

---

Coastal and Estuarine Data Archaeology and Rescue Program

## RESOURCE SURVEY OF LOOE KEY NATIONAL MARINE SANCTUARY 1983



Looe Key National Marine Sanctuary

December 2002



**US Department of Commerce**  
National Oceanic and Atmospheric  
Administration  
Silver Spring, MD

---



---

## RESOURCE SURVEY OF LOOE KEY NATIONAL MARINE SANCTUARY 1983

James A. Bohnsack  
(Editor, 1983)

Prepared for: Office of Ocean and Coastal Zone Management  
National Oceanic and Atmospheric Administration

Prepared by: Southeast Fisheries Science Center, National Marine Fisheries Service  
National Oceanic and Atmospheric Administration  
Miami, Florida

With Contributions From:

Cooperative Institute for Marine and Atmospheric Studies (CIMAS) University of Miami  
Miami, Florida

Department of Natural Resources, State of Florida  
St. Petersburg, Florida

Fisher Island Laboratory, United States Geological Survey  
Miami Beach, Florida



James A. Bohnsack  
NOAA National Marine Fisheries Service

Adriana Y. Cantillo  
NOAA National Ocean Service

Maria J. Bello  
NOAA Miami Regional Library

(Editors, 2002)

December 2002

---

United States  
Department of Commerce

Donald L. Evans  
Secretary

National Oceanic and  
Atmospheric Administration

Conrad C. Lautenbacher, Jr.  
Vice-Admiral (Ret.),  
Administrator

National Ocean Service

Jamison S. Hawkins  
Acting Assistant Administrator

For further information please call or write:

NOAA  
National Ocean Service  
National Centers for Coastal Ocean Science  
1305 East West Hwy.  
Silver Spring, MD 20910  
301 713 3020

#### Disclaimer

This report has been reviewed by the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use by the United States Government.

## TABLE OF CONTENTS

PREFACE .....	i
LIST OF TABLES.....	iii
LIST OF FIGURES.....	vii
LIST OF PLATES.....	xi
LIST OF ACRONYMS .....	xix
FOREWORD.....	xxi
ABSTRACT.....	xxv
CHAPTER 1. INTRODUCTION.....	1
CHAPTER 2. USES OF THE SANCTUARY.....	5
CHAPTER 3. GENERAL HABITAT DESCRIPTION AND MAPPING.....	15
Introduction.....	15
Methods .....	15
Results.....	15
Discussion.....	17
Literature cited.....	17
Appendix 3.A. Large scale section maps of the Looe Key Reef forereef spur formations. ....	19
CHAPTER 4. HOLOCENE SEDIMENT THICKNESS AND FACIES DISTRIBUTION, LOOE KEY NATIONAL MARINE SANCTUARY, FLORIDA .....	55
Introduction.....	55
Methods .....	56
Subbottom profiling.....	56
Sediment sampling and preparation.....	56
Navigation problems and water depth .....	57
Results.....	58
Bathymetry.....	58
Bedrock topography.....	59
Sediment thickness.....	60
Rates of accumulation.....	60
Sediment composition .....	60
Coral.....	61
Molluscs.....	62
Halimeda .....	62
Minor particles.....	63
Discussion.....	64
Coral rubble and sand transport.....	64
Sediment composition .....	65
Conclusions .....	66
Acknowledgments.....	66
References cited.....	66
CHAPTER 5. GROWTH HISTORY OF <i>MONTASTRAEA ANNULARIS</i> AT LOOE KEY NATIONAL MARINE SANCTUARY, FLORIDA .....	91
Introduction.....	91
Area description.....	91
Methods .....	91
Results.....	92

Discussion and conclusions.....	94
Acknowledgments.....	95
References.....	95
CHAPTER 6. LOOE KEY NATIONAL MARINE SANCTUARY RESOURCE SURVEY: CORALS AND OTHER MAJOR BENTHIC CNIDARIA .....	113
Introduction.....	113
Methods and materials.....	113
Results and Discussion.....	114
Spur and groove community.....	116
<i>Montastraea</i> buttress community.....	118
Livebottom community.....	118
Summary .....	119
Acknowledgments.....	122
Literature cited.....	122
Appendix 6.A. Stony coral abundance and distribution, Looe Key Reef.....	164
CHAPTER 7. RESOURCE SURVEY OF FISHES WITHIN LOOE KEY NATIONAL MARINE SANCTUARY .....	187
Introduction.....	187
Methods .....	188
Study area .....	188
Field methods .....	188
Random point censuses.....	188
Rapid visual samples.....	189
Data analysis.....	189
Results.....	189
Discussion and conclusions.....	190
Rapid visual census data .....	190
Random point data.....	191
Trophic ecology.....	192
Activity patterns .....	192
Literature cited.....	193
Appendix 7.A. Abundance, distribution, and frequency of occurrence of selected species at Looe Key National Marine Sanctuary. ....	245
CHAPTER 8. STATUS OF SELECTED CORAL RESOURCES.....	289
Introduction.....	289
Methods .....	289
Results.....	290
Mapping.....	290
Natural sources of damage and mortality.....	290
Human sources of damage and mortality.....	291
Discussion and conclusions.....	292
CHAPTER 9. MANAGEMENT CONSIDERATIONS .....	323
TAXONOMIC APPENDIX.....	325

## PREFACE

There is a significant number of documents and data related to the marine environment of Florida that have never been published, and are, therefore, not readily available for use by scientific community and academia. These documents and data are important because they can help define the state of the coastal environment in the past, and can be essential when evaluating the current state of degradation and restoration goals. Due to the nature of the paper and electronic media on which they exist, and, in some cases, the poor conditions in which they are housed, the data and documents are in jeopardy of being irretrievably lost. These materials cannot be located using electronic and manual bibliographic searches because they have not been catalogued or archived in libraries.

One of the objectives of the Coastal and Estuarine Data/Document Archeology and Rescue (CEDAR) Program is to collect unpublished data and documents on the South Florida coastal and estuarine ecosystem; convert and restore those judged valuable to the South Florida restoration effort into electronic and printed form, and distribute them electronically to the scientific community, academia and the public. CEDAR parallels other data and document rescue efforts including the Global Oceanographic Data Archeology and Rescue (GODAR) of the NOAA National Oceanographic Data Center (NODC)/World Data Center-A for Oceanography (WDC-A). CEDAR, however, is focused on coastal and estuarine data and documents which cover relatively small temporal and spatial scales.

"Data Archaeology" describes the process of seeking out, restoring, evaluating, correcting, and interpreting historical data sets. "Data Rescue" refers to the effort to save data at risk of being lost to the science community. One of the major users of these rescued materials is the South Florida Ecosystem Restoration Task Force.

CEDAR is joint effort between the NOAA National Ocean Service/National Centers for Coastal Ocean Science, and other government and universities in South Florida such as the the NOAA National Marine Fisheries Service, the NOAA Central Library, the University of Miami, Mote Marine Laboratory, and other organizations.





## LIST OF TABLES

4.1.	Brief bottom description of each surface sediment sample location, total grain count per thin section, and percentage for each of seven constituent particles. ....	69
4.2.	Comparative data for boundary marker buoys. ....	74
4.3.	Water depths within inner core area taken by weighted tape measure at sites of 19 sediment samples, locations of 11 reef rock core holes and nine coral core stations.....	75
4.4.	Summary of dominant-grain percentages of all samples analyzed, their percent average and range of total grains counted, and their percent dominance within inner core area.....	76
6.1.	Synopsis of quantitative coral sampling sites, Looe Key, August 1983.....	125
6.2.	Morphological characteristics, depths, and zones at sites II and III, spur and groove tract, Looe Key, August 1983.....	126
6.3.	Abundance of octocorals, site I (east spur), Looe Key, August 1983.....	128
6.4.	Abundance of stony corals, site I (east spur), Looe Key, August 1983.....	128
6.5.	Abundance of Zoanthidae and coral limorpharia at six sites, Looe Key, August 1983.....	129
6.6.	Abundance of stony corals, site II (middle spur), <i>Millepora/Palythoa</i> zone, Looe Key, August 1983.....	130
6.7.	Abundance of stony corals, site III (western spur), <i>Millepora/Palythoa</i> zone, Looe Key, August 1983.....	130
6.8.	Abundance of octocorals, site II (middle spur), <i>Millepora/Palythoa</i> zone, Looe Key, August 1983.....	131
6.9.	Abundance of octocorals, site III (western spur), <i>Millepora/Palythoa</i> zone, Looe Key, August 1983.....	131
6.10.	Abundance of stony corals, site II (saddle spur), <i>Acropora/transition</i> zone, Looe Key, August 1983.....	132
6.11.	Abundance of stony corals, site III (western spur), <i>Acropora/transition</i> zone, Looe Key, August 1983.....	132
6.12.	Abundance of octocorals, site II (middle spur), <i>Acropora/transition</i> zone, Looe Key, August 1983.....	133
6.13.	Abundance of octocorals, site III (western spur), <i>Acropora/transition</i> zone, Looe Key, August 1983.....	134
6.14.	Abundance of stony corals, site II (middle spur), <i>Montastraea/octocoral</i> zone, Looe Key, August 1983.....	135

6.15.	Abundance of stony corals, site III (western spur), <i>Montastraea</i> /octocoral zone, Looe Key, August 1983.....	136
6.16.	Abundance of octocorals, site 11 (middle spur), <i>Montastraea</i> /octocoral zone, Looe Key, August 1983.....	137
6.17.	Abundance of octocorals, site III (western spur), <i>Montastraea</i> /octocoral zone, Looe Key, August 1983.....	137
6.18.	Abundance of stony corals, site IV, <i>Montastraea</i> buttress community, Looe Key, August 1983. ....	138
6.19.	Abundance of octocorals, site IV, <i>Montastraea</i> buttress community, Looe Key, August 1983. ....	139
6.20.	Abundance of octocorals, site V, 9 m livebottom community, Looe Key, August 1983.....	140
6.21.	Abundance of stony corals, site V, 9 m livebottom community, Looe Key, August 1983. ....	141
6.22.	Abundance of octocorals, site VI, inshore (6 m) live bottom community, Looe Key, August 1983. ....	142
6.23.	Abundance of stony corals, site VI, inshore (6 m) livebottom community, Looe Key, August 1983. ....	143
6.24.	Summary, octocoral analyses, Looe Key, August 1983.....	144
6.25.	Summary, stony coral (Milleporina, Scleractinia less Corallimorpharia) analyses, Looe Key, August 1983. ....	145
6.26.	Stony corals, site II (middle spur), Looe Key, August 1983. ....	146
6.27.	Abundance of octocorals, site II (middle spur), Looe Key, August 1983.....	147
6.28.	Systematic listing of Cnidaria sampled at six sites, Looe Key, August 1983.....	148
6.29.	Abundance of octocorals at six sites, Looe Key, August 1983.....	150
6.30.	Abundance of stony corals (Milleporina, Scleractinia) at six sites, Looe Key, August 1983. ....	151
6.31.	Abundance of non-coral Cnidaria (Zoanthidae, Corallimorpharia) at six sites, Looe Key, August 1983.....	152
6.32.	Comparison of Looe Key Octocorallia records. ....	153
6.33.	Comparison of Looe Key stony coral (Milleporina and Scleractinia) records.....	154
7.1.	Phylogenetic listing of species observed at Looe Key National Marine Sanctuary during surveys. ....	198

7.2.	Distribution of numbers of species by family at Looe Key Reef based on censuses of 73,981 individuals.....	206
7.3.	Alphabetical listing of fishes observed in Looe Key National Marine Sanctuary during visual surveys using the Bohnsack and Bannerot (1983) Random Point Visual Technique (RPT) and the Jones and Thompson (1977) Rapid Visual Technique (J-T). .....	208
7.4.	Mean abundance ( $\pm$ standard error) of selected species in different habitats at Looe Key National Marine Sanctuary. ....	214
7.5.	Percent frequency of occurrence ( $\pm$ 95% confidence intervals) of selected species in different habitats at Looe Key National Marine Sanctuary. Unidentified species are deleted. ....	223
7.6.	Trophic structure of fishes at Looe Key National Marine Sanctuary. ....	232
7.7.	Summary of trophic activity analysis of fishes censused in Looe Key National Marine Sanctuary. ....	243
8.1.	Changes in long-spined urchin densities as a result of the 1983 disease epidemic at Looe Key Reef. ....	296
8.2.	Recent shipwrecks at Looe Key Reef. ....	297



## LIST OF FIGURES

1.1.	Index map for Looe Key National Marine Sanctuary. ....	4
3.1.	Map of the Looe Key forereef.....	19
3.2.	Section maps of Looe Key Reef. ....	20-24
3.3.	Location of permanent study spur on Looe Key Reef.....	25
3.4.	Habitat map of Looe Key National Marine Sanctuary.....	26
3.5.	Vertical and horizontal profiles in Looe Key National Marine Sanctuary. ....	27
3.6.	Representative view of <i>Montastraea</i> /octocoralia zone. ....	28
3.7.	Representative view of <i>Acropora</i> transition zone. ....	29
3.8.	Representative view of <i>Millepora/Palythoa</i> zone. ....	30
3.9.	Key to coral identification for Figures 3.6, 3.7 and 3.8.....	31-32
4.1.	Index map for Looe Key National Marine Sanctuary. ....	77
4.2.	Two examples of seismic reflection profiles showing dropoff south of core area. ....	78
4.3.	Loran C grid chart/base nap showing seismic track lines.....	79
4.4.	Bathymetric map based an 838 seismic data points. Core area not covered due to shallow water. ....	80
4.5.	Subsurface Pleistocene bedrock topography. Note no data zones where overlying Holocene reef growth prevented penetration of seismic signals. ....	81
4.6.	Isopachous map of unconsolidated carbonate sands and reef material based on difference between depth to bottom and depth to bedrock. ....	82
4.7.	Sanctuary inner core area traced from aerial photomosaic and showing location of 19 sediment sample sites along with core bolas drilled in earlier study. ....	83
4.8.	Photomicrographs of thin sections showing typical clean carbonate sand particles and approximate size range at Looe Key Sanctuary. Scale for all photomicrographs in the saw.....	84
4.9.	Percentage distribution of coral particles in sediment based on 77 samples outside core area. ....	86
4.10.	Percentage distribution of molluscan particles in sediment. ....	87
4.11.	Percentage distribution of <i>Halimeda</i> in sediment. ....	88

4.12.	Cross section of Looe Key reef showing radiocarbon ages of corals recovered in cores. ....	88
5.1.	Index map for Looe Key National Marine Sanctuary. Loran C lines of position for Stations 1 and 4 for the Gulf of Mexico were reproduced from National Ocean Service chart #11442. ....	97
5.2.	Map of core area in Looe Key National Marine Sanctuary showing spur and groove system of coral buttresses.....	98
5.3.	Panoramic view of 2-m high <i>Montastraea annularis</i> on seaward tip of spur buttress at Looe Key reef. ....	99
5.4A.	Newly installed pre-cast cement plug (LK1) fills hole left by removal of live core plug. ....	100
5.4B.	Cement plug (LK1) rephotographed one month after installation. Note that lesions have been covered with new tissue. Also note that most of the lesions associated with coring have healed.....	101
5.5A.	Closeup photograph of live core plug (LK6) three months after being implanted. ....	102
5.5B.	Closeup photograph of live core plug (LK6) six months after being implanted. ....	103
5.5C.	Closeup of live core plug (LK1) nine months after implanting. ....	104
5.5D.	Magnification (x 5) of inset in 5.5C. ....	105
5.6.	Growth history graphs of individual Looe Key <i>Montastraea annularis</i> plotted at 5-year intervals. ....	106
5.7.	Growth history graphs of individual Looe Key <i>Montastraea annularis</i> plotted at 5-year intervals. ....	107
5.8.	Growth history graphs of individual Looe Key <i>Montastraea annularis</i> plotted at 5-year intervals. ....	108
5.9.	Growth history graphs of individual Looe Key <i>Montastraea annularis</i> plotted at 5-year intervals. ....	109
5.10.	Composite growth history graphs showing average growth rate of 10 <i>Montastraea annularis</i> from the Key Largo Coral Reef Marine Sanctuary. ....	110
5.11.	Map of Florida Keys from Upper Matecumbe Key to Key West. ....	111
6.1.	Geographic location of Looe Key, Florida. Orientation of main spur and groove tract, Looe Key reef.....	156
6.2.	Looe Key quantitative coral sampling sites, August 1983.....	157
6.3.	Looe Key reef, spur and groove tract, zonation patterns.....	158

6.4.	Intersite similarities [Czekanowski's (A) Quantitative and (B) Qualitative Community Coefficients] of cnidarian fauna sampled at six sites, Looe Key National Marine Sanctuary, August 1983. ....	159
6.5.	Intersite similarities [Czekanowski's (A) Quantitative and (B) Qualitative Community Coefficients] of octocoral fauna sampled at six sites, Looe Key National Marine Sanctuary, August 1983. ....	160
6.6.	Intersite similarities [Czekanowski's (A) Quantitative and (B) Qualitative Community Coefficients] of stony coral fauna sampled at six sites, Looe Key National Marine Sanctuary, August 1983. ....	161
6.7.	Intersite similarities Czekanowski's Quantitative Community Coefficients for (A) all sampled Cnidaria, (B) stony corals, (C) octocorals at sites II and III, Looe Key National Marine Sanctuary, August 1983. ....	162
6.8.	Intersite similarities Czekanowski's Quantitative Community Coefficients for (A) all sampled Cnidaria, (B) stony corals, (C) octocorals at sites II and III, Looe Key National Marine Sanctuary, August 1983. ....	163
7.1.	Mean number of species and individuals per point sample by habitat. ....	244
8.1.	Distribution of elkhorn coral, <i>Acropora palmata</i> , (stars); staghorn coral, <i>Acropora cervicornis</i> , (dots); and pillar coral <i>Dendrogyra cylindricus</i> (diamonds). ....	298
8.2.	Map showing approximate locations of vessel groundings at Looe Key Reef. ....	302





LIST OF PLATES

A. Aerial photograph of Looe Key National Marine Sanctuary showing approximate boundaries.....x x

B. The high diversity of marine life and lush coral growth distinguish Looe Key National Marine Sanctuary.....xxi

2.3. Observing colorful fishes and beautiful coral formations is one of the major activities by snorkelers and SCUBA divers. The queen angelfish, *Holocanthus ciliaris*, (top) is one of the most colorful and graceful reef fish in Looe Key National Marine Sanctuary. Large colonies of pillar coral (*Dendrogyra cylindrus*) (bottom) are rare in the Florida Keys.....7

2.4. Underwater photography. (top) and the observation of natural behavior are popular activities by both scientists and non-scientists at Looe Key Reef. A hogfish, *Lachnolaimus maximus*, (bottom) is being cleaned of parasites at a cleaning station by neon gobies, *Gobiosoma oceanops* (upper and lower arrows), and a Spanish hogfish, *Bodianus rufus* (center arrow). Approaching fishes to observe behavior or to take pictures is very difficult in areas where spearfishing is a common activity.....8

2.5. Divers often take food underwater to attract fish such as these yellowtail, *Ocyurus chrysurus* (top). Sometimes sea urchins are broken up to attract smaller fishes (bottom). The impact of this activity is unknown.....9

2.6. Commercial fishing with wire fish traps (top) has increased in popularity in the Florida Keys during the last decade. Although fish traps are currently allowed only in waters deeper than 100 ft., there may be effects on fish populations within the Sanctuary. Lobster traps (bottom) are not allowed in the core reef area although an occasional trap is washed onto the reef where it can damage coral through wave action.....10

2.7. Fishing for food and sport are popular activities in Looe Key National Marine Sanctuary. Snapper and grouper (top) are the most desired food fishes. Fishes with hooks (bottom) are frequently seen by divers at Looe Key Reef. Impact of fishing pressure on reef fishes in the Sanctuary is unknown.....11

2.8. Trolling for barracuda (*Sphyraena barracuda*) (top) is a popular activity. Barracuda are usually caught only for sport because the potential for ciguatera poisoning makes them dangerous to eat.....12

2.9. The Sanctuary is commonly used for scientific research. Research activities frequently require some manipulation and disturbance of reef organisms. A live coral plug (bottom) was placed in a hole where a core had been removed in order to determine the effects of recent climatic history. The damaged area will eventually heal and not be noticeable.....12

2.10. Spearfishing (top) was a common activity at Looe Key Reef before it was prohibited with the establishment of the Sanctuary. Fishes with spear wounds are still occasionally observed (bottom) due to poaching. Poaching occurs either as a deliberate act or because divers are not aware of sanctuary rules.....13

3.1.	Oblique aerial photo of the forereef looking northwest. Letters show several reef Zones.....	41
3.2.	Typical live bottom (left) and buttress zone coral reef formation (right). Live bottom is characterized by expanses of dead calcium carbonate substrate dominated by sponges and soft corals (Octocoralla) with occasional colonies of hard coral (Scleractinia). Coral reefs are characterized by a dominance of living hard corals. Live bottoms generally have low vertical relief relative to coral reefs.....	42
3.3.	Representative deep live bottom (top) with sponges, soft corals, and isolated colonies of hard corals. A bluehead wrasse, <i>Thalassoma bifasciatum</i> , is swimming in the foreground. A diver (bottom) provides scale and shows the general low relief habitats typical of live bottoms.....	43
3.4.	Shallow live bottom habitats (top and bottom) exist in a narrow line along the northern boundary of the Sanctuary near the edge of Hawk Channel. Sponges, soft corals, and small hard coral colonies dominate the benthic fauna.....	44
3.5.	Spur and groove formation of the forereef habitat showing typical low relief formations on the seaward ends of spurs in closeup (top) and at a distance (bottom).....	45
3.6.	Representative views of middle spur formation showing a large colony of brain coral, <i>Colpophyllia natans</i> , (top) and two growth forms of mountainous star coral, <i>Montastraea annularis</i> (bottom).....	46
3.7.	The portions of many spurs form nearly vertical walls (top) which frequently have lush growths of soft coral (bottom).....	47
3.8.	Spurs formation has historically been based on elkhorn coral, <i>A. palmata</i> , which in some areas forms extensive stands (top) that provide shelter for many species of reef fish. In shallow water spurs are usually topped by firecoral ( <i>Millepora complanata</i> ) and the zoanthid <i>Palythoa caribaeorum</i> (bottom).....	48
3.9.	View looking seaward (top) showing the top of a typical shallow spur formation. The tops of spurs in shallow water are usually nearly flat and dominated by firecoral ( <i>M. complanata</i> ) and the zoanthid <i>Palythoa caribaeorum</i> (bottom).....	49
3.10.	Only isolated colonies of soft coral (top) and hard coral (bottom) occur in the rubble zone which is composed mostly of dead coral fragments thrown up behind the forereef after major storms.....	50
3.11.	Typical rubble (top) found on the rubble horns on the east and west sides of the lagoon. Isolated colonies of elkhorn coral ( <i>Acropora palmata</i> ) (bottom) frequently occur in the rubble zone just landward of the forereef crest.....	51
3.12.	A few isolated coral heads (top) are infrequently found in lagoonal grass beds. Typical grass beds (bottom) are dominated by turtle grass ( <i>Thalassia testudinum</i> , wide blades) and eel grass ( <i>Syringodium filiforme</i> , narrow rounded blades). In the lagoon the substrate is often a mixture of rubble and sand.....	52

3.13.	Sand flats (top) dominate much of the Sanctuary and have little relief except for occasional isolated coral patches. Sparse sea grasses (bottom) occur most commonly near hard bottom and reef areas. ....	53
3.14.	Typical views of medium density (top) and high density (bottom) sea grass beds. These habitats are important sources of food for many reef organisms. ....	54
4.1.	Storm-deposited pebble- to boulder-size coral blocks that form rubble horns shown in Figure 4.7. ....	89
6.1.	Sparse seagrass community inshore of rubble zone, Looe Key, August 1983. ....	180
6.2.	Rubble zone, Looe Key, August 1983. <i>Diadema antillarum</i> (urchin) sheltered by overturned <i>Acropora palmata</i> with hovering reef fish. ....	180
6.3.	Porite porites on boulders in rubble zone, Looe Key, August 1983. ....	181
6.4.	<i>Gorgonia ventalina</i> (seafan) cluster, rubble zone, Looe Key, August 1983. ....	181
6.5.	<i>Millepora complanata</i> , shallow spur and groove, Looe Key, August 1983. ....	182
6.6.	<i>Palythoa caribaerum</i> (golden sea mat) with <i>Zoanthus soriatius</i> (green zoanthid), shallow spur and groove, Looe Key, August 1983. ....	182
6.7.	Colonies of <i>Acropora palmata</i> , top of spur, <i>Acropora</i> /transition zone, Looe Key, August 1983. ....	183
6.8.	<i>Agaricea agaricites</i> (lettuce coral) and <i>Plexaura homomalla</i> (lower left), <i>Acropora</i> /transition zone, Looe Key, August 1983. ....	184
6.9.	Stands of <i>Acropora palmata</i> with schools of reef fish, <i>Acropora</i> /transition zone, Looe Key, August 1983. ....	184
6.10.	<i>Montastraea</i> /octocoral zone, deep spur and groove zone, Looe Key, August 1983. ....	185
6.11.	<i>Dendrogyra cylindricus</i> (pillar coral), <i>Montastraea</i> /octocoral zone, Looe Key, August 1983. ....	186
6.12.	<i>Plexaura</i> sp., <i>Montastraea</i> /octocoral zone, Looe Key, August 1983. ....	186
6.13.	<i>Montastraea annularis</i> , <i>Montastraea</i> /buttress community, forereef, Looe Key, August 1983. ....	187
6.14.	Shallow livebottom community, inshore of main spur and groove, Looe Key, August 1983. ....	187
7.1.	Ledges along the forereef spur formations are a favorite shelter for many reef fishes. ....	269
7.2.	Parrotfishes, the largest herbivores, are frequently seen in the forereef, buttress, and rubble zones. Shown are schools of rainbow parrotfish ( <i>Scarus guacamaia</i> ) in the rubble zone (top) .and midnight parrotfish ( <i>S. coelestinus</i> ) in the forereef zone (bottom). ....	270

7.3.	The three spot damselfish ( <i>Pomacentrus planifrons</i> ) (top) is herbivorous and usually found defending a territory in branches of elkhorn coral ( <i>A. palmata</i> ). These fishes are one of the most aggressive species on the reef and will not hesitate to attack a fish (or diver) hundreds of times its size. Often large schools of surgeonfishes (bottom) or parrotfishes temporarily overwhelm the defenses of a single damselfish before moving on to new areas. The predatory trumpetfish, shown in the center of the photograph, often uses the confusion created by the activity of these schools of fish to approach and attack small reef fishes.....	271
7.4.	Two of the larger schooling midwater fishes are the Bermuda chub ( <i>Kyphosus sectatrix</i> ) (top) that feeds primarily on drifting algae and the yellowtail snapper ( <i>Ocyurus chrysurus</i> ) (bottom) that feeds primarily on plankton when small and on fishes when larger.....	272
7.5.	The sharpnose puffer ( <i>Canthigaster rostrata</i> ) (top left) feeds by picking small microinvertebrates off the bottom. Angelfishes primarily browse on sponges. Shown are the rock beauty ( <i>Holocanthus tricolor</i> ) (top right) and an adult French angelfish ( <i>Pomacanthus paru</i> ) (bottom).....	273
7.6.	Typical assemblages of fishes feeding in midwater.....	274
7.7.	Common diurnally active microinvertebrates include the four-eye butterflyfish ( <i>Chaetodon capistratus</i> ) (top) and the harlequin bass ( <i>Serranus tigrinus</i> ) (bottom).....	275
7.8.	Two of the most abundant fishes at Looe Key Reef are the bicolor damselfish ( <i>Pomacentrus partitus</i> ) (top) and the bluehead wrasses ( <i>Thalassoma bifasciatum</i> ) (bottom). Many wrasses change sex and color with age. Shown are mostly (A) juvenile colored blueheads, (B) a supermale bluehead, (C) a clown wrasse ( <i>Halichoeres maculipinna</i> ), and (D) a hogfish ( <i>Bodianus rufus</i> ).....	276
7.9.	Glassy sweepers ( <i>Pempheris schomburgki</i> ) (top) and the twospot cardinalfishes ( <i>Apogon pseudomaculatus</i> ) (bottom) hide in caves in the reef by day and come out to feed on plankton at night.....	277
7.10.	Grunts (Haemulidae) are one of the most important groups of reef fishes in terms of species, abundance, and biomass. Although seen in schools on the reef during the day, most species feed on invertebrates away from the reef at night. The white grunt ( <i>Haemulon plumieri</i> ) (top) is most abundant on inshore hard bottoms. The tomtate ( <i>H. aurolineatum</i> ) dominates the forereef zone.....	278
7.11.	Goatfish and mojarra feed primarily on microinvertebrates in sand bottoms. Shown are schools of yellowfin mojarra ( <i>Gerres cinereus</i> ) (top) and yellow goatfish ( <i>Mulloidichthys martinicus</i> ) (bottom).....	279
7.12.	The sailor's choice ( <i>Haemulon parrai</i> , Haemulidae) (top) and the hagfish ( <i>Lachnolaimus maximus</i> , Labridae) (bottom) are two typical macroinvertebrates. Large schools of sailor's choice were first observed at Looe Key Reef after it became a Sanctuary. The hagfish was a favorite spearfishing target that became more frequent after the Sanctuary was established.....	280

7.13.	The schoolmaster snapper (top), the most common snapper (Lutjanidae) observed in the Sanctuary, was frequently seen in schools around colonies of elkhorn coral ( <i>Acropora palmata</i> ) (bottom).....	281
7.14.	Two species that feed primarily on the larger macroinvertebrates on sand bottoms are the jolthead porgy ( <i>Calamus bajonado</i> ) (top) and the eagle ray ( <i>Aetobatus narinari</i> ) (bottom).....	282
7.15.	Moray eels and groupers are two small predators that feed on macroinvertebrates and fishes. Eels are more active at night and grouper more active during the day. Shown are a spotted moray ( <i>Gymnothorax moringa</i> ) being fed by a diver (top) and a graysby ( <i>Epinephelus cruentatus</i> ), the most common grouper at Looe Key Reef (bottom).....	283
7.16.	The bar jack ( <i>Caranx ruber</i> ) (top) and the yellowtail snapper ( <i>Ocyurus chrysurus</i> ) (bottom) are midwater fishes that feed primarily on plankton when small and on fishes when larger. ....	284
7.17.	The great barracuda ( <i>Sphyræna barracuda</i> ) is a piscivorous predator that feeds on small fishes when medium in size (top) and large fishes when large in size (bottom). This is one of many species not seen in the Sanctuary as juveniles.....	285
7.18.	Adult tarpon ( <i>Megalops atlanticus</i> ) (top) are piscivorous predators frequently seen over reef areas in the Sanctuary. The Nassau grouper ( <i>Epinephelus striatus</i> ) (bottom) is a large grouper that feeds mostly on large invertebrates.....	286
7.19.	The bull shark ( <i>Carcharhinus leucas</i> ) is one of the largest predators in the Sanctuary. Although often caught in the Sanctuary at night they are rarely seen on the reef during the day.....	287
7.20.	Classifications of reef fishes into trophic categories is somewhat misleading because most reef fishes are opportunists and will eat almost anything available. A stoplight parrotfish, <i>Sparisoma viride</i> , is normally herbivorous but could be seen attacking and eating sick long-spined urchins ( <i>Diadema antillarum</i> ) (top) during an unusual sea urchin die off in the summer of 1983. Similar disease epidemics and winter cold spells have killed reef fishes in or around the Sanctuary. Dead fishes (bottom) in Cupon Bight, just north of the Sanctuary, killed by a severe January 1977.....	288
8.1.	Pillar coral, <i>Dendrogyra cylindrus</i> , colonies were found in only four places on the forereef. Locations of colonies are shown in Figure 8.1. Photographs of other colonies appearing Plates 8.2, 8.3 and 8.3.....	303
8.2.	Natural storms are a major source of damage to corals. A colony of elkhorn coral ( <i>Acropora palmata</i> ) (top) was turned over after a severe winter storm. <i>A. palmata</i> is a rapidly growing branching coral and is a major contributor to reef rubble formation through wave damage. Despite being easily broken, the broken fragments are an important source of vegetative reproduction for the species. A colony (bottom) is beginning to spread and grow upward after being turned over.....	304
8.3.	Severe heat and cold temperatures can kill coral. Staghorn coral ( <i>A. cervicornis</i> ).....	305

8.4.	Some animals such as this bristle worm ( <i>Hermodice</i> sp.) (top) feed on coral tissues. Direct and interference competition between corals (bottom) is a common occurrence. The arrow shows the site of direct interaction between two corals which are attempting to digest each other with mesentary filaments. A more common form of competition is indirect where corals shade each other from light.....	306
8.5.	The lower white portion of the coral (top) has been killed recently by being temporarily buried by sediments. Lighter patches on the upper half of the colony show unhealthy tissue exposed to excessive sediment stress. The white area of the elkhorn coral (bottom) was recently killed by unknown causes.....	307
8.6.	Two common coral diseases are black ring disease caused by a bluegreen algae (top) and white ring disease of unknown cause (bottom).....	308
8.7.	Periodic diseases of unknown origin affect several species of coral. Dead staghorn coral ( <i>Acropora cervicornis</i> ) (top) recently killed at Looe Key reef. <i>Montastraea annularis</i> (bottom) in the process of bleaching (arrow) and dying.....	309
8.8.	During late August 1983 a disease killed most of the long-spined urchins ( <i>Diadema antillarum</i> ) found within the Sanctuary. Although still alive, loss of spines and discoloration characterize the disease whose cause has not been identified (top). Normally, urchins are an abundant and conspicuous member of the herbivorous reef community (bottom).....	310
8.9.	The forereef is the most intensively used area in the Sanctuary (left). The shrimp boat Cleo in the center had run aground on the reef and damaged the coral. The top arrow (right) shows a groove the Cleo's keel cut into the spur and bottom arrow shows a colony of brain coral ( <i>Colpophyllia natans</i> ) cut in half by the vessel. ....	311
8.10.	Poor anchoring practices damage coral (left and right). Anchors should be placed only on sand or rubble bottoms. Broken coral from poor anchoring practices is certainly an aesthetic problem, however, its ecological consequences may be less important because many corals are adapted to (and may require) periodic physical damage.....	312
8.11.	A cross was deposited in the forereef as a monument (top). Excessive amounts of human materials may reduce the aesthetic experience of visiting a natural reef. Inexperienced divers may damage corals by deliberately or accidentally touching the tissues (bottom). The ecological impact of such treatment are unknown.....	313
8.12.	Wreckage and a groove cut into a coral spur from the Robby Dale. The engine (bottom) of the Robby Dale shortly after its sinking on 18 March 1977. The salvaging of the engine further damaged the reef.....	314
8.13.	Wreckage of the Robby Dale seen extending above surface shortly after its sinking on 18 May 1977 (top) and as it appeared during the survey in 1963 (bottom).....	315
8.14.	Wreckage of the Robby Dale shortly after sinking in 1977 (top) and in 1983 (bottom).....	316

8.15.	Damage to the reef caused by groundings of the shrimp boat Noah Smith on 15 Oct 1982. View of the beginning of the impact area with a 3 ft groove (top). View of the core impact area showing crushed coral (bottom). Photos by John Halas.....	317
8.16.	Aerial view of Looe Key Reef showing damage from the grounding of the 110-ft Lola grounding of 5 March 1976 (top). Arrows show light areas on spur where surface coral was crushed and killed (Photo by Bill Becker). Closeup view (bottom) of groove cut into a spur by the keel of the Cleo, a 88 ft shrimper, grounded on 28 May 1983.....	318
8.17.	Wreckage materials left by the grounding of the 110-ft Lola, grounding of 5 March 1976 (top and bottom). Materials from previous wrecks are common on Looe Key forereef.....	319
8.18.	A potential exists for a major disaster caused by collision of a large ship with the reef. Ships traveling west frequently pass close to the forereef in order to avoid strong easterly currents in the Straights of Florida (top). Although a modern wreck of a large ship on a reef would be considered a major calamity, the wreckage of the warship H.M.S. Loo (bottom) and her prize are considered historical artifacts of great cultural value. Although much of the Loo has been removed, balast materials (below diver) can still be seen on the reef and are protected by the Sanctuary.....	320
8.19.	Oil spills have frequently occurred in the Florida Keys. An oil slick (top) can be seen with the Lower Florida Keys in the background (21 July 1975). Oil floating over shallow sea grass beds (bottom) north of the Sanctuary (21 July 1975).....	321
8.20.	Land cleared for development on Big Pine Key north of the Sanctuary (top). Turbidity in Hawk's channel caused by a tugboat pushing a barge (bottom).....	322





## LIST OF ACRONYMS

BNP	Biscayne National Park
CIMAS	University of Miami/Cooperative Institute for Marine and Atmospheric Studies
cm	Centimeter(s)
DEIS	Draft environmental impact statement
FDNR	Florida Department of Natural Resources
ft	Feet
in	Inch(es)
KLNMS	Key Largo National Marine Sanctuary
km	Kilometer(s)
LKNMS	Looe Key National Marine Sanctuary
LKR	Looe Key Reef
LOP	Loran C lines of position
m	Meter(s)
MHE	Marine Habitats and Ecosystems
NMFS	NOAA/National Marine Fisheries Service
nmi	Nautical mile(s)
NOAA	National Oceanic and Atmospheric Administration
NOS	NOAA/National Ocean Survey
SPD	Sanctuary Programs Division/NOAA Office of Ocean and Coastal Resource Management
USGS	US Geological Survey



## FOREWORD

Looe Key National Marine Sanctuary (LKNMS) was designated in 1981 to protect and promote the study, teaching, and wise use of the resources of Looe Key Sanctuary (Plate A). In order to wisely manage this valuable resource, a quantitative resource inventory was funded by the Sanctuary Programs Division (SPD), Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration (NOAA) in cooperation with the Southeast Fisheries Center, National Marine Fisheries Service, NOAA; the Cooperative Institute for Marine and Atmospheric Studies (CIMAS), University of Miami; the Fisher Island Laboratory, United States Geological Survey; and the St. Petersburg Laboratory, State of Florida Department of Natural Resources. This report is the result of this cooperative effort.

The objective of this study was to quantitatively inventory selected resources of LKNMS in order to allow future monitoring of changes in the Sanctuary as a result of human or natural processes. This study, referred to as Phase I, gives a brief summary of past and present uses of the Sanctuary (Chapter 2); and describes general habitat types (Chapter 3), geology and sediment distribution (Chapter 4), coral abundance and distribution (Chapter 5), the growth history of the coral *Montastraea annularis* (Chapter 6), reef fish abundance and distribution (Chapter 7), and status of selected resources (Chapter 8). An interpretation of the results of the survey are provided for management consideration (Chapter 9). The results are expected to provide fundamental information for applied management, natural history interpretation, and scientific research.

Numerous photographs and illustrations were used to supplement the report to make the material presented easier to comprehend (Plate B). We anticipate the information provided will be used by managers, naturalists, and the general public in addition to scientists. Unless otherwise indicated, all photographs were taken at Looe Key Reef by Dr. James A. Bohnsack. The top photograph in Plate 7.8 was taken by Michael C. Schmale. Illustrations were done by Jack Javech, NMFS.

Field work was initiated in May 1983 and completed for the most part by October 1983 thanks to the cooperation of numerous people and organizations. In addition to the participating agencies and organizations we thank the Newfound Harbor Marine Institute and the Division of Parks and Recreation, State of Florida Department of Natural Resources for their logistical support. Special thanks goes to Billy Causey, the Sanctuary Manager, for his help, information, and comments.

We thank in alphabetical order: Scott Bannerot, Margie Bastian, Bill Becker, Barbara Bohnsack, Grant Beardsley, John Halas, Raymond Hixon, Irene Hooper, Eric Lindblad, and Mike Schmale. We dedicate this effort to the memory of Ray Hixon who participated in the study and who loved Looe Key.



Plate A. Aerial photograph of Looe Key National Marine Sanctuary showing approximate boundaries.

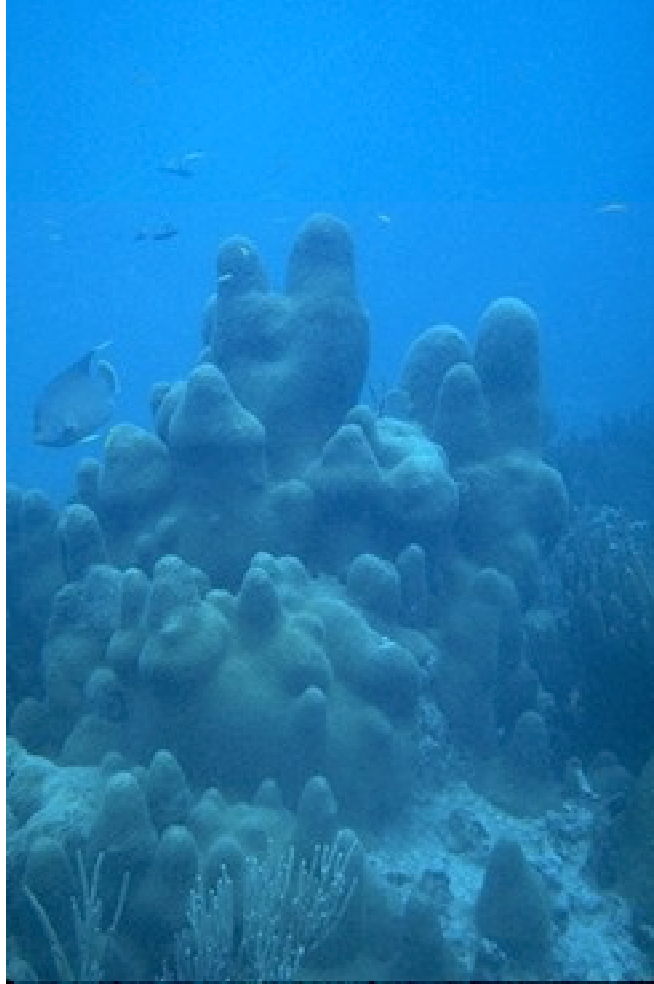


Plate B. The high diversity of marine life and lush coral growth distinguish Looe Key National Marine Sanctuary.



## ABSTRACT

Looe Key National Marine Sanctuary (LKNMS) was designated in 1981 to protect and promote the study, teaching, and wise use of the resources of Looe Key Sanctuary. A quantitative resource inventory was funded in 1983 by NOAA in cooperation with the University of Miami, the United States Geological Survey, and the Florida Department of Natural Resources. The objective of the study was to quantitatively inventory selected resources of LKNMS in order to allow future monitoring of changes in the Sanctuary as a result of human or natural processes. This study, referred to as Phase I, gives a brief summary of past and present uses of the Sanctuary; and describes general habitat types, geology and sediment distribution, coral abundance and distribution, the growth history of the coral *Montastraea annularis*, reef fish abundance and distribution, and status of selected resources. An interpretation of the results of the survey are provided for management consideration. The results are expected to provide fundamental information for applied management, natural history interpretation, and scientific research.





## CHAPTER 1

### INTRODUCTION

Walter C. Jaap  
State of Florida Department of Natural Resources  
Bureau of Marine Research  
St. Petersburg, FL

Looe Key was named after a British 44 gun frigate, the HMS Loo. (Loo is a city in Cornwall, England; spelling was either Loo or Looe during the 1700's) that grounded on the reef with a companion smaller vessel on 5 February 1744 (Peterson, 1955). The Loo's log and Captain Utting's letters describe a 274 by 91 m sandy island (Key) that existed on the reef during this time. The shipwreck survivors remained on the island for three days before setting fire to the wrecked vessels, and sailing to the Bahamas and Port Royal, South Carolina in a commandeered sloop and small boats. The island was found by Romans in 1775 and still existed in 1851 (Agassiz, 1852). The remains of this island may be the rubble zone on the east end of the reef which is emergent during low tide.

Looe Key National Marine Sanctuary, established in February 1981, is an offshore bank reef community, located approximately 24° 32' N latitude, 81° 24' W longitude, or 12.9 km off the SW point of Big Pine Key, Monroe County, Florida (Figure 1.1). The main axis of the Florida Current flows through the Straits of Florida about 36 km seaward of Looe Key Reef. The entire sanctuary encompasses 5.3 square nmi, and surrounds an inner "core" area of less than 0.5 square nmi encompassing Looe Key Reef. Within the "core" area, "removing or damaging natural features, using harmful fishing methods, removing or damaging distinctive historical or cultural resources" is prohibited.

The sanctuary features include seagrass, coral reef, livebottom, rock, and bare carbonate sand communities. The reef is characterized by a spectacular spur and groove zone compassed of elongate formations of reefal limestone capped by living corals, interspersed with valleys lined with carbonate sand and rubble. Seagrass meadows carpet the bottom inshore of the spur and groove formation. Livebottom, sedimentary, and rock habitats are scattered inshore, east, and west of the spur and groove system. The deeper reef is poorly known; scattered outcrops of irregular relief bottom occur in depths of 30 m. At or about 25 - 30 m the slope changes precipitously and the reef biotope terminates at a flat sand plane, characterized by silty sediments.

The reef was described as an outer reef "par excellence" by Agassiz (1852); he referred to the spur and groove tract as "submarine elongated hillocks"; and reported that the reef was located at the narrowest portion of Hawk Channel (determined by a line running between Big Pine Key and Looe Key). However, modern navigational charts document that Alligator Reef seaward of Matecumbe Key is closer to shore.

Two major assemblages of outer bank reefs with pronounced spur and groove zones and populations of elkhorn coral (*Acropora palmata*) are found in the Florida Reef tract. The northern component is found off Key Largo within the Key Largo National Marine Sanctuary (KLNMS) and Biscayne National Park (BNP), and has a north-south alignment. From north to south the reefs include unnamed reefs in BNP and Carysfort, Elbow, Key Largo Dry Rocks, Grecian, French, and Molasses reefs in KLNMS. The southwestern component extends from seaward of Big Pine Key to slightly beyond Key West. These reefs have a more east-west alignment, reflecting the continental shelf margin which controls the archipelago axis. Reefs in

this set include Looe Key, Maryland Shoal, Eastern, Middle, and Western Sambo, Eastern Dry Rocks, Rock Key, Sand Key, and Western Dry Rocks.

The discontinuous distribution of bank reefs in the Florida Reef tract is attributable to the dam effect of the Pleistocene island archipelago. The upper and lower Keys' islands form a dike-like barrier to water exchange between Florida Bay - Gulf of Mexico and the Atlantic. The middle portion of the Keys is typified by small isolated islands and large open channels between the Atlantic and Florida Bay - Gulf of Mexico. These waters exhibit unpredictable water quality; almost every parameter is profoundly influenced within the shallow Florida Bay basin. Temperature is affected by winter cold fronts (Shinn, 1976; Walker *et al.*, 1982; Roberts *et al.*, 1982) and summer doldrums (Jaap, 1979). Salinity is affected through evaporation and the influx of fresh water from the Everglades and Ten Thousand Islands drainage systems. Turbidity is highly variable due to fine carbonate muds and silts which are resuspended during winter and summer storms. Reef coral distribution is controlled by cross platform transport of Florida Bay water into the Atlantic (Ginsburg and Shinn 1964; Shinn, 1976). Areas seaward of large tidal channels have sparse reef development, areas located seaward of larger island masses, such as Key Largo support thriving coral reefs.

Looe Key's location is on the southeast fringe of the lower Keys protected zone. Smaller channels (Niles, Pine, and Bogie) are nearly directly inshore of Looe Key. Major channels (Bahia Honda and Moser) are found short distances to the northeast. Large volumes of Florida Bay water are transported through these channels into the Atlantic. Satellite imagery (USGS, 1974) documents that net water movement in this region moves SW from these channels.

Though *Acropora palmata* (elkhorn coral) is an efficient monopolizer of space on shallow western Atlantic reefs (Glynn, 1973; Adey, 1977), they are sparse at Looe Key. Looe Key appears to be suitable habitat for *A. palmata* and drilling has shown that during earlier periods, *A. palmata* was a significant contributor to spur construction at Looe Key Reef (Shinn *et al.*, 1981). The demise of *A. palmata* may reflect short term environmental events such as hurricanes or thermal shock, or the geologically recent development of Florida Bay caused by rising sea level which allowed water to flow out of the Bay into the Atlantic and detrimentally affect the water quality around Looe Key. There was also minor impact from harvest of elkhorn coral for the souvenir trade (which was legal prior to 1976).

Reefs located southwest of Looe Key (Sambo complex) are less affected by Gulf of Mexico waters due to the larger islands and narrow channels in this area and display a somewhat different pattern of organism abundance. Eastern Sambo for example is capped by thriving populations of *A. palmata*. There are also dense thickets of *Acropora cervicornis* (staghorn coral), just seaward of the spur and groove habitat at the Sambos. The large flow of poor quality water from Florida Bay appears to be the most probable cause for the demise of *A. palmata* populations at Looe Key.

The sequence of events typical in the reef building process for *A. palmata* includes (1) initial recruitment, exploitation and monopolization of the habitat. Much of the success of *A. palmata* is a consequence of its vegetative recruitment via broken fragments which lodge in the substrate and develop into new colonies. (2) Upward growth to low tide level and increase of population densities to a point of overcrowding. Localized deterioration of water quality caused by restricted circulation reduces population vitality, and perhaps allows greater susceptibility to disease, making them less competitive in this now unfavorable micro-habitat.

Disease can exterminate populations of *A. palmata* (Gladfelter, 1982; Peters *et al.*, 1983). Populations usually adjust to these conditions by retreating seaward. As reef growth reached sea level, organisms adjust by recruitment into more favorable niches (Mcintyre and Glynn, 1976). Looe Key is somewhat anomalous in terms of topography. The spurs terminate at about 9 m depth on a sandy plane. Corals require a stable rocky substrate with low sedimentation,

therefore at Looe Key, *A. palmata* fragments and larvae find little suitable substrate to colonize seaward of the spurs. Looe Key is also unusual in that the bulk of the spurs are growing over coral rubble and carbonate sands. Looe Key reef growth began ca. 6500 BP; early growth originated on a topographic elevation formed by Pleistocene bedrock and progressed landward, constructing spurs atop coral rubble and sand; the reef flat is a shingle rampart composed of coral fragments lying atop a sedimentary sequence approximately 4 m thick (Shinn *et al.*, 1983; Lidz, this volume).

Understanding the history of Looe Key Reef is important for understanding present conditions discussed in later chapters.

#### Literature cited

- Adey, W. 1977. Shallow water Holocene bioherms of the Caribbean Sea and West Indies. Proc., Third Internatl. Coral Reef Symp., Vol. 2, University of Miami, Coral Gables, FL. p. xxi - xxiv.
- Agassiz, L. 1852. Florida reefs, keys and coast. Annu. Rep. Supt. Coast Survey, 1851:107-134.
- Ginsburg, R. N. and E. A. Shinn. 1964. Distribution of the reefbuilding community in Florida and the Bahamas (abs.). American Assoc. Petroleum Geol. Bull., 48:527.
- Gladfelter, E. H. 1982. Skeletal Development in *Acropora cervicornis*. I. Patterns of calcium carbonate accretion in the axial corallite. 1(1):45-51.
- Glynn, P. W. and Stewart, R. H. 1973. Distribution of coral reefs in the Pearl Islands (Gulf of Panama) in relation to thermal conditions. Limnol. Oceanogr., 18: 367-379.
- Jaap, W. C. 1979. Observations on zooxanthellae expulsion at Middle Sambo Reef, Florida Keys. Bull. Mar. Sci., 29(3):414- 422.
- Mcintyre, I. G. and Glynn, P. W. 1976. Evolution of modern Caribbean fringing reef, Galeta Point, Panama. Amer. Assoc. Petroleum Geol. Bull., 60(7):1054-72.
- Peters, E. C., Oprandy, J. J., and Yevich, P. P. 1983. Possible causal agent of "white band disease" in Caribbean acroporid corals. J. Invertebr. Pathol., 41:394-396.
- Peterson, M. L. 1955. The last cruise of the H. M. S. Loo. Smithson. Misc. Collect., 131(2):1-54.
- Roberts, H. H., Rouse, L. J., Jr., Walker, N. D., and Hudson, J. H. 1982. Cold-water stress in Florida Bay and northern Bahamas: a product of winter cold-air. J. Sed. Petrology, 52(1):145-155.
- Shinn, E. A. 1963. Formation of spurs and grooves on the Florida reef tract. J. Sedimentary Petrology, 33:291-303.
- Shinn, E. A. 1976. Coral reef recovery in Florida and the Persian Gulf. Environ. Geol., 1:241-254.
- Shinn, E. A., J. Hudson, D. Robin, and B. Lidz. 1981. Spurs and grooves revisited: construction versus erosion, Looe Key Reef, Florida. Proc. 4th Int. Coral Reef Symp., 1: 475-483.
- Walker, N. D., H. H. Roberts, L. J. Rouse, Jr., and O. K. Huh. 1982. Thermal history of reef-associated environments during a record cold-air outbreak event. Coral Reefs, 1: 83-87.

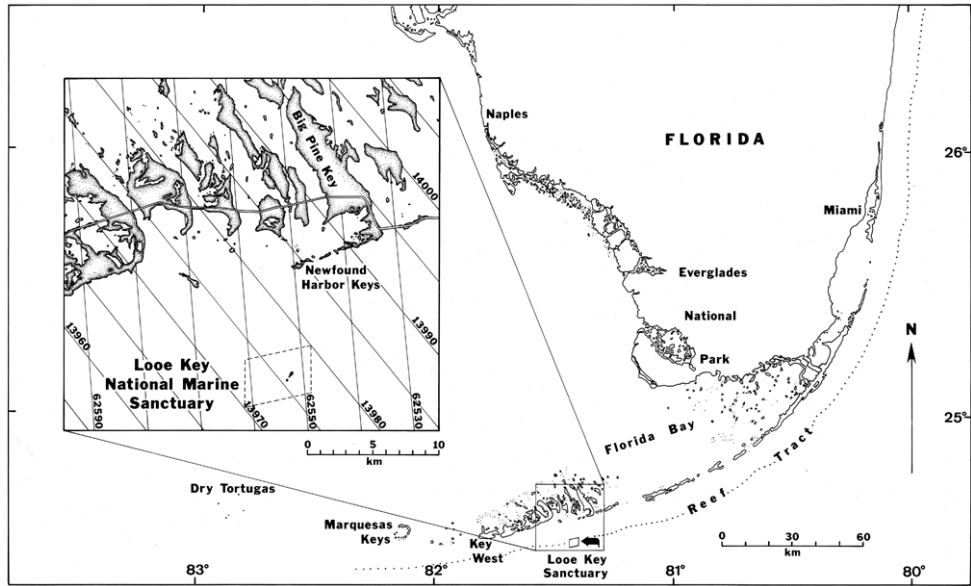


Figure 1.1. Index map for Looe Key National Marine Sanctuary. Loran C lines of position for Stations 1 (13900  $\mu$ sec) and 4 (62500  $\mu$ sec) for the Gulf of Mexico were reproduced from National Ocean Service chart #11442. Coast Guard Marker 24 within sanctuary (dashed lines on inset) indicated by standard nautical chart symbol for position of lighted fixed marker.

## CHAPTER 2

### USES OF THE SANCTUARY

James A. Bohnsack  
NOAA National Marine Fisheries Service  
Southeast Fisheries Science Center  
Miami, FL

and

Walter C. Jaap  
State of Florida Department of Natural Resources  
Bureau of Marine Research  
St. Petersburg, FL

Looe Key National Marine Sanctuary is an important economic, educational, recreational, cultural, and scientific resource for the southeastern United States. The Sanctuary receives concentrated and often conflicting use because of its unique reef habitat and abundant resources. Here we document present and major recent uses of the Sanctuary. The Draft Environmental Impact Statement (Department of Commerce, 1980) and the Looe Key National Marine Sanctuary Management Plan (Department of Commerce, 1983) provide a history of the development of the Sanctuary.

The most popular recreational use of the Sanctuary is by snorkelers and SCUBA divers who want to experience the aesthetic pleasure of diving on a well-developed coral reef. The forereef area is especially attractive because of the high vertical relief, abundant marine life, and the shallow, usually clear, water. At times during periods of amenable weather, over 50 commercial and private boats may be counted in the small spur and groove zone. Major activities are recreational diving and fishing. Diving businesses teaching SCUBA diving use Looe Key for open-water training.

The major activities of divers are viewing and photographing the lush coral formations and colorful fishes (Plates 2.3 and 2.4). The diversity and abundance of organisms make the reef a popular site for viewing the behavior of organisms in their natural surroundings (Plate 2.4). Attracting fishes by feeding them is also a popular activity (Plate 2.5). Divers may bring bait from shore, but often attract fishes by breaking up sea urchins (Plate 21.5). Inexperienced divers may damage coral by grasping, bumping and standing on coral. Poor seamanship in anchoring and running aground also damage the reef. More detail on human impacts on corals are presented later (Chapter 8).

Direct consumptive uses of the sanctuary involve collecting and fishing for commercial and recreational purposes. Commercial fishing in the Sanctuary concentrates on fishes and lobster. Lobster fishing is done primarily with wooden traps and to a lesser extent by hand. Both methods are prohibited in the forereef by Sanctuary regulations (Plate 2.6). Commercial fishing is done primarily with hook and line at night. Wire trap fishing only recently became popular in southern Florida despite being used for a long time throughout the Caribbean (Plate 2.6). Wire traps were legalized by the Fishery Management councils in 1984 for waters deeper than 100 ft which includes only a small portion of the Sanctuary. Some commercial tropical fish collecting occurred at Looe Key Reef before being banned in the Sanctuary.

Most recreational fishing is by hook and line and is directed toward either food fishes (Plate 2.7) or sport fishes (Plate 2.8). Among food fishes the traditional target species are snapper

(Lutjanidae), grouper (Serranidae), grunt (Haemulidae), mackerel (Scombridae), and the hogfish (*Lachnolaimus maximus*, Labridae). Sport fishing traditionally concentrated on barracuda (Sphyraenidae) (Plate 2.8), jacks (Carangidae), and sharks (usually Carcharhinidae). Recreational fishing efforts focus on bottom angling for bottom fishes and trolling for mid-water species. The population of southern Florida has grown dramatically in the last two decades and so has the number of fishermen. The cultural background of the population has also changed dramatically. These changes have resulted in more species being considered as acceptable food items.

Direct or indirect impacts of commercial and recreational fishing on the Sanctuary are not well documented. The amount of harvest from the Sanctuary is not known. Fishing activity results in hooks in fishes, corals and other organisms. Lost lures, hooks, sinkers, leaders, and line entangle octocorals, sponges and branching stony corals. Lobster traps, set on corals or dragged along the bottom by storm waves or during recovery, damage or destroy reef habitat.

The Sanctuary is also used as an educational and scientific resource. Educational institutions such as Seacamp the Newfound Harbor Marine Institute, use Looe Key Reef as a living laboratory for students of all ages and educational levels. The reef is ideal for teaching marine science as well as environmental awareness, appreciation, and understanding. A variety of scientific projects have been done in the sanctuary. Scientific research activities often involve some manipulation or temporary disturbance to the environment (Plate 2.9). Permits are required to collect for scientific or educational purposes.

Regulations have limited some historical consumptive uses in the sanctuary. Harvesting of coral at Looe Key Reef has stopped although it was apparently a common activity before being banned in Florida in the early 1970's. Amateurs and professionals collected coral primarily for tourist souvenirs. Unfortunately, no data are available on the extent to which coral harvesting occurred at Looe Key Reef. Spearfishing (Plate 2.10), tropical fish collecting, and shell collecting were also common activities at LKNMS before being banned with the establishment of the Sanctuary. Some poaching still occasionally occurs, however, either as a deliberate act or through ignorance of Sanctuary regulations.

#### Literature cited

U. S. Department of Commerce. 1980. Draft environmental impact statement, proposed Looe Key National Marine Sanctuary, April 1980. Natl. Oceanic Atmospheric Admin., Office Coastal Zone Mgmt. 128 pp.

U. S. Department of Commerce. 1983. Looe Key National Marine Sanctuary Management Plan. Natl. Oceanic Atmospheric Admin., Office Coastal Zone Mgmt. 58 pp.



Plate 2.3. Observing colorful fishes and beautiful coral formations is one of the major activities by snorkelers and SCUBA divers. The queen angelfish, *Holacanthus ciliaris*, (top) is one of the most colorful and graceful reef fish in Looe Key National Marine Sanctuary. Large colonies of pillar coral (*Dendrogyra cylindrus*) (bottom) are rare in the Florida Keys.

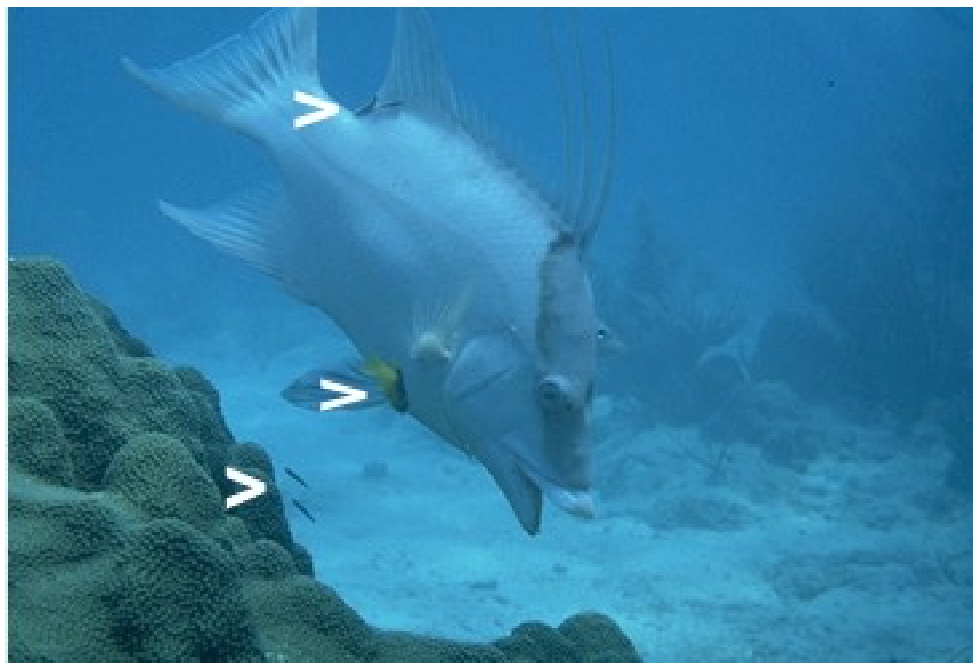


Plate 2.4. Underwater photography. (top) and the observation of natural behavior are popular activities by both scientists and non-scientists at Looe Key Reef. A hogfish, *Lachnolaimus maximus*, (bottom) is being cleaned of parasites at a cleaning station by neon gobies, *Gobiosoma oceanops* (upper and lower arrows), and a Spanish hogfish, *Bodianus rufus* (center arrow). Approaching fishes to observe behavior or to take pictures is very difficult in areas where spearfishing is a common activity.





Plate 2.5. Divers often take food underwater to attract fish such as these yellowtail, *Ocyurus chrysurus* (top). Sometimes sea urchins are broken up to attract smaller fishes (bottom). The impact of this activity is unknown.



Plate 2.6. Commercial fishing with wire fish traps (top) has increased in popularity in the Florida Keys during the last decade. Although fish traps are currently allowed only in waters deeper than 100 ft., there may be effects on fish populations within the Sanctuary. Lobster traps (bottom) are not allowed in the core reef area although an occasional trap is washed onto the reef where it can damage coral through wave action.

