

# Results Of A Workshop On Coral Reef Research And Management In The Florida Keys: A Blueprint For Action

James W. Miller  
Editor

September 1988





# **Results Of A Workshop On Coral Reef Research And Management In The Florida Keys: A Blueprint For Action**

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#### ACKNOWLEDGEMENTS

The Florida Keys Coral Reef Workshop was held at the facilities of the Marine Resources Development Foundation, Key Largo, Florida. Funding was provided through a grant from the National Undersea Research Program of the National Oceanic and Atmospheric Administration.

The host of the Workshop was Mr. Ian G. Koblick, President, Marine Resources Development Foundation. The chairman of the Workshop was Dr. James W. Miller, Florida Institute of Oceanography.

The Workshop sponsors, host, and chairman are most appreciative of the time, effort, and expertise provided by each of the participants. Hopefully, the results of our collective efforts will help preserve the Florida Keys as a national treasure for future generations.



## PREFACE

The National Undersea Research Program (NURP) of the National Oceanic and Atmospheric Administration supports in situ investigations in the oceans and large lakes of the world. By placing investigators safely undersea to conduct manipulative experiments not possible within the limitations of traditional laboratory and ship-based research, the NURP researchers will develop knowledge about processes in biological, chemical, and physical systems in the oceans and large lakes and across the boundaries of their basins in order to provide a sound basis for decisions governing uses of the ocean and its resources.

Program activities are supported with a wide array of advanced undersea sampling and sensing platforms including manned submersibles, remotely operated vehicles, and saturation habitats.

Occasionally, NURP sponsors symposia and workshops to disseminate results of past investigations and to possibly guide future research activities. In June 1988, NURP sponsored a workshop to address the anthropogenic perturbations affecting coral reefs adjacent to the Florida Keys and to develop recommendations for addressing these effects. The workshop was supported through grant NA88AA-D-UR063 with the Marine Resources Development Foundation. A report, prepared and submitted under the terms of that grant, which covers workshop presentations, discussions, and recommendations is herein presented in its entirety, as part of the NURP Research Report series.

The Research Report series published by the NURP is intended to provide the marine community with the results of program-sponsored symposia and workshops in a timely fashion. Reports in this series do not necessarily reflect NURP policy. Comments on the report are welcome and may be addressed to:

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National Undersea Research Program  
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Rockville, Maryland 20852

## EDITOR'S FOREWORD

The Florida Keys Coral Reef Research and Management Workshop was held at the facilities of the Marine Resources Development Foundation (MRDF), Key Largo, Florida. Funding was provided through a grant to the MRDF from the Office of Undersea Research of the National Oceanic and Atmospheric Administration. Chairman of the Workshop was Dr. James W. Miller, Florida Institute of Oceanography.

Workshop sponsors, host, and chairman are most appreciative of the time, effort, and expertise provided by each of the participants. Hopefully, the results of our collective efforts will serve as a tool to help preserve the Florida Keys as a national treasure for future generations.

Information and recommendations contained in this report represent the knowledge and experience of over 50 experts in various fields of environmental science, education, and technology. The goal of the Workshop was to apply this expertise towards the development of a long term program plan to aid in the recovery and preservation of the Florida Reef Tract and surrounding waters.

This report includes basic background information on coral reef ecology, summaries of the presentations and discussions, and recommendations for definitive programs. Selected appendices are included to indicate the current widespread interest of the public in the future of the Florida coral reefs and the fact that the recommendations of the Workshop are consistent with those of other concerned groups and experts.

Short and long term solutions to the critical problems affecting the survival of the Florida Reef Tract, of necessity, involve scientific, socioeconomic, and political issues. Accordingly, effective implementation of recommendations contained in this report will require the cooperation of all concerned.

## EXECUTIVE SUMMARY

There has been a growing scientific and public concern over the past few years, about the deteriorating health of the Florida Reef Tract and the potential environmental and economic consequences of this deterioration. In response to this concern, the Florida Keys Coral Reef Research and Management Workshop was held in June 1988. Over 50 experts on coral reefs and their management were gathered at the site of the Marine Resources Development Foundation, Key Largo, Florida.

Objectives of the Workshop were to: (1) identify problems and potential solutions in the areas of management, education, assessment and monitoring, and research; (2) develop a short and long term research and management strategy; and (3) set priorities and develop a plan of implementation.

The Workshop opened with a series of lectures addressing problems relating to human and natural impacts on the Florida Reef Tract. These lectures were followed by presentations discussing the research, management, and educational requirements to overcome or ameliorate the problems identified by the earlier speakers. Participants then were divided into four working groups (management, education, assessment and monitoring, and research) each of which was tasked to identify and rank specific problem areas and to recommend a plan of action addressing those areas.

Recommendations and conclusions are described in detail in this report. General conclusions and recommendations were:

1. Excessive amounts of nutrients invading the Florida Reef Tract from the Keys and from Florida Bay are a serious and widespread problem.
2. At least four permanently instrumented monitoring stations should be established to identify the specific causes and sources of the nutrients along the reef tract ranging from Key Largo to the Dry Tortugas.
3. Standardized, reliable, unsophisticated, and proven data collection methods and instrumentation should be used for obtaining data.
4. A concerted management and public education program should begin immediately to advise residents and visitors to the Keys of the seriousness of the problems and what they can do to help.
5. Existing data centers should be used to assure ready storage and access of information.
6. Continuity of funding is critical for a successful program. A specific amount of money spent over a long time is more important than the same amount spent once.



Did we? 7. A Steering Committee should be formed to provide leadership for the implementation of the recommended program.

Did we? The clear consensus of the Workshop participants was that the Florida Reef Tract is being impacted adversely by both direct and indirect human activities. Experience in other parts of the world has shown that, with a concerted effort, the current degenerative trend should be reversible. It is critical, however, that action be taken immediately to initiate the necessary short and long term management, education, and research programs.

## INTRODUCTION

200 miles

8 to 15 mi

Southeast of the Florida Peninsula, where the Keys begin their extension into the Gulf of Mexico, lies the only living coral reef system in the continental United States. This unique national treasure is the 354-km long Florida Reef Tract which runs from Soldier Key to the Dry Tortugas. It encompasses a mosaic of coral reefs that provide a wide spectrum of vocational and recreational activities. Included in this spectacular reef tract are bank reefs, patch reefs, and a diverse pattern of hardgrounds stretching at a distance of about 13 to 26km offshore (see Figure 1).

def?

Coral reefs are ecologically and economically important tropical marine ecosystems. They serve as a highly complex and diverse habitat for commercially valuable species such as lobster, grouper, snapper, and a host of other sport and commercial fish. In addition, they play a significant role in the tourist industry of southeast Florida and are responsible for bringing in millions of dollars each year.

While the formation of coral reefs is due to the presence of scleractinian corals (from which they obtain their name), the bulk of the biomass actually is algae. Thus, a more descriptive term might be biotic reefs instead of coral reefs. In fact, however, the healthier the reef, the less prevalent is the algal biomass.

The species of scleractinian coral most responsible for reef formation on the Florida Reef Tract are Montastrea annularis, M. cavernosa, Acropora palmata, A. cervicornis, Diploria spp., Siderastrea siderea and Colpophyllia spp. (Jaap 1984). Many of these species have been affected by recent episodes of coral bleaching that extended throughout the Caribbean region, as well as by outbreaks of white band and black band disease. In addition, genera such as Acropora and Montastrea have been stressed or killed by cold water outflow from Florida Bay that results from extreme winter cold fronts that descend into Florida several times per decade.

The accessibility, spectacular coral formations, and the associated complex marine community make the Florida Reef Tract attractive to over one million SCUBA divers, snorkelers, fishermen, and boaters each year. The impact of these activities can induce both short and long term stress on this fragile reef community in addition to the stress caused by dredge and fill, channelization, land development, and water pollution. Significant damage to the reefs could have a severe adverse impact on the economy of the Florida Keys which are heavily dependent upon tourism for survival.

Two areas of this reef system have been designated as National Marine Sanctuaries. The first, designated in 1975, is located 4.8km seaward of Key Largo and encompasses 259 square km of the coral reef tract and surrounding ecosystems. The



second, designated in 1981, is located at Looe Key about 8km south of Big Pine Key and encompasses about 14.2 square km.

Because of the importance of preserving these reefs as national treasures, while simultaneously making them available to the public, it is essential that a research and management plan be developed and implemented at the earliest possible time. NOAA's National Marine Sanctuary Program already has initiated significant steps in this direction. Highly competent management personnel are located at both Sanctuaries and selected studies have been carried out or are underway. As the stress on the reefs increases, however, management practices need to be reviewed and research priorities reassessed.

#### A. Objectives of the Workshop

1. To assemble a group of experts on coral reefs and their management for the purpose of developing a short and long term research and management strategy for coral reef communities.
2. To identify problems and potential solutions in the areas of (1) management, (2) education, (3) assessment and monitoring, and (4) research.
3. To develop a plan of implementation including priorities for each of four areas cited above.

#### B. Format

The workshop began with a series of 30-minute talks by 11 invited speakers. The first six presentations were designed to identify existing problems caused by direct or indirect human impact on the reef tract. The five presentations which followed addressed needs and potential solutions to the problems identified.

The 52 participants then were divided into four subgroups, each with a designated group leader:

1. Management  
Lt. Michael M. White  
Manager, Key Largo National Marine Sanctuary
2. Education  
Mr. Billy Causey  
Manager, Looe Key National Marine Sanctuary
3. Assessment and Monitoring  
Dr. James W. Porter  
University of Georgia



#### 4. Research

Dr. John C. Ogden

Director, Florida Institute of Oceanography

*Exc  
proceeding!*

The four subgroups were tasked to identify and rank specific projects and goals in response to the problems and needs cited in the preceding presentations and discussions. Each group leader then presented the results of the subgroup discussions to all participants along with overall recommended rankings of projects. Following a general discussion, a final listing of recommendations was agreed upon. A program agenda is contained in Appendix I.

#### I. HUMAN IMPACT ON REEFS

##### A. Direct Impact

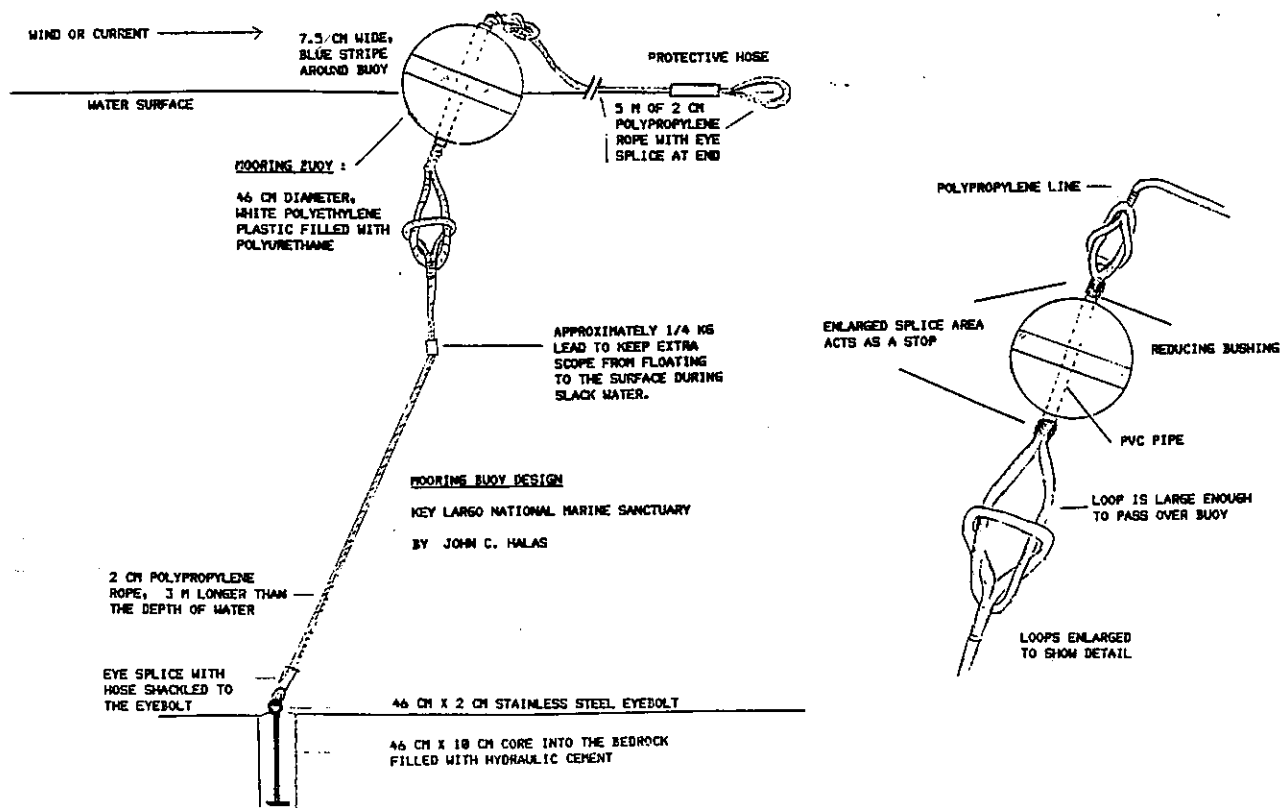
The first two speakers described the direct impact of boat groundings, small boats, diving, and fishing on the reef tract. Because of the heavy visitation load, a significant amount of damage continues to be inflicted upon the reef. Several studies have been conducted to document the type and extent of damage including Dustan and Halas (1987) and Jaap (1984).

Common causes identified are boat groundings and anchoring which can produce extensive physical fragmentation of reef colonies. Dustan and Halas (1984) reported 22 vessel groundings within the Key Largo Marine Sanctuary during the two-year period August 1983 to August 1985. In the Looe Key Sanctuary, 17 boat groundings have been recorded since 1976 with the majority of these being reported since Sanctuary designation in 1981. A particularly disastrous grounding occurred in 1984 when the 121m M/V Wellwood ran aground and damaged a large area of Molasses Reef. Additional damage was incurred by the rescuing tugs and towing cables. A total of 7.5 hectares of reef were impacted as a result of the grounding and the subsequent salvage operation. Studies have been underway since to monitor the recovery of the reef and to help replant where possible.

Anchoring in reef areas has been a chronic problem for years and is responsible for extensive damage to corals. Since 1981, special mooring buoys have been installed in the Key Largo and later in the Looe Key National Marine Sanctuaries (see Figure 2). The use of these buoys avoids the necessity of using anchors. To date, 120 mooring buoys have been installed in the Key Largo Sanctuary and 52 at Looe Key. A special reef conservation group called "Reef Relief" has initiated a mooring buoy project on reefs in the Key West area. Their first project involved emplacement of a total of 60 buoys at five reef locations.

Other sources of physical damage to the reefs include: the emplacement and recovery of lobster traps; the capturing of lobsters by sport divers; damage to corals by careless sport divers who may grab onto them for support; and hook and line fishing which can result in monofilament line snagging and

Figure 2 Mooring Buoy Assembly



Mooring Buoy Design  
Key Largo National Marine Sanctuary  
By John C. Halas



scarring reef surfaces.

*Note:* Efforts to repair damaged reefs continue to be made such as righting fallen corals, cementing them back into place, as well as removing fishing line and other debris. These labor-intensive activities are limited, however, to small areas of heavily visited trails and reefs.

#### B. Indirect Impact

*Halas* It is well documented that coral reef communities in many parts of the world are becoming endangered by waste products and nutrients (nitrates and phosphates) resulting from human activity (Kuhlman 1988). The Florida Reef Tract is no exception. Recent evidence clearly shows that the reefs in the Keys are neither as healthy nor productive as in the past (Dustan and Halas 1987). This decline can be attributed to waste sources such as: (1) polluted roadway runoff of stormwater, (2) eutrophication, (3) sewage and agrichemicals, (4) toxins and anti-fouling paints. The combined effects of these pollutants are damaging the coral reefs and carbonate platforms in the Keys as they have elsewhere (Smith et al., 1981). It should be noted that besides man-related eutrophication, there are natural sources such as accumulation of seagrasses on shorelines, etc. that also contribute to the problem.

The destruction wrought by excessive nitrates and phosphates takes several forms (Hallock and Schlager 1986). They stimulate growth of plankton which reduces water transparency which in turn limits the depths at which zooxanthellate corals and calcareous algae can grow, thus reducing carbonate production. Nutrients also can stimulate the growth of certain algae and animals that cause erosion of the reef structure. For example, studies in Hawaii showed that the "bubble alga" Dictyosphaeria bloomed and overgrew the coral reefs in Kaneohe Bay due to nutrient enrichment from a sewage outfall (Laws and Redalje 1979). A more recent study in Bermuda concluded that there is enhanced growth and increased biomass of the green alga Cladophora prolifera (Chlorophyta, Cladophorales) as a result of cumulative seepage of nitrogen-rich groundwaters coupled with efficient utilization and recycling of dissolved organo-phosphorus compounds (Lapointe and O'Connell 1988). Studies also suggest that the addition of high levels of phosphates to seawater may inhibit the calcification of corals and other calcareous marine organisms (Simkiss 1964, Kinsey and Domm 1974). There is further evidence that increased nutrients may stimulate overfeeding stress and increase predation on both coral larvae and adults. It is clear, thus, that while boat groundings, anchoring, diver abuse, and fishing are serious threats to the reefs, an additional major threat is the high nutrient content of runoff from coastal areas.

In a recent study conducted for NOAA, the Florida Department of Environmental Regulation, and Monroe County, the effects of on-site sewage disposal systems on groundwater and surface water quality were assessed (Lapointe and O'Connell 1988). The study



demonstrated that the use of septic tanks and shallow injection wells in the porous geology of the Keys is accelerating eutrophication of surface waters. The mean concentration of ammonium and nitrate were 350-fold higher in developed vs. pristine groundwaters, while phosphate was some 60-fold higher. Maximum rates of contaminated groundwater discharge to surface waters occurs during the summer, when elevated tides and groundwater recharge enhances groundwater seepage. The resulting higher nutrient concentrations of surface waters in summer were significantly correlated with increased chlorophyll concentration (i.e. phytoplankton), suggesting that ever-increasing groundwater contamination is enhancing eutrophication and "greening" of the Keys nearshore waters.

While there is proof that eutrophication leads to an increase in algal biomass and the eventual damage and even destruction of coral reefs, the effects are reversible. In Kaneohe Bay, Hawaii, over 99% of the corals within an area of 880 hectares were destroyed by sedimentation from shoreline erosion and municipal sewage over a period of years. The sediment impact ended with the completion of the development phase around the Bay. Following the removal of the sewage site discharge, the corals are recovering (Kuhlman 1988).

## II. NATURAL IMPACTS ON REEFS

### A. Oceanographic/Meteorological

The most severe natural impact on coral reef communities is caused by hurricanes (Jaap 1984). This impact takes on many forms. In addition to physical damage caused by wind and waves, the accompanying torrential rains can reduce salinity to dangerous levels and the churning of bottom sediments can cause severe turbidity and sediment abrasion. Although each of these factors, individually or in combination, can result in the destruction of some corals, displacement of others, and the dislocation of fish and sessile organisms, evidence indicates that it is possible for reefs in the Keys to recover in a few years depending upon the severity of the storm (Shinn 1975). On the other hand, Woodley et al. have indicated a very long recovery period for the Discovery Bay Reef following Hurricane Allen in 1980.

Another direct effect of hurricanes is the introduction of thermal stress. Recent evidence shows that there can be a significant cooling of sea surface temperatures following a hurricane. This is thought to be due to the cyclonic action of the wind creating currents in the sea that diverge from a focal point. This, in turn, causes large upwellings of cooler water which have been observed to reduce sea surface temperatures by as much as 2.6°C (Black, Elsberry, and Shay 1988).

Hurricanes also can add to the eutrophication process. Nutrients are added as a result of increased land runoff caused by heavy rains; the stirring up of nutrient-laden sediment; and



the nutrients contained in the cool waters introduced by upwelling.

In addition to major upwellings, hurricanes can produce internal waves which can persist for as long as 10 days following the storm. Whether coral reefs are adversely affected by "short term" temperature reductions and internal waves has yet to be determined.

## B. Biological

The after-effects of hurricanes can result in biological as well as physical changes in reef communities. These changes may be reflected in the form of alteration of predation patterns, reduction of species diversity, and significant differences in species survival. Although there is not a clear explanation at the present time, enlarged photos of damaged reef areas show that certain animals such as the snail, Coralophyllia, will eat non-favored corals when discovering that its normal food source is destroyed.

Seasonal changes in water temperature exceeding normal ranges can damage coral reef communities. For example, in the winter of 1976-77, 96% of the shallow-water coral reefs in the Dry Tortugas surveyed died due to the intrusion of 14°C water onto the reef (Porter, Battey, and Smith 1982). This temperature was significantly below the normal annual range of 18° - 30°C. Such a severe reef-kill also affects nearby reefs and alters the amount of space available to surviving organisms which can affect the resulting species diversity. Drastic wide-spread reduction in coastal water temperatures, such as experienced in the Dry Tortugas, are caused by the incursion of polar air masses.

int!  
The rate and extent of reef recovery following damage or destruction depends on many factors including whether an entire colony or only a selected species was killed. In any event, the building of a reef is a slow process. For example, in the Dry Tortugas, studies have shown that the rate of growth (carbonate deposition) during the period ranging from 11,000 - 2,000,000 years ago was 1.91 to 4.47m per 1000 years (Shinn et al., 1977).

A recent study revealed a disturbing loss of both the number of coral species as well as the percent of living cover of coral species in underwater photoquadrats within the boundaries of Looe Key and Key Largo National Marine Sanctuaries. The study, which relied on repeated photographs taken annually from 1984 to 1987, encompassed an area of 18m<sup>2</sup> at Looe Key and 36m<sup>2</sup> at Key Largo (Porter and White n.d.) The investigators determined that since 1984, shallow water sites (3 - 4m) at both Looe Key and Key Largo have been losing coral cover at the rate of 4% per year within the study areas. This statement can be made with 95% confidence as a result of the large amount of data that was acquired with repeated photographs. Branching coral species in the genus Acropora suffered the most damage. Curiously, the skeletons of



the dead corals remained in view, demonstrating that the cause of death was not mechanical destruction by storms or anchors even though two hurricanes passed through the Florida Straits during the study period.

It should be pointed out that these rates were measured before the coral bleaching event seen in the Florida Keys between 1987 and 1988. While projections of the die-off rates beyond 1988 are risky, the data at hand are suggestive of an ecosystem under stress. The numbers also suggest that more data are needed soon to see if the rate of loss of coral cover is continuing and what the cause might be.

CORAL  
Bleach  
Need

Regardless of whether the die-off is natural or man-induced, the management issues raised by the loss of such an important member of the ecosystem is clearly great.

### III. MANAGEMENT AND EDUCATION NEEDS

#### A. Enforceable Management

The dilemma of managing a coral reef resource as accessible as that in the Florida Keys was aptly summed up in Jaap (1984). "The wisdom of Solomon would be put to the test to devise a management plan for these resources that would satisfy all the users and management and enforcement agencies. Decisions will have to be made that do not satisfy some users. The criteria that should be used in judging any particular decision should be: (1) does it significantly impact the resource and/or (2) will it cause undue economic hardship on a large segment of the population. It is literally impossible not to cause some impact and some economic hardship. Overall, the goal should be prudent stewardship of the coral reef resources."

EXL  
words  
goal  
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mgt  
plan

The management staff at the two Keys Sanctuaries, thus, must tread the fine line between protecting the resource and serving the public. This is a difficult task at best given the limited personnel and budget, and the impact of 1 - 1½ million visitors in the parks each year.

Management methods must be consistent with existing rules and regulations and be carried out with diplomacy. They presently include: dissemination of information to the public; use of patrol boats; mooring buoys; boundary markers; issuance of citations (both on the surface and underwater); holding open seminars and other educational programs; and conducting survey, research, and monitoring programs. Although the management practices used are for the designated Sanctuaries, most of them apply to reef areas outside the Sanctuaries as well, particularly the dissemination of information to the public.

Research, education, survey, and monitoring programs play a key role in any management strategy. Existing rules and regulations can be changed or new rules issued only on the basis of proper documentation. Thus the research needs and management



\* needs are intimately related.

## B. Education and Volunteerism

*Exc. mention*  
As with any nationally recognized attraction, the coral reefs of the Florida Keys are the subject of two kinds of educational efforts. One kind is designed to attract visitors to the area and the other is to identify their responsibilities once they arrive. In recent years, efforts have been greatly increased with respect to educating the public about preserving the beauty and integrity of the Keys. These efforts have taken many forms both in the private and public sector. For example, environmental organizations, national magazines, television, and radio all have publicized the need to preserve the Florida Keys.

*Appendix II*  
Significant efforts are being made by the National Marine Sanctuaries to inform the public about the Keys and how to care for them. The growth and breadth of the interpretive programs at the Looe Key National Marine Sanctuary over the past six years is shown in Appendix II. The multifaceted approach described is designed to reach all levels of the public. Similar efforts are underway at the Key Largo National Marine Sanctuary.

Existing education and volunteer programs in the Sanctuaries as well as local programs outside the Sanctuaries should be expanded, capitalizing on the knowledge and experience of Sanctuary personnel. For example, there needs to be wider distribution of brochures, additional on-site aids to navigation, more work with local civic groups, and expansion of the volunteer program. While the Sanctuary programs actively use volunteers, the Sanctuaries represent only a small part of the Florida Reef Tract. Volunteers are needed urgently to help in non-Sanctuary areas. Supervised volunteers can collect data on environmental health and water quality, conduct fish counts, set up mooring buoys and navigational aids, as well as perform many other useful tasks. Existing diving clubs can be enlisted to regularly monitor specific reef areas and/or selected marine organisms. Such programs have been successful in many other fields including volunteer weather watchers, bird counters, and fish taggers. There is a very active group of volunteers assisting the staff of the National Key Deer Wildlife Refuge. Volunteer and special student programs also have been conducted by the Newfound Harbor Marine Institute on Big Pine Key.

## IV. ASSESSMENT and MONITORING

### A. Measurement Techniques

There is a wide spectrum of measurement techniques available for collecting data on shallow-water reefs such as those of the Florida Reef Tract. The techniques range from simple diver fish counts and casual observation to sophisticated and expensive subsurface, surface, aircraft, and satellite-based instrumentation. Any one of several strategies could be adopted for implementing, a coral reef assessment and monitoring program.



One approach could be: (1) an intensive study of well-known sites which includes underwater mapping; (2) correlation with low-level aerial photography; and (3) calibration with satellite imagery for broad surveys over large regions. There are ongoing studies as well as information in the scientific literature that provide a solid basis for beginning such a program.

Six satellite reconnaissance photos recently obtained from the French satellite "Spot" using a multi-spectral imaging system are now available which depict the Florida Reef Tract from Key Largo to Key West. These photos were obtained by the Issac Walton League with the aid of a grant from the Elizabeth Ordway Dunn Foundation (Estrin 1988). To be useful, however, these photos must be supplemented by ground truth data obtained by on-site observation methods.

Such data can be obtained by the use of various types of oceanographic instrumentation including: moored or bottom-mounted current meters; salinometers; bathythermographs; and anemometers. Battery technology has advanced to a level where such instruments theoretically can run unattended for months at a time. Other techniques include: the use of expendable buoys, coring devices operated either from a ship or by a diver; underwater television cameras; and the many data collection methods used by divers. Because the selection of an instrument or data collection technique is determined by programmatic needs, the manager or researcher must interact with instrumentation specialists, manufacturers, divers, and other operational personnel when planning the program. Only in this way can effective use be made of the wide range of available methods. It is equally important that scientists actively participate in the design of such instruments, at least on an advisory level. Perhaps in this way, the chronic problem of over-sophistication for its own sake, and lack of reliability can be minimized. A "crude" instrument that works is far more desirable than a state-of-the-art system with low reliability. int

## B. Research Needs

Although specific actions can be and are being taken to minimize the direct effects of human impact on the reef community, such as boating, diving, and fishing, the more serious and long term effects are caused by improper or irresponsible land use. The problems stem not only from activities on adjacent shorelines but also from upland areas where excessive nutrients and other pollutants originate. As a consequence, researchers need to keep the "big picture" in mind when addressing the long term problems of coral reefs. Land use

The importance of addressing the overall problems becomes even clearer when considering the fact that coral reefs buffer the impact of the ocean on the coastal zone, creating lagoons and protected waters that favor the growth of seagrasses and mangroves. Mangrove forests and seagrass beds buffer coral reefs from contact with land, and promote reef growth offshore by Adv  
Coral  
Reef



trapping sediments, removing excessive nutrients, and interrupting freshwater discharge, thus stabilizing the salinity of the coastal zone. Coral reefs must be studied within the complex mosaic of coastal ecosystems of which they are a part (Ogden, in press).

The importance of studying coral reef communities as part of the tropical coastal zone has been apparent for years. This awareness has stimulated the cooperation of laboratories in many parts of the world. There are more than 17 marine laboratories in the Caribbean region, many of which have a long tradition of sharing research results. Individually, their small size limits their ability to carry out large research projects independently; but spread over the Caribbean as they are, together they can take on the sort of regional research necessary for crucial resource management issues.

*AIMLC*  
*3.11.82 →*  
*CARICOMP*  
*7*  
*B.11.82*

The Association of Island Marine Laboratories of the Caribbean (AIMLC), with 24 member laboratories including Florida and Bermuda, was founded in 1957, and hosts a meeting at a member laboratory nearly every year. At several workshop meetings of Caribbean marine scientists, held at the West Indies Laboratory in St. Croix and the Discovery Bay Marine Laboratory in Jamaica in 1982 and 1985, under the sponsorship of the National Science Foundation (NSF) and UNESCO, a program of sustained ecological research, involving a cooperating network of Caribbean marine laboratories was designed. The program, called Caribbean Coastal Marine Productivity (CARICOMP), will establish research sites; map the distribution of coral reefs, seagrasses, and mangroves; and collect monitoring data using standardized methods and techniques. For example, one of the most simple yet fundamental measures that integrates the environment and organisms is temperature. Yet, as the recent coral bleaching episode demonstrated, we know nothing about temperature of the Caribbean at the coastal zone scale critical for coral reefs (Ogden and Wicklund 1988). Other critical physical, chemical, and ecological data will be incorporated into a data base from sites surrounding the Caribbean. As the data base develops, it will prove to be essential for specialized research projects. Research of a unique regional character, directed at an understanding of the factors controlling coastal ecosystems structure and function, will be the result (Ogden 1987).

#### V. RECOMMENDATIONS BY SUBTOPICS

Each of the four designated subgroups met and identified specific topics in their respective areas based on the information contained in the invited presentations and the experience of those in the subgroup. These topics subsequently were ranked by the members of the subgroup in their order of importance with respect to the potential development and implementation of a program plan. Each topic also is marked as to whether it can be considered a short or long term goal.



A. Management

Recommendations for improving management practices and procedures were divided into five categories. In order of priority these categories are as follows:

\* 1. Visitor Management

- Did you?
- a) Publish a comprehensive users' guide to the Florida Keys. (short term)
  - b) Develop a better system for distributing information to the public. (short term)
  - c) Develop a computer-based visitor survey documentation system including: number of visitors; types of activities; private and public access points; and commercial services. (short term)
  - d) Develop an overall visitor management plan for waters in the Florida Reef Tract. (long term)
  - e) Determine the potential of using core areas (e.g., Looe Key) or other forms of multi-use area zonation. (long term)

2. Interagency Coordination

- Did you?
- Are you?
- Did you start?
- a) Improve enforcement, regulations, procedures, and coordination. (short term)
  - b) Increase manpower and lobbying support. (short term)
  - c) Coordinate enforcement with other regulatory agencies. (short term)
  - d) Improve system of sharing information among agencies. (short term)
  - e) Develop simplified and consistent regulations. (long term)
  - f) Develop an overall management plan for the entire reef tract. (long term)
  - g) Establish a Coral Reef Commission similar to the fisheries management councils to lay groundwork for management and enforcement of all Florida Keys Waters: should be comprised of federal, state, and local agencies. (long term)

3. Data Acquisition and Retrieval

- Did you?
- a) Translate scientific and technical data into a format useable by management personnel. (short term)



- b) Conduct a literature search and compile a management data base. (short term)
- c) Develop a reference retrieval system. (short term)

#### 4. Monitoring for Management

- a) Compile a list of scientific and technical management needs in a format such that the scientific community can develop experiments and programs designed to satisfy these needs in such areas as: eutrophication, visitation, resource use, weather, and enforcement. (long term)
- b) Develop coral reef environmental monitoring studies for:
- |                   |               |
|-------------------|---------------|
| nutrient flux     | conch         |
| coral health      | algae         |
| fishes            | disease       |
| weather           | water quality |
| key invertebrates |               |
- (long term)

#### 5. Boat Groundings

- a) Install additional daymarkers and larger signs for navigational aids. (short term)
- b) Assess the needs and merits of recreational boat operators' licenses. (short term)
- c) Reduce boat groundings through improved boater education programs. (short term)
- d) Reduce boat groundings through increased enforcement. (short term)
- e) Return revenue from boat groundings and other fines to reef management programs. (long term)

### B. Education

Based on issues and concerns presented by coral reef researchers, biologists, and managers, the education subgroup identified and prioritized topics that must be addressed by various educational means to better protect and manage the reef resources. Those concerns and brief suggested solutions are as follows:

#### 1. Land-use/Eutrophication

- a) Develop pamphlets and literature for the public that explain the problems, their source and the means of correcting the situation (see Appendix III) e.g.,



fish parts in canals, detergents, fertilizers, poor septic systems. (short term)

- b) Solicit the aid of researchers to identify and quantify natural contributing sources of nutrients e.g., decaying seagrasses. (short term)
- c) Develop reference list of information available for distribution. (short term)
- d) Increase awareness of problems related to eutrophication through education at primary education levels (K - 12) e.g., teaching packets, lesson plans. (long term)

## 2. Physical Impact on Coral Reefs

- a) Diver Impact - touching, handling and standing on coral, fish feeding, diver conflicts, etc. Potential solutions to some of these problems are:
  - o Prepare a five minute fast-moving video of commercial quality, that solicits cooperation of the public. (short term)
  - o Prepare and implement an instructor/diver training course that teaches coral reef ecology and diving etiquette to instructors. (long term)
  - o Conduct the research necessary to answer the question "Does touching coral really kill it?" (long term)

int

### b) Boat Groundings

Recreational and commercial boat groundings have caused extensive reef damage over the years. In addition to navigational markers, there are several other steps that can be taken:

#### (1) Large vessels

- o Publish information for the public on vessel groundings, including the findings of the research completed at the site of the M/V Wellwood grounding on Molasses Reef. (short term)
- o Supply literature to vessel pilot associations addressing boat groundings and the fines imposed for groundings within the Sanctuaries. (short term)
- o Complete follow-up research on known grounding sites. (long term)



## (2) Recreational Craft

- o Prepare a video specifically addressing boating in reef areas and seagrass flats e.g., how to "read" the waters, the legal consequences of running aground in a Sanctuary, and how the loss of reefs affects everyone. (short term)
- o Pursue licensing of all recreational boaters. (long term)

## (3) Media Coverage (short term)

With the cooperation of the news media and other government agencies, the problem of boat groundings can be brought home to the public. Examples of such efforts are:

- o public service announcements
- o Inclusion of a brochure with issuance of boat licenses.
- o U.S. Coast Guard Auxiliary training
- o Installation of low frequency radio beacons located at heavily impacted reefs that transmit signals and messages warning of the presence of reefs and shoals in the area.
- o Channel 13 VHS - Broadcast by USCG

## 3. Visitation Levels and Over-Use

- a) Develop volunteer programs to obtain information on visitor use. (short term)
- int* b) Establish criteria, through research, for recognizing early signs of over-use of the reefs. (long term)
- int* c) Study the feasibility and practicality of using various visitor dispersion techniques such as: removal of mooring buoys; closure of areas; placement of buoys in low-use areas or areas not familiar to the public. (long term)
- d) Establish user fees. (long term)

## 4. Alteration and Disruption of Sea Floor

- a) Identify and quantify the sources and extent of damage to the sea floor resulting from fishing and trapping, divers damaging coral heads, etc. (long term)



- b) Determine the effects of accumulation of debris on reef health. (Long term)

The Educational Subgroup identified the need to "sensitize" the public to the causes and consequences of human impact on the coral reefs and surrounding habitats. The use of volunteer groups to assist in collecting data, resource monitoring, removal of debris, and in educational functions was recommended. \*

The conclusions and recommendations of the Education Subgroup are consistent with those of an Educator's Workshop held in Key West on May 13, 1988. This workshop, sponsored by the Looe Key and Key Largo National Marine Sanctuaries, was attended by 18 marine educators and four members of the Sanctuaries' staff. The objective of the Key West Workshop was to assist in developing educational strategies and public materials for Sanctuary managers. The results of the workshop are summarized in the three Tables contained in Appendix IV.

C. C. Assessment and Monitoring *note!*

The Assessment and Monitoring Subgroup had the task of addressing not only topics for study, but also the instrumentation required for carrying out the investigations. *Did we do anything?*  
The five major areas recommended in order of priority are:

1. Measurement of the population dynamics of long-lived organisms.

- a) Utilization of underwater photogrammetry to assess the rates of recruitment and mortality and the health of permanently marked sites. Highest priority should be given to computer automation of the sampling program using micro-computers and underwater video technology. If possible, the monitoring should be done on a fine enough scale to include information on the population dynamics of some short-lived organisms such as algae which respond quickly to stresses currently present in the Florida Keys. (long term) *int*
- b) Use of repeated aerial surveys on a scale of 1:5,000 or 1:10,000. Resulting photographs should be digitized to facilitate the analysis of ecosystem-wide changes. The images should be stored for easy access with the National Ocean Service. (long term)
- c) To obtain temporal-scale data, geological cores should be obtained from long-lived coral species to determine changes in coral and community growth patterns. (long term)

2. Automated measurements of total phytoplankton and bacteria should be obtained to assess the amount and extent of nitrogen and phosphorous pollution. (long term)



3. Instrumented weather stations should be established that are capable of collecting data on: surface light; water temperature at depths of 0.5m and 10m; turbidity; and wave height. The Sea-Man weather station currently operating at Molasses Reef and routinely used by NOAA is an excellent off-the-shelf standard model. (long term)

4. Measurement of the biotic processes of reef productivity and calcification should be carried out using remote pairs of drogues. Data should include upstream and downstream oxygen, carbon dioxide, pH, and alkalinity. (long term)

5. Inventories of plant and animal biotic diversity should be made at several locations along the Florida Reef Tract. Four areas are recommended that represent a logical span of east-west and north-south reef gradients. (long term)

- Diversity*
- a) Fort Jefferson National Monument
  - b) Looe Key National Marine Sanctuary
  - c) Key Largo National Marine Sanctuary
  - d) Biscayne National Park

*We doing this?*

In addition to ranking specific projects, general recommendations were made by the Assessment and Monitoring Subgroup that relate to all the projects cited: i.e. (1) long term monitoring is essential and will serve both the short and long term goals of research, management, and education; (2) standardized measurement techniques and equipment must be employed; and (3) investigative methods selected must be both practical and simple rather than technically sophisticated and complicated if reliability and wide use is to be achieved.

*D.*

#### D. Research

The general conclusions and approach of the Research Subgroup were similar to those of the Assessment and Monitoring Subgroup, i.e., that long term studies at fixed locations addressing the interaction of the land mass and the sea were a prime consideration in assessing and preserving the health of the reef tract. The three major areas of study selected in order of priority were:

##### 1. Land/Sea Interaction: Florida Bay-Sea Grass-Coral Reefs (long term)

- a) Measurement of transport and nutrient loading of waters entering the Florida Reef Tract from Florida Bay at a minimum of four permanently marked sites.
- b) On a spatial scale, at four sites, do quarterly sampling using satellite imagery, aerial photos, zone studies, and studies at the species level



## 2. Coral Physiology (long term)

- a) At permanently marked sites in the reef tract, examine and record existing environmental parameters including: temperature, nutrients, light, currents, salinity, pH, and other relevant parameters.
- b) Conduct controlled experiments to determine the effects of the following parameters on coral health:

zooxanthellae density	contribution of zooxanthellae to animal respiration
respiration	biochemical composition of tissue
photosynthesis	nutrient exchange
calcification	stable isotopic composition of tissue

- c) Conduct a study of laboratory-induced bleaching to determine, among other things, the recovery and repopulation rates of zooxanthellae and the importance of zooxanthellae strains. This could include monitoring of zooxanthellae populations in certain host species to collect baseline data to aid in the detection of bleaching events.

\* The products of this approach will be: the definition of a set of "indicator parameters" that could be used to monitor natural populations; and the identification of ranges of environmental parameters that will be detrimental to coral health that should be watched for.

Bleaching

Comparison to Key Largo proposed

## 3. Coral Population Dynamics (long term)

- a) At permanently selected sites, conduct studies of long-lived organisms, including corals, using photographic and video techniques while simultaneously collecting physical/chemical data.
- b) Develop models incorporating nutrients, grazing, and physical processes.
- c) Conduct studies of reproduction and settlement mortality at selected grounding sites. The sites recommended by the Research Subgroup for conducting the studies are: Biscayne National Park, Key Largo National Marine Sanctuary, Looe Key National Marine Sanctuary and the Dry Tortugas. It also was recommended that the selected permanently marked sites be closed and limited to research use.

←



- D.d we?
- d) Develop and implement a rapid response plan to be activated in case a major natural or man-induced event occurs in the reef tract. The purpose of this plan is to assess any damage and to establish new baseline data if necessary. Steps to assist recovery may be warranted in some cases (e.g., restoring coral head orientation, cementing coral fragments, transplanting corals, etc.).

## VI. SUMMARY OF RECOMMENDATIONS

\* D.d we?

A summary of the recommendations is shown on Table 1. It is seen here that the number one recommendation of the Education, Assessment and Monitoring, and Research Subgroups is to address the effect of excessive nutrient loading in the waters "upstream" of the Florida Reef Tract. A review of the remaining recommendations of the Assessment and Monitoring and Research Subgroups shows a consistent approach for attacking the nutrient problem, i.e., to select four or five permanently marked sites along the reef tract and establish instrumented monitoring/weather stations and to initiate specific studies of the reefs and associated organisms. This approach will result in a broad picture of the health of the reefs and provide data on local events as well.

The recommendations of the Education and Management Subgroups focus on the development of public education programs, broader distribution of information about reefs, improved coordination with both private and public organizations, documentation of public use of the Sanctuaries and nearby reefs, and in telling concerned citizens specifically what they can do to help. As illustrated in Appendix VI, these recommendations are consistent with those expressed by local government, civic organizations, and concerned citizens. The logical next step is to formulate a plan of action to implement these recommendations.

## VII. PROGRAM IMPLEMENTATION

### A. Program Guidelines

Prior to implementing the recommendations contained in this report, some general guidelines need to be identified. These guidelines, as expressed by the workshop participants, are:

1. Continuity of funding is more important than the dollar amount, i.e., a specific amount of money spent over a long time is more important than the same amount spent once.
2. Standardization of methods and instrumentation that are reliable and simple are essential if data are to be meaningful and comparable both within and between sites.
3. Proper storage and ready access to both existing and new data are more important than the size of the data set accumulated. Existing data centers should be used whenever



TABLE 1

## Summary of Recommendations

Management	Education	Assessment & Monitoring	Research
1. Improve visitor documentation and develop visitor management plan	1. Public education on nutrification	1. Effects of nutrient loading on population dynamics of long-lived organisms	1. Measurement of transport and nutrient loading of the Florida Reef Tract
2. Develop plan for long range interagency coordination	2. Develop media presentations and courses on effects of physical impact on corals	2. Installation of instrumented weather stations	2. Studies of coral physiology at designated sites
3. Develop management data base and retrieval system	3. Study reef visitation and overuse	3. Automated chemical measurements of chlorophyll	3. Studies of coral population dynamics at designated sites
4. Develop lists of technical, scientific, and study needs for improved management	4. Identify and quantify sources of disruption and alteration of the seafloor	4. Measurement of biotic processes of reef productivity and calcification	4. Develop plan for response to catastrophic events
5. Reduce boat groundings		5. Develop inventories of plant and animal diversity in designated areas	



possible. Available centers include the National Oceanographic Data Center (NODC), the National Ocean Survey (NOS), the National Weather Service (NWS), and the Data Archives Division of the Library of Congress.

It also would seem advisable that an organization be selected to coordinate the overall effort to ensure close liaison with the involved federal, state, and local agencies; private industry; as well as public participants such as environmental and volunteer groups. The first step towards achieving this is to form a steering committee to develop the mechanism needed to implement the program. Although there is a significant likelihood of funding becoming available, the recommendations resulting from this workshop need to be crystallized and put within the context of formal proposals for funding to agencies and foundations.

#### VIII. CONCLUSIONS

The major conclusions of this workshop are as follows:

A. The Florida Reef Tract is in serious trouble because of a combination of events including:

1. Excessive nutrients and other waste products in the water originating from nearby land masses and Florida Bay.
2. Physical damage to the corals caused by boaters, divers, and fishermen.
3. Natural causes such as storms, thermal shock from cold water in periodic winter storms, warm water events (e.g., 1980, 1981, 1983, 1987).
4. The lack of consistent management policies, especially in areas outside of the National Marine Sanctuaries.
5. The lack of sufficient data to make effective long range management decisions.
6. Insufficient education of the public regarding coral reef problems and what they can do to help.

B. A series of definitive steps can be taken now to reduce the rate of deterioration of the Florida Reef Tract and to aid in its recovery.

1. Establish permanent monitoring sites at the following locations:
  - a) Biscayne National Park
  - b) Key Largo National Marine Sanctuary
  - c) Looe Key National Marine Sanctuary



d) Dry Tortugas

2. Initiate the following research studies, using standardized instrumentation, at each of the permanent monitoring sites:

- a) animal and plant inventories
- b) nutrient transport and loading
- c) installation of oceanographic "weather" stations
- d) satellite, aerial, and underwater photography
- e) coral physiology, population dynamics, and biotic processes

3. Initiate a series of education and management programs aimed at immediately reducing the adverse human impact on the reefs including:

- a) production of educational video tapes
- b) initiation of new volunteer programs
- c) development of diver education workshops
- d) expansion of distribution of educational materials to the public
- e) increased coordination among federal, state, and local agencies

4. Form a steering committee to initiate the implementation of the programs.

C. Program Costs

Although detailed cost figures were not calculated, it was estimated that a meaningful program could be undertaken for approximately:

Research, Assessment and Monitoring	\$600,000
Education and Management	<u>250,000</u>
Total (per year)	<u>\$850,000</u>

The need for continuity of funding was stressed rather than a single one-time amount. Only in this way, can the long term data needed for management decisions be acquired. It was felt that because of the broad interest and concern for the reef tract, funding should be sought in both the private and public sectors.



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# PROGRAM

## CORAL REEF RESEARCH AND MANAGEMENT WORKSHOP

MARINE RESOURCES DEVELOPMENT FOUNDATION  
KEY LARGO, FLORIDA

JUNE 9-12, 1988

### June 9

4:00 - 6:00 P.M.

Registration (Chickee)

6:00 - 8:00 P.M.

Informal Reception

### June 10

8:00 - 8:30 A.M.

Breakfast (Cafeteria)

8:30 - 9:00 A.M.

Welcome and Introductions  
Goals and Format of Workshop  
Slide Presentation, Alice Biays,  
Coral Reef Community Foundation

### SESSION I: HUMAN IMPACT ON REEFS

9:00 - 9:30 A.M.

A. Speakers: Mr. John Halas, Key Largo  
Natl. Marine Sanctuary  
Mr. Billy Causey - Looe Key  
Natl. Marine Sanctuary

Direct Impact - groundings, diving, anchoring,  
fishing, poaching, water skiing, visitation level

9:30 - 10:00 A.M.

B. Speaker: Dr. Brian E. Lapointe - Harbor  
Branch Research Institute

Indirect Impact - dredge and fill, nutrients, pollution,  
ship wastes, sedimentation, pesticides, phosphates,  
nitrates, change in natural features

10:00 - 10:15 A.M.

Coffee (Chickee)



## **SESSION 2: NATURAL IMPACT ON REEFS**

10:15 - 10:45 A.M.

A. Speaker: **Dr. Peter Black** - National Hurricane Center  
Biological, oceanographic meteorological

10:45 - 11:15 A.M.

B. Speaker: **Dr. James W. Porter**  
University of Georgia  
Dynamics of Benthic Organisms

## **SESSION 3: MANAGEMENT AND EDUCATION NEEDS**

11:15 - 11:45 a.m.

A. Speaker: **Lt. Michael W. White** - Mgr.  
Key Largo Natl. Marine Sanctuary

Enforceable management - mooring buoys, diving-boating-fishing regulations, level of permissible activity

11:45 - 12:15 P.M.

B. Speakers: **Dr. James W. Miller**  
Fla. Inst. Oceanography  
**Mr. John Booker**  
Newfound Harbor Marine Inst.

Education and volunteerism

12:15 - 1:30 P.M.

Lunch (Cafeteria)

## **SESSION 4: MEASUREMENT AND RESEARCH NEEDS**

1:30 - 2:00 P.M.

A. Speaker: **Dr. Richard A. Shaul**  
Continental Shelf Assoc.

Measurement techniques - instrumentation, remote sensing, divers, concentrated vs. broad area transects

2:00 - 2:30 P.M.

B. Speaker: **Dr. John C. Ogden**  
Florida Institute of Oceanography

Research needs - diseases, population dynamics, bleaching, artificial reefs

## **SESSION 5: IDENTIFICATION OF SPECIFIC PROJECTS**

2:30 - 3:00 P.M.

Delineate project categories and select four subgroups: (management, education, measurement, research)

3:00 - 3:15 P.M.

Coffee

3:15 - 5:15 P.M.

Break into subgroups, define and rank specific projects and identify required on-site equipment

6:30 - 8:30 P.M.

Dinner (Hideout)

**June 11**

## **SESSION 6: PRIORITIZATION OF PROJECTS**

8:00 - 8:30 A.M.	Breakfast (Cafeteria)
8:30 - 10:00 A.M.	Subgroup chairmen present prioritized list of projects
10:00 - 10:15 A.M.	Coffee (Chickee)
10:15 - 12:00 P.M.	Refine and rank order all recommended projects-
12:00 - 1:00 P.M.	Lunch (Cafeteria)
1:00 - 5:00 P.M.	Visit (dive/snorkel) selected reef sites Habitat visit, tour of Marine Resources Development Foundation Facility
7:00 - 9:00 P.M.	Barbeque and Press Conference (Chickee)

## **SESSION 7: FINALIZATION OF PROGRAM**

**June 12**

8:00 - 8:30 A.M.	Breakfast (Cafeteria)
8:30 - 10:00 A.M.	Finalize recommended management and research programs and identify principal investigators
10:00 - 10:15 A.M.	Coffee
10:15 - 12:00 P.M.	Derive program cost estimates
12:00 P.M.	Adjourn

NOTE: Locations are marked by (     ). If there are any changes, they will be announced.



# APPENDIX II

## CHRONOLOGICAL SEQUENCE IN THE DEVELOPMENT OF THE EDUCATIONAL/ INTERPRETATIONAL PROGRAMS AT THE LOOE KEY NATIONAL MARINE SANCTUARY

1983 Staff: Sanctuary Manager Sanctuary Ranger	1984 Staff: Sanctuary Manager Sanctuary Ranger	1985 Staff: Sanctuary Manager Sanctuary Rangers Sanctuary Secretary	1986 Staff: Sanctuary Manager Sanctuary Rangers Sanctuary Secretary	1987 Staff: Sanctuary Manager Sanctuary Rangers Sanctuary Senior Clerk Education Coordinator	1988 Staff: Sanctuary Manager Sanctuary Rangers Sanctuary Sen. Cl. Education Coordinator
INTERPRETIVE PROGRAMS	INTERPRETIVE PROGRAMS	INTERPRETIVE PROGRAMS	INTERPRETIVE PROGRAMS	INTERPRETIVE PROGRAMS	INTERPRETIVE PROGRAMS
(1) School Groups (2) Spec. Interest Gr. (3) Freq. User Groups. Seacamp/NMHI Boy Scouts Of Am. (4) Distinguished Guests	(5) Community Groups  CAMPFIRE PROGRAMS  INTERPRETIVE FIELD TRIPS	(6) Career Day (7) Civic Groups (OFF)  CAMPFIRE PROGRAMS  INTERPRETIVE FIELD TRIPS	(1)-(7)  CAMPFIRE PROGRAMS  INTERPRETIVE FIELD TRIPS	(1)-(7)  CAMPFIRE PROGRAMS  INTERPRETIVE FIELD TRIPS	(1)-(7)  CAMPFIRE PROGRAMS  INTERPRETIVE FIELD TRIPS
INTERPRETIVE MATERIAL DISTRIBUTION	INTERPRETIVE MATERIAL DISTRIBUTION	INTERPRETIVE MATERIALS DISTRIBUTION	INTERP. MATERIALS DISTRIBUTION	INTERP. MATERIALS DISTRIBUTION	INTERP. MATERIALS DISTRIBUTION
(1) Brochure Route Mthn. to Key West (2) On-site brochure distribution & interpretation boat-to-boat	Brochure Route On-site Boat-to-Boat contacts	Brochure Route On-site boat-to-boat contacts	Brochure Route On-site boat-to-boat contacts	Brochure Route - Broch. Packets to Realtors & Boat Rental Businesses On-site boat-to-boat contacts Interpretive Signage  Other Interp. Materials (1) WHF/RARE Coral Reef Educational Packets (2) A Nation of Oceans (3) Sanctuary Videos	Broch. distribution On-site boat-to-boat Interpretive signage: new dive shop on Summerland Key (wall mount)
	INTERPRETIVE MATERIALS DEVELOPMENT	INTERPRETIVE MATERIALS DEVELOPMENT	INTERPRETIVE MATERIALS DEVELOPMENT	INTERPRETIVE MATERIALS DEVELOPMENT	INTERPRETIVE MATERIALS DEVELOPMENT
	Brochures: (1) LKNMS - (brown) incl. Spanish version (2) Keeping Your Keel Off Coral	Photogrammetry & Hydro- graphic Surveys: (3) Aerial fr. 15,000' (4) Base Maps & Overlays (not rec'd to date)	Interpretive signage: Wayside Exhibits (5) Boat ramp signs (6) Wall mount signs	New Brochures: (7) Color LKNMS (rec'd) (8) Safe Btg/Reef Etiq. (9) Fish'g Regs. B-LKNMS (10) Btg. Access to LKNMS (11) Mooring Buoys (in progress) (12) Sanctuary videos	(13) Coral Reef Kit Educ. Materials specific to FL Sanctuaries - FL Audubon (in progress)
	INTERPRETIVE EXHIBITS (1) Boat shows	INTERPRETIVE EXHIBITS	INTERPRETIVE EXHIBITS (2) 5TH Anniversary Celebration	INTERPRETIVE EXHIBITS (3) DEMA Trade Show Las Vegas (4) Big Pine Key Founder's Day (5) Monroe County Fair (6) Lower Keys Marine Expo & Food Fest.	INTERPRETIVE EXHIBITS (7) Ocean Expo Coconut Grove (8) International Dive and Travel Show Orlando (9) Design of Visitor Center at Sanct. Headquarters (10) DEMA Show New Orleans
		SEMINARS & WORKSHOPS	SEMINARS & WORKSHOPS	SEMINARS & WORKSHOPS	SEMINARS & WORKSHOPS
		(1) Freq. Users Mtg. (2) LKNMS & LKNMS Researcher's Workshop	(3) International Marine Protected Areas Seminar	(4) "Emergency Managet of Diving Accidents" Seminar-Dick Rutkowski (5) Researcher's Workshop	(6) Educator's Workshop
		ANNUAL SPECIAL EVENTS	ANNUAL SPECIAL EVENTS	ANNUAL SPECIAL EVENTS	ANNUAL SPECIAL EVENTS
		(1) U/H Music Festival	(2) U/H Photo Contest	(3) "ENFORCEMENT DAY"	(4) REEF FAIR - special Science Fair Pge.
				INTERNATIONAL TRAINING PROGRAM	INTERNATIONAL TRAINING PROGRAM
				(1) Malaysian trainees: Ab Rahim Gor Yaman Sukarno Hagiman	(2) Belizian Trainee: James Azueta
					EXTENSION PROGRAMS
					(1) Monroe County Environmental Ed. Task Force
					VOLUNTEER PROGRAM
					(1) Distinguished guests Sanct. clean-up (2) Community Service workers

# Port Pine Heights

Property Owners Association, Inc. • P.O. Box 43 • Big Pine Key, Florida 33043

## KEEPING OUR CANALS CLEAN

### Do We Have a Problem?

Not too many years ago, the canals of Port Pine Heights were reported to be "Gin Clear". While they are still better than many canal systems in the Keys, signs of wear and degradation are appearing. With the recent rapid growth in Port Pine Heights, the rate of deterioration of water quality in the canals cannot help but increase.

This is the first in a series of bulletins from your Property Owners Association designed to provide guidelines on how we can all help protect and restore the quality and beauty of our canals.

### What is Causing the Problem?

The primary cause of the degradation of water quality in the canals is the introduction of man-made nutrients into the water. As the water is enriched with these nutrients, a series of observable changes occur including: a decrease in water clarity, excessive growth of algae, decreased diversity of fish and plant life, and an increase in hydrogen sulphide (rotten egg smell). This degradation process, called eutrophication, results in a significant reduction of dissolved oxygen in the water and it is this reduction of oxygen that kills canals.

### Where Do These Nutrients Come From?

A primary source of unwanted nutrients is our household soaps, detergents, and other cleaning materials, especially those containing phosphates and nitrates. These materials slowly leach into the groundwater from septic tanks, and ultimately make their way into the canals and surrounding waters. By the time this nutrient-laden groundwater reaches the canals, most of the oxygen already has been eliminated. Over 50% of canal pollution is from septic tanks.

Other sources of nutrients/pollutants include: fertilizers, detergents used to wash boats, fish carcasses, and rotting sea grasses. All these things use up precious oxygen.

### How Can We Help as Individuals?

- Do not use household products containing phosphates or nitrates such as cleansers, laundry detergents, etc. Eliminating these sources alone will reduce the introduction of phosphorus into nearby open water by 20 to 30%. There are concentrated organic liquid cleaners readily available that do not contain any phosphates or nitrates. Read the labels on these household products



before buying, and select those that do not contain ingredients harmful to the environment.

- . Do not dump fish wastes and carcasses into the canals. Contrary to popular belief, this is not a good practice. Put such wastes in the trash or dispose of them in open water on your next fishing trip. The uneaten carcasses become covered with bacteria whose action further depletes the supply of oxygen.
- . Minimize the use of fertilizers, as the runoff pollutes the canals. If you must use fertilizers, select a slow release product that will allow a more thorough dilution of the runoff.
- . Keep branches, leaves, grasses, and other debris out of the canals so the flow of water will not be impeded. The deposition of a single heavy grass mat in a canal can cause permanent damage by "smothering" the bottom.
- . To maintain the beauty of our area, do not throw cans, bottles, and other trash in the canals. Pick up such trash from the bottom and along the sides of your canal. In particular, avoid spilling grease, oils, and similar products associated with boat maintenance into the canals.
- . Report any signs of fish kills, algae blooms, oil spills, or other adverse events in Port Pine Heights canals, as such information is useful in assessing water quality. These occurrences are more frequent following heavy rainfalls. Attempts will be made to promptly obtain water samples in such cases to aid in ongoing water quality studies. Please call Dr. Miller (872-4003) or Dr. LaPointe (872-2247).

#### What About Future Bulletins?

Maintaining the beauty and quality of our area requires a continuing effort by all of us. Future bulletins will contain additional guidelines for maintaining and improving the canals and adjacent lands of Port Pine Heights including lists of specific, readily available household products that are not harmful to the environment.

Prepared by:

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Brian LaPointe, Ph.D.  
Member, Board of Directors

July 1987

# Port Pine Heights

Property Owners Association, Inc. • P.O. Box 43 • Big Pine Key, Florida 33043

## KEEPING OUR CANALS CLEAN Bulletin #2

### Review of the Problem

In the July 1987 Port Pine Heights Canal Bulletin, it was pointed out that as a result of recent growth, the water quality of the canals in Port Pine Heights is deteriorating. The basic cause of this deterioration is the decrease in the amount of dissolved oxygen in the water which, in turn, results in a degradation process called eutrophication. The decrease in oxygen primarily is caused by the introduction of man-made nutrients and other adverse substances into the water.

The purpose of this bulletin is to identify more specifically the sources of these dangerous substances and to offer guidelines for selecting alternative products.

### Fertilizers

One of the most serious polluters of our canals is fertilizers. The most harmful ingredient is phosphate which is present to some degree in all available fertilizer products we were able to check. The amount, however, varies from 0.5% to 6.0%. This means that some fertilizers have 12 times the amount of phosphate as others. The product containing the least phosphate is composted cow manure (0.5-1.0%). The phosphate content of available inorganic fertilizers ranges from 2.0-6.0%. Even fertilizers that claim to be organic often have phosphates ranging from 2-3%, so reading the contents on the label is important. Usually the second number of the three listed in large print is the amount of phosphate, for example, Scotty's 16-4-8 is 4% phosphate, Vigoro's 18-3-6 is 3% phosphate, etc. In addition to selecting a fertilizer for low phosphate, whenever possible, select one marked "slow release" or equivalent. These fertilizers are made so that the chemical action occurs over a longer period of time, which decreases the concentration of phosphate not only in the surface runoff, but also in the seepage that finds its way into our groundwater.

The rate at which groundwater moves horizontally towards the canals varies greatly in our area and is increased from an average of 2-4 feet per day on dry days to as high as 20 feet per day during a heavy rain. If a fertilizer is put down just before a heavy rain therefore, much of the beneficial effect is lost because of rapid seepage and the concentration of phosphate entering the canals is much higher. In recent months, a serious algal bloom occurred in one of our canals as a direct result of heavy fertilization prior to a hard rain.



Recommendations:

- o Minimize use of all fertilizers
- o Read all labels carefully
- o Use composted cow manure or other organic fertilizers low in phosphate
- o Select a slow release fertilizer
- o Don't fertilize just prior to an expected heavy rain

Soaps, Detergents, and Cleaners

Laundry and dish detergents are notorious for causing environmental damage because of their high phosphorus content. In recent years, however, manufacturers have eliminated phosphorus from many of their detergent products. For example, the phosphorus content in powdered laundry detergents ranges from 0% in Ivory Snow and Dutch, to 14.7% in Fresh Start with a wide variety of concentrations in between. Most liquid laundry detergents do not contain phosphorus and there is a wide choice of safe liquids.

Most liquid dish detergents for use in the sink are free of phosphorus and are not a problem. Powdered detergents for automatic dishwashers contain significant amounts of phosphorus (8.1-8.7%), however, and should be avoided. Liquid detergents for automatic dishwashers contain less phosphorus (4% in Sunlight and 5.9% in Palmolive) and are safer to use. At least eight states already have banned the sale of detergents containing phosphorus. Hopefully, Florida will follow soon.

When selecting cleaners other than soaps and detergents, phosphorus-free products should be chosen. There are many environmentally safe products on the market, such as Shaklee organic liquid cleaner, that are readily available on Big Pine Key. While liquid bleaches generally do not contain phosphorus, some of the powdered bleaches such as BIZ (8.7%) do, so reading labels is important. Products used for removing rust, such as OSPHO, should be used in such a way that runoff does not enter canals as it is high in phosphoric acid.

Recommendations:

- o Read all labels carefully
- o Select laundry and dish detergent products and other cleaners containing no phosphorus
- o Wash and clean boats and cars only with environmentally safe, phosphorus-free products.

Antifouling Paints

Antifouling coatings for boat bottoms have been in use for years. The toxic substance contained in the coating leaches into the surrounding water and either kills the microorganisms or interferes with their attaching or cementing mechanism. Most antifouling paints available in retail stores contain toxins such

as cuprous oxide (copper) which can provide protection for up to 18 months, or organometallic toxins such as tributyltin oxide which has longer lasting protection but is highly toxic to the environment. In fact, there are environmental warnings on the cans stating that tributyltin is toxic to fish, cautioning against washing contaminated material and tools in open water, and instructing consumers to dispose of materials in authorized landfills.

The environmental hazards of tributyltin oxide are well known and its use already has been banned in the United Kingdom. In January 1988, the Environmental Protection Agency banned its use in the U.S. for all boats less than 65 feet in length except aluminum boats. Unfortunately, paint containing tributyltin will remain on retail store shelves for up to three years unless a U.S. Senate bill is passed prohibiting its sale.

Recommendations:

- o Read all labels carefully
- o Minimize use of antifouling paints
- o Use paints containing cuprous oxide (copper) and not those containing tributyltin oxide

To keep our canals from deteriorating further, we all need to pitch in. Remember, that in addition to the toxic products discussed in this bulletin, the dumping of fish wastes and other debris all decrease oxygen in the canals and contribute to our problems.

We need your help!

Prepared by:

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Member, Board of Directors

February 1988



# APPENDIX IV

## RECOMMENDATIONS OF MARINE EDUCATORS WORKSHOP

↳ Ref p 17

TABLE 1: Recommendations of Sub-Group 1: ON-SITE INTERPRETATION

Management Issue	Strategy	Comments/Examples
ISSUE 1: Boat groundings	(1) utilize existing volunteer groups to educate the boating public in the use of NOS navigation charts, "reading the water", etc. (2) utilize existing funds to produce divers navigational guides: a. guide offering navigational interpretation complimented by aerial photos b. guide with detailed maps and overlays (3) design aerial charts that include color photos to illustrate different habitats and hazardous navigational areas (4) NOAA chart inserts describing individual reefs and access to them (5) boating driver's license (6) informational transmissions to inform the public, such as a RADIO BUOY	Power Squadron Coast Guard Auxiliary Monroe County Boating Improvement Funds side-by-side presentation i.e., NOS charts with corresponding aerials Reef Crest, Patch Reefs, day markers, etc. i.e., NOS chart 11462, 11445, 11442 VHF radio channel with limited range transmission
ISSUE 2: Diver contact with coral	(1) discourage use of gloves (2) require guides to accompany all divers and snorkelers (3) utilize a "threat of harm" approach to discourage contact	divemasters i.e., dangerous marine organisms
ISSUE 3: Hand Feeding Fish	(1) utilize scare tactics to develop arguments that people will respond to (2) explanation of behavioral changes (3) conduct long-term research study to document impacts of this activity	conditioning of marine life such as morays and barracudas leads to more aggressive behavior i.e., "Feeding the animals may be hazardous to your health" -wild, natural behavior -vulnerability to predation -vulnerability to hook-and-line fishing -change in diet and implications (chemicals in food products dispersed) to support educational efforts
ISSUE 4: Disruption of Seabed	(1) educate divers of the importance of seemingly insignificant habitats	"How to look"
ISSUE 5: User Conflicts a. Littering b. Diver/Fishing conflicts c. Increased Boating Activity	(1) utilize existing volunteer and special interest groups to document types and quantities of litter upon removal (2) community service on land to all offenders (3) suggest alternate fishing locations outside areas of heavy diving activity (4) diver courtesy around chum slicks (5) limit number of visitors	i.e., American Littoral Society provide Loran C coordinates "racing for buoys" leads to reckless approach to diving sites
ISSUE 6: Bottom Damage	(1) provide anchoring tips information	

TABLE 2: Recommendations of Sub-Group 2: STRATEGIC CONTACT POINTS

Contact Point	Medium	Comments/Examples
(1) dive boats, en route	(a) pre-dive briefing (b) laminated wayside display (c) brochures	mount on board vessels distribute to passengers during the trip to the reef
(2) dive shops campgrounds parks beaches marinas marine supply stores special events marine education facilities Chambers of Commerce Welcome Stations  Local Attractions: Key West Aquarium Theatre of the Sea Dolphin Research Center Dolphins Plus glass bottom boats	(a) enclosures with equipment sales (b) trivia quizzes (c) posters (d) videos (e) slide programs (f) bumper stickers (g) charts with "blow up" windows (h) aerial photo with windows (j) kiosks	(brochures)  poster contest for artwork ideas, include regulations  slogan contest similar to road maps (see also Sub-Group 1, Table 1) windows corresponding to major dive destinations  i.e., Key Largo Tourist Information Center, MM 98
(3) Restaurants	placemat series	trivia, regulation quizzes, environmental education, management issues i.e., McDonald's is always looking for ideas
(4) hotel/motel rooms	in-house video which presents local attractions	hotel TV channel i.e., Fort Zachary Taylor Historic Site has done so (Jeff DiMaggio)
(5) radio TV	(a) Public Service Announcements (PSA's) (b) guest interviews (c) morning reef reports	local radio such as US 1 Radio local TV such as Channel 5 - Bill Trantham's show
(6) movie houses	movie ads or pre-show clips	
(7) roadways	(a) environmental awareness radio station (b) legal notices (D.O.T.) (c) billboard notices	i.e., recently installed Key Deer station (Key Deer National Wildlife Refuge) i.e., trap molesting warnings along US 1 i.e., along 18 mi. stretch to Key Largo where every tourist would see
(8) Airports	(a) billboard notices (b) kiosks	i.e., wall advertisements in terminals
BOATING PUBLIC:		
(9) Coast Guard	Captain's Exam	incorporate questions about FL Sanctuaries into
(10) NOAA	NOA navigation charts	Sanctuary notation should include contact points for available information i.e., reference Sanctuary headquarters/visitor center, radio buoy/VHF channel (see Table 1), envt'l awareness radio station, etc.
(11) Tax Collector's Office	Boater Registration enclosure	i.e., include a brochure packet with each registration
(12) boat dealerships	enclosure	i.e., brochure packet given with every new boat sale



TABLE 3: Recommendations of Sub-Group 3; EDUCATIONAL PROJECTS/MATERIALS FOR THE GENERAL PUBLIC

Management Issue	Strategy	Location	Comments/Examples
General	Kiosks	Interstate welcome stations turnpike rest areas airports	Sanctuary Program information and site-specific descriptions, etc.  great captive audiences
ISSUE 1: Boat groundings	(1) video (2) conduct USER SURVEY NOAA  (3) educate existing volunteer groups (4) signs (5) brochure boxes (6) distribution of interpretive materials with the sale of marine supplies  (7) educate school students (8) PSA's	motels/hotels/resorts  appropriate shallow reef areas  Power Squadron Coast Guard Auxiliary  public boat ramps  dive shops  boat shows boat sale outlets bait-and-tackle shops marinas wherever charts are sold!  Monroe County schools  radio, TV	i.e., "Keeping Your Keel Off Coral"  to determine who is the audience (a) detail of typical day-use activity (b) detail of boaters/vessels that have grounded  to lend assistance in addressing management issues in and outside protected areas (existing)  i.e., "Guide to Safe Boating"  school presentations (indirectly educate parents) those by REEF RELIEF have been well received!
ISSUE 2: Diver contact with coral	(1) Underwater Guide books  (2) get information to organizations that control people's access to diving	on-site use  equipment manufacturers  SCUBA certifying organizations i.e., PADI & NAUI dive operators/charter boats dive rental and equipment shops hotels, guest houses	discussed project currently being developed and some potential problems that could lead to increased diver contact, suggest alternate ideas: i.e., flip chart or laminated cards address mgt. issues on packaging of dive products i.e., diver's gloves - "armoured bodies" coral reef education to training materials provide videos
	(3) Special events with positive emphasis	on site	"Be Kind to Corals Day" or "Conservation Day" Emphasize fragile nature of the resource and solicit support from the public to protect it
ISSUE 3: Feeding Fish	effective slides video National Publications		convey the message of impact through visual aids point out the result of impact i.e., results in the capture (by hook-and-line) of fish tamed by feeding activity results in changing fish behavior
ISSUE 4: of Seabed	address: prop scarring lobster trap and related impacts prying off organisms replacing organisms in their natural position over-turning rocks and coral heads		incorporate into literature on reading water (see ISSUE 1)  explain the importance of these living resources and the need to protect them
ISSUE 5: USER CONFLICTS	Stress the importance of the multi-use concept of the program	Presented to a National audience as an important feature of the Sanctuary initiative	Positive support - gathering of all potential user groups
Littering	(1) utilize volunteer groups (2) mitigation efforts (3) promote "Clean-up Week" (4) add explanations to on-site interpretation	On-site and local alternative for soliciting support	Good opportunity to involve special interest groups in a "hands-on" experience with an "objective" when visiting the site i.e., American Littoral Society  i.e., plastic bags and the mechanical problems associated with them
Boating Activity Conflicts	(1) limit intensity of use		

# APPENDIX V

## CORAL REEF RESEARCH AND MANAGEMENT WORKSHOP

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Key Largo, Florida

JUNE 9-12, 1988

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THE KEYNOTER

SATURDAY, JUNE 11, 1988

Many say marine sanctuaries needed

# Locals call for preserves

By KEVIN WADLOW  
News Editor

FLORIDA KEYS — The national marine sanctuary program in the Florida Keys has been a success and more areas of protection are needed, a number of local residents are telling the federal government.

Response from the federal level has been encouraging, if noncommittal.

**KADO** The Keys Association of Dive Operators (KADO) recently endorsed an expansion of the existing Key Largo National Marine Sanctuary, suggesting a move of the sanctuary's southern boundary down to Snake Creek.

Such a move of approximately 11 miles would add protection to waters holding the new *Duane* and *Bibb* shipwrecks, along with popular dive sites such as Pickles Reef, Conch Reef, Hens and Chickens and Crocker Reef.

"I think the majority of our members realize the reef is an embattled resource," said KADO president Stephen Frink. "This is the world's most popular diving destination, and it's not going to spontaneously protect itself."

At the other end of the county, the Florida Association of Dive Operators (FADO) proposed to the federal sanctuaries program that it create a new Lower Keys preserve, stretching from the Western Dry Rocks to the Eastern Sambos.

"In order to preserve the quality of the reefs and ensure they are available for future generations to enjoy, we propose establishment of a federal marine sanctuary," FADO President Bob Holston wrote federal officials.

Russ Teall, a founder of the non-profit Florida Keys Marine Sanctuaries, Inc., has discussed preserve status for Sombbrero Reef off Marathon with federal officials.

"The idea of the entire Keys being a marine sanctuary sounds tremendous and I would like to see a sanctuary out

there," said Mr. Teall, "but only after a long series of public meetings to get input."

"A lot of people in Monroe County understandably feel abused by state and federal government programs," he added, "well-meaning though those programs might be."

Mr. Frink also noted KADO does not expect immediate results from the Key Largo request. "Nothing happens fast in a bureaucracy," he said.

He said some KADO members, primarily worried about the sanctuary's prohibition on spearfishing, declined to support the preserve expansion, but did not vote against it, either.

"At the outset, we know there are going to be some people upset," Mr. Frink said, "but I think in this case you really have to look at the greater good."

Florida Keys Marine Sanctuaries, Inc., grew out of a proposal to seek a Sombbrero Reef sanctuary, said Mr. Teall. The group now is mostly concerned with placing mooring buoys and educational materials for non-sanctuary reefs.

"We want to make sure there are reefs left by the time the sanctuaries do come in," he said.

The FADO bid for a sanctuary off Key West follows on the heels of a state proposal to declare the same area an underwater state park. The state plan essentially has hit a dead end over a lack of funding.

U.S. Rep. Dante Fascell (D-South Dade/Monroe) recently recommended to a Congressional committee that a study should be undertaken to determine if the entire Keys reef tract should receive sanctuary status.

Areas designated as marine sanctuaries generally receive protection against destruction of the ocean environment, and are given funding for educational, research and enforcement.

## Creating new sanctuaries takes time

By KEVIN WADLOW  
News Editor

FLORIDA KEYS — New marine sanctuaries for the Keys — perhaps even one covering the entire coral-reef tract — are possible but definitely not imminent, say federal officials.

"We haven't been looking at the Keys, but people keep calling us up," said Ralph Lopez, Florida regional manager for the Marine and Estuarine Management Division of the National Oceanic and Atmospheric Administration.

"That shows we must be doing something right down there, if people want us to come in," said Mr. Lopez. "I guess the sanctuaries program didn't turn out to be the federal ogre a lot of people expected."

Joseph Uravitch, head of the marine management division, responded to the Keys Association of Dive Operators' request to move the Key Largo boundary south. "I am looking into how we may act on your proposal," he stated. "I believe that a boundary extension to the Key Largo sanctuary can provide additional protection to nationally significant marine resources."

Mr. Lopez cautioned that even if the decision is made to expand the Keys' offshore marine preserves, the designation process is lengthy. "We've got a lot of legwork to do, and we're certainly not ready to designate anything right now."

But opinions at the federal level apparently have changed significantly since the creation of the Looe Key National Marine Sanctuary in 1981. After that Lower Keys preserve was designated along with three other sites by President Jimmy Carter, marine sanctuaries program staff maintained since the Keys held two of the six sanctuaries in existence (Key Largo being the other), it was time to move onto other areas.

Under the Reagan Administration, however, only a 160-acre sanctuary in American Samoa has been added to the program.

"Unfortunately, the promise and potential of the sanctuary program have been seriously eroded in recent years," says a March publication of the Center for Environmental Education. "In the past seven years, the process of designating sanctuaries has ground to a near standstill."

Presently there are four sites under "active" consideration for designation, and a 1983 federal study listed 29 other sites as candidates for new sanctuaries. None are in the Keys.

The future of new or expanded sanctuaries in the Keys is linked to a reauthorization bill for the sanctuary program now making its way through Congress.

"If we don't have the money, we can't do much," said Mr. Lopez. "We don't want to jump into the process of looking at Keys sites, only to have Congress tell us they don't want that."

But he said federal officials could put out feelers to Gov. Bob Martinez and various state agencies to gauge their reaction to possible Keys expansion. Opinions of state officials weigh heavily in the designation process.

"If we get some kind of positive response, things could start happening," Mr. Lopez noted.

Local hearings would play a major role in consideration of new Keys sanctuaries, he said. "It's fine to have the commercial dive groups say they want sanctuaries, but there are other user groups to be heard from."

He added, "I think, though, that a lot of the opposition we faced over Looe Key has dissipated because of the way we've managed things. It will be interesting to see what the reactions down there are."

By MARGARIA FICHTNER  
Herald Staff Writer

**T**he long struggle has been riddled with a fitful succession of gains, frustrating disappointments and the occasional kindly interference of the Almighty. Yet, more than 50 years after Gilbert Voss began his intimate association with South Florida's coral reefs, he can do no better than speculate as to what the future holds.

"The reefs are in very, very great danger," says Voss, a University of Miami biological oceanographer. "We have won so many fights, but as far as habitat is concerned out there, we're losing."

More than 100 reefs trickle down the seaward edge of the state from Fowey Rocks just south of Miami to the Dry Tortugas. Their names roll

along the map on a promise of courage and brava-do and an occasional barbed whimsy: American Shoal, Pelican Shoal, The Sambos, Triumph, Ajax, The Elbow, Alligator, Tennessee, Pickles. As the only true coral reefs within U.S. continental waters, they act as a buffer to protect the Keys from the erosive threat of tides and storms and as shelter for an almost unimaginable variety of marine plant and animal life.

Perhaps as many as 60 coral species make their home here, seductively waving and fanning in their eery underwater paradise. Parrotfish, triggerfish, yellowtail, sergeant major, damselfish and bluehead flit in and out, over and under. Sponges, mollusks, shrimps, crabs, lobsters, urchins and marine worms are everywhere. Squid and octopus patrol, too. No wonder no other place on earth attracts so many snorkelers and -cuba divers as Florida. Australia, with its Great

Barrier Reef, can boast only a tenth as many as show up here.

But today the Keys reefs are in trouble, their lovely corals dying, victims of man's intrusion and mishandling. They are too popular, too accessible, too close to shore, too beautiful for their own good. It is as true of coral reefs as anything else: You always hurt the one you love.

## A CORAL CHAIN REACTION

"If the corals were to die," says Gilbert Voss, "you would lose a very large percentage of the species of fish and invertebrates that form the coral-reef community. And with those gone, you would also lose a lot of the other fish that depend upon them as part of the food chain. . . .

"If the corals die, the amount of water above the reefs will increase, and you'll get more wave action, which erodes the shoreline and limestone rock and causes soil erosion. Your buffer is going to be gone. . . .

"If the corals die, the underwater turtle grass will be killed. . . . Turtle grass is nursery ground for a large percentage of our sports fish, food fish and shrimp. . . .

"In my opinion, when these things go, when the water is turbid, when there's not much fish out there, when there's nothing to go diving on, the Keys are going to be an economic disaster area. The whole economy of the Florida Keys is based on the water, the fish and the reefs, and if they ruin them, who in blazes will want to go down there anymore?"

### Gilbert Voss' Wish List for Saving the Coral Reefs:

1. Establish an effective master plan and enforce it.
2. Place a moratorium on the construction of new marinas and boat basins.
3. Ban vertical seawalls or retaining walls on private property. Owners would be encouraged to use natural shorelines or limestone riprap.
4. Furnish visitors to the reefs and water parks with an illustrated booklet on do's and don'ts.
5. Establish a major visitors' center on Key Largo with a teaching museum devoted to the ecosystem of the reefs and hammocks.
6. If all else fails, be prepared to consider more dire measures: limiting access, rotating reefs, restricting or prohibiting diving and, as a last resort, closing the underwater parks to the public altogether.



# Satellite data a bleak look at Keys' ecology

By JAMES F. CARNEY

Herald Staff Writer

In Largo Sound, home of the Pennekamp Coral Reef State Park, the quality of the water is deteriorating. The same is true of Tavernier Creek, of the waters around Boot Key and the canals of Big Pine Key.

It's also true of areas up and down the islands of Monroe County.

These are the findings of Stephen Estrin, a civil engineer and planner from upstate New York who was hired by the Keys chapter of the Izaak Walton League, an environmentalist group with about 200 members.

Waters near heavily developed areas, especially Key Largo, Islamorada and Marathon, show signs of high turbidity (caused by pollution) and substantial loss of sea grass.

With a \$50,000 grant from the Elizabeth Ordway Dunn Foundation, the League enlisted Estrin to use photogrammetry - sensitive and accurate satellite photography - to ing conventional marine biologists disapprove of photogrammetry because they feel it could replace their own methods. "They do not understand the process, so they're frightened and they reject it out of hand."

On Aug. 31 and Sept. 1 at 10 a.m., Estrin will return to give a another presentation, this time bringing back-up data from previous state and federal on-site studies on Keys water quality and making specific recommendations about how and where development, and commercial enterprises, should be regulated.

The meetings, to be held at the Marathon Jaycees building, are open to the public and will include Brown, Craig, a member of the County Commission, local and Tallahassee representatives of the state Department of Community Affairs - the department which oversees Monroe County land planning and development - and others.

document patterns of environmental degradation throughout the Keys, and to use that documentation to prove that overdevelopment is to blame.

Spokesman George Kundtz said the league wants to use Estrin's scientific data to back up claims Keys environmentalists have been making for more than a decade. Unchecked development will destroy the waters, reefs, mangroves and hammocks that make the Keys unique.

Changes in the county's two-year-old land plan based on Estrin's information have to be made as soon as possible, Kundtz said. But such changes, if they come at all, will take time, said County Planning Director Donald Craig, who met with Kundtz on Friday.

"I'm not convinced yet that (Estrin's) report tells us what we need to know to make changes in the text of the land-use plan," Craig said. "There are a lot of questions about

The process Estrin used was to have a series of photographs taken of the Keys from a commercial French satellite and then interpret them with a color scale.

In simplified terms, Estrin correlates areas of environmental degradation with the amount of nearby development. Sewage, stormwater runoff, boat propellers, jetskis and commercial seafood processing wastes all contribute to water quality deterioration.

He challenged Craig to bring in any other certified photogrammetrist to examine his work on the Keys.

Craig said Estrin's findings could be useful to the county if they are supplemented with other data from on-site studies, called "ground truthing."

The Department of Community Affairs planning manager in the Keys, Maria Abadal, said her agency, which has struggled with Mon-

whether Estrin's data, by itself, is valid. I don't want to act hastily when there's disagreement among the experts."

Few scientists who study the Keys environment disagree with Estrin's account of the water-quality problem. But whether Estrin's photographs - and conclusions about them he released this week - prove a direct link between poor water quality and the building of homes, roads and resorts is another issue.

In early July, Estrin presented his pictures to an audience that included County Administrator Tom Brown, a representative from Gov. Bob Martinez's office and several county planning staff members. Brown said he had heard "nothing new" and Billy Causey, a marine biologist who manages the Looe Key National Marine Sanctuary, questioned whether Estrin's data supported his claims.

Estrin counters criticism by saying Monroe County over development since the early 1980s, is "very interested in the results" of Estrin's studies.

"This information will be very useful," Abadal said. "Right now the county is going through zoning changes that increase the density of development, and one of the premises of the land-use plan is to reduce overall density."

Meanwhile, next week's meetings could decide what, if anything, the county plans to do with Estrin and the Izaak Walton League. Craig, who said he expects the meetings to be a productive first step, also said changes to the land-use plan based on Estrin's study would not happen in the next six months.

"There's not enough time to make amendments to the plan now," Craig said. "There's a difference of opinion as to what we have before us and how valuable it is. We shouldn't try to overwork this data to fit one conclusion."