NOAA Technical Memorandum NOS NCCOS CCMA 160
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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

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RESOURCE SURVEY OF LOOE KEY NATIONAL MARINE SANCTUARY 1983

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(Editor, 1983)

Prepared for: Office of Ocean and Coastal Zone Management
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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One of the objectives of the Coastal and Estuarine Data/Document Archeology and Rescue (CEDAR) Program is to collect unpublished data and documents on the South Florida coastal and estuarine ecosystem; convert and restore those judged valuable to the South Florida restoration effort into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 Archaeology 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.

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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

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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 excellance" 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.

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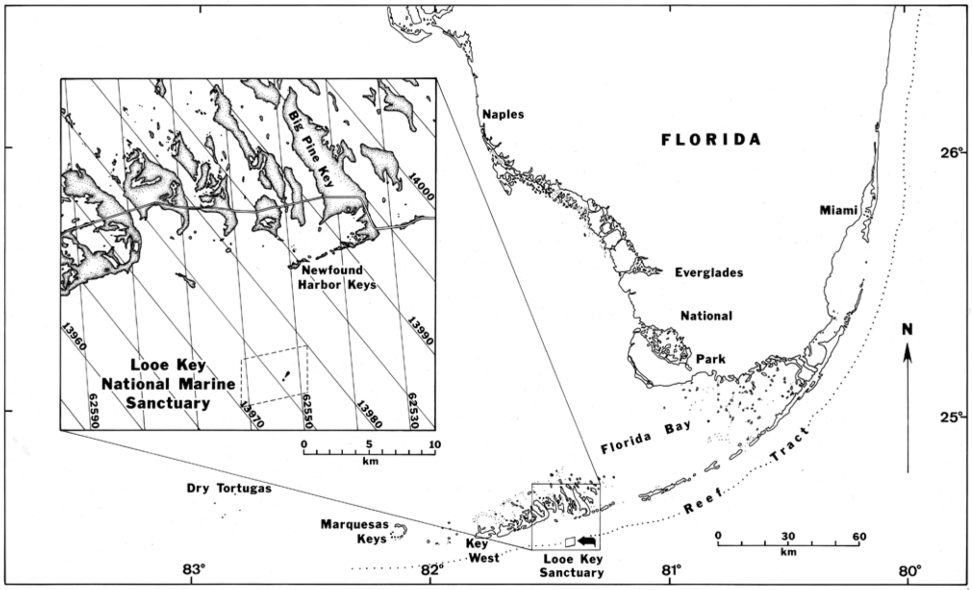

Figure 1.1. Index map for Looe Key National Marine Sanctuary. Loran C lines of position for Stations 1 (13900 µsec) and 4 (62500 µsec) for the Gulf of Mexico were reproduced from National Ocean Service chart #11442. Coast Guard Marker 24 within sanctuary (dashed lines on inset) indicated by standard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

CHAPTER 2

USES OF THE SANCTUARY

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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 (*Lachnolainus 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.

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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.

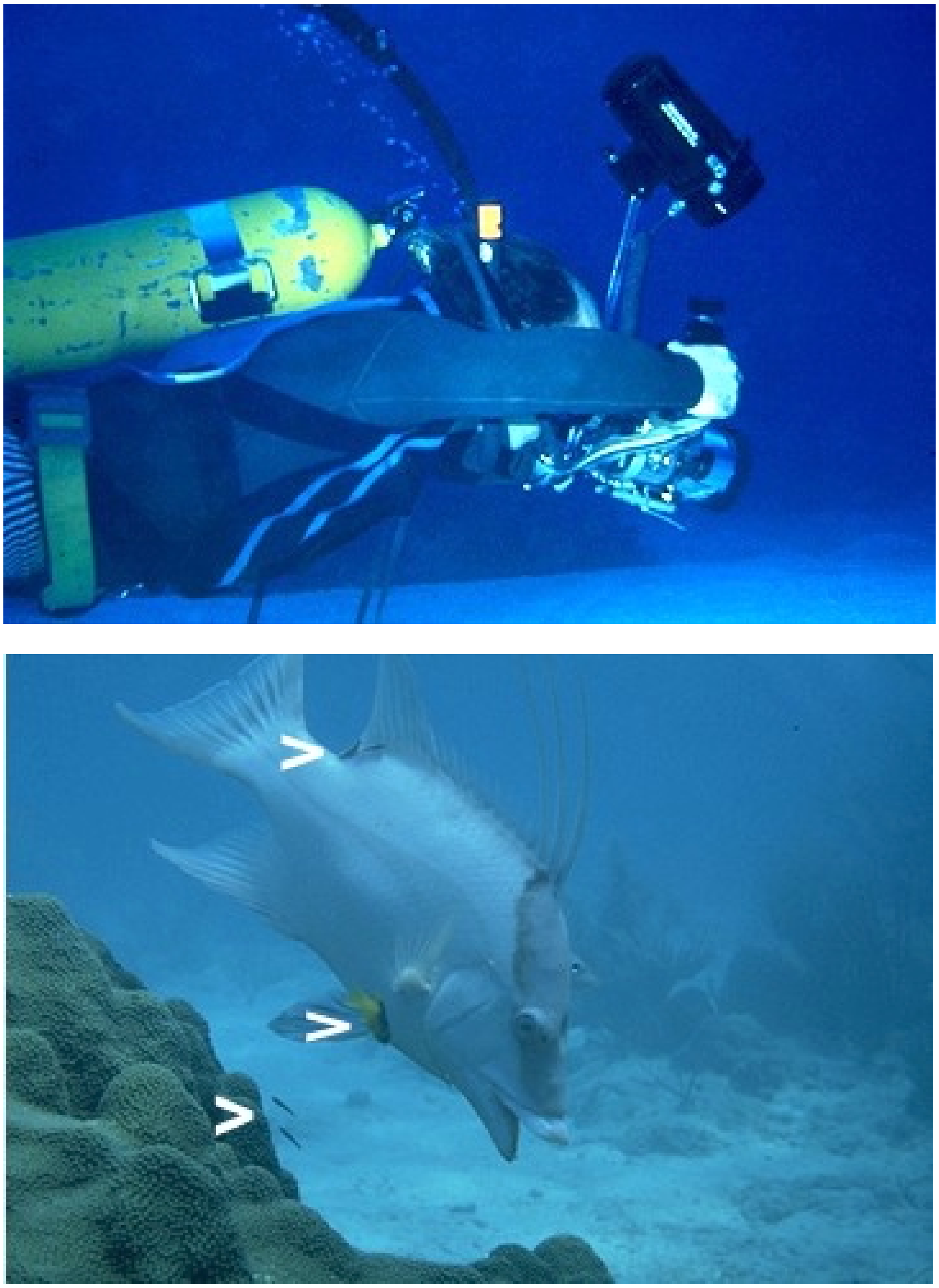

Plate 2.4. Underwater photography. (top) and the observation of natural behavior are popular activities by both scientists and non-scientists at Looe Key Reef. A hogfish, *Lachnolaimus maximus*, (bottom) is being cleaned of parasites at a cleaning station by neon gobies, *Gobiosoma oceanops* (upper and 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.