exhibited total deposition rates higher than 100 $g/m^2/day$ during less than 40% of the deployments, the Long Key Transects exhibited "stressful" deposition rates during as much as 80% of deployments (Fig. 8).

Much of the high variability in both fine and coarse sediment deposition rates at each station is a result of the difference in wind intensity, direction, and cumulative wind stress of the deployment periods. Personnel from the Atlantic Oceanographic and Meteorological Laboratory (AOML), a division of NOAA, manage a CMAN station at Molasses Reef at which they collect wind data, as well as temperature, salinity, etc. I was able to analyze the data within this continuous wind record in conjunction with sediment deposition rates in order to observe any significant wind effect.

When I analyzed fine sediment deposition with respect to the average wind speed of deployment period using a One Way ANOVA, there was a statistically significant difference ($P \leq 0.001$) between inshore and offshore stations when average wind speeds exceeded 15 knots. There was no significant inshore to offshore trend for coarser sediment deposition rates regardless of wind conditions. However, we measured unusually high deposition rates at the mid-transect station along the northern-most Fowey Rocks transect.

Total sediment deposition tends to increase with the percentage of deployment period in which wind speeds were in excess of 15 knots (Fig. 9). During some deployments, however, sediment deposition rates for certain stations do not exhibit a noticeable increase even when the average wind speed is upwards of 20 knots. This variance in response to wind intensity is probably due to wind direction since deposition rates were more strongly correlated with wind components from the south and east than from the north or west.

Both cumulative wind stress and position relative to shore were significant ($P < 0.001$) for the BNP and Key Largo Transects, however, the significance of cumulative wind stress with respect to fine sediment deposition in the Long Key Area was lower ($P < 0.04$). For coarser sediments, cumulative wind stress does not seem to be a major factor in the amount of deposition.

The nitrogen content of the sediment grab samples exhibited a statistically significant ($P \leq 0.001$) inshore-offshore gradient, decreasing from 50 to 150 , μg-at. N/g sed. inshore, to less than 25 ug-at. N/gm sed. offshore, along all transects (Fig. 10). Sediment phosphorus concentrations generally increased from as low as 2 μg-at. N/g sed. inshore to over 8 μg-at. N/g sed. offshore, although there is no statistically significant inshore to offshore difference (Fig. 11). Sediment N:P ratios decreased from 20 - 40 inshore to much less than 10 at the offshore sites, therefore, the more offshore areas displayed characteristics of N limitation (Fig. 12).

The nitrogen content of resuspended sediments was highest inshore and decreased offshore, mirroring the composition of the surrounding sediment beds. The basic inshore to offshore pattern of sediment trap phosphorus composition is also very similar to that of surrounding sediment samples, however, trapped sediments were typically more enriched in both nitrogen and phosphorus than the surrounding sediments (Figs. 13 & 14).

4.4 Discussion and Conclusion

Inshore resuspended sediments tended to be finer than offshore sediments with increasing rates of fine sediment resuspension toward the Long Key area. With respect to coarse sediments, resuspension rates were highest at the northern and southern ends of our study area, which receive effluent from large embayments (Biscayne and Florida Bays). Sedimentation rates were highly variable between deployments because of differences in the frequency and severity of storm events during each trap deployment. Fall and winter rates of deposition were frequently in the 100 to 200 $g/m^2/day$ range, exhibiting much higher deposition rates than those during the summer months.

Wind intensity and duration can explain some of these seasonal differences in sediment deposition. Average daily wind speeds during the summer deployments were typically below 15 knots while those during some winter deployments were above 15 knots during as much as 50% of the deployment period. Fine sediment deposition is significantly affected by sustained wind speeds of 15 knots or greater, although coarser sediments do not exhibit a significant increase in deposition regardless of wind speed or direction. Wind also appears to have a cumulative effect on the amount of fine sediment deposition during a specific trap deployment. Deposition rates for fine sediments increased according to the amount of consecutive days within a deployment period in which the average wind speed was 15 knots or greater.

Within the Long Key transects, the percent of deployments in which total sediment deposition rates were measured in the "physiologically stressful" range was nearly double that of the Key Largo or BNP Transects which have healthier reef distributions. The reef tract offshore of Long Key is characterized by fewer and less developed reefs probably due, in part, to this pattern of sedimentation as well as the fact that the area is subject to greater nutrient input as a result of tidal exchange with Florida Bay. The USGS has conducted recent studies which illustrate that "1) there is quasi-steady non-tidal flow of water into Hawk Channel from Florida Bay; 2) the long-term net flow is consistently from Florida Bay/Gulf of Mexico to the Atlantic Ocean; 3) near bottom circulation in Hawk Channel is primarily influenced by local winds and secondarily by tides; and 4) net flow appears to reflect seasonal changes in local wind conditions" [9]. Also, in this area, currents are typically more strongly correlated with wind direction than intensity (Chiapppone, 1996), which would explain the static rates of sediment deposition during some deployments with greater average wind speeds. These results as well as the decreased reef development in the Long Key area support the suggestion that the distribution of Holocene coral reefs within the Florida reef tract has been heavily influenced by sediments and other materials exiting the Bays to the reef tract (Ginsburg and Shinn, 1993; Shinn, *et al*. 1989).

Sediment nitrogen content was consistently higher inshore than offshore, indicating the land and nearshore areas as the major sources of nitrogen enrichment within the coastal zone. The very low levels of nitrogen in offshore and reef sediments suggest that either the nitrogen from the nearshore areas is not being transported offshore or that, as it moves offshore, it is removed from the system through tidal flushing. A potential mechanism for the latter is resuspension.

[9]Chiapppone, M. 1996. Oceanography and Shallow Water Processes of the Florida Keys and Florida Bay: Site Characterization for the Florida Keys National Marine Sanctuary and Environments. Vol. 2, The Nature Conservancy, p. 22

Trapped sediments were more enriched in nitrogen in comparison to the surrounding sediments. This suggests that, during storm events, nitrogen enriched, lighter sediment particles are resuspended and gradually washed out of the system. Thus, to some degree, the offshore reef areas are more resistant to nutrification than are inshore areas (inshore of Hawk Channel) where water residence time is greater. Denitrification is another mechanism that could account for some of the nitrogen loss.

The most likely interpretation of the increase in sediment phosphorus with distance from shore is a possible oceanic source of phosphorus for the Florida Reef tract. This was previously suggested by Szmant and Forrester (1996) based on similar earlier results. The low phosphorus content of inshore sediments indicates that anthropogenic inputs to the Florida Keys have not caused a major phosphorus enrichment. The higher inshore N:P ratios suggest that phosphorus tends to be the more limiting nutrient, however, the low N:P of offshore area sediments indicate that nitrogen is the more limiting nutrient at those locations (Redfield *et. al,* 1963).

5.0 RESEARCH COORDINATION EFFORTS

5.1 The Florida Keys National Marine Sanctuary Management Plan

The FKNMS Management Plan mandates that research and management efforts within the Sanctuary be coordinated using input from all Federal and State agencies, local government, and various user groups. The Interagency Group is comprised of agency staff as well as members of all contributing agencies [10] and local groups in order to collaborate in the development and

[10] Interagency members consist of NOAA, DEP, DCA, SFWMD, EPA, NPS, USFWS, the Army Corp. of Engineers, Monroe County, and incorporated cities.

implementation of the Management Plan. The main purpose of this group is to review current research/management plans and to make recommendations for the allocation of funds. The prioritization of research projects has become a main theme in management programs since funding is often insufficient to address each ecological question for an area.

The Resource Management Team consists of representatives from Federal, State, local, and regional government with the goal of facilitating management objectives and resource protection within the Sanctuary. Sanctuary Advisory Council and Technical Advisory Committee members are responsible for the creation of actual management plans but the major collaborative effort occurs within the Resource Management Team. Members of this team will be ultimately responsible for the implementation of conservation objectives so their input regarding the necessity and feasibility of such options is important to the success of the program.

The FKNMS established various committees to specifically address problems such as water quality, enforcement, education, and outreach. Each committee is composed of experts in their respective fields to foster discussion and share their expertise with the both the Sanctuary Advisory Council and the Resource Management Team. Sanctuary officials decided to create the South Florida Ecosystem Restoration Task Force to address coordination problems associated with such a large collaborative effort as the management of the FKNMS. I will discuss the Task Force in greater detail in section *5.1a.*

5.1 a: Interagency Agreement on South Florida Ecosystem Restoration

On September 23, 1993, officials within the FKNMS established a coordination effort for the restoration of the South Florida Ecosystem in order to ensure that consistent interagency policies, plans, programs, and priorities were maintained. The Department of the Interior, Department of Commerce, Department of the Army, U.S. Environmental Protection Agency, Department of Justice, Department of Agriculture, State of Florida, South Florida Water Management District, and local governments became signatories to the "Interagency Agreement on

South Florida Ecosystem Restoration", which sought to facilitate a comprehensive restoration project for the Kissimmee watershed, Lake Okeechobee, the Big Cypress Basin, the Everglades, Florida Bay, and the Florida Keys.

The agreement establishes an "Interagency Task Force" which contains representatives from each of the federal agencies as well as representatives from state, local, and tribal governments. The Task Force conducts public, semi-annual meetings to discuss project objectives and to monitor the efforts of member agencies. In addition, the agreement establishes the "Management and Coordination Working Group", which meets quarterly and is responsible for recommending appropriate management policies, projects and priorities to the Task Force. The Working Group must present an annual "integrated plan for ecosystem restoration, maintenance, and protection, detailing current achievements, ongoing activities, and projected accomplishments"[11]. This annual report must also contain a financial plan detailing possible sources of funding as well as an ecosystem-based science program, a water quality program, and a multi-species recovery plan.

The Florida Keys Project Coordination Team Directive is the working sub-group of the South Florida Ecosystem Restoration Task Force which is assigned to discuss the environmental issues and projects which concern the Florida Keys reef tract. The specific area of concern for the Florida Keys sub-group includes the FKNMS, extending from Biscayne National Park to the Dry Tortugas National Park, and the southern portion of Florida Bay. Project managers from each of the various agencies conducting research in the Florida Keys are present at each bi-annual meeting to share information from ongoing projects, discuss funding issues, and discuss plans for the future. The main goal of the working sub-group is to implement an integrated, continuous management process for the Florida Keys sub-region.

[11]http://www.sfrestore.org/documents/interagr.html

5.2 The Program Management Committee for Florida Bay and Adjacent Coastal Waters

The Program Management Committee (PMC) for Florida Bay and Adjacent Waters was established in 1994 to oversee the plans, policies, and procedures of the Interagency Florida Bay Science Program. The committee consists of representatives from state and federal agencies as well as from the many scientific organizations which conduct research in the area. Within the scientific community, many began to develop concerns that differing sampling protocols and techniques for analysis would cause scientific results to differ among contributing agencies. Scientists and policy makers recognized the need for consistency and formed the PMC in order to encourage collaboration, monitor current research projects, and make recommendations for the future.

The Committee developed a Strategic Science Plan including the "Central Questions" which must be addressed for the better understanding of Florida Bay and the surrounding ecosystem. Based upon these questions, committee members prioritized the pending research projects to ensure that critical research needs were funded. In addition, the Strategic Science Plan established Scientific Advisory Boards to examine agency implementation plans for possible duplicated efforts, identify and address gaps in the information base, and ensure that the most effective scientific techniques and strategies are used.

The Scientific Oversight Panel, created for the purpose of peer review, is composed of a group of scientists who are not involved in the Florida Bay Project to both provide technical input and recommend possible shifts in the research emphasis. Members of the Oversight Panel as well as representatives from all the contributing agencies, committees, and investigator teams are invited to attend the Florida Bay Conference each year to share the results of ongoing research projects. In order to maintain communication throughout the scientific community, the proceedings of this meeting, as well as a report by the Scientific Oversight Panel and by each of the individual Research Teams, are published annually

6.0 INTERNSHIP CONCLUSION:

For me and for my personal career goals, this internship was very applicable and quite beneficial. The Marine Affairs curriculum at the Rosenstiel School of Marine and Atmospheric Science provides a very well rounded background in policy and management issues and, while one is encouraged as a student to explore classes outside of the department, one might find that their overall background in other areas is rather limited. Hands-on experience in any discipline would be invaluable regardless of my future goals, however, I felt that I needed to pursue a laboratory-based internship in order to complete my education. The combination of both lab and field experience with an environmental policy and management educational background proved to be a very useful.

In order to become an environmental manager or consultant, one must have a working knowledge of both the legislation and programs intended to protect the ecosystems as well as the scientific processes which drive them. Within working groups, advisory panels, and conservation boards, scientific issues will be discussed at length, so it was important to me to have had the chance to work in the field and gain a better understanding of some of the most pressing problems. Also, the field work which I conducted within the Florida Keys National Marine Sanctuary allowed me to make contacts with many in the field who share my interests and who continue to be a very good sources of advice and information. This internship was very labor intensive, but I would recommend a similar project to future students who wish to pursue a career within the management or university setting.

References

Chiapppone, M. 1996. Oceanography and Shallow water Processes of the Florida Keys and Florida Bay: Site Characterization for the--314314 Florida Keys National Marine Sanctuary and Environments. Vol. 2. The Nature Conservancy

Cortes, J.N., Risk, M.J., 1985. A reef under siltation stress: Cahuita, Costa Rica. Bulletin of Marine Science 36: 339-356

Crosby, M., 1997. South Florida Ecosystem Success Indicator-11: Improvement of Coral Reef Conditions. National Oceanic and Atmospheric Administration. p. 2.

Crossland, C.J., 1988. Latitudinal comparisons of coral reef structure and function. Proceedings of the 6' International Coral Reef Symposium. Townsville, Australia. Pp. 221-226.

Davis, S.M., 1991. Sawgrass and cattail nutrient flux: Leaf turnover, decomposition, and nutrient flux of sawgrass and cattail in the Everglades. Aquatic Botany 40: 203224.

Florida Statutes 380.005 (2) (d) 1993. Florida Keys Area; protection and designation as an area of critical state concern.

Florida Statutes 381.0065 1995. Onsite Sewage Treatment and disposal systems

Fourqurean, J.W., Jones, R.D., Zieman, J.C., 1993. Processes influencing water column nutrient characteristics and phosphorus limitation of phytoplankton biomass in Bay, Fl, USA: Inferences from spatial distributions. Estuarine, Coastal and Shelf Science 36: 295-314

Ginsburg, R.N., Shinn, E.A., 1993. Preferential distribution of reefs in the Florida reef tract: the past is the key to the present. Global Aspects of Coral Reefs: Health, Hazards, and History. University of Miami Press. pp. H21-H26.

Jones R.D., Amador J.A., 1992. Removal of total phosphorus and phosphate by peat soils in the Florida Everglades. Canadian Journal of Fisheries and Aquatic Sciences 49: 577-583

Lapointe, B.E., Clark, M.W., 1992. Nutrient inputs from the watershed and coastal eutrophication in the Florida Keys. Estuaries 15 (4): 465-476

McPherson, B.F., Halley, R., 1996. The South Florida Environment- A Region under stress. U.S. Geological Survey Circular 1134. United States Government Printing Office.

National Oceanic and Atmospheric Administration, 1995. Florida Keys National Marine Sanctuary Draft Management Plan/ Environmental Impact Statement.

National Oceanic and Atmospheric Administration, 1996. Florida Keys National Marine Sanctuary Final Management Plan/ Environmental Impact Statement.

Parsons, T.R., Takahashi, M., Hargrave, B., 1984. Biological Oceanographic Processes. Pergamon, NY. USA.

Pastorok, R.A., Bilyard, G.R., 1985. Effects of sewage pollution on coral reef communities. Marine Ecology Progress Series 21: 175-189

Porter, J.W., Meier O.W., 1992. Quantification of loss and change in Florida reef coral populations. American Zoology 32: 625-640.

Redfield, A.C., Ketchum, B.H., Richards, F.A., 1963. The influence of organisms on the composition of seawater. In "The Sea" vol. 2, pp.26-27. Ed. M.N. Hill, Interscience p. 554.

Rogers, C.S., 1990. Responses of coral reefs and organisms to sedimentation. Marine Ecology Progress Series 62: 185-202.

Senate Bill sb2434. 1995. An Act relating to the regulation of onsite sewage treatment and disposal systems.

Shinn, E.A., Lidz, B.H., Kindinger, J.L., Hudson, J.H., Halley, R.B., 1989. Reefs of Florida and the Dry Tortugas: A guide to the modern carbonate environment of the Florida Keys and the Dry Tortugas. USGS, St. Petersburg, FL.

Shinn, E.A., Reese, R.S., Reich, C.D. 1994. Fate and pathways of injection well effluent in the Florida Keys. U.S. Geological Survey Open File Report 94-276, p. 121

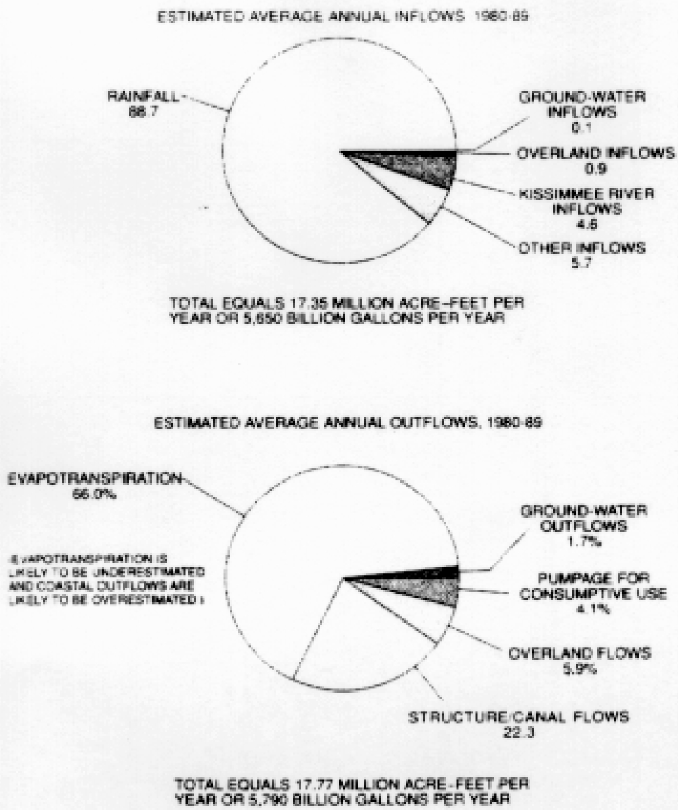
Shinn, E.A., Reich, C.D., Hickey, D.T., Bohlke, J.K., Plummer, L.N., Coplen, T.B., Busenbeberg, E., Chanton, J., Burnett, W., Dillon, K., Corbett, R., 1996. Assessing the Origin and Fate of Groundwater in the Florida Keys, Florida Bay Science Conference, Program and Abstracts.

Szmant, A.M. 1991 Inshore-offshore patterns of nutrient and chlorophyll concentration along the Florida Reef Tract. Pages 42-63 in SEAKEYS Phase I. Sustained Ecological Research Related to the Management of the Florida Keys Seascape. Florida Institute of Oceanography, St. Petersburg, Florida.

Szmant, A.M., Forrester, A. 1996. Water column and sediment nitrogen and phosphorus distribution patterns in the Florida Keys, USA. Coral Reefs 15: 21-41

U.S. Army Corp of Engineers, 1998. Central and Southern Florida Ecosystem Restoration Critical Project Letter Report.

U.S. Environmental Protection Agency, 1993. Water Quality Protection Plan for the Florida Keys National Marine Sanctuary Program. Prepared by Batelle Ocean Sciences. Duxbury, MA.



The average annual budget summary for the modeled area shows that rainfall dominates inflow and that evapotranspiration dominates outflow (*fig. 1*). Rainfall directly accounts for 89 percent of the total inflow, and river and stream inflows indirectly account for another 11 percent. Ground water contributes less than 1 percent of the total inflow, and evapotranspiration accounts for 66 percent of the total outflow. Canal discharge to tidewater is the next largest outflow (22 percent). Overland flow, which is primarily to the Shark River and Taylor Sloughs, and pumpage for consumptive use contribute about 6 and 4 percent, respectively, to the average total outflow.

A summary of the water budget shows a negative change in storage, which indicates more

***Figure 1. Comparison of estimated average annual inflows and outflows (as percentages) for the modeled region in south Florida.* (South Florida Water Management District, 1993.)**

Preliminary estimates of natural water budget, in 1,000 acre-feet, for the lower east coast area, south Florida, 1980-89

[area, 5,814 square miles. From South Florida Water Management District, 1993]

Component	Average annual (Jan.–Dec.)	Wet season (June–Oct.)	Dry season (Nov.–May)	1980–81 (June–May)	1988–89 (June–May)
Rainfall	15,398	9,336	6,050	12,237	13,694
Evapotranspiration	11,729	5,668	6,024	11,359	11,285
Net groundwater outflow	298	150	151	274	289
Structure/tributary outflow	1,794	904	934	473	1,113
Structure/canal outflow	3,956	1,953	2,032	2,857	3,015
Wellfield pumpage	723	301	424	663	847
Net overland outflow	905	583	326	753	1,212
Changes in storage	–338	+1,632	–1,937	–3,526	–1,971

Source: McPherson and Halley, 1996.

Index of Restoration Projects (sorted subregionally)

Figure 2.

	Project ID No.	PPM	Lead Organization	Start	End	Financial Requirement	Appropriated to Date
Florida Keys							
Complete Land Acquisition for Biscayne National Park	FK02	Frost	NPS	1998	2000	6,100,000	0
Complete Crocodile Lake National Wildlife Refuge	FK03	Steiglitz	USFWS	1998	2000	786,000	400,000
Complete Florida Keys Ecosystem CARL Project	FK05	Outland	FDEP	1992	END	36,793,484	27,174,425
Complete Key Deer National Wildlife Refuge	FK06	Steiglitz	USFWS	1997	2001	14,000,000	0
Complete North Key Largo Hammocks State Botanical Site	FK07	Outland	USFWS	1983	END	73,733,875	71,000,034
Florida Keys Carrying Capacity Study	FK14	Pattison	DCA	1998	2001	6,000,000	500,000
Florida Keys Nutrient Feasibility Study	FK15	Teague	DOH	1996	1998	1,060,000	1,060,000
Florida Keys Stormwater Master Plan	FK16	Garrett	Monroe	1997	2001	2,000,000	100,000
Florida Keys Sanitary Wastewater Master Plan	FK17	Garrett	DCA	1997	1999	2,200,146	1,624,970
Florida Keys National Marine Sanctuary Water Quality Protection Program	FK18	McManus	EPA	1995	1999	5,800,000	3,475,200
Marathon Community Wastewater Treatment Plant	FK19	Garrett	Monroe	2000	2004	70,000,000	314,000
Florida Keys Cesspit Identification and Ilimination Program – Administrative	FK21	Teague	FDEP	1997	END	1,000,000	1,000,000
Florida Keys Tidal Creek Restoration Project	FK28	Hebling	FDEP	1998	2000	1,224,000	250,000
Florida Keys Cesspit Identification and Elimination Program - Financial Assistance to Citizens	FK29	Braun	Monroe	1997	2007	2,200,000	1,200,000
Florida Keys Channel Marking Master Plan (Monroe County)	FK30	Garrett	Monroe	1997	2002	620,000	70,000
Florida Keys Invasive Exotic Plant Control Stratergy	FK31	Steiglitz	USFWS	1998	2000	4,190,000	0
Florida Keys Multi-Species Habitat Conservation Plan	FK32	Symroski	FDCA	1999	2000	250,000	0
Florida Keys NMS: Level I Monitoring of Ecosystem Structure and Function	FK33	Haskell	NOAA	1997	2002	1,100,000	200,000
Florida Keys NMS: Level II Sentinel Fisheries Program	FK34	Haskell	NOAA	1997	2002	128,000	18,000

Florida Keys NMS: Level II Monitoring for Lobster/Conch	FK35	Haskell	NOAA	1997	2002	195,000	30,000
Florida Keys NMS: Level II Rapid Assessment	FK36	Haskell	NOAA	1997	2002	200,000	40,000
Florida Keys NMS: Level II Human Activities Assessment	FK37	Haskell	NOAA	1997	2002	1,050,000	50,000
Florida Keys NMS: Level II Monitoring of Sea Grass	FK38	Haskell	NOAA	1997	2002	60,000	20,000
Florida Keys NMS: Level III Volunteer Benthic Monitoring	FK39	Haskell	NOAA	1997	2002	100,000	20,000
Florida Keys NMS: Level III Rapid Response	FK40	Haskell	NOAA	1997	2002	300,000	20,000
Florida Keys NMS: Level III Fish Survey	FK41	Haskell	NOAA	1997	2002	64,000	12,000
Team Ocean	FK42	Tagliarini	NOAA	1997	2001	680,000	40,000
Coral Reef Classroom	FK43	Kelly	NOAA	1997	2001	110,320	20,515
Subtotal for Florida Keys:						**231,944,825**	**108,639,144**
Grand Total all Subregions:						**5,267,184,278**	**1,611,688,336**

Source: http://www.sfrestore.org/documents/ifp98/fk.htm

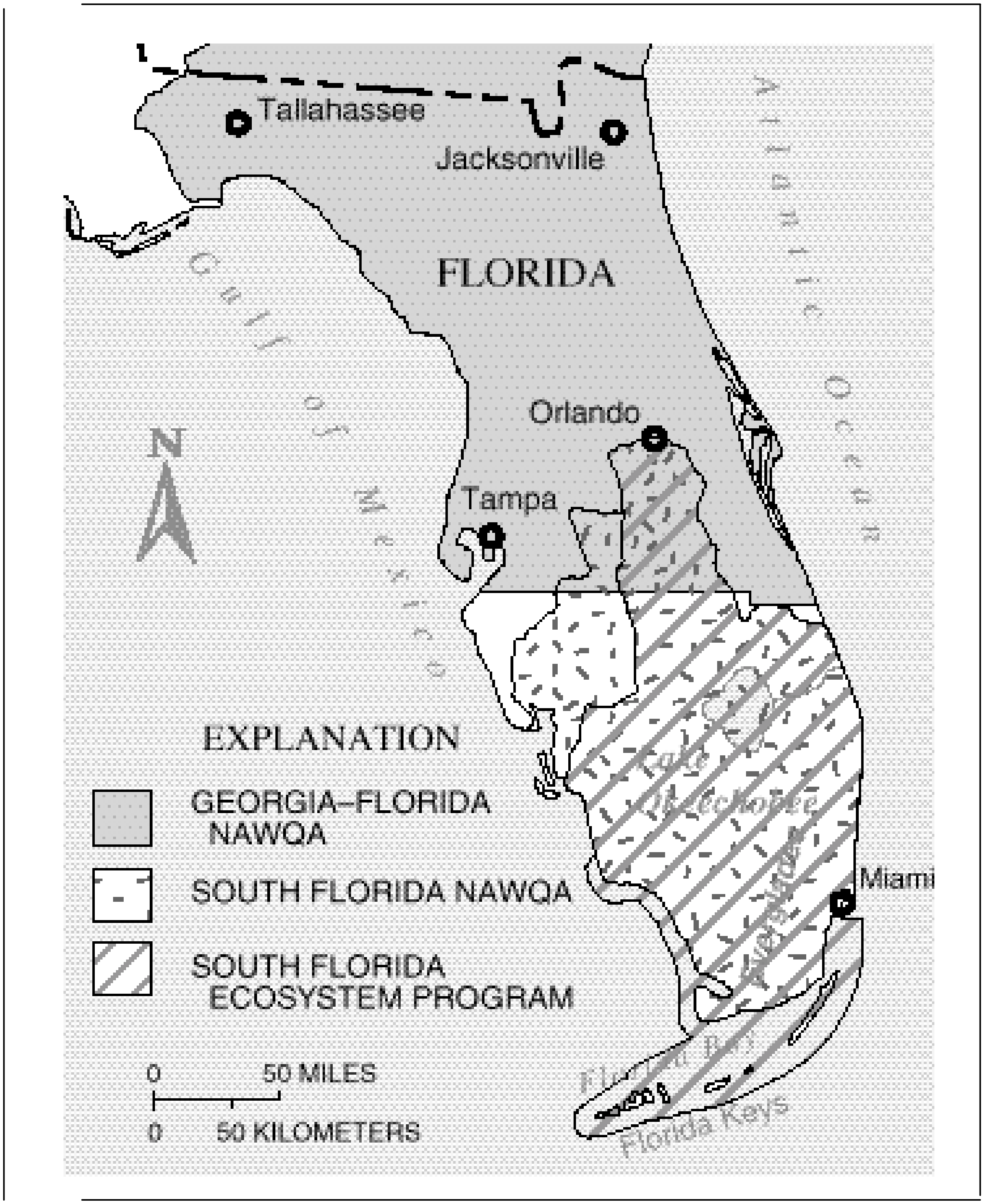


Figure 3: Study Areas of the Southern Florida National Water Quality Assessments (NAWQA) and the South Florida Ecosystem

Source: http:/water.usgs.gov/public/pubs/FS/FS-009096/

Table 24. *Summary of Water Quality Strategies*

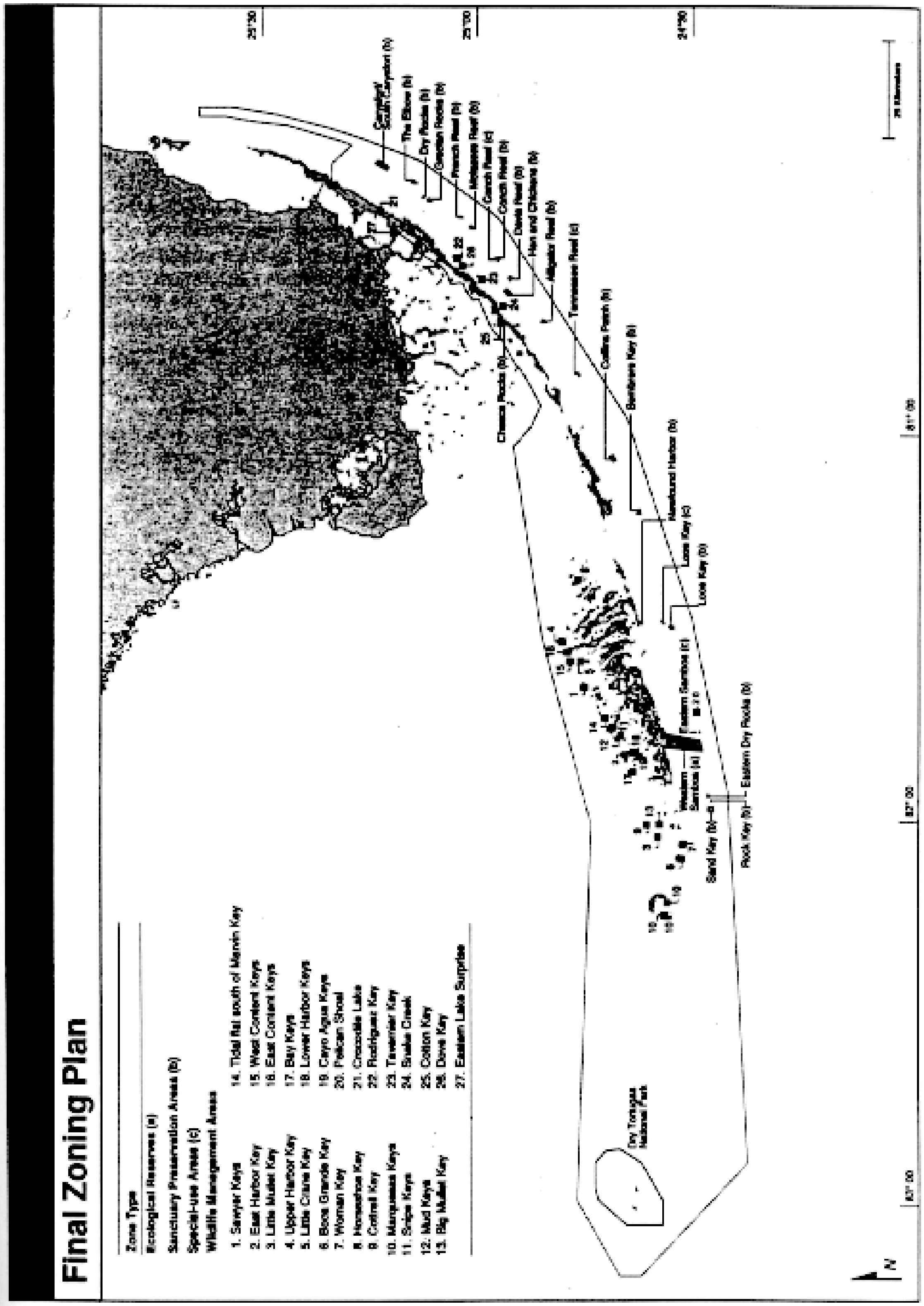
Page	Strategies	Overall Sanctuary Priority Level*	Planned Level of Action in Year 1 (FY 94) ++	Months to Complete	Funding for Full Implementation	Number of Activities to be Undertaken	Number of Institutions
210 Florida Bay/External Influence							
210 W.19	Florida Bay Freshwater Flow	High	Medium	36+	100%	2	10
212 W.24	Florida Bay Influence	High	High	48	<50%	3	5
212 Domestic Wastewater							
213 W.1	OSDS Demonstration Project	High	High	36	100%	2	5
214 W.2	AWT Demonstration Project	Medium	Low	36	<50%	2	4
214 W.3	Wastewater Management Systems	High	High	36	<50%	4	8
216 W.4	Wastewater Disposal, City of Key West	High	Low	48	<50%	2	6
217 W.5	Water Quality Standards	Medium	None	60+	<50%	2	4
217 W.6	NPDES Program Delegation	*	--	24	100%	1	2
217 W.7	Resource Monitoring of Surface Discharges	Low	Low	36	100%	1	2
218 W.8	OSDS Permitting	Low	None	36	100%	3	3
219 W.9	Laboratory Facilities	Low	None	36	<50%	2	3
220 Stormwater							
220 W.11	Stormwater Retrofitting	Medium	Low	60+	<50%	2	4
220 W.12	Stormwater Permitting	*	--	0	100%	1	5
221 W.13	Stormwater Management	Medium	Medium	24	100%	2	7
222 W.14	Best Management Practices	Medium	Low	36	<50%	1	8
222 Marinas and Live-Aboards							
223 B.7	Pollution Discharges	Medium	Medium	48	<50%	5	5
224 Z.5	Special-use Areas	Medium	Low	12+	<50%	3	5
225 L.1	Marina Pump-Out	High	Low	60	<50%	3	8
225 L.6	Mobile Pump-Out	Medium	None	36	<50%	1	2
226 L.2	Marina Sitings and Design	Low	None	36	100%	1	3
226 L.3	Marina Operations	Medium	None	36	<50%	3	5
227 E.4	Training/Workshops/School Programs	Medium	Medium	24	<50%	1	2
228 Landfill							
228 L.7	SWD Problem Sites	Medium	None	60+	<50%	3	3
229 Hazardous Material							
229 W.15	HAZMAT Response	Medium	Low	36	<50%	3	5
230 W.16	Spill Reporting	Low	Low	24	<50%	2	3
231 L.10	HAZMAT Handling	Medium	None	36	?	1	4
231 Mosquito Spraying							
231 W.17	Mosquito Spraying	High	High	12	75-99%	4	2
232 W.18	Pesticide Research	High	None	36+	<50%	3	3
233 Canals							
233 W.10	Canal WQ	High	Low	60	<50%	8	5
235 Research and Monitoring							
236 W.20	Monitoring	High	High	60+	<50%	4	2
237 W.21	Predictive Models	High	Low	12+	<50%	2	4
237 W.22	Special Studies: Wastewater Pollutants	High	Low	36	<50%	1	4
238 W.23	Special Studies: Other Pollutants and WQ Problems	Medium	None	36	75-99%	4	6
238 W.28	Regional Database	High	High	12	100%	3	3
239 W.29	Dissemination of Findings	Medium	Low	60+	<50%	4	3
240 W.32	Technical Advisory Committee	*	--	0	100%	1	3
240 W.33	Ecological Monitoring Program	High	Refer to Research and Monitoring Action Plan				

* Strategies with an "*" for Overall Sanctuary Priority Level are already existing programs and/or will be completed in the first year of sanctuary operation.

++ Began October 1, 1993

Figure 5.

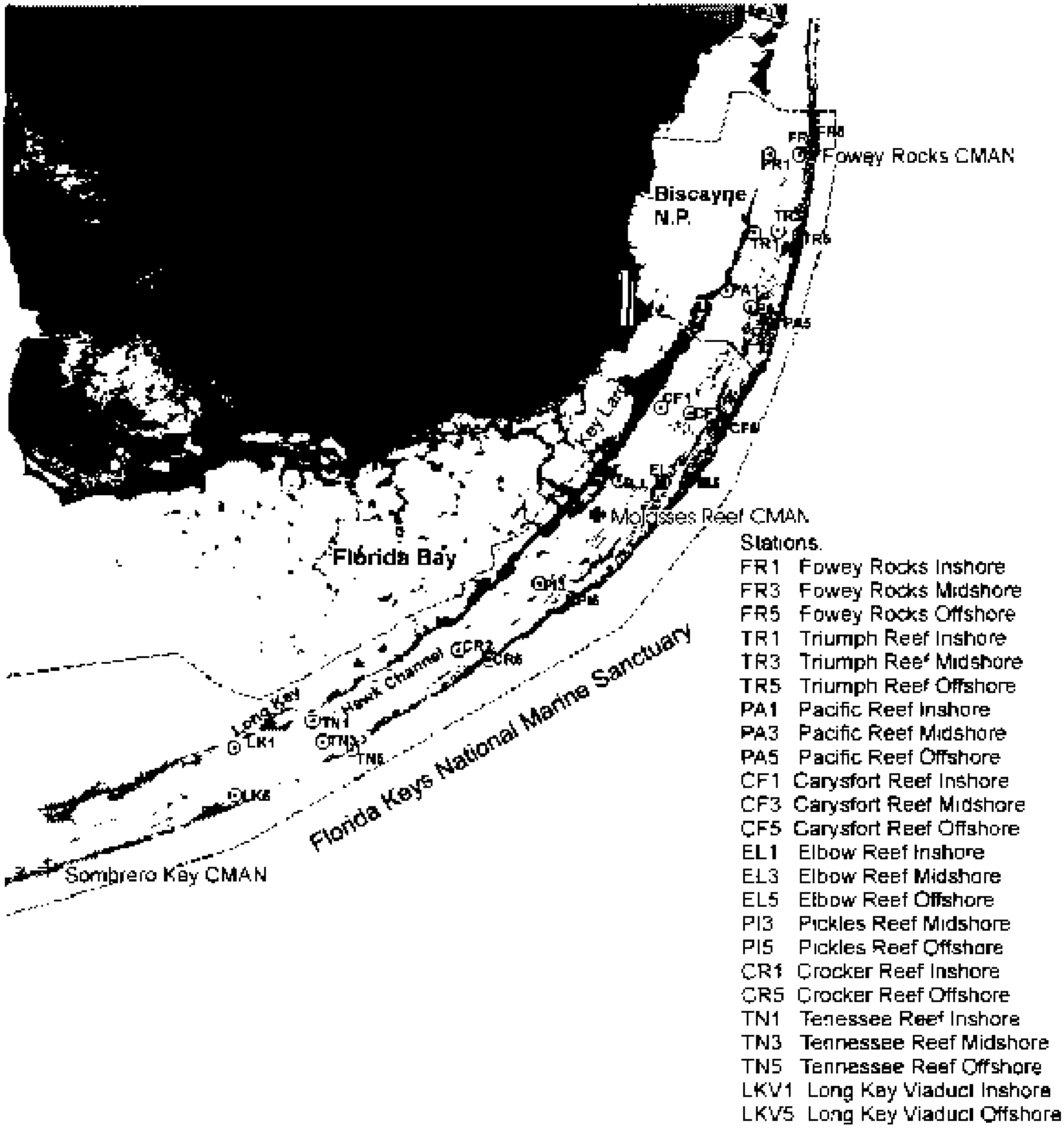
Action Plans: Zoning



Source: Florida Keys National Marine Sanctuary Management Plan, 1996. p. 268

35

Fig. 6. Map of the Florida Keys with the locations of turbidity and sedimentation monitoring stations, and the CMAN wind stations



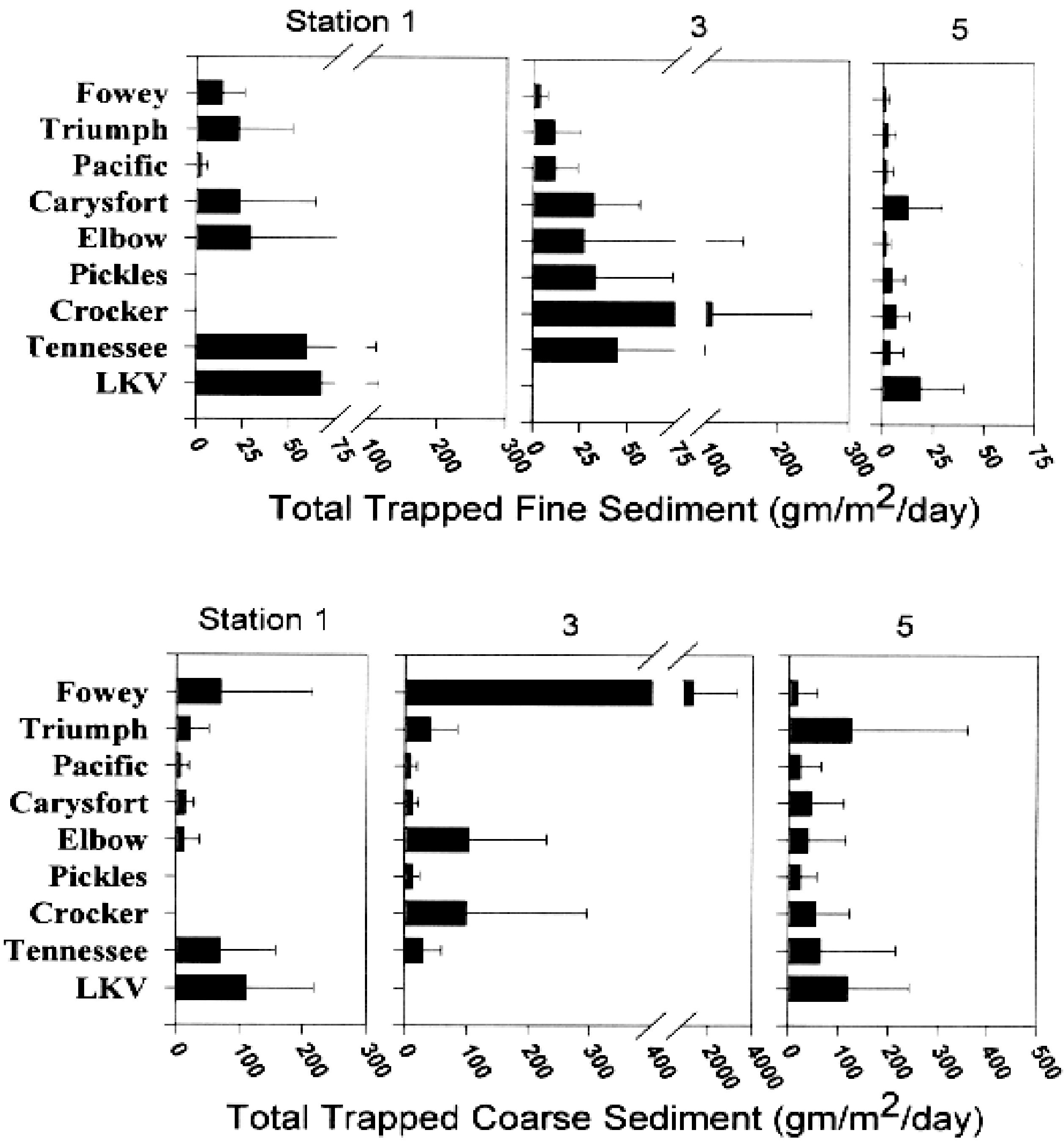


Figure 7. Average Rates of both fine and Coarse Sediment Particle Deposition within the Florida Keys National Marine Sanctuary from November 1996- December 1997.

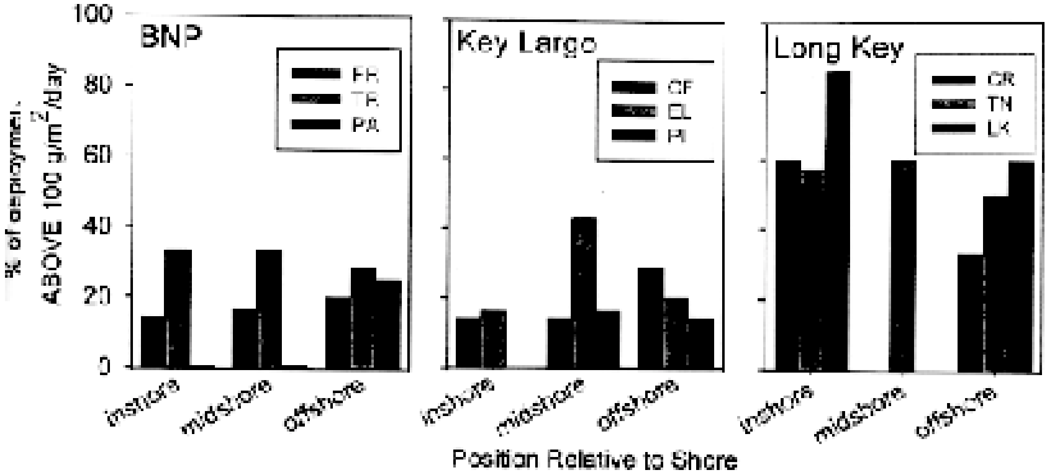


Figure 8. Percent of deployment periods in which Total Deposition (Coarse + Fine) Rates exceeded 100 g/m^2/day at each of 9 transects.

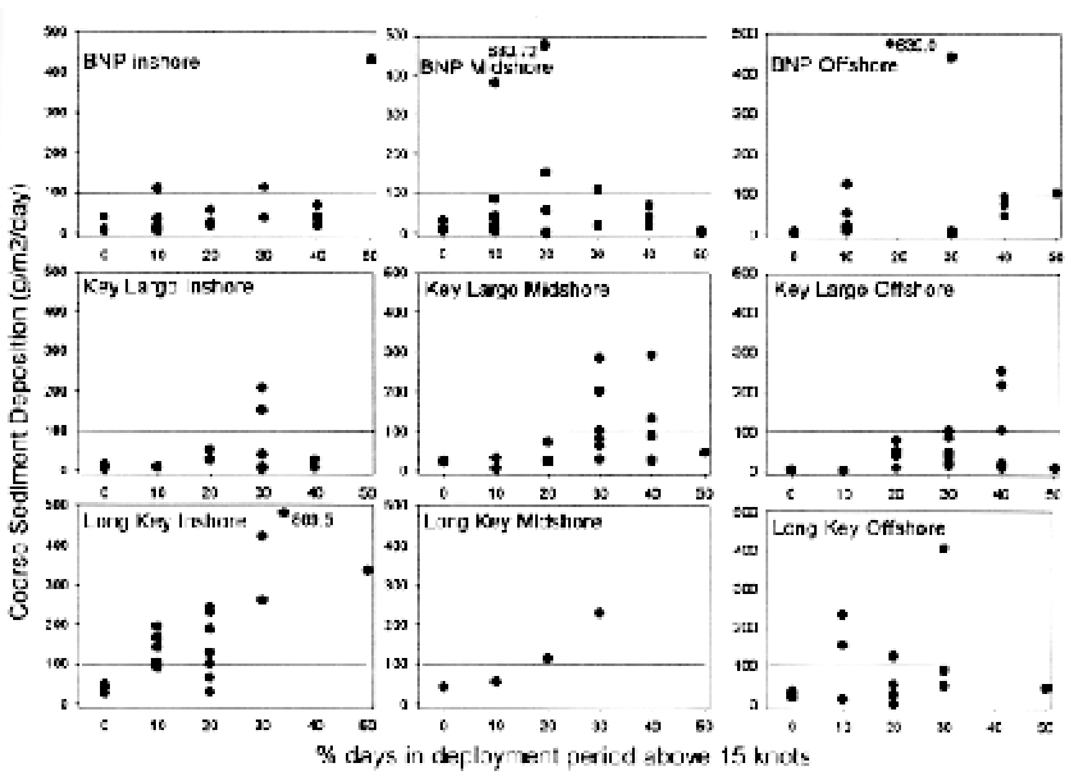


Figure 9. Total Sediment Deposition Rates for each sampling station within Biscayne National Park, Key Largo, and the Long Key area with the corresponding percent of days during the deployment in which the average wind speed exceeded 15 knots.

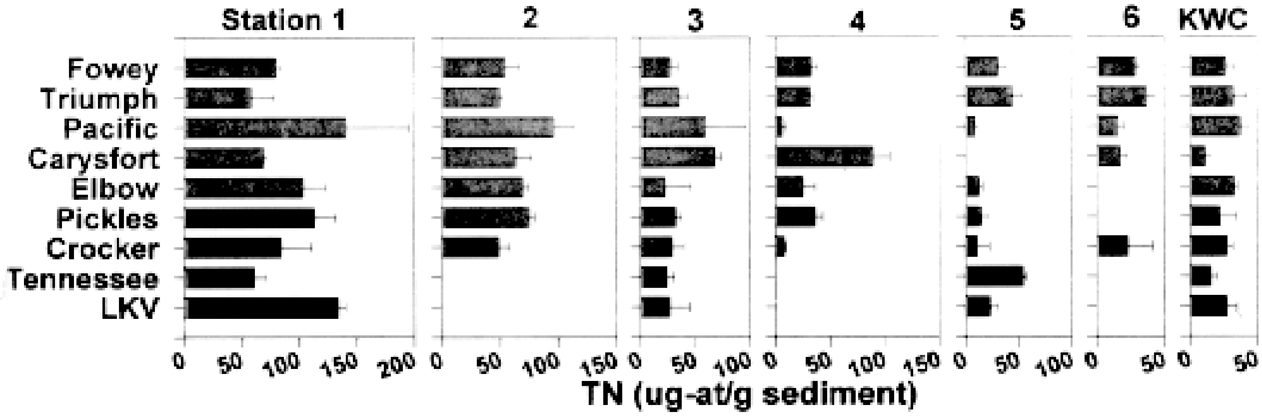


Figure 10. Total nitrogen content of sediment grab samples from March 1996. Samples were taken in an Inshore (Station 1) to offshore (Station 6) pattern, with one additional offshore station sampled during a Keys-Wide cruise (KWC).

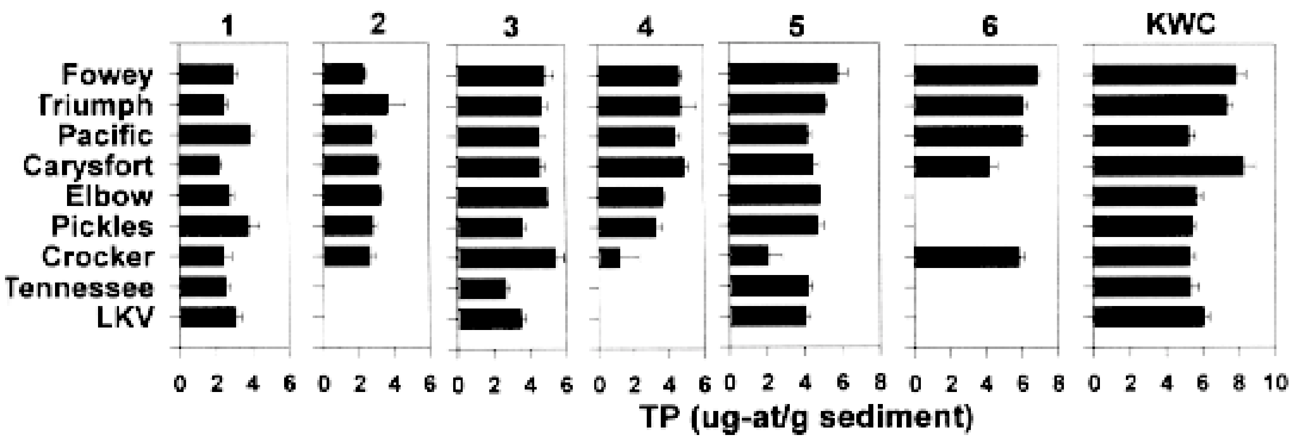


Figure 11. Total phosphorus content of sediment grab samples from March 1996. Samples were taken in an Inshore (Station 1) to offshore (Station 6) pattern, with one additional offshore station sampled during a Keys-Wide cruise (KWC).

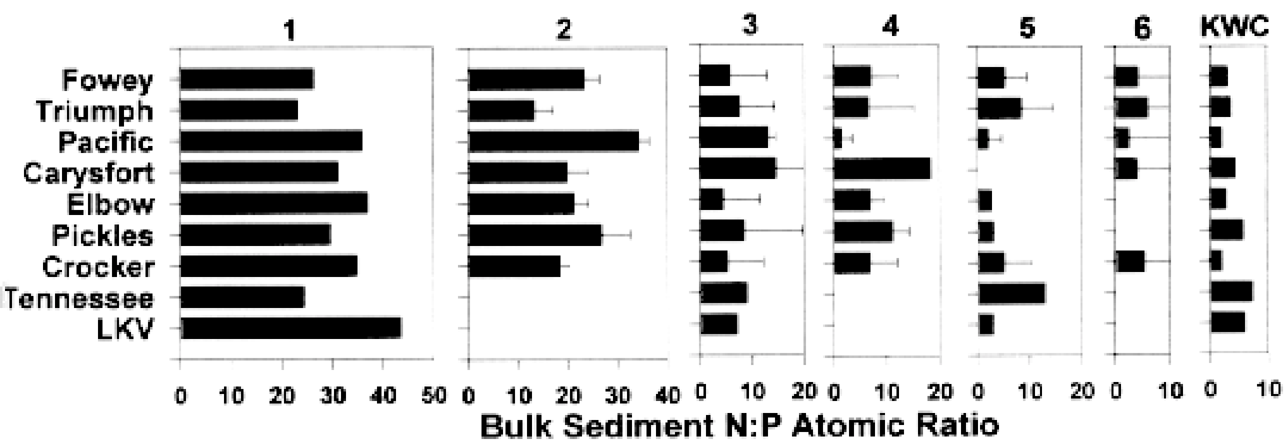


Figure 12. Atomic N:P ratio of sediment grab samples from March 1996. Samples were taken in an Inshore (Station 1) to offshore (Station 6) pattern, with one additional offshore station sampled during a Keys-Wide cruise (KWC).

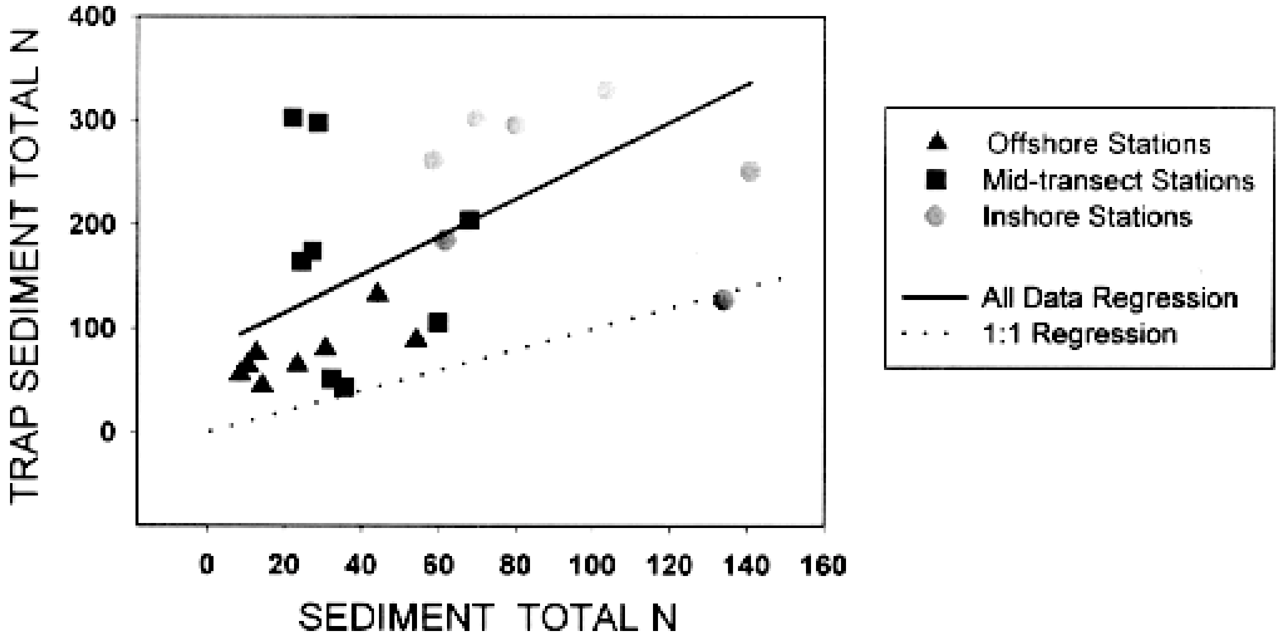


Figure 13. Comparison of the total nitrogen composition of sediment trap contents with the total nitrogen composition of grab samples taken from the surrounding sediments.

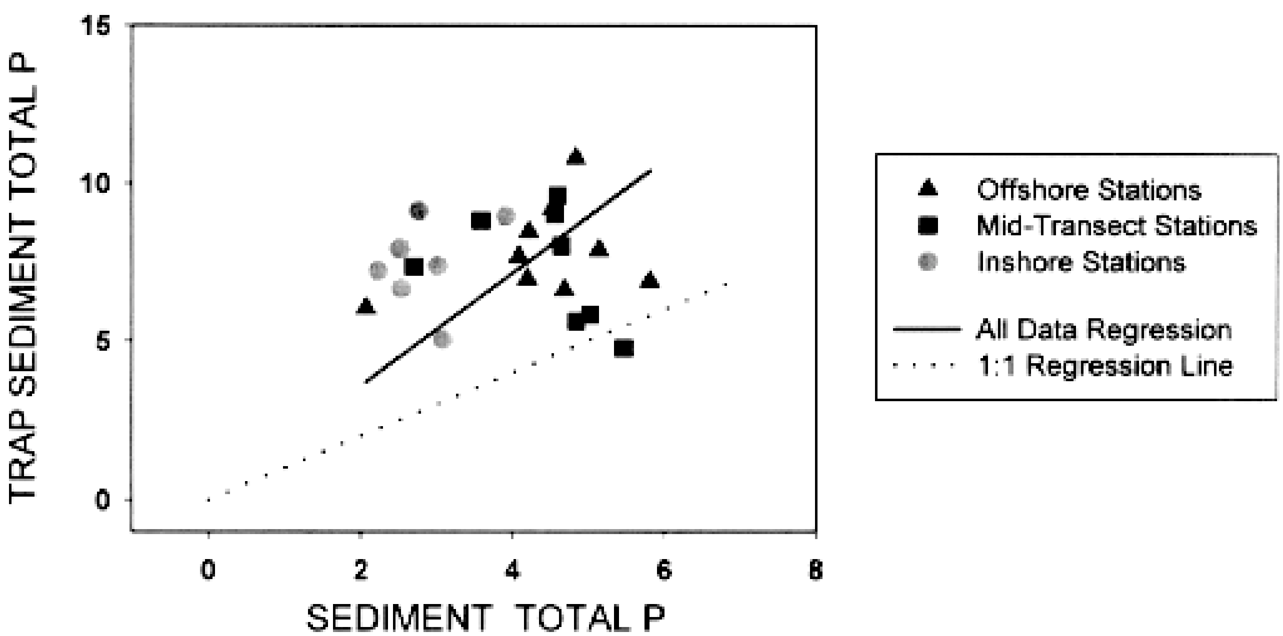


Figure 14. Comparison of the total phosphorus composition of sediment trap contents with the total phosphorus composition of grab samples taken from the surrounding sediments.

House Bill hb2391

Appendix 1. Summary of House Bill 2391

Corresponding Bill Information and History

103-142-3-5 HB 2391

A bill to be entitled

An act relating to the regulation of onsite sewage treatment and disposal systems; amending s. 381.0065, F.S.; defining the term "potable water line"; amending standards for the placement of onsite sewage treatment and disposal systems; providing for system compliance with specified rules; providing standards for design criteria and for performance criteria; providing for local public health units to approve or disapprove systems and to refer disapprovals to the Department of Health and Rehabilitative Services for a further determination; providing deadlines for such reviews; providing for written notification to the applicant of the department's determination and for the applicant's opportunity to pursue a variance or seek review; deleting provisions concerning a research review and advisory committee; providing a standard for sizing drainfields; amending s. 381.0068, F.S.; redesignating the technical review panel as the technical review and advisory panel; providing duties of the panel; providing for panel membership, terms, meetings, and reimbursement; requiring the department to present proposed rules to the panel for comment; requiring the department to keep minutes of panel meetings; providing an effective date.

Source: http://www.house.state.fl.us/session/1995/house/bills/BILLInfo/Html/h2391.html