NOAA Technical Memorandum
NOS MEMD 5

RESOURCE SURVEY OF FISHES WITHIN LOOE KEY NATIONAL MARINE SANCTUARY

James A. Bohnsack, Douglas E. Harper, David B. McClellan, David L. Sutherland, and Michael W. White*

Miami Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 75 Virginia Beach Drive, Miami, FL 33149

* Sanctuary Manager, Key Largo National Marine Sanctuary, P.O. Box 1083, Key Largo, FL 33037

Washington, D.C.
August 1987

UNITED STATES DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Ocean Service

NOAA TECHNICAL MEMORANDA

National Ocean Service Series

Marine and Estuarine Management Division

The National Ocean Service, through its Office of Ocean and Coastal Resource Management, conducts natural resource management related research in its National Marine Sanctuaries and National Estuarine Reserve Research System to provide data and information for natural resource managers and researchers. The National Ocean Service also conducts research on and monitoring of site-specific marine and estuarine resources to assess the impacts of human activities in its Sanctuaries and Research Reserves and provides the leadership and expertise at the Federal level required to identify compatible and potentially conflicting multiple uses of marine and estuarine resources while enhancing resource management decisionmaking policies.

The NOAA Technical Memoranda NOS MEMD subseries facilitates rapid distribution of material that may be preliminary in nature and may be published in other referreed journals at a later date.

MEMD 1 M.M. Littler, D.S. Littler and B.E. Lapointe. 1986. Baseline Studies of Herbivory and Eutrophication on Dominant Reef Communities of Looe Key National Marine Sanctuary.

MEMD 2 M.M. Croom and N. Stone, Eds. 1987. Current Research Topics in the Marine Environment.

MEMD 3 C.E. Birkeland, R.H. Randall, R.C. Wass, B. Smith and S. Wilkens. 1987. Biological Resource Assessment of the Fagatele Bay National Marine Sanctuary

MEMD 4 H. Huber. 1987. Reproduction in Northern Sea Lions on Southeast Farallon Island, 1973-1985.

MEMD 5 J.A. Bohnsack, D.E. Harper, D.B. McClellan, D.L. Sutherland, and M.W. White. 1987. Resource Survey of Fishes within Looe Key National Marine Sanctuary.

National Marine Sanctuary Program
Marine and Estuarine Management Division
Office of Ocean and Coastal Resource Management
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

NOTICE

REPORT TO
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA TECHNICAL MEMORANDA SERIES NOS/MEMD

Resource Survey of Fishes Within Looe Key National Marine Sanctuary

James A. Bohnsack, Douglas E. Harper, David B. McClellan,
David L. Sutherland, and Michael W. White

August 1987

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
MARINE AND ESTUARINE MANAGEMENT DIVISION
WASHINGTON, D.C.

REPORT TO
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA TECHNICAL MEMORANDA SERIES NOS/MEMD

Resource Survey of Fishes Within Looe Key National Marine Sanctuary

James A. Bohnsack, Douglas E. Harper, David B. McClellan,
David L. Sutherland, and Michael W. White*

Miami Laboratory, Southeast Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
75 Virginia Beach Drive
Miami, FL 33149

* Sanctuary Manager
Key Largo National Marine Sanctuary
P.O. Box 1083
Key Largo, Fl 33037

This work is the result of research sponsored by the U.S.
Department of Commerce, National Oceanic and Atmospheric
Administration, National Ocean Service, Office of Ocean and
Coastal Resource Management, Marine and Estuarine Management Division
Under Contract Number NA-83-GA-C-00034

ABSTRACT

Reef fishes in Looe Key National Marine Sanctuary were visually quantified during the spring and summer of 1983 in habitats less than 13 m depth. Provided is the most detailed description of reef fish community structure ever done on a large reef system using non-destructive sampling methods. A total of 73,979 individuals representing 188 species and 48 families were observed in 10 habitat zones. Families that included more than 1% of the observed individuals were Pomacentridae (29%), Labridae (27%), Haemulidae (20%), Gobiidae (6%), Scaridae (5%), Lutjanidae (3%), Acanthuridae (3%), Carangidae (1%), and Chaetodontidae (1%). Six families had eight or more species: Serranidae (14), Scaridae (13), Pomacentridae (12), Haemulidae (12), Labridae (11), and Gobiidae (8). Indices of abundance with standard errors and percent frequency of occurrence with 95% confidence intervals are provided for reef fishes in the 10 habitat zones. Graphics are provided for selected species that were particularly abundant or ecologically important. Mean length and size ranges are shown for 117 species observed in the forereef habitat. The reef fish fauna was abundant, complex, and similar to reef fish community structures found on well-developed reefs worldwide. The usefulness of visual sampling of reef fish populations can provide an insight to reef fish trophic ecology. A basis for monitoring and detecting any significant future changes in reef fish distribution or abundance within the Sanctuary is also provided.

CONTENTS

Abstract 1

Contents 2

Introduction 4

Methods 5
Study area 5
Field methods 7
Stationary sampling (SS) censuses 7
Rapid visual (RV) censuses 8
Data analysis 9

Results 10

Discussion and conclusions 12
Visual census data 12
Community structure 14
Trophic ecology 17
Daily activity patterns 18

Acknowledgments 20

Literature cited 21

Figure captions 27

Plate captions 72

FIGURES

1. Location of Looe Key National Marine Sanctaury 28
2. Habitat map of Looe Key National Marine Sanctaury 29
3. Mean number of species and individuals per sample by habitat 30
4. Patterns of total abundance, frequency-of-occurrence, and estimated fork lengths of species observed in the forereef zone 31

TABLES

1. Phylogenetic listing of species observed at Looe Key National Marine Sanctuary 34
2. Distribution of numbers of species by family 41
3. Alphabetical listing of fishes observed 42
4. Mean abundance in different habitats 46
5. Percent frequency of occurrence in different habitats . . . 53
6. Summary of species in the forereef zone 60
7. Trophic structure of fishes 63
8. Summary of trophic activity analysis 71

PLATES

1. Ledges along the forereef spur formations provide shelter for many reef fishes 75
2. Parrotfishes 76
3. Typical damselfish and surgeonfish herbivores 77
4. Midwater herbivores 78
5. Typical pickers and browsers 79
6. Typical assemblages of fishes feeding in midwater 80
7. Typical diurnally active microinvertivores 81
8. Typical abundant damselfish and wrasses 82
9. Typical nocturnal planktivores 83
10. Typical nocturnal macroinvertivores 84
11. Typical softbottom microinvertivores 85
12. Typical macroinvertivores 86
13. The schoolmaster snapper, Lutjanus apodus 87
14. Typical roaming, soft bottom macroinvertivores 88
15. Typical small predators 89
16. Typical midwater predators 90
17. The great barracuda, Sphyraena barracuda 91
18. Large roaming predators 92
19. The bull shark, Carcharhinus leucas 93
20. Major disturbance events at Looe Key National Marine Sanctuary 94

APPENDICIES

1. Abundance, distribution, and frequency-of-occurrence of selected species 95

INTRODUCTION

Coral reefs have the highest concentration and diversity of fish species found on Earth. Coral reef fishes can be defined as fishes that spend part or all of their life cycle in close association with coral reefs. Starck (1968) divided species into primary and secondary reef fish species depending on whether they were closely associated with reef habitats or whether they were more closely associated with some other habitat. In reality, the definition of a coral reef fish is arbitrary because reef fishes are distributed in a continuous gradient ranging from obligate species, those almost completely associated with corals, to opportunistic species, whose occurrence on a reef is incidental or accidental. Probably all Caribbean reef fishes spend part of their life cycle away from reefs as planktonic eggs or larvae.

Coral reefs provide food and shelter for reef fishes (Plate 1) although little is known about the dynamics and community structure of coral reef fishes and their microhabitat requirements. Few quantitative studies of reef fish community structure on large reefs are reported (Talbot and Goldman, 1973; Jones and Chase, 1975; Alevizon and Brooks, 1975; Goldman and Talbot, 1976; Gladfelter and Gladfelter, 1978; Smith, 1979; Gladfelter et al., 1980). Most quantitative studies have concentrated on small sections of reef, on sparsely populated reefs, or on small isolated patch reefs or coral heads (Randall, 1963; Risk, 1972; Smith and Tyler, 1972, 1973a, 1973b, 1975; Reese, 1973; Smith, 1973, 1978; Russell et al., 1974; Sale, 1974, 1975, 1976a, 1976b, 1977, 1978; Sale and Dybdahl, 1975, 1978; Nolan, 1975; Luckhurst and Luckhurst, 1977, 1978; Itzkowitz, 1977; Molles, 1978; Talbot et al., 1978; Bohnsack, 1979). With two exceptions (Alevizon and Brooks, 1975; Bohnsack, 1982), only frequency data exist from large reefs in the

Florida Keys (Thompson and Schmidt, 1977; Jones and Thompson, 1978; Bohnsack, 1979; Colton and Alevizon, 1979; Tilmant et al., 1980; Bannerot and Schmale, 1983) which have only limited value.

This research was designed to provide quantitative data on reef fish populations in different habitats at Looe Key National Marine Sanctuary (LKNMS), Florida. The intent of this study was to provide a detailed baseline for future comparisons and to provide a better understanding of reef fish distribution and ecology. The effects of a marine sanctuary on biotic resources, including fishes, have never been quantitatively documented. At the time of the study, no studies of reef fish zonation had been published for Caribbean fishes, although several studies have been done in the Indo-Pacific region (e.g. Hiatt and Strasburg, 1960; Talbot and Goldman, 1973; Edwards and Rosewell, 1981; Harmelin-Vivien, 1981).

METHODS

Study Area

All observations were in habitats less than 13 m (40 ft) deep in Looe Key National Marine Sanctuary (LKNMS), a 5.3 mi^2 area of the Florida Reef Tract, located south of Big Pine Key, Florida (Fig. 1). The Sanctuary includes Looe Key Reef (LKR) and several reef-associated habitats (Fig. 2). The Sanctuary was established in part to protect the LKR forereef, which is large for the Florida Reef Tract and is noted for its well-developed spur and groove formations with high vertical relief.

We sampled six general bottom types: sand flats, seagrass beds, live bottom, buttress zone, forereef, and rubble zone (Fig. 2). Sand flats were barren flat areas of calcium carbonate sand composed primarily of fragments of corals, molluscs, and Halimeda (Lidz et al.,

1985). This habitat predominates in the Sanctuary and surrounds most of the reef, seagrass, and live bottom habitats. Seagrass beds were flat areas dominated by Thalassia testudinum with variable amounts of Syringodium filliforme. Live bottom was considered solid calcium carbonate substrate dominated by scattered sponges and soft corals, with some isolated hard corals. The buttress zone was dominated by hard corals, mainly Montastraea annularis, and was located seaward of the forereef in a depth range of 10 to 12 m (30 to 40 ft). The forereef was characterized by high relief spur and groove formations (Shinn et al., 1981) and was dominated by many species of hard coral (Wheaton and Jaap, in press). The forereef extended between the surface and a depth of 10 m. The rubble zone, located immediately shoreward of the forereef, was composed predominantly of unconsolidated broken coral fragments in shallow water between 0 and 3 m (10 ft). A deep reef ridge habitat also exists in LKNMS along the edge of the Straits of Florida at depths greater than 13 m, but it was not surveyed in this study. More detailed descriptions of habitats in LKNMS are provided by Shinn et al. (1981), Lidz et al. (1985), and Wheaton and Jaap (in press).

We divided the six bottom types into 10 zones for investigation (Fig. 2). Sand and live bottom habitats were separated into inshore and offshore zones because the location appeared to have influenced fish composition more than bottom type alone. Sand flats and seagrass beds in the lagoon shoreward of the forereef were also treated separately because of their proximity to the main reef and their shallow depth (1 to 3 m).

Field Methods

Fish censuses were taken with open-circuit SCUBA using a stationary visual census method described below. Management considerations required a non-destructive quantitative sampling method that could be repeated without harm to the sanctuary resources. Traditional sampling techniques utilizing ichthyocides, trawls, or blasting were not possible or were undesirable because of potential damage to the reefs. Visual censusing methods were ideal because of the predominately clear waters in the Sanctuary and the ease with which coral reef fishes could be identified. Visual sampling was non-destructive and provided data suitable for statistical treatment. Data were collected between 0930 and 1630 hours on various dates between 25 May 1983 and 17 September 1983, using a team of four divers.

Stationary Sampling (SS) Censuses

All fishes were counted by a diver standing on the bottom at randomly selected points in each habitat in the Sanctaury. At each point we recorded all species observed in 5 min within an imaginary cylinder extending from the surface to the bottom with an 8 m radius from the observer. Numbers of individuals of each species were counted and the mean and range of sizes (fork lengths) were estimated for each species. A ruler held out perpendicularly at the end of a meter stick aided in making size estimates by reducing apparent magnification errors. Size estimates of large fishes were made relative to the meter stick. Bohnsack (1979) found a significant correlation ($r = 0.99$, $p < 0.01$) between estimated and measured fish lengths.

A rigorous sampling regime was used to avoid bias and prevent counting the same individuals more than once. All sample points were

selected using a table of random numbers. Divers began each sample by facing seaward and listing all species within the field of view in the sample radius. When no new species were noted, new sectors were scanned by rotating to the left. New species were listed as observed. This process was continued for 5 min. Several complete rotations usually were made for each sample. Individuals were counted and size estimated immediately for species with few individuals (e.g. pomacanthids, chaetodontids, scarids) or for species not likely to remain in the sample area (e.g. carangids and Clepticus parrai). Species that were always present in the sample area (e.g., Thalassoma bifasciatum and Abudefduf saxatilis) and species not likely to leave the sample area (e.g., damselfishes) were initially listed as observed and counted after the initial five minute sample period. At the end of the initial five minute sample period, divers would make one 360° revolution for each species in the latter two groups, during which data were collected. To avoid bias, divers always worked back up the list counting and measuring each species in reverse order to their initial sighting. This procedure eliminated the bias towards counting species that were particularly noticeable and abundant. With the addition of the last procedure, each point census took approximately 20 min to complete. At each sample point, bottom features were recorded.

Rapid Visual (RV) Censuses

A total of 16 rapid visual samples (Thompson and Schmidt, 1977) were taken to provide comparative data for surveys done at other reefs in southern Florida (Jones and Thompson, 1978; Bannerot and Schmale, 1983). In this method divers attempted to find all observable species in 50-min periods. Each species was given a score from 5 to 1,

depending on which sequential 10-min interval the species was first observed. The survey area for this method only included the buttress, forereef, and lagoon areas. The same divers that collected data in the Bannerot and Schmale (1983) study collected 13 of the 16 samples reported here for Looe Key Reef.

Data Analysis

Data were computerized and analyzed at the Southeast Fisheries Center, National Marine Fisheries Service, Miami, Florida, U.S.A. Means and standard error estimates were calculated for abundance data, and percent frequency of occurrence with 95% confidence intervals were calculated for each species in each habitat zone. Species were then classified according to activity patterns and trophic characteristics based on published literature about the same or similar species (Hiatt and Strasburg, 1960; Starck and Davis, 1966; Randall, 1967; Hobson, 1972, 1973, 1974, 1975; Smith and Tyler, 1972, 1973a, 1973b; Hobson and Chess, 1976; Gladfelter and Johnson, 1983; Sano et al., 1984). We assigned species to trophic categories based on primary items found in the diet of adults (few juvenile fishes were observed for most species). This classification was used to characterize the trophic ecology of the observed reef fish community structure. Activity patterns were classified as diurnal, nocturnal, crepuscular, and generally active day and night. Trophic classifications used were herbivore, planktivore, carnivorous browser, microinvertivore, macroinvertivore, and piscivore. Feeding activity was characterized as being primarily near the bottom, in midwater, or at the surface.

RESULTS

A total of 188 fish species representing 48 families (Table 1) were observed during censuses in 10 habitat zones in LKNMS (Table 2). Temperatures during the study averaged 29.9 °C and ranged between 27.3 and 32.5 °C. Visibility averaged 17 m (54 ft) and ranged between 11 and 30 m (35 and 100 ft). A total of 161 species (155 in 5-min samples and six species after 5 min) were observed in 417 stationary samples; a total of 147 species were observed in 16 rapid visual samples (Table 3). To save space, some tables use a code for each species based on the first three letters of the genus and the first four letters of the trivial name. Full names can be identified in an alphabetical species list (Table 3).

Six families had eight or more species: Serranidae (14), Scaridae (13), Pomacentridae (12), Haemulidae (12), Labridae (11), and Gobiidae (8). Random point samples included a total of 73,979 counted individuals. Families that included more than 1% of the observed individuals were Pomacentridae (29%), Labridae (27%), Haemulidae (20%), Gobiidae (6%), Scaridae (5%), Lutjanidae (3%), Acanthuridae (3%), Carangidae (1%), and Chaetodontidae (1%). Total observed abundance (SS method), frequency of occurrence (SS and RV methods), and total scores (RV method) were reported for each species (Table 3). Random point data were summarized by species and habitat for abundance (Table 4) and frequency of occurrence (Table 5). Graphical presentations are provided for selected species that were particularly abundant or ecologically important (Appendix 1).

All observed species were classified according to trophic level, major periods of feeding activity, and the depth zone in which they

normally feed (Table 6). From this data, a summary of the trophic ecology of observed reef fishes was produced (Table 7). Trophic classification of 188 species observed yielded 32 herbivores (14% of all individuals); 32 planktivores (48% of individuals); 14 browsers (2% of individuals); 31 microinvertivores (10% of individuals); 52 macroinvertivores (24% of individuals); and 27 piscivores (2% of individuals). Herbivorous species were dominated by scarids, pomacentrids (i.e., Pomacentrus), acanthurids, and kyphosids (Plates 2, 3, 4). Carniverous browsers, dominated by pomacanthids, chaetodontids, ostraciids, and tetradontids (Plates 5, 7), fed by taking bites out of animals such as sponges, tunicates, and polychaete worms. Microinvertivores (Plates 7, 8), dominated by clinids, labrids, and smaller serranids, were mostly active during the day. Planktivores were usually found just above the reef in midwater and were dominated by pomacentrids (i.e., Chromis and Abudefduf) and labrids during the day (Plates 6, 8) and by apogonids and phempherids (Plate 9) at night. Macroinvertivores, dominated by haemulids, holocentrids, mullids, and some lutjanids (Plates 10, 11, 12, 13) tended to feed actively at night, although some fed at other times (Plate 14). Piscivores varied greatly in size (Plates 15 to 19), were dominated by crepuscularly active species, and included resident, visiting, and transient species. Piscivores were dominated by lutjanids (Plates 13, 16), muraenids (Plate 15), serranids (Plates 15, 18), carangids (Plate 16), sphyraenids (Plate 17), and elopids (Plate 18). Carcharhinids (requieum sharks), the largest predators known to occur in the sanctuary, tend to be crepuscularly or nocturnally active and were not observed during censuses.

DISCUSSION AND CONCLUSIONS

Collected data provide a detailed quantitative description of the fish fauna observed in Looe Key National Marine Sanctuary for depths less than 13 m. The 188 total species observed in LKNMS was consistent with other reef fish studies from the Florida Keys based on visual techniques. Jones and Thompson (1978) found a total of 165 species (146 species on reefs in Key Largo and 134 species on reefs in the Dry Tortugas). Bannerot and Schmale (1983) recorded 228 species from 18 sites (including non-reef habitats) in Key Largo. Longley and Hildebrand (1941) reported 440 species of fishes from the Dry Tortugas region of Florida. Starck (1968) reported 517 species of fishes from the Alligator Reef region of the Florida Keys, but only 389 species were associated with reefs. Of these, 253 species were primarily associated with reefs and 134 species were more characteristic of other habitats (Starck, 1968). Differences in sampling methods explain the greater number of species found by Longley and Hildebrand (1941) and Starck (1968). These studies were based on sampling for many years in a variety of habitats. Also a variety of sampling techniques were used which collected fishes not easily observed by visual sampling. In this study we did not sample deeper reef areas which would have added additional species.

Visual Census Data

Results show clearly that LKNMS has a well-developed reef fish fauna. Comparison of rapid visual census data with previous studies using the same methods indicates that Looe Key Reef is comparable to other outer reefs in Key Largo, Florida. We found 128 species in each of two independent sets of eight rapid visual samples at Looe Key Reef

(147 species in 16 samples). Jones and Thompson (1978) and Bannerot and Schmale (1983) reported 120 and 123 species, respectively, from Molasses Reef, 118 and 126 species from French Reef, and 104 and 131 (n=12 samples) species from Carysfort Reef in eight rapid visual samples. Elbow Reef had 118 species (Bannerot and Schmale, 1983). The slightly higher number of species reported for Looe Key Reef is not statistically significant ($p > 0.05$). More detailed comparisons and analysis of RV data were not undertaken for this report because of questions concerning the assumptions and validity of the RV method (DeMartini and Roberts, 1982; Bannerot and Schmale, 1983)

This study was not intended to be a comparison of rapid visual methods with stationary sampling methods. Data from the two methods (Table 3) are not directly comparable, because different habitat zones were sampled using the two methods. Although both methods counted similar species, the rapid visual census method probably is better at detecting some rare, cryptic, and secretive species (e.g., Apogonidae). The random point census method, however, is probably better at providing more precise quantitative data on abundance, size, and habitat specificity.

Abundance data reported from stationary samples are indices of abundance that probably underestimate the true abundance of most species, because some individuals are not likely to be seen from any one vantage point. Thus, calculations of absolute density are inappropriate unless empirically derived correction factors are applied (Sale and Sharp, 1983; Bohnsack and Bannerot, in press). However, the data do provide an estimate of relative abundance and should be quantitatively comparable when contrasting similar habitats between reefs or the same

locations through time. Bohnsack and Bannerot (1983, in press) provide further discussion on the stationary sampling census technique.

Community Structure

Data presented here provide a static description (or snapshot) of reef fish community structure at LKNMS from May through September 1983. Data presented (Tables 4 and 5) do not show seasonal changes (intrayear) or normal between-year (interyear) variation. Different species and abundances could have been observed if sampling had occurred in other seasons and in deeper habitats. Past observations (JAB) indicated barracuda, Sphyraena barracuda, and bar jack, Caranx ruber, in particular, were more abundant during winter months when water temperatures were lower than observed during this study.

Little is known about natural seasonal or yearly dynamic changes in reef fish populations, although a major controversy exists regarding the stability of reef fish populations and communities. One group considers reef fish fauna on large reefs essentially stable (Gladfelter and Gladfelter, 1978; Smith 1978, Gladfelter et al., 1980; Ogden and Ebersole, 1981) while another considers the fauna quite variable (Sale, 1980a, b; Williams and Sale, 1981; Bohnsack, 1983b). Results reported here do not answer this controversy, although they can be used as a basis for detecting any future changes, whether from natural or human causes.

Natural occurrences such as storms (Kaufman, 1983), epidemic diseases, cold kills (Bohnsack, 1983a; see Plate 20), and variations in recruitment also can affect reef fish communities. Two unique phenomena involving the entire Caribbean area occurred in 1983 that potentially could have influenced the fish fauna: extremely high water

temperatures associated with El Nino oceanographic events (Canby, 1984) and a mass mortality in August of the sea urchin, Diadema antillarum (Lessios et al., 1984). No obvious impacts of either of these two events on reef fish community structure were noted. Between 18 June and 9 July 1980, one of us (JAB) documented large numbers of fishes killed at Looe Key Reef and other reefs by an unknown disease. Species most affected included pomacanthids, lutjanids, balistids, and holocentrids. Nothing is known about the causes or ecological impacts of such epidemics of reef fishes at Looe Key reef.

One important result of this survey was the documentation of variation in species occurrence and abundance between different reef habitat zones (Tables 4 and 5; Fig. 3; Appendix 1). Data for all observed species are presented by zone for future reference purposes (Tables 4 and 5). Too often, only common, abundant, or economically important species are treated while other species are ignored. Rare species can be important, however, because they are often more sensitive than common species to environmental changes, and over time rare species can become abundant. Increases in abundance of rare species may be as important as decreases in abundance of common species.

Average numbers of species and individuals observed per sample (Fig. 3) show that fishes are closely associated with the presence of reef habitat. Whether this close association with coral habitat is a consequence of availability of food, shelter, or both cannot be ascertained from this study. A reef is an association of several different habitats. Many past studies have reported population values from reefs based on censuses that lumped different habitat zones (Jones and Thompson, 1978; Bannerot and Schmale, 1983). Results presented here suggest that such figures may be misleading without taking into account

the relative sampling effort in different zones and the absolute area of different habitats comprising a reef. Patterns of species distribution between habitat zones over a distance of a couple of kilometers in this study are similar to patterns found along distances well over 100 km in the Great Barrier Reef (Anderson et al., 1981; Williams, 1982). Each species tends to have its unique patterns of abundance and frequency of occurrence (Appendix 1), although there is a clear trend for planktivores to be associated with the forereef zone where plankton resources are abundant and can be easily exploited.

Community structure of the forereef zone was examined in detail because it receives the most intensive human use and was structurally the most complex habitat. Results demonstrate no necessary correlation between abundance, frequency-of-occurrence, and length for individual species (Fig. 4, Table 6) based on 117 species observed in 160 random stationary samples from the forereef. The approximate linear decline in ranked $\log_{10}$ abundance patterns (Fig. 4a) is typical of many undisturbed, highly diverse tropical communities (Brower and Zar, 1977; Hubbell, 1979). Species ranked according to frequency of occurrence (Figure 4b) showed an orderly decline from a few common species to many rare species which is typical of tropical reef systems. Mean fish lengths varied by two orders of magnitude (Fig. 4c), which suggests that total biomass varied greatly between species. Similar patterns exist for other habitats, although detailed analyses were not done for this report.

Trophic Ecology

General patterns of feeding relationships for observed reef fishes were examined. Assigning species into trophic or ecological categories is imprecise and often arbitrary. Most species are food generalists and will eat a wide variety of items available (Randall, 1967; Sale, 1977; Hobson, 1972, 1974; Sano et al., 1984) (see Plate 20). Diets for predators often change greatly depending on habitat and individual size (Starck, 1968). Despite these cautions, trophic and activity analyses provide some insight into the ecology of the reef fish fauna in LKNMS.

Classification of the 188 species observed showed 17% were herbivores, 16% were planktivores, and the remaining 67% were carnivores (Table 7). Harmelin-Vivien (1981) used a slightly different classification but found similar results from reefs in Madagascar: 9% herbivores, 17% omnivores, and 74% carnivores at some level. Almost half (48%) of the 73,979 counted individuals were planktivorous, 14% were herbivorous, and the remaining 38% were carnivorous at some level (Table 8). Only about 2% of the observed individuals could be considered primarily piscivores. Harmelin-Vivien (1981) reviewed reports from other reefs and found similar percentages worldwide. Low percentages of herbivores reported here were also reported by Randall (1963, 1967), Talbot and Goldman (1973), Bakus (1967), and Goldman and Talbot (1976), but not by Odum and Odum (1955).

Other studies have reported an inverse pyramid of biomass for reef fishes from other areas (Bardach, 1959; Randall, 1963; Talbot and Goldman, 1973). This study showed a similar pattern, although data were not directly comparable because we used number of individuals; the previous studies were based on biomass. Most planktivores are small fishes whereas predators tend to be larger fishes, so biomass would be

skewed more in favor of the top carnivores than numbers of individuals alone reflect.

Daily Activity Patterns

Harmelin-Vivien (1981) found 60% of reef fish species sampled in Madagascar were diurnally active, 32% were nocturnally active, and 8% were active day and night. We found similar results: 61% diurnal, 34% nocturnal (including 10% primarily creprescular), and only 5% active day and night. Harmelin-Vivien (1981) found that 63.5% of the individuals in explosive and rotenone samples species that were active during the day. Similarly, we found that 73% of the individuals in visual samples were active during the day. The degree of similarity is surprising considering visual methods are probably greatly biased against detecting nocturnally active species and individuals.

Primary patterns of activity were closely related to trophic structure (Table 7) as has been described for other reef systems (Hobson 1972, 1973, 1974, 1975). Herbivores and browsers were entirely diurnally active and microinvertivores were almost exclusively diurnally active. These fishes probably require good light conditions to see their food resources. Planktivorous fishes are divided into diurnally active and nocturnally active species with no overlap. Nocturnally active planktivores have large eyes for nighttime feeding. Macroinvertivores and piscivores have representatives in all classifications of activity, although most macroinvertivores are nocturnal and most piscivores are crepuscular. Most Caribbean nocturnal macroinvertivores are schooling species that remain in inactive schools on reefs during the day and forage away from the reef at night (Randall, 1965; Ogden and Ehrlich, 1977). This daytime resting behavior is

thought to be an adaption to avoid predation (McFarland et al., 1979). Piscivores have eyes particularly adapted for changing crepuscular light conditions, which probably gives them advantages over species that are either diurnally or nocturnally active. All fishes active both day and night were carnivorous, as found by Harmelin-Vivien (1981), and tended to be large, which probably helps them to escape predation.

In conclusion, the objective of this investigation was to quantitatively describe reef fish resources in LKNMS using visual methods. This study is the most detailed description of reef fish community structure ever done on a large reef system using non-destructive sampling methods. Indicies of abundance with standard errors and percent frequency of occurrence with 95% confidence intervals were calculated for observed reef fishes in 10 habitat zones. Mean length and size ranges were shown for 117 species observed in the forereef habitat. Results demonstrated the usefulness of visual sampling of reef fish populations and provided an insight to reef fish trophic ecology. Results also provided a basis for monitoring and detecting any significant future changes in reef fish distribution or abundance within the Sanctuary. The reef fish fauna at LKNMS is abundant, complex, and similar to reef fish community structures found on well-developed reefs worldwide.

ACKNOWLEDGMENTS

We thank in alphabetical order: S. Bannerot, M. Bastian, B. Becker, B. Bohnsack, G. Beardsley, J. Halas, R. Hixon, I. Hooper, E. Lindblad, and M. Schmale. Special thanks goes to B. Causey, LKNMS Manager, for his help, information, and comments and to B. Lidz for editorial comments and for providing Figure 1. Unless otherwise indicated all photographs were taken at Looe Key Reef by J. Bohnsack. Funding for this project was provided by the Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, NOAA. Research was supported in part under Contract NA83-GA-C-00034 to the Cooperative Institute for Marine and Atmospheric Studies, University of Miami. Additional logistical support was provided by the Newfound Harbor Marine Institute, and the Division of Parks and Recreation, State of Florida Department of Natural Resources. We dedicate this report to the memory of Raymond F. Hixon who participated in the study and who loved Looe Key Reef.

LITERATURE CITED

Alevizon, W. S. and M. G. Brooks. 1975. The comparative structure of two western Atlantic reef-fish assemblages. Bull. Mar. Sci. 25: 482-490.

Anderson, G. R. V., A. H. Ehrlich, P. R. Ehrlich, J. D. Roughgarden, B. C. Russell, and F. H. Talbot. 1981. The community structure of coral reef fishes. Am. Nat. 117: 476-495.

Bakus, G. J. 1967. The feeding habits of fishes and primary production at Eniwetok, Marshall Islands. Micronesica 3(2): 135-149.

Bannerot, S. P. and M. C. Schmale. 1983. Assessment of fish communities in John Pennekamp Coral Reef State Park and Key Largo Coral Reef Marine Sanctuary with comments on the use of a rapid visual technique. Final Report to the Sanctuary Programs Office, Division of Ocean and Coastal Resource Management, NOAA, Department of Commerce, Washington, D.C. 99 p.

Bardach, J. E. 1959. The summer standing crop of fish on a shallow Bermuda reef. Limnol. Oceanogr. 4:77-85.

Bohnsack, J. A. 1979. The ecology of reef fishes on isolated coral heads: An experimental approach with emphasis on island biogeographic theory. Ph. D. Dissertation. University of Miami, Coral Gables, Fla. 279 p.

Bohnsack, J. A. 1982. Effects of piscivorous predator removal on coral reef fish community structure. In G. M. Caillet and C. A. Simenstad (eds.). Gutshop'81: Fish food habits studies. Washington Seagrant Publication, Univeristy of Washington. Seattle.

Bohnsack, J. A. 1983a. Resiliency of reef fish communities in the Florida Keys following a January 1977 hypothermal fish kill. Env. Biol. Fish. 9(1): 41-53.

Bohnsack, J. A. 1983b. Species turnover and the order versus chaos controversy concerning reef fish community structure. Coral Reefs 1(1): 223-228.

Bohnsack, J. A. and S. P. Bannerot. 1983. A random point census technique for visually assessing coral reef fishes. In C.A. Barans and S.A. Bortone (eds.). The visual assessment of fish populations in the southeastern United States: 1982 Workshop. South Carolina Sea Grant Consortium, Technical Report 1 (SC-SG-TR-01-83). p. 5-7.

Bohnsack, J. A. and S. P. Bannerot. (in press). A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NMFS Technical Reports.

Brower, J. E. and J. H. Zar. 1977. Field and laboratory methods for general ecology. Wm. C. Brown Co., Publishers. Dubuque, Iowa, 194 p.

Canby, T. Y. 1984. El Nino's ill wind. Nat. Geo. 165(2): 144-183.

Colton, D. E. and W. S. Alevizon. 1979. A description of the fish assemblage associated with a calcium carbonate reef off the Florida Keys. Fla. Sci. 42 (Suppl. 1): 22 (Abstract).

DeMartini, E. E. and D. Roberts. 1982. An empirical test of biases in the rapid visual technique for species-time censuses of reef fish assemblages. Mar. Biol. 70: 129-134.

Edwards, A. and J. Rosewell. 1981. Vertical zonation of coral reef fishes in the Sudanese Red Sea. Hydrobiologia 79:21-31.

Gladfelter, W. B. and E. H. Gladfelter. 1978. Fish community structure as a function of habitat structure of West Indian patch reefs. Rev. Biol. Trop. 26 (suppl 1): 65-84.

Gladfelter, W. B. and W. S. Johnson. 1983. Feeding niche separation in a guild of tropical reef fishes (Holocentridae). Ecology 64(3): 552-563.

Gladfelter, W. B., J. C. Ogden, and E. H. Gladfelter. 1980. Similarity and diversity among coral reef fish communities: a comparison between tropical western Atlantic (Virgin Islands) and tropical central Pacific (Marshall Islands) patch reefs. Ecology 61: 1156-1168.

Goldman, B. and F. Talbot. 1976. Aspects of the ecology of coral reef fishes. In O. A. Jones and R. Endean (editors), Biology and gdeology of coral reefs. Vol. 3, Biol. 2. p. 125-154. Academic Press. N.Y.

Harmelin-Vivien, M. L. 1981. Trophic relationships of reef fishes in Tulear (Madagascar). Oceanologica ACTA 4(3): 365-374.

Hiatt, R. W. and D. W. Strasburg. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. Ecol. Monogr. 30:65-127.

Hobson, E. S. 1972. Activity of Hawaiian reef fishes during the evening and morning daylight and darkness. Fish. Bull. U.S. 70(3): 715-740.

Hobson, E. S. 1973. Diel feeding migrations in tropical reef fishes. Helgolander will. Meeresunters. 24: 361-370.

Hobson, E. S. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. Fish. Bull. U.S. 72: 915-1031.

Hobson, E. S. 1975. Feeding patterns among tropical reef fishes. Am. Sci. 63: 382-392.

Hobson, E. S. and J. R. Chess. 1976. Trophic relationships among fishes and plankton in a lagoon at Enewetak Atoll, Marshall Islands. Fish. Bull. U.S. 74: 567-598.

Hubbell, S. P. 1979. Tree dispersion, abundance, and diversity in a tropical dry forest. Science 203: 1299-1309.

Itzkowitz, M. 1977. Spatial organization of the Jamaican damselfish community. J. Exp. Biol. Ecol. 28: 217-241.

Jones, R. S. and J. A. Chase. 1975. Community structure and distribution of fishes in an enclosed high island lagoon in Guam. Micronesica 11: 127-148.

Jones, R. S. and M. J. Thompson. 1978. Comparison of Florida reef fish assemblages using a rapid visual technique. Bull. Mar. Sci. 28: 159-172.

Kaufman, L. S. 1983. Effects of Hurricane Allen on reef fish assemblages near Discovery Bay, Jamaica. Coral Reefs 2(1): 43-47.

Lessios, H. A., D. R. Robertson, and J. D. Cubit. 1984. Spread of Diadema mass mortality through the Caribbean. Science 226: 335-337.

Lidz, B. H., D. M. Robbin, and E. A. Shinn. 1985. Holocene carbonate sedimentary petrology and facies accumulation, Looe Key National Marine Sanctuary, Florida. Bull. Mar. Sci. 36(3): 672-700.

Longley, W. H. and S. F. Hildebrand. 1941. Systematic catalogue of the fishes of Tortugas, Florida with observations on color, habits and local distributions. Pap. Tortugas Lab. 34. 331 p.

Luckhurst, B. E. and K. Luckhurst. 1977. Recruitment patterns of coral reef fishes on the fringing reef of Curacao, Netherlands Antilles. Can. J. Zool. 55: 681-689.

Luckhurst, B. E. and K. Luckhurst. 1978. Nocturnal observations of coral reef fishes along depth gradients. Can. J. Zool. 56: 155-158.

McFarland, W. N., J. C. Ogden, and J. N. Lythgoe. 1979. The influence of light on the twilight migrations of grunts. Envir. Biol. Fish. 4: 9-22.

Molles, M. C., Jr. 1978. Fish species diversity on model and natural reef patches: experimental insular biogeography. Ecol. Monog. 48: 289-305.

Nolan, R. S. 1975. The ecology of patch reef fishes. (Ph. D. Dissertation). U. of California, San Diego. 229 p.

Odum, H. T. and E. P. Odum. 1955. Trophic structure and productivity of a windward coral reef community on Eniwetok Atoll. Ecol. Monogr. 25: 291-320.

Ogden, J. C. and J. P. Ebersole. 1981. Scale and community structure of coral reef fishes: A long-term study of a large artificial reef. Mar. Ecol. Prog. Ser. 4:97-103.

Ogden, J. C. and P. R. Ehrlich. 1977. The behavior of heterotypic resting schools of juvenile grunts (Pomadasyidae). Mar. Biol. 42: 273-280.

Randall, J. E. 1963. An analysis of the fish populations of artificial and natural reefs in the Virgin Islands. Carib. J. Sci. 3(1): 31-47.

Randall, J. E. 1965. Grazing effect on sea grasses by herbivorous reef fishes in the West Indies. Ecology 46:255-60.

Randall, J. E. 1967. Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. 5: 665-847.

Reese, E. S. 1973. Duration of residence by coral reef fishes on "home" reefs. Copeia 1973: 145-149.

Risk, M. J. 1972. Fish diversity on a coral reef in the Virgin Islands. Atoll Res. Bull. 193:1-6.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A.Lachner, R. N. Lea, and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 12. Bethesda, Maryland. 174 p.

Russell, B. C., F. H. Talbot, and S. B. Domm. 1974. Patterns of colonizaton of artificial reefs by coral reef fishes. Proc. 2nd Int'l. Coral Reef Symp. 1: 207-215.

Sale, P. F. 1974. Mechanisms of co-existence in a guild of territorial fishes at Heron Island. Proc. 2nd Int'l. Coral Reef Symp. 1:193-206.

Sale, P. F. 1975. Patterns of use of space in a guild of territorial reef fishes. Mar. Biol. 29: 89-97.

Sale, P. F. 1976a. The effect of territorial adult pomacentrid fishes on the recruitment and survival of juveniles on patches of coral rubble. J. Exp. Mar. Ecol. 24: 297-306.

Sale, P. F. 1976b. Reef fish lottery. Nat. Hist. 85: 60-65.

Sale, P. F. 1977. Maintenance of high diversity in coral reef fish communities. Am. Nat. 111: 337-359.

Sale, P. F. 1978. The ecology of fishes on coral reefs. Oceanogr. Mar. Biol. Ann. Rev. 18:367-421.

Sale, P. F. 1980a. Assemblages of fish on patch reefs - predictable or unpredictable? Env. Biol. Fish. 5(3): 243-249.

Sale, P. F. 1980b. The ecology of fishes on coral reefs. Oceanogr. Mar. Biol. Ann. Rev. 18: 367-421.

Sale, P. F. and R. Dybdahl. 1975. Determinants of community structure for coral reef fishes in an experimental habitat. Ecology 56: 1343-1355.

Sale, P. F. and R. Dybdahl. 1978. Determinants of community structure for coral reef fishes in isolated coral heads at lagoonal and reef slope sites. Oecologia 34: 57-74.

Sale, P. F. and B. J. Sharp. 1983. Correction for bias in visual transect censuses of coral reef fishes. Coral Reefs 2(1): 37-42.

Sano, M., M. Scimizu, and Y. Nose. 1984. Food habits of teleostean reef fishes in Okinawa island, southern Japan. The University Museum, University of Tokyo, Bulletin No. 25. 128 p.

Shinn, E. A., J. H. Hudson, D. M. Robbin and B. Lidz. Spurs and grooves revisited: construction versus erosion, Looe Key Reef, Florida. Proc. Fourth Int'l. Coral Reef Symp. 1: 475-484.

Smith, C. L. 1973. Small rotenone stations: A tool for studying coral reef fish communities. Amer. Mus. Novit. 2512: 1-21.

Smith, C. L. 1978. Coral reef communities: A compromise view. Env. Biol. Fish. 3: 109-128.

Smith, C. L. and J. C. Tyler. 1972. Space resource sharing in a coral reef fish community. L. A. Co. Natur. Hist. Mus. Sci. Bull. 14: 125-170.

Smith, C. L. and J. C. Tyler. 1973a. Direct observations of resource sharing in coral reef fish. Helgolander wiss. Meeresunters. 24: 264-275.

Smith, C. L. and J. C. Tyler. 1973b. Population ecology of a Bahamian suprabenthic shore fish assemblage. Amer. Mus. Novit. 2528: 1-38.

Smith, C. L. and J. C. Tyler. 1975. Succession and stability in fish communities of dome-shaped patch reefs in the West Indies. Amer. Mus. Novit. 2572. 1-18.

Smith, G. B. 1979. Relationship of eastern Gulf of Mexico reef-fish communities to the species equilibrium theory of insular biogeography. J. Biogeography 6: 49-61.

Starck, W. A., II. 1968. A list of fishes of Alligator Reef, Florida with comments on the nature of the Florida reef fish fauna. Undersea Biol. 1(1): 5-36.

Starck, W. A., II., and W. P. Davis. 1966. Night habits of fishes of Alligator Reef, Florida. Ichthyologica 38(4): 313-356.

Talbot, F. H. and B. Goldman. 1973. A preliminary report on the diversity and feeding relationships of reef fishes of One Tree Island, Great Barrier Reef System. p. 425-443. In Proc. Symp. Coral and Coral Reefs 1969. Mar. Biol. Assoc. India.

Talbot, F. H., B. C. Russell, and G. R. V. Anderson. 1978. Coral reef fish communities: Unstable, high diversity systems? Ecol. Monog. 48: 425-440.

Thompson, J. P. and T. W. Schmidt. 1977. Validation of the species/time random count technique for sampling fish assemblages at Dry Tortugas. Proc. 3rd Int'l. Coral Reef Symp. 1: 283-288.

Tilmant, J. T., G. P. Schmahl, and D. Morrison. 1980. An ecological assessment of Biscayne National Monument's coral reefs in relation to recreational use. In J. Gouge (editor). Proc. 2nd Conf. on Sci. Resch. in the Nat. Pks. San Francisco, Ca. 9: 183-224.

Wheaton, J. L. and W. C. Jaap. (in press). Looe Key National Marine Sanctuary Resource Survey: corals and other major benthic cnidaria. NOAA Technical Report OCRM SPD 000.

Williams, D. M. 1982. Patterns in the distribution of fish communities across the central Great Barrier Reef. Coral Reefs 1(1):35-43.

Williams, D. M., and P. F. Sale. 1981. Spatial and temporal patterns of recruitment of juvenile coral reef fishes to coral habitats within "One Tree Lagoon", Great Barrier Reef. Mar.Biol. 65: 245-253.

FIGURE CAPTIONS

Figure 1.--Location of Looe Key National Marine Sanctuary. Loran C lines of position were reproduced from National Ocean Survey chart #11442. Coast Guard Marker 24 within the Sanctuary (dashed lines on inset) was indicated by standard nautical chart symbol for position of lighted fixed marker. Figure is from Lidz et al. (1985).

Figure 2.--Habitat map of Looe Key National Marine Sanctuary. Areas seaward (south) of the dashed line could not be distinguished from aerial photography. The dotted line encloses the lagoon. Offshore sand bottom describes sand bottom seaward of the forereef; inshore sand bottom was considered sand bottom shoreward of the forereef.

Figure 3.--Mean number of species (top) and individuals (bottom) per stationary sample by habitat. Boxes show 95% confidence limits, vertical lines show ranges, and numbers indicate the number of samples in each habitat. Habitats are in approximate ordered they occur proceeding from offshore to inshore areas (See Fig. 2).

Figure 4.--Patterns of total abundance, frequency-of-occurrence, and estimated fork lengths for 117 species observed in 160 stationary samples in the forereef zone. A. Ranked abundance. B. Ranked frequency-of-occurrence. C. Ranked estimated mean lengths with ranges from minimum to maximum observed length. Coded species names can be identified from the alphabetical listings (Table 3). Actual abundance, frequency, and length values for each species are provided in Table 6.

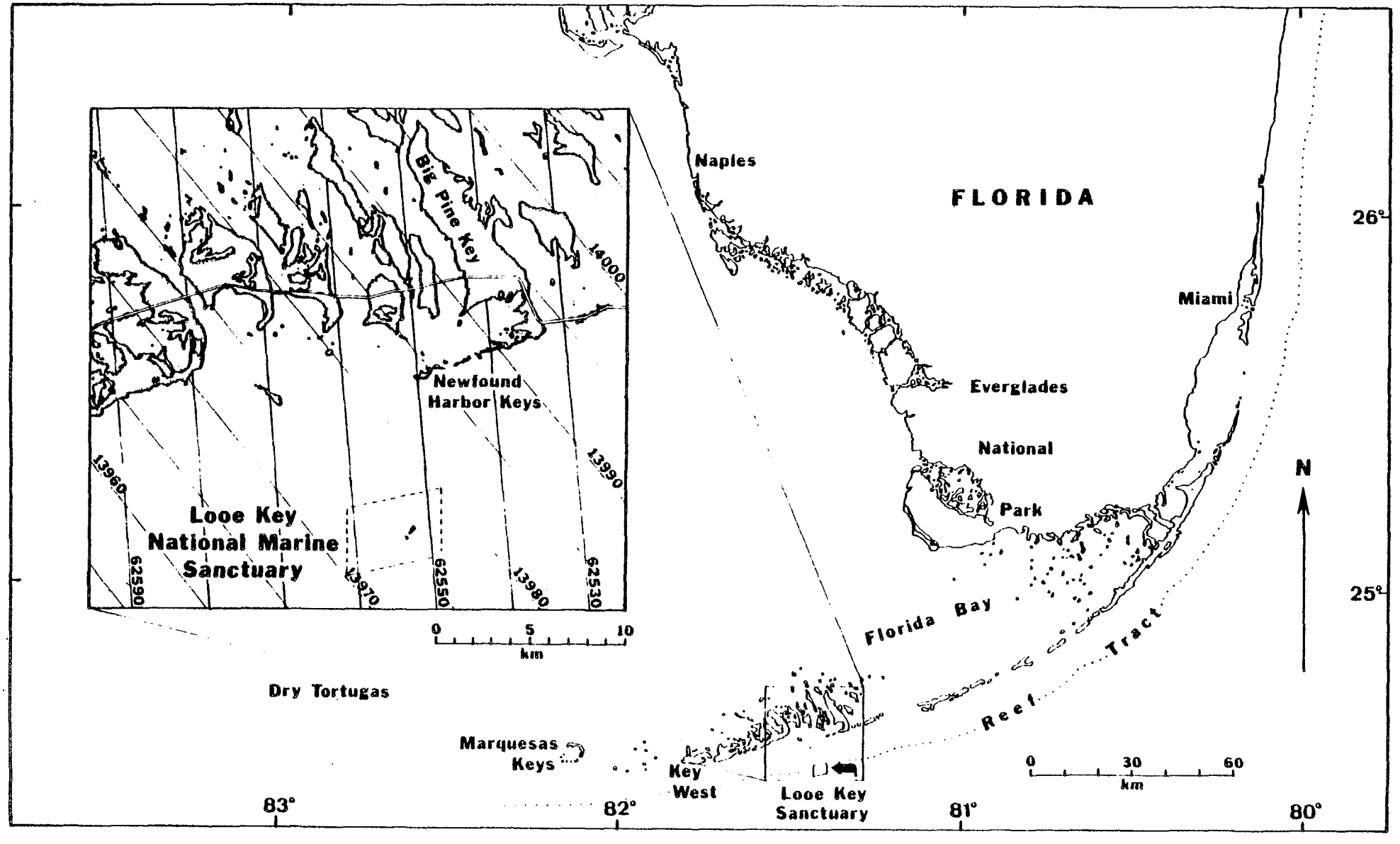
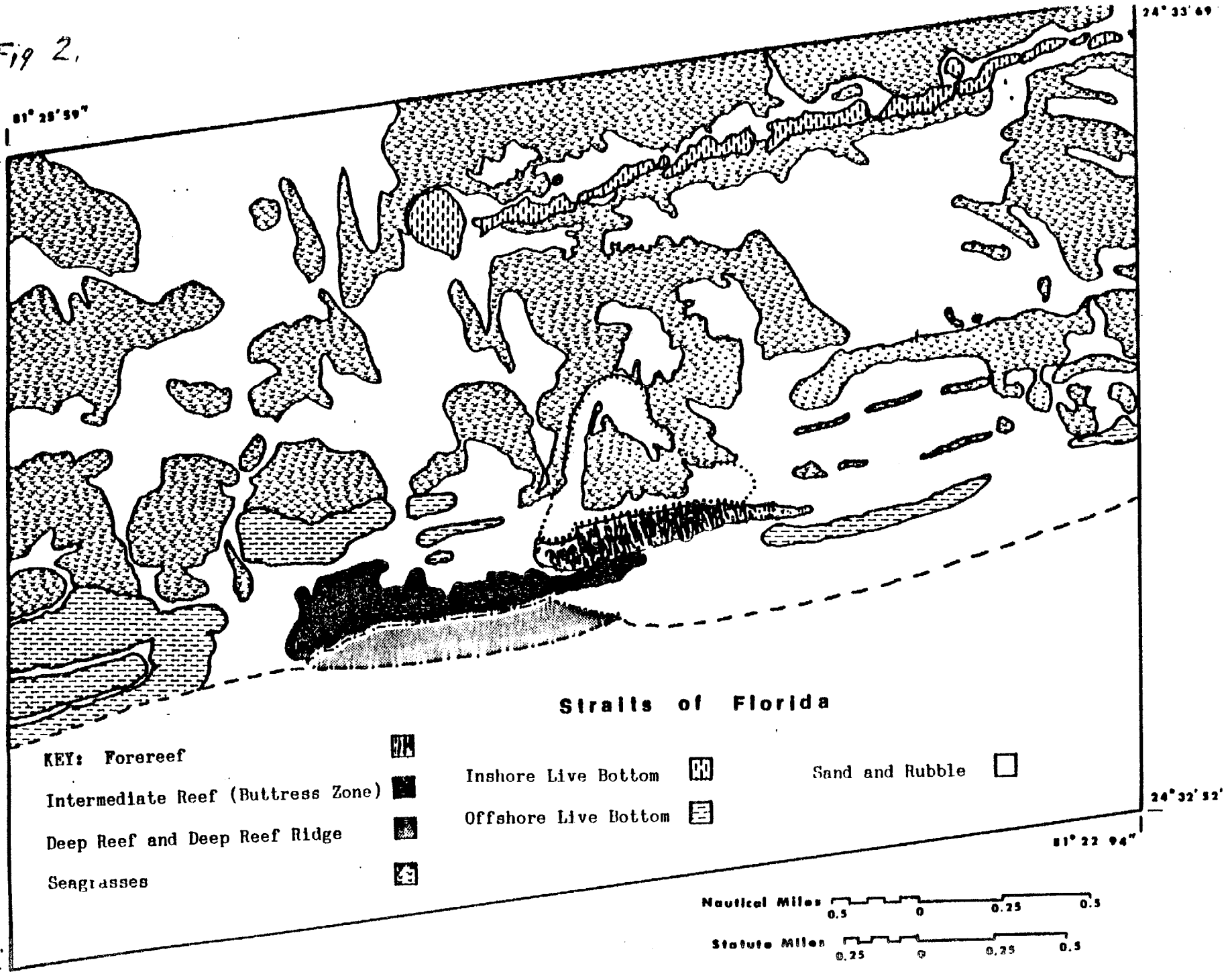
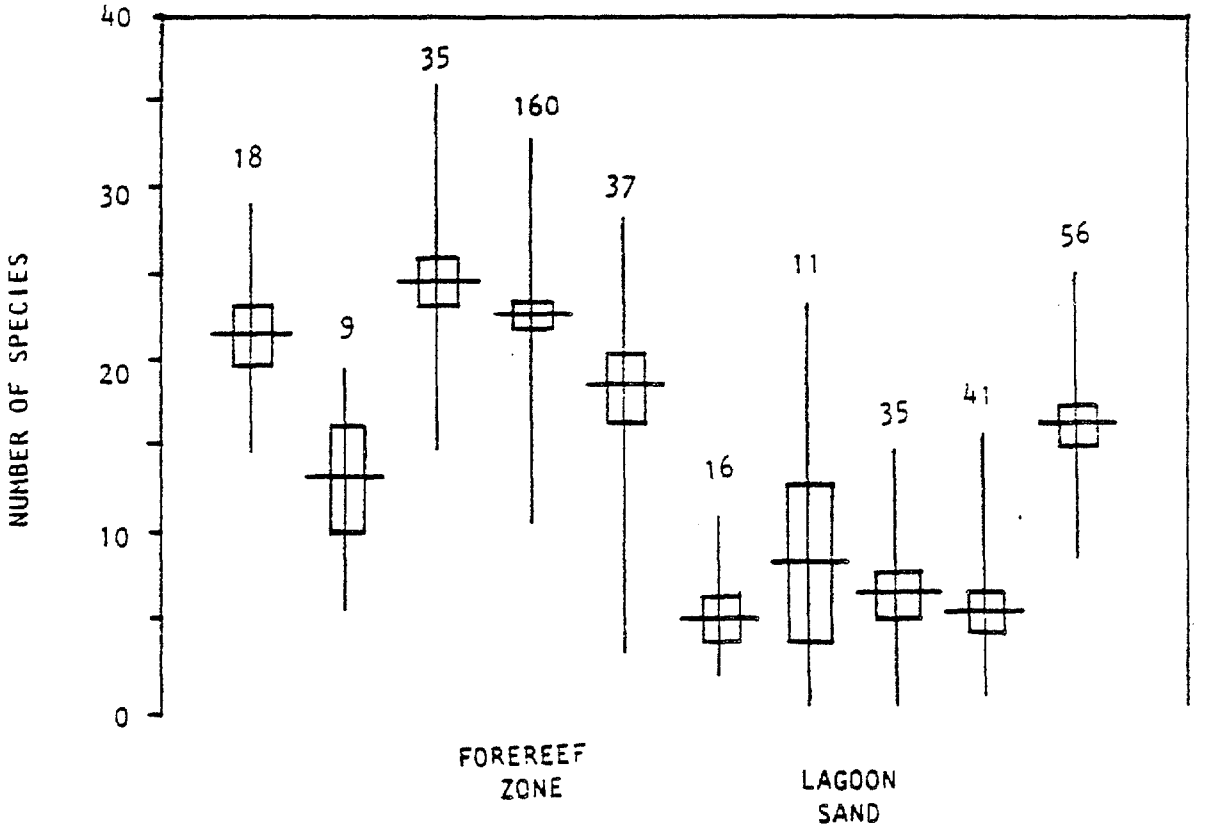
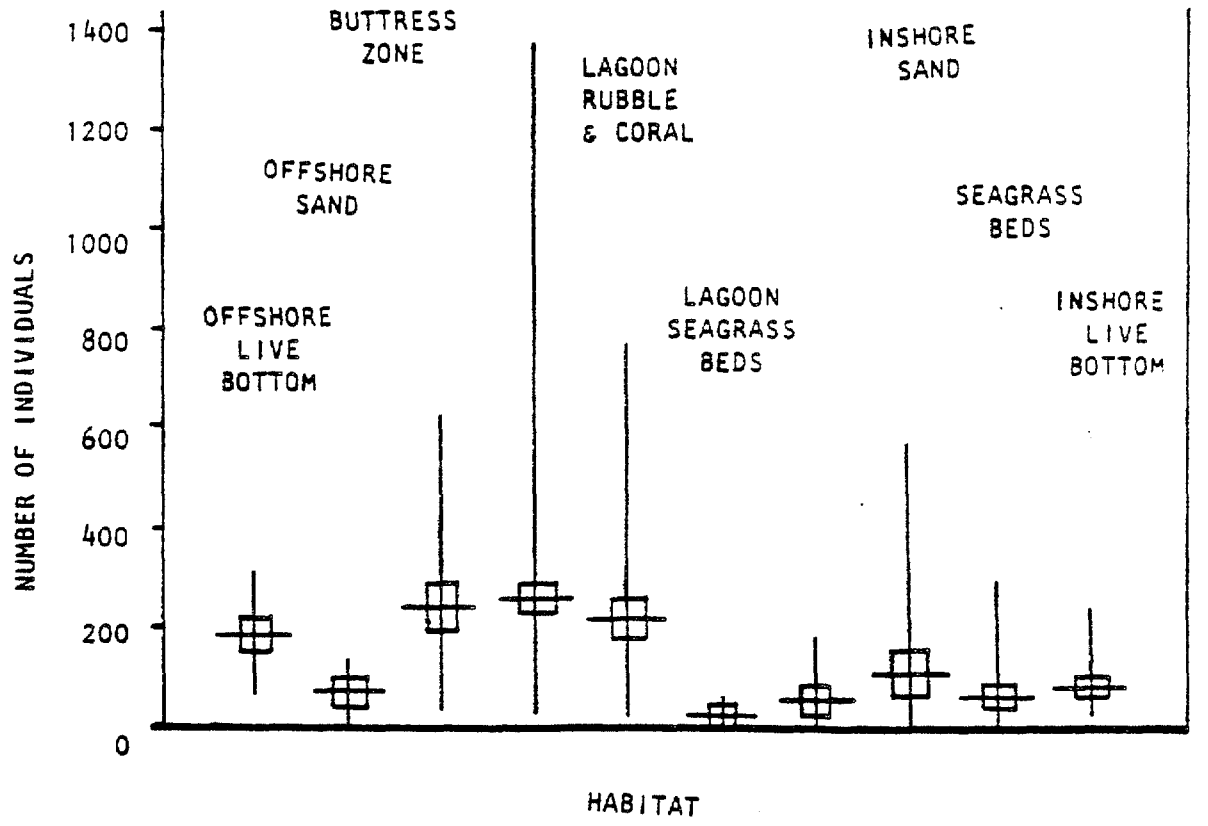
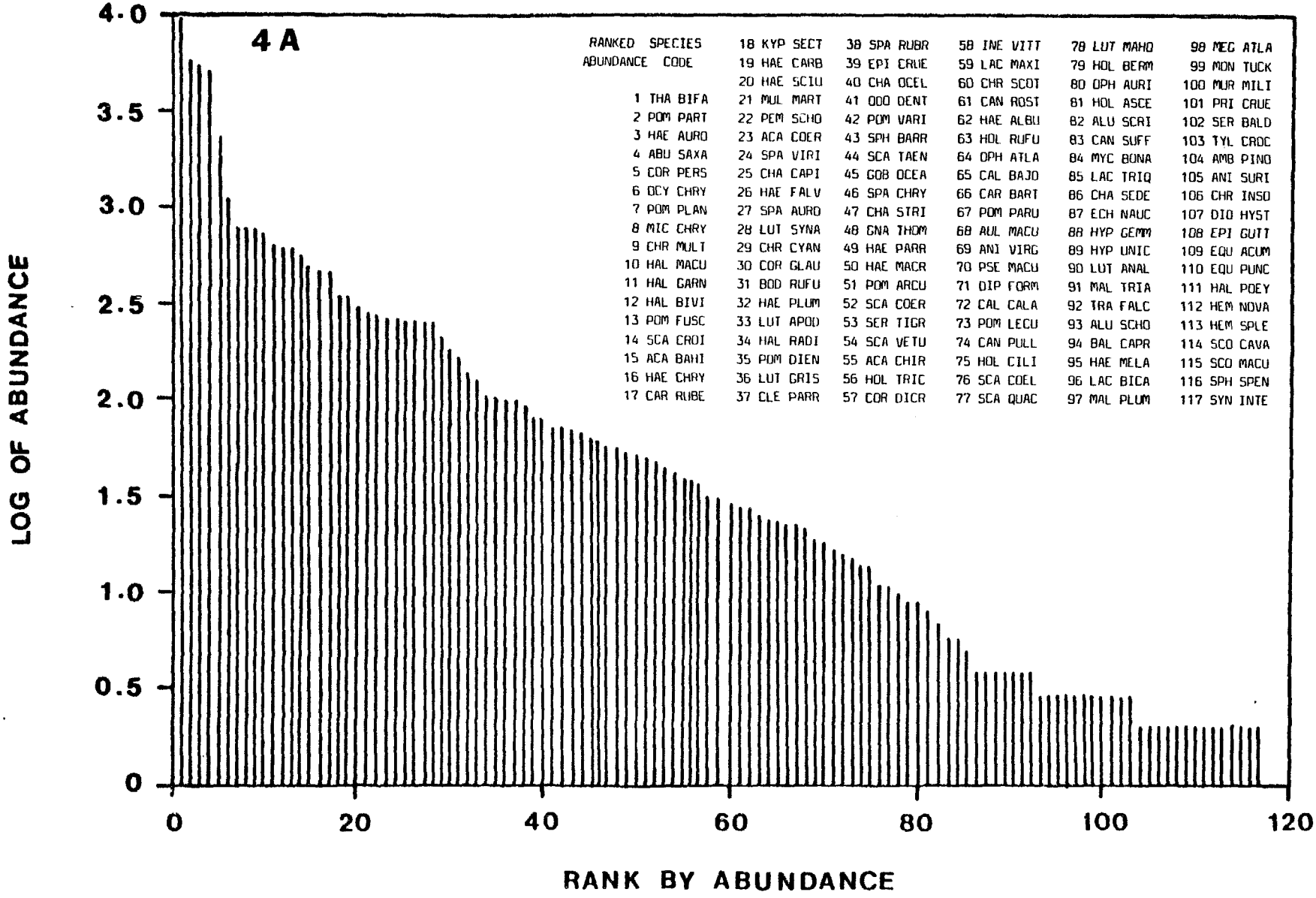

Naples
FLORIDA
Miami
Everglades
National
Park
Florida Bay
Reef Tract
Big Pine Key
Newfound
Harbor Keys
Looe Key
National Marine
Sanctuary
14000
13960
13990
62590
13970
62550
13980
62530
0 5 10
km
Dry Tortugas
Marquesas
Keys
Key
West
Looe Key
Sanctuary
0 30 60
km
N
26°
25°
83°
82°
81°
80°

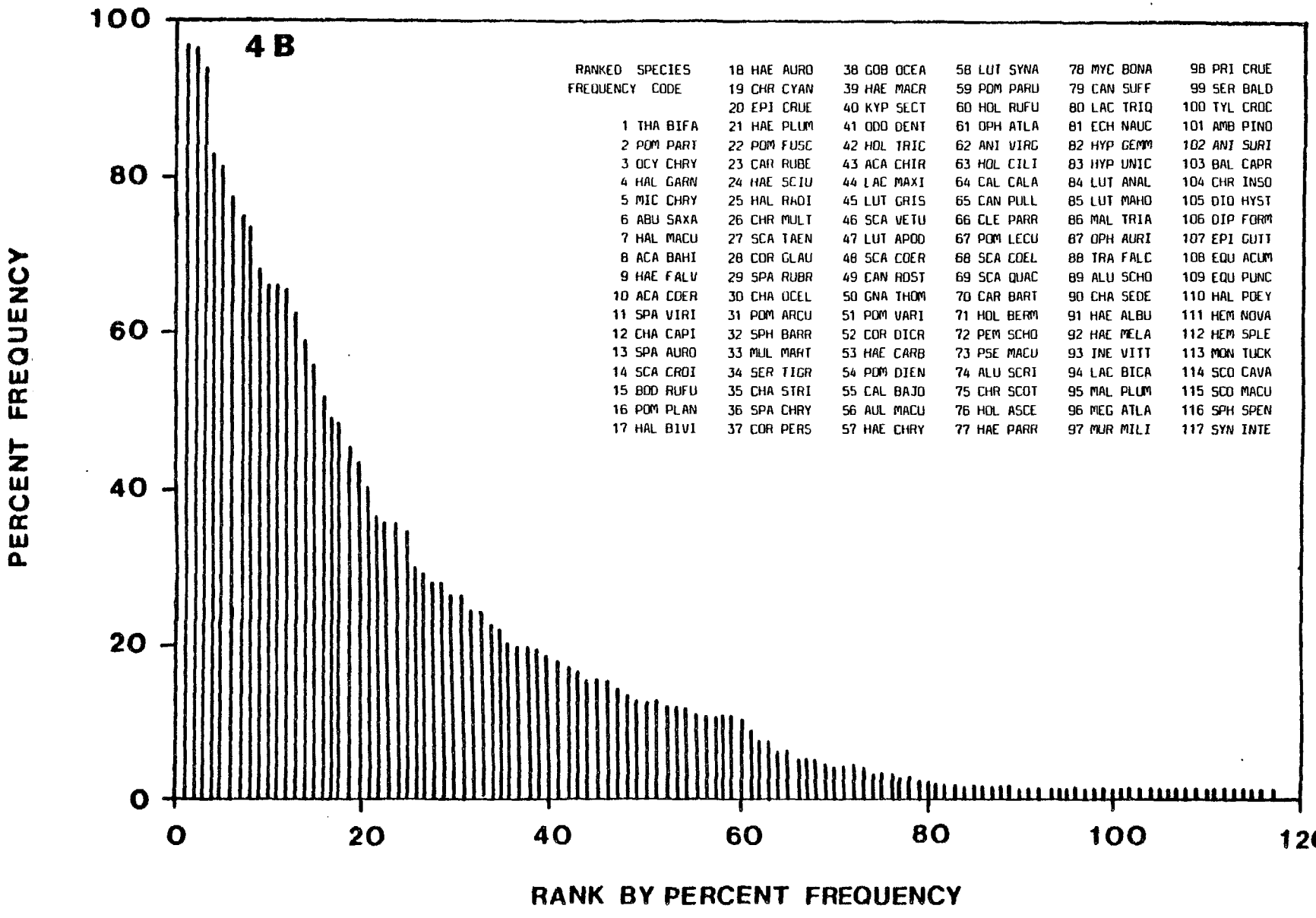
Fig 2.


81° 25' 59"
24° 33' 34"
24° 33' 69
24° 32' 52'
81° 22 94"
24 31'81"
Straits of Florida
KEY: Forereef
Intermediate Reef (Buttress Zone)
Deep Reef and Deep Reef Ridge
Seagrasses
Inshore Live Bottom
Offshore Live Bottom
Sand and Rubble
Nautical Miles
0.5 0 0.25 0.5
Statute Miles
0.25 0 0.25 0.5


NUMBER OF SPECIES
40
30
20
10
0
18
9
35
160
37
16
11
35
41
56
FOREREEF ZONE
LAGOON SAND


NUMBER OF INDIVIDUALS
1400
1200
1000
800
600
400
200
0
BUTTRESS ZONE
OFFSHORE SAND
OFFSHORE LIVE BOTTOM
LAGOON RUBBLE & CORAL
LAGOON SEAGRASS BEDS
INSHORE SAND
SEAGRASS BEDS
INSHORE LIVE BOTTOM
HABITAT


4 A
LOG OF ABUNDANCE
RANK BY ABUNDANCE
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0
20
40
60
80
100
120
RANKED SPECIES ABUNDANCE CODE
1 THA BIFA
2 POM PART
3 HAE AURO
4 ABU SAXA
5 COR PERS
6 OCY CHRY
7 POM PLAN
8 MIC CHRY
9 CHR MULT
10 HAL MACU
11 HAL GARN
12 HAL BIVI
13 POM FUSC
14 SCA CROI
15 ACA BAHI
16 HAE CHRY
17 CAR RUBE
18 KYP SECT
19 HAE CARB
20 HAE SCIU
21 MUL MART
22 PEM SCHO
23 ACA COER
24 SPA VIRI
25 CHA CAPI
26 HAE FALV
27 SPA AURO
28 LUT SYNA
29 CHR CYAN
30 COR GLAU
31 BOD RUFU
32 HAE PLUM
33 LUT APOD
34 HAL RADI
35 POM DIEN
36 LUT GRIS
37 CLE PARR
38 SPA RUBR
39 EPI CRUE
40 CHA OCEL
41 000 DENT
42 POM VARI
43 SPH BARR
44 SCA TAEN
45 GOB OCEA
46 SPA CHRY
47 CHA STRI
48 GNA THOM
49 HAE PARR
50 HAE MACR
51 POM ARCU
52 SCA COER
53 SER TIGR
54 SCA VETU
55 ACA CHIR
56 HOL TRIC
57 COR DICR
58 INE VITT
59 LAC MAXI
60 CHR SCOT
61 CAN ROST
62 HAE ALBU
63 HOL RUFU
64 OPH ATLA
65 CAL BAJO
66 CAR BART
67 POM PARU
68 AUL MACU
69 ANI VIRG
70 PSE MACU
71 DIP FORM
72 CAL CALA
73 POM LEUC
74 CAN PULL
75 HOL CILI
76 SCA COEL
77 SCA QUAC
78 LUT MAHO
79 HOL BERM
80 OPH AURI
81 HOL ASCE
82 ALU SCRI
83 CAN SUFF
84 MYC BONA
85 LAC TRIQ
86 CHA SEDE
87 ECH NAUC
88 HYP GEMM
89 HYP UNIC
90 LUT ANAL
91 MAL TRIA
92 TRA FALC
93 ALU SCHO
94 BAL CAPR
95 HAE MELA
96 LAC BICA
97 MAL PLUM
98 MEG ATLA
99 MON TUCK
100 MUR MILI
101 PRI CRUE
102 SER BALD
103 TYL CROC
104 AMB PINO
105 ANI SURI
106 CHR INSO
107 DIO HYST
108 EPI GUTT
109 EQU ACUM
110 EQU PUNC
111 HAL POEY
112 HEM NOVA
113 HEM SPLE
114 SCO CAVA
115 SCO MACU
116 SPH SPEN
117 SYN INTE



RANKED FREQUENCY	SPECIES CODE																			
1	THA BIFA	18	HAE AURO	38	GOB OCEA	58	LUT SYNA	78	MYC BONA	98	PRI CRUE
2	POM PARI	19	CHR CYAN	39	HAE MACR	59	POM PARU	79	CAN SUFF	99	SER BALD
3	OCY CHRY	20	EPI CRUE	40	KYP SECT	60	HOL RUFU	80	LAC TRIQ	100	TYL CROC
4	HAL GARN	21	HAE PLUM	41	ODO DENT	61	OPH ATLA	81	ECH NAUC	101	AMB PINO
5	MIC CHRY	22	POM FUSC	42	HOL TRIC	62	ANI VIRG	82	HYP GEMM	102	ANI SURI
6	ABU SAXA	23	CAR RUBE	43	ACA CHIR	63	HOL CILI	83	HYP UNIC	103	BAL CAPR
7	HAL MACU	24	HAE SCIU	44	LAC MAXI	64	CAL CALA	84	LUT ANAL	104	CHR INSO
8	ACA BAHI	25	HAL RADI	45	LUT GRIS	65	CAN PULL	85	LUT MAHO	105	DIO HYST
9	HAE FALV	26	CHR MULT	46	SCA VETU	66	CLE PARR	86	MAL TRIA	106	DIP FORM
10	ACA COER	27	SCA TAEN	47	LUT APOD	67	POM LECU	87	OPH AURI	107	EPI GUTT
11	SPA VIRI	28	COR GLAU	48	SCA COER	68	SCA COEL	88	TRA FALC	108	EQU ACUM
12	CHA CAPI	29	SPA RUBR	49	CAN ROST	69	SCA QUAC	89	ALU SCHO	109	EQU PUNC
13	SPA AURO	30	CHA OCEL	50	GNA THOM	70	CAR BART	90	CHA SEDE	110	HAL POEY
14	SCA CROI	31	POM ARCU	51	POM VARI	71	HOL BERM	91	HAE ALBU	111	HEM NOVA
15	BOD RUFU	32	SPH BARR	52	COR DICR	72	PEM SCHO	92	HAE MELA	112	HEM SPLE
16	POM PLAN	33	MUL MART	53	HAE CARB	73	PSE MACU	93	INE VITT	113	MON TUCK
17	HAL BIVI	34	SER TIGR	54	POM DIEN	74	ALU SCRI	94	LAC BICA	114	SCO CAVA
		35	CHA STRI	55	CAL BAJO	75	CHR SCOT	95	MAL PLUM	115	SCO MACU
		36	SPA CHRY	56	AUL MACU	76	HOL ASCE	96	MEG ATLA	116	SPH SPEN
		37	COR PERS	57	HAE CHRY	77	HAE PARR	97	MUR MILI	117	SYN INTE

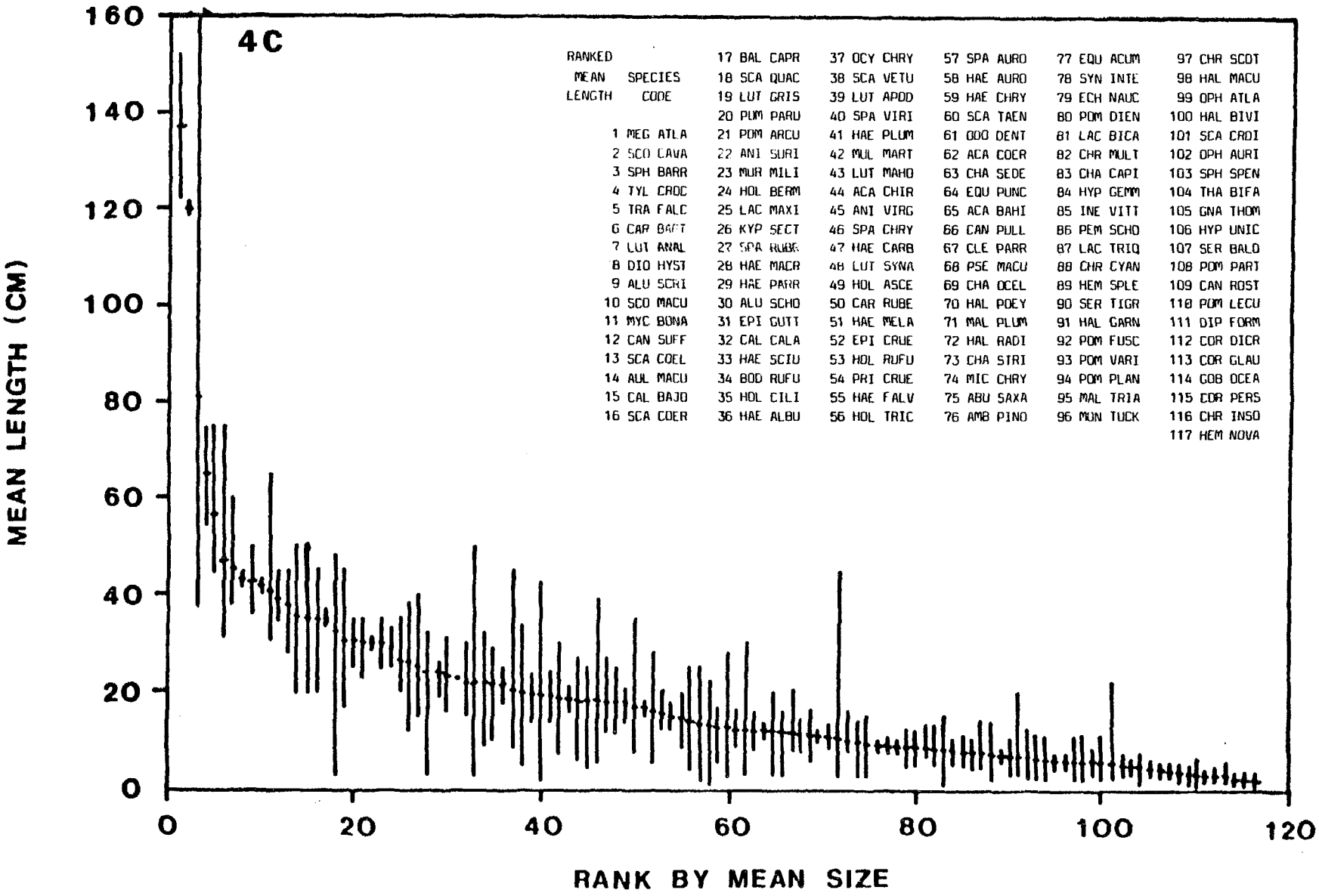

4C
MEAN LENGTH (CM)
RANK BY MEAN SIZE
0
20
40
60
80
100
120
140
160
RANKED MEAN LENGTH SPECIES CODE
1 MEG ATLA
2 SCO CAVA
3 SPH BARR
4 TYL CROC
5 TRA FALC
6 CAR BART
7 LUT ANAL
8 DIO HYST
9 ALU SCRI
10 SCO MACU
11 MYC BONA
12 CAN SUFF
13 SCA COEL
14 AUL MACU
15 CAL BAJO
16 SCA COER
17 BAL CAPR
18 SCA QUAC
19 LUT GRIS
20 POM PARU
21 POM ARCU
22 ANI SURI
23 MUR MILI
24 HOL BERM
25 LAC MAXI
26 KYP SECT
27 SPA RUBR
28 HAE MACR
29 HAE PARR
30 ALU SCHO
31 EPI GUTT
32 CAL CALA
33 HAE SCIU
34 BOD RUFU
35 HOL CILI
36 HAE ALBU
37 OCY CHRY
38 SCA VETU
39 LUT APOD
40 SPA VIRI
41 HAE PLUM
42 MUL MART
43 LUT MAHO
44 ACA CHIR
45 ANI VIRG
46 SPA CHRY
47 HAE CARB
48 LUT SYNA
49 HOL ASCE
50 CAR RUBE
51 HAE MELA
52 EPI CRUE
53 HOL RUFU
54 PRI CRUE
55 HAE FALV
56 HOL TRIC
57 SPA AURO
58 HAE AURO
59 HAE CHRY
60 SCA TAEN
61 ODO DENT
62 ACA COER
63 CHA SEDE
64 EQU PUNC
65 ACA BAHI
66 CAN PULL
67 CLE PARR
68 PSE MACU
69 CHA OCEL
70 HAL POEY
71 MAL PLUM
72 HAL RADI
73 CHA STRI
74 MIC CHRY
75 ABU SAXA
76 AMB PINO
77 EQU ACUM
78 SYN INTE
79 ECH NAUC
80 POM DIEN
81 LAC BICA
82 CHR MULT
83 CHA CAPI
84 HYP GEMM
85 INE VITT
86 PEM SCHO
87 LAC TRIQ
88 CHR CYAN
89 HEM SPLE
90 SER TIGR
91 HAL GARN
92 POM FUSC
93 POM VARI
94 POM PLAN
95 MAL TRIA
96 MON TUCK
97 CHR SCOT
98 HAL MACU
99 OPH ATLA
100 HAL BIVI
101 SCA CROI
102 OPH AURI
103 SPH SPEN
104 THA BIFA
105 GNA THOM
106 HYP UNIC
107 SER BALO
108 POM PART
109 CAN ROST
110 POM LECU
111 DIP FORM
112 COR DICR
113 COR GLAU
114 GOB OCEA
115 COR PERS
116 CHR INSO
117 HEM NOVA

Table 1.--Phylogenetic listing of species observed at Looe Key National Marine Sanctuary. All names used are according to Robins et al. (1980). Species codes used elsewhere are derived using the first three letters of the genus and the first four letters of the trivial name.

ORECTOLOBIDAE	Carpet Sharks	
	Ginglymostoma cirratum	Nurse shark
DASYATIDAE		
	Dasyatis americana	Southern stingray
	Urolophus jamaicensis	Yellow stingray
MYLIOBATIDAE	Eagle rays	
	Aetobatus narinari	Spotted eagle ray
ELOPIDAE	Tarpons	
	Megalops atlanticus	Tarpon
MURAENIDAE	Morays	
	Enchelycore nigricans	Viper moray
	Gymnothorax funebris	Green moray
	Gymnothorax moringa	Spotted moray
	Muraena miliaris	Goldentail moray
CLUPEIDAE	Herrings	
	Jenkinsia spp.	Unknown herring
	Jenkinsia lamprotaenia	Dwarf herring
ENGRAULIDAE	Anchovies	
	Anchoa lyolepis	Dusky anchovy
SYNODONTIDAE	Lizardfishes	
	Synodus intermedius	Sand diver
BELONIDAE	Needlefishes	
	Strongylura notata	Redfin needlefish
	Strongylura timucu	Timucu
	Tylosurus crocodilus	Houndfish
ATHERINIDAE	Silversides	
	Atherinomorus stipes	Hardhead silverside

Table 1. (Continued)

HOLOCENTRIDAE	Squirrelfishes	
	Holocentrus ascensionis	Squirrelfish
	Holocentrus coruscus	Reef squirrelfish
	Holocentrus rufus	Longspine squirrelfish
	Holocentrus vexillarius	Dusky squirrelfish
	Myripristis jacobus	Blackbar soldierfish
AULOSTOMIDAE	Trumpetfishes	
	Aulostomus maculatus	Trumpetfish
SERRANIDAE	Sea Basses	
	Diplectrum formosum	Sand perch
	Epinephelus adscensionis	Rock hind
	Epinephelus cruentatus	Graysby
	Epinephelus fulvus	Coney
	Epinephelus guttatus	Red hind
	Epinephelus itajara	Jewfish
	Epinephelus morio	Red grouper
	Epinephelus striatus	Nassau grouper
	Hypoplectrus gemma	Blue hamlet
	Hypoplectrus nigricans	Black hamlet
	Hypoplectrus puella	Barred hamlet
	Hypoplectrus unicolor	Butter hamlet
	Liopropma rubre	Peppermint bass
	Mycteroperca bonaci	Black grouper
	Paranthias furcifer	Creole-fish
	Serranus baldwini	Lantern bass
	Serranus tabacarius	Tobaccofish
	Serranus tigrinus	Harlequin bass
	Serranus tortugarum	Chalk bass
GRAMMISTIDAE	Soapfishes	
	Rypticus saponaceus	Greater soapfish
PRIACANTHIDAE	Bigeyes	
	Priacanthus cruentatus	Glasseye snapper
APONGONIDAE	Cardinalfishes	
	Apogon binotatus	Barred cardinalfish
	Apogon maculatus	Flamefish
	Apogon pseudomaculatus	Twospot cardinalfish
	Apogon quadrisquamatus	Sawcheck cardinalfish
MALACANTHIDAE	Tilefishes	
	Malacanthus plumieri	Sand tilefish

Table 1. (Continued)

ECHENEIDAE	Remoras	
	Echeneis naucrates	Sharksucker
CARANGIDAE	Jacks	
	Alectis ciliaris	African pompano
	Caranx bartholomaei	Yellow jack
	Caranx crysos	Blue runner
	Caranx ruber	Bar jack
	Decapterus macarellus	Mackerel scad
	Decapterus punctatus	Round scad
	Seriola dumerili	Greater amberjack
	Trachinotus falcatus	Permit
LUTJANIDAE	Snappers	
	Lutjanus analis	Mutton snapper
	Lutjanus apodus	Schoolmaster snapper
	Lutjanus griseus	Gray snapper
	Lutjanus jocu	Dog snapper
	Lutjanus mahogoni	Mahogony snapper
	Lutjanus synagris	Lane snapper
	Ocyurus chrysurus	Yellowtail snapper
GERREIDAE	Mojarras	
	Gerres cinereus	Yellowfin mojarra
HAEMULONIDAE	Grunts	
	Anisotremus surinamenis	Black margate
	Anisotremus virginicus	Porkfish
	Haemulon album	Margate
	Haemulon aurolineatum	Tomtate
	Haemulon carbonarium	Caesar grunt
	Haemulon chrysargyreum	Smallmouth grunt
	Haemulon flavolineatum	French grunt
	Haemulon macrostomum	Spanish grunt
	Haemulon melanurum	Cottonwick
	Haemulon parrai	Sailors choice
	Haemulon plumieri	White grunt
	Haemulon sciurus	Bluestriped grunt
INERMIIDAE	Bonnetmouths	
	Imermia vittata	Boga

Table 1. (Continued)

SPARIDAE	Porgies	
	Calamus spp.	Unknown porgy
	Calamus bajonado	Jolthead porgy
	Calamus calamus	Saucereye porgy
	Calamus penna	Sheepshead porgy
	Pagrus pagrus	Red porgy
SCIAENIDAE	Drums	
	Equetus acuminatus	High-hat
	Equetus lanceolatus	Jackknife-fish
	Equetus punctatus	Spotted drum
	Odontoscion dentex	Reef croaker
MULLIDAE	Goatfishes	
	Mulloidichthys martinicus	Yellow goatfish
	Pseudupeneus maculatus	Spotted goatfish
PEMPHERIDAE	Sweepers	
	Pempheris schomburgki	Glassy sweeper
KYPHOSIDAE	Sea chubs	
	Kyphosus sectatrix	Bermuda chub
EPHIPPIDAE	Spadefishes	
	Chaetodipterus faber	Atlantic spadefish
CHAETODONTIDAE	Butterflyfishes	
	Chaetodon capistratus	Foureye butterflyfish
	Chaetodon ocellatus	Spotfin butterflyfish
	Chaetodon sedentarius	Reef butterflyfish
	Chaetodon striatus	Banded butterflyfish
POMACANTHIDAE	Angelfishes	
	Holacanthus bermudensis	Blue angelfish
	Holacanthus tricolor	Rock beauty
	Holacanthus ciliaris	Queen angelfish
	Pomacanthus arcuatus	Gray angelfish
	Pomacanthus paru	French angelfish

Table 1. (Continued)

POMACENTRIDAE	Damselfishes	
	Abudefduf saxatilis	Sergeant major
	Chromis cyaneus	Blue chromis
	Chromis insolatus	Sunshinefish
	Chromis multilineatus	Brown chromis
	Chromis scotti	Purple reeffish
	Microspathodon chrysurus	Yellowtail damselfish
	Pomacentrus diencaeus	Longfin damselfish
	Pomacentrus fuscus	Dusky damselfish
	Pomacentrus leucostictus	Beaugregory
	Pomacentrus partitus	Bicolor damselfish
	Pomacentrus planifrons	Threespot damselfish
	Pomacentrus variabilis	Cocoa damselfish
CIRRHITIDAE	Hawkfishes	
	Amblycirrhitus pinos	Redspotted hawkfish
LABRIDAE	Wrasses	
	Bodianus pulchellus	Spotfin hogfish
	Bodianus rufus	Spanish hogfish
	Clepticus parrai	Creole wrasse
	Halichoeres bivattatus	Slippery dick
	Halichoeres garnoti	Yellowhead wrasse
	Halichoeres maculipinna	Clown wrasse
	Halichoeres pictus	Rainbow wrasse
	Halichoeres poeyi	Blackear wrasse
	Halichoeres radiatus	Puddingwife
	Hemipteronotus novacula	Pearly razorfish
	Hemipteronotus splendens	Green razorfish
	Lachnolaimus maximus	Hogfish
	Thalassoma bifasciatum	Bluehead
SCARIDAE	Parrotfishes	
	Cryptotomus roseus	Bluelip parrotfish
	Scarus coelestinus	Midnight parrotfish
	Scarus coeruleus	Blue parrotfish
	Scarus croicensis	Striped parrotfish
	Scarus guacamaia	Rainbow parrotfish
	Scarus taeniopterus	Princess parrotfish
	Scarus vetula	Queen parrotfish
	Sparisoma atomarium	Greenblotch parrotfish
	Sparisoma aurofrenatum	Redband parrotfish
	Sparisoma chrysopterum	Redtail parrotfish
	Sparisoma radians	Bucktooth parrotfish
	Sparisoma rubripinne	Redfin parrotfish
	Sparisoma viride	Stoplight parrotfish

Table 1. (Continued)

SPHYRAENIDAE	Barracudas	
	Sphyraena barracuda	Barracuda
OPISTOGNATHIDAE	Jawfishes	
	Opistognathus aurifrons	Yellowhead jawfish
CLINIDAE	Clinids	
	Acanthemblemaria spp.	unknown blenny
	Acanthemblemaria chaplini	Papillose blenny
	Hemiemblemaria simulus	Wrasse blenny
	Malacoctenus gilli	Dusky blenny
	Malacoctenus macropus	Rosy blenny
	Malacoctenus triangulatus	Saddled blenny
	Malacoctenus versicolor	Barfin blenny
	Paraclinus nigripinnis	Blackfin blenny
BLENNIIDAE	Combtooth blennies	
	Hypleurochilus spp.	unknown blenny
	Ophioblennius atlanticus	Redlip blenny
	Scartella cristatus	Molly miller
CALLIONYMIDAE	Dragonets	
	Callionymus bairdi	Lancer dragonet
GOBIIDAE	Gobies	
	Coryphopterus dicrus	Colon goby
	Coryphopterus glaucofraenum	Bridled goby
	Coryphopterus personatus	Masked goby
	Coryphopterus sp	unidentified goby
	Gnatholepis thompsoni	Goldspot goby
	Gobiosoma macrodon	Tiger goby
	Gobiosoma oceanops	Neon goby
	Ioglossus calliurus	Blue goby
	Microgobius carri	Seminole goby
ACANTHURIDAE	Surgeonfishes	
	Acanthurus bahianus	Ocean surgeon
	Acanthurus chirurgus	Doctorfish
	Acanthurus coeruleus	Blue tang
SCOMBRIDAE	Mackerels/Tunas	
	Scomberomorus cavalla	King mackerel
	Scomberomorus maculatus	Spanish mackerel
	Scomberomorus regalis	Cero

Table 1. (Continued)

SCORPAENIDAE	Scorpionfishes
Scorpaena plumieri	Spotted scorpionfish
BALISTIDAE	Triggerfishes/Filefishes
Aluterus schoepfi	Orange filefish
Aluterus scriptus	Scrawled filefish
Balistes capriscus	Gray triggerfish
Balistes vetula	Queen triggerfish
Cantherhines macrocerus	Whitespotted filefish
Cantherhines pullus	Orangespotted filefish
Canthidermis sufflamen	Ocean triggerfish
Monacanthus tuckeri	Slender filefish
OSTRACIIDAE	Trunkfishes
Lactophrys bicaudalis	Spotted trunkfish
Lactophrys polygonia	Honeycomb cowfish
Lactophrys quadricornis	Scrawled cowfish
Lactophrys triqueter	Smooth trunkfish
TETRADONTIDAE	Puffers
Canthigaster rostrata	Sharpnose puffer
Sphoeroides spengleri	Bandtail puffer
DIODONTIDAE	Porcupinefishes
Diodon hystrix	Balloonfish
Diodon holocanthus	Porcupinefish

Table 2.--Distribution of numbers of species by family at Looe Key Reef based on censuses of 73,979 individuals.

Family	Common Name	Total Species	Percent of Total Individuals	Zones of Occurence: Deep Live Bottom	Deep Sand	Buttress Zone	Spur & Groove	Lagoon Rubble	Lagoon Grasses	Lagoon Sand	Grass Flats	Shallow Sand	Shallow Live Bottom
ACANTHURIDAE	Surgeonfishes	3	2.55	3	2	3	3	3	1	2	2	2	3
APOGONIDAE	Cardinalfishes	1	0.00									1	
ATHERINIDAE	Silversides	*	-										
AULOSTOMIDAE	Trumpetfishes	1	0.04			1	1	1					1
BALISTIDAE	Leatherjackets	7	0.06			3	6	3			1	1	3
BELONIDAE	Needlefishes	2	0.00				1	1		1			
BLENNIIDAE	Combtooth Blennies	2	0.09		2		1	2		1	1	1	1
CALLIONYMIDAE	Dragonets	*	-										
CARANGIDAE	Jacks	6	1.30	2	2	3	3	1	2	1	1	5	2
CHAETODONTIDAE	Butterflyfishes	4	1.12	4		4	4	3		1	2		4
CIRRHITIDAE	Hawkfishes	1	0.00	1			1						
CLINIDAE	Clinids	5	0.02		2		1	4					1
CLUPEIDAE	Herrings	*	-										
DASYATIDAE	Stingrays	1	0.01	1							1	1	1
DIODONTIDAE	Porcupinefishes	2	0.00	1			1						
ECHENEIDAE	Remoras	1	0.01	1		1	1						
ELOPIDAE	Tarpons	1	0.00				1						
ENGRAULIDAE	Anchovies	*	-										
EPHIPPIDAE	Spadefishes	1	0.00			1							
GERREIDAE	Mojarras	1	0.92					1					
GOBIIDAE	Gobies	8	6.31	5	4	6	6	5	1	1	5	2	6
GRAMMIDAE	Basslets	*	-										
GRAMMISTIDAE	Soapfishes	*	-										
HAEMULIDAE	Grunts	12	19.88	3	4	7	12	9	5	4	5	5	3
HOLOCENTRIDAE	Squirrelfishes	3	0.05			1	2	1					
INERMIIDAE	Bonnetmouths	1	0.48				1					1	1
KYPHOSIDAE	Sea Chubs	1	0.55			1	1	1					
LABRIDAE	Wrasses	12	26.94	6	8	8	11	9	7	8	8	8	8
LUTJANIDAE	Snappers	7	3.02	1	2	4	6	4	1	2		2	1
MALACANTHIDAE	Tilefishes	1	0.01		1	1	1						
MULLIDAE	Goatfishes	2	0.57	1	1	2	2	2				1	1
MURAENIDAE	Morays	2	0.01				1	1					
MYLIOBATIDAE	Eagle Rays	*	-										
OPISTOGNATHIDAE	Jawfishes	1	0.06		1		1	1			1	1	1
ORECTOLOBIDAE	Carpet Sharks	1	0.00					1					
OSTRACIIDAE	Boxfishes	3	0.01	1			2				1		
PEMPHERIDAE	Sweepers	1	0.67			1	1	1					
POMACANTHIDAE	Angelfishes	5	0.38	5	1	4	5	3				1	5
POMACENTRIDAE	Damselfishes	12	28.95	8	3	9	12	7		7	4	4	6
PRIACANTHIDAE	Bigeyes	1	0.01				1	1				1	
SCARIDAE	Parrotfishes	13	4.77	7	4	10	10	10	3	6	6	8	8
SCIAENIDAE	Drums	3	0.13	1		2	3	1					1
SCOMBRIDAE	Mackerels	3	0.01	1			2					1	
SERRANIDAE	Sea Basses	14	0.60	7	3	6	9	5		3	3	4	6
SPARIDAE	Porgies	5 #	0.18	1	1	2	2				2	2	3
SPHYRAENIDAE	Barracudas	1	0.14	1	1	1	1	1	1		1	1	1
SYNODONTIDAE	Lizardfishes	1	0.00				1				1		
TETRAODONTIDAE	Puffers	2	0.07			1	1	1					1

* Observed only in samples using the rapid visual technique.

\# Includes one unidentified individual as a separate species.

Table 3.--Alphabetical listing of fishes observed in Looe Key National Marine Sactuary during visual surveys using the Bohnsack and Bannerot (1983) Stationary Sampling Visual (SS) and the Jones and Thompson (1978) Rapid Visual Technique (RV). RV sampling only surveyed major reef areas including buttress, forereef and rubble zones. SS surveyed all habitats although effort varied between habitats. Dashes indicate that species were not observed by that technique. * indicates that the species was observed during point samples but after the initial 5-minute sample period and thus no abundance estimate data were recorded.

SCIENTIFIC NAME	COMMON NAME	RAPID VISUAL SAMPLES		RANDOM POINT SAMPLES	
		FREQUENCY	SCORE	FREQUENCY	TOTAL ABUNDANCE
Maximum Value		16	80	417	N/A
Abudefduf saxatilis	Sergeant major	16	80	185	6799
Acanthemblemaria chaplini	Papillose blenny	4	14	1	5
Acanthemblemaria spp	unidentified blenny	6	20		
Acanthurus bahianus	Ocean surgeon	16	80	265	1231
Acanthurus chirurgus	Doctorfish	11	34	53	97
Acanthurus coeruleus	Blue tang	16	77	189	561
Aetobatus narinari	Spotted eagle ray	1	1		
Alectis ciliaris	African pompano	1	4		
Aluterus schoepfi	Orange filefish	2	7	4	6
Aluterus scriptus	Scrawled filefish	7	18	7	7
Amblycirrhitus pinos	Redspotted hawkfish	9	35	2	2
Anchoa lyolepis	Dusky anchovy	1	1		
Anisotremus surinamensis	Black margate	2	9	1	1
Anisotremus virginicus	Porkfish	12	42	20	28
Apogon binotatus	Barred cardinalfish	3	7		
Apogon maculatus	Flamefish	8	24		
Apogon pseudomaculatus	Twospot cardinalfish	3	8	1	2
Apogon quadrisquamatus	Sawcheek caradinalfish	1	1		
Atherinomorus stipes	Hardhead silverside	1	3		
Aulostomus maculatus	Trumpetfish	14	44	23	27
Balistes capriscus	Gray triggerfish	-		3	4
Balistes vetula	Queen triggerfish	-		2	2
Bodianus pulchellus	Spotfin hogfish	1	3		
Bodianus rufus	Spanish hogfish	16	77	129	218
Calamus sp.	Unidentified porgy	1	4	1	1
Calamus bajonado	Jolthead porgy	4	14	27	35
Calamus calamus	Saucereye porgy	7	27	65	94
Calamus penna	Sheepshead porgy	-		2	3
Callionymus bairdi	lancer dragonet	3	9		
Cantherhines macrocerus	Whitespotted filefish	3	15		
Cantherhines pullus	Orangespotted filefish	9	28	15	17
Canthidermis sufflamen	Ocean triggerfish	1	1	6	7
Canthigaster rostrata	Sharpnose puffer	16	72	42	53
Caranx bartholomaei	Yellow jack	4	14	18	48
Caranx crysos	Blue runner	-		1	28
Caranx ruber	Bar jack	14	65	93	661

Table 3 (Continued)

Chaetodipterus faber	Atlantic spadefish	-		1	1
Chaetodon capistratus	Foureye butterflyfish	16	80	206	555
Chaetodon ocellatus	Spotfin butterflyfish	13	49	90	162
Chaetodon sedentarius	Reef butterflyfish	2	7	12	18
Chaetodon striatus	Banded butterflyfish	11	35	53	92
Chromis cyaneus	Blue chromis	15	74	107	324
Chromis insolatus	Sunshinefish	-		1	1
Chromis multilineatus	Brown chromis	13	53	59	892
Chromis scotti	Purple reeffish	6	19	12	47
Clepticus parrai	Creole wrasse	15	54	14	274
Coryphopterus dicrus	Colon goby	9	32	45	111
Coryphopterus glaucofraenum	Bridled goby	13	55	119	623
Coryphopterus personatus	Masked goby	12	50	69	3611
Coryphopterus sp	unidentified goby	-		*	*
Cryptotomus roseus	Bluelip parrotfish	-		8	22
Dasyatis americana	Southern stingray	1	1		
Decapterus macarellus	Mackerel scad	-		1	70
Decapterus punctatus	Round scad	-		1	150
Diodon holocanthus	Balloonfish	2	4	1	1
Diodon hystrix	Porcupinefish	3	7	1	1
Diplectrum formosum	Sand perch	-		13	59
Echeneis naucrates	Sharksucker	5	13	6	6
Enchelycore nigricans	Viper moray	-		*	*
Epinephelus adscensionis	Rock hind	1	1		
Epinephelus cruentatus	Graysby	15	71	114	133
Epinephelus fulvus	Coney	1	5		
Epinephelus guttatus	Red hind	1	2	1	1
Epinephelus itajara	Jewfish	1	1		
Epinephelus morio	Red grouper	-		1	1
Epinephelus striatus	Nassau grouper	5	20	2	2
Equetus acuminatus	High-hat	3	9	7	7
Equetus lanceolatus	Jacknife-fish	1	5		
Equetus punctatus	Spotted drum	3	7	1	1
Fry	Unidentified species	-		1	15
Gerres cinereus	Yellowfin mojarra	-		6	681
Ginglymostoma cirratum	Nurse shark	-		1	1
Gnatholepis thompsoni	Goldspot goby	16	68	39	108
Gobiosoma macrodon	Tiger goby	-		1	3
Gobiosoma oceanops	Neon goby	16	75	60	132
Gymnothorax funebris	Green moray	5	22		
Gymnothorax moringa	Spotted moray	-		2	2
Haemulon album	Margate	-		9	49
Haemulon aurolineatum	Tomtate	16	80	138	10842
Haemalon carbonarium	Caesar grunt	16	51	23	355
Haemulon chrysargyreum	Smallmouth grunt	14	49	21	877
Haemulon flavolineatum	French grunt	16	79	175	714
Haemulon macrostomum	Spanish grunt	9	31	40	90
Haemulon melanurum	Cottonwick	1	5	7	21
Haemulon parrai	Sailor's choice	9	32	11	62
Haemulon plumieri	White grunt	15	70	163	1122
Haemulon sciurus	Bluestriped grunt	15	65	111	542
Halichoeres bivittatus	Slippery dick	15	67	258	3590

Table 3 (Continued)

Halichoeres garnoti	Yellowhead wrasse	16	80	251	1110
Halichoeres maculipinna	Clown wrasse	16	74	246	1512
Halichoeres pictus	Rainbow wrasse	1	1		
Halichoeres poeyi	Blackear wrasse	-		40	119
Halichoeres radiatus	Puddingwife	16	71	123	252
Hemiemblemaria simulus	Wrasse blenny	-		1	1
Hemipteronotus novacula	Pearly razorfish	1	4	2	2
Hemipteronotus splendens	Green razorfish	1	1	49	267
Holacanthus bermudensis	Blue angelfish	8	29	17	18
Holacanthus ciliaris	Queen angelfish	10	27	23	23
Holacanthus tricolor	Rock beauty	13	61	58	77
Holocentrus ascensionis	Squirrelfish	10	40	6	7
Holocentrus coruscus	Reef squirrelfish	1	4		
Holocentrus rufus	Longspine squirrelfish	14	51	20	32
Holocentrus vexillarius	Dusky squirrelfish	6	19	1	1
Hypleurochilus spp	unidentified blenny	1	5		
Hypoplectrus gemma #	Blue hamlet	2	6	16	18
Hypoplectrus nigricans #	Black hamlet	-		1	1
Hypoplectrus puella #	Barred hamlet	-		3	3
Hypoplectrus unicolor	Butter hamlet	2	5	31	38
Ioglossus calliurus	Blue goby	-		15	75
Inermia vittata	Boga	2	6	6	352
Jenkinsia lamprotaenia	Dwarf herring	3	11		
Jenkinsia spp		1	4		
Kyphosus sectatrix	Bermuda chub	13	44	39	407
Lachnolaimus maximus	Hogfish	12	43	70	98
Lactophrys bicaudalis	Spotted trunkfish	1	5	2	2
Lactophrys polygonia	Honeycomb cowfish	1	4		
Lactophrys quadricornis	Scrawled cowfish	2	7	1	1
Lactophrys triqueter	Smooth trunkfish	9	32	5	5
Liopropoma rubre	Peppermint bass	3	8		
Lutjanus analis	Mutton snapper	1	1	6	6
Lutjanus apodus	Schoolmaster snapper	16	68	42	208
Lutjanus griseus	Gray snapper	11	44	29	157
Lutjanus jocu	Dog snapper	2	8	1	1
Lutjanus mahogoni	Mahogany snapper	3	8	3	9
Lutjanus synagris	Lane snapper	4	19	17	254
Malacanthus plumieri	Sand tilefish	2	6	7	10
Malacoctenus gilli	Dusky blenny	1	4	2	6
Malacoctenus macropus	Rosy blenny	4	10	1	1
Malacoctenus triangulatus	Saddled blenny	5	21	5	5
Malacoctenus versicolor	Barfin blenny	-		*	*
Megalops atlanticus	Tarpon	5	21	2	2
Microgobius carri	Seminole goby	-		3	5
Microspathodon chrysurus	Yellowtail damselfish	16	79	180	974
Monacanthus tuckeri	Slender filefish	-		3	4
Mulloidichthys martinicus	Yellow goatfish	16	73	53	346
Muraena miliaris	Goldentail moray	2	10	2	2
Mycteroperca bonaci	Black grouper	10	28	9	9
Myripristis jacobus	Blackbar soldierfish	1	3		
Ocyurus chrysurus	Yellowtail snapper	16	80	259	1602
Odontoscion dentex	Reef croaker	16	67	37	87

Table 3 (Continued)

Ophioblennius atlanticus	Redlip blenny	13	39	19	38
Opistognathus aurifrons	Yellowhead jawfish	2	9	17	43
Paranthias furcifer	Creole-fish	-		2	2
Paraclinus nigripinnis	Blackfin blenny	-		1	1
Pagrus pagrus	Red Porgy	-		1	1
Pempheris schomburgki	Glassy sweeper	15	62	15	493
Pomacanthus arcuatus	Gray angelfish	11	47	96	121
Pomacanthus paru	French angelfish	10	40	35	45
Pomacentrus diencaeus	Longfin damselfish	9	33	21	109
Pomacentrus fuscus	Dusky damselfish	10	30	82	692
Pomacentrus leucostictus	Beaugregory	3	11	46	132
Pomacentrus partitus	Bicolor damselfish	16	80	322	10021
Pomacentrus planifrons	Three spot damselfish	14	69	152	1257
Pomacentrus variabilis	Cocoa damselfish	9	29	61	166
Priacanthus cruentatus	Glasseye snapper	9	22	6	6
Pseudupeneus maculatus	Spotted goatfish	11	37	36	78
Rypticus saponaceus	Greater soapfish	2	5		
Scartella cristata	Molly miller	3	6	12	20
Scarus coelestinus	Midnight parrotfish	12	34	14	51
Scarus coeruleus	Blue parrotfish	12	44	30	61
Scarus croicensis	Striped parrotfish	16	74	212	1645
Scarus guacamaia	Rainbow parrotfish	7	23	15	20
Scarus taeniopterus	Princess parrotfish	4	8	84	215
Scarus vetula	Queen parrotfish	14	54	34	57
Scomberomrous cavalla	King mackerel	-		1	1
Scomberomrous maculatus	Spanish mackerel	-		1	1
Scomberomorus regalis	Cero mackerel	3	7	3	3
Scorpaena plumieri	Scorpion fish	1	1		
Seriola dumerili	Greater amberjack	-		*	*
Serranus baldwini	Lanternfish	6	16	8	11
Serranus tabacarius	Tobaccofish	-		*	*
Serranus tigrinus	Harlequin bass	15	62	113	185
Serranus tortugarum	Chalk bass	-		2	2
Sparisoma atomarium	Greenblotch parrotfish	-		3	7
Sparisoma aurofrenatum	Redband parrotfish	15	69	180	441
Sparisoma chrysopterum	Redtail parrotfish	3	14	84	190
Sparisoma radians	Bucktooth parrotfish	1	5	43	246
Sparisoma rubripinne	Yellowtail parrotfish	15	65	76	200
Sparisoma viride	Stoplight parrotfish	16	78	167	386
Sphoeroides spengleri	Bandtail puffer	-		1	1
Sphyraena barracuda	Barracuda	15	63	69	107
Strongylura notata	Redfin needlefish	-		*	*
Strongylura timucu	Timucu	-		1	1
Synodus intermedius	Inshore lizardfish	4	7	2	2
Thalassoma bifasciatum	Bluehead wrasse	16	80	328	12484
Trachinotus falcatus	Permit	3	10	6	8
Tylosurus crocodilus	Houndfish	-		3	3
Urolophus jamaicensis	Yellow stingray	-		9	9

- Observed only during random point samples.
Now considered color forms of H. unicolor (American Fisheries Society, 1980)

Table 4.— Mean abundance (± standard error) of selected species in different habitats at Looe Key National Marine Sanctuary. Unidentified species are deleted. "*" distribution plotted in Appendix 1.

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
SPECIES CODE	N 18	9	34	160	37	16	11	35	41	56
ABU SAXA*	0 -	0.56 (0.29)	22.38 (7.87)	32.20 (4.10)	21.50 (7.40)	5.20 (3.30)	0 -	0 -	0.02 (0.02)	0.18 (0.18)
ACA CHAP	0 -	0 -	0 -	0 -	0.14 (0.14)	0 -	0 -	0 -	0 -	0 -
ACA BAHI*	1.67 (0.24)	1.67 (0.60)	2.38 (0.33)	3.08 (0.49)	10.16 (1.61)	0.19 (0.14)	4.36 (1.65)	1.66 (0.48)	0.46 (0.20)	1.95 (0.3
ACA CHIR*	0.17 (0.12)	0 -	0.15 (0.15)	0.24 (0.05)	0.11 (0.08)	0 -	0 -	0 -	0.05 (0.05)	0.79 (0.24)
ACA COER*	0.67 (0.20)	0.33 (0.24)	1.12 (0.27)	1.61 (0.21)	3.68 (0.83)	0 -	1.45 (0.62)	0.03 (0.03)	0 -	1.54 (0.77)
ALU SOCO	0 -	0 -	0 -	0.01 (0.11)	0 0	0 0	0 -	0 -	0 -	0.07 (0.05)
ALU SCRI	0 -	0 -	0 -	0.04 (0.02)	0 -	0 -	0 -	0 -	0 -	0.02 (0.02)
AME PINC	0.06 (0.06)	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
ANI SURI	0 -	0 -	0.29 (0.11)	0.11 (0.04)	0 -	0 -	0 -	0 -	0 -	0 -
ANI VIRG	0 -	0 -	0.29 (0.11)	0.11 (0.04)	0 -	0 -	0 -	0 -	0 -	0 -
APO PSEU	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.15 (0.15)	0 -
AUL MACU	0 -	0 -	0.18 (0.09)	0.12 (0.03)	0 -	0 -	0 -	0 -	0 -	0.02 (0.02)
BAL CAPR	0 -	0 -	0.18 (0.09)	0.01 (0.01)	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
BAL VETU	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.06 (0.04)	0 -	0 -
BOD RUFU*	0.22 (0.10)	0 -	1.06 (0.16)	0.99 (0.09)	0.32 (0.10)	0 -	0 -	0 -	0 -	0.07 (0.04)
CAL BAJO*	0 -	0 -	0.29 (0.11)	0.14 (0.03)	0 -	0 -	0 -	0 -	0 -	0.04 (0.03)
CAL CALA	0.44 (0.17)	0.11 (0.11)	0.27 (0.08)	0.08 (0.03)	0 -	0 -	0 -	0.37 (0.24)	0.10 (0.07)	0.71 (0.10)
CAL PENA	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.05 (0.05)	0 -
CAN PULL	0 -	0 -	0.03 (0.03)	0.08 (0.03)	0.05 (0.23)	0 -	0 -	0 -	0.02 (0.02)	0 -
CAN SUFF	0 -	0 -	0.03 (0.03)	0.03 (0.02)	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
CAN ROST	0.39 (0.12)	0 -	0.16 (0.12)	0.17 (0.04)	0.03 (0.03)	0 -	0 -	0 -	0 -	0.21 (0.08)
CAR BART*	0.11 (0.08)	1.56 (1.31)	0.29 (0.29)	0.14 (0.10)	0 -	0.25 (0.19)	0 -	0 -	0.49 (0.03)	0.05 (0.54)
CAR CRYS	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.68 (0.68)	0 -
CAR RUBR*	0.06 (0.06)	1.67 (1.67)	2.03 (1.18)	0.32 (0.69)	0.32 (0.13)	0.31 (0.18)	0.18 (0.12)	2.54 (1.51)	0.10 (0.05)	0.20 (0.10)
CHA FABE	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -	0 -	0 -
CHA CAPI*	3.00 (1.24)	0 -	2.16 (0.25)	1.62 (0.12)	0.84 (0.20)	0 -	0.27 (0.27)	0 -	0 -	2.38 (0.30)
CHA OCEL*	4.44 (0.19)	0 -	0.74 (0.14)	0.49 (0.90)	0.16 (0.08)	0 -	0 -	0.06 (0.04)	0 -	0.79 (0.17)
CHA SEDE	0.50 (0.20)	0 -	0.03 (0.03)	0.02 (0.01)	0 -	0 -	0 -	0.03 (0.03)	0 -	0.07 (0.04)
CHA STRI	0.50 (0.25)	0 -	0.27 (0.12)	0.37 (0.06)	0 -	0 -	0 -	0 -	0 -	0.13 (0.08)
CHR CYAN*	3.22 (.73)	0 -	1.26 (0.39)	1.33 (0.15)	0 -	0 -	0 -	0 -	0 -	0.16 (0.09)
CHR INSC	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
CHR MULT*	0.56 (0.35)	0 -	3.03 (1.57)	4.90 (1.40)	0 -	0 -	0 -	0 -	0 -	0 -
CHR SCOT	0.06 (0.06)	0 -	0.50 (0.28)	0.18 (0.14)	0 -	0 -	0 -	0 -	0 -	0 -
CLE PARP*	0 -	0 -	5.00 (3.70)	0.61 (0.30)	0 -	0 -	0 -	0 -	0 -	0 -
COR DICR*	0.67 (0.39)	0.11 (0.11)	0.09 (0.07)	0.23 (0.06)	0.38 (0.22)	0 0	0 0	0.29 (0.29)	0 -	0.79 (0.29)
COR GLAU*	8.50 (2.10)	0.89 (0.56)	2.82 (0.92)	1.14 (0.19)	0.68 (0.28)	0.06 (0.06)	0.09 (0.09)	0.37 (0.15)	0.32 (0.27)	2.32 (0.48)
COR PERS*	50.20 (14.60)	0 -	2.94 (1.35)	14.60 (6.10)	0 -	0 -	0 -	0 -	0 -	4.10 (1.30)
CRY ROSE	0 -	0.22 (0.22)	0 -	0 -	0 -	0 -	0 -	0.06 (0.06)	0.44 (0.26)	0 -
DEC MACA	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1.70 (1.70)	0 -
DEC PUNC	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3.70 (3.70)	0 -
DID HOLO	0.06 (0.06)	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
DID HYST	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
DIP FORM	0 -	0.11 (0.11)	0 -	0.10 (0.10)	0 -	0 -	0 -	0.43 (0.18)	0.49 (0.27)	0 -
ECH NAUC	0.06 (0.06)	0 -	0 -	0.02 (0.01)	0.05 (0.04)	0 -	0 -	0 -	0 -	0
EPI CRUE*	0.78 (0.21)	0 -	0.53 (0.10)	0.51 (0.06)	0.11 (0.05)	0 -	0.09 (0.09)	0 0	0 0	0.25 (0.06)
EPI GUTT	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0
EPI MORI	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.02 (0.02)
EPI STRI	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -	0 -	0.02 (0.02)
EQU ACUM	0.11 (0.08)	0 -	0.03 (0.03)	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0.05 (0.03)
EQU PUNC	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
GER CINE	0 -	0 -	0 -	0 -	18.40 8.10	0 -	0 -	0 -	0 -	0 -
GIN CIRR	0 -	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
GNA THOM	0.17 (0.12)	0.67 (0.37)	0.09 (0.07)	0.36 (0.09)	0.62 (0.29)	0 -	0 -	0.03 (0.03)	0 -	0.25 (0.12)
GOB MACR	0 -	0 -	0 -	0 -	0.08 (0.08)	0 -	0 -	0 -	0 -	0 -
GOB OCEA	0.94 (0.37)	0 -	0.50 (0.24)	0.39 (0.08)	0.08 (0.06)	0 -	0 -	0 -	0 -	0.59 (0.31)
GYM MORI	0 -	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0.02 (0.02)
HAE ALBU	0 -	0.89 (0.68)	0 -	0.17 (0.16)	0.14 (0.08)	0 -	0 -	0.23 (0.16)	0.02 (0.02)	0 -
HAE AURO*	2.78 (2.78)	0.78 (0.36)	87.97 (19.00)	34.03 (5.70)	2.32 (1.18)	1.81 (1.44)	1.64 (1.35)	61.02 (21.00)	1.98 (1.55)	0 -
HAE CARB	0 -	0 -	0.03 (0.03)	2.20 (1.50)	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
HAE CHRY*	0 -	0 -	0 -	2.89 (1.00)	11.20 (8.80)	0 -	0 -	0 -	0 -	0 -
HAE FLAV*	1.50 (0.99)	0 -	1.62 (0.19)	1.60 (0.15)	7.30 (2.80)	0.13 (0.13)	5.50 (5.10)	0.29 (0.29)	0 -	0.37 (0.15)
HAE MACR	0 -	0 -	0 -	0.35 (0.11)	0.33 (0.09)	0.70 (0.70)	0 -	0 -	0 -	0 -
HAE MELA	0 -	0.89 (0.68)	0 -	0.01 (0.01)	0 -	0 -	0 -	0.23 (0.23)	0.07 (0.05)	0 -
HAE PARR	0 -	0 -	0 -	0.33 (0.20)	0.11 (0.05)	0.06 (0.06)	0 -	0 -	0.10 (0.10)	0 -

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
HAE PLUM*	0.67 (0.21)	1.22 (0.52)	0.76 (0.25)	0.85 (0.21)	3.90 (1.70)	0.88 (0.36)	0.36 (0.15)	2.80 (1.53)	5.19 (2.70)	8.25 (2.30)
HAE SCIU*	0 -	0 -	1.29 (0.29)	1.86 (0.46)	2.65 (1.25)	0.13 (0.13)	0 -	0 -	0 -	1.73 (0.68)
HAL BIVI*	0.50 (0.25)	18.00 (4.60)	2.44 (0.77)	3.88 (0.75)	36.50 (4.80)	13.70 (4.00)	10.27 (2.55)	9.86 (1.45)	13.00 (3.30)	2.80 (0.80)
HAL GARN*	4.26 (0.95)	1.56 (0.88)	3.97 (0.61)	3.98 (0.34)	1.32 (0.41)	0.06 (0.06)	0.27 (0.27)	0.47 (0.19)	0.98 (0.06)	3.25 (0.48)
HAL MACU*	1.56 (0.36)	3.86 (1.20)	2.91 (0.61)	4.58 (0.64)	8.62 (1.35)	0.09 (0.09)	0.55 (0.31)	2.57 (1.04)	2.12 (0.80)	2.04 (0.40)
HAL POEY*	0 -	2.11 (1.05)	0 -	0.01 (0.01)	0.41 (0.21)	0.62 (0.27)	0.27 (0.20)	0.31 (0.15)	1.41 (0.63)	0.04 (0.03)
HAL RADI*	0 -	0.33 (0.24)	0.61 (0.24)	0.67 (0.10)	1.51 (0.27)	0.81 (0.46)	0.46 (0.28)	0.94 (0.29)	0.15 (0.07)	0.32 (0.09)
HEM SIMU	0 -	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
HEM NOVA	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0.09 (0.09)	0 -	0 -	0 -
HEM SPLE	0 -	0.56 (0.44)	0 -	0.01 (0.01)	0.03 (0.03)	1.19 (0.48)	0.16 (0.18)	3.23 (0.73)	3.07 (1.31)	0 -
HOL BERM	0.11 (0.32)	0 -	0 -	0.05 (0.02)	0 -	0 -	0 -	0 -	0 -	0.14 (0.05)
HOL CILI	0.06 (0.06)	0 -	0.09 (0.05)	0.06 (0.02)	0.03 (0.03)	0 -	0 -	0 -	0 -	0.05 (0.04)
HOL TRIC*	0.94 (0.22)	0.44 (0.11)	0.59 (0.04)	0.23 (0.05)	0.14 (0.07)	0 -	0 -	0 -	0 -	0.02 (0.02)
HOL ASCE	0 -	0 -	0 -	0.04 (0.02)	0 -	0 -	0 -	0 -	0 -	0 -
HOL RUFU	0 -	0 -	0.21 (0.11)	0.16 (0.04)	0 -	0 -	0 -	0 -	0 -	0 -
HOL VEXI	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -	0 -
HYP UNIC (all forms)	1.22 (0.21)	0 -	0.03 (0.03)	0.04 (0.02)	0.03 (0.03)	0 -	0 -	0 -	0 -	0.53 (0.10)
IDG CALL	0 -	0.22 (0.15)	0.06 (0.06)	0 -	0 -	0 -	0 -	1.80 (0.87)	0.15 (0.12)	0.04 (0.04)
INE VITT	0 -	0 -	0 -	0.19 (0.17)	0 -	0 -	0 -	0 -	7.80 (5.40)	0.02 (0.02)
KYP SECT	0 -	0 -	0.76 (0.38)	2.23 (0.74)	0.65 (0.54)	0 -	0 -	0 -	0 -	0 -
LAC MAXI	0.33 (0.11)	0.14 (0.73)	0.53 (0.14)	0.19 (0.04)	0.08 (0.05)	0 -	0 -	0.14 (0.07)	0.29 (0.16)	0.41 (0.11)
LAC BICA	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
LAC QUAD	0.06 (0.06)	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
LAC TRIQ	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -
LUT ANAL*	0 -	0.11 (0.11)	0 -	0.02 (0.01)	0.03 (0.03)	0 -	0 -	0 -	0.02 (0.02)	0 -
LUT APOD*	0 -	0 -	1.76 (0.63)	0.81 (0.22)	0.46 (0.21)	0 -	0.18 (0.12)	0 -	0 -	0 -
LUT GRIS*	0 -	0 -	1.65 (1.47)	0.62 (0.28)	0 -	0 -	0 -	0 -	0 -	0 -
LUT JOCU	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -	0 -	0 -
LUT MAHO	0 -	0 -	0 -	0.06 (0.04)	0 -	0 -	0 -	0 -	0 -	0 -
LUT SYNA*	0 -	0 -	0 -	1.59 (0.50)	0 -	0 -	0 -	0 -	0 -	0 -
MAL PLUM	0 -	0.33 (0.24)	0.15 (0.10)	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
MAL GILL	0 -	0 -	0 -	0.16 (0.12)	0 -	0 -	0 -	0 -	0 -	0 -
MAL MACR	0 -	0.11 (0.11)	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
MAL TRIA	0 -	0 -	0 -	0.02 (0.01)	0.03 (0.03)	0 -	0 -	0 -	0 -	0.02 (0.02)
MEG ATLA	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
MIC CARR	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.14 (0.08)	0 -	0 -
MIC CHRY*	0 -	0 -	2.88 (0.55)	4.92 (0.44)	2.05 (0.43)	0 0	1.00 (0.65)	0 -	0 -	0 -
MON TUCK	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	(0.04) (0.03)
MUL MART*	0 -	0 -	1.59 (0.62)	0.81 (0.42)	0 -	0 -	0 -	0 -	0 -	0 -
MUR MILI	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
MYC BONA	0.06 (0.06)	0 -	0.06 (0.24)	0.03 (0.01)	0 -	0 -	0.09 (0.09)	0 -	0 -	0 -
OCY CHRY*	0.39 (0.14)	0.89 (0.39)	9.38 (1.27)	6.92 (0.82)	2.43 (0.69)	1.12 (0.26)	0.36 (0.20)	0 -	.0.27 (0.13)	0.68 (0.14)
ODO DENT	0 -	0 -	0.38 (0.17)	0.45 (0.14)	0.05 (0.04)	0 -	0 -	0 -	0 -	0 -
OPH ATLA	0 -	1.00 (1.00)	0 -	0.15 (0.06)	0.11 (0.07)	0 -	0.09 (0.09)	0 -	0 -	0 -

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
DPI AURI	0 -	1.00 (0.60)	0 -	0.05 (0.03)	0.16 (0.09)	0 -	0 -	0.23 (0.13)	0.12 (0.07)	0.13 (0.13)
PAR FURC	0 -	0 -	0.06 (0.04)	0 -	0 -	0 -	0 -	0 -	0 -	0 -
PAR NIGR	0 -	0.11 (0.11)	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
PAG PAGR	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.02 (0.02)
PEM SCHO	0 -	0 -	6.40 (5.90)	1.70 (1.30)	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
POM ARCU*	0.50 (0.51)	0 -	0.75 (0.13)	0.32 (0.05)	0.05 (0.04)	0 -	0 -	0 -	0.02 (0.02)	0.61 (0.11)
POM PARU	0.44 (0.17)	0 -	0.03 (0.03)	0.13 (0.03)	0 -	0 -	0 -	0 -	0 -	0.27 (0.08
POM DIEN	0 -	0 -	0 -	0.64 (0.17)	0.03 (0.03)	0 -	0.45 (0.45)	0 -	0 -	0 -
POM FUSC*	0.11 (0.08)	0 -	0.91 (0.49)	3.75 (0.69)	1.54 (0.46)	0 -	0.09 (0.09)	0 -	0 -	0 -
POM LEUC	0.39 (0.20)	0.22 (0.22)	0.03 (0.03)	0.09 (0.03)	2.32 (0.66)	0 -	1.18 (0.50)	0.09 (0.05)	0.05 (0.03)	0.07 (0.05)
POM PART*	54.60 (6.70)	13.90 (5.20)	29.70 (4.80)	35.60 (2.30)	24.10 (6.60)	0 -	4.09 (1.56)	6.50 (1.90)	5.10 (1.90)	14.90 (2.30)
POM PLAN*	4.67 (2.16)	0 -	6.15 (1.47)	5.09 (0.65)	0.49 (0.26)	0 -	0 -	0 -	0 -	2.36 (0.53)
POM VARI	0.83 (0.31)	0.78 (0.55)	0 -	0.45 (0.16)	0.70 (0.23)	0 -	0.18 (0.12)	0.17 (0.12)	0.07 (0.05)	0.52 (0.19)
PRI CRUE	0 -	0 -	0 -	0.01 (0.01)	0.03 (0.03)	0 -	0 -	0.03 (0.03)	0.05 (0.04)	0 -
PSE MACU*	0.22 (0.13)	0.22 (0.15)	0.06 (0.04)	0.11 (0.04)	0.35 (0.12)	0 -	0 -	0 -	0.24 (0.24)	0.54 (0.17)
SCA CRIS	0 -	1.11 (0.48)	0 -	0 -	0.11 (0.09)	0 -	0 -	0.09 (0.05)	0.05 (0.03)	0.02 (0.02)
SCA COEL	0 -	0 -	1.15 (0.91)	0.06 (0.02)	0.05 (0.04)	0 -	0 -	0 -	0 -	0 -
SCA COER	0.06 (0.06)	0 -	0.29 (0.14)	0.30 (0.13)	0.03 (0.03)	0 -	0.09 (0.09)	0 -	0 -	0 -
SCA CROI*	7.44 (0.95)	0.89 (0.89)	4.09 (1.03)	3.50 (0.41)	11.80 (2.60)	0 -	2.45 (1.10)	0.51 (0.27)	0.71 (0.51)	5.23 (0.66)
SCA GUAC	0 -	0 -	0.12 (0.06)	0.06 (0.03)	0.16 (0.11)	0 -	0 -	0 -	0 -	0 -
SCA TAEN	1.33 (0.34)	0 -	0.65 (0.31)	0.42 (0.07)	1.68 (1.12)	0 -	0 -	0 -	0.15 (0.15)	0.61 (0.30)
SCA VETU	0 -	0 -	0.15 (0.06)	0.26 (0.06)	0.11 (0.07)	0 -	0 -	0 -	0 -	0.09 (0.09)

Table 4. Abundance (Continued).

SPECIES CODE	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
SCO CAVA	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
SCO MACU	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
SCO REGA	0.06 (0.06)	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.05 (0.03)	0 -
SER BALD	0 -	0.33 (0.24)	0 -	0.01 (0.01)	0.08 (0.06)	0 -	0.18 (0.18)	0 -	0.02 (0.02)	0 -
SER TIGR	1.83 (0.44)	0.67 (0.37)	0.47 (0.11)	0.28 (0.04)	0.19 (0.12)	0 -	0 -	0.03 (0.03)	0.10 (0.06)	1.34 (0.17)
SER TORT	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.03 (0.03)	0.02 (0.02)	0 -
SPA ATOM	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0.06 (0.06)	0.12 (0.09)	0 -
SPA AURO*	1.78 (0.46)	0.67 (0.47)	1.12 (0.21)	1.60 (0.15)	0.81 (0.29)	0 -	0 -	0.03 (0.03)	0.05 (0.03)	1.36 (0.20)
SPA CHRY*	0.22 (0.17)	0 -	0.41 (0.41)	0.39 (0.39)	1.00 (0.24)	0.44 (0.18)	0.55 (0.37)	0.11 (0.07)	0.95 (0.76)	0.30 (0.10)
SPA RADI	0 -	1.56 (0.78)	0 -	0 -	0.68 (0.36)	2.00 (0.68)	0.46 (0.25)	0.11 (0.53)	4.00 (1.45)	0.02 (0.02)
SPA RUBR*	0.39 (0.29)	0 -	0.49 (0.19)	0.59 (0.10)	1.62 (0.45)	0.06 (0.06)	0.09 (0.09)	0 -	0 -	0.27 (0.15)
SPA VIRI*	0.50 (0.23)	0 -	1.44 (0.24)	1.64 (0.17)	1.22 (0.24)	0 -	0.18 (0.18)	0 -	0 -	0.34 (0.10)
SPH SPEN	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
SPH BARR*	0.06 (0.06)	0.22 (0.15)	0.27 (0.09)	0.43 (0.10)	0.41 (0.15)	0.25 (0.11)	0 -	0.03 (0.03)	0.10 (0.05)	0.04 (0.03)
STR TIMU	0 -	0 -	0 -	0 -	0.03 (0.03)	0 -	0 -	0 -	0 -	0 -
SYN INTE	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0 -	0 (0.03)	0 -	0 -
THA BIFA*	26.44 (5.30)	6.56 (1.38)	26.60 (4.50)	59.70 (5.20)	17.60 (2.50)	0.69 (0.51)	2.09 (1.01)	3.29 (1.08)	2.22 (0.96)	10.68 (1.24)
TRA FALC	0 -	0 -	0.15 (0.10)	0.02 (0.01)	0 -	0 -	0 -	0 -	0 -	0 -
TYL CROC	0 -	0 -	0 -	0.01 (0.01)	0 -	0 -	0.09 (0.09)	0 -	0 -	0 -
URO JAMA	0.11 (0.08)	0 -	0 -	0 -	0 -	0 -	0 -	0.06 (0.04)	0.05 (0.03)	0.54 (0.03)

Table 5.—Percent frequency of occurrence (± 95% confidence intervals) of selected species in different habitats at Looe Key National Marine Sanctuary. Unidentified species are deleted. '*', distribution plotted in Appendix 1.

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
SPECIES CODE N	18	9	34	160	37	16	11	35	41	58
ABU SAXA*	0 0 - 19	33 7 - 70	85 68 - 95	78 71 - 84	62 45 - 78	38 15 - 66	0 0 - 29	0 0 - 10	2 0 - 13	2 0 - 10
ACA CHAF	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	14 4 - 29	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
ACA BAHI*	94 73 -100	67 30 - 93	82 65 - 93	73 66 - 80	86 71 - 96	13 2 - 38	45 17 - 77	34 19 - 52	20 9 - 35	66 54 - 80
ACA CHIP*	11 1 - 35	0 0 - 34	15 5 - 31	16 11 - 23	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	30 19 - 44
ACA COEP*	44 21 - 69	22 3 - 60	56 38 - 73	66 58 - 74	76 59 - 88	0 0 - 21	45 17 - 77	3 0 - 15	0 0 - 9	38 25 - 52
ALL SCHO	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	4 0 - 12
ALL SCRI	0 0 - 19	0 0 - 34	0 0 - 10	4 1 - 8	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
AME PINO	6 0 - 27	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
ANI SURI	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
ANI VIRG	0 0 - 19	0 0 - 34	21 9 - 38	8 4 - 14	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
APO PSEU	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
AUL MACU	0 0 - 19	0 0 - 34	12 3 - 27	11 7 - 17	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
BAL CAPR	0 0 - 19	0 0 - 34	3 0 - 15	1 0 - 4	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
BAL VETU	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	6 1 - 19	0 0 - 9	0 0 - 6
BOO RUFU*	22 6 - 48	0 0 - 34	65 46 - 80	56 48 - 64	27 14 - 44	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	7 2 - 17
CAL BAJO*	0 0 - 19	0 0 - 34	21 9 - 38	11 7 - 17	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	4 0 - 12
CAL CALA	33 13 - 59	11 0 - 48	26 13 - 44	7 3 - 12	0 0 - 10	0 0 - 21	0 0 - 29	11 3 - 27	5 1 - 17	57 43 - 70
CAL PENA	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
CAN PULL	0 0 - 19	0 0 - 34	3 0 - 15	7 3 - 21	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
CAN SUFF	0 0 - 19	0 0 - 34	3 0 - 15	3 1 - 7	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
CAN ROST	39 18 - 65	0 0 - 34	9 2 - 23	13 8 - 23	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	5 1 - 15
CAR BART*	11 1 - 35	33 8 - 70	3 0 - 15	4 1 - 8	0 0 - 10	13 2 - 38	0 0 - 29	0 0 - 10	2 0 - 13	2 0 - 10
CAR CRYS	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
CAR RUBE*	6 0 - 27	11 0 - 48	32 17 - 51	35 26 - 43	19 8 - 35	19 4 - 46	19 2 - 52	7 0 - 19	10 3 - 23	9 3 - 20
CHA FABE	0 0 - 19	0 0 - 34	3 0 - 15	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
CHA CAPI*	100 81 -100	0 0 - 34	82 65 - 93	65 57 - 72	38 22 - 55	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	73 60 - 84
CHA OCEL*	28 10 - 54	0 0 - 34	50 32 - 68	26 20 - 34	11 3 - 25	0 0 - 21	0 0 - 29	6 1 - 19	0 0 - 9	36 23 - 50
CHA SEDE	28 10 - 54	0 0 - 34	3 0 - 15	2 0 - 5	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	0 0 - 9	5 0 - 15
CHA STRI	22 6 - 48	0 0 - 34	15 5 - 31	22 16 - 29	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	9 3 - 20
CHR CYAN*	89 65 - 99	0 0 - 34	41 25 - 59	45 37 - 53	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 0	9 3 - 20
CHR INSO	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
CHR MULT*	17 4 - 41	0 0 - 34	26 13 - 44	29 22 - 36	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
CHR SCOT	6 0 - 27	0 0 - 34	15 5 - 31	4 0 - 8	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
CLE PARR*	0 0 - 19	0 0 - 34	15 5 - 31	6 3 - 11	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
COR DICR*	22 6 - 48	11 0 - 48	6 1 - 20	12 7 - 18	16 6 - 32	0 0 - 21	0 0 - 29	3 0 - 15	0 0 - 9-	21 12 - 34
COR GLAU*	61 36 - 83	33 8 - 70	44 27 - 62	28 21 - 36	22 10 - 38	6 0 - 30	9 0 - 41	17 7 - 34	7 2 - 20	48 35 - 62
COR PERS*	72 46 - 90	0 0 - 34	24 11 - 41	19 13 - 26	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	30 19 - 44
CRY ROSE	0 0 - 19	11 0 - 48	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	15 6 - 29	0 0 - 6
DEC MACA	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
DEC PUNC	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
DIO HOLO	6 0 - 27	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
DIO HYST	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
DIP FORM	0 0 - 19	11 0 - 48	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	11 3 - 27	10 3 - 23	0 0 - 6
ECH NAUC	6 0 - 27	0 0 - 34	0 0 - 10	2 0 - 5	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
EPI CRUE*	55 31 - 79	0 0 - 34	50 32 - 68	43 35 - 51	11 3 - 25	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	23 13 - 36
EPI GUTT	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
EPI MORI	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
EPI STRI	0 0 - 19	0 0 - 34	3 0 - 15	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
EQU ACUT	11 0 - 35	0 0 - 34	3 0 - 15	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
EQU PUNC	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
GEP CINE	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	16 6 - 32	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
GIN CIRR	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
GNA THOM	11 1 - 35	33 7 - 70	6 1 - 20	13 8 - 20	16 6 - 32	0 0 - 21	0 0 - 29	3 0 - 15	0 0 - 9	9 0 - 20
GOB MACP	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
GOB OCEA	39 18 - 65	0 0 - 34	19 13 - 26	5 1 - 18	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	20 10 - 32
GYM MORI	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
HAE ALBI	0 0 - 19	11 0 - 48	0 0 - 10	1 0 - 4	8 1 - 22	0 0 - 21	0 0 - 29	6 1 - 19	2 0 - 13	0 0 - 6
HAE AURO*	6 0 - 27	35 7 - 70	74 56 - 87	48 40 - 56	16 6 - 32	15 4 - 46	27 6 - 61	37 21 - 55	15 6 - 29	0 0 - 6
HAE CARB	0 0 - 19	0 0 - 34	3 0 - 15	12 7 - 18	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HAE CHRY*	0 0 - 19	0 0 - 34	0 0 - 10	11 7 - 17	36 20 - 53	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HAE FLAV*	17 4 - 41	0 0 - 34	82 65 - 93	68 60 - 75	54 37 - 71	6 0 - 30	36 11 - 69	3 0 - 15	0 0 - 9	16 8 - 26
HAE MACR	0 0 - 19	0 0 - 34	26 13 - 44	19 13 - 26	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HAE MELA	0 0 - 19	22 3 - 60	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	5 0 - 17	0 0 - 6
HAE PARR	0 0 - 19	0 0 - 34	0 0 - 10	3 1 - 7	11 3 - 25	6 0 - 31	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
HAE PLUM*	44 21 - 69	44 14 - 79	41 25 - 59	40 32 - 48	43 27 - 61	38 15 - 65	9 0 - 41	17 7 - 34	22 11 - 38	46 33 - 60
HAE SCIU*	0 0 - 19	0 0 - 34	56 38 - 73	35 28 - 43	46 30 - 63	6 0 - 30	0 0 - 29	0 0 - 10	0 0 - 9	29 17 - 42
HAL BIVI*	28 10 - 54	100 66 -100	44 27 - 62	49 41 - 57	95 82 - 99	94 70 -100	73 39 - 94	83 66 - 93	80 65 - 91	55 41 - 69
HAL GARN*	100 81 -100	44 14 - 79	88 73 - 97	83 76 - 89	32 18 - 50	6 0 - 30	9 0 - 41	14 5 - 30	7 1 - 20	80 68 - 90
HAL MACU*	67 41 - 87	78 40 - 97	62 44 - 78	74 66 - 80	78 62 - 90	9 0 - 61	27 17 - 49	31 17 - 49	32 18 - 48	54 40 - 67
HAL POEY	0 0 - 19	44 14 - 79	0 0 - 10	1 0 - 4	14 4 - 29	38 16 - 65	18 2 - 52	14 5 - 30	37 23 - 53	4 0 - 12
HAL RADI*	0 0 - 19	78 40 - 97	21 9 - 38	34 27 - 42	65 47 - 80	25 7 - 52	28 6 - 61	31 17 - 49	12 4 - 26	23 13 - 36
HEM SIMU	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HEM NOVA	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
HEM SPLE	0 0 - 19	22 3 - 60	0 0 - 10	1 0 - 4	3 0 - 14	44 20 - 71	9 0 - 41	71 47 - 89	29 15 - 45	0 0 - 6
HOL BERM	11 1 - 35	0 0 - 34	0 0 - 10	4 1 - 8	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	14 6 - 26
HOL CILI	6 0 - 27	0 0 - 34	9 2 - 23	8 4 - 14	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	9 3 - 20
HOL TRIC*	67 41 - 87	35 7 - 70	6 1 - 20	17 11 - 24	11 3 - 25	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
HOL ASCE	0 0 - 19	0 0 - 34	0 0 - 10	4 1 - 8	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HOL RUFU	0 0 - 19	0 0 - 34	12 3 - 27	10 6 - 16	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HOL VEXI	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
HYP UNIC (all forms)	83 59 - 96	0 0 - 34	3 0 - 15	4 1 - 8	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	41 26 - 55
IDG CALL	0 0 - 19	22 3 - 60	3 0 - 15	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	26 13 - 43	49 33 - 65	2 0 - 10
INE VITT	0 0 - 19	0 0 - 34	0 0 - 10	2 0 - 5	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	7 2 - 20	2 0 - 10
KYP SECT	0 0 - 19	0 0 - 34	18 7 - 35	18 12 - 26	11 3 - 25	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
LAC MAXI	33 13 - 59	11 0 - 48	38 22 - 56	15 10 - 22	8 2 - 22	0 0 - 21	0 0 - 29	11 3 - 27	10 3 - 23	27 16 - 41
LAC BICA	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
LAC QUAD	6 0 - 27	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
LAC TRIO	0 0 - 19	0 0 - 34	0 0 - 10	3 1 - 7	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	0 0 - 9	0 0 - 6
LUT ANAL*	0 0 - 19	11 0 - 48	0 0 - 10	2 0 - 5	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	0 0 - 6
LUT APOD*	0 0 - 19	0 0 - 34	32 17 - 51	14 9 - 20	16 6 - 32	0 0 - 21	19 2 - 52	0 0 - 10	0 0 - 9	0 0 - 6
LUT GRIS*	0 0 - 19	0 0 - 34	12 3 - 28	15 10 - 22	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
LUT JOCU	0 0 - 19	0 0 - 34	3 0 - 15	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
LUT MAHO	0 0 - 19	0 0 - 34	0 0 - 10	2 0 - 5	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
LUT SYNA*	0 0 - 19	0 0 - 34	0 0 - 10	11 7 - 17	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MAL PLUM	0 0 - 19	22 3 - 60	9 2 - 23	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MAL GILL	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MAL MACR	0 0 - 19	11 0 - 48	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MAL TRIA	0 0 - 19	0 0 - 34	0 0 - 10	2 0 - 5	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
MEG ATLA	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MIC CARP	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	9 2 - 23	0 0 - 9	0 0 - 6
MIC CHRY*	0 0 - 19	0 0 - 34	74 56 - 87	81 74 - 87	59 42 - 75	0 0 - 21	27 6 - 61	0 0 - 10	0 0 - 9	0 0 - 6
MON TUCK	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	4 0 - 12
MUL MART*	0 0 - 19	0 0 - 34	41 25 - 59	24 17 - 31	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MUR MILI	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
MYC BONA	6 0 - 27	0 0 - 34	6 1 - 20	3 1 - 7	0 0 - 10	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
OCY CHRY*	33 13 - 59	44 14 - 79	97 85 -100	94 89 - 97	62 45 - 78	75 48 - 93	27 6 - 61	0 0 - 10	13 4 - 26	41 26 - 55
ODO DENT	0 0 - 19	0 0 - 34	21 9 - 38	18 12 - 26	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
OPH ATLA	0 0 - 19	11 0 - 48	0 0 - 10	9 5 - 15	8 2 - 22	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
OPH AURI	0 0 - 19	33 7 - 70	0 0 - 10	2 0 - 5	8 2 - 22	0 0 - 21	0 0 - 29	11 3 - 27	7 2 - 20	2 0 - 10
PAR FURC	0 0 - 19	0 0 - 34	6 1 - 20	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
PAR NIGR	0 0 - 19	11 0 - 48	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
PAG PAGR	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10
PEM SCHO	0 0 - 19	0 0 - 34	21 9 - 38	4 1 - 8	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
POM ARCU*	50 26 - 74	0 0 - 34	56 38 - 73	26 20 - 34	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 12	41 28 - 55
POM PARU	33 13 - 59	0 0 - 34	3 0 - 15	11 7 - 17	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	20 10 - 32
POM DIEN	0 0 - 19	0 0 - 34	0 0 - 10	12 7 - 18	3 0 - 14	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
POM FUSC*	11 1 - 35	0 0 - 34	57 38 - 73	36 29 - 44	35 20 - 53	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
POM LEUC	22 6 - 48	11 0 - 48	3 0 - 15	26 20 - 34	51 34 - 68	0 0 - 21	45 17 - 77	9 2 - 23	5 1 - 17	4 0 - 12
POM PART*	94 73 -100	89 52 -100	91 76 - 98	96 92 - 99	65 48 - 80	0 0 - 21	45 17 - 77	57 39 - 74	27 14 - 43	93 83 - 98
POM PLAN*	44 21 - 69	0 0 - 34	76 59 - 89	52 44 - 60	11 3 - 25	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	55 41 - 69
POM VARI	33 13 - 59	33 7 - 70	0 0 - 10	13 8 - 20	27 14 - 44	0 0 - 21	9 0 - 41	6 1 - 19	5 1 - 17	29 17 - 42
PRI CRUE	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	3 0 - 14	0 0 - 21	0 0 - 29	3 0 - 15	5 0 - 17	0 0 - 6
PSE MACU*	17 4 - 41	22 3 - 60	59 41 - 75	4 1 - 8	22 10 - 38	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	23 13 - 36
SCA CRIS	0 0 - 19	11 0 - 48	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	9 2 - 23	5 1 - 17	2 0 - 10
SCA COEL	0 0 - 19	0 0 - 34	9 2 - 23	6 3 - 11	5 1 - 18	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
SCA COER	6 0 - 27	0 0 - 34	18 7 - 35	13 8 - 20	3 0 - 14	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
SCA CROI*	94 73 -100	13 0 - 48	56 38 - 73	59 51 - 67	76 59 - 88	0 0 - 21	45 17 - 77	11 3 - 27	10 3 - 23	71 58 - 83
SCA GUAC	0 0 - 19	0 0 - 34	12 3 - 27	5 2 - 10	8 2 - 22	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
SCA TAEN	78 52 - 94	0 0 - 34	24 11 - 41	29 22 - 36	16 6 - 32	0 0 - 21	0 0 - 29	0 0 - 10	2 0 - 13	11 7 - 29
SCA VETU	0 0 - 19	0 0 - 34	18 7 - 35	15 10 - 22	8 2 - 22	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	2 0 - 10

Table 5. Frequency of Occurrence (Continued).

HABITAT	DEEP LIVE BOTTOM	DEEP SAND	BUTTRESS ZONE	FOREREEF ZONE	LAGOON RUBBLE	LAGOON GRASS	LAGOON SAND	SHALLOW SAND	GRASS FLATS	SHALLOW LIVE BOTTOM
SCO CAVA	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
SCO REGA	6 0 - 27	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	5 1 - 17	0 0 - 6
SER BALD	0 0 - 19	11 0 - 48	0 0 - 10	1 0 - 4	5 1 - 18	0 0 - 21	9 0 - 41	0 0 - 10	2 0 - 13	0 0 - 6
SER TIGR	78 52 - 94	33 7 - 70	38 22 - 56	23 16 - 31	11 3 - 25	0 0 - 21	0 0 - 29	3 0 - 15	7 2 - 20	70 56 - 82
SER TORT	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	2 0 - 13	0 0 - 6
SPA ATOM	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	5 1 - 17	0 0 - 6
SPA AURO*	78 52 - 94	22 3 - 60	58 41 - 75	62 54 - 69	24 12 - 42	0 0 - 21	0 0 - 29	3 0 - 10	49 33 - 65	59 45 - 72
SPA CHRY*	11 1 - 35	0 0 - 34	26 13 - 44	20 14 - 27	43 27 - 61	31 11 - 59	27 6 - 69	5 2 - 23	10 3 - 23	16 9 - 30
SPA RADI	0 0 - 19	33 7 - 70	0 0 - 10	0 0 - 2	19 8 - 35	44 20 - 71	27 6 - 61	6 1 - 19	49 33 - 65	2 0 - 10
SPA RUBR*	13 1 - 35	0 0 - 34	19 7 - 35	28 21 - 36	43 27 - 61	6 0 - 30	9 0 - 41	0 0 - 10	0 0 - 9	7 2 - 17
SPA VIRI*	22 6 - 48	0 0 - 34	68 50 - 83	66 58 - 74	59 42 - 75	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	21 12 - 34
SPH SPEN	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
SPH BARR*	6 0 - 27	22 3 - 60	24 11 - 41	24 17 - 31	22 10 - 38	25 7 - 52	0 0 - 29	3 0 - 15	10 3 - 23	4 0 - 12
STR TIMU	0 0 - 19	0 0 - 34	0 0 - 10	0 0 - 2	3 0 - 14	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
SYN INTE	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	0 0 - 29	3 0 - 15	0 0 - 9	0 0 - 6
THA BIFA*	100 82 -100	100 66 -100	97 85 -100	98 95 -100	89 75 - 97	19 4 - 46	36 11 - 69	34 19 - 52	27 14 - 43	86 76 - 95
TRA FALC	0 0 - 19	0 0 - 34	9 2 - 23	2 0 - 5	0 0 - 10	0 0 - 21	0 0 - 29	0 0 - 10	0 0 - 9	0 0 - 6
TYL CROC	0 0 - 19	0 0 - 34	0 0 - 10	1 0 - 4	0 0 - 10	0 0 - 21	9 0 - 41	0 0 - 10	0 0 - 9	0 0 - 6
URO JAMA	11 1 - 35	0 0 - 34	0 0 - 10	0 0 - 2	0 0 - 10	0 0 - 21	0 0 - 29	6 1 - 19	5 1 - 17	5 1 - 15

Table 6.--Summary of species in the forereef zone.

SPECIES CODE	RANKED ABUNDANCE	RANKED FREQUENCY	RANKED MEAN LENGTH	TOTAL ABUNDANCE	FREQUENCY (N = 160)	PERCENT FREQUENCY	MEAN LENGTH (cm)	MINIMUM LENGTH (cm)	MAXIMUM LENGTH (cm)
ABU SAXA	4	6	75	5174	124	77.50	9.69	3	15
ACA BAHI	15	8	65	492	117	73.13	11.84	3	20
ACA CHIR	55	43	44	39	26	16.25	18.35	6	27
ACA COER	23	10	62	263	105	65.63	12.05	3	30
ALU SCHO	93	89	30	2	2	1.25	23.5	16	31
ALU SCRI	82	74	9	6	6	3.75	42.67	36	50
AMB PINO	104	101	76	1	1	0.63	9	9	9
ANI SURI	105	102	22	1	1	0.63	30	30	30
ANI VIRG	69	62	45	18	13	8.13	18.15	4	25
AUL MACU	68	56	14	19	17	10.63	35.59	20	50
BAL CAPR	94	103	17	2	1	0.63	35	35	35
BOD RUFU	31	15	34	158	89	55.63	21.85	9	32
CAL BAJO	65	55	15	23	18	11.25	35.22	20	50
CAL CALA	72	64	32	15	11	6.88	21.91	15	30
CAN PULL	74	65	66	13	11	6.88	11.56	3	16
CAN SUFF	83	79	12	5	4	2.50	39.5	35	45
CAN ROST	61	49	109	27	20	12.50	3.58	2	5
CAR BART	66	70	6	22	7	4.38	47.1	32	75
CAR RUBE	17	23	50	453	56	35.00	17.15	8	35
CHA CAPI	25	12	83	260	104	65.00	8.32	1	15
CHA OCEL	40	30	69	79	42	26.25	11	6	16
CHA SEDE	86	90	63	3	2	1.25	12	9	15
CHA STRI	47	35	73	59	35	21.88	10.29	8	16
CHR CYAN	29	19	88	213	72	45.00	7.08	2	14
CHR INSO	106	104	116	1	1	0.63	2	2	2
CHR MULT	9	26	82	779	47	29.38	8.35	5	13
CHR SCOT	60	75	97	29	6	3.75	5.83	2	11
CLE PARR	37	66	67	98	9	5.63	11.33	8	20
COR DICR	57	52	112	36	19	11.88	2.84	2	4
COR GLAU	30	28	113	183	44	27.50	2.83	2	5
COR PERS	5	37	115	2338	31	19.38	2.07	1	3
DIO HYST	107	105	8	1	1	0.63	43	43	43
DIP FORM	71	106	111	16	1	0.63	3	3	3
ECH NAUC	87	81	79	3	3	1.88	8.67	5	12
EPI CRUE	39	20	52	82	69	43.13	16.24	6	28
EPI GUTT	108	107	31	1	1	0.63	23	23	23
EQU ACUM	109	108	77	1	1	0.63	9	9	9
EQU PUNC	110	109	64	1	1	0.63	12	12	12
GNA THOM	48	50	105	58	20	12.50	4.25	3	5
GOB OCEA	45	38	114	62	31	19.38	2.39	2	3
HAE ALBU	62	91	36	27	2	1.25	21.5	18	25
HAE AURO	3	18	58	5444	77	48.13	13.15	1	22
HAE CARB	19	53	47	351	19	11.88	17.94	12	27
HAE CHRY	16	57	59	463	17	10.63	13	6	17
HAE FALV	26	9	55	256	109	68.13	14.65	9	20
HAE MACR	50	39	28	52	30	18.75	24.36	3	32
HAE MELA	95	92	51	2	2	1.25	17	17	17
HAE PARR	49	77	29	53	5	3.13	24	19	26
HAE PLUM	32	21	41	136	64	40.00	19.32	14	24
HAE SCIU	20	24	33	299	56	35.00	21.88	3	50

HAL BIVI	12	17	100	620	78	48.75	5.62	3	11
HAL GARN	11	4	91	636	132	82.50	6.67	3	20
HAL MACU	10	7	98	733	119	74.38	5.75	2	11
HAL POEY	111	110	70	1	1	0.63	11	11	11
HAL RADI	34	25	72	107	54	33.75	10.87	3	45
HEM NOVA	112	111	117	1	1	0.63	-	-	-
HEM SPLE	113	112	89	1	1	0.63	7	7	7
HOL BERM	79	71	24	8	7	4.38	29	25	33
HOL CILI	75	63	35	13	13	8.13	21.58	10	29
HOL TRIC	56	42	56	37	27	16.88	14.08	4	25
HOL ASCE	81	76	49	7	6	3.75	17.17	14	20
HOL RUFU	63	60	53	25	16	10.00	16.13	13	20
HYP GEMM	88	82	64	3	3	1.88	8	7	10
HYP UNIC	89	83	106	3	3	1.88	4	3	5
INE VITT	58	93	85	31	2	1.25	8	5	11
KYP SECT	18	40	26	357	29	18.13	26.15	12	38
LAC MAXI	59	44	25	30	24	15.00	26.73	20	35
LAC BICA	98	94	81	2	2	1.25	8.5	8	9
LAC TRIQ	85	80	87	4	4	2.50	7.5	4	14
LUT ANAL	90	84	7	3	3	1.88	45.7	38	60
LUT APOD	33	47	39	129	23	14.38	19.7	14	24
LUT GRIS	36	45	19	100	24	15.00	30.55	17	45
LUT MAHO	78	85	43	9	3	1.88	18.67	16	21
LUT SYNA	28	58	48	254	17	10.63	17.71	12	25
MAL PLUM	97	95	71	2	2	1.25	11	9	13
MAL TRIA	91	86	95	3	3	1.88	6	5	7
MEG ATLA	98	96	1	2	2	1.25	137	122	152
MIC CHRY	5	5	74	787	130	81.25	10.02	3	14
MON TUCK	99	113	96	2	1	0.63	6	6	6
MUL MART	21	33	42	290	38	23.75	18.83	7	30
MUR MILI	100	97	23	2	2	1.25	30	25	35
MYC BONA	84	78	11	5	5	3.13	41.5	31	65
OCY CHRY	6	3	37	1107	150	93.75	20.68	9	45
ODO DENT	41	41	61	72	28	17.50	12.32	9	16
OPH ATLA	64	61	99	24	14	8.75	5.64	3	8
OPH AURI	80	87	102	8	3	1.88	5	3	7
PEM SCHO	22	72	86	274	7	4.38	8	5	10
POM ARCU	51	31	21	51	42	26.25	30.21	23	35
POM PARU	67	59	20	21	17	10.63	30.44	25	35
POM DIEN	35	54	80	103	19	11.88	8.63	5	12
POM FUSC	13	22	92	595	58	36.25	6.32	4	12
POM LEUC	73	67	110	14	9	5.63	3.13	1	6
POM PART	2	2	108	5694	154	96.25	3.82	2	5
POM PLAN	7	16	94	814	83	51.88	6.21	2	11
POM VARI	42	51	93	72	20	12.50	6.31	2	11
PRI CRUE	101	98	54	2	2	1.25	15.5	14	17
PSE MACU	70	73	68	17	7	4.38	11.29	8	14
SCA COEL	76	68	13	10	9	5.63	38.89	28	45
SCA COER	52	48	16	48	21	13.13	35.1	20	45
SCA CROI	14	14	101	560	94	58.75	5.59	2	22
SCA QUAC	77	69	18	10	8	5.00	32.6	3	48
SCA TAEN	44	27	60	67	46	28.75	12.37	3	28
SCA VETU	54	46	38	42	24	15.00	20.61	5	34
SCO CAVA	114	114	2	1	1	0.63	120	120	120
SCO MACU	115	115	10	1	1	0.63	42	42	42
SER BALD	102	99	107	2	2	1.25	4	4	4

SER TIGR	53	34	90	44	36	22.50	6.94	3	10
SPA AURO	27	13	57	256	99	61.88	13.75	2	25
SPA CHRY	46	36	46	62	32	20.00	17.96	6	39
SPA RUBR	38	29	27	94	44	27.50	25.14	15	40
SPA VIRI	24	11	40	262	105	65.63	19.52	2	43
SPH SPEN	116	116	103	1	1	0.63	5	5	5
SPH BARR	43	32	3	69	39	24.38	81	39	160
SYN INTE	117	117	78	1	1	0.63	9	9	9
THA BIFA	1	1	104	9558	156	97.50	4.46	1	7
TRA FALC	92	88	5	3	3	1.88	56.7	45	75
TYL CROC	103	100	4	2	2	1.25	65	55	75

Table 7.-- Trophic structure of fishes at Looe Key National Marine Sanctuary. Species, listed alphabetically by family and genus, are grouped according to times of major feeding activity (diurnal, nocturnal, crepuscular, and generally active). Abundance values are based on all random point samples in all habitats regardless of effort in different habitats. Trophic level codes: H, herbivore; P, planktivore; B, browser; Mi, microinvertivore; Ma, macroinvertivore; F, piscivore. Principal feeding zones: S, surface; M, midwater, B, bottom. "off" indicates feeding is usually away from the reef proper. Dashes indicate species observed in rapid visual samples but not in point samples. "*" indicates species observed after 5 min in random point samples.

TAXON	COMMON NAME	FREQUENCY (N = 417)	TOTAL ABUNDANCE	TROPHIC LEVEL (H,P,B, Mi,Ma,F)	FEEDING ZONE (S,M,B)	FEEDS OFF REEF
DIURNALLY FEEDING FISHES						
ACANTHURIDAE (surgeonfishes)						
Acanthurus bahianus	Ocean surgeon	265	1231	H	B	
Acanthurus chirurgus	Doctorfish	53	97	H	B	
Acanthurus coeruleus	Blue tang	189	561	H	B	
AULOSTOMIDAE (trumpetfishes)						
Aulostomus maculatus	Trumpetfish	23	27	F	B	
BALISTIDAE (leatherjackets)						
Aluterus schoepfi	Orange filefish	4	6	H	B	
Aluterus scriptus	Scrawled filefish	7	7	B,H	B	
Balistes capriscus	Gray triggerfish	3	4	Ma	B	
Balistes vetula	Queen triggerfish	2	2	Ma	B	
Cantherhines macrocerus	Whitespotted filefish	-	-	H	B	
Cantherhines pullus	Orangespotted filefish	15	17	H,B	B	
Canthidermis sufflamen	Ocean triggerfish	6	7	P,Ma	B	
Monacanthus tuckeri	Slender filefish	3	4	Mi	B	
BELONIDAE (needlefishes)						
Strongylura notata	Redfin needlefish	*	*	F	S	
Strongylura timucu	Timucu	1	1	F	S	
Tylosurus crocodilus	Houndfish	3	3	F	S	
BLENNIIDAE (combtooth blennies)						
Hypleurochilus spp	unidentified blenny	-	-	H	B	
Ophioblennius atlanticus	Redlip blenny	19	38	H	B	
Scartella cristata	Molly miller	12	20	H	B	

CALLIONYMIDAE (dragonets)						
Callionymus bairdi	Lancer dragonet	-	-	Mi	B	
CHAETODONTIDAE (butterflyfishes)						
Chaetodon capistratus	Foureye butterflyfish	206	555	B	B	
Chaetodon ocellatus	Spotfin butterflyfish	90	162	B	B	
Chaetodon sedentarius	Reef butterflyfish	12	18	Mi	B	
Chaetodon striatus	Banded butterflyfish	53	92	B	B	
CIRRHITIDAE (hawkfishes)						
Amblycirrhitus pinos	Redspotted hawkfish	2	2	Mi	B	
CLINIDAE (clinids)						
Acanthemblemaria chaplini	Papillose blenny	1	5	P	B	
Acanthemblemaria spp	unidentified blenny	-	-	P	B	
Malacoctenus gilli	Dusky blenny	2	6	P,Mi	B	
Malacoctenus macropus	Rosy blenny	1	1	P,Mi	B	
Malacoctenus triangulatus	Saddled blenny	5	5	P,Mi	B	
Malacoctenus versicolor	Barfin blenny	*	*	P,Mi	B	
Paraclinus nigripinnis	Blackfin blenny	1	1	P,Mi	B	
DIODONTIDAE (porcupinefishes)						
Diodon holocanthus	Balloonfish	1	1	Ma	B	
Diodon hystrix	Porcupinefish	1	1	Ma	B	
EPHIPPIDAE (spadefishes)						
Chaetodipterus faber	Atlantic spadefish	1	1	Ma	B	off
GOBIIDAE (gobies)						
Coryphopterus dicrus	Colon goby	45	111	H	B	
Coryphopterus glaucofraenum	Bridled goby	119	623	H	B	
Coryphopterus personatus	Masked goby	69	3611	P	B	
Coryphopterus sp	unidentified goby	*	*	H	B	
Gnatholepis thompsoni	Goldspot goby	39	108	H	B	
Gobiosoma macrodon	Tiger goby	1	3	Mi	B	
Gobiosoma oceanops	Neon goby	60	132	Mi	B	
Ioglossus calliurus	Blue goby	15	75	P	B	
Microgobius carri	Seminole goby	3	5	P	B	
GRAMMIDAE (basslets)						
Liopropoma rubre	Peppermint bass	-	-	Ma	B	
HAEMULIDAE (grunts)						
Haemulon album	Margate	9	49	Ma	B	

KYPHOSIDAE (sea chubs)						
Kyphosus sectatrix	Bermuda chub	39	407	H	M,S	
LABRIDAE (wrasses)						
Bodianus pulchellus	Spotfin hogfish	-	-	Mi	B	
Bodianus rufus	Spanish hogfish	129	218	Ma,Mi	B	
Clepticus parrai	Creole wrasse	14	274	P	M	
Halichoeres bivittatus	Slippery dick	258	3590	Mi,Ma	B	
Halichoeres garnoti	Yellowhead wrasse	251	1110	Mi,Ma	B	
Halichoeres maculipinna	Clown wrasse	246	1512	Mi,Ma	B	
Halichoeres pictus	Rainbow wrasse	-	-	P	M	
Halichoeres poeyi	Blackear wrasse	40	119	Mi,Ma	B	off
Halichoeres radiatus	Puddingwife	123	252	Mi,Ma	B	
Hemiemblemaria simulus	Wrasse blenny	1	1	Mi,P	B	
Hemipteronotus novacula	Pearly razorfish	2	2	Mi,Ma	B	off
Hemipteronotus splendens	Green razorfish	49	267	Mi,Ma	B	off
Lachnolaimus maximus	Hogfish	70	98	Ma	B	
Thalassoma bifasciatum	Bluehead wrasse	328	12484	P,Mi	B,M	
MALACANTHIDAE (tilefishes)						
Malacanthus plumieri	Sand tilefish	7	10	Mi,Ma	B	
MULLIDAE (goatfishes)						
Pseudupeneus maculatus	Spotted goatfish	36	78	Mi	B	
OPISTOGNATHIDAE (jawfishes)						
Opistognathus aurifrons	Yellowhead jawfish	17	43	P	B	
OSTRACIIDAE (boxfishes)						
Lactophrys bicaudalis	Spotted trunkfish	2	2	B	B	
Lactophrys polygonia	Honeycomb cowfish	-	-	B	B	
Lactophrys quadricornis	Scrawled cowfish	1	1	B	B	
Lactophrys triqueter	Smooth trunkfish	5	5	B	B	
POMACANTHIDAE (angelfishes)						
Holacanthus bermudensis	Blue angelfish	17	18	B	B	
Holacanthus ciliaris	Queen angelfish	23	23	B	B	
Holacanthus tricolor	Rock beauty	58	77	B	B	
Pomacanthus arcuatus	Gray angelfish	96	121	B	B	
Pomacanthus paru	French angelfish	35	45	B	B	
POMACENTRIDAE (damselfishes)						
Abudefduf saxatilis	Sergeant major	185	6799	P	M,S	
Chromis cyaneus	Blue chromis	107	324	P	M	
Chromis insolatus	Sunshinefish	1	1	P	M	
Chromis multilineatus	Brown chromis	59	892	P	M	

Chromis scotti	Purple reeffish	12	47	P	M	
Microspathodon chrysurus	Yellowtail damselfish	180	974	H	B	
Pomacentrus diencaeus	Longfin damselfish	21	109	H	B	
Pomacentrus fuscus	Dusky damselfish	82	692	H	B	
Pomacentrus leucostictus	Beaugregory	46	132	H	B	
Pomacentrus partitus	Bicolor damselfish	322	10021	P,H	B	
Pomacentrus planifrons	Three spot damselfish	152	1257	H	B	
Pomacentrus variabilis	Cocoa damselfish	61	166	H	B	
SCARIDAE (parrotfishes)						
Cryptotomus roseus	Bluelip parrotfish	8	22	H	B	
Scarus coelestinus	Midnight parrotfish	14	51	H	B	
Scarus coeruleus	Blue parrotfish	30	61	H	B	
Scarus croicensis	Striped parrotfish	212	1645	H	B	
Scarus guacamaia	Rainbow parrotfish	15	20	H	B	
Scarus taeniopterus	Princess parrotfish	84	215	H	B	
Scarus vetula	Queen parrotfish	34	57	H	B	
Sparisoma atomarium	Greenblotch parrotfish	3	7	H	B	
Sparisoma aurofrenatum	Redband parrotfish	180	441	H	B	
Sparisoma chrysopterum	Redtail parrotfish	84	190	H	B	
Sparisoma radians	Bucktooth parrotfish	43	246	H	B	
Sparisoma rubripinne	Yellowtail parrotfish	76	200	H	B	
Sparisoma viride	Stoplight parrotfish	167	386	H	B	
SERRANIDAE (groupers)						
Diplectrum formosum	Sand perch	13	59	Ma,Mi	B	off
Hypoplectrus gemma #	Blue hamlet	16	18	Mi	B	
Hypoplectrus nigricans #	Black hamlet	1	1	Mi	B	
Hypoplectrus unicolor	Butter hamlet	31	38	Mi	B	
Hypoplectrus puella #	Barred hamlet	3	3	Mi	B	
Serranus baldwini	Lanternfish	8	11	Mi	B	
Serranus tabacarius	Tobaccofish	*	*	Mi	B	off
Serranus tigrinus	Harlequin bass	113	185	Mi	B	
Serranus tortugarum	Chalk bass	2	2	Mi	B	off
Paranthias furcifer	Creole-fish	2	2	P,F	M	off
SPARIDAE (porgies)						
Calamus sp.	Unidentified porgy	1	1	Ma	B	
Calamus bajonado	Jolthead porgy	27	35	Ma	B	
Calamus calamus	Saucereye porgy	65	94	Ma	B	
Calamus penna	Sheepshead porgy	2	3	Ma	B	
Pagrus pagrus	Red Porgy	1	1	Ma	B	
TETRADONTIDAE (puffers)						
Canthigaster rostrata	Sharpnose puffer	42	53	B,H	B	
Sphoeroides spengleri	Bandtail puffer	1	1	Mi,B	B	
Other (unclassified)						
Fry	Unidentified species	1	15	P	M	

APOGONIDAE (cardinalfishes)						
Apogon binotatus	Barred cardinalfish	-	-	P	M	
Apogon maculatus	Flamefish	-	-	P	M	
Apogon pseudomaculatus	Twospot cardinalfish	1	2	P	M	
Apogon quadrisquamatus	Sawcheek caradinalfish	-	-	P	M	
ATHERINIDAE (silversides)						
Atherinomorus stipes	Hardhead silverside	-	-	P	M	off
CLUPEIDAE (herrings)						
Jenkinsia lamprotaenia	Dwarf herring	-	-	P	M	off
Jenkinsia spp	unidentified Jenkinsia	-	-	P	M	off
ENGRAULIDAE (anchovies)						
Anchoa lyolepis	Dusky anchovy	-	-	P	M	off
GERREIDAE (mojarras)						
Gerres cinereus	Yellowfin mojarra	6	681	Ma,Mi	B	off
HAEMULIDAE (grunts)						
Anisotremus surinamenis	Black margate	1	1	Ma	B	off
Anisotremus virginicus	Porkfish	20	28	Ma	B	off
Haemulon aurolineatum	Tomtate	138	10842	Ma	B	off
Haemalon carbonarium	Caesar grunt	23	355	Ma	B	off
Haemulon chrysargyreum	Smallmouth grunt	21	877	Ma	B	off
Haemulon flavolineatum	French grunt	175	714	Ma	B	off
Haemulon macrostomum	Spanish grunt	40	90	Ma	B	off
Haemulon melanurum	Cottonwick	7	21	Ma	B	off
Haemulon parrai	Sailor's choice	11	62	Ma	B	off
Haemulon plumieri	White grunt	163	1122	Ma	B	off
Haemulon sciurus	Bluestriped grunt	111	542	Ma	B	off
HOLOCENTRIDAE (squirrelfishes)						
Holocentrus ascensionis	Squirrelfish	6	7	Ma,Mi	B	
Holocentrus coruscus	Reef squirrelfish	-	-	Ma,Mi	B	
Holocentrus rufus	Longspine squirrelfish	20	32	Ma,Mi	B	
Holocentrus vexillarius	Dusky squirrelfish	1	1	Ma,Mi	B	
Myripristis jacobus	Blackbar soldierfish	-	-	P	M	off
INERMIIDAE (bonnetmouths)						
Inermia vittata	Boga	6	352	P	M	off

LUTJANIDAE (snappers)

Lutjanus analis	Mutton snapper	6	6	Ma,F	B	off
Lutjanus apodus	Schoolmaster snapper	42	208	F,Ma	B	off
Lutjanus griseus	Gray snapper	29	157	F,Ma	B	off
Lutjanus jocu	Dog snapper	1	1	F,Ma	B	off
Lutjanus mahogoni	Mahogany snapper	3	9	F.Ma	B	off
Lutjanus synagris	Lane snapper	17	254	Ma,F	B	off
Ocyurus chrysurus	Yellowtail snapper	259	1602	Ma,F	B	off

MULLIDAE (goatfishes)

Mulloidichthys martinicus	Yellow goatfish	53	346	Mi	B	off

MURAENIDAE (morays)

Enchelycore nigricans	Viper moray	*	*	F	B
Gymnothorax funebris	Green moray	-	-	Ma,F	B
Gymnothorax moringa	Spotted moray	2	2	F	B
Muraena miliaris	Goldentail moray	2	2	Ma	B

ORECTOLOBIDAE (carpet sharks)

Ginglymostoma cirratum	Nurse shark	1	1	F,Ma	B

PEMPHERIDAE (sweepers)

Pempheris schomburgki	Glassy sweeper	15	493	P	M

PRIACANTHIDAE (bigeyes)

Priacanthus cruentatus	Glasseye snapper	6	6	Ma,P	M

SCIAENIDAE (drums)

Equetus acuminatus	High-hat	7	7	Ma	B
Equetus lanceolatus	Jacknife-fish	-	-	Ma	B
Equetus punctatus	Spotted drum	1	1	Ma	B
Odontoscion dentex	Reef croaker	37	87	Ma	B

CREPUSCULARLY (Twlight) FEEDING FISHES

CARANGIDAE (jacks)						
Alectis ciliaris	African pompano	-	-	Ma	B	off
Caranx bartholomaei	Yellow jack	18	48	F	M	
Caranx crysos	Blue runner	1	28	F	M	off
Caranx ruber	Bar jack	93	661	F	M	
Seriola dumerili	Greater amberjack	*	*	F	M	off
Trachinotus falcatus	Permit	6	8	Ma	B	off
GRAMMISTIDAE (soapfishes)						
Rypticus saponaceus	Greater soapfish	-	-	Ma,F	B	
SCORPAENIDAE (scorpionfishes)						
Scorpaena plumieri	Scorpion fish	-	-	F	B	
SERRANIDAE (sea basses)						
Epinephelus adscensionis	Rock hind	-	-	Ma,F	B	
Epinephelus cruentatus	Graysby	114	133	Ma,F	B	
Epinephelus fulvus	Coney	-	-	Ma,F	B	
Epinephelus guttatus	Red hind	1	1	Ma,F	B	
Epinephelus itajara	Jewfish	-	-	Ma,F	B	
Epinephelus morio	Red grouper	1	1	Ma,F	B	
Epinephelus striatus	Nassau grouper	2	2	Ma,F	B	
Mycteroperca bonaci	Black grouper	9	9	F	B	
SPHYRAENIDAE (barracudas)						
Sphyraena barracuda	Barracuda	69	107	F	M	
SYNODONTIDAE (lizardfishes)						
Synodus intermedius	Sand diver	2	2	F	B	

DAY AND NIGHT FEEDING FISHES

CARANGIDAE (jacks)						
Decapterus macarellus	Mackerel scad	1	70	P	M	off
Decapterus punctatus	Round scad	1	150	P	M	off
DASYATIDAE (stingrays)						
Dasyatis americana	Southern stingray	-	-	Ma	B	off
Urolophus jamaicensis	Yellow stingray	9	9	Ma	B	off
ECHENEIDAE (remoras)						
Echeneis naucrates	Sharksucker	6	6	F	M	off
ELOPIDAE (tarpons)						
Megalops atlanticus	Tarpon	2	2	F	S,M	off
MYLIOBATIDAE (eagle rays)						
Aetobatus narinari	Spotted eagle ray	-	-	Ma	B	off
SCOMBRIDAE (mackerels)						
Scomberomrous cavalla	King mackerel	1	1	F	M	off
Scomberomrous maculatus	Spanish mackerel	1	1	F	M	off
Scomberomorus regalis	Cero	3	3	F	M	off

Now considered color forms of H. unicolor (American Fisheries Society, 1980)

Table 8.--Summary of trophic activity analysis of fishes censused in Looe Key National Marine Sanctuary. Data summarized from Table 7. Classification was based on primary behavior of adults.

PRIMARY TROPHIC CLASSIFICATION:	HERBIVORE	PLANKTIVORE	CARNIVOROUS BROWSER	MICRO-INVERTIVORE	MACRO-INVERTIVORE	PISCIVORE	TOTAL
			Number of Species				
Diurnal Species	32	18	14	30	16	4	114 (61%)
Nocturnal Species	0	11	0	1	25	8	45 (24%)
Crepuscular Species	0	1	0	0	8	10	19 (10%)
Generally Active Species	0	2	0	0	3	5	10 (5%)
Total	32 (17%)	32 (17%)	14 (7%)	31 (17%)	52 (28%)	27 (14%)	185 (100%)
			Number of Individuals				
Diurnal Species	10,090	34,603	1,161	7,362	577	31	53,824 (73%)
Nocturnal Species	0	847	0	346	17,340	378	18,911 (26%)
Crepuscular Species	0	2	0	0	142	858	1002 (1%)
Generally Active Species	0	220	0	0	9	13	242 (0%)
Total	10,090 (14%)	35,672 (48%)	1,161 (2%)	7,708 (10%)	18,068 (24%)	1,280 (2%)	73,979 (100%)

PLATE CAPTIONS

Plate 1.--Ledges along the forereef spur formations provide shelter for many reef fishes. Width of view is approximately 4 m.

Plate 2.--Parrotfishes. Parrotfishes are the largest herbivores and are frequently seen in the forereef, buttress, and rubble zones. Shown are schools of rainbow parrotfish, Scarus quacamaia, in the rubble zone (top) and midnight parrotfish, S.coelestinus, in the forereef zone (bottom). Fishes are approximately 50 to 60 cm in length.

Plate 3.--Typical damselfish and surgeonfish herbivores. (Top) The threespot damselfish, Pomacentrus planifrons, approximately 9 cm long, is usually found defending a territory of algal turf in branches of elkhorn coral, Acropora. palmata. 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. (Bottom) A school of surgeonfishes, Acanthurus bahianus and A. chirurgus. Often large schools of surgeonfishes or parrotfishes temporarily overwhelm the defenses of a single damselfish before moving on to new areas. The predatory trumpetfish, Aulostomus maculatus (60 cm), 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.

Plate 4.--Midwater herbivores. The Bermuda chub, Kyphosus sectatrix feeds on drifting algae and is usually found in schools in midwater. The average length in the photograph is 30 cm.

Plate 5.--Typical pickers and browsers. The sharpnose puffer, Canthigaster rostrata (top left, 3 cm), feeds by picking small microinvertebrates off the bottom. Angelfishes primarily browse on sponges. Shown are the rock beauty, Holocanthus tricolor (top right, 14 cm), and an adult French angelfish, Pomacanthus paru (bottom, 35 cm).

Plate 6.--Typical assemblages of fishes feeding in midwater. (Top) A. piscivorous yellowtail, Ocyurus chrysurus (30 cm); B. herbivorous Bermuda chub, Kyphosus sectatrix (30 cm); and C. planktivorous bluehead wrasses, Thalassoma bifasciatum (6 cm), D. sergeant majors, Abudefduf saxatilis (11 cm), and E. bicolor damselfishes, Pomacentrus partitus (4 cm). (Bottom) A. brown chromis, Chromis multilineatus (5 cm) and B. blue chromis, Chromis cyaneus (4 cm).

Plate 7.--Typical diurnally active microinvertivores. The foureye butterflyfish, Chaetodon capistratus (7 cm) (top), and harlequin bass, Serranus tigrinus (8 cm) (bottom), are commonly seen in pairs on the reef.

Plate 8.--Typical abundant damselfish and wrasses. Two of the most abundant fishes at Looe Key Reef are the bicolor damselfish, Pomacentrus partitus (4 cm) (top), and the bluehead wrasses, Thalassoma bifasciatum (average 7 cm) (bottom). Many wrasses change sex and color with age. Shown are mostly (A) juvenile colored blueheads, (B) a supermale bluehead, (C) a clown wrasse, Halichoeres maculipinna, and (D) a hogfish, Bodianus rufus.

Plate 9.--Typical nocturnal planktivors. Glassy sweepers, Pempheris schomburgki (10 cm) (top) and the twospot cardinalfishes, Apogon pseudomaculatus (3 cm) (bottom) hide in caves in the reef by day and come out to feed on plankton at night.

Plate 10.--Typical nocturanl macroinvertivores. 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, Haemulon plumieri (18 cm) (top) is most abundant on inshore live bottoms. The tomtate, H. aurolineatum (14 cm) dominates the forereef zone.

Plate 11.--Typical softbottom microinvertivores. Goatfish and mojarra feed primarily on microinvertebrates in sand bottoms. Shown are schools of yellowfin mojarra, Gerres cinereus (25 cm) (top) and yellow goatfish, Mulloidichthys martinicus (30 cm) (bottom).

Plate 12.--Typical macroinvertivores. The sailor's choice, Haemulon parrai (Haemulidae, 27 cm) (top) and the hogfish, Lachnolaimus maximus (Labridae, 22 cm) (bottom) are two typical macroinvertivores. Large schools of sailor's choice were first observed at Looe Key Reef after it became a Sanctuary. The hogfish, a favorite spearfishing target, became more frequent after the Sanctuary was established.

Plate 13.--The schoolmaster snapper, Lutjanus apodus. Schoolmaster were the most common snapper (Lutjanidae) observed in the Sanctuary (top, 20 cm). Schools were frequently seen around colonies of elkhorn coral, Acropora palmata (bottom).

Plate 14.--Typical roaming, soft bottom macroinvertivores. The jolthead porgy, Calamus bajonado (40 cm) (top) and the eagle ray, Aetobatus narinari (1.3 m diameter) (bottom), feed primarily on the larger macroinvertebrates on sand bottoms and can range over large areas.

Plate 15.--Typical small predators. Moray eels and groupers feed on macroinvertebrates and fishes. Eels are more active at night and groupers more active during the day. Shown are a spotted moray, Gymnothorax moringa, being fed by a diver (top) and a graysby, Epinephelus cruentatus (18 cm), the most common grouper at Looe Key Reef (bottom).

Plate 16.--Typical midwater predators. The bar jack, Caranx ruber (15 cm) (top), and the yellowtail snapper, Ocurus chrysurus (22 cm) (bottom), are midwater fishes that feed primarily on plankton when small and on fishes when larger.

Plate 17.--The great barracuda, Sphyraena barracuda. This is a piscivorous predator that feeds on small fishes when medium in size (top, 45 cm) and large fishes when large in size (bottom, 90 cm). This is one of many species rarely seen in the Sanctuary as juveniles.

Plate 18.--Large roaming predators. (Top) Adult tarpon, Megalops atlanticus (1.5 m) are piscivorous predators frequently seen over reef areas in the Sanctuary. (Bottom) The Nassau grouper, Epinephelus striatus (50 cm) feeds mostly on invertebrates and represents one of the larger grouper predators.

Plate 19.--The bull shark, Carcharhinus leucas. This 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. The shark in the photograph measured 2.3 m.

Plate 20.--Major recent disturbance events at Looe Key National Marine Sanctuary. (Top) A normally herbivorous stoplight parrotfish, Sparisoma viride, (35 cm) opportunistically attacking and eating a sick sea urchin. The long-spined urchin, Diadema antillarum, is an important reef herbivore that was almost eliminated from most reefs around the Caribbean by an epidemic in the summer of 1983. (Bottom) Dead fishes (15 - 18 cm) in Cupon Bight just north of the Sanctuary were killed by a severe January 1977 cold spell.

Plate 1.--Ledges along the forereef spur formations provide shelter for many reef fishes. Width of view is approximately 4 m.

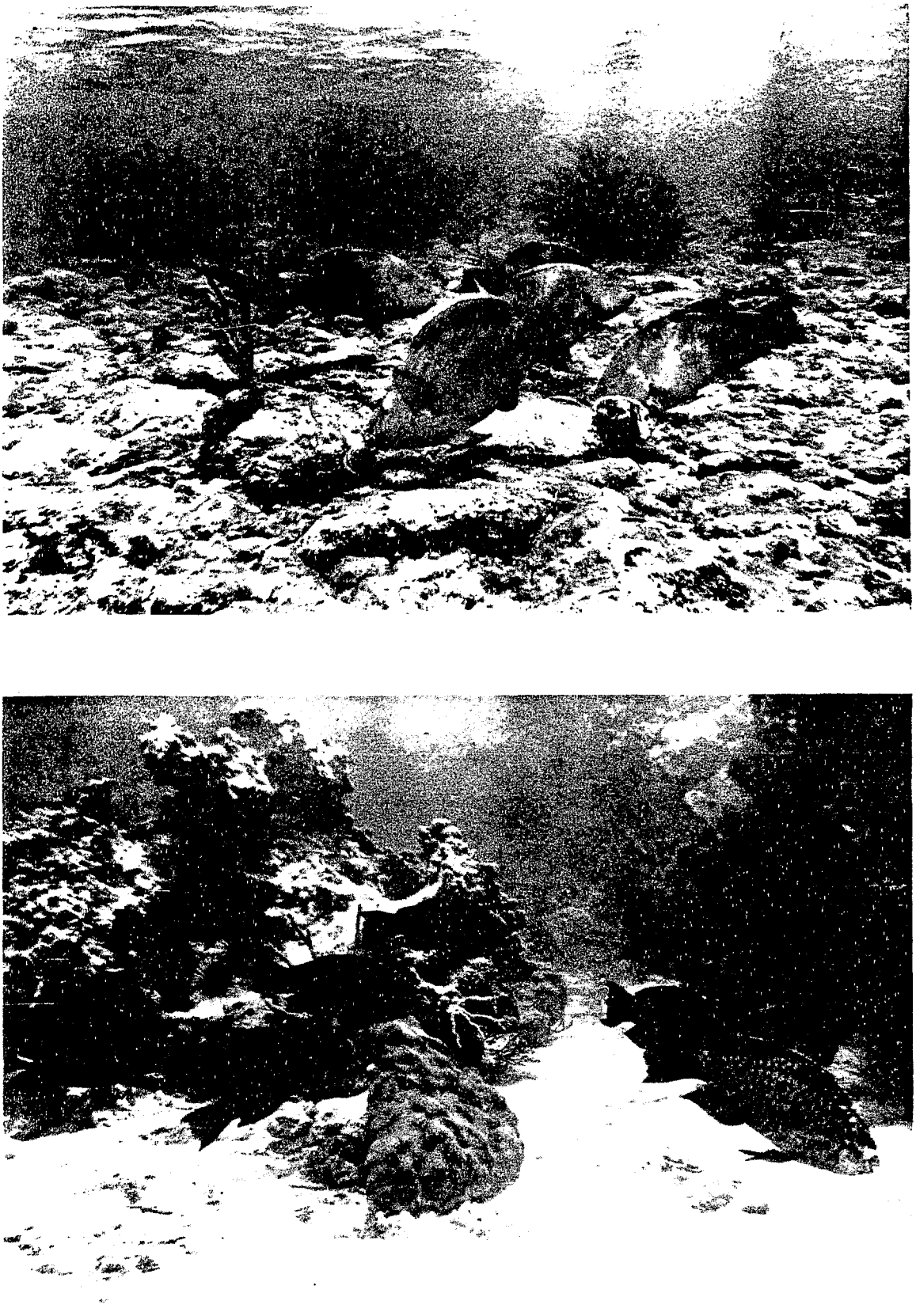


Plate 2.--Parrotfishes. Parrotfishes are the largest herbivores and are frequently seen in the forereef, buttress, and rubble zones. Shown are schools of rainbow parrotfish, Scarus guacamaia, in the rubble zone (top) and midnight parrotfish, S.coelestinus, in the forereef zone (bottom). Fishes are approximately 50 to 60 cm in length.

Plate 3.--Typical damselfish and surgeonfish herbivores. (Top) The threespot damselfish, Pomacentrus planifrons, approximately 9 cm long, is usually found defending a territory of algal turf in branches of elkhorn coral, Acropora palmata. 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. (Bottom) A school of surgeonfishes, Acanthurus bahianus and A. chirurgus. Often large schools of surgeonfishes or parrotfishes temporarily overwhelm the defenses of a single damselfish before moving on to new areas. The predatory trumpetfish, Aulostomus maculatus (60 cm), 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.

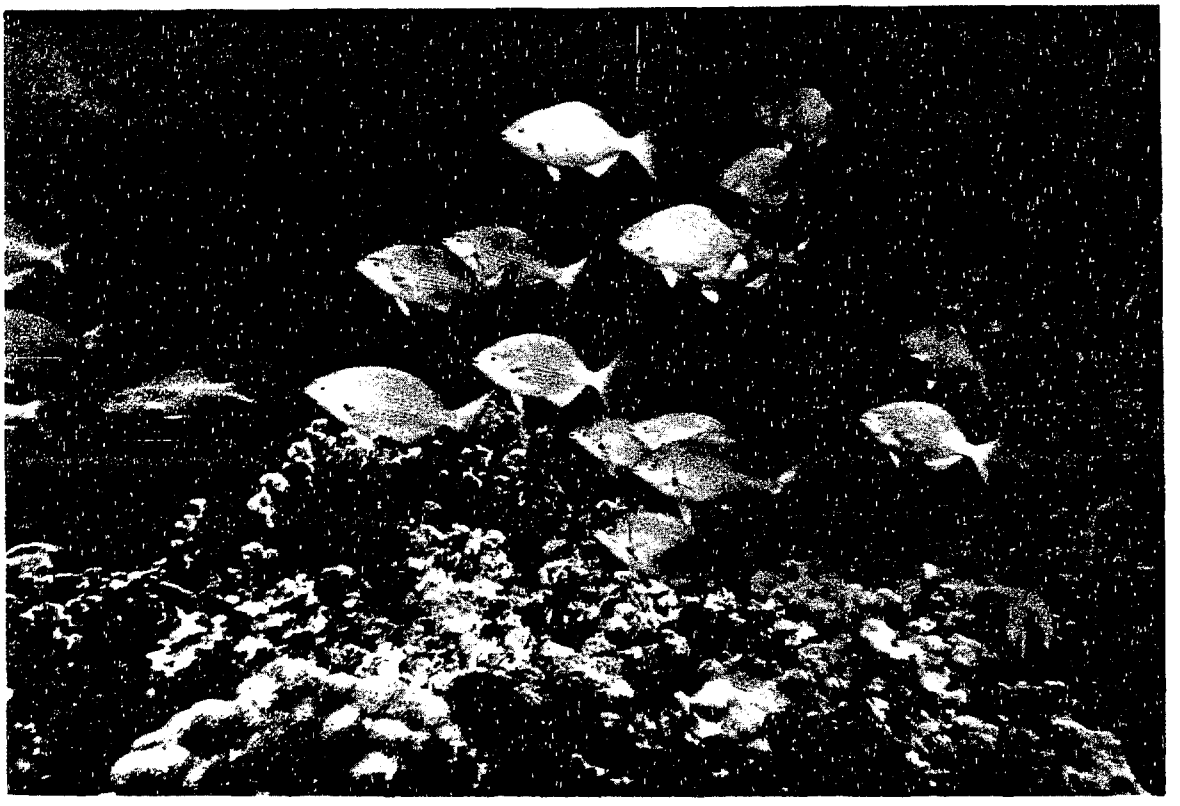


Plate 4.--Midwater herbivores. The Bermuda chub, Kyphosus sectatrix feeds on drifting algae and is usually found in schools in midwater. The average length in the photograph is 30 cm.

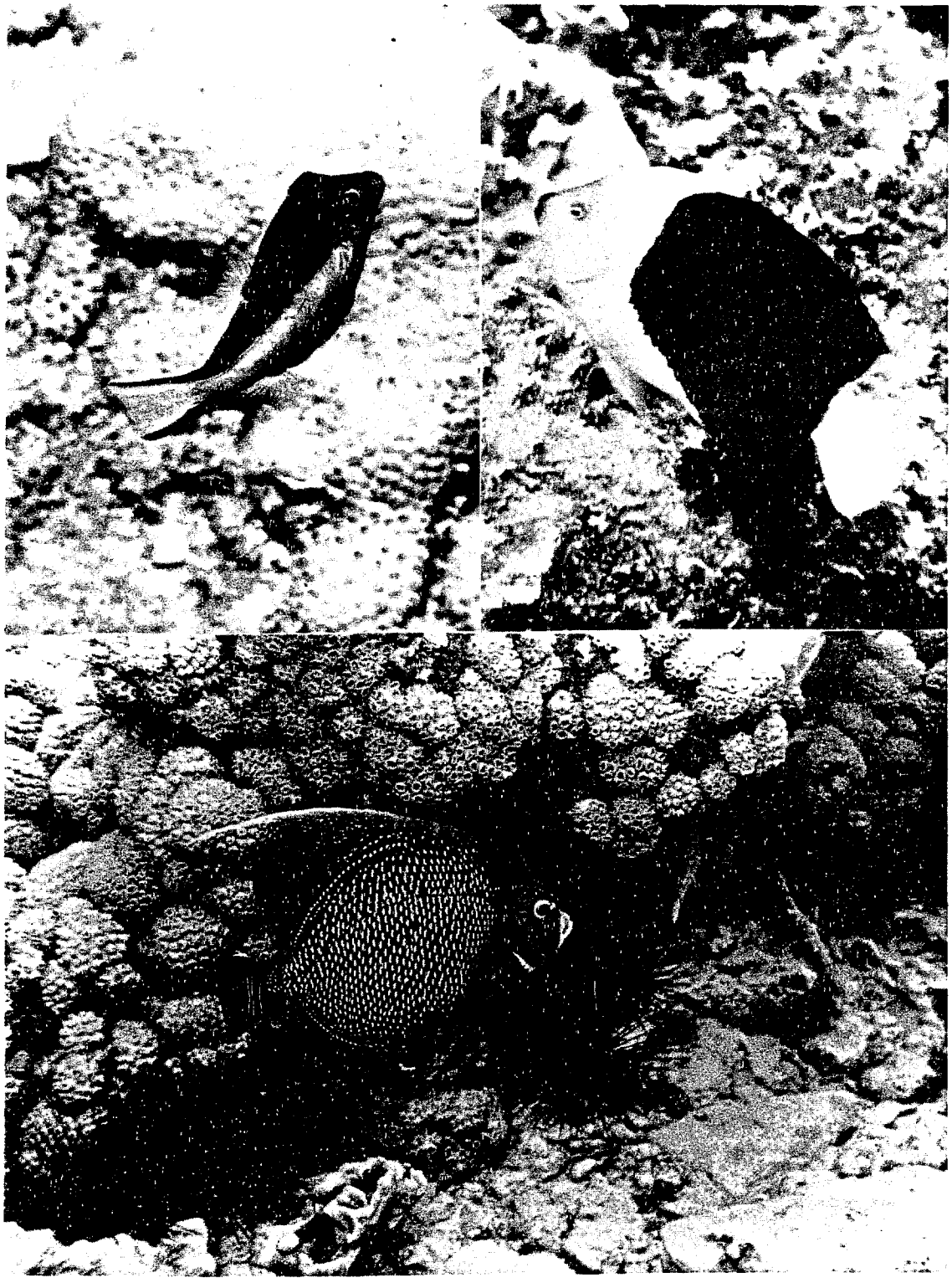
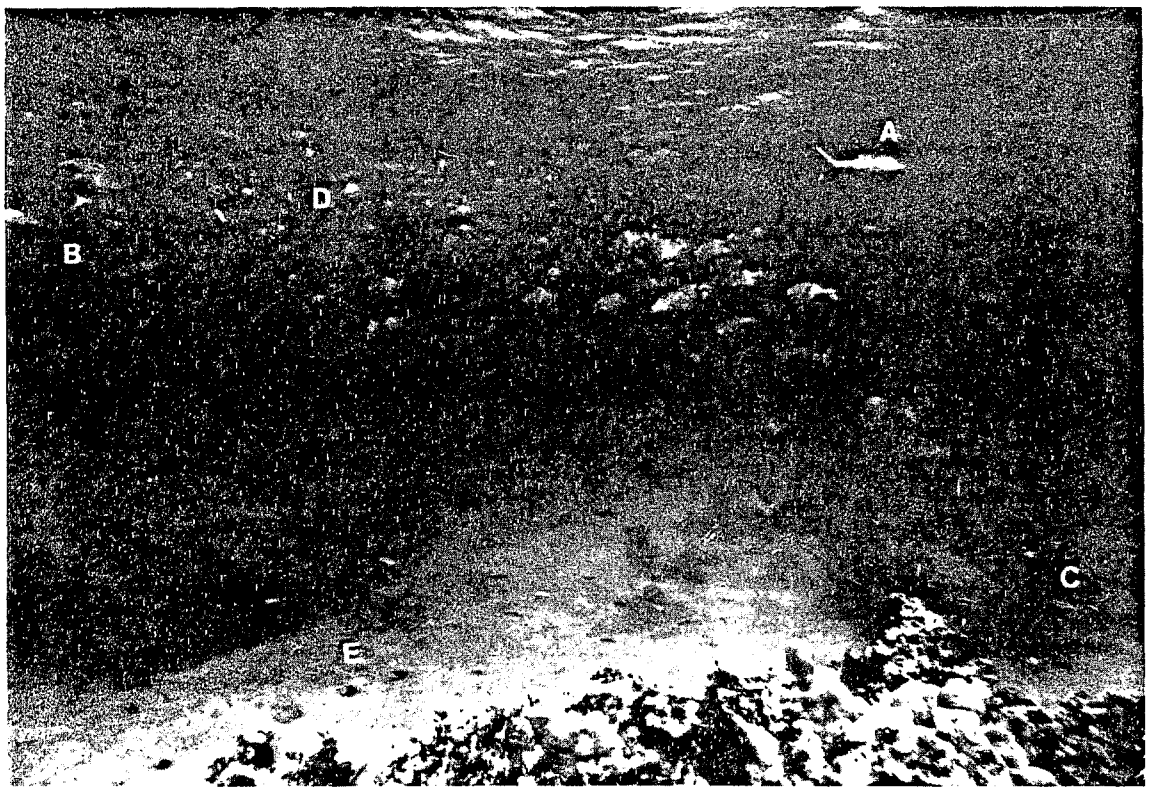


Plate 5.--Typical pickers and browsers. The sharpnose puffer, Canthigaster rostrata (top left, 3 cm), feeds by picking small microinvertebrates off the bottom. Angelfishes primarily browse on sponges. Shown are the rock beauty, Holocanthus tricolor (top right, 14 cm), and an adult French angelfish, Pomacanthus paru (bottom, 35 cm).



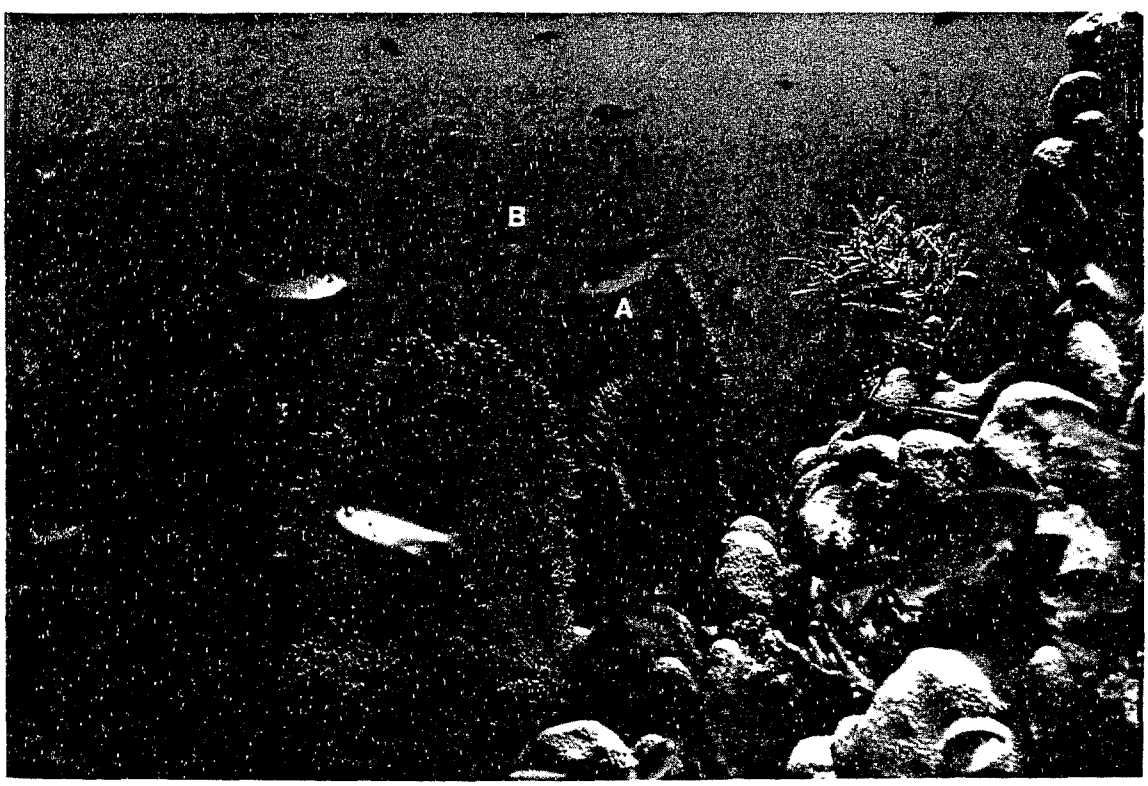


Plate 6.--Typical assemblages of fishes feeding in midwater. (Top) A. piscivorous yellowtail, Ocyurus chrysurus (30 cm); B. herbivorous Bermuda chub, Kyphosus sectatrix (30 cm); and C. planktivorous bluehead wrasses, Thalassoma bifasciatum (6 cm), D. sergeant majors, Abudefduf saxatilis (11 cm), and E. bicolor damselfishes, Pomacentrus partitus (4 cm). (Bottom) A. brown chromis, Chromis multilineatus (5 cm) and B. blue chromis, Chromis cyaneus (4 cm).

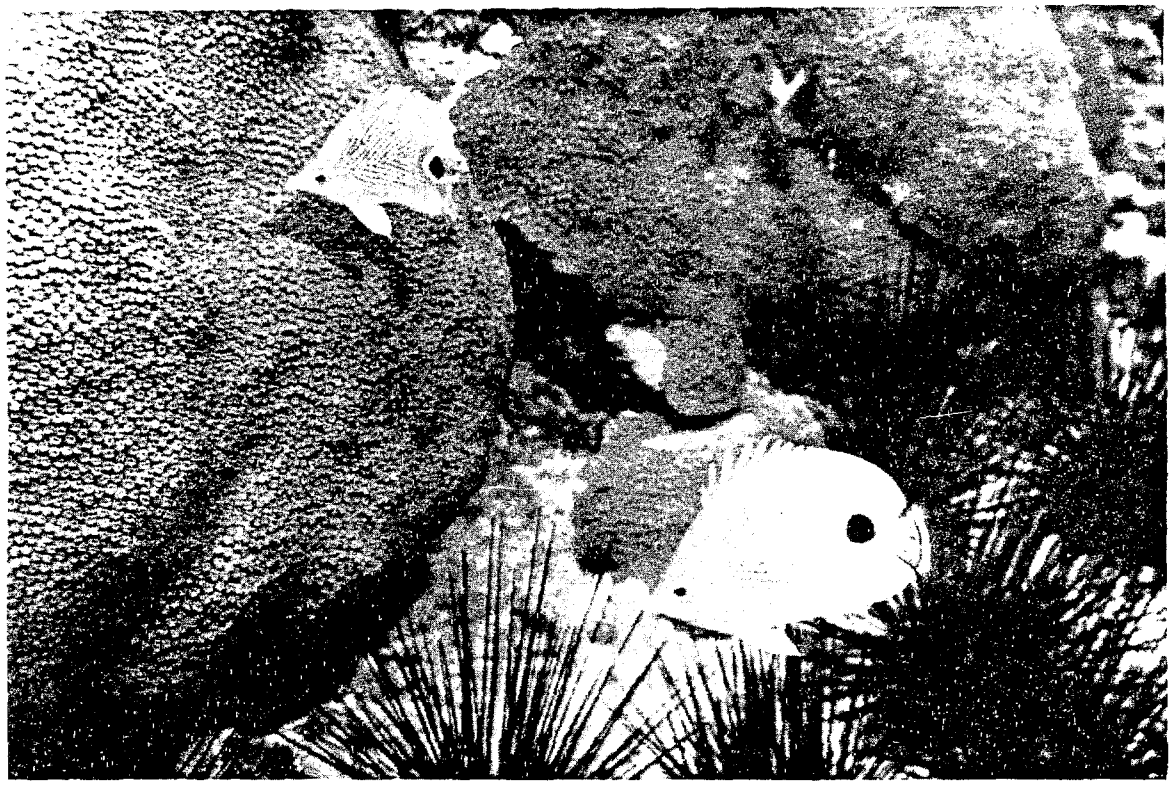


Plate 7.--Typical diurnally active microinvertivores. The foureye butterflyfish, Chaetodon capistratus (7 cm) (top), and harlequin bass, Serranus tigrinus (8 cm) (bottom), are commonly seen in pairs on the reef.

Plate 8.--Typical abundant damselfish and wrasses. Two of the most abundant fishes at Looe Key Reef are the bicolor damselfish, Pomacentrus partitus (4 cm) (top), and the bluehead wrasses, Thalassoma bifasciatum (average 7 cm) (bottom). Many wrasses change sex and color with age. Shown are mostly (A) juvenile colored blueheads, (B) a supermale bluehead, (C) a clown wrasse, Halichoeres maculipinna, and (D) a hogfish, Bodianus rufus.

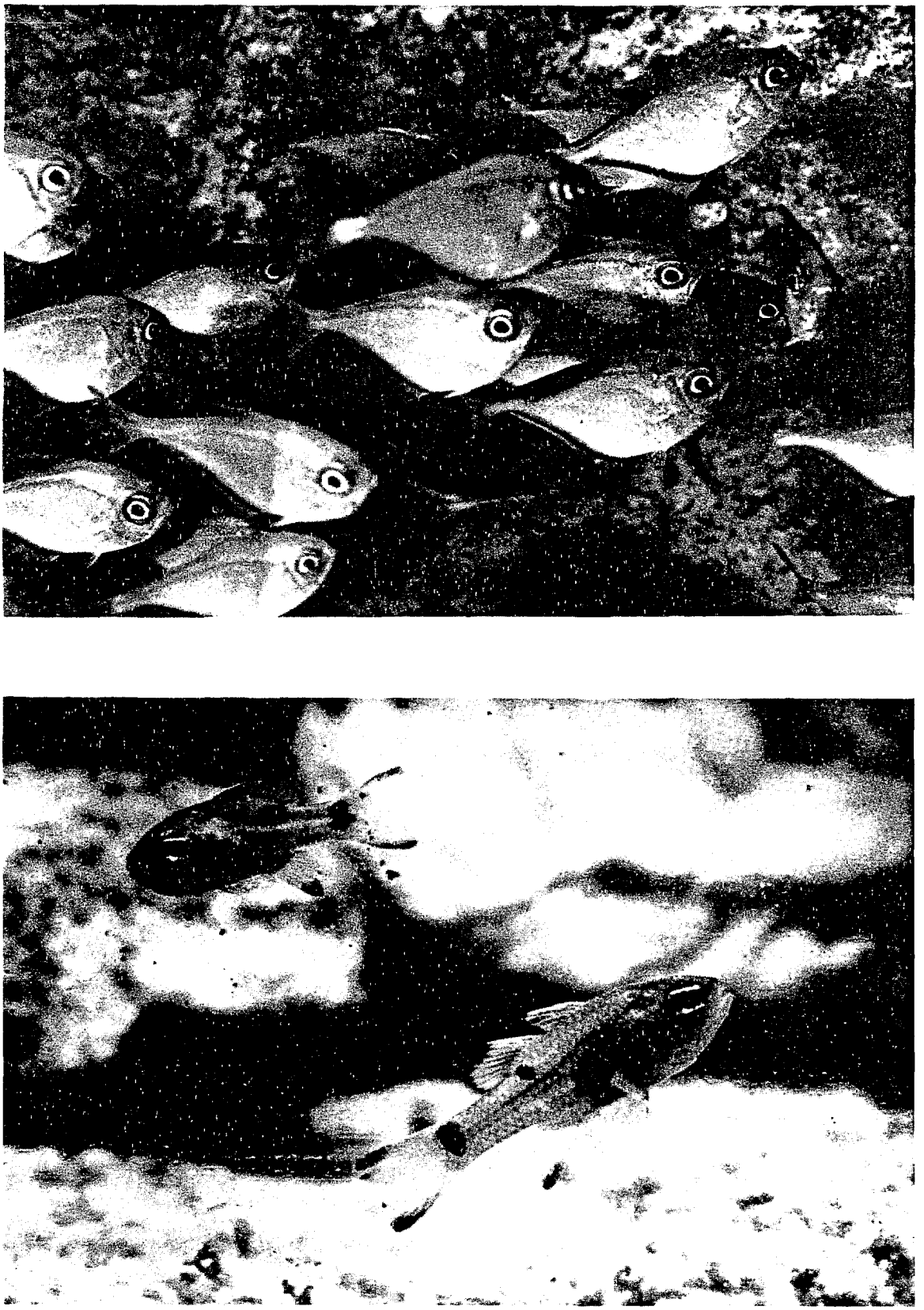


Plate 9.--Typical nocturnal planktivors. Glassy sweepers, Pempheris schomburgki (10 cm) (top) and the twospot cardinalfishes, Apogon pseudomaculatus (3 cm) (bottom) hide in caves in the reef by day and come out to feed on plankton at night.

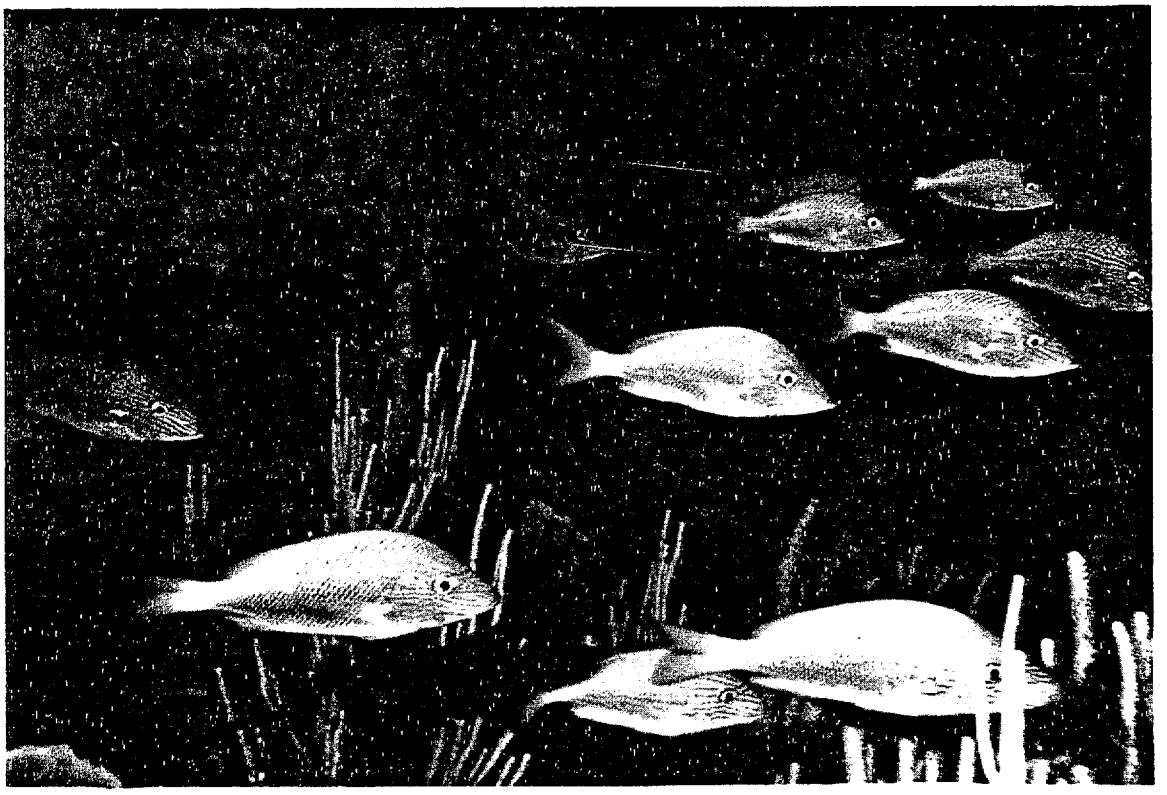


Plate 10.--Typical nocturanl macroinvertivores. Grunts (Haemulidae) are one of the most important groups of reef fishes in terms of species, abundance, and biomass. Although seen in schools on the reef during the day, most species feed on invertebrates away from the reef at night. The white grunt, Haemulon plumieri (18 cm) (top) is most abundant on inshore live bottoms. The tomtate, H. aurolineatum (14 cm) dominates the forereef zone.

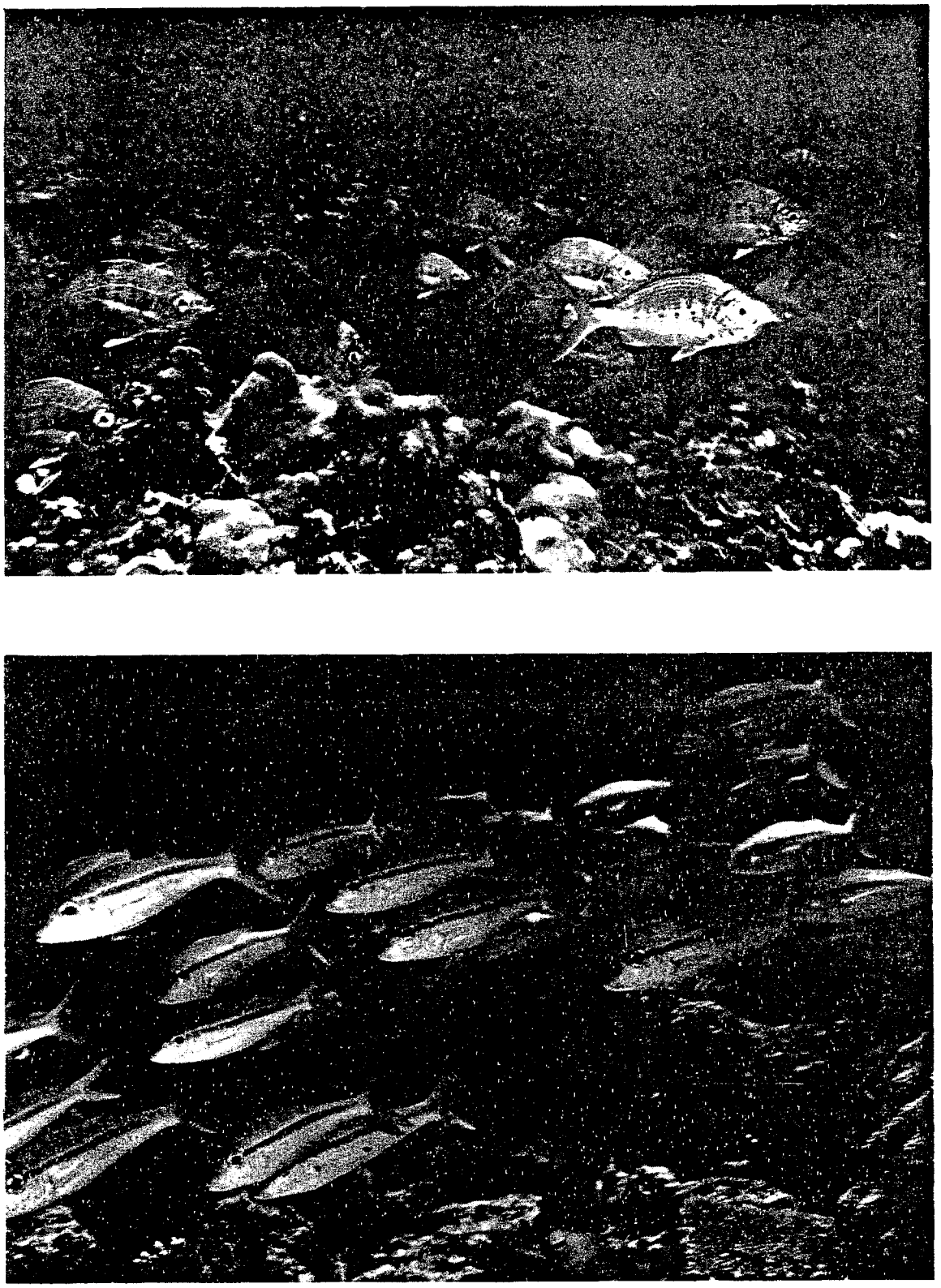


Plate 11.--Typical softbottom microinvertivores. Goatfish and mojarra feed primarily on microinvertebrates in sand bottoms. Shown are schools of yellowfin mojarra, Gerres cinereus (25 cm) (top) and yellow goatfish, Mulloidichthys martinicus (30 cm) (bottom).

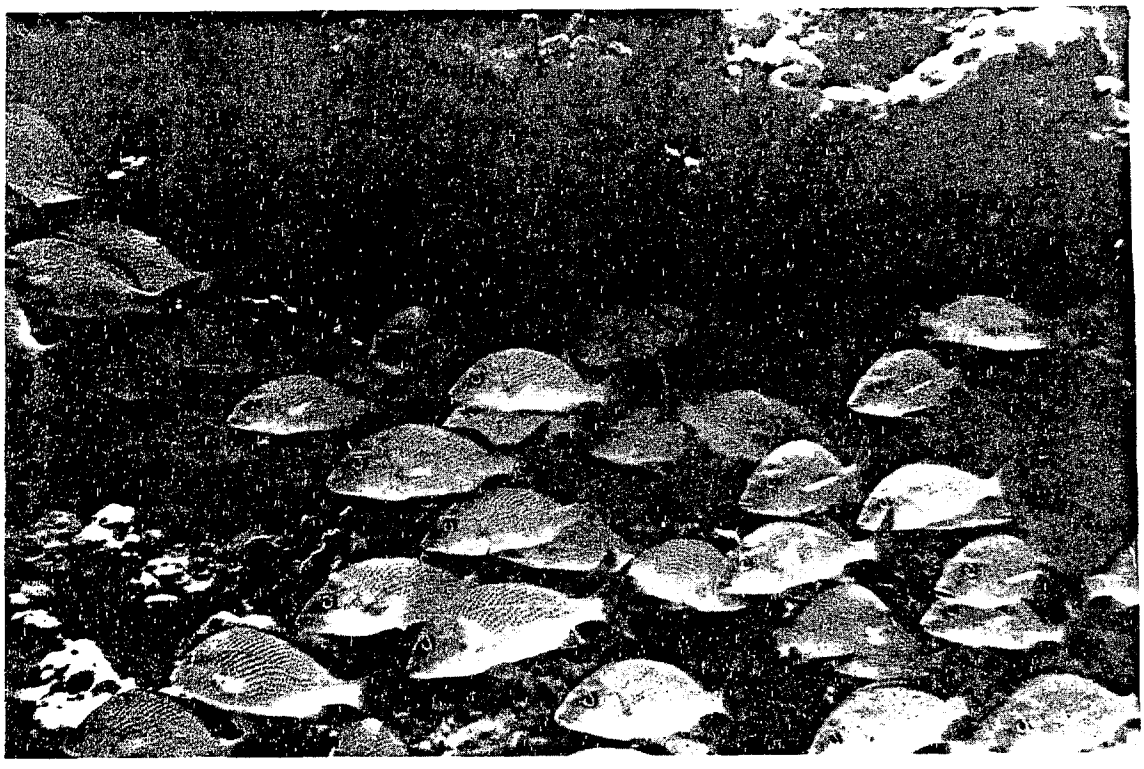


Plate 12.--Typical macroinvertivores. The sailor's choice, Haemulon parrai (Haemulidae, 27 cm) (top) and the hogfish, Lachnolaimus maximus (Labridae, 22 cm) (bottom) are two typical macroinvertivores. Large schools of sailor's choice were first observed at Looe Key Reef after it became a Sanctuary. The hogfish, a favorite spearfishing target, became more frequent after the Sanctuary was established.

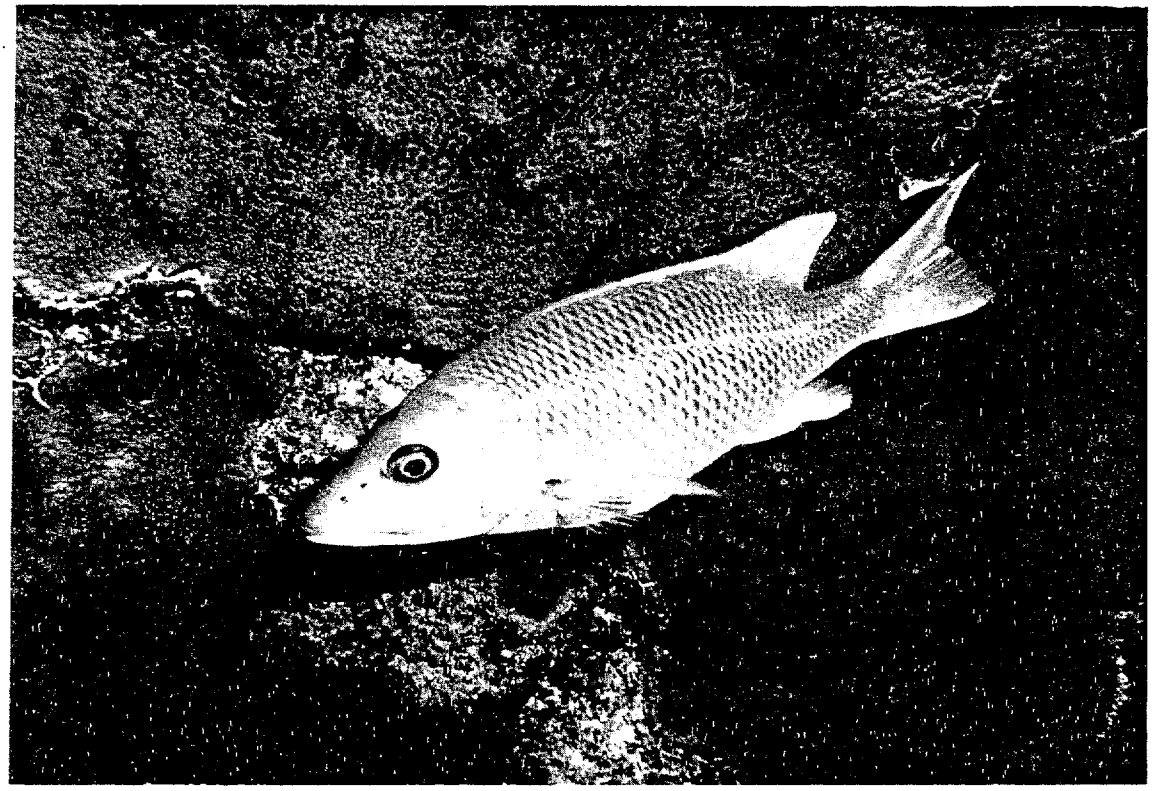


Plate 13.--The schoolmaster snapper, Lutjanus apodus. Schoolmaster were the most common snapper (Lutjanidae) observed in the Sanctuary (top, 20 cm). Schools were frequently seen around colonies of elkhorn coral, Acropora palmata (bottom).

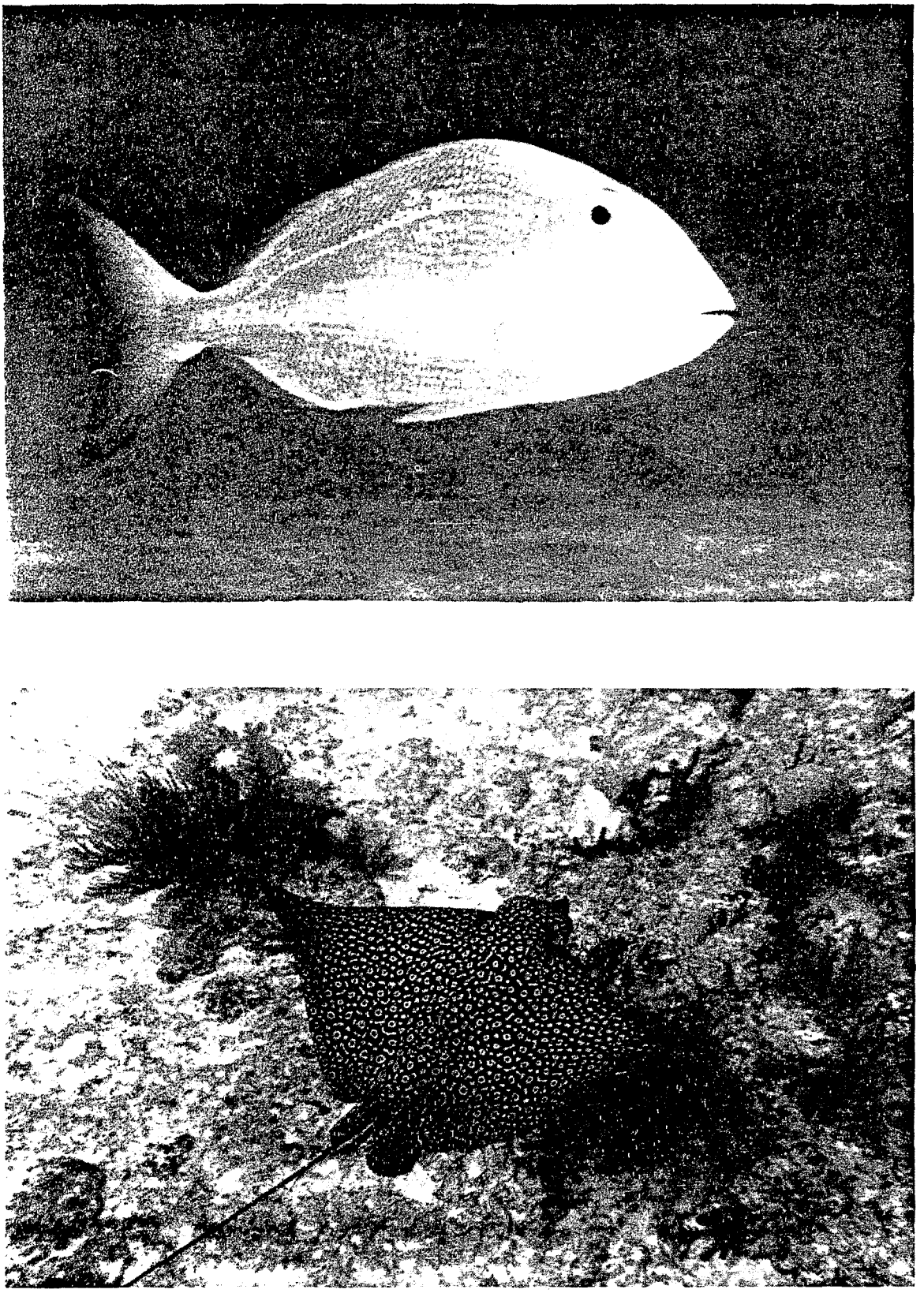
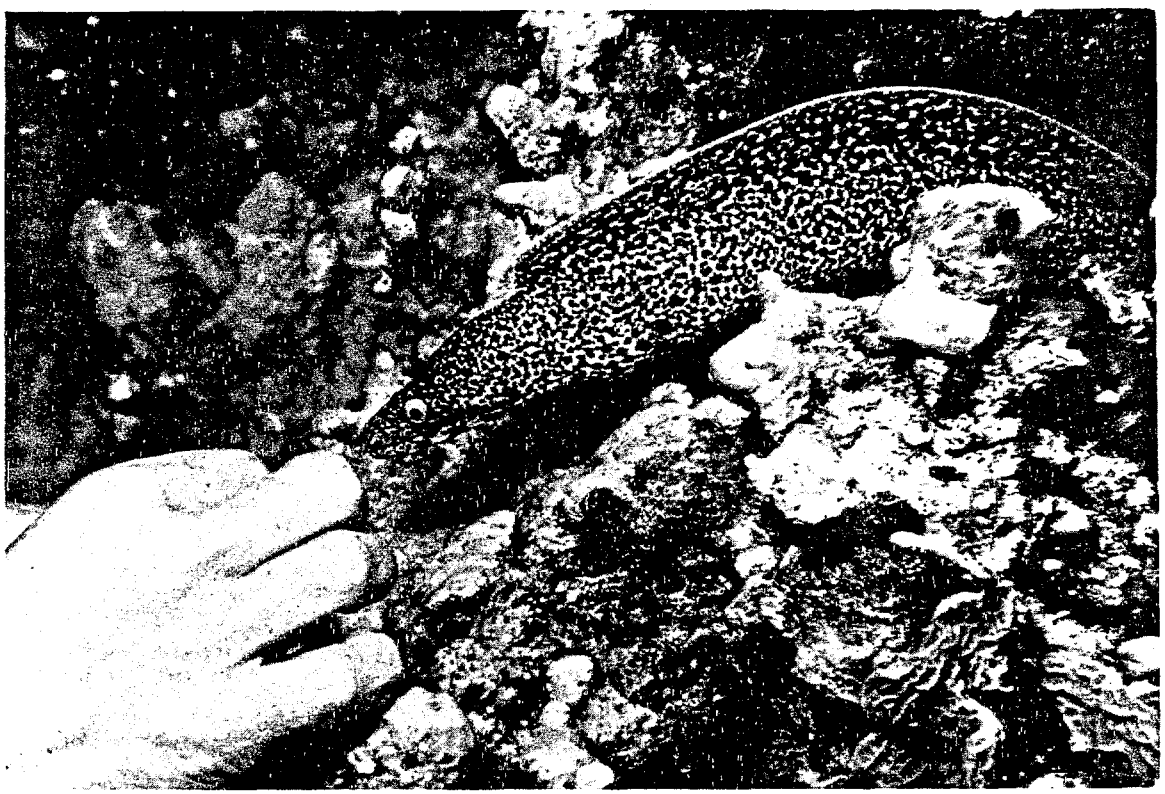


Plate 14.--Typical roaming, soft bottom macroinvertivores. The jolthead porgy, Calamus bajonado (40 cm) (top) and the eagle ray, Aetobatus narinari (1.3 m diameter) (bottom), feed primarily on the larger macroinvertebrates on sand bottoms and can range over large areas.



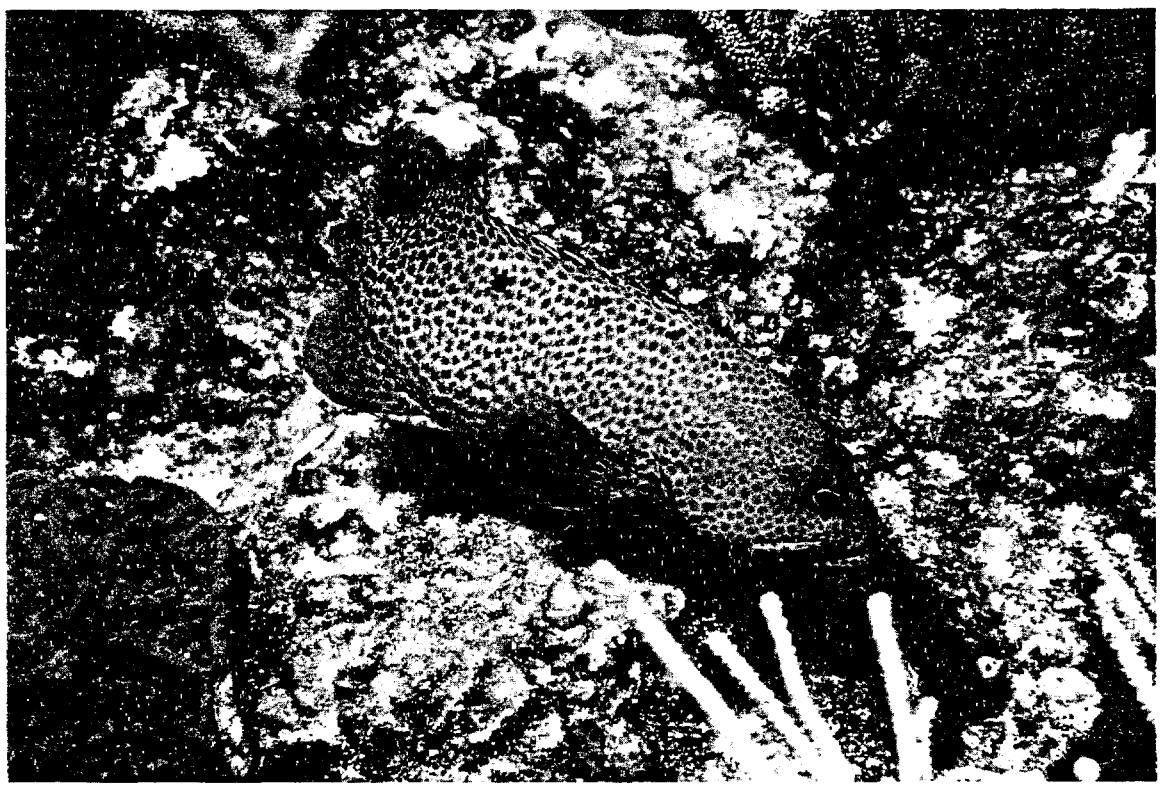
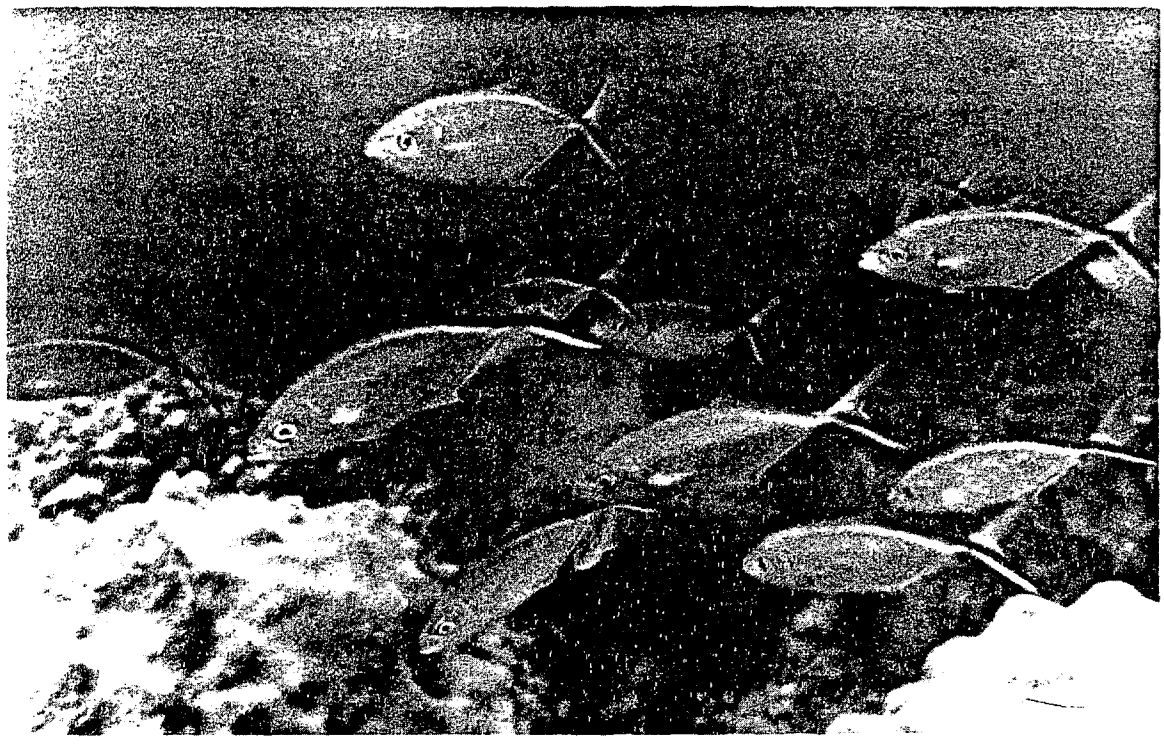


Plate 15.--Typical small predators. Moray eels and groupers feed on macroinvertebrates and fishes. Eels are more active at night and groupers more active during the day. Shown are a spotted moray, Gymnothorax moringa, being fed by a diver (top) and a graysby, Epinephelus cruentatus (18 cm), the most common grouper at Looe Key Reef (bottom).



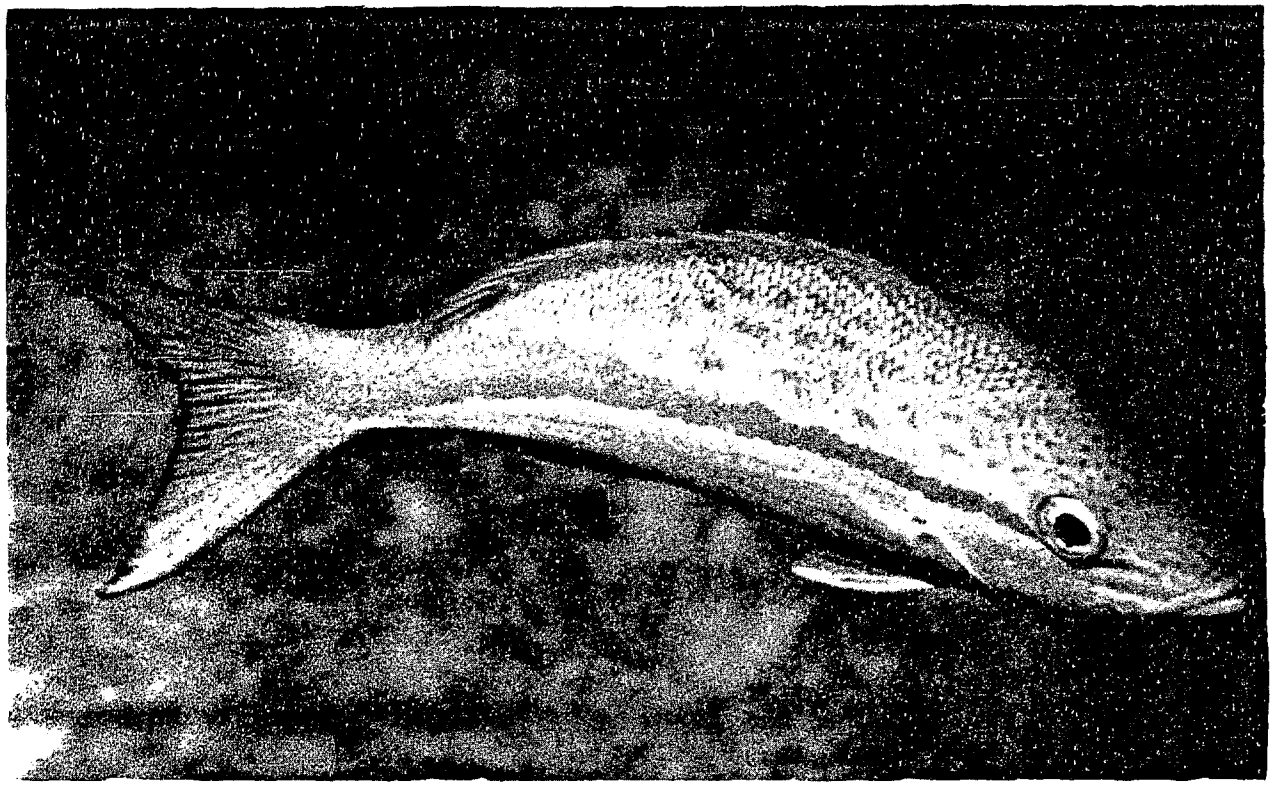


Plate 16.--Typical midwater predators. The bar jack, Caranx ruber (15 cm) (top), and the yellowtail snapper, Ocurus chrysurus (22 cm) (bottom), are midwater fishes that feed primarily on plankton when small and on fishes when larger.

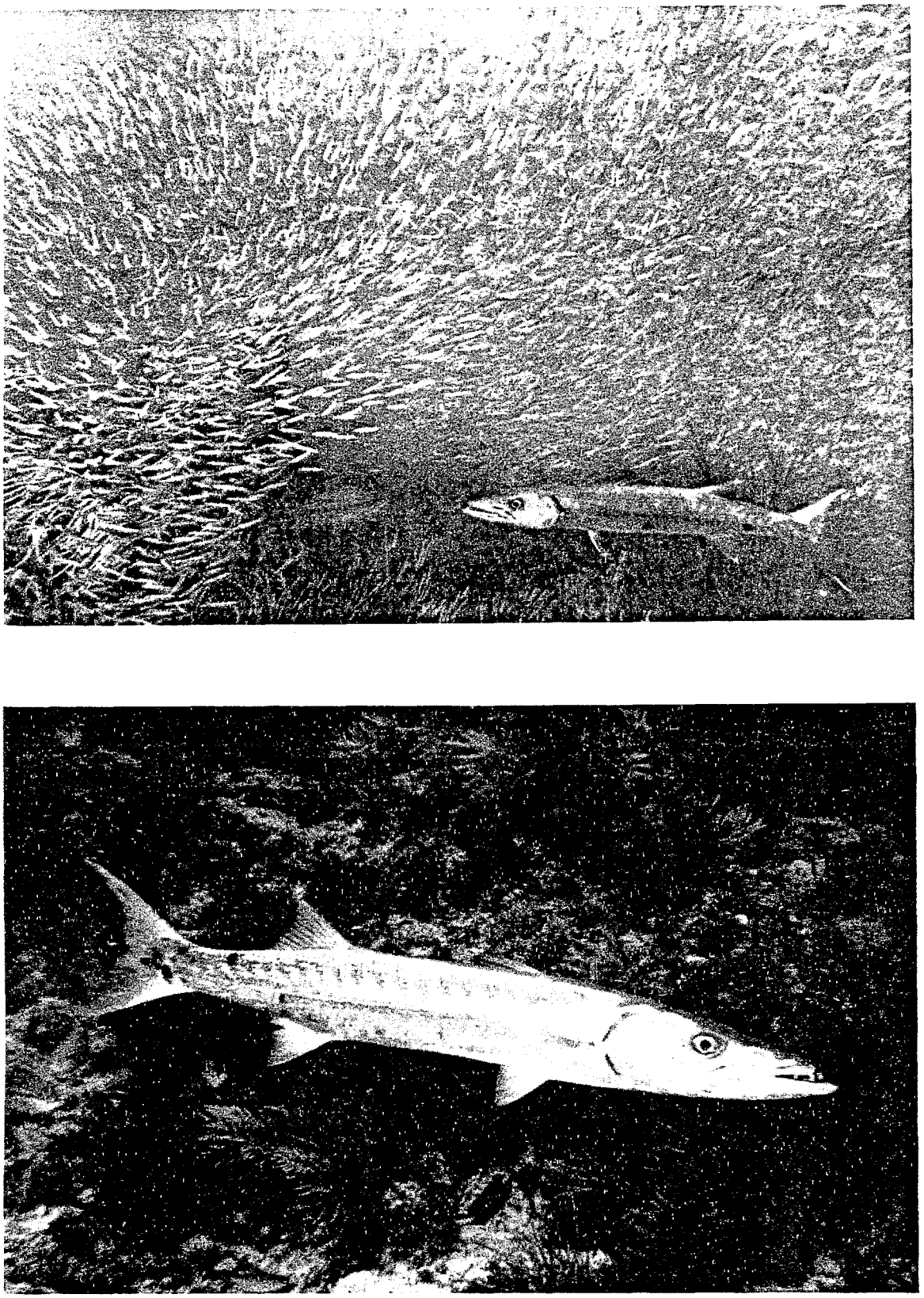


Plate 17.--The great barracuda, Sphyraena barracuda. This is a piscivorous predator that feeds on small fishes when medium in size (top, 45 cm) and large fishes when large in size (bottom, 90 cm). This is one of many species rarely seen in the Sanctuary as juveniles.

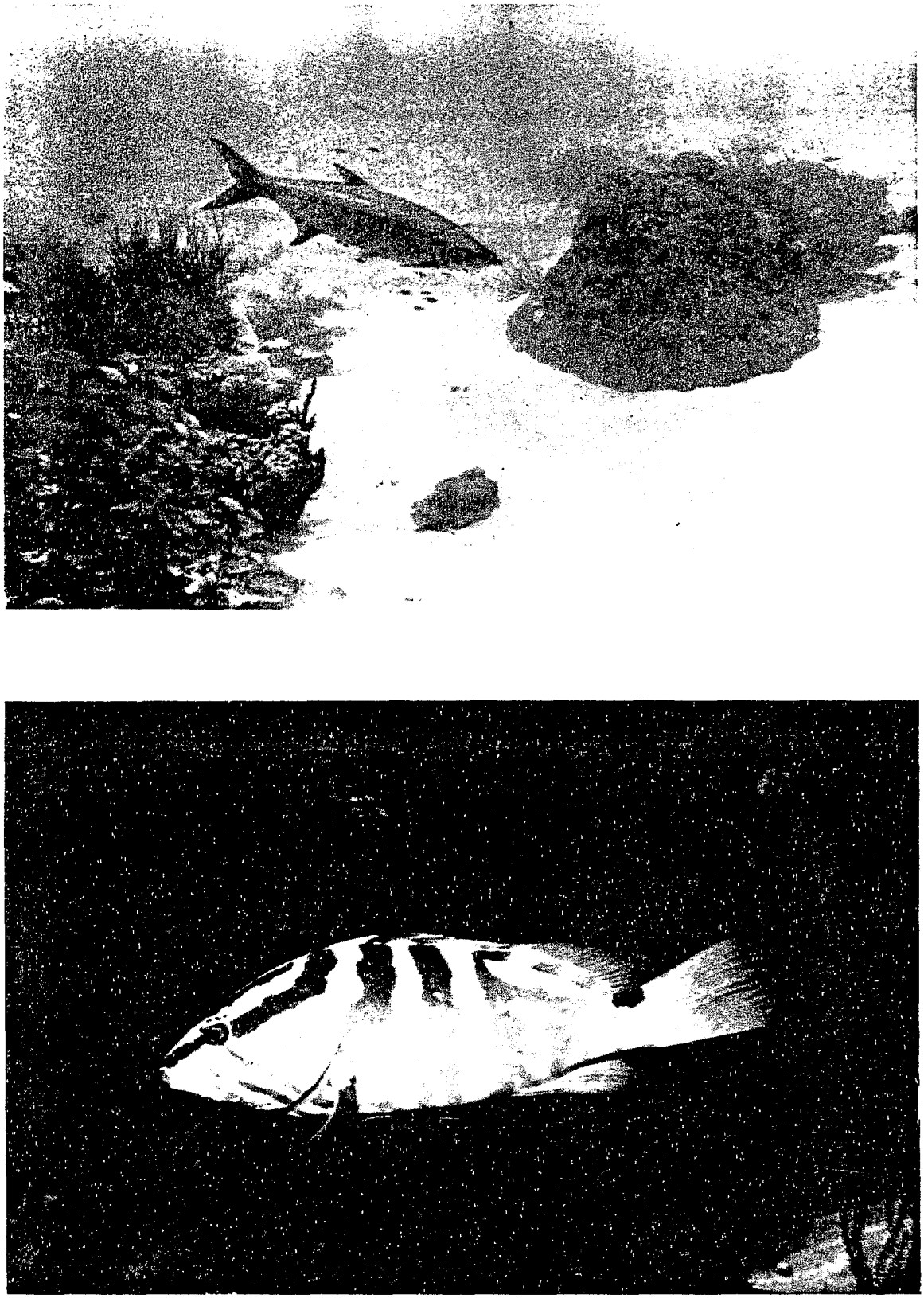


Plate 18.--Large roaming predators. (Top) Adult tarpon, Megalops atlanticus (1.5 m) are piscivorous predators frequently seen over reef areas in the Sanctuary. (Bottom) The Nassau grouper, Epinephelus striatus (50 cm) feeds mostly on invertebrates and represents one of the larger grouper predators.

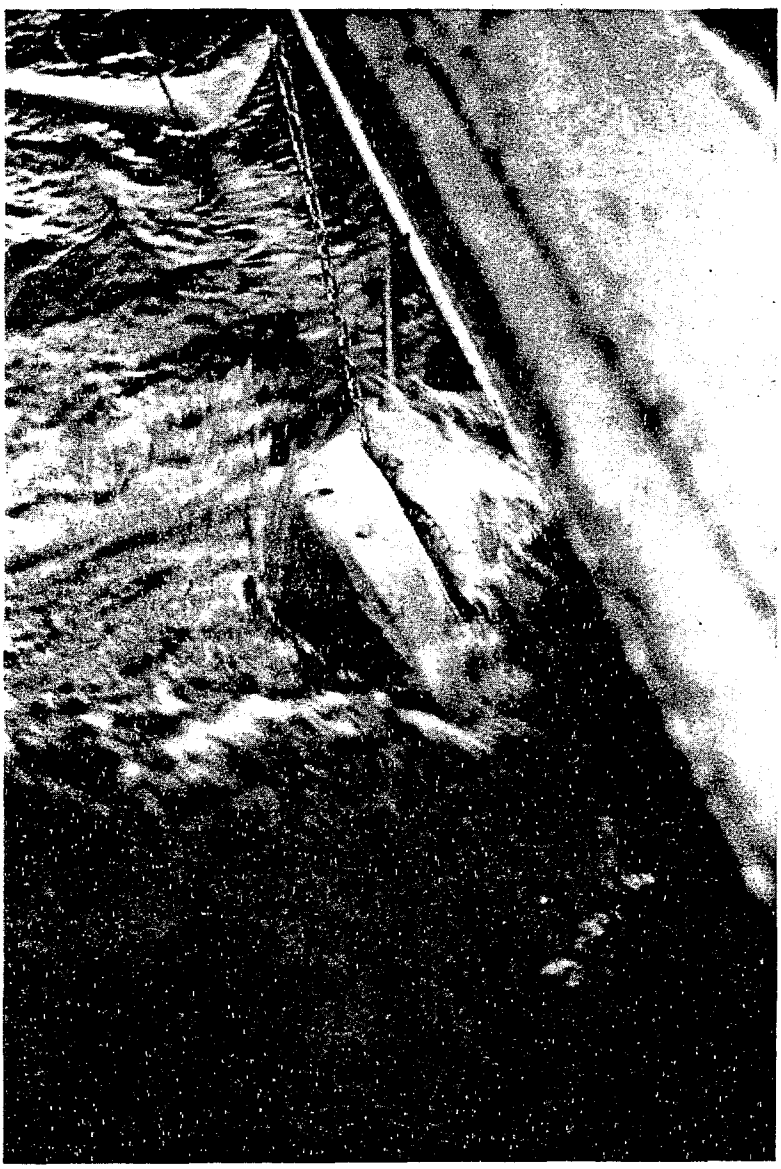


Plate 19.--The bull shark, Carcharhinus leucas. This is one of the largest predators in the Sanctuary. Although often caught in the Sanctuary at night they are rarely seen on the reef during the day. The shark in the photograph measured 2.3 m.

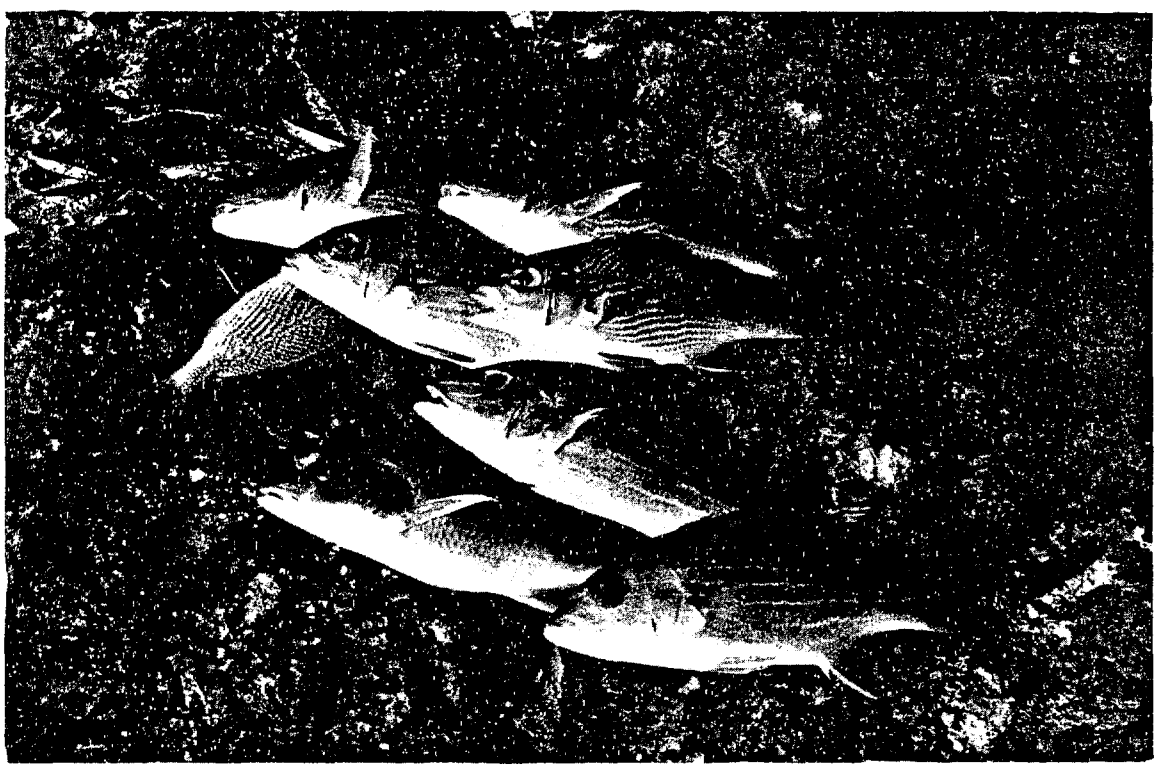


Plate 20.--Major recent disturbance events at Looe Key National Marine Sanctuary. (Top) A normally herbivorous stoplight parrotfish, Sparisoma viride, (35 cm) opportunistically attacking and eating a sick sea urchin. The long-spined urchin, Diadema antillarum, is an important reef herbivore that was almost eliminated from most reefs around the Caribbean by an epidemic in the summer of 1983. (Bottom) Dead fishes (15 - 18 cm) in Cupon Bight just north of the Sanctuary were killed by a severe January 1977 cold spell.

Appendix 1.-Abundance, distribution, and frequency-of-occurrence of selected species at Looe Key National Marine Sanctuary. Vertical bars show 95% confidence limits and vertical lines show ± one standard error of the mean. Data are presented in Tables 4 and 5. Index:

TROPHIC LEVEL	SPECIES	PAGE
Herbivores		
	Acanthurus bahianus	97
	Acanthurus chirurgus	97
	Acanthurus coeruleus	97
	Sparisoma viride	97
	Scarus croicensis	98
	Sparisoma aurofrenatum	98
	Sparisoma chrysopterum	98
	Sparisoma rubripinne	98
	Microspathodon chrysurus	99
	Pomacentrus fuscus	99
	Pomacentrus planifrons	99
	Coryphopterus dicrus	99
	Coryphopterus glaucofraenum	100
Planktivores		
	Pomacentrus partitus	100
	Chromis cyaneus	100
	Chromis multilineatus	100
	Abudefduf saxatilis	101
	Clepticus parrai	101
	Coryphopterus personatus	101
	Thalassoma bifasciatum	101
Microinvertivores		
	Halichoeres maculipinna	102
	Halichoeres garnoti	102

Halichoeres bivittatus 102
Halichoeres radiatus 102
Mulloidichthys martinicus 103
Pseudopeneus maculatus 103
Chaetodon ocellatus 103

Carnivorous Browsers

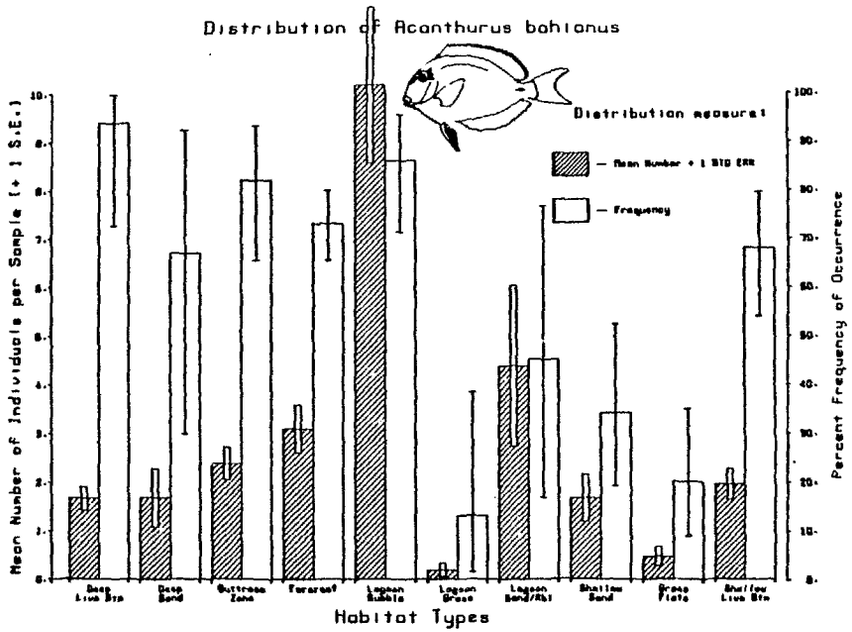
Chaetodon capistratus 103
Holacanthus tricolor 104
Pomacanthus arcuatus 104

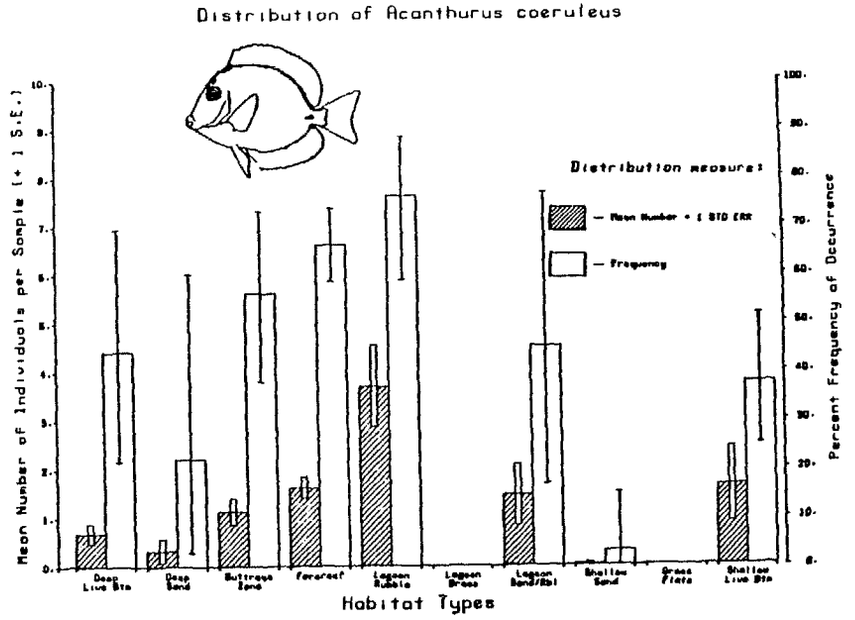
Macroinvertivores

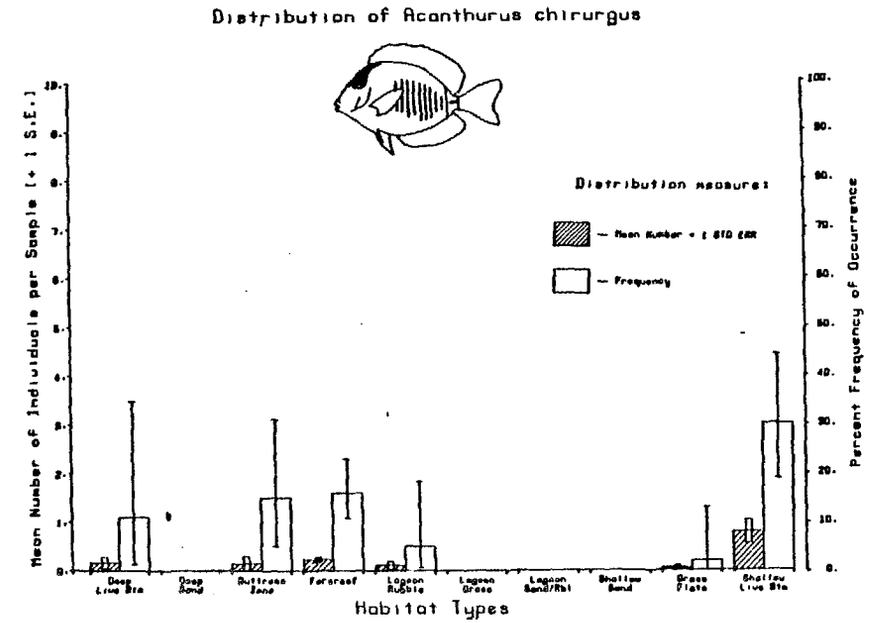
Haemulon aurolineatum 104
Haemulon chrysargyreum 104
Haemulon flavolineatum 105
Haemulon plumieri 105
Haemulon sciurus 105
Calamus bajanado 105
Bodianus rufus 106
Epinephalus cruentatus 106
Lutjanus analis 106
Lutjanus synagris 106

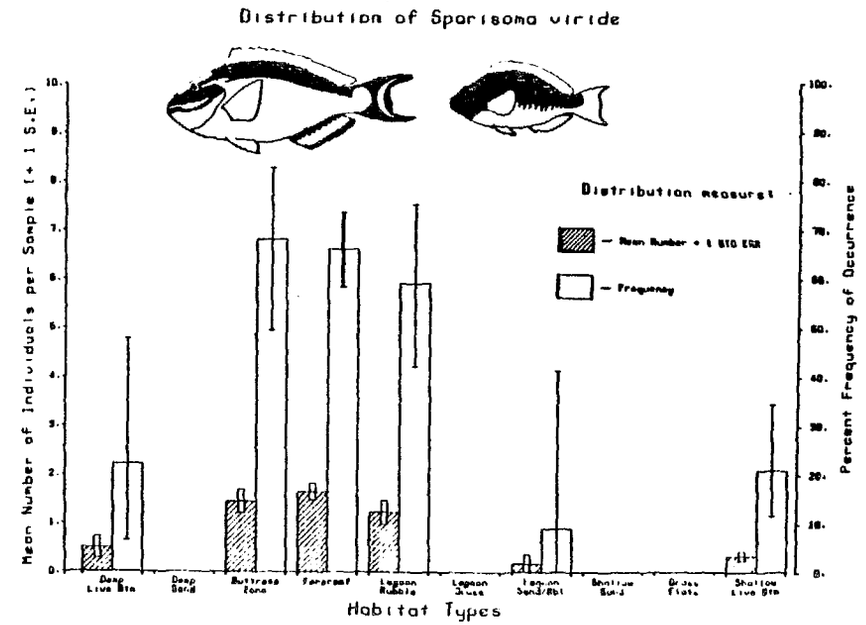
Carnivores

Lutjanus apodus 107
Lutjanus griseus 107
Caranx bartholomaei 107
Caranx ruber 107
Ocyurus chrysurus 108
Sphyraena barracuda 108

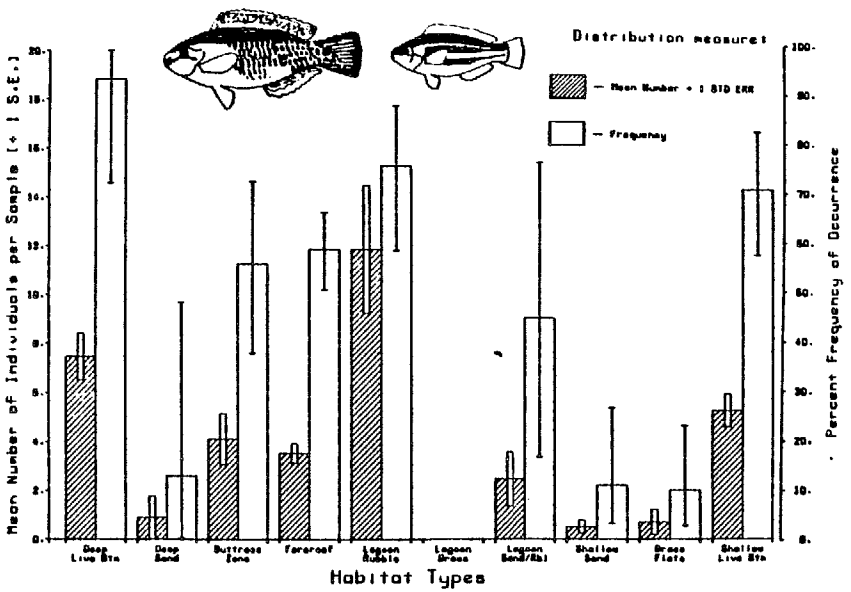

Distribution of Acanthurus bahianus
Distribution measure:
— Mean Number + 1 STD ERR
— Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types


Distribution of Acanthurus coeruleus
Distribution measure:
— Mean Number + 1 STD ERR
— Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types

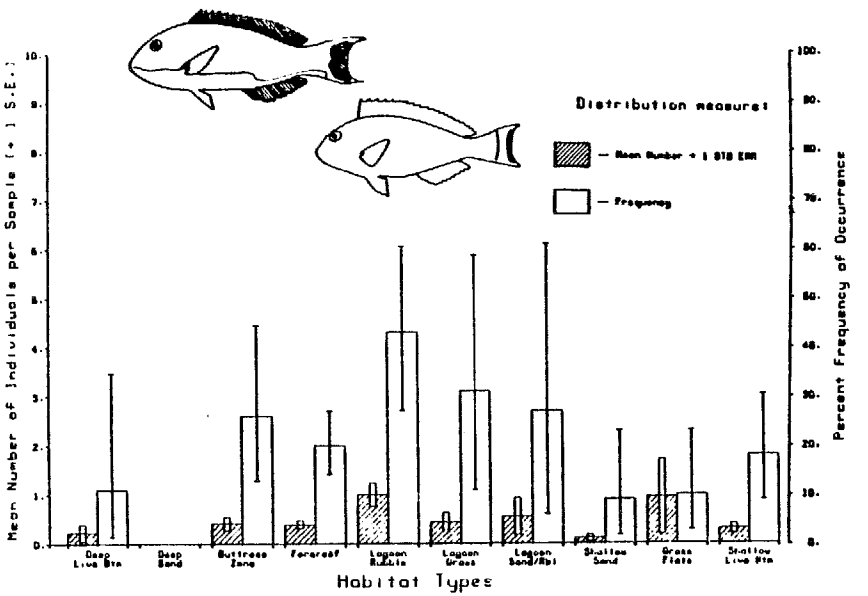

Distribution of Acanthurus chirurgus
Distribution measure:
— Mean Number + 1 STD ERR
— Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types


Distribution of Sparisoma viride
Distribution measure:
— Mean Number + 1 STD ERR
— Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types

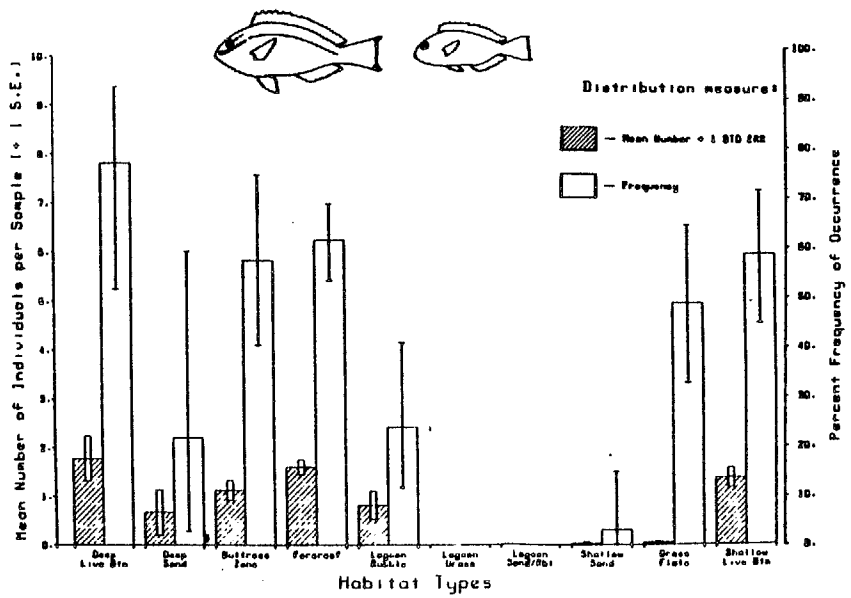
Distribution of Scarus croicensis



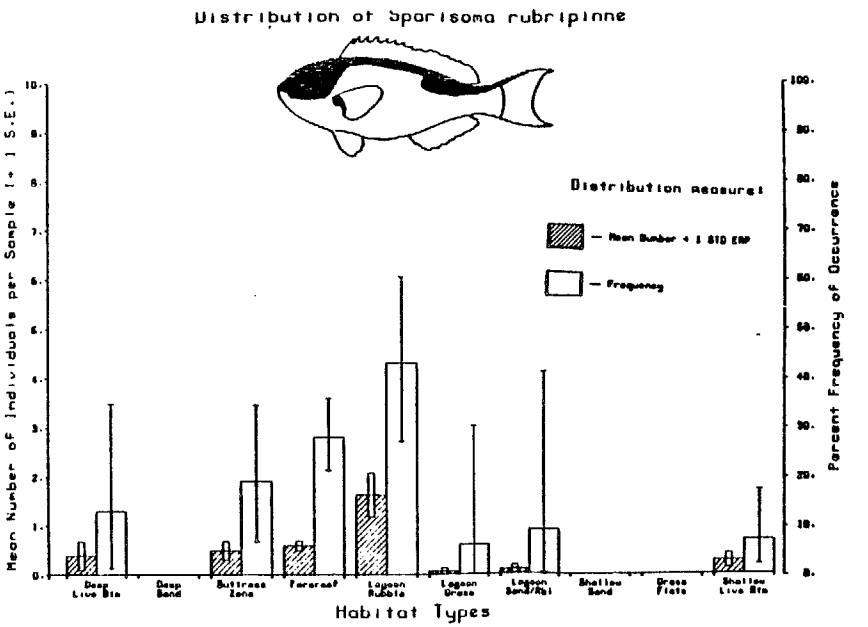
Distribution of Sparisoma chrysopterum



Distribution of Sparisoma aurofrenatum

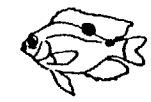


Distribution of Sparisoma rubripinne



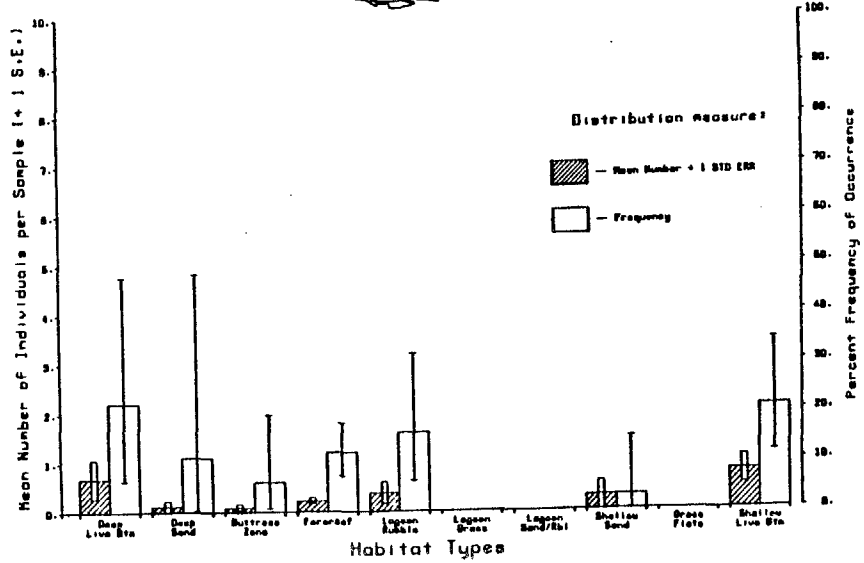
Distribution of Microspathodon chrysurus

Distribution of Pomacentrus planifrons

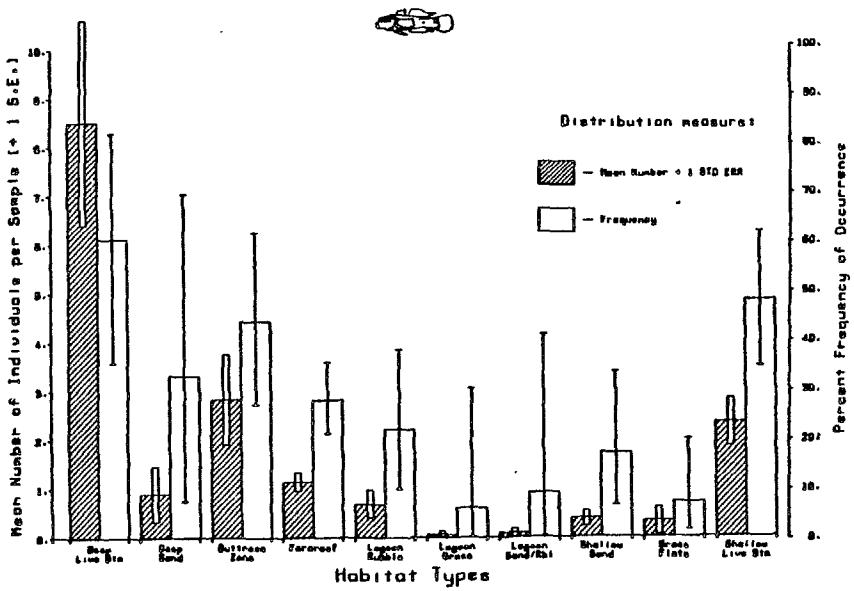


Distribution of Pomacentrus fuscus

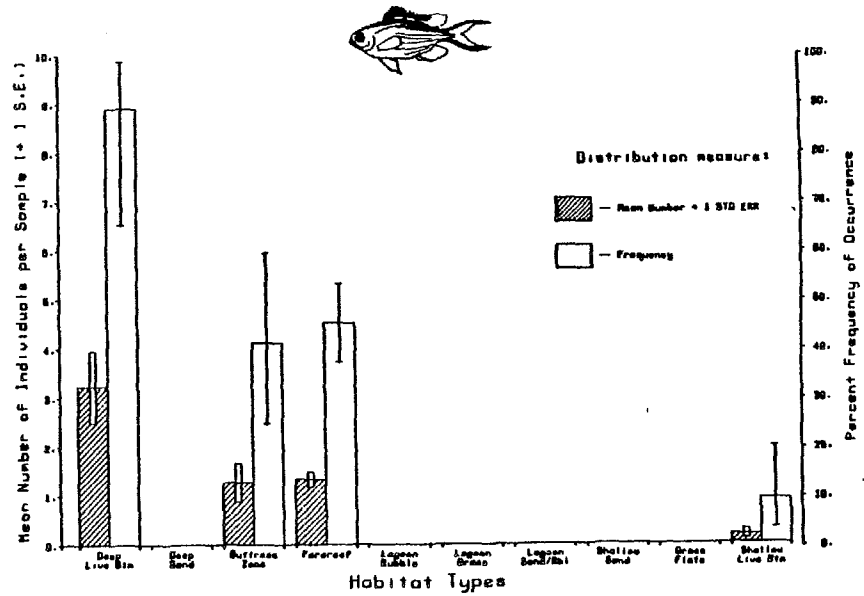
Distribution of Coryphopterus dicrus



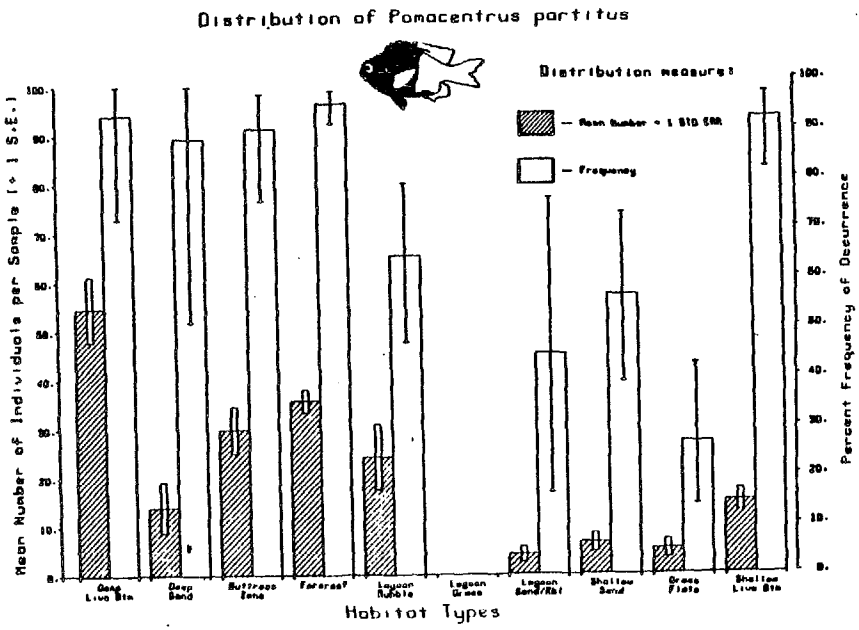
Distribution of Coryphopterus glaucofraenum



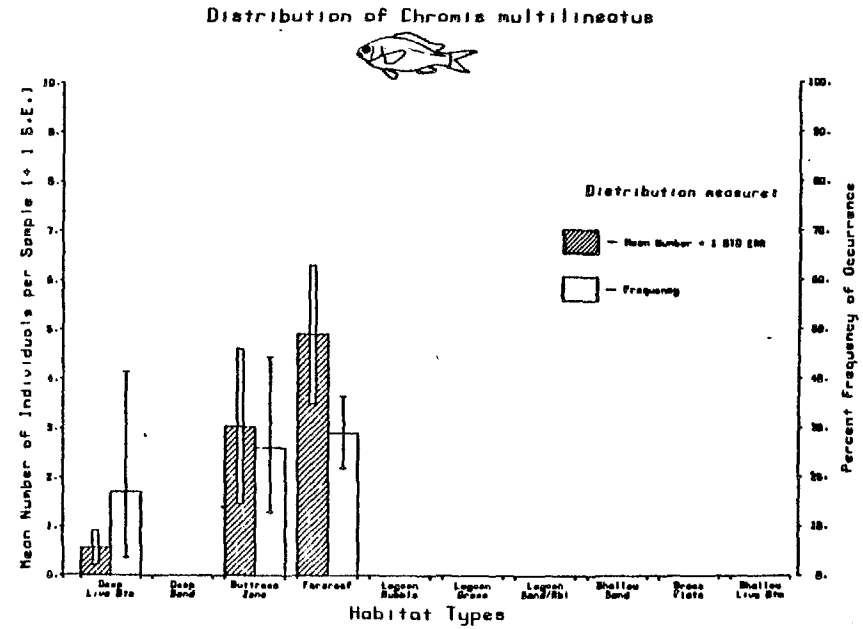
Distribution of Chromis cyaneus



Distribution of Pomacentrus partitus

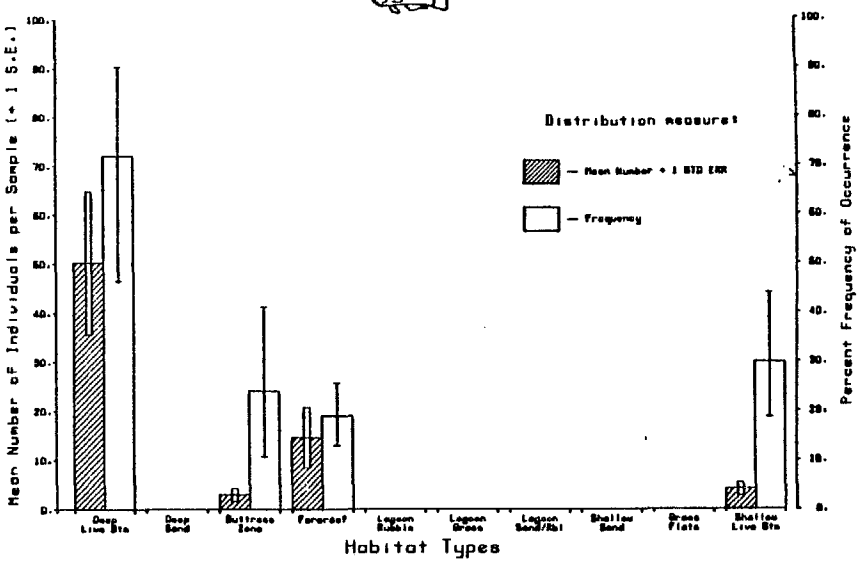


Distribution of Chromis multilineatus

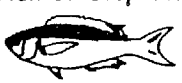


Distribution of Abudefduf saxatilis

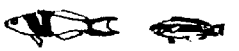
Distribution of Coryphopterus personatus

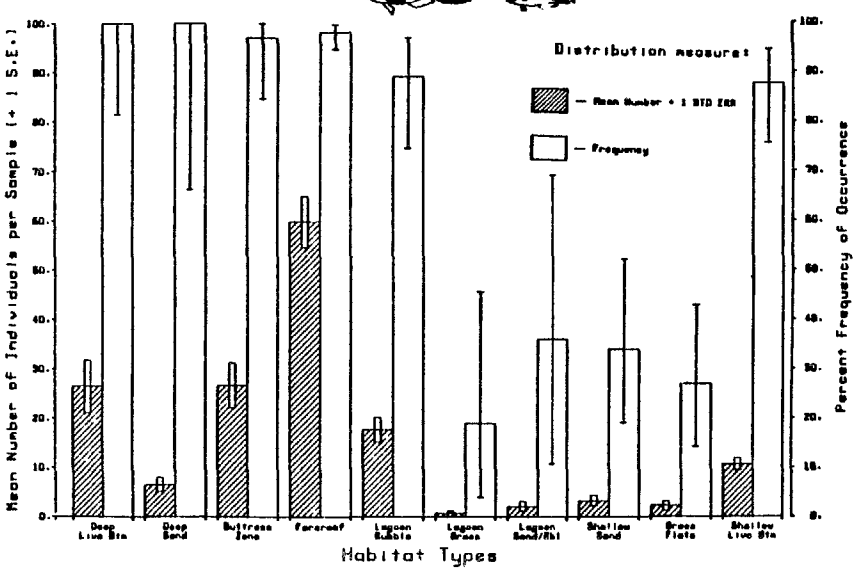


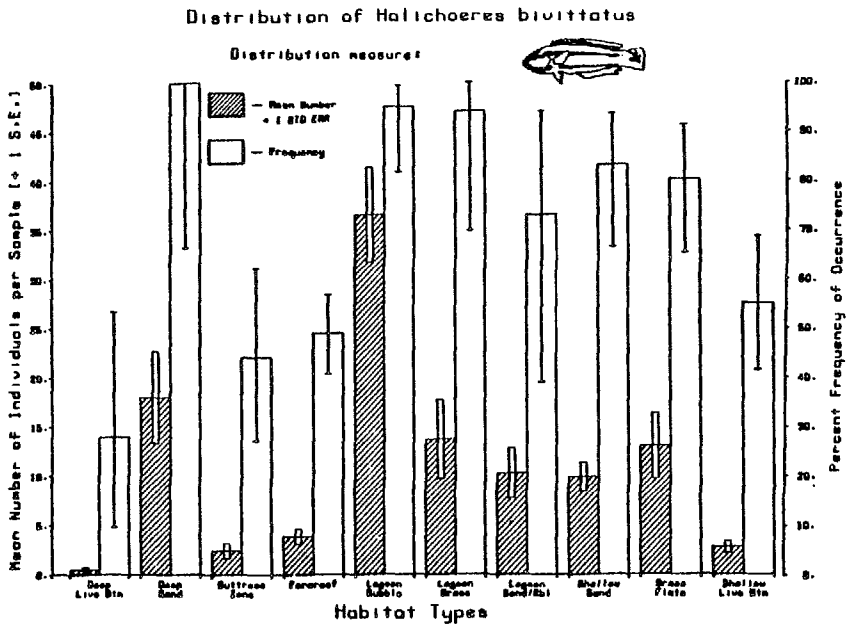
Distribution of Clepticus parrai

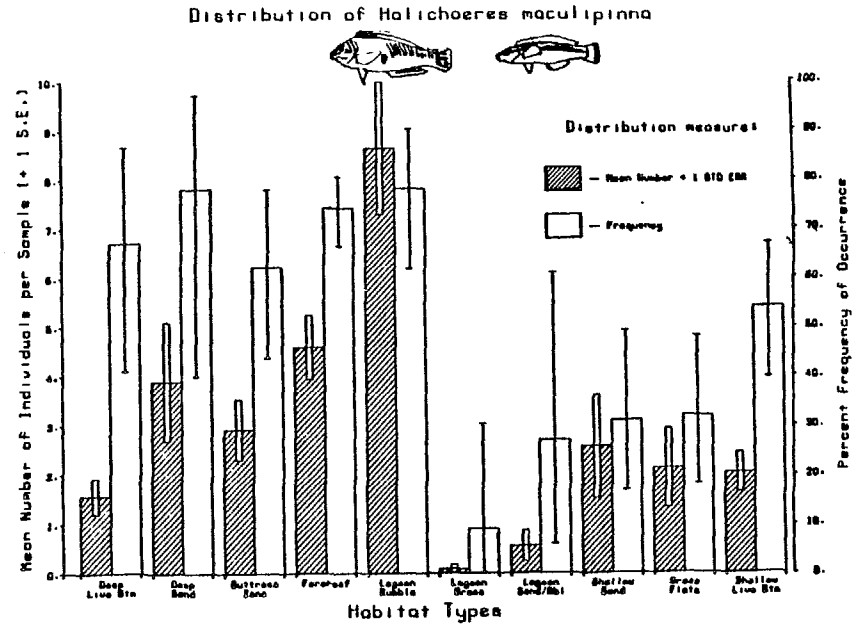


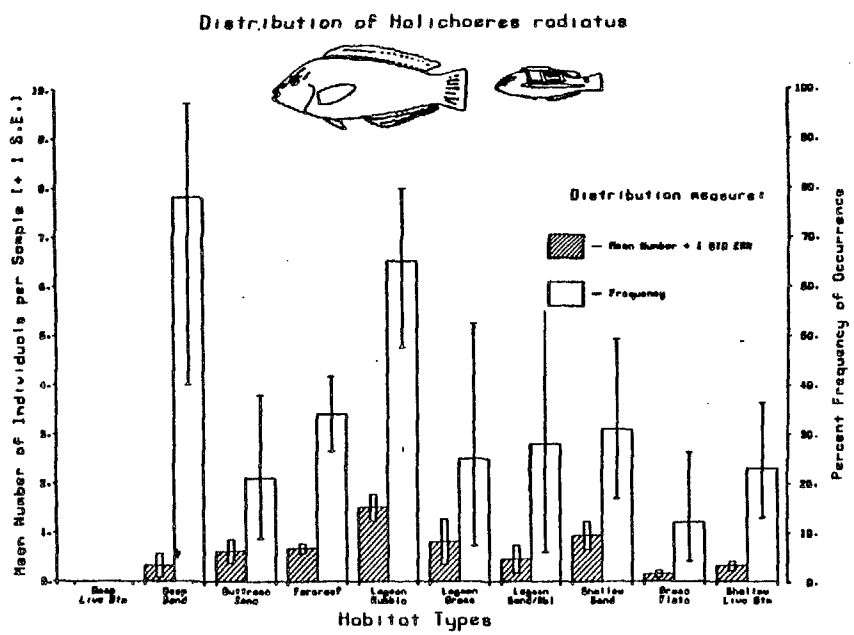
Distribution of Thalassoma bifasciatum

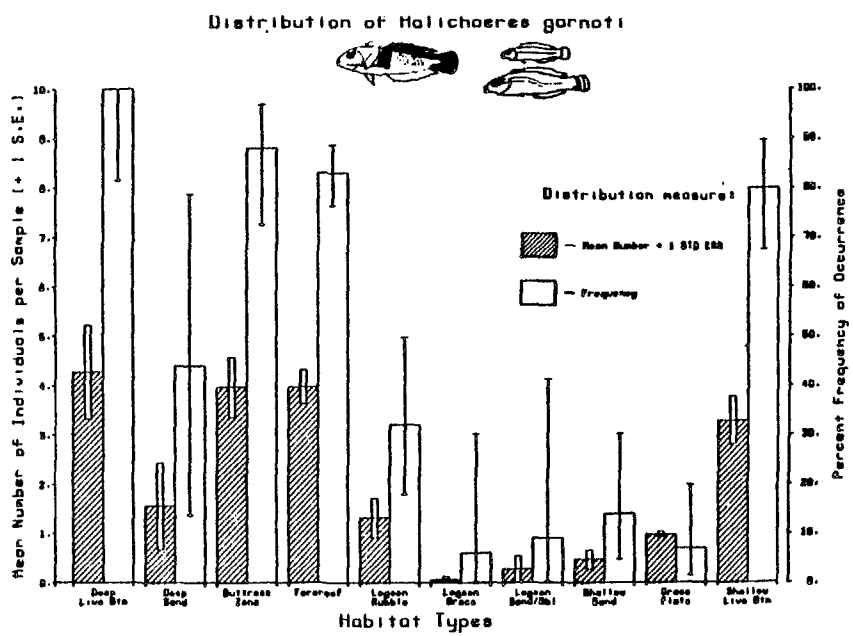





Distribution of Halichoeres bivittatus
Distribution measures
Mean Number + 1 STD ERR
Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types


Distribution of Halichoeres maculipinna
Distribution measures
Mean Number + 1 STD ERR
Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types


Distribution of Halichoeres radiatus
Distribution measures
Mean Number + 1 STD ERR
Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types


Distribution of Halichoeres garnoti
Distribution measures
Mean Number + 1 STD ERR
Frequency
Mean Number of Individuals per Sample (+ 1 S.E.)
Percent Frequency of Occurrence
Habitat Types

Distribution of Mulloidichthys martinicus

Distribution of Chaetodon ocellatus

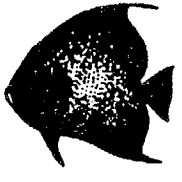
Distribution of Pseudopeneus maculatus

Distribution of Chaetodon capistratus

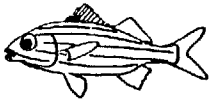
Distribution of Holacanthus tricolor

Distribution of Haemulon aurolineatum

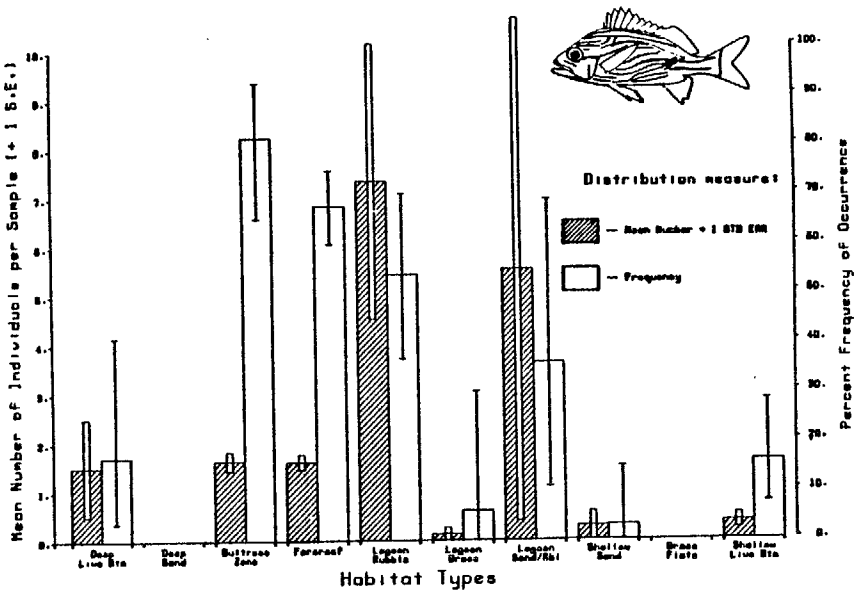
Distribution of Pomacanthus arcuatus



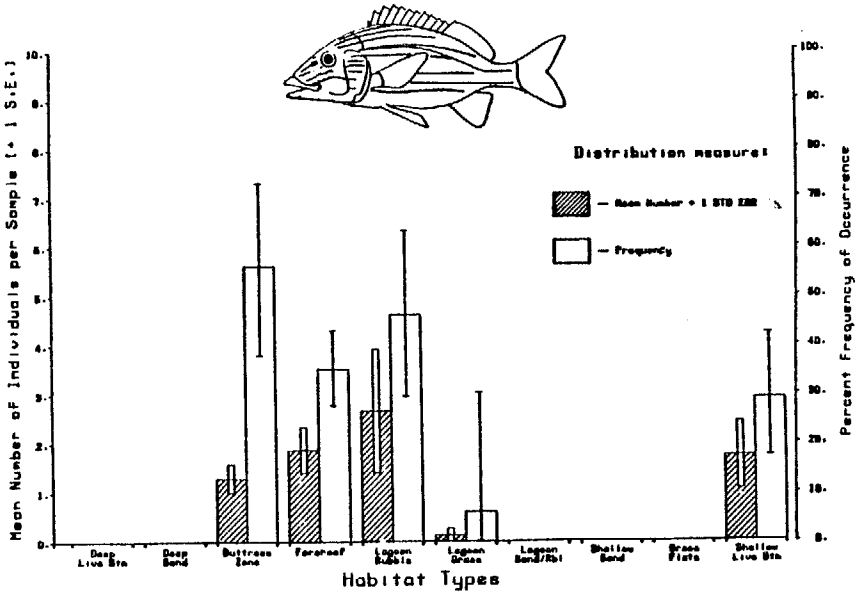
Distribution of Haemulon chrysargyreum



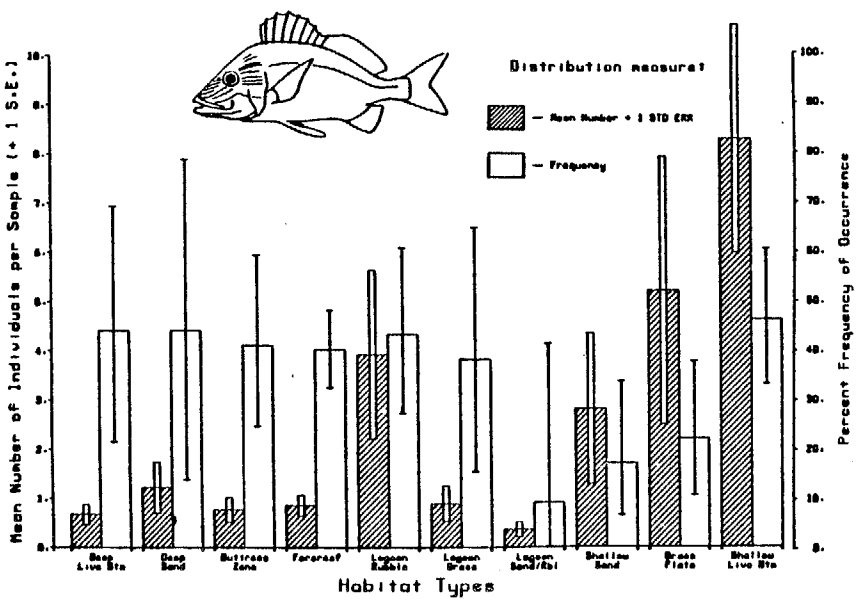
Distribution of Haemulon flavolineatum



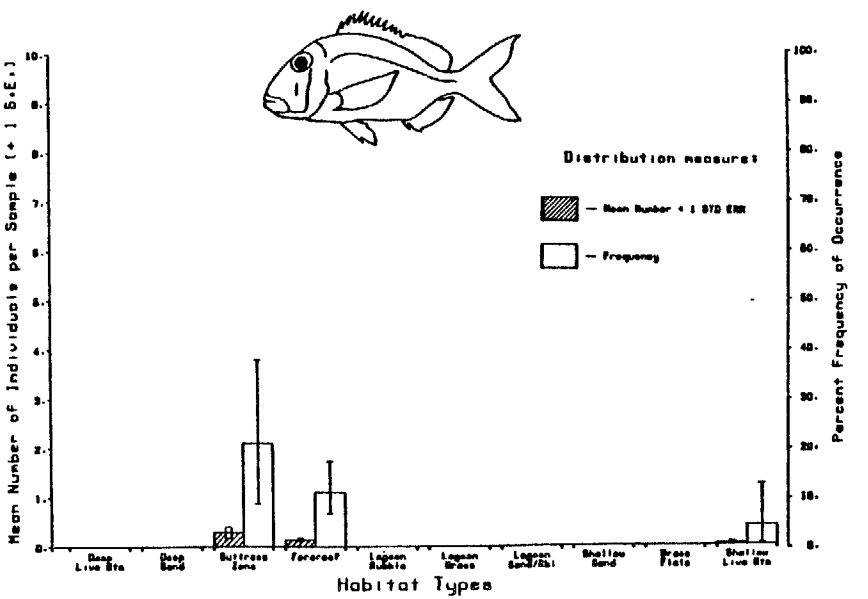
Distribution of Haemulon sciurus



Distribution of Haemulon plumieri



Distribution of Calamus bajonado

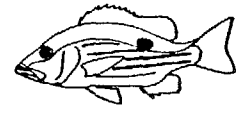


Distribution of Bodianus rufus

Distribution of Lutjanus analis

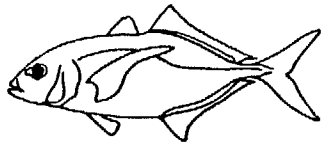
Distribution of Epinephalus cruentatus

Distribution of Lutjanus synagris

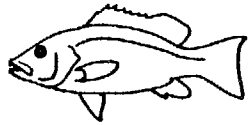


Distribution of Lutjanus apodus

Distribution of Caranx bartholomaei

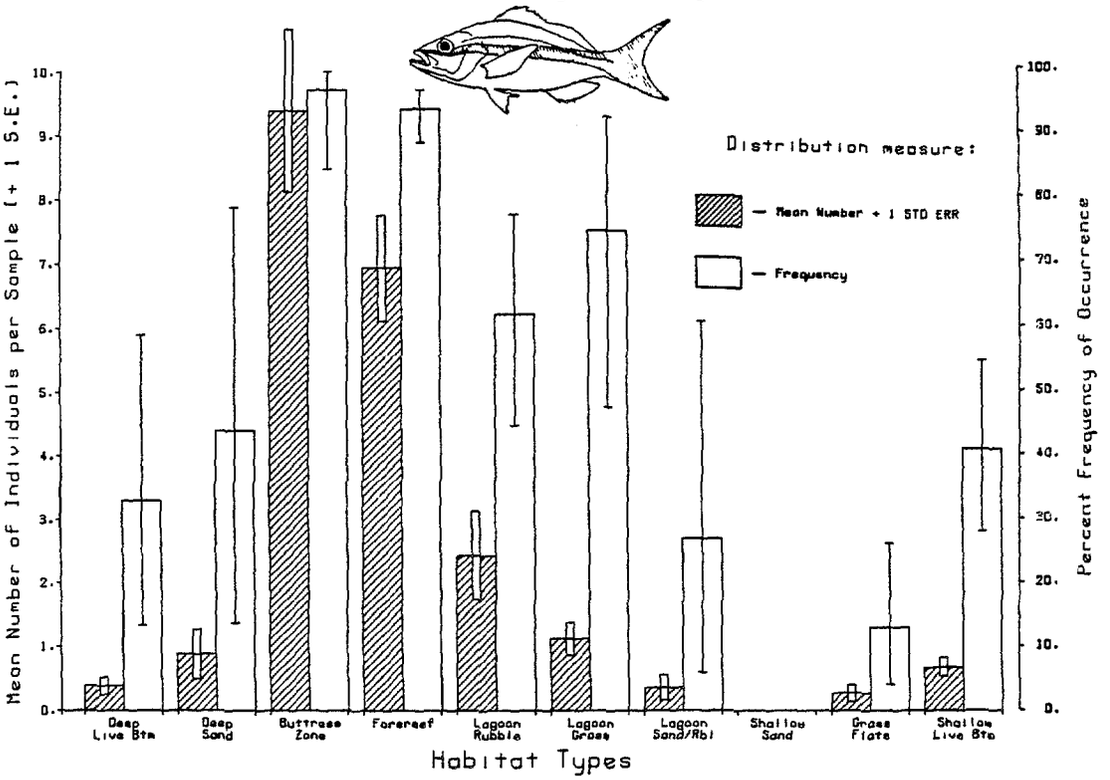


Distribution of Lutjanus griseus



Distribution of Caranx ruber

Distribution of Ocyurus chrysurus



Distribution of Sphyraena barracuda