

**CORAL REEF FISH COMMUNITY STRUCTURE:
A COMPARISON OF SMALL LAGOONAL
PATCH REEFS WITH
OUTER REEF TRANSECTS.**

**THESIS SUBMITTED FOR THE DEGREE OF B.Sc. (HONS)
UNIVERSITY OF STIRLING**

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CHAPTER ONE

1. INTRODUCTION

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1 INTRODUCTION.

1.1 Why coral reef fish.

Coral reefs are very important coastal structures which often act as front line sea defenses against the oceans. Coral reefs also lock away carbon dioxide from the atmosphere and the oceans into a very long term store. There is also a diverse range of habitats in these coastal systems, from the steep reef slopes, shallow fields of seagrass, dense mangrove swamps, lagoons to sweeping sandy beaches. The high topographical complexity of coral reefs serves as shelter and homes for approximately one third of all the fish species in the world.

The study of the ecology of reef fishes began only recently with the most important reviews occurring in the previous two decades. These important reviews are by Ehrlich (1975), Goldman and Talbot (1976), Sale (1980a) and Doherty and Williams (1988a). Pronounced segregation of species between habitats was found by Goldman and Talbot (1976). Authors such as Russ (1984) showed that there were also large changes in the fauna from the inner shelf to outer shelves of the Great Barrier Reef. Much of the literature sets out to prove that coral reef fish families or groups are ordered primarily by interspecific competition. Or if a more flexible view of how assemblages of fish species are put together and maintained, Strong et al (1984), Diamond & Cox (1986), Roughgarden et al (1981). The fact that there is present many ecologically similar species over a very broad habitat led Sale (1974, 1975, 1977, 1979) to develop the lottery hypothesis. This states that reef fish assemblages are determined by stochastic recruitment from the oceanic plankton to a limited spatial resource Doherty and Sale (1986). Recent work by Schulman and Ogden (1987) and Hixon (1991) refer

to predation as being a major controlling mechanism of the community structure. Caley (1995) stated that predation may override other ecological effects such as recruitment. Although reef fish faunas vary spatially in richness and species composition, they have a certain global uniformity. Through further research in this area it may be possible to identify patterns or make generalisations of their structure.

Coral reef fishes are an excellent subject to study due to their mobility, accessibility and temporal and spatial scales of the processes in which they are involved. They also provide rich assemblages of small organisms which operate on scales easily encompassed by the mobility of the average diver. Reef fish are relatively sedentary throughout most of their lives despite the fact that they have a pelagic larval phase which can be of considerable time periods (Sale 1991). Accessibility in tropical coral reef environments is aided by the mainly shallow, warm and clear nature of these waters in which reef fish exist. Most of the reef fish apart from the more cryptic, moray eels, gobiids and blennids are visually accessible. Another major advantage of studying reef fish is the ability of the ecologists to use patch reefs as essentially discrete and protected groups of fish. In this paper I attempt to compare these discrete patch reef systems with fish communities on two outer reef transects.

1.2 Location.

Belize is in the heart of Central America between Mexico, Guatemala and the Caribbean sea. Belize is 180 miles long and 68 miles wide (approx. 8866 sq.miles) which is equivalent to the size of Wales. The climate is sub-tropical with a mean annual temperature of 27°C. The wet season occurs during the months of June to November.

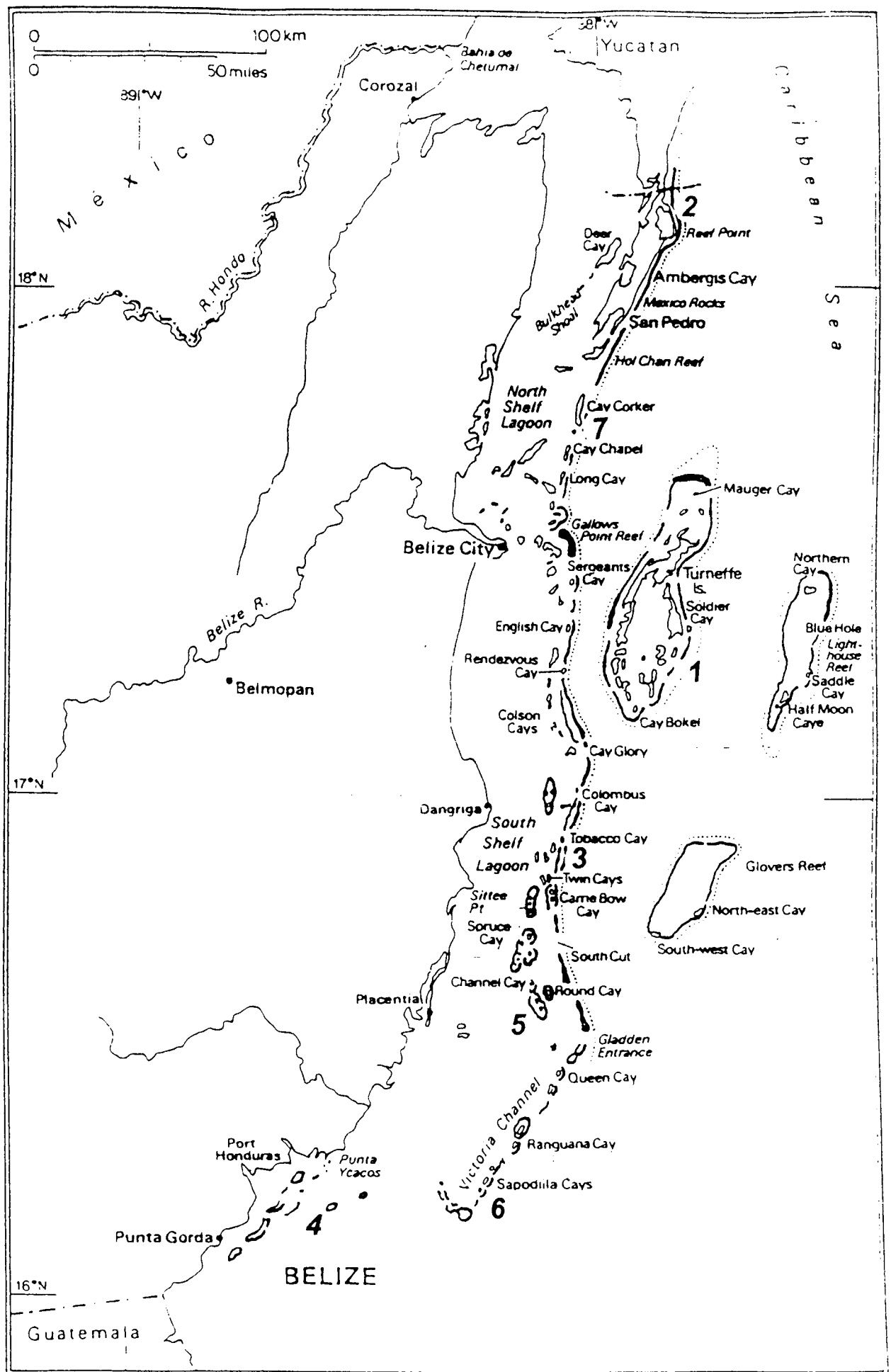


Figure 1. Map of Belize highlighting the barrier reef and the three atolls (Reproduced from IUCN/UNEP Publication: Coral Reefs of the World). The sites which Coral Cay have worked around are shown: 1 - Calabash Cay; 2 - Bacalar Chico; 3 - South Water Cay; 4 - Snake Cays; 5 - Laughing Bird Cay; 6 - Sapodilla Cays; 7 - Cay Caulker.

Gravel Caves



Parallel to Belize's coastline lies the largest barrier reef in the western hemisphere. (See Figure 1). Further offshore there are three out of the four Caribbean atolls, Turneffe Atoll, Lighthouse Reef and Glovers Reef. Belize's Barrier Reef and atolls support a dazzling variety of marine life, ranging from the brightly coloured corals and sponges to dolphins, whales and the endangered manatee.

The research on the physical and biological composition of the outer and patch reefs was carried out on Turneffe Atoll. This atoll is situated 35 miles off mainland Belize and is approximately 850 Km². The expedition base camp was situated on Calabash Cay which is in the middle of the eastern side of the atoll. This is where the main research center of the University of Belize and Coral Cay Conservation is located. However, the study area in this paper lies on the north eastern edge of the atoll approximately 1 mile from the small coral island of Dog Flea or locally named Baby Roach Cay. The study area also involves patch reefs located in the lagoon half a mile to the north west of Dog Flea Cay (See Figure 2.).

This area is well described in work by Rutzler and Macintyre (1982) who carried a detailed study of the distribution and community structure of the Barrier reef complex at Cowie Bow Cay which lies to the south of Turneffe Atoll. Turneffe Atoll is also very well described by Coral Cay Conservation (1995) in a Final report to the Darwin Initiative for the Survival of Species

1.3 Aims.

This study looks at the physical and biological structure of outer reefs and lagoonal patch reefs combined with their associated fish communities. On both types of reefs detailed topographic, bathymetric and biological data was collected. The species

composition and abundances of observed fauna were recorded during the dives using an ordinal scale. In previous studies of the fish fauna on coral reefs there has been considerable debate as to the factors affecting coral reef fish communities, Sale (1991). This study does not attempt to elucidate these factors but looks at an area of tropical marine ecology previously lacking in research. The structure of two distinct habitat types separated by the reef flat and a small geographical distance are examined in order to see if the species and family composition are determined by the different types of habitat. These two areas have undergone very little anthropogenic disturbance i.e. fishing and pollution and they have not been subjected to any sort of manipulation or disturbance in this study. Therefore this study should represent a natural and diverse sample of the coral reef fish communities. The

The aims of this study are:

1. To describe topographically and biogeographically the structure of two differing coral reef environments.
2. To examine the differences exhibited in the fish faunas of the lagoonal patch reef and those of the outer reef transects. Do patterns of abundance of local communities differ between locations separated by a reef crest.

CHAPTER TWO

2. MATERIALS AND METHODS

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2.1 MATERIALS

SCUBA GEAR:

Mask.
Snorkel.
Fins.
Knife.
Wetsuit.
Tank.
7lb weights.
1st and 2nd stage regulator.
Octopus.
Depth gauge.
Compass.
Watch.
BCD.

SUNDRY EQUIPMENT:

Waterproof Notebook.
Thermometer.
Secchi disk.
SMB (Surface Marker Buoy.)
10m rope (polypropylene).
Underwater Camera
Shaving mirror.
Zip lock bags
Field Microscope
Petri dishes

BOAT EQUIPMENT:

First aid kit.
Oxygen.
Suncream.
Fresh water.
Tool kit.
VHF Radio.
Diver down flag.
Spare fuel.
GPS unit.

RECORDING EQUIPMENT:

Boat form.
Physical forms.
Biological forms.

FIELD LITERATURE:

CORAL ID.
FISH ID.
INVERTEBRATE ID.
ALGAE ID.

2.2 METHODS.

2.2.1 Training Program.

In order to undertake this type of tropical marine ecology survey it was necessary for me to participate in an intensive seven day training programme in marine life identification and survey techniques. This programme was run by Coral Cay marine biologists with several years experience in this field. The program incorporated lectures, practical exercises, one to one tuition, video, slides and frequent testing. The course syllabus included the identification of all species of microalgae, seagrass, coral and other marine invertebrates; training in marine survey techniques as described in section 2.2.2 (assessment of biological cover abundance and topographical features);

aspects of relevant biological issues (species interactions, taxonomy, physiology) and consideration of current coastal zone management issues and practices. See outline of training schedule and certificate of completion in Appendix 1.

2.2.2 Synopsis of Baseline Survey Technique.

To describe patterns of habitat zonation the transects were orientated perpendicular to the reef crest. In Belize the reef crest runs predominately from north to south and therefore transects usually run from east to west, incorporating all major reef zones. The transects were surveyed by individual teams of four SCUBA divers. The teams were split into two pairs each of which had a specific task during the survey. The information gathered by each diver was as follows:

First Pair

Diver 1: Physical information including depths at every 10m point along the transect, substratum types and any visible human or natural impacts.

Diver 2: Fish species and relative abundance as defined by the ordinal scale in table 1 within the habitats encountered along the transect.

Second Pair

Diver 3: Hard coral species, soft coral and sponge growth forms and their relative abundance (table 1) within each habitat along each transect.

Diver 4: Algae and invertebrates within each habitat both identified to a range of taxonomic levels depending on the ease of differentiation and relative abundance.

Three members of each team carried out a biological survey which assessed the abundance of fish, scleractinia and macroalgae to species level and octocorals and porifera by life form. These divers compiled a list of the species or growth forms

present using an underwater notebook or slate and also assigned each an ordinal rating using the scale shown in table 1 below.

The ordinal scale was also applied to categorise each of five substrate classes, (live coral, dead coral, rubble, sand and silt) and each of the six principle biotic classes (scleractinia, gorgonions, porifera, other invertebrates, macroalgae and seagrass) which are used to broadly classify habitats.

In addition to the biological survey the fourth diver qualitatively describes topography and records depths to define a bathymetric profile.

TABLE 1: The original semi quantitative scale used during surveys of coral, algae and substratum cover and for fish and invertebrate relative abundance.

Rating	Meaning	Coral/substratum / Algae	Fish within 10m radius /Invertebrates in 4m radius of transect
0	None	None	0
1	Rare	Little	1-5
2	Occasional	Some	6-20
3	Frequent	Nearly Half	21-50
4	Abundant	More than Half	51-250
5	Dominant	Almost All	250 +

The distance over the duration of the transect was measured with a 10m rope which one diver in each pair held either end. Ten metre sections of the transect were surveyed on a given compass bearing at 180° to the reef crest. The transect was surveyed approximately 2m to either side of the rope thus the transects were 4m wide. This process was repeated for the entire length of the sub transect. The rope was positively buoyant to avoid damage to the benthos. When a different habitat was encountered during the transect survey, diver 1 signaled to the rest of the team to ensure that all the divers were aware that they should start compiling a separate species list and associated abundances particular to that habitat.

A surface marker buoy (SMB) was towed by diver 2, this allowed the cover boat to record the start and end points of each sub-transect using a global positioning system (GPS). At the end of the dive, diver 2 secured the SMB line to the sea bed before ascending up the line to the surface with the other divers. The transect could then be resumed from the last position at the next dive opportunity. In this study I am only using data from two outer reef transects each of which I dived on 4 times.

2.2.3 Lagoon Patch Reef Surveys.

The procedure for surveying the lagoonal patch reefs uses the same ordinal scale for the benthic and physical characteristics. However, the practices of using a transect and 10m rope are abandoned due to the complex nature of these reef systems. The 4 divers are split up into the two pairs described above, each with their own task. They swim around the perimeter and through the center of the patch reef recording the biological and physical characteristics contained within it. As the patch reefs within the lagoon were in a maximum depth of 4m it meant that a considerably longer time period could be spent by the divers on these surveys. The duration of these dives was up to an hour compared to the 17 to 40 minute dives carried out on the outer reefs. Each patch reef was completely surveyed twice to enhance the accuracy of the results.

In total over the period of 26 days I took part in 20 survey dives both on the lagoonal patch reefs and on the four outer reef transects surveyed. All the patch reefs used in this study were visited by myself a least once and many twice.

2.2.4 Data Recording Forms.

The information from the survey dives was transcribed from the underwater note books onto the recording forms. (See Appendix 2). The recording forms are subdivided into those describing the habitat or physical aspects of an area (physical & boat

form) and those describing the biological communities within each habitat (biological form).

The physical form records the location of the dive site and its main physical characteristics, it also give a bathymetric profile of a particular section of the transect. This form was completed by diver number 1 after each dive.

The boat form includes data on the GPS position of the surface marker buoy at the start and end of each dive. Information on the wind, waves, current speed and direction, water temperature and turbidity were recorded by the members of the team in the cover boat.

The biological form is essentially a “snapshot“ picture of a given habitat that quantitatively describes the biological community. This data includes a general description of the area, the nature of the substratum and biological cover, the species present and the relative abundance ratings. Divers 2, 3 & 4 completed the biological forms after each dive.

2.2.5 Habitat Classifications.

The habitat classes within the transect were selected from a classification scheme devised by Coral Cay Conservation. See habitat classifications below.

SAND BED.

Any large area with predominantly sandy substrate and little biological cover (may be corals and algae).

CORAL DROP OFF.

The seaward slope of the reef with extensive biological cover.

MATRIX DROP OFF.

The seaward slope of the reef that has large mounds of coral separated by sand channels.

SANDY DROP OFF.

The seaward slope of the reef with a predominantly sandy substratum and little biological cover.

SAND AND CORAL MATRIX.

An area which has a mixture of sand, hard and soft corals with no one dominant feature.

GORGONIAN PLAIN.

An area dominated by soft corals with little hard coral coverage.

CARBONATE PAVEMENT.

Shallow flat expanse of carbonate bedrock behind the reef crest covered with a mix of wave resistant fauna.

HARD CORAL REEF.

Any area with high and unusually diverse hard coral coverage along with numerous soft corals and sponges.

SPURS AND GROVES.

An area which has a number of sand / rubble channels (groves) alternating ridges of coral growth (spurs) orientated perpendicular to the reef crest.

SEAGRASS BED.

An area with either a mixed or monospecific (single species) seagrass coverage. Often hard and soft coral present and almost always some algae except in all but the densest beds.

PATCHES OF SEAGRASS AND SOFT SEDIMENT.

Seagrass does not spread continuously over an entire area but forms discrete patches on the sediment.

SEAGRASS BEDS WITH CORAL HEADS.

Seagrass beds with numerous or large coral heads.

PATCH REEF.

Patches of reef with a mixed biological cover within the back reef or lagoon zone. These patch reefs are found in a variety of sites.

SANDY ALGAL CANOPY.

Sandy area dominated by algae with very little or no seagrass.

MUD BED.

Any large area of mud substrate with little or no biological cover.

RUBBLE WITH ALGAE.

An area where the substratum is dominated by coral rubble with algal growth.

2.2.6 Diving Practices.

The survey diving was strictly regulated by a dive marshal in the cover boat on every dive. A dive plan and profile was specified according to the deepest part of the transect and was explained to all the divers before the dive. The dive profiles were set according to the B.S.A.C. 88 dive tables. The maximum permitted depth was 30m and all dive plans were biased on the conservative side of the maximum times at depths. No decompression diving was permitted by anyone on the expedition. Recordings of air in and air out along with the max. depth reached by each diver was used to calculate the residual nitrogen levels in the tissues and to ensure that no diver broke the dive profile. The minimum time interval between dives was 3 hours so that the tissues could sufficiently degas. Only 2 dives were carried out per day and no diving was done on Sundays to allow complete degassing. The dives were carried out in “buddy pairs” to ensure safety and every diver was equipped with an alternate air source or octopus in case of an emergency. One of the divers in the team was equipped with an SMB so that the cover boat could constantly keep close to the position of the divers. All other basic diving safety precautions were practiced. Every boat was equipped with an oxygen cylinder, vinegar (in case of jelly fish and coral stings) fresh fruit and plenty of fresh water and suncream. In the event of an emergency the boats had a VHF radio which could alert the base camp.

2.2.7 Analytical Techniques.

Raw ordinal abundance data (see Appendix 2 tables 1-3) were grouped together to give numerical abundances of the 18 most important fish groups. (See Appendix 2 table 4). This ordinal survey data was converted by taking the median numerical values of the abundance score i.e.

Score 1 meaning 1-5 median = 3
 Score 2 meaning 6-20 median = 13
 Score 3 meaning 21-50 median = 35.5
 Score 4 meaning 51-250 median = 150.5
 Score 5 meaning 250 + median = 300

The sum of each site abundance was divided by the number of fish species within that group observed. The data in Appendix 2 Table 4 was run through ANOVA against the null hypothesis which is the hypothesis of equality.

1. Fish group abundances on patch reefs vs. outer reef transect pooled data.
2. Fish group abundance of patch reefs vs. outer reef transect one vs. outer reef transect two.
3. Fish reef abundances on patch reefs vs. outer reef transect one.
4. Fish group abundances on patch reefs vs. outer reef transect two.
5. Fish group abundances on outer reef transect one vs. outer reef transect two.

The fish abundances of the 13 most important fish groups were tested for each between the three sites using one way ANOVAS.

- | | |
|------------------|-----------------|
| 1. Butterfly. | Choetodontidae. |
| 2. Angel Fish. | Pomacanthidae. |
| 3. Surgeon fish. | Acanthuridae. |
| 4. Jacks. | Carangidae. |
| 5. Snapper. | Lutjanidae. |
| 6. Grunt. | Haemulidae. |
| 7. Damsel Fish. | Pomacentridae. |
| 8. Bass. | Serranidae. |
| 9. Parrot. | Scaridae. |
| 10. Wrasse. | Labridae. |
| 11. Gobies. | Gobiids. |
| 12. Blennies. | Blennids. |
| 13. Triggerfish. | Balistidae. |

The means of the groups abundances within each area were calculated and these were used to construct Figure 4 (See the results section.).

CHAPTER THREE

3. RESULTS

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3. RESULTS

3.1 Patch Reefs:

The patch reefs were located within the lagoon at a depth of 4m on a sandy bottom. The patch reef substratum consisted of outcrops of live hard and soft corals on top of dead coral or bedrock. Surrounding the patch reefs were many small outcrops of live corals forming pillars in some cases. (Appendix 2, Figure 1)

The live Scleractinia (hard) and Octocorallia (soft) corals were very abundant and there was also a considerable amount of algal cover. The sandy bottom surrounding the patch reefs was colonised by a dense stand of turtle grass. A halo of bare sand surrounded the patch reefs.

3.1.1 Corals:

The most common corals observed on the patch reefs were Mountainous Star, Smooth Brain, Grooved Brain, Mustard Hill (Scleractinia) and Common Sea Fan, Branching Rods and Plumes, Corky Sea Finger; (Octocorrallia; See Table 2 for relative abundances and Latin names). The coral cover within the patch reefs showed a lower diversity than that shown by the Outer Reef transects 1 and 2. However the species which did occur were abundant. (See Table 2)

3.1.2 Algae:

The algal cover was not as diverse as the two outer reef transects and algae showed a different species composition on the patch reefs. The abundances for green algae was greater on the patch reefs than outer reefs but the red and brown algae were lower in abundance on the patch reefs than outer reefs.

3.1.3 Sponges and Cnidaria:

The most frequent sponges were the Encrusting, Tube, Ball and Vase sponges and these were present in high numbers. Cnidaria such as Corallimorphs and Fire Coral were abundant and anenomes were frequent. (See Table 2).

3.1.4 Fish:

The main fish groups observed on the patch reefs were the Surgeon, (Acanthuridae) Parrot, (Scaridae) Gobies, (Gobiids) Wrasse, (Labridae) and Blennies, (Blennids) (Figure 4). However I suggest that other groups such as the Snappers, (Lutjanus) Grunts, (Haemulidae) and Damselfish, (Pomacentridae) may occur in greater numbers than represented in Figure 4 especially as these species showed a shyness in the presence of divers. The observations of fish species abundances has placed the following species as most abundant on patch reefs:

Fish Species

Surgeon- Blue Tang and Ocean.

Yellow tail Snapper.

Blue striped Grunt, French Grunt.

Fairy Basslet.

Striped Parrotfish, Stoplight Parrotfish, Princess Parrotfish.

Wrasse- Yellowhead and Bluehead.

Damselfish-Dusky, Longfin, Cocoa, Beaugregory, Bicolour, Threespot, Blue Chromis.

3.2 Outer Reef Transect 1:

The depth profile of transect 1 is shown in Figure 3, this also shows the habitat types. The transect mostly comprised of shallow spurs and groves running at different angles to the reef crest which depended upon the depth. The groves were filled with a coral and sand matrix as described in the habitat classifications in the methods (2.7.1).

3.2.1 Corals:

The corals observed along the transect are listed in Table 2 along with their average abundances. However this takes no account of the position of the corals. The same is true for the Algae and other Cnidaria data in Table 2. From seaward the first 350 metres of transect 1 consisted mainly of soft corals such as the Common Sea Fan, Branching Rod, Branching Plume and Corky Sea Fingers. The hard corals occurred upon the spurs and they included Cavernous Star, Club Finger and Fungus corals. At approximately 350 metres from the seaward end of the transect there was a large ribbon coral ridge which rose to a depth of 10m. The coral composition changed to include Elliptical Star, Smooth Starlet- Rough Starlet, Leaf and Staghorn corals (See Table 2).

3.2.2 Fish:

Despite the observed coral and substrata changes, the fish species and groups remained constant along the transect. This may suggest that the most obvious and abundant fish are not greatly influenced by the coral structure of the seabed. Along the length of the transect the most common groups were the Triggerfish, (Balistidae), Surgeon, (Acanthuridae), Wrasse, (Labridae), Parrotfish, (Scaridae), and Damselfish, (Pomacentridae). The main species in the groups observed were the Surgeonfish, Black Durgon and Ocean, Wrasse, Yellowhead and Bluehead, Damselfish, Blue

Chromis and Bicolour Damselfish. The Bicolour damsel was the dominant fish species in terms of abundances (See Appendix 2 Table 2) and from the overall observational impression. The distribution of the main groups of fish in the three study areas will be discussed later.

3.3 Outer Reef Transect 2:

The profile and corresponding substratum types along the transect are shown in Figure 4, and the profile of transect 2 was similar to those of transect 1. Both had spurs and groves interspersed with a sand and coral matrix for the first 200-300 metres of the transects. Towards the reef crest much deeper spurs and groves occurred in both transects, these were separated from the spurs and groves at depth by a gorgonian plain and a ribbon coral ridge. As depth decreased towards the reef crest a larger proportion of the substrate consisted of dead coral rubble which was interspersed by outcrops of Mountainous star and Brain corals.

3.3.1 Corals:

The dominant corals were the Octocorals, Sea Rods, Sea Fans and Plumes. The Scleractinia consisted mainly of Mountainous Star, Cavernous Star and Mustard hill (See Table 2).

3.3.2 Fish:

Fish observations were very similar to those groups and species found on transect 1. However there were differences in some families abundances, such as Angel fish (Pomacanthidae). There was also fewer fish observed on transect 2. (See Raw data for transect 2 Table 3 in Appendix II).

Figure 3.

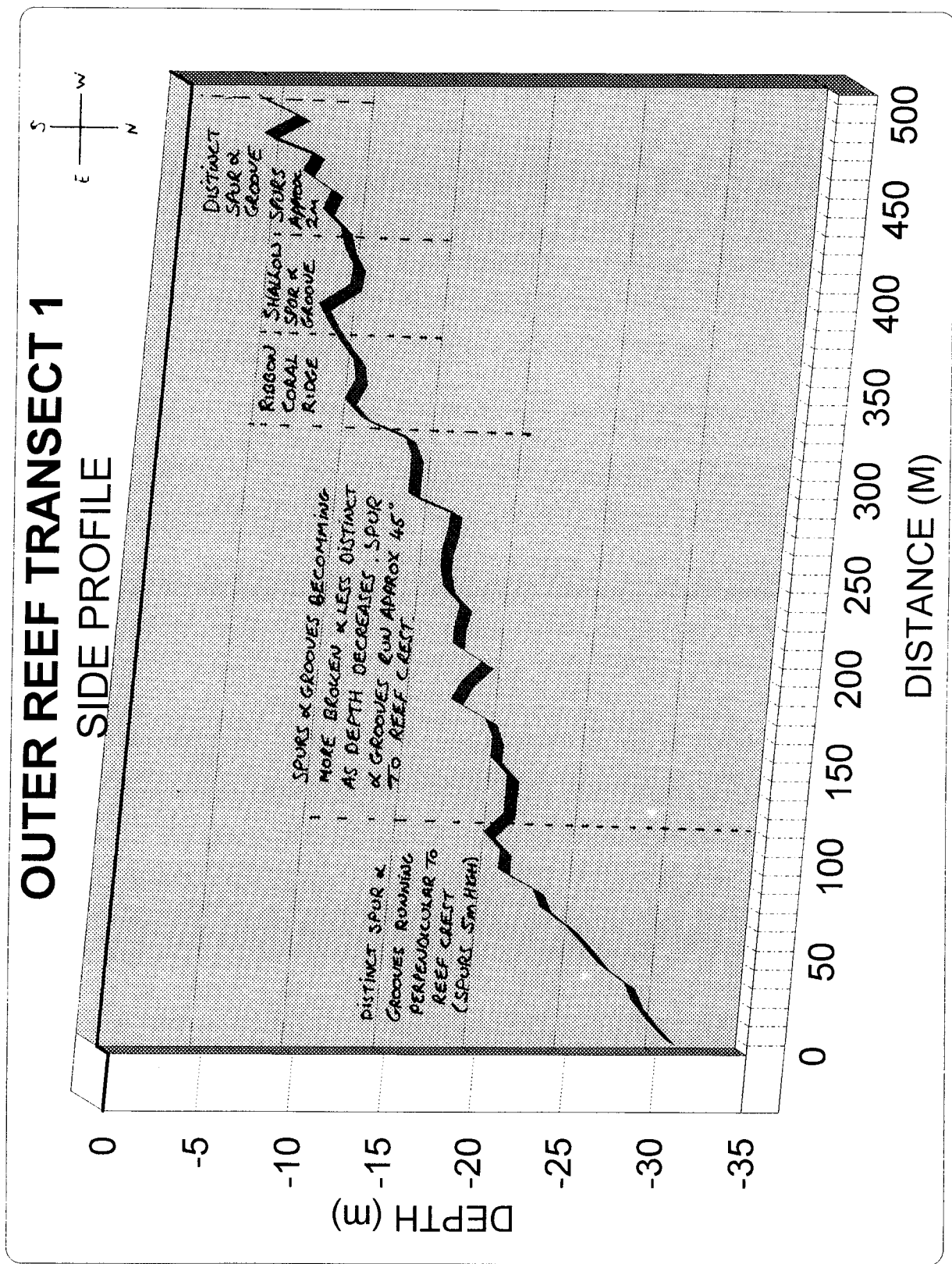
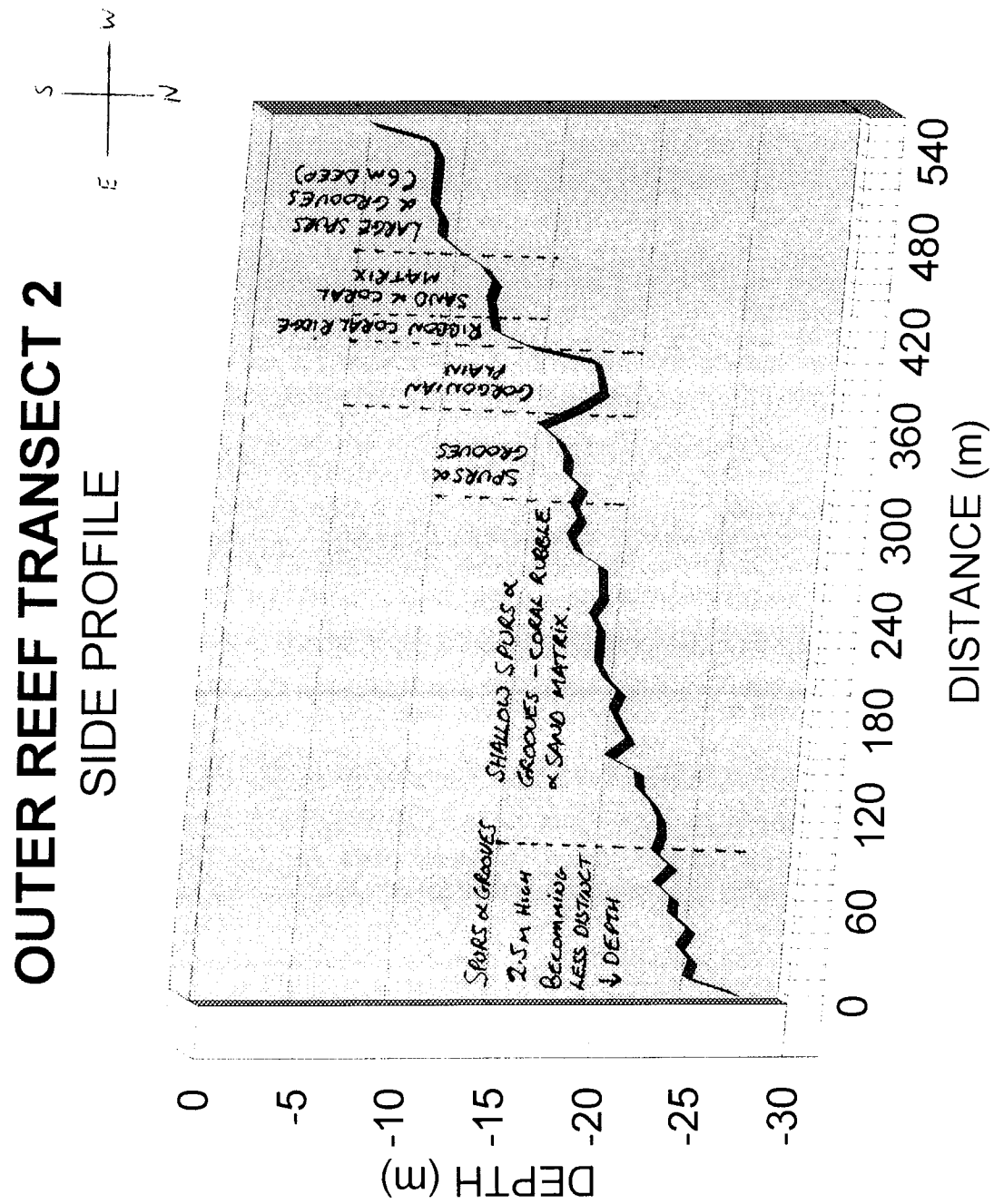


Figure 4.



3.4 Fish Group Composition of The Three Study Sites:

The composition of the 12 main fish families on the outer reef transects showed similar abundances as shown by the % compositions for each site (See Figure 5). The two most abundant groups were the Surgeon, (Acanthuridae), and the Damselfish, (Pomacentridae), followed closely by Triggerfish, (Balistidae), and Gobies (Gobiids). Many other similarities occurred between the two transects within the less abundant species such as Bass, (Serranidae), Jacks, (Carangidae), Snapper, (Lutjanidae), and Grunts, (Haemulidae). However there were clear differences in the abundances of Angelfish, (Pomacanthidae) and Blennies, (Blennids) both of which were more abundant in transect 2 in terms of % composition (See Figure 5). The patch reef composition was broadly similar to those of the outer reef transects as Surgeon fish, Gobies and Wrasse again dominated. Differences did occur between the patch reefs and the transects. Among the patch reefs the composition contained a greater proportion of Parrotfish, Grunt, Snapper and Bass than observed on the transects. Also there were very few Trigger fish and approximately half as few Damselfish observed on the patch reefs than the transects.

In summary, from observing the percentage composition from the mean abundances, the seven most characteristic groups for each area can be presented in decreasing order of importance for each study area.

PATCH REEF	TRANSECT 1	TRANSECT 2
Surgeon	Surgeon	Damselfish
Gobies	Damselfish	Surgeon
Parrotfish	Triggerfish	Triggerfish
Wrasse	Gobies	Gobies
Blennies	Wrasse	Blennies
Damselfish	Bass	Wrasse
Grunt	Blennies	Angelfish

A pattern of similarity can be seen between the patch reefs and transect 1, but not with the patch reefs and transect 2. Also transects 1 and 2 are still relatively similar to each other.

After examining the fish group abundances the coral and algae data collected were combined to find the average abundance for each life form in order to elucidate possible causes of fish group composition. The average abundance scores for the most common species of coral, algae, sponges and cnidaria are shown in Table 2. The table shows that the coral composition of the two outer reef transects were similar both in species diversity but also abundances. The coral composition of the patch reefs was less diverse than the outer reef transects but coral abundances for the species present in the patch reefs were greater. Coral species such as Golf ball and Rose coral were much more prominent on the patch reef habitats than the outer reef transects. The octocorals (soft corals) showed similar abundances on all of the study sites.

The algal composition of the two transects were similar in terms of species composition, however the algal abundance was greater on transect 1 than on transect 2 however transect 2 appeared to have a slightly greater diversity of algae when compared to transect 1.

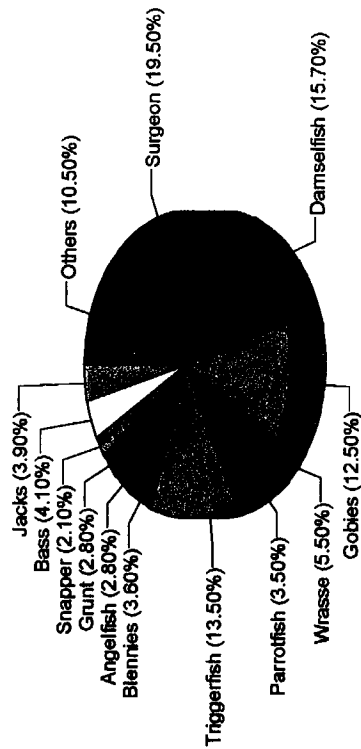
The two transects showed a different algal composition than the patch reefs. The patch reefs had a high abundance of algae but of different species. There appeared to be a larger abundance and diversity of green algae and a lower diversity of red and brown algae on the patch reefs when compared with the transects. The sponges and Cnidaria species observed were comparable, with the patch reefs showing the greatest abundances but the outer reef transects demonstrated a greater species diversity.

Figure 5

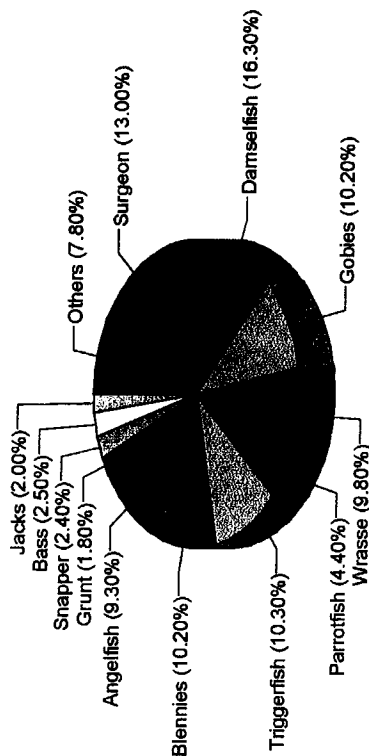
FISH GROUPS IN THE STUDY AREAS

% COMPOSITION FROM MEAN ABUNDANCES

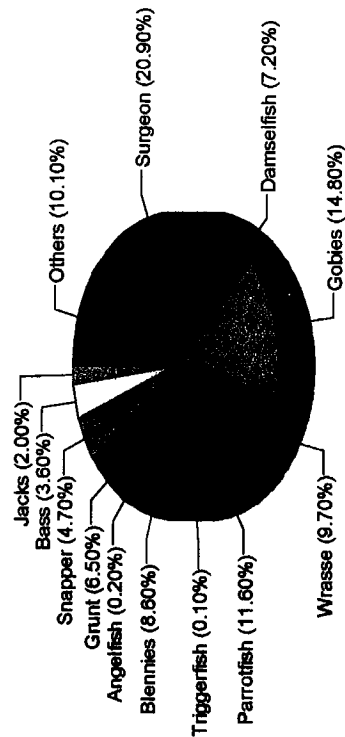
Transect 1



Transect 2



Patch Reefs



3.5 Statistical Results:

The means of the abundances of the eighteen most important groups of fish in each area were calculated and used to construct the pie charts in Figure 2. The means are shown in Table 4 in Appendix 2; these data were converted from the raw abundance scores from the patch reefs, transect 1 and transect 2.

The mean abundances of the fish groups observed on patch reefs was greater than the mean abundances on transect 1 and transect 2. Transect 2 showed the lowest mean abundance for all the main fish groups. These mean results suggest that overall fish abundances were greatest in the patch reef environments and least on the outer reef transect 2 as shown below in Table 3.

REEF	MEAN	ST. DEVIATION
Patch reef	9.45	0.98
Transect 1	8.96	1.02
Transect 2	6.50	1.07

Table 3: Abundance Means for all fish groups observed per survey in each study site.

A General Linear ANOVA was carried out on the converted abundance data in Table 4, in Appendix II. The data from the patch reef, transect 1 and transect 2 were analysed in all possible combinations. As shown in Appendix 3 no significant difference was found between the mean fish abundances on the patch reefs and the outer reef transects pooled together. No significant difference also occurred when a comparison was made between outer reef transects 1 and 2 vs. patch reefs.. However, the p value of 0.102 was nearer to the 10% rejection region of the normal distribution curve. Hence, there was no significant difference between the fish group abundances on the patch reef and the outer transect 1 & 2. The patch reef abundances vs. outer reef transect 1 also showed no significant difference. However, when the patch reef fish

abundances were compared with the outer reef transect 2 a significant difference occurred (P value 0.028).

Surprisingly no significant difference was found for the fish groups between outer reef transect 1 and outer reef transect 2. Never the less the P value for this test was $P = 0.082$ which is below the 10% probability level and can therefore be considered to be slightly significant.

ANOVAS to compare the mean fish abundances for each group between 3 reef sites gave no significant differences for :

Angelfish.
Butterfly fish.
Surgeon fish.
Jacks.
Snapper.
Damsel fish.
Bass.
Wrasse.
Gobies.
Blennies.

However, the minitab print out for test number 9 (see appendix 3) gives the test statistic F as 4.77 this is greater than the critical F value for (2, 30) degrees of freedom at $\alpha 0.05$ of $F = 3.22$. It is therefore possible to reject the null hypothesis of similarity of abundances of fish between all reefs and conclude that the means of abundance for the Parrot fish is significantly greater on the patch reefs than on the other two transects.

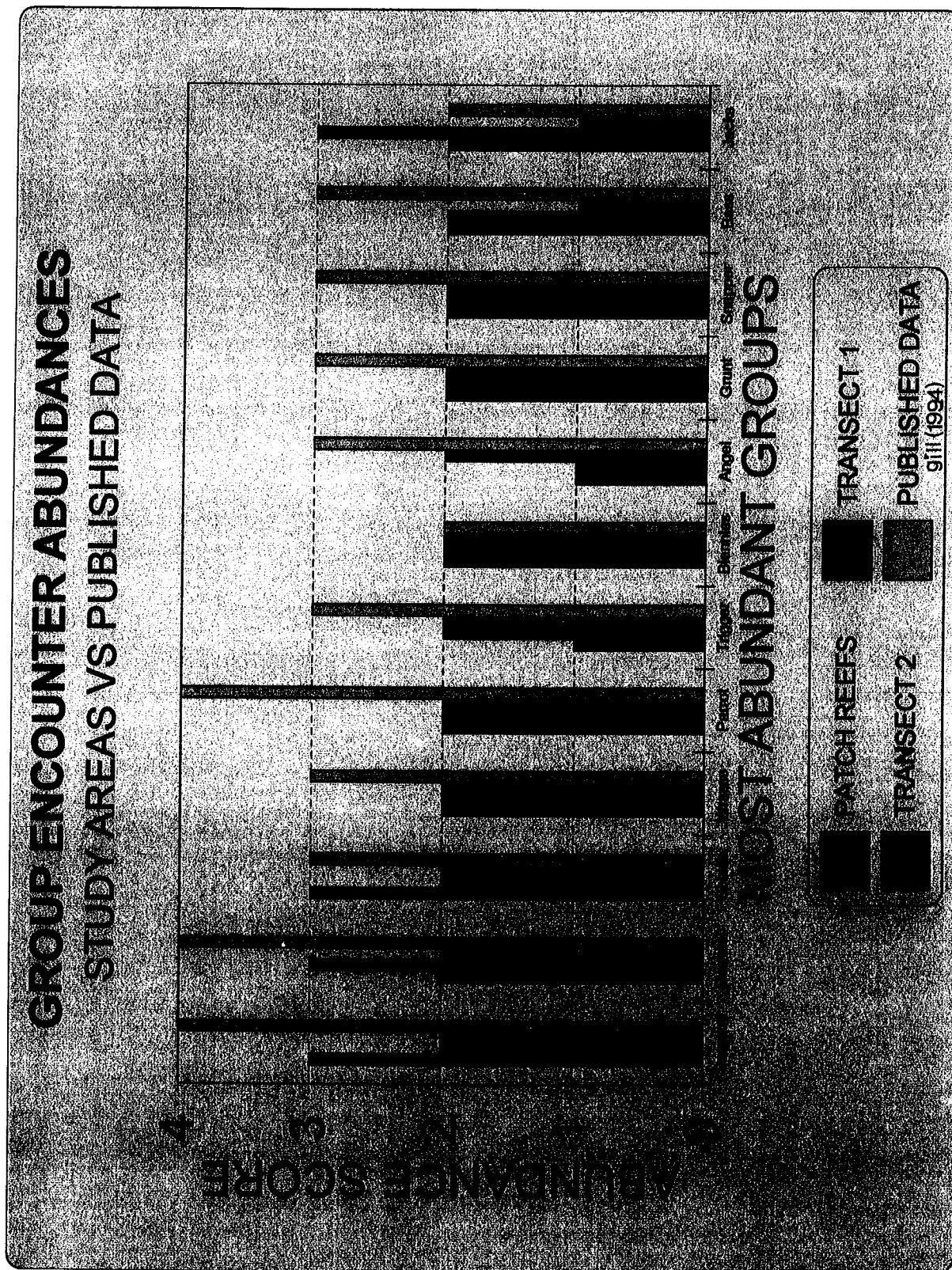
At a higher probability of 10% or $\alpha = 0.1$ the ANOVA test number 6 in Appendix 3 for Grunts gave a significant result, the critical F value at $\alpha = 0.1$ degrees of freedom (2, 30) = 2.49. The test value for F 2.84 > F critical 2.49. Therefore there was a significant difference between the mean abundances of Grunts between the patch reefs and outer reef transects.

Tests which are not significant but whose means were different between the patch reefs and outer reef transects, are ANOVA test number 5 for the Snapper fish. This gave a higher mean abundance within the patch reefs than in the outer reef transects. Also the F value is 2.42 which is only slightly less than F at $\alpha = 0.1 = 2.49$ shows that the difference was nearly significant. Two other fish groups show lower mean abundances on the patch reefs than on the outer reef transects, these were the Damsel fish ANOVA test 7 and Triggerfish ANOVA test 13. The F values for these were 2.03 and 2.04 respectively, which is close to the critical F value of 2.49 but not significant.

3.6 Comparison of Fish and Coral Abundances with Published Data:

The data of fish abundances was compared with published data Gill (1994) personal communication in Appendix IV. The average score for each fish group is compared with Gill's data in Figure 6. The data (Gill, 1994) applies to the whole of Turneffe Atoll. The data which I collected seems to slightly underestimate the abundance of fish groups. My abundance data gives the same scores for the Wrasse, Parrot, Blennies Grunt and Snapper. The comparison scores to show which groups may have been underestimated and in which study site this occurred. The two transects showed lower abundances for fish groups than the published data. Damselfish abundance on transect 2 and patch reefs was also much lower. Other groups which did not show the same results as the published data are the Parrotfish, Triggerfish and Angelfish. The data of coral abundance was also compared with published data from Fenner (1994 - personal communication). Table 2 shows that the coral abundances on patch reefs and transects 1 and 2 are comparable with the published data. However some species of coral may have been slightly underestimated, although this error may only be slight.

Figure 6



CHAPTER FOUR

4. DISCUSSION

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DISCUSSION

4.1 Algae:

The distribution and abundance of algae within the study sites provides information about the families of fish grazing the habitat. Herbivory has been suggested by Hay et al (1983), and Ogden et al, (1973) to influence plant and species composition.

The grazing effect on algae can be seen clearly by the halo of bare sand surrounding the periphery of the patch reefs. This phenomenon was first described by Randall (1965) and Hay et al. (1981a). This demonstrates the necessity for proximity of suitable shelter for herbivorous fish and is supported by these observations.

Damselfish affect the algal composition due to their territorial behaviour and energy spent protecting the algal mat cover on the substratum within their territories. Territorial grazing fish have been found to enhance the algal growth within territories by Vine, (1974). Lewis (1986) described the algae within Damselfish territories at Cowie Bow Cay, Belize as including the species of algae *Podina*, *Turbinaria*, *Sargassum*, *Laurencia*, *Coelothria*. Pomacentrids facilitate the growth of filaments and the also control the abundance and distribution of many benthic crustaceans and invertebrates. The presence of a greater abundance of Damselfish on the outer reef transects may account for the increased abundance of Red and Brown algae on the outer reef transects.

Grazing activities of fish can result in a reduction of algal biomass on the dead coral substratum and cause a shift in the epibenthic algal community structure. When this occurs there is a change from red algae to blue green algae dominating. The data in Wilkinson and Sammarco's (1983) study is consistent with this data as the patch and outer reef transects have very different algal communities. They also suggest that

increased grazing pressure will increase the nitrogen fixation in these areas by stimulating the growth of pioneer species such as blue green algae.

4.2 Corals:

Data from Cowie Bow Cay at the southern end of the Belizian Barrier Reef reveals that there are distinct communities in different habitats as reported by Lasker and Coffroth (1983). *Table 2* demonstrates that there is a difference in the coral compositions and abundances between the patch reefs and the fore reefs. Patch reefs have been shown by Lasker and Coffroth (1983) to have the lowest diversity with an average of 12 species. This is comparable with the small number of coral species observed on the patch reefs in this study. Also both this study and Lasker and Coffroth (1983) observed that colonies in the patch reef environment were large colonies with few small juvenile colonies present. This suggests that there is low recruitment of coral species on these patch reefs. The two studies also showed that there was a high abundance of gorgonians on the fore reef, both at Cowie Bow Cay and near Dog Flea Cay where gorgonian plains were found on transects 1 and 2.

There are differences between these two studies, the study at Cowie Bow Cay found Corky Sea Fingers to be very abundant in the patch reef and fore reef. Whereas the patch reefs on transects 1 and 2 at Dog Flea Cay were dominated by Mountainous Star Cavernous Star and Common Sea Fans and Plumes.

4.3 Fish:

The main fish groups involved in interactions on the reefs are the abundant groups of herbivorous fish such as Surgeon, Parrot and Damselfish (Russ, 1984). The abundance of many herbivorous fish are documented in papers by Miller (1982) and Russ (1984) which show that there exists considerable variation among reef habitats. Russ (1984)

found fish assemblages of these three families of herbivorous fish had a distinctive pattern on reef flats and over sandy areas in both lagoon and back reef environments. These authors have suggested that there is a difference in the reef fish assemblages between lagoonal or back reefs and the fore reef. This is highlighted by the Triggerfish abundances within the study sites which are consistent with their preferred deep water outer reef habitat. The majority of observations of Triggerfish were made on the outer edges of the transects near the drop off.

Surgeon fish and Parrot fish generally had a higher number of species and individuals in lagoons than on the reef slopes (Russ, 1984). The significant difference between the patch reef environment and outer reef transect combined with the significant ANOVA test on Parrot fish are consistent with this view.

Another factor which will contribute to the greater abundance of Surgeon fish and Parrot fish on the patch reefs is the distinct diurnal variations which these families undertake. This is discussed by Lewis (1986) where she describes these fish migrating during the early morning and afternoon between the fore reefs and the patch reefs. The high abundances of Parrot fish and Surgeon fish on the patch reefs can be explained in this manner.

Fewer herbivorous were observed i.e. Parrotfish, fish at greater depths along the transects on the outer reefs. An explanation for this is given by Hay et al. (1984) who states that fish grazing normally decreases with depth because the substratum is less structurally complex and this leaves herbivorous fish open to attack by predatory fish.

Lewis (1986) also found Damselfish to be more abundant on the outer reef environment than the back reef. Lewis (1986) found Acanthurids, Surgeon fish to constitute 51% and Parrot fish 26% of all individuals in the back reef environment.

These results are quite consistent with those in this study in which these two families are abundant in the patch reefs and Damselfish are abundant on the outer reef transects. The low abundance of Damselfish on the patch reefs compared to that found on the outer reefs may be due to the lack of coral rubble in the lagoonal patch reef habitats. This coral rubble is the Damselfish preferred habitat substrate where it tends to establish its algal territory. This limitation of suitable areas for their territories on the patch reef may cause the abundance difference which occurred between the two areas. Vine (1974) suggested that fish faunal diversity is reduced in areas where Damselfish (Pomacentridae) establish large territories. The data support this as there is less diversity of species observed on the two outer reef transects.

A suggestion that one of the reasons why fewer Damselfish are observed on the patch reefs is due to the shyness of the fish species mainly found there and the difficulty of surveying such a topographically complex environment. Fish such as Damselfish were observed to seek shelter on the approach of a diver, this may have led to the lower abundance of these fish on the patch reef habitats.

A possible cause of the difference in mean fish abundances on outer reef transects 1 & 2 may have been caused by the lower abundance of algae observed on transect 2. This combined with the high Damselfish abundance may have reduced the quality of foraging in this area.

Fish group abundances remained more or less constant along the transects. This statement is supported by Sale and Douglas (1984) who stated that apart from the size of reefs i.e. the patch reefs, the structural characteristics of reefs are of little use for predicting the reef fish assemblages.

Factors such as predation are important factors in determining local patterns of coexistence in reef fish communities (Caley 1995). Much discussion had taken place on the effects of predation on the juvenile mortalities and the recruitment of these juveniles to the different reef habitats. The patch reefs are a more hospitable area for juveniles to live due to the complex topographic nature of these reefs.

The higher abundance of Grunts and Snappers may be a response to the high abundance of herbivorous fishes such as Parrot fish, Surgeon fish and Butterfly fish. All observations of the reef fish suggest that a high abundance of juveniles in these patch reefs may be an added attraction to piscivorous fish such as the Snapper and the Grunt.

The lower abundances up on the outer reef of Parrotfish and other types of juvenile may be due to pressures exerted by predation and the lack of suitable shelters as stated by Hay (1984). The extent to which predation determines the fish community structure is an area where further research is necessary.

The results of this study show that the reef fish community structure is not a predictable entity and it is one which has many regulatory factors, some of which have been discussed. These findings are consistent with the Non-Equilibrium hypothesis as discussed by Sale (1991).

4.4 SUMMARY

There were distinct algal and coral habitats observed between the patch reef environment and the outer reef transects. Community structure differences were also demonstrated by Parrotfish and Grunts. The observed abundances for Damselfish and Triggerfish were lower on the patch reefs than on the outer reef transects.

Possible reasons for the significant difference of the patch reefs and transects may be because of the distinct diurnal migrations Parrotfish and Surgeonfish to the patch reefs, (See Lewis 1986).

Predation may also be a driving force in determining the composition of reef fish assemblages as suggested here and by Caley (1995).

The coral composition demonstrates little effect on the community structure in this study. This is consistent with Sale and Douglas (1984) in which it is stated that size of reefs is the only regulatory factor on reef fish assemblages.

The impact of the territorial habits of Damselfish 'gardening' mats of algae may reduce the abundance of other herbivorous fish.

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APPENDIX ONE

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CCC 7 DAY TRAINING SCHEDULE

		AM	PM	EVENING
Sun	Lecture	(Travel to Calabash)	Introduction to CCC and training week	Background to coral reefs
	Practical	(Set up tents, island intro)	Snorkel to reef crest / buoyancy tests	-
Mon	Lecture	Corals 1. Introduction to coral biology. ID of soft corals.	Corals 2. Major hard coral groups	Coral slide show
	Practical	15m dive (soft, hydro- coral ID)	Shallow dive (hard coral ID)	-
Tues	Lecture	Corals 3. Species level identification	Corals 4. Species level identification. Variation between morphotypes in different reef zones	Coral slide show
	Practical	20m dive (hard coral ID)	12m dive (general coral ID)	-
Wed	Lecture	Fish 1. Introduction to fish and how to identify them	Fish 2. Fish video	Fish slide show
	Practical	20m dive (fish ID)	Shallow dive (fish ID)	-
Thurs	Lecture	Invertebrates (note also coral shapes at depth)	Plants & algae main genera ID features	Study of algal reference collection / invertebrate & algae slide show
	Practical	25m dive (invertebrate)	15m dive / lagoon & reef crest snorkelling for algal collection	-
Fri	Lecture	Overview of survey method and beach dry-run. Completion of boat forms	Physical and biological forms. Concept of separate habitat types	Coral test
	Practical	18m practise survey dive	Coral trail test	-
Sat	Lecture	General biology recap (species/forms found at depth)	Survey and form recap	Fish test
	Practical	30m dive	Practice transect and form filling	-
Sun	Lecture	-	-	Re-tests
	Practical	-	Possible snorkel (Re-test)	-

1

Passer:	☐	Remora:	☐
English:	☐	Coatfish:	☐
Amish hogfish:	☐	Yellow:	☐
Stingray:	☐		☐

Spotted drum	☐	☐	☐	☐
EELS				
Moray eels:				
Green				
Goldentail				
Spotted				
Conger eels:				
Garden eel				
Snake eels:				

[illegible]

☐ ☒ ☐

Further species information:	
Trumpetfish/Cornetfish	☐
Pufferfish:	
Bandtail	☐
Sharpnose	☐
Spiny	☐
Triggerfish:	
Queen	☐
Black durgon	☐
Cowfish:	
Honeycomb	☐
Scrawled	☐
Trunkfish:	
Smooth	☐
Spotted	☐
Filefish:	
Scrawled	☐
White-spotted	☐

None = 0
Rare = 1
Occasional = 2
Frequent = 3
Abundant = 4
Dominant = 5

MARINE ALGAEGREEN

Filamentous - loose tufts:

Volvox polyphysoides
Enteromorpha flexuosa
Cladophora prolifera

Sheet - like:
Ulva sp.

Cup - like:
Ulva cyathiformis

Disc - like:
Acetabularia sp.

Lacy:
Anadyomene sp.

Marble - like:
Ventricaria ventricosa
Halicystis-Derbesia osterhoutii
Valonia dictyosphaeria

Brush - like:
Caulerpa cupressoides
Caulerpa paspaloides
Caulerpa prolifera
Caulerpa sp.
Chirocephalus phoenix
Penicillus capitatus
Penicillus dumetosus
Penicillus pyramiformis
Neomeris annulata

Blade - like:
Avrainvillea
Chadocephalus luteofuscus
Ulota flabellum
Ulota wilsonii
Ulota occidentalis

Calcified:
Halimeda incrassata
Halimeda opuntia
Halimeda monile
Halimeda goreaui
Halimeda copiosa
Halimeda tuna
Halimeda discoides

RED

Sheet - like:
Halymenia florescens
Agiloya or *Immuringhii*

Course branched: (eg. *Gracilaria* sp.)

Fine branched:
Liagora sp.

Calcified:
Amphiroa sp.
Encrusting
Reef cement

Filamentous:

Turf:
Wrangelia argus

BROWN

Pyramid - like:
Turbinaria sp.

Fine branched:
Dictyota sp.

Blade - like:
Stypopodium zonale
Lobophora variegata
Padina sp.

Leaf - like:
Sargassum sp.
Sargassum hystrix

BLUE - GREENMARINE PLANTS

Red mangrove
White mangrove
Black mangrove

Seagrass:
Turtle (blade - like)
Manatee (cylindrical)
Halophila decipiens (leaf - like)

SCLERACTINIA: Hard Corals

Elkhorn
Staghorn
Fused staghorn
Club finger
Finger
Green cactus

Yellow pencil

Mountainous star

Cavernous star

Rough starlet

Smooth starlet

Flower coral

Solitary disk

Encrusting

Large flower

Blushing star

Elliptical star

Golfball

Rose coral

Sheet coral

Leaf coral

Massive leaf

Ribbon

Scroil

Purple leaf

Fragile saucer

Saucer

Giant brain

Smooth brain

Grooved brain

Knobby brain

Butterprint brain

Fungus

Fat fungus

Thin fungus

Grooved fungus

Ridgeless cactus

Rough star

Sinuous cactus coral

Pillar coral

Mustard hill

Eight ray finger

OCTOCORALLIA: Soft Corals

Common sea fan
Deepwater fan
Branching: rod
plume
Red sea whip
(deep water)
Flat sea whip
(shallow water)
Corky sea finger

ANTIPATHARIA: Black Corals

Antipathes sp.
Wire

PORIFERA: SPONGES

Encrusting
Barrel
Vase
Tube
Branching
Ball
Plate
Rope
Lumpy

CNIDARIA

Corallimorphs
Hydroids
Anemones
Zoanthids (eg. *Palvthoa* sp.)
Fire coral (*Millepora*)
Jellyfish

ANNELIDA

Lugworm
Christmas tree
Feather duster
Horseshoe
Spaghetti

CRUSTACEA

Spiny lobster*
Shrimps
Arrow crab
Coral crab
Spider crab
Hermit crab

MOLLUSCS

Conch*
Bivalves
Cowrie
Topshell
Nudibranchs
Squid

ECUINODERMS

Feather stars
Sea stars
Brittle stars

Short spined sea urchin*
Long spined sea urchin*
Sea cucumbers

TUNICATESFISH

Butterfly:
Spotfin
Four-eye
Banded
Reef
Longsnout

Angelfish:
Rock beauty
Queen
French
Gray
Cherubfish

Surgeon:
Ocean
Doctor
Blue tang

Jacks:
Barjack
Horse-eye
Yellow

Porgy

Chub/Mojarra/Spautefish

Barracuda/Mackerel/Tarpon

Bonefish/Snook/Mulle/Boga

Needlefish/Bonnetmouth

Cobia/Flyingfish/Silverside

Snapper:

Schoolmaster
Mahogany
Dog
Gray
Mutton
Lane
Yellowtail
Cubera

Grunts:

Blue striped
Spanish
Smallmouth
Striped
White
Caesar

Cottonwick
French
Tomate
Sailor's choice
Margate
Black margate
Porkfish

* Include total number of species seen - left hand box

PHYSICAL RECORDING FORM

Study: _____ Transect No. _____ Zone Code: _____

Date: ____ / ____ / ____

Start Time: _____ End Time: _____

Recorder's Name: _____ Phys. _____

Depth Limits - Min: _____ m

_____ Fish _____

- Max: _____ m

_____ Coral/Sponge _____

Underwater visibility _____ m

_____ Algae/Inverts. _____

Repeat visit? _____ Y/N _____

TYPE OF SURVEY**ZONE****IMPACTS**Spot dive ☐**Barrier Reef:**Back Reef ☐**Lagoon:**Sediment ☐Transect ☐Reef Crest ☐Seagrass ☐General ☐Inner Fore ☐Patch Reef ☐Mapping ☐Outer Fore ☐Mangrove ☐Photography ☐Ridge ☐Other ☐Sounding ☐Inner Drop Off ☐Litter ☐Other ☐Outer Drop Off ☐Sewage ☐Coral Damage ☐Lobster Potting ☐Fish Traps ☐Other ☐**YOUR IMPRESSION OF THE SITE**

	AESTHETIC	BIOLOGICAL
Excellent		
V. Good		
Good		
Average		
Poor		
Other comments:		

Navigation bearing: _____ °

Depth buoy tied: _____ m

Buoy colour/I.D.: _____

SITE DESCRIPTION (Describe general location of the site, topography and main habitats - coral, sand, etc.)

General Location _____

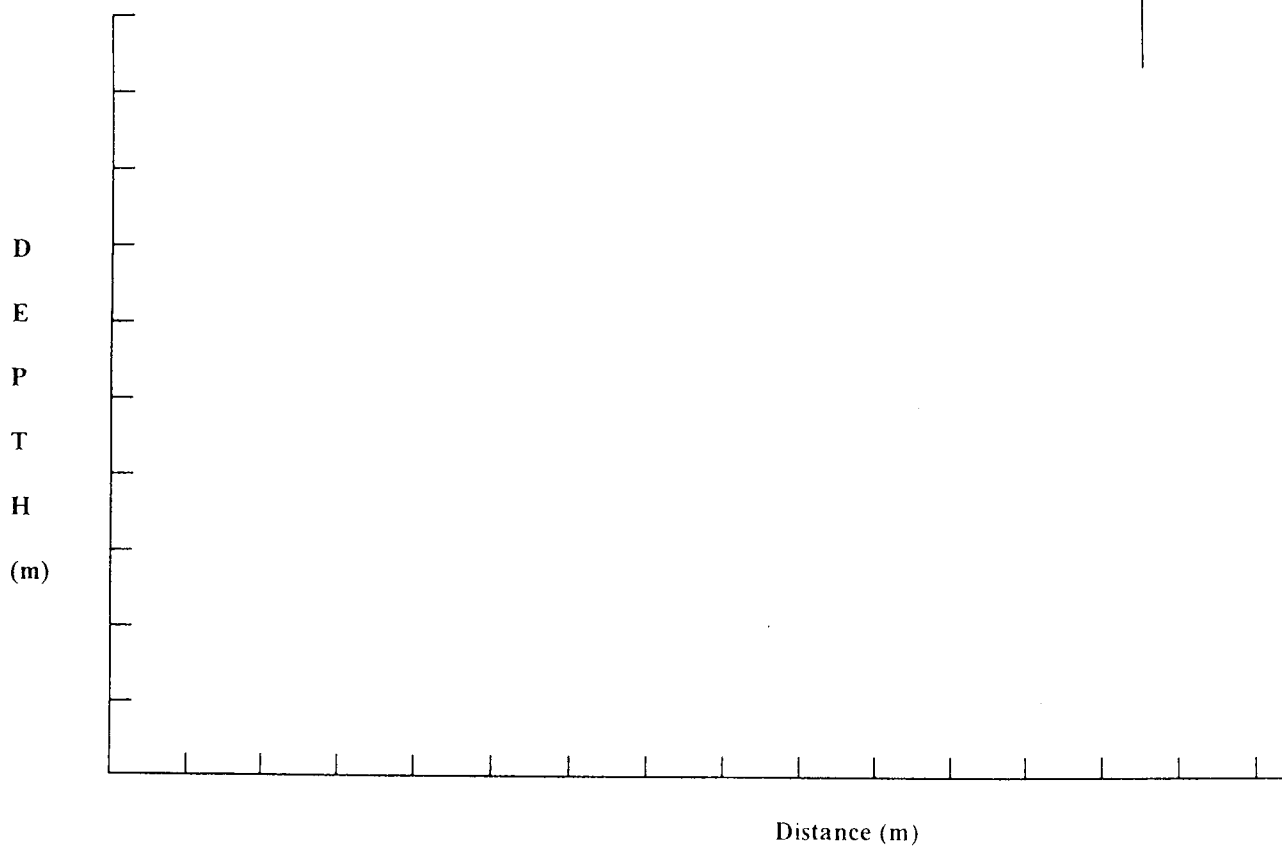
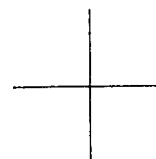
Topography _____

Main Habitats _____

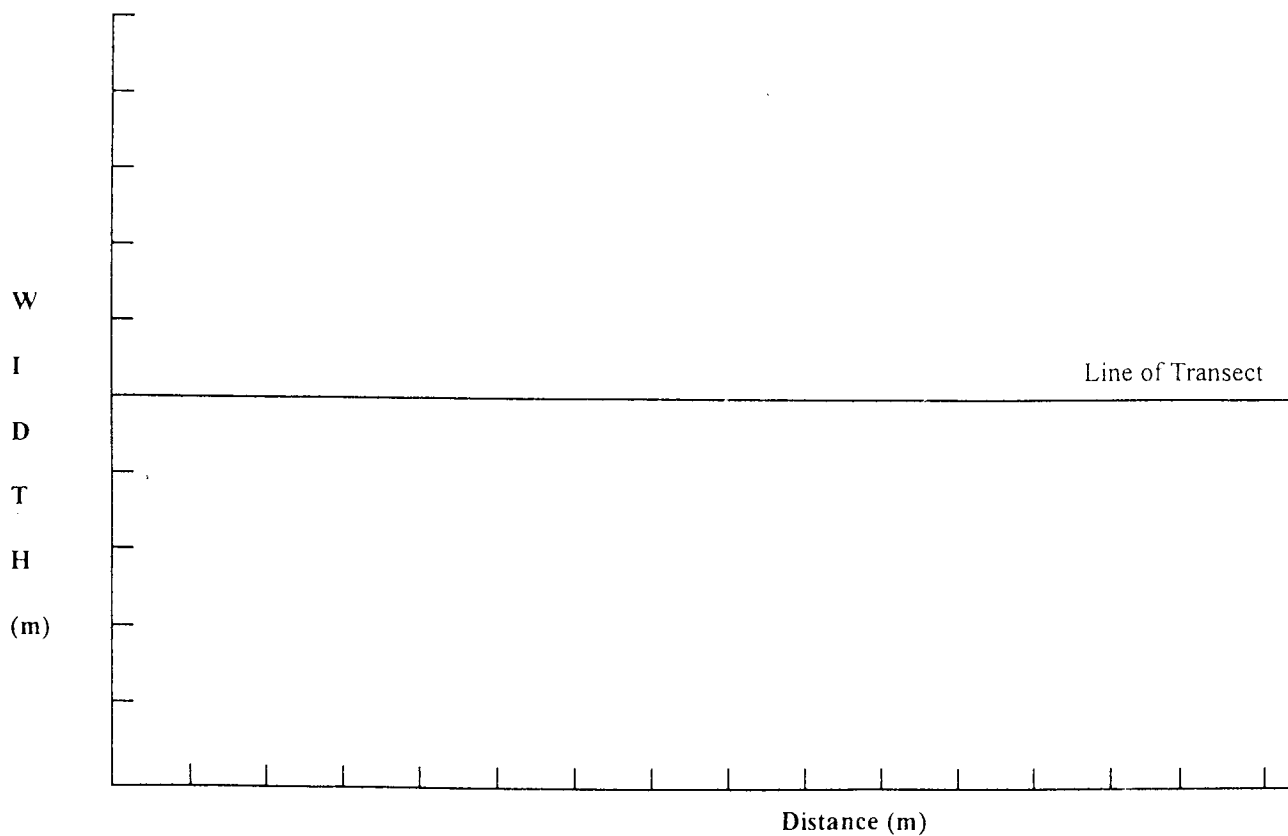
SITE PROFILE /PLAN DRAWING (Note depths, distances and habitats)

SIDE VIEW:

Orientation:



AERIAL VIEW:



BOAT RECORDING FORM

Date: _____
Site: _____
Transect No.: _____
Zone code: _____

Cox: _____
DM: _____
Buoy I.D.: _____

GPS COORDINATES
START

GPS unit: _____

	LATITUDE(N)	LONGITUDE(W)	TIME	SATS	HDOP	EST ERROR*
1.						
2.						
3.						

END

	LATITUDE(N)	LONGITUDE(W)	TIME	SATS	HDOP	EST. ERROR*
1.						
2.						
3.						

* If available

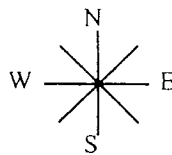
PHYSICAL PARAMETERS

Divers:

CURRENT
STRENGTH

none
weak
medium
strong

CURRENT
DIRECTION
(towards)

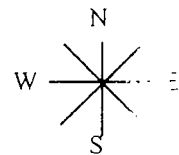


Boat:

WIND
STRENGTH
(1-12)

1 5
2 6
3 7
4 8

WIND
DIRECTION
(from)



Temperature: _____ °C Depth: _____ m Secchi disc: _____ m Surface Temperature _____ °C

SURFACE ACTIVITY

No. Boats	No. Occupants	Distance away (m)	Activity
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

SURFACE IMPACTS (please tick)

Litter ☐ Sewage ☐ Driftwood ☐ Algae ☐ Nets/pots ☐

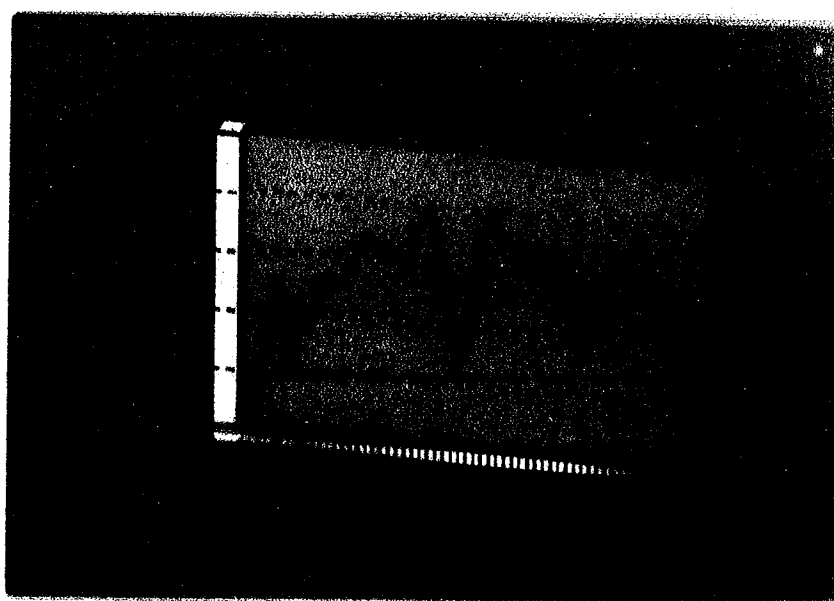
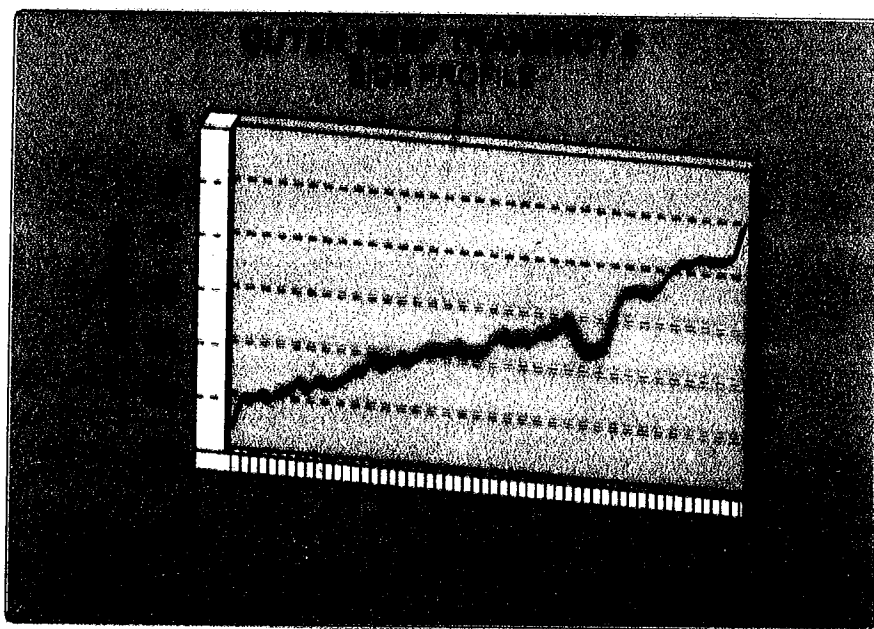
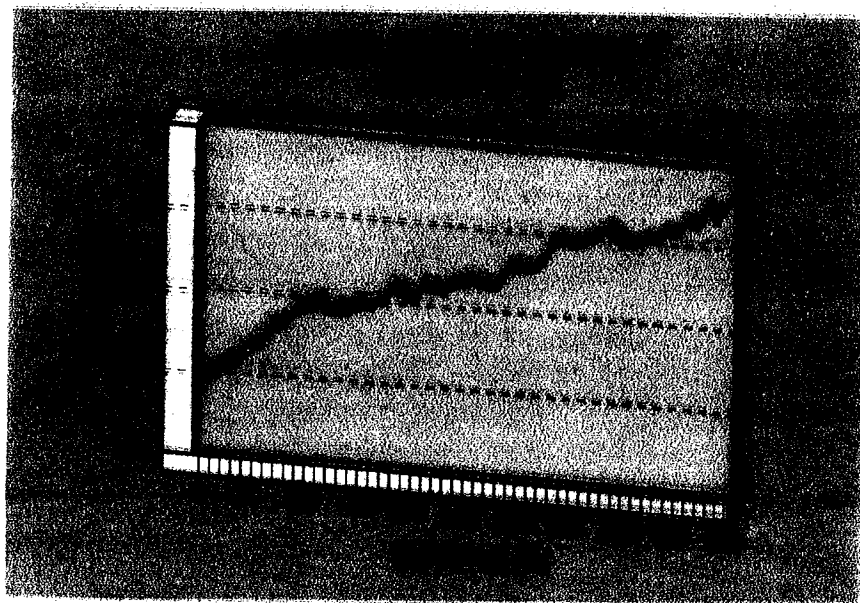
Other Impacts/Details: _____

APPENDIX TWO

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PATCH REEF RAW DATA
ABUNDANCE ON AN ORDINAL SCALE

GROUP	SPECIES	P1A	P1B	P2A	P2B	P3A	P3B	P4A	P4B	P5A	P5B	P5C	P6A
Butterfly	Spotfin	1	1	#NULL!	2	3	#NULL!	1	#NULL!	2	2	2	1
Butterfly	Foureye	2	2	2	2	3	#NULL!	3	2	2	3	2	2
Butterfly	Banded	1	1	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	1	1	#NULL!
Butterfly	Reef	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Butterfly	Longsnout	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Angel	Rock beauty	1	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	1	#NULL!	1	1	1
Angel	Queen	1	#NULL!	#NULL!	#NULL!	1	#NULL!	1	1	1	1	1	1
Angel	French	#NULL!	#NULL!	#NULL!	1	#NULL!	1	2	1	1	2	#NULL!	#NULL!
Angel	Grey	#NULL!	1	2	1	#NULL!	1	2	#NULL!	1	#NULL!	1	1
Surgeon	Ocean	2	#NULL!	3	#NULL!	#NULL!	#NULL!	#NULL!	3	2	3	2	#NULL!
Surgeon	Doctor	2	2	1	#NULL!	3	#NULL!	3	#NULL!	2	2	2	4
Surgeon	Blue Tang	2	3	3	3	2	2	4	2	4	3	2	3
Jacks	Bar Jack	2	1	#NULL!	#NULL!	#NULL!	2	2	3	#NULL!	#NULL!	2	2
Jacks	Horse-eye	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Jacks	Yellow	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	2	#NULL!	#NULL!	1	#NULL!
	Porgy	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
	Chub/Mj/Sp	#NULL!	2	#NULL!	1	1	2	3	#NULL!	2	2	#NULL!	1
	Barracuda	1	1	#NULL!	1	1	1	1	#NULL!	#NULL!	#NULL!	1	1
Snapper	Schoolmaster	2	1	#NULL!	1	#NULL!	1	3	#NULL!	#NULL!	4	1	2
Snapper	Mahogany	1	2	#NULL!	1	1	1	1	#NULL!	#NULL!	2	#NULL!	2
Snapper	Dog	1	1	#NULL!	#NULL!	2	#NULL!	#NULL!	1	#NULL!	#NULL!	1	#NULL!
Snapper	Gray	1	1	#NULL!	#NULL!	2	#NULL!	1	1	2	#NULL!	2	1
Snapper	Mutton	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	2	#NULL!	2	1	1	1
Snapper	Lane	1	1	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!
Snapper	YellowTail	1	2	3	#NULL!	3	#NULL!	4	3	2	3	1	2
Snapper	Cubera	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Grun	Blue striped	2	3	3	2	3	#NULL!	4	2	2	2	#NULL!	4
Grun	Spanish	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	#NULL!	#NULL!
Grun	Striped	2	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	2	2	#NULL!	#NULL!
Grun	White	#NULL!	1	2	1	2	#NULL!	2	#NULL!	#NULL!	2	#NULL!	3
Grun	Caesar	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	1
Grun	Cottonwick	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grun	French	2	3	3	2	3	#NULL!	3	2	3	3	3	4
Grun	Tomtate	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	5	#NULL!	#NULL!	2	#NULL!	#NULL!
Grun	Sailor's choice	2	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	1
Grun	Margate	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!
Grun	Porkfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Damselfish	Yellowtail	2	#NULL!	2	#NULL!	1	#NULL!	#NULL!	1	1	1	1	#NULL!
Damselfish	Dusky	2	1	#NULL!	1	2	1	1	2	#NULL!	2	2	2
Damselfish	Longfin	2	#NULL!	#NULL!	1	2	#NULL!	1	1	1	#NULL!	2	#NULL!
Damselfish	Cocoa	2	2	1	#NULL!	2	#NULL!	3	2	2	3	2	5
Damselfish	Beaugregory	1	1	#NULL!	1	#NULL!	1	#NULL!	2	3	3	1	3
Damselfish	Bicolor	4	3	2	1	3	#NULL!	2	2	2	1	2	3
Damselfish	Threespot	2	3	1	1	3	1	4	3	3	3	1	3
Damselfish	Sergeant Major	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Damselfish	Blue Chromis	3	1	2	#NULL!	2	1	2	2	2	#NULL!	2	2
Hamlets	Barred	1	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Hamlets	Masked	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Hamlets	Indigo	1	#NULL!	#NULL!	1	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Hamlets	Blue	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Hamlets	Golden	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!
Hamlets	Yellowbelly	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Hamlets	Shy	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Hamlets	Black	#NULL!	1	1	#NULL!	1	#NULL!	1	1	#NULL!	2	#NULL!	1
Hamlets	Butter	1	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	#NULL!	#NULL!
Grouper	Nassau	1	#NULL!	#NULL!	1	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Grouper	Red	1	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Black	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	1

PATCH REEF RAW DATA
ABUNDANCE ON AN ORDINAL SCALE

Grouper	Comb	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Grouper	Tiger	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!		#NULL!	#NULL!
Grouper	Redhind	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Rockhind	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Grasby	1	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Coney	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	1	#NULL!
Bass	Chalk	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Bass	Harlequin	1	1	1	#NULL!	2	#NULL!	2	1	#NULL!	1	1	#NULL!	#NULL!
Bass	Tabaccofish	1	#NULL!	2	#NULL!	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Bass	Fairy Basslet	2	3	3	1	2	1	4	2	3	3	1	2	
Bass	Blackcap basslet	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Bass	Lantern	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Parrotfish	Bucktooth	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Queen	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	1	1
Parrotfish	Rainbow	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Princess	2	#NULL!	#NULL!	3	4	2	2	2	#NULL!	3	2	1	
Parrotfish	Blue	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Striped	2	2	3	#NULL!	4	#NULL!	5	3	4	4	2	5	
Parrotfish	Stoplight	1	3	1	2	2	2	4	3	4	3	3	5	
Parrotfish	Redband	1	#NULL!	1	#NULL!	2	#NULL!	3	#NULL!	#NULL!	#NULL!	1	2	
Parrotfish	Yellowtail	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	1	#NULL!	1	
Parrotfish	Redtail	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	
Wrasse	Hogfish	1	1	1	#NULL!	2	#NULL!	2	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!
Wrasse	Spanish Hogfish	1	1	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Wrasse	Puddingwife	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Wrasse	Creole	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!
Wrasse	Yellowhead	#NULL!	3	#NULL!	1	4	1	4	3	#NULL!	3	2	5	
Wrasse	Slippery dick	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	3	
Wrasse	Bluehead	2	3	2	2	3	1	4	2	#NULL!	4	1	5	
Wrasse	Clown	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Cardinalfish	Belted	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Cardinalfish	Flamefish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Squirrelfish	Squirrelfish	1	1	#NULL!	#NULL!	1	1	1	1	#NULL!	2	1	1	
Squirrelfish	Longjaw	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	1	1	#NULL!	#NULL!
Squirrelfish	Longspine	2	1	#NULL!	1	3	#NULL!	2	#NULL!	#NULL!	2	1	2	
Squirrelfish	Reef	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
	Gobies	3	3	2	#NULL!	4	3	5	3	#NULL!	2	2	3	
	Blennies	3	3	#NULL!	#NULL!	#NULL!	2	4	2	#NULL!	1	2	2	
	Searobin	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
	Trumpetfish	1	1	1	1	1	1	2	#NULL!	#NULL!	1	#NULL!	1	
Pufferfish	Bandtail	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	#NULL!
Pufferfish	Sharpnose	1	2	#NULL!	1	1	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	2	
Triggerfish	Queen	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Triggerfish	Black durgon	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Cowfish	Sdcrawled	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Trunkfish	Spotted	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	
Filefish	Scrawled	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Filefish	Whitespotted	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!
	Remora	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Goatfish	Yellow	1	1	#NULL!	#NULL!	#NULL!	1	3	#NULL!	#NULL!	#NULL!	#NULL!	2	
Goatfish	Spotted	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Rays	Southern	#NULL!	#NULL!	#NULL!	1	#NULL!	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!

TRANSECT 1 RAW DATA
ABUNDANCE ON AN ORDINAL SCALE

GROUP	SPECIES	TRANSA	TRANSB	TRANSC	TRANSD	TRANSE	TRANSF	TRANSGA	TRANSGB	TRANSHA	TRANSHB	TRANSHC
Butterfly	Spotfin	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Butterfly	Fourseye	1	1	2	3	3	2	2	3	2	1	1
Butterfly	Banded	#NULL!	1	2	1	2	1	1	#NULL!	2	1	#NULL!
Butterfly	Reef	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Butterfly	Longsnout	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Angel	Rock beauty	1	1	2	2	2	1	2	2	2	2	1
Angel	Queen	#NULL!	#NULL!	#NULL!	1	#NULL!	1	1	1	2	1	1
Angel	French	#NULL!	#NULL!	#NULL!	2	#NULL!	1	#NULL!	#NULL!	1	1	1
Angel	Gray	1	#NULL!	2	2	2	1	2	1	2	2	1
Angel	Chenubfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Surgeon	Ocean	1	1	3	3	3	2	4	2	1	2	2
Surgeon	Doctor	1	#NULL!	1	3	3	3	4	2	3	2	2
Surgeon	Blue Tang	2	1	4	3	3	3	3	3	2	2	2
Jacks	Bar Jack	1	#NULL!	#NULL!	1	#NULL!	3	4	2	1	#NULL!	#NULL!
Jacks	Yellow	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	3	1	#NULL!	#NULL!	#NULL!
	Porgy	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
	Barracuda	1	#NULL!	#NULL!	#NULL!	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
	Flyngfish	#NULL!	#NULL!	2	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Snapper	Schoolmaster	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	1
Snapper	Gray	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	1
Snapper	YellowTail	2	#NULL!	#NULL!	#NULL!	3	3	2	4	2	2	#NULL!
Grun	Blue striped	2	#NULL!	#NULL!	1	1	1	#NULL!	4	2	2	2
Grun	Spanish	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grun	Smallmouth	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grun	Striped	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grun	White	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	2	2
Grun	French	2	#NULL!	#NULL!	2	3	2	3	4	2	1	2
Damselfish	Yellowtail	#NULL!	2	#NULL!	2	#NULL!	#NULL!	#NULL!	2	2	2	2
Damselfish	Dusky	#NULL!	#NULL!	2	2	#NULL!	1	#NULL!	2	2	3	3
Damselfish	Longfin	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	1
Damselfish	Cocoa	#NULL!	#NULL!	2	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	1
Damselfish	Beaugregory	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1
Damselfish	Bicolor	3	2	4	4	5	4	5	4	3	3	3
Damselfish	Threespot	#NULL!	2	#NULL!	2	2	#NULL!	3	3	#NULL!	2	1
Damselfish	Sargent Major	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	3	3
Damselfish	Blue Chromis	4	3	5	#NULL!	5	4	5	3	3	2	3
Damselfish	Brown chromis	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	2	2	1
Damselfish	Sunshinefish	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Hamlets	Barred	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Hamlets	Indigo	#NULL!	#NULL!	#NULL!	1	1	#NULL!	1	1	1	#NULL!	#NULL!
Hamlets	Shy	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Hamlets	Black	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Nassau	#NULL!	#NULL!	1	1	1	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Black	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Grouper	Tiger	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!
Grouper	Redhind	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!	#NULL!	#NULL!	1	#NULL!
Grouper	Rockhind	#NULL!	#NULL!	1	#NULL!	1	#NULL!	2	2	#NULL!	#NULL!	#NULL!
Grouper	Grasby	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	2	2	2
Grouper	Coney	#NULL!	#NULL!	2	2	2	2	1	#NULL!	2	2	2
Bass	Harlequin	1	1	#NULL!	1	3	#NULL!	1	#NULL!	#NULL!	2	1
Bass	Tabaccofish	1	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2
Bass	Fairy Basslet	3	2	4	2	4	#NULL!	2	3	#NULL!	1	1
Bass	Blackcap basslet	#NULL!	#NULL!	2	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Queen	1	#NULL!	1	1	#NULL!	#NULL!	1	2	1	1	1
Parrotfish	Rainbow	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Princess	1	3	2	1	#NULL!	1	2	3	1	2	2
Parrotfish	Blue	#NULL!	#NULL!	#NULL!	#NULL!	3	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Striped	1	2	3	#NULL!	#NULL!	3	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Midnight	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Stoplight	1	1	2	#NULL!	#NULL!	2	3	3	3	3	2
Parrotfish	Redband	1	#NULL!	#NULL!	1	3	1	#NULL!	#NULL!	1	1	#NULL!
Parrotfish	Redtail	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Wrasse	Hogfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	1	1	#NULL!
Wrasse	Spanish Hogfish	#NULL!	1	1	#NULL!	2	1	#NULL!	#NULL!	1	1	1
Wrasse	Croole	3	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Wrasse	Yellowhead	2	2	2	1	4	3	2	3	3	3	3
Wrasse	Slippery dick	#NULL!	#NULL!	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Wrasse	Bluehead	2	2	3	3	3	3	2	3	3	3	3
Wrasse	Clown	#NULL!	#NULL!	2	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Cardinalfish	Belted	1	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Cardinalfish	Flamefish	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Squirrelfish	Squirrelfish	1	1	2	1	3	1	2	2	2	1	2
Squirrelfish	Longjaw	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Squirrelfish	Longspine	1	1	#NULL!	1	#NULL!	1	#NULL!	1	1	1	#NULL!
	Gobies	1	#NULL!	3	2	3	2	1	2	2	1	2
	Blennies	1	#NULL!	#NULL!	2	2	3	2	1	2	1	2
	Jawfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
	Tilefish	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	1	#NULL!
	Trumpetfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Pufferfish	Sharpnose	1	#NULL!	1	#NULL!	#NULL!	#NULL!	1	#NULL!	1	1	1
Triggerfish	Queen	1	#NULL!	2	#NULL!	2	1	1	2	2	1	1
Triggerfish	Black durgon	2	2	2	#NULL!	3	2	2	3	2	2	5
Trunkfish	Smooth	1	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!
Trunkfish	Spotted	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Filefish	Screwfiled	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1
Filefish	whitespotted	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!

TRANSECT 2 RAW DATA
ABUNDANCE ON AN ORDINAL SCALE

GROUP	SPECIES	TRANSA	TRANSB	TRANSC	TRANSD	TRANSE	TRANSFA	TRANSFB	TRANSFC	TRANSFD	TRANSG
Butterfly	Spotfin	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2
Butterfly	Foureye	2	2	3	1	1	2	2	3	3	#NULL!
Butterfly	Banded	#NULL!	#NULL!	#NULL!	1	1	1	#NULL!	2	#NULL!	1
Butterfly	Longsnout	#NULL!	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Angel	Rock beauty	2	1	2	1	1	#NULL!	#NULL!	3	3	2
Angel	Queen	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	2	3	1
Angel	French	#NULL!	#NULL!	#NULL!	1	1	#NULL!	#NULL!	1	#NULL!	1
Angel	Grey	1	1	#NULL!	1	1	#NULL!	#NULL!	#NULL!	2	#NULL!
Surgeon	Ocean	#NULL!	2	#NULL!	1	1	2	2	3	3	#NULL!
Surgeon	Doctor	1	2	#NULL!	1	1	3	2	3	3	#NULL!
Surgeon	Blue Tang	2	1	3	1	2	2	2	3	3	3
Jacks	Bar Jack	2	#NULL!	2	#NULL!	#NULL!	2	1	1	#NULL!	#NULL!
Jacks	Yellow	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	2
	Porgy	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!
	Barracuda	1	1	1	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	2
	Flyingfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!
Snapper	Schoolmaster	#NULL!	2	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Snapper	Dog	1	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!
Snapper	Gray	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Snapper	YellowTail	2	3	2	1	#NULL!	3	2	3	3	2
Grun	Blue striped	2	#NULL!	2	1	1	#NULL!	2	2	2	2
Grun	Spanish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Grun	Striped	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grun	White	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Grun	French	1	1	2	#NULL!	2	2	2	3	2	2
Grun	Portfish	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Damselfish	Yellowtail	#NULL!	#NULL!	2	#NULL!	1	#NULL!	1	3	3	1
Damselfish	Dusky	2	2	1	1	2	1	#NULL!	3	3	1
Damselfish	Longfin	1	2	2	#NULL!	1	#NULL!	#NULL!	2	1	3
Damselfish	Cocoa	#NULL!	1	2	2	1	#NULL!	#NULL!	1	2	#NULL!
Damselfish	Beaugregory	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!
Damselfish	Bicolor	3	3	3	3	2	4	2	4	4	3
Damselfish	Threespot	1	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	3	3	2
Damselfish	Sergeant Major	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!
Damselfish	Blue Chromis	4	4	3	#NULL!	2	4	2	5	5	3
Damselfish	Brown chromis	#NULL!	#NULL!	#NULL!	#NULL!	1	1	#NULL!	2	#NULL!	#NULL!
Hamlets	Shy	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Hamlets	Black	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Nassau	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!
Grouper	Yellowfin	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Grouper	Redhind	#NULL!	1	#NULL!	1	1	#NULL!	#NULL!	1	#NULL!	#NULL!
Grouper	Rockhind	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	1	#NULL!
Grouper	Grasby	#NULL!	2	#NULL!	1	1	#NULL!	2	#NULL!	#NULL!	#NULL!
Grouper	Coney	2	#NULL!	#NULL!	1	2	#NULL!	#NULL!	3	2	2
Bass	Chalk	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Bass	Harlequin	#NULL!	1	#NULL!	2	1	#NULL!	#NULL!	#NULL!	1	#NULL!
Bass	Tabaccofish	1	#NULL!	#NULL!	1	1	1	#NULL!	#NULL!	1	#NULL!
Bass	Fairy Basslet	3	1	3	1	1	3	2	#NULL!	#NULL!	#NULL!
Bass	Blackcap basslet	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Bass	Lantern	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	1	#NULL!	#NULL!	#NULL!
Parrotfish	Queen	1	#NULL!	1	1	#NULL!	1	#NULL!	1	2	1
Parrotfish	Rainbow	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!	#NULL!	#NULL!	2
Parrotfish	Princess	3	2	2	2	2	2	#NULL!	2	2	1
Parrotfish	Striped	#NULL!	3	#NULL!	#NULL!	2	#NULL!	#NULL!	3	4	#NULL!
Parrotfish	Stoplight	#NULL!	1	2	2	1	2	2	2	3	1
Parrotfish	Redband	1	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Parrotfish	Yellowtail	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	#NULL!
Wrasse	Hogfish	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	2	#NULL!	1
Wrasse	Spanish Hogfish	1	#NULL!	#NULL!	#NULL!	#NULL!	2	#NULL!	1	#NULL!	#NULL!
Wrasse	Creole	#NULL!	4	#NULL!	#NULL!	1	#NULL!	2	3	#NULL!	#NULL!
Wrasse	Yellowhead	2	2	2	2	2	1	3	4	3	2
Wrasse	Slippery dck	#NULL!	1	#NULL!	1	1	3	#NULL!	#NULL!	3	#NULL!
Wrasse	Bluehead	2	3	2	2	2	2	3	4	#NULL!	2
Wrasse	Clown	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	#NULL!
Squirrelfish	Squirrelfish	#NULL!	1	1	1	1	2	2	#NULL!	2	1
Squirrelfish	Longjaw	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Squirrelfish	Longspine	#NULL!	1	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	2
	Gobies	2	#NULL!	#NULL!	1	2	3	1	3	2	1
	Blennies	2	#NULL!	#NULL!	1	2	2	1	3	3	1
	Jawfish	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	3	#NULL!	#NULL!	#NULL!
	Tilefish	#NULL!	1	#NULL!	1	1	#NULL!	1	#NULL!	#NULL!	#NULL!
Pufferfish	Bandtail	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!
Pufferfish	Sharpnose	#NULL!	#NULL!	#NULL!	1	#NULL!	2	#NULL!	1	1	#NULL!
Triggerfish	Queen	#NULL!	#NULL!	2	1	#NULL!	#NULL!	#NULL!	2	2	#NULL!
Triggerfish	Black durgon	2	2	3	2	1	3	2	3	3	#NULL!
Filefish	Scrawled	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	#NULL!	1	#NULL!	#NULL!

CONVERTED DATA FOR THE ABUNDANCES OF THE MOST COMMON FISH GROUPS FOR EACH STUDY AREA

PATCH REEFS												
GROUP	NUMBER	SAMPLE POINT										
		1	2	3	4	5	6	7	8	9	10	11
Butterfly	1	5.00	14.00	2.60	5.30	14.20	0.60	7.70	2.6	5.20	10.33	5.80
Angelfish	2	0.60	0.60	2.60	1.20	1.20	1.20	5.80	1.80	1.80	5.80	1.80
Surgeon	3	13.00	16.20	24.70	11.80	16.20	4.30	162.30	16.20	58.80	28.00	13.00
Jack	4	4.30	1.00	0.00	0.00	0.00	4.30	5.30	16.20	0.00	0.00	6.30
Snapper	5	3.50	4.75	4.40	0.75	11.30	0.75	25.60	5.20	5.30	25.25	3.90
Grunt	6	5.50	7.00	7.60	3.80	7.90	0.00	45.40	2.40	6.00	12.90	3.80
Damselfish	7	23.40	8.45	4.01	1.64	11.45	1.09	19.81	9.70	10.54	11.32	7.00
Hamlet	8	0.60	1.77	0.33	0.33	1.00	0.33	0.33	0.33	0.00	7.50	0.33
Grouper	9	7.22	1.77	0.33	0.33	0.66	0.66	0.66	0.00	0.00	2.11	0.33
Bass	10	3.50	6.42	8.58	0.50	7.00	0.50	27.75	3.16	5.92	6.42	2.00
Parrot	11	2.70	4.85	5.45	4.85	33.00	2.90	51.75	8.40	30.40	22.45	6.75
Wrasse	12	3.50	9.63	2.38	2.00	25.25	0.75	41.25	6.06	0.00	23.25	4.38
Cardinal	13	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squirrel	14	4.75	1.50	0.75	0.75	9.63	0.75	4.75	0.75	0.00	18.50	2.25
Gobies	15	35.00	35.00	13.00	50.00	35.00	60.00	35.00	0.00	0.00	13.00	13.00
Blennies	16	35.00	35.00	0.00	0.00	0.00	13.00	50.00	13.00	0.00	3.00	13.00
Pufferfish	17	1.50	6.50	0.00	1.50	1.50	0.00	6.50	1.50	0.00	1.50	0.00
Triggerfish	18	1.50	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00
TRANSECT 1												
GROUP	NUMBER	SAMPLE POINT										
		1	2	3	4	5	6	7	8	9	10	11
Butterfly	1	0.60	1.80	3.80	8.30	9.70	3.20	3.20	7.10	5.20	1.80	0.60
Angelfish	2	1.20	0.60	5.20	8.40	5.20	2.40	5.80	3.80	9.00	6.40	2.40
Surgeon	3	6.33	2.00	63.00	35.50	35.50	28.00	112.10	20.50	17.16	13.00	13.00
Jack	4	1.00	0.00	1.00	1.00	0.00	11.83	47.00	5.33	1.00	0.00	0.00
Snapper	5	1.65	1.63	0.00	0.00	4.44	4.44	1.63	18.81	2.40	2.40	0.75
Grunt	6	2.36	0.27	0.00	1.45	4.95	1.73	3.23	27.36	2.36	2.64	3.55
Damselfish	7	11.05	6.77	39.23	16.95	56.27	27.64	58.05	18.68	11.00	17.91	15.45
Hamlet	8	0.00	0.00	0.00	0.66	0.33	0.33	0.33	0.33	0.33	0.33	0.00
Grouper	9	0.33	0.00	2.11	2.44	2.44	2.11	2.11	1.44	3.55	3.55	2.88
Bass	10	6.90	2.67	19.75	3.16	25.66	0.00	2.66	5.92	0.00	2.66	3.16
Parrot	11	1.50	5.15	6.45	2.20	8.40	5.75	10.90	8.40	4.25	5.45	2.90
Wrasse	12	7.69	3.63	8.44	7.20	19.25	10.00	3.25	8.86	9.63	9.63	9.63
Cardinal	13	3.00	0.00	0.00	0.00	0.00	6.50	0.00	0.00	0.00	0.00	0.00
Squirrel	14	2.25	1.50	3.25	1.50	35.00	1.50	3.25	4.00	4.00	1.50	3.25
Gobies	15	3.00	0.00	35.00	13.00	13.00	13.00	3.00	13.00	13.00	3.00	13.00
Blennies	16	3.00	0.00	0.00	13.00	0.00	3.50	13.00	3.00	13.00	3.00	13.00
Pufferfish	17	3.00	0.00	3.00	0.00	24.25	0.00	3.00	0.00	3.00	3.00	3.00
Triggerfish	18	8.00	6.50	13.00	0.00	0.00	8.00	8.00	24.25	13.00	8.00	151.50
TRANSECT 2												
GROUP	NUMBER	SAMPLE POINT										
		1	2	3	4	5	6	7	8	9	10	
Butterfly	1	2.60	3.20	5.71	1.20	1.80	3.20	2.60	9.7	7.10	3.20	
Angelfish	2	2.60	1.20	2.60	3.20	1.80	0.00	0.00	10.30	84.00	3.80	
Surgeon	3	5.33	9.66	11.83	3.00	6.33	20.50	13.00	35.30	35.50	11.80	
Jack	4	4.33	0.00	4.33	0.00	0.00	4.33	1.00	1.00	4.33	4.33	
Snapper	5	2.38	6.44	1.63	0.38	0.38	4.44	1.63	4.81	4.81	1.63	
Grunt	6	1.73	1.45	2.36	0.54	1.45	1.18	2.36	4.68	2.64	2.36	
Damselfish	7	14.82	15.45	10.27	4.95	4.64	29.01	2.64	49.45	48.54	11.41	
Hamlet	8	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	
Grouper	9	2.11	2.11	0.00	1.00	2.11	0.00	1.44	8.55	1.77	1.44	
Bass	10	6.42	1.00	5.90	3.66	2.00	6.42	2.66	0.00	1.00	0.00	
Parrot	11	4.15	5.45	2.90	2.90	4.50	2.90	1.30	7.75	16.70	2.20	
Wrasse	12	3.63	19.63	3.25	3.63	4.37	8.06	10.50	44.06	13.31	3.63	
Cardinal	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Squirrel	14	0.75	1.50	0.75	0.75	1.50	3.25	3.25	0.00	3.25	4.00	
Gobies	15	13.00	0.00	0.00	3.00	13.00	35.50	3.00	35.50	13.00	3.00	
Blennies	16	13.00	0.00	0.00	3.00	13.00	13.00	3.00	35.50	35.50	3.00	
Pufferfish	17	0.00	0.00	0.00	1.50	1.50	6.50	0.00	1.50	1.50	0.00	
Triggerfish	18	6.50	6.50	24.25	8.00	1.50	17.75	6.50	24.25	24.25	0.00	

APPENDIX THREE

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General Linear Model

Factor	Levels	Values									
Group	18	1	2	3	4	5	6	7	8	9	10
		11	12	13	14	15	16	17	18		
Reef	3	1	2	3							

Analysis of Variance for Abundanc

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	17	30997.3	30997.3	1823.4	8.79	0.000
Reef	2	949.0	949.0	474.5	2.29	0.102
Error	574	119046.2	119046.2	207.4		
Total	593	150992.5				

Unusual Observations for Abundanc

Obs.	Abundanc	Fit	Stdev.Fit	Residual	St.Resid
31	162.000	29.068	2.626	132.932	9.39R
33	58.800	29.068	2.626	29.732	2.10R
36	62.000	29.068	2.626	32.932	2.33R
67	45.400	7.249	2.626	38.151	2.69R
127	51.750	11.606	2.626	40.144	2.84R
132	62.500	11.606	2.626	50.894	3.59R
144	79.430	13.465	2.626	65.965	4.66R
172	50.000	20.543	2.626	29.457	2.08R
174	60.000	20.543	2.626	39.457	2.79R
187	50.000	11.921	2.626	38.079	2.69R
241	63.000	28.576	2.643	34.424	2.43R
245	112.100	28.576	2.643	83.524	5.90R
256	47.000	4.611	2.643	42.389	2.99R
287	56.270	19.290	2.643	36.980	2.61R
289	58.050	19.290	2.643	38.760	2.74R
364	35.000	4.456	2.643	30.544	2.16R
375	113.000	20.050	2.643	92.950	6.57R
414	151.500	11.558	2.643	139.942	9.89R
433	84.000	3.730	2.662	80.270	5.67R
482	49.450	16.833	2.662	32.617	2.30R
483	48.540	16.833	2.662	31.707	2.24R
532	44.600	10.515	2.662	34.085	2.41R

R denotes an obs. with a large st. resid.

Means for Abundanc

Reef	Mean	Stdev
1	9.449	0.9799
2	8.957	1.0235
3	6.500	1.0734

General Linear Model

Factor	Levels	Values									
Group	18	1	2	3	4	5	6	7	8	9	10
		11	12	13	14	15	16	17	18		
Reef	2	1	2								

Analysis of Variance for Abundanc

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	17	30997.3	30997.3	1823.4	8.77	0.000
Reef	1	379.8	379.8	379.8	1.83	0.177
Error	575	119615.4	119615.4	208.0		
Total	593	150992.5				

Unusual Observations for Abundanc

Obs.	Abundanc	Fit	Stdev.Fit	Residual	St.Resid
31	162.000	29.068	2.630	132.932	9.37R
33	58.800	29.068	2.630	29.732	2.10R
36	62.000	29.068	2.630	32.932	2.32R
67	45.400	7.249	2.630	38.151	2.69R
127	51.750	11.606	2.630	40.144	2.83R
132	62.500	11.606	2.630	50.894	3.59R
144	79.430	13.465	2.630	65.965	4.65R
172	50.000	20.543	2.630	29.457	2.08R
174	60.000	20.543	2.630	39.457	2.78R
187	50.000	11.921	2.630	38.079	2.69R
241	63.000	27.406	2.550	35.594	2.51R
245	112.100	27.406	2.550	84.694	5.97R
256	47.000	3.441	2.550	43.559	3.07R
287	56.270	18.120	2.550	38.150	2.69R
289	58.050	18.120	2.550	39.930	2.81R
364	35.000	3.286	2.550	31.714	2.23R
375	113.000	18.880	2.550	94.120	6.63R
414	151.500	10.388	2.550	141.112	9.94R
433	84.000	5.017	2.550	78.983	5.56R
482	49.450	18.120	2.550	31.330	2.21R
483	48.540	18.120	2.550	30.420	2.14R
532	44.600	11.803	2.550	32.797	2.31R

R denotes an obs. with a large st. resid.

General Linear Model

Factor	Levels	Values									
Group	18	1	2	3	4	5	6	7	8	9	10
		11	12	13	14	15	16	17	18		
Reef	2	1	2								

Analysis of Variance for Abundanc

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	17	28747.6	28747.6	1691.0	6.73	0.000
Reef	1	25.0	25.0	25.0	0.10	0.753
Error	395	99321.9	99321.9	251.4		
Total	413	128094.5				

Unusual Observations for Abundanc

Obs.	Abundanc	Fit	Stdev.Fit	Residual	St.Resid
31	162.000	33.813	3.390	128.187	8.28R
67	45.400	8.217	3.390	37.183	2.40R
127	51.750	13.164	3.390	38.586	2.49R
132	62.500	13.164	3.390	49.336	3.18R
144	79.430	13.054	3.390	66.376	4.28R
174	60.000	23.018	3.390	36.982	2.39R
187	50.000	10.648	3.390	39.352	2.54R
240	2.000	33.321	3.405	-31.321	-2.02R
245	112.100	33.321	3.405	78.779	5.09R
256	47.000	4.520	3.405	42.480	2.74R
287	56.270	18.297	3.405	37.973	2.45R
289	58.050	18.297	3.405	39.753	2.57R
375	113.000	22.526	3.405	90.474	5.84R
414	151.500	10.319	3.405	141.181	9.12R

R denotes an obs. with a large st. resid.

General Linear Model

Factor	Levels	Values									
Group	18	1	2	3	4	5	6	7	8	9	10
		11	12	13	14	15	16	17	18		
Reef	2	1	2								

Analysis of Variance for Abundanc

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	17	19477.0	19477.0	1145.7	6.49	0.000
Reef	1	854.0	854.0	854.0	4.84	0.028
Error	377	66539.0	66539.0	176.5		
Total	395	86870.0				

Unusual Observations for Abundanc

Obs.	Abundanc	Fit	Stdev.Fit	Residual	St.Resid
19	84.000	4.532	2.925	79.468	6.13R
68	49.450	13.796	2.925	35.654	2.75R
69	48.540	13.796	2.925	34.744	2.68R
118	44.600	12.583	2.925	32.017	2.47R
211	162.000	27.625	2.897	134.375	10.36R
213	58.800	27.625	2.897	31.175	2.40R
216	62.000	27.625	2.897	34.375	2.65R
247	45.400	8.347	2.897	37.053	2.86R
307	51.750	14.375	2.897	37.375	2.88R
312	62.500	14.375	2.897	48.125	3.71R
324	79.430	15.532	2.897	63.898	4.93R
352	50.000	20.477	2.897	29.523	2.28R
354	60.000	20.477	2.897	39.523	3.05R
367	50.000	14.704	2.897	35.296	2.72R

R denotes an obs. with a large st. resid.

General Linear Model

Factor	Levels	Values									
Group	18	1	2	3	4	5	6	7	8	9	10
		11	12	13	14	15	16	17	18		
Reef	2	1	2								

Analysis of Variance for Abundanc

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Group	17	18905.5	18905.5	1112.1	5.95	0.000
Reef	1	569.2	569.2	569.2	3.05	0.082
Error	359	67096.1	67096.1	186.9		
Total	377	86570.8				

Unusual Observations for Abundanc

Obs.	Abundanc	Fit	Stdev.Fit	Residual	St.Resid
25	63.000	24.891	3.058	38.109	2.86R
29	112.100	24.891	3.058	87.209	6.54R
40	47.000	5.542	3.058	41.458	3.11R
71	56.270	23.560	3.058	32.710	2.45R
73	58.050	23.560	3.058	34.490	2.59R
148	35.000	4.980	3.058	30.020	2.25R
159	113.000	17.408	3.058	95.592	7.17R
198	151.500	18.301	3.058	133.199	10.00R
217	84.000	6.299	3.073	77.701	5.83R
266	49.450	21.103	3.073	28.347	2.13R
267	48.540	21.103	3.073	27.437	2.06R
316	44.600	8.800	3.073	35.800	2.69R
356	35.500	7.451	3.073	28.049	2.11R
357	35.500	7.451	3.073	28.049	2.11R

R denotes an obs. with a large st. resid.

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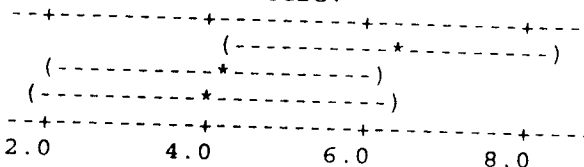
One-Way Analysis of Variance 1. Butterfly.

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	40.5	20.2	1.63	0.213
Error	30	373.0	12.4		
Total	32	413.5			

Level	N	Mean	StDev
C14	12	6.378	4.405
C15	11	4.118	3.098
C16	10	4.031	2.657

Individual 95% CIs For Mean
Based on Pooled StDev



Pooled StDev = 3.526

MTB > AOVOneway C17 C18 C19.

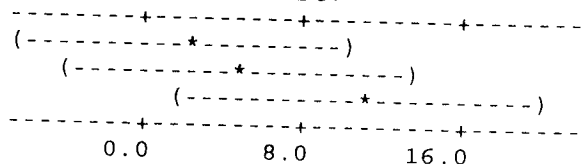
One-Way Analysis of Variance 2. Angel Fish.

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	438	219	1.07	0.355
Error	30	6118	204		
Total	32	6556			

Level	N	Mean	StDev
C17	12	2.18	1.78
C18	11	4.58	2.78
C19	10	10.95	25.83

Individual 95% CIs For Mean
Based on Pooled StDev



Pooled StDev = 14.28

MTB > AOVOneway C14 C15 C16.

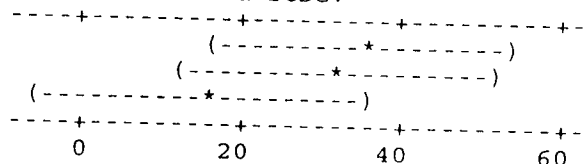
One-Way Analysis of Variance 3. Surgeon fish.

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	2447	1224	1.13	0.335
Error	30	32353	1078		
Total	32	34800			

Level	N	Mean	StDev
C14	12	35.52	43.78
C15	11	31.46	31.70
C16	10	15.20	11.64

Individual 95% CIs For Mean
Based on Pooled StDev



Pooled StDev = 32.84

MTB > AOVOneway C14 C15 C16.

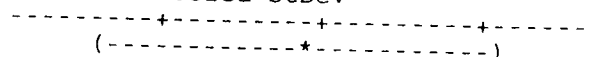
One-Way Analysis of Variance 4. Jacks

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	83.0	41.5	0.56	0.579
Error	30	2240.6	74.7		
Total	32	2323.6			

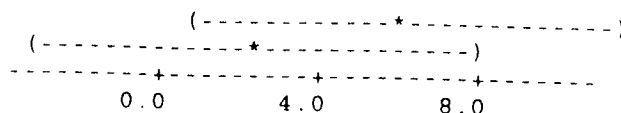
Level	N	Mean	StDev
C14	12	3.475	4.688

Individual 95% CIs For Mean
Based on Pooled StDev



C15	11	6.196	13.996
C16	10	2.365	2.103

Pooled StDev = 8.642
MTB > AOVOneway C14 C15 C16.



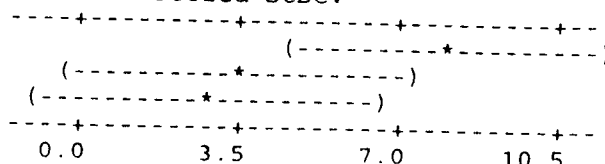
One-Way Analysis of Variance 5. Snapper

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	2	181.6	90.8	2.42	0.106
Error	30	1125.8	37.5		
Total	32	1307.4			

Level	N	Mean	StDev
C14	12	8.025	8.554
C15	11	3.468	5.301
C16	10	2.853	2.108

Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 6.126
MTB > AOVOneway C14 C15 C16.

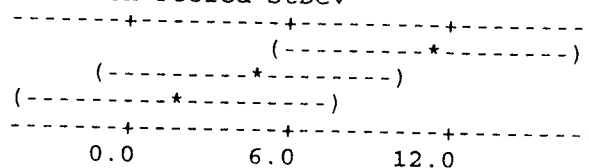
One-Way Analysis of Variance 6. Grunt

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	489.8	244.9	2.84	0.074
Error	30	2585.2	86.2		
Total	32	3075.0			

Level	N	Mean	StDev
C14	12	11.117	13.423
C15	11	4.561	7.694
C16	10	2.075	1.126

Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 9.283
MTB > AOVOneway C14 C15 C16.

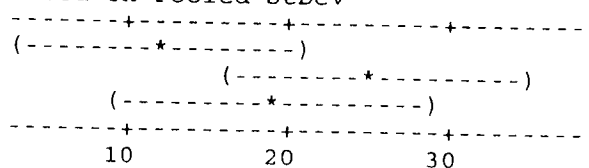
One-Way Analysis of Variance 7. Damsel Fish

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	980	490	2.03	0.149
Error	30	7254	242		
Total	32	8235			

Level	N	Mean	StDev
C14	12	12.31	10.75
C15	11	25.36	18.02
C16	10	19.12	17.43

Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 15.55
MTB > AOVOneway C14 C15 C16.

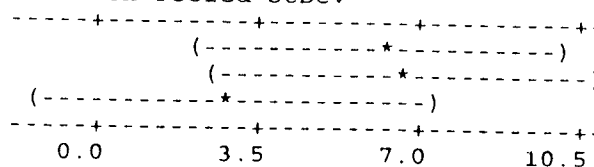
One-Way Analysis of Variance 8. Bass

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	84.6	42.3	0.95	0.399
Error	30	1339.6	44.7		
Total	32	1424.2			

Level	N	Mean	StDev
C14	12	6.159	7.301
C15	11	6.595	8.331
C16	10	2.906	2.566

Individual 95% CIs For Mean Based on Pooled StDev



Pooled StDev = 6.682
MTB > AOVOneway C14 C15 C16.

One-Way Analysis of Variance 9. Parrot

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	1569	785	4.77	0.016
Error	30	4931	164		
Total	32	6500			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	
C14	12	19.67	20.60	(-----*-----)
C15	11	5.58	2.87	(-----*-----)
C16	10	5.08	4.48	(-----*-----)

Pooled StDev = 12.82
MTB > AOVOneway C14 C15 C16.

One-Way Analysis of Variance 10.Wrasse

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	347	173	0.67	0.519
Error	30	7757	259		
Total	32	8104			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	
C14	12	16.47	23.55	(-----*-----)
C15	11	8.84	4.17	(-----*-----)
C16	10	11.46	12.83	(-----*-----)

Pooled StDev = 16.08
MTB > AOVOneway C14 C15 C16.

One-Way Analysis of Variance 11.Gobies

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	968	484	0.90	0.417
Error	30	16100	537		
Total	32	17068			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	
C14	12	25.17	19.25	(-----*-----)
C15	11	20.18	32.23	(-----*-----)
C16	10	11.90	13.49	(-----*-----)

Pooled StDev = 23.17
MTB > AOVOneway C14 C15 C16.

One-Way Analysis of Variance 12.Blennies.

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	452	226	1.34	0.277
Error	30	5058	169		
Total	32	5510			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	
C14	12	14.58	16.74	(-----*-----)
C15	11	5.86	5.81	(-----*-----)
C16	10	11.90	13.49	(-----*-----)

Pooled StDev = 12.99
MTB >

One-Way Analysis of Variance 13. Triggerrisen

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	2	2689	1344	2.04	0.148
Error	30	19777	659		
Total	32	22466			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	
C14	12	0.25	0.58	(-----+-----+-----+-----)
C15	11	21.84	43.51	(-----*-----)
C16	10	11.95	9.69	(-----*-----)
Pooled StDev = 25.68				(-----+-----+-----+-----)
MTB >				0 15 30

APPENDIX FOUR

CONTENTS

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1. FISH SPECIES AND RELATIVE ABUNDANCE FOR TURNEFFE ATOLL BY ANDREW GILL	i
2. CORAL SPECIES OF TURNEFFE ATOLL BY DOUG FENNER	iv

Please refer to note at head of coral species list. In addition the fish species list gives some values which appear high, however, these values have been derived from the encounter abundance of these species in the particular zone/habitat which they are known to inhabitat.

Fish Species and Relative Abundance for Turneffe Atoll by Andrew Gill

<u>Species</u>	<u>Encounter Abundance</u>	<u>Species</u>	<u>Enc. Abundance</u>
spotfin butterfly	3	yellowtail snapper	5
foureye butterfly	4	bluestriped grunt	5
banded butterfly	3	spanish grunt	2
longsnout butterfly	2	smallmouth "	2
reef butterfly	2	striped "	2
rock beauty	3	white "	5
queen angelfish	3	caesar "	2
french "	3	cottonwick "	?
grey "	4	french "	5
cherubfish	1	tomtate	2
ocean surgeonfish	2	sailors choice	3
doctorfish	5	margate	2
blue tang	5	black margate	2
barjack	5	porkfish	3
yellow jack	2	yellowtail damselfish	4
horse-eye "	3	dusky "	5
crevalle "	1	longfin "	4
black "	1	cocoa "	2
rainbow runner	1	beaugregory	4
palometa	2	bicolor	5
saucereye porgy	4	threespot	5
jolthead	2	sergeant major	3
bermuda chub	3	night sergeant	1
yellowfin mojarra	4	blue chromis	5
atlantic spadefish	2	brown chromis	2
great barracuda	4	sunshinefish	3
cero	2	barred hamlet	2
tarpon	2	butter "	2
bonefish	2	masked	?
snook	1	black	4
needlefish	4	indigo	2
boga	2	yellowbelly	1
bonnetmouth	2	shy	3
flying fish	3	jewfish	1
silversides	4	nassau grouper	4
schoolmaster	3	red grouper	?
mahogany snapper	3	yellowfin grouper	2
dog snapper	3	black grouper	3
grey snapper	2	comb grouper	2
mutton snapper	2	tiger grouper	3
lane snapper	2	dusky squirrel fish	2

marbled grouper	2	blackbar soldierfish	2
red hind	3	glass-eye snapper	1
rock hind	3	barsnout goby	3
graysby	4	cleaning goby	2
coney	4	shark-nose goby	2
chalk bass	3	broad-stripe goby	2
harlequin bass	4	neon goby	5
tobaccofish	3	orange-sided goby	1
peppermint bass	2	goldspot goby	3
lantern bass	3	colon goby	2
mutton hamlet	1	pallid goby	3
fairy basslet	4	bridled goby	3
blackcap basslet	4	masked goby	4
queen parrotfish	3	peppermint goby	3
rainbow parrot	1	diamond blenny	2
princess parrot	3	saddled blenny	2
blue parrot	2	rosy blenny	2
striped parrot	5	spiny-head blenny	2
midnight parrot	2	arrow blenny	4
stoplight parrot	5	blackedge triplefin	1
redband parrot	5	yellowhead jawfish	4
yellowtail parrot	4	dusky jawfish	1
redtail parrot	4	short-nose batfish	2
green blotch parrot	4	peacock flounder	2
bucktooth parrot	4	spotted scorpionfish	2
hogfish	3	splendid toadfish	2
spanish hogfish	3	red-spotted hawkfish	2
spotfin hogfish	1	bluestriped lizardfish	3
creole wrasse	5	sand diver	2
yellowhead wrasse	5	trumpetfish	4
slippery dick	3	sand tilefish	4
yellowcheek wrasse	1	bandtail puffer	2
bluehead wrasse	5	sharpnose puffer	4
clown wrasse	2	chequered puffer	1
rosy razorfish	2	web birrfish	2
green razorfish	2	bridled birrfish	2
belted cardinalfish	2	balloonfish	2
barred cardinalfish	2	porcupinefish	2
flame fish	2	honeycomb cowfish	2
squirrelfish	5	scroll cowfish	2
longjaw squirrelfish	5	smooth trunkfish	2
longspine squirrelfish	3	spotted trunkfish	2
buffalo trunkfish	2	queen triggerfish	3
ocean triggerfish	2	black durgon	3
scrawled filefish	2	orange-spotted filefish	2
white-spotted filefish	2	slender filefish	2
shark sucker	2	yellow goatfish	3
spotted goatfish	3	spotted drum	3
reef croaker	2	greater soapfish	1

short-fin pikefish	1
spotted moray	2
garden eel	3
southern stingray	3
spotted eagleray	3
ballyhoo	2
spotfin mojarra	3

green moray	3
goldentail moray	?
nurse shark	3
yellow stingray	2
atlantic manta	1
cubera snapper	2

Note: the following species lists have abundance values associated with them. These values reflect comparisons made on interspecies abundances not the abundance within the habitat. The values give an indication of the likelihood of encountering these species on a dive/survey (1=rare; 5=dominant).

Coral species of Turneffe Atoll by Doug Fenner- (preliminary)

<u>Species</u>	<u>Encounter Abundance</u>
Stephanocoenia michelini	3
Acropora palmata	3
cervicornis	3
prolifera	1
Siderastrea siderea	4
radians	2
Diploria strigosa	3
clivosa	2
labyrinthiformis	3
Colpophyllia natans (=brevi)	3
Porites porites	3
furcata	3
divaricata	1
astreoides	3
colonensis	1 (new to Belize)
Montastrea annularis barrel	3 (together:4)
lobed	3
lumpy	1
M. cavernosa	4
Manicina areolata forma areolata	2
mayori	1
Agaricia tenuifolia	3
agaricites forma agaricites	4
purpurea	2
carinata	2
danai	2
fragilis	1
lamarcki	3
undata	2 (new to Belize)
humilis	2
Leptoseris cuculata	3
Madracis mirabilis	3
decactis f. decactis	1
(new to Belize) luciphila (=Madracis pharensis f.luciphila)	1
pharensis (=Madracis pharensis f. phar.)	1
formosa	2 (new to Belize)
Favia fragum	3
Isophyllia sinuosa	3
Isophylastrea rigida	2
Dichocoenia stokesi	3

Mycetophyllia lamarcki	3
dananna	3
alicia	2
ferox	2
reesi	2-3
Dendrogyra cylindrus	2
Eusmilia fastigiata	2
Mussa angulosa f. angulosa	1
lacera (=Scolymia lacera)	1
Mussa cubensis (=Scolymia cubensis)	1
Meadrina meandrites	3
Thalamophyllia riisei (?)	1 (new to Belize)
Millepora alcicornis	3
complanata	3
striata (?)	1 (new to Belize)
Stylaster roseus	1

Antipatharia and sponges of Turneffe Atoll by Doug Fenner

Antipatharia:

Cirrhipathes leutkeni
 Anipathes lenta
 Antipathes atlantica
 scraggly black coral
 bushy black coral

Sponges:

Cliona langae	3
Cliona deletrix	3
Xestospongia muta	4
Callyspongia vaginalis	3
Callyspongia plicifera	3
Aplysina lacunosa	3
Aplysina cauliformis	2
Aplysina fulva	1
Aplysina archeri	1
Iotrochota birotulata	4
Chondrilla nucula	2
Mycale laxissima	4
Mycale laevis	2
Ectoplasia ferox	4
Ircinia strobilina	3
Ircinia felix	2
Ircinia campana	1
Pseudoceratina crassa	2
Niphates digitalis	4
Niphates erecta	3
Cinachyrella sp.	2
Anthosigmella varians	3

Agelas conifera	3
Agelas clathrodes	3
Agelas screptum	2
Calyx podatypa	3
Verongula gigantea	1
Verongula rigida	3
Monachora barbadensis	1
Cribochalina vasculum	2
Neofibularia nolitangere	2
Amphimedon compressa	2
Amphimedon erina	1
Oceanapia bartschi	1
Rahpidopholous juniperi	1
Ptilosarcus sp	1
Clathria sp	1
Leucetta barbata	1
Siphonodyctyon coraliphagum	1
Ulosa ruetzleri	2
Plakortis halichondroides	1
Spirastrella coccinea	1
Pseudoaxinella lunaecharta	1
Tethya crypta	1

APPENDIX FIVE

COMMON NAMES AND LATIN NAMES FOR ALL SPECIES IN THE STUDY

CONTENTS

PAGE

1. HARD AND SORT CORALS

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2. FISH

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4. DOLPHINS

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ENGLISH

HARD CORALS

Elkhorn
Staghorn
Fused Staghorn
Club Finger
Finger
Green Cactus
Yellow Pencil
Mountainous Star
Cavernous Star
Rough Starlet
Smooth Starlet
Flower Coral
Solitary Disk
Large Flower
Blushing Star
Elliptical Star
Golfball
Rose Coral
Leaf Coral
Ribbon
Scroll
Purple Leaf
Fragile Saucer
Saucer
Giant Brain
Smooth
Grooved
Knobby
Butterprint
Fungus
Fat Fungus
Thin Finger
Grooved Finger
Ridgeless Finger
Rough Star
Sinuous Cactus Coral
Pillar Coral
Mustard Hill
Eight Ray Finger
SOFT CORALS
Common Sea Fan
Deepwater Fan

LATIN

SCLERACTINIA

Acropora polmata
Acropora ceruicornis
Acropora prolifera
Porites porites forma porites
Porites porites
Madracis decactis
Madracis mirabilis
Montastraea annularis
Montastraea cavernosa
Siderostrea rodions
Siderostrea siderea
Eusmilia fastigiata
Scolymia wellsi
Mussa anguasa
Stephanocaonia mechalinii
Dichocoenia stakesii
Favia frogum
Manicina aneolota
Agaricia agaricites
Agaricia tenuifolia
Agaricia undata
Agaricia purpurea
Agaricia fragilis
Leptoseris cucullata
Colpophyllia natans
Diplora strigosa
Diplonia labyrinthiformis
Diplonia aliciae
Meandrina meandrites
Mycetophyllia lamarckiana
Mycetophyllia danaana
Mycetophyllia aliciae
Mycetophyllia ferox
Mycetophyllia reesi
Isophyllastrea rigida
Isophyllastrea sinuosa
Dendragipra cylindrus
Porites astreoides
Madracis formosa
OCTOCORALLIA
Gorgonia ventalina
Iciligorgia schramme

FISH

BUTTERFLY

Spotfin
Foureyeye
Banded
Reef
Longsnout

ANGELFISH

Rock Beauty
Queen
French
Gray
Cherubfish

SURGEONFISH

Ocean
Doctor
Blue Tang

JACKS

Barjack
Horse-eye
Yellow

PORGY

CHUB/MOJARRA/SPADEFISH

BARRACUDA/MACKEREL

BONEFISH/SNOOK/MULLET

COBIA/FLYFISH/SILVERSIDE

SNAPPER

Schoolmaster
Mahogany
Dog
Gray
Mutton
Lane
Yellowtail
Cubera

CHAETONDONTIDAE

Chaetodon ocellatus
Chaetodon capistratus
Chaetodon striatus
Chaetodon sedentarius
Chaetodon aculeatus

POMACANTHIDAE

Holacanthus tricolor
Holacanthus Ciliaris
Pomacanthus pari
Pomacanthus arcuatus
Centropyge argi

ACANTHURIDAE

Acanthurus bahianus
Acanthurus chirurgus
Acanthurus coeruleus

CARANGIDAE

Caranx ruber
Caranx lotus
Caranx bartholamaei

SPARIDAE sp

GERREIDAE sp

SPHYRACNIDAE sp

PLAYBELORE sp

SPECULIGER sp

LUTJANIDAE

Lutjanus apodus
Lutjanus mahogoni
Lutjanus jocu
Lutjanus griseus
Lutjanus analis
Lutjanus synognis
Ocyurus chrysurus
Lutjanus cyanopterus

GRUNTS

Blue Striped
Spanish
Smallmouth
Striped
White
Caeser
Cottonwick
French
Tomtate
Sailor's Choice
Margate
Balck Margate
Porkfish

DAMSELFISH

Yellowtail
Dusky
Longfin
Cocoa
Beaugregory
Bicolor
Threespot
Sergeant Major
Night Sergeant
Blue Chromis
Brown Chromis
Sunshinefish

HAMLETS

Barred
Masked
Indigo
Blue
Golden
Yellowbelly
Shy
Black

GROUPE

Jewish
Nassau
Red
Black
Yellowfin
Comb
Tiger
Marbled

HAEMULDIAE

Haemulon sciurus
Haemulon macrastomum
Haemulon chrysargyreum
Haemulon striatum
Haemulon Plumiera
Haemulon carbonarium
Haemulon melanurum
Haemulon flavolineatum
Haemulon aurolineatum
Haemulon para
Haemulon album
Anisotremus surinamensis
Anisotremus virginicus

POMACENTRIDAE

Microspathodon chrysurus
Stegastes fuscus
Stegastes dieneaeus
Stegastes variabilis
Stegastes leucastictus
Stegastes partitus
Stegastes planifrons
Abudefduf saxatilis
Abudefduf taurus
Chromis cyarea
Chromis multilneata
Chromis insolata

HYPOPLECTRUS

Hypoplectrus puella
Hypoplectrus sp
Hypoplectrus indigo
Hypoplectrus gemma
Hypoplectrus gummigutta
Hypoplectrus aberrans
Hypoplectrus guttavarius
Hypoplectrus nigricons

EPINEPHELUS

Epinephelus itajara
Epinephelus striatus
Epinephelus monio
Mycteroperca bonaci
Mycteroperca venenosa
Mycteroperca rubra
Mycteroperca tigrus
Epinephelus inermis

Red hind
Roch hind
Graysby
Coney

BASS

Chalk
Harlequin
Tobaccofish
Fariy basslet
Blackcap basslet
Lantern

PARROTFISH

Bucktooth
Queen
Rainbow
Princess
Blue
Striped
Midnight
Stoplight
Redband
Redtail
Greenblotch

WRASSE

Hogfish
Spanish Hogfish
Puddingwife
Creole
Yellowhead
Slippery dick
Bluehead
Clown
Rosy razorfish

CARDINALFISH

Belted
Barred
Flamefish

SQUIRRELFISH

Sqiurrelfish
Longjaw
Longspine
Dusky
Reef

Epinephelus guttatus
Epinephelus adscensionis
Epinephelus cruentatus
Epinephelus fulvus

SERRANIDAE

Serranus torugarum
Serranus tigrinus
Serranus tabacarius
Gramma loreto
Gramma melacora
Gramma baldwini

SCARIDAE

Sparisoma radians
Scarus vetula
Scarus gaucamaia
Scarus taeniopterus
Scarus coeruleus
Scarus croicensis
Scarus coelestirus
Sparisoma vinide
Sparisoma aurofrenatum
Sparisoma chrysopterus
Sparisoma alomarium

LABRIDAE

Lachnolomaimus maximus
Bochianus rufus
Halichoeres radiatus
Clepticus parrae
Halichoeres garnoti
Halichoeres bivittatus
Thalassoma bifasciatum
Halichoeres maculipinna
Hemipteronotus martinicensis

APOGNIDAE

Apogon townsendi
Apogon binotatus
Apogon maculatus

HOLCENTRIDAE

Holocentrus adscensionis
Holocentrus marianus
Holocentrus rufus
Holocentrus vexillarius
Holocentrus coruscum

Blackbar	<i>Myripristis jacobus</i>
Bigeye	<i>Priacanthus arenatus</i>
GOBBIES	GOBIIDAE
BLENNIES	BLENNIIDAE
JAWFISH	OPISTOGNATHIDAE
BATFISH/FLOUNDER	OGCOCEPHALIDAE/ BOTHIDAE
TILEFISH	MALACANTHUS PLUMIERI
SCORPIONFISH	SCORPAENA sp
TOADFISH	BATRACHOIDIDAE
SEAROBIN	PRIOROTUS OPHRYAS
TRUMPETFISH	AULOSTOMUS MACULATIUS
PUFFERFISH	TETRAODINTIDAE
Bandtail	<i>Sphoeroides spengleri</i>
Sharpnose	<i>Canthigaster rostrata</i>
TRIGGERFISH	BALISTIDAE
Queen	<i>Balistes vetula</i>
Black Durgon	<i>Melichthys niger</i>
COWFISH	LACTOPHYDAE
Honeycomb	<i>Lactophrys polygonia</i>
Scrawled	<i>Lactophrys quadricornis</i>
Trunkfish	<i>Lactophrys trigonus</i>
Smooth Trunkfish	<i>Lactophrys triqueter</i>
Spotted	<i>Lactophrys bicaudalis</i>
FILEFISH	BALISTIDAE
Scrawled	<i>Aluterus scriptus</i>
Whitespotted	<i>Cantherhines macrocerus</i>
Orangespotted	<i>Cantherhines pullus</i>
REMORA	ECHENEIDAE

GOATFISH

Spotted
Yellow
Spotted Drum

MULLIDAE

Pseudopendeus maculates
Mulloidichys martinicus
Equetus punctatus

EELS**MORAY**

Green
Goldentail
Spotted

MURAENIDAE

Gymnothorax funebris
Gymnothorax miliaris
Gymnothorax moringa

CONGER EELS

Garden eel

CONGRIDAE

Heterconger halis

SNAKE EELS**OPHICHTHIDAE****SHARKS**

Nurse
Balcktip
Reef

Ginglymostoma cirratum
Carcharinus limbatus
Carcharinus perezii

RAYS

Spotted Eagle
Southern
Yellwtail
Manta

Aetobatus narinari
Dasyatis americana
Urolphus jamaicensis
Manta birostris

TURTLES

Green
Hawksbill
Loggerhead
Leatherback

Chelonia mydas
Eretmochelys imbricata
Caretta caretta
Dermochelys coriacea

DOLPHINS

Atlantic spotted
Bottlenosed

Stenella plagiodon
Tursiops truncatus

APPENDIX SIX

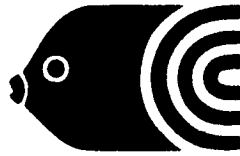
CONTENTS

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1. TROPICAL MARINE ECOLOGY CERTIFICATE

I

CORAL CAY



CONSERVATION

CERTIFICATE

THIS IS TO CERTIFY THAT

Tim Sparrow

*Has supported the Coral Cay Conservation Marine Survey Programme
in Belize and has undertaken and successfully completed a
training course in Tropical Marine Ecology*

SIGNED

DAVID BELLAMY - PRESIDENT



In May 1992 Coral Cay Conservation was awarded the first
"International Marine Environment Award", founded by the World Underwater Federation
(CMAS), and sponsored by U.N.E.S.C.O.