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Joe D. Tanner
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24 June 1983

Ms. Carroll Curtis
Sanctuary Programs Division
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National Oceanic and Atmospheric Administration
3300 Whitehaven Street, NW
Washington, D. C. 20235

Dear Carroll:

Please find enclosed the revised reef fish paper (it has just completed the CRD in-house review). I assume you have the original photographs, and if you need the negatives, please let me know.

In regards to your comments concerning Tables 4 and 5, the counts do represent comparisons between diver "a" and "b" (two divers counting the same station at the same time). A similarity index was not run between teams and counts because the participants indicated that it was unnecessary (all that would give you is a station-station comparison). For this similarity index, the higher the percentage the more similar the two counts. If you use the standard 95 percentile, then the comparison (or indication of accuracy) between core counts versus all species encountered is indeed poor.

Table 5, count number 3, teams 3, 4 and 5 were the counts performed above the ledge on the plateau. The names of the participants were not listed by dive team to avoid any possible embarrassment resulting from a low similarity index score.

The number of species selected for core counts is adequate for confidence in the data. The problem we ran into was that not all nine species were encountered each dive. Consequently, the data is skewed due to the low numbers and not really the sample size.

If you have any questions, please don't hesitate to call.

Sincerely,

Nick Nicholson

Nick Nicholson
Sanctuary Coordinator

NN/lw

Enclosure

cc: S. Shipman
H. Ansley
A. Danneberg

# FINAL REPORT

# THE GRAY'S REEF NATIONAL MARINE SANCTUARY
# VISUAL REEF FISH CENSUSING WORKSHOP

6-9 JULY 1982


Submitted by

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A Report Prepared For

U. S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Ocean and Coastal Resource Management
Sanctuary Programs Division


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## ABSTRACT

A workshop on the reef fish community at the Gray's Reef National Marine Sanctuary (GRNMS) was convened in July 1982 by the Georgia Department of Natural Resources, Coastal Resources Division (DNR-CRD) in conjunction with the National Oceanic and Atmospheric Administration's Sanctuary Programs Division (NOAA-SPD). The purpose of the workshop was to:

(i) develop a reliable field survey method of GRNMS fish communities utilizing a non-destructive, non-consumptive technique;

(ii) provide data which can serve as a baseline for future studies and Sanctuary monitoring programs;

(iii) quantify the reef fish community at GRNMS; and

(iv) encourage increased cooperation between Sanctuary managers and members of the scientific community.

The species/time random count technique of Jones and Thompson (1978), or a modification thereof, was recommended for evaluation at GRNMS.

Nine regional scientists familiar with contemporary visual censusing techniques participated in the workshop. Over the two days of field testing at GRNMS, a total of 62 fish species was observed during the 25 dive team counts conducted at Gray's Reef. Limited statistical analysis on the resulting data was possible. A simple percent similarity index (Krebs, 1977) was used to test variability between fish counts recorded at each station.

The variability ranged from 0 - 96 percent. Duncan's multiple range test was also used to test for variance between counts conducted at the ledge break stations and a series of fish counts taken above the ledge break on the plateau area. Results from this test indicated no statistical difference between the ledge break area fish counts and the adjacent plateau area fish counts.


## INTRODUCTION

Several underwater visual survey methods are currently used to quantitatively census reef fish biota and characterize community structure in reefal areas (Brock, 1954; Randall, 1963; Smith, 1973; Jones and Chase, 1975; Bohnsack, 1979; and Stone et al., 1979). The species/time random count technique of Jones and Thompson (1978) was suggested for testing at the Gray's Reef National Marine Sanctuary,

located 17 nautical miles east of Sapelo Island, Georgia (Figure 1). The technique was suggested because it is simple and non-destructive, requires little equipment other than SCUBA, and avoids the establishment of time-consuming reference points, while still providing the data needed for making comparative evaluations of reef fish assemblages.

Erosion along the ledge break has at several points caused the ledge to collapse, creating multiple fissures and an abundance of small hollows and caves (Figure 2). Associated invertebrate assemblages are dominated by *Chondrilla nucula* (chicken liver sponge), *Geodia gibberosus*, *Cliona* spp. (boring sponge), *Spirastrella coccinea*, *Haliclona oculata* (dead man's fingers) and *Ircinia* spp. (stinker) sponges; *Clavalina* sp., *Styela plicata*, *Distaplia bermudensis* and *Aplidium* sp. ascidians; *Lytechinus varigatus* (decorator urchin) and *Arbacia punctata*, sea urchins; while *Arca zebra* and *A. imbricata* are the most obvious macromolluscs. Unless recently exposed, all rock material is covered with either hydroid or bryozoan mats, or a thick growth of barnacles (Figure 3).

Vertebrate fauna consists of a mixture of temperate and tropical species. On almost every dive one can expect to see the demersals black sea bass (*Centropristis striata*), sheepshead (*Archosargus probatocephalus*), grouper (*Mycteroperca* sp.), cardinalfish (*Apgon* sp.), cubbyu (*Equetus umbrosus*), porgies (*Pagrus* and *Stenotomus* sp.) and toadfish (*Opansus* sp.). From late spring through the summer and into the fall the pelagics king and Spanish mackerel (*Scomberomorus cavalla* and *S. maculatus*, respectively), amberjack (*Seriola dumerili*) and barracuda (*Sphyraena barracuda*) are common on the reef.

A selected group of regional experts (Table 1) familiar with contemporary visual censusing techniques was invited to participate with the Georgia Department of Natural Resources, Coastal Resources Division. Their role was to:

- Determine the applicability of the species/time random count technique for use at GRNMS.
- Modify the technique as necessitated by the environmental constraints of the site.
- Develop appropriate field techniques.
- Evaluate the resulting method's reliability and suitability.
- Recommend future research needs related to the effective assessment of fishery resources within GRNMS.

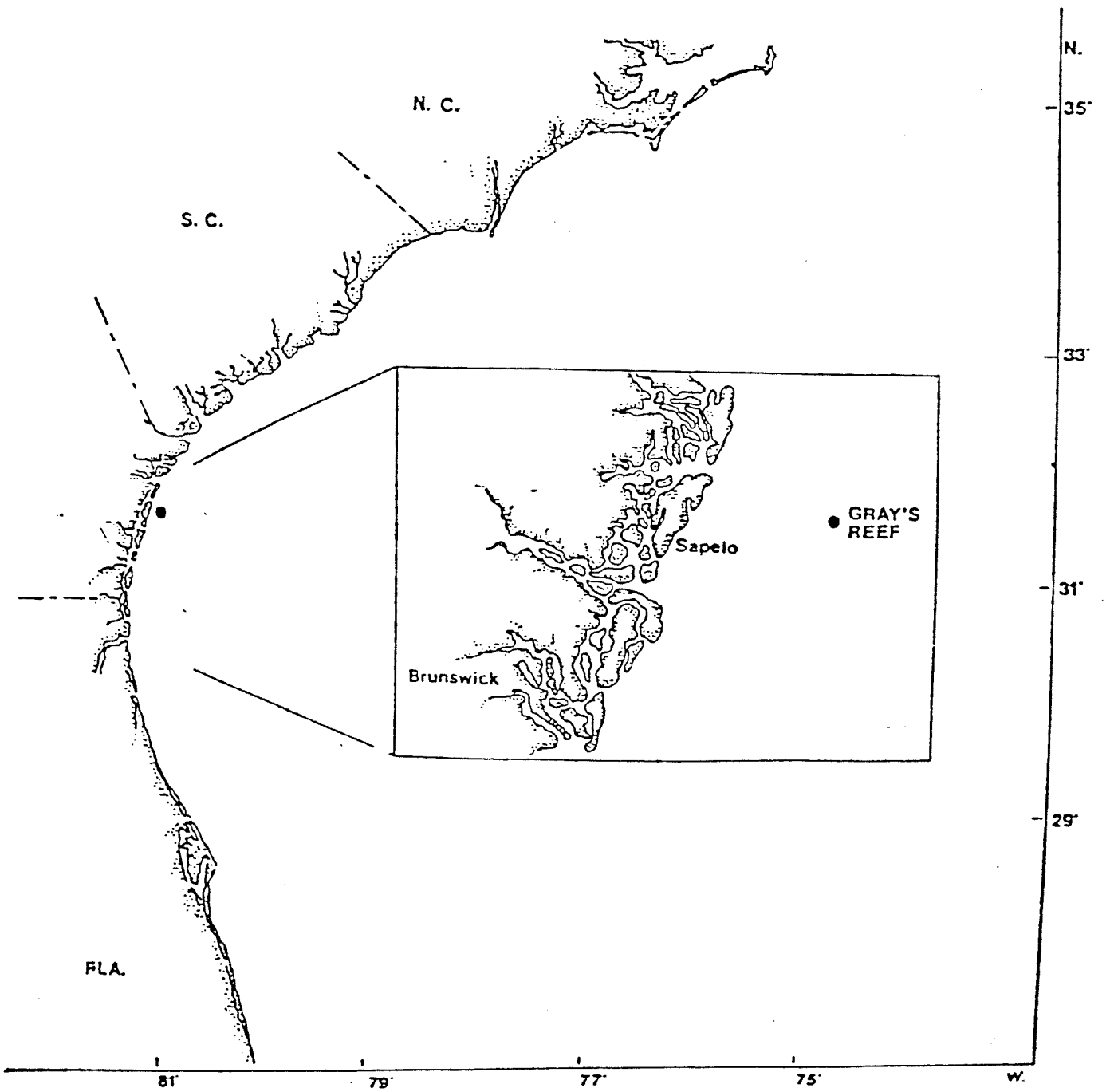


Figure 1. Location of Gray's Reef National Marine Sanctuary.

Source: Office of Coastal Zone Management, NOAA. (1980) Final Environmental Impact Statement on the Proposed Gray's Reef Marine Sanctuary.

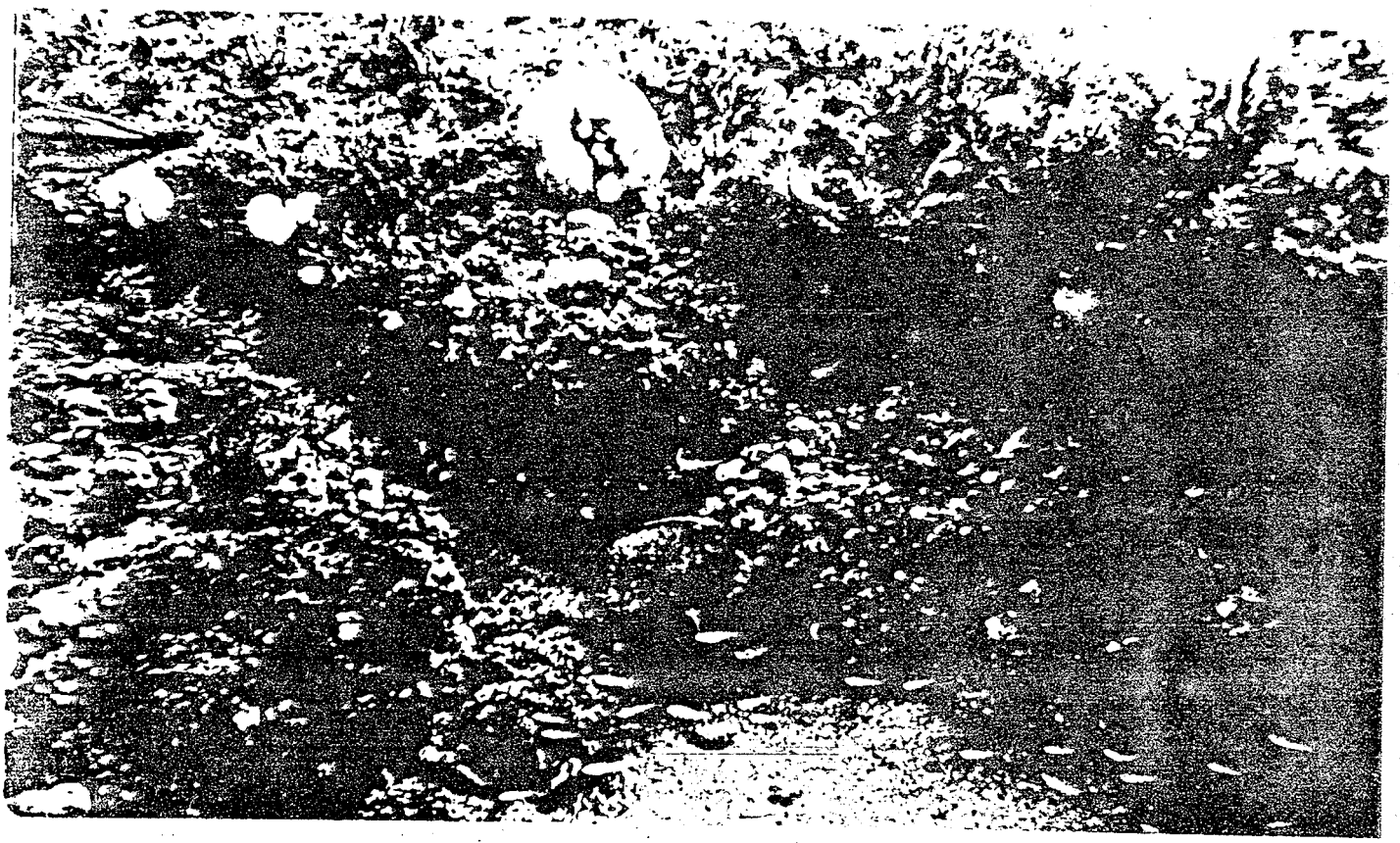

Figure 2. A section of the lower portion of the ledge that has collapsed, illustrating the abundance of microhabitat (photograph by D. Ansley).

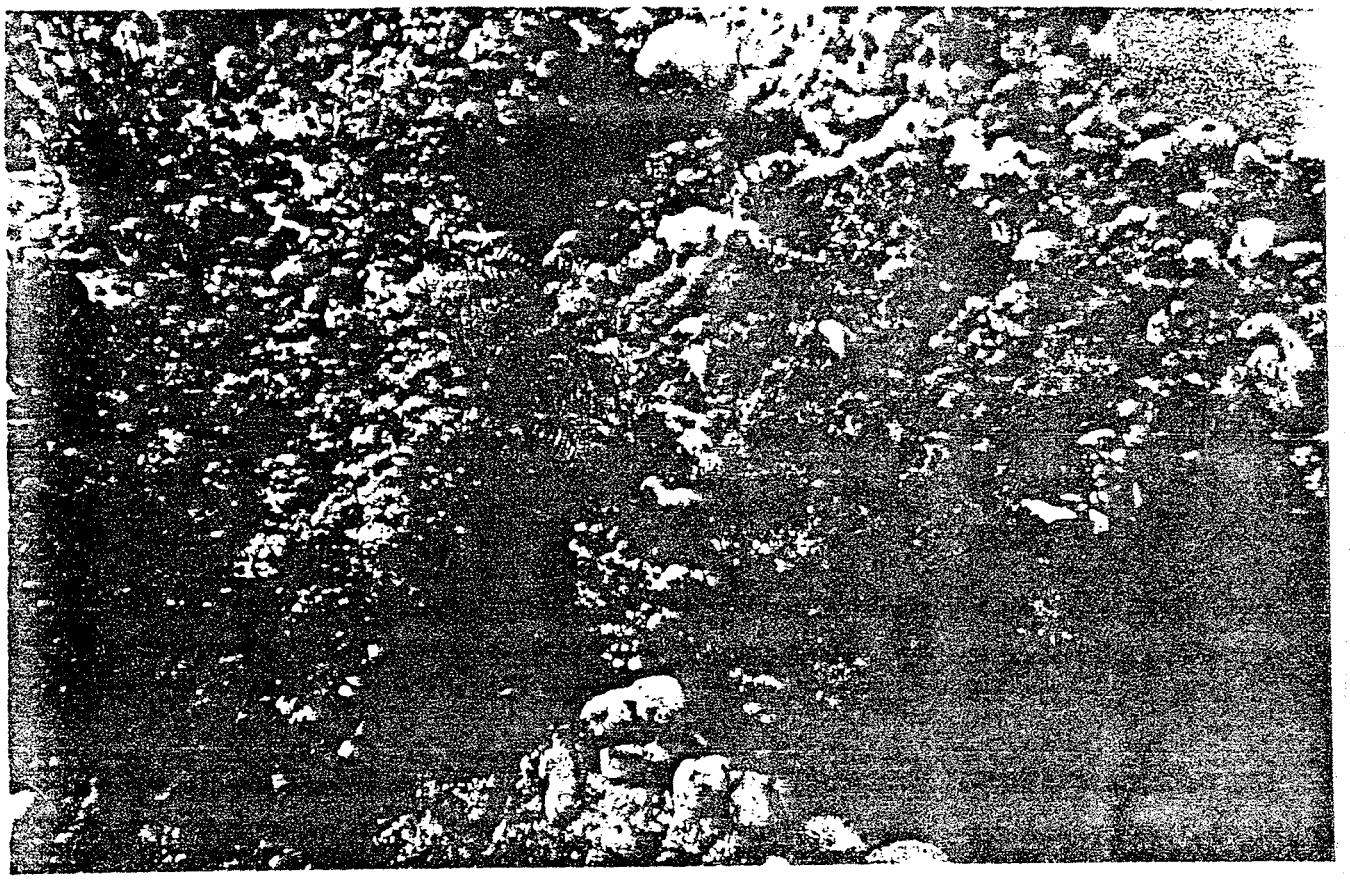

Figure 3. A close-up of the ledge face illustrating the diverse invertebrate community (photograph by H. Ansley).

Table 1. Gray's Reef National Marine Sanctuary visual reef fish censusing workshop participants and affiliations, 6-9 July 1982.

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## STUDY DESIGN

The study site selected within GRNMS consisted of a fairly isolated ledge break (Figure 4) located at a heading of 210° approximately 500 m from the sanctuary marker buoy. Water depth at this site ranges from 17-21 m. The ledge break runs from 250-300 m in a NE-SW direction with relief varying from .5 m to approximately 2 m. This particular site was selected because of its isolation. Not only would the study not interfere with visitor activities, but the site would also have the predators that are often missing from areas more heavily fished.

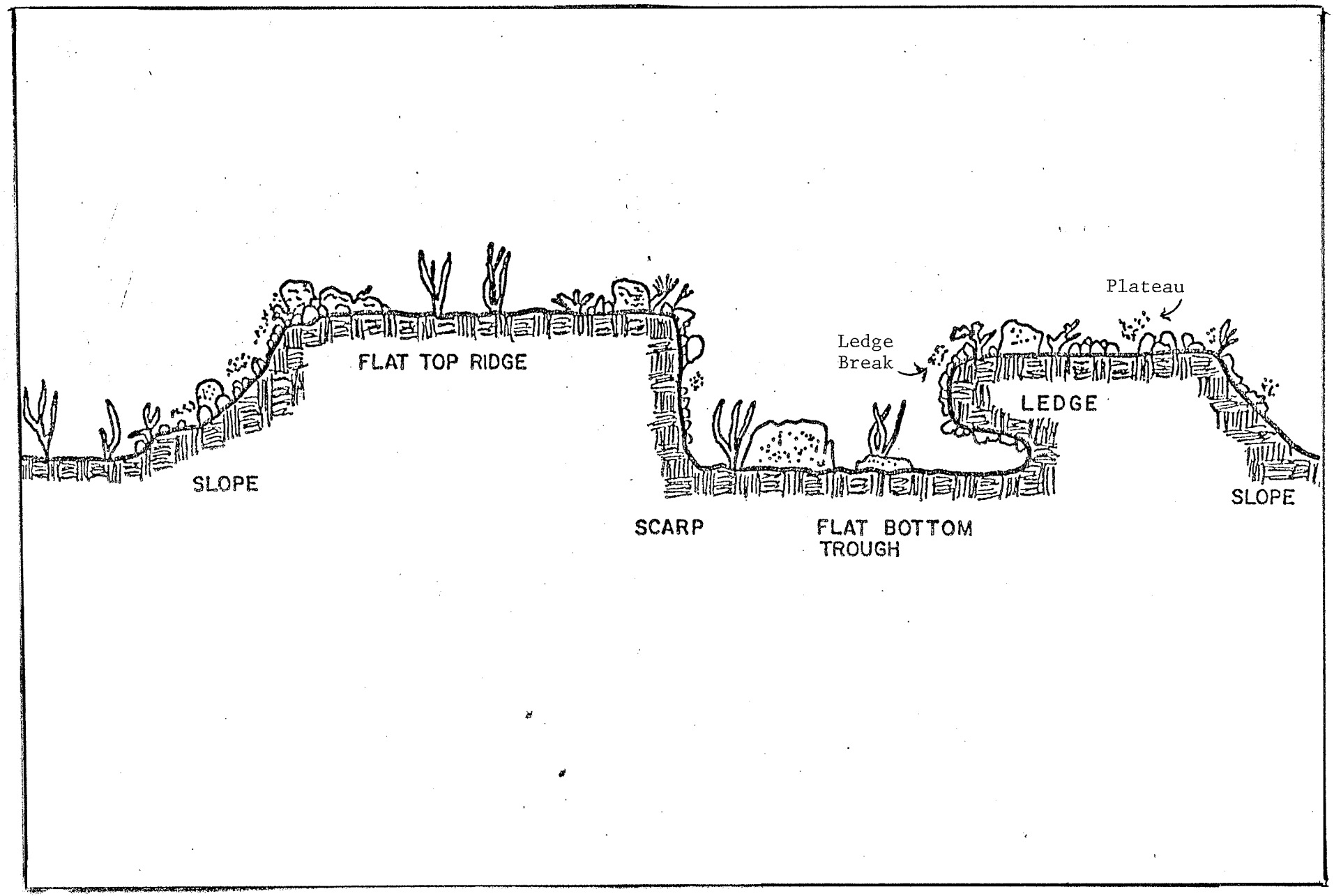
A primary goal of the workshop was to incorporate as much input from the participants as possible. Two project leaders were selected to coordinate the study design phase. The participants met to discuss the proposed study design and to alter the sampling methodology to fit what they felt was the best technique for GRNMS. This technique was then field tested at Gray's Reef. After the first day of testing, the project leaders held a meeting to discuss the initial findings and to incorporate changes to the sampling methodology the participants felt necessary.

The participants decided that the Jones and Thompson technique was not sensitive enough for the low diversity encountered at Gray's Reef, as compared to tropical coral reefs. A typical count at the Sanctuary would consist of 15-25 species whereas a count over a coral reef might contain up to 75 species (Tilmant, pers. comm.). Also, the limited safe bottom time of a SCUBA diver at Gray's Reef (50 minutes safe bottom time) and the number of repetitive counts required by the Jones and Thompson technique (eight) rendered the technique impractical for use at GRNMS. The participants agreed that a random point census counting technique, similar to Bohnsack (in press), would best fit the environmental constraints at GRNMS.

## METHODS

Fish counts were not performed on the initial dive of the field testing period. Instead, the participants made an orientation dive to become familiar with the habitat and local fish fauna at Gray's Reef. Using the recommended technique, the participants were placed into two-man counting teams with an accompanying DNR-CRD diver. Each team planned two 30-35 minute dives/day and fish counts were initiated on the first repetitive dive on day one of the field testing.

Upon reaching the bottom, the divers moved to the ledge break and set up a simple boundary marker system. The system consisted of dive weights attached to the ends of a 6 m line laid out across the bottom. The divers centrally located themselves between the two markers and recorded the fish species and estimates of their size and numbers occurring within the 6 m diameter circle. In addition to the counts,




e 4. Gray's Reef Topography M ied from Hunt (1974)

divers also recorded estimates of the amount of ledge break relief, the average depth of sand veneer, and the percentage of live growth within the 6 m circle. Each diver counted for 10 minutes and recorded the data on underwater writing paper.

Movement during the count was kept to a minimum to restrict attraction/avoidance tendencies noted in some fish species. Schooling species that occurred within the boundaries were typically counted by subsample, with an approximate number of individuals recorded.

At the end of the 10 minute counting period, the divers recovered the boundary markers and swam a predetermined number (generated from a random numbers table) of fin kicks to a new location along the ledge break. Following setup and recording of the associated environmental parameters, the divers initiated a second 10 minute fish count. At the end of this count, the divers marked their location with an inflatable float and ascended. The next dive team then descended on the marked location and moved a random number of kicks prior to starting their series of fish counts.

On day two of the field testing, the sampling scenario was modified slightly. Instead of both divers attempting to record every species observed, one diver recorded only a "core" group of species consisting of commercially and recreationally important fish species (Table 2), while the other diver continued to count all species encountered. Also, in order to obtain preliminary information determining if a significant variability exists between the ledge break and plateau area fish communities, three of the dive teams moved their final counts from the ledge break onto the plateau area. At the end of the field testing period, each participant had made a total of five 10-minute fish counts.

Study participants recommended utilizing a simple percent similarity index (Krebs 1977) to analyze the variability between diver counts and to test the hypothesis that a diver can record all species encountered as accurately as just a core group of target species. The simple percent similarity equation from Krebs (1977) involves a two-step operation. First, a table of importance values is generated for each sample by using the formula:

$$P_i = \frac{n_i}{N}$$

where $P_i$ is a proportion of the i-th sample; $n_i$ is the number of individuals recorded for the n-th taxon, and N is the total number of individuals recorded in the sample.

Then:

$PS$ = minimum ($p_a$ or $P_b$) where PS equals the percent similarity, and $P_a$ and $P_b$ are the proportions generated in the first step for the samples a and b.

Table 2. List of target fish species counted by divers performing "core" counts during field studies associated with the Gray's Reef visual reef fish censusing workshop, 6-9 July 1982.

| Scientific Name | Common Name |
|---|---|
| *Archosargus probatocephalus* | Sheepshead |
| *Balistes capriscus* | Gray triggerfish |
| *Calamus leucosteus* | Whitebone porgy |
| *Centropristis striata* | Black sea bass |
| *Diplodus holbrooki* | Spottail pinfish |
| *Lutjanus campechanus* | Red snapper |
| *Mycteroperca microlepis* | Gag |
| *Mycteroperca phenax* | Scamp |
| *Pagrus pagrus* | Red porgy |

Duncan's multiple range test, as outlined in Steel and Torrie (1960), was utilized to ascertain significant variance between ledge break fish counts and those performed above the ledge break on the plateau area.

Upon completion of the field testing, the participants met a final time to verify the field data, to comment on the study, and to make recommendations on how the data should be analyzed. The field data were tabulated and sent to the participants for further editing. Following a reasonable time for response, the data was analyzed by DNR-CRD and the results returned to the participants for comment.

## RESULTS

Sixty-two fish species were observed by the participants during the two days of field testing at GRNMS (Table 3). This compares similarly with the findings in previous visual fish counts performed at GRNMS (Harris, 1978; BLM Living Marine Resources study, 1981). The results of the percent similarity index are presented in Tables 4 and 5.

## DISCUSSION

Upon completion of the first two fish counts (in which both divers in each dive team recorded all species encountered), the consensus among the participants was that they were uncomfortable with their first count, but felt more settled and confident with their accuracy on the second fish count. However, percent similarity analysis (Table 4) indicated that, in

Table 3. Fish species observed during GRNMS visual reef fish censusing study, 6-9 July, 1982 (Robins et al, 1980).

| Scientific Name | Common Name |
|---|---|
| *Acanthurus bahianus* | Ocean surgeon |
| *Acanthemblemaria sp.* | Blenny |
| *Apogon pseudomaculatus* | Twospot cardinalfish |
| *Archosargus probatocephalus* | Sheepshead |
| *Balistes capriscus* | Gray triggerfish |
| *Balistes sp.* | Triggerfish |
| Blennidae | Combtooth blenny family |
| *Calamus leucosteus* | Whitebone porgy |
| *Calamus nodosus* | Knobbed porgy |
| *Caranx ruber* | Bar jack |
| *Caranx sp.* | Jack |
| *Centropristis striata* | Black sea bass |
| *Chaetodipterus faber* | Atlantic spadefish |
| *Chaetodon ocellatus* | Spotfin butterflyfish |
| *Chromis enchrysurus* | Yellowtail reeffish |
| *Coryphopterus punctipectophorus* | Spotted goby |
| *Coryphopterus sp.* | Goby |
| *Decapterus punctatus* | Round scad |
| *Decapterus sp.* | Scad |
| *Diplectrum formosum* | Sand perch |
| *Diplodus holbrooki* | Spottail pinfish |
| Engraulidae | Anchovy family |
| Gobiidae | Goby family |
| *Equetus umbrosus* | Cubbyu |
| *Haemulon aurolineatum* | Tomtate |
| *Halichoeres bivittatus* | Slippery dick |
| *Halichoeres caudalis* | Painted wrasse |
| *Halichoeres sp.* | Wrasse |
| *Hemipteronotus novacula* | Pearly razorfish |
| *Hypleurochilus geminatus* | Crested blenny |
| *Lactophrys quadricornis* | Scrawled cowfish |

Table 3. (Continued). Fish species observed during GRNMS visual reef fish censusing study, 6-9, 1982 (Robins et al, 1980).

| Scientific Name | Common Name |
|---|---|
| *Lagodon rhomboides* | Pinfish |
| *Lutjanus campechanus* | Red snapper |
| *Monacanthus hispidus* | Planehead filefish |
| *Monacanthus sp.* | Filefish |
| *Mullus auratus* | Red goatfish |
| *Mycteroperca microlepis* | Gag |
| *Mycteroperca phenax* | Scamp |
| *Pagrus pagrus* | Red porgy |
| *Parablennius marmoreus* | Seaweed blenny |
| *Paralichthys albigutta* | Gulf flounder |
| *Pomacentrus partitus* | Bicolor damselfish |
| *Pomacentrus variabilis* | Cocoa damselfish |
| *Rypticus maculatus* | Whitespotted soapfish |
| *Sardinella aurita* | Spanish sardine |
| *Sardinella sp.* | Sardine |
| Scombridae | Mackerel family |
| *Scomberomorus maculatus* | Spanish mackerel |
| *Seriola dumerili* | Greater amberjack |
| *Seriola rivoliana* | Almaco jack |
| *Serranus subligarius* | Belted sandfish |
| Sparidae | Porgy family |
| *Sphyraena barracuda* | Great barracuda |
| *Sphyraena borealis* | Northern sennet |
| *Sphyraena picudilla* | Southern sennet |
| *Sphyraena sp.* | Barracuda |
| *Stenotomus caprinus* | Longspine porgy |
| *Stenotomus chrysops* | Scup |
| *Synodus sp.* | Lizardfish |
| *Urophycis earlli* | Carolina hake |

Table 4. Percent similarities for team counts generated from fish counts where both divers recorded all fish species encountered during the Gray's Reef visual fish censusing workshop.

| Dive Team | Count 1 | Count 2 |
|---|---|---|
| 1 | 84% | 96% |
| 2 | 83% | 83% |
| 3 | 72% | 52% |
| 4 | 87% | 58% |
| 5 | 89% | 78% |

Table 5. Percent similarities for team counts generated from fish counts where one diver recorded all fish species encountered while the other diver simultaneously counted just a core group of fish species.

| Dive Team | Count 1 | Count 2 | Count 3 |
|---|---|---|---|
| 1 | 39% | 59% | 42% |
| 2 | 41% | 51% | 75% |
| 3 | 75% | 0% | 81% |
| 4 | 78% | 52% | 85% |
| 5 | 48% | 71% | 63% |

fact, three of the five dive teams' fish counts were more similar on their first fish count than on their second fish count, and another team's fish count percentages remained unchanged, while only the remaining team's fish counts showed improvement.

In testing the assumption that a diver could record all species encountered as accurately as just a selected core group, the percentages generated from percent similarity analysis (Table 5) were lower than when both divers were recording all species encountered. Since there were fewer species to account for when counting the core species, the core counts should be more accurate. Indeed, the percent similarity analysis (Table 5) does suggest that there is some loss in accuracy when attempting to record all species encountered versus counting a smaller core group.

This drop, however, in the similarity between observers may be the result of the small sample size. As there were only nine species selected for the core group and not all nine species were observed at each station, the similarity percentages generated from the diver observations could be affected by the low number of core species encountered. Another factor that could account for the relatively low similarity percentages in Table 5 could be attributed to the sampling technique itself. With two divers counting the same station simultaneously, it is quite possible for one of the divers to have missed observing one or more species that may have only made a brief excursion into the sampling area while the diver was busy recording his data, looking under the ledge or just not looking in the right direction at the right time.

It is interesting to note that the final series of fish counts in Table 5 indicate a distinct improvement in the similarity of observations between core counts and all species encountered counts in four of the five dive teams' fish counts. This suggests that the participants were becoming more familiar and comfortable with the technique and, therefore, perhaps more accurate.

Analysis of the data taken above the ledge break on the plateau area utilizing the Duncan's Multiple Range Test did not indicate significant variability between the ledge break area and plateau fish communities. Several possibilities exist that could account for this. The fish counts on the plateau area may have been conducted too close to the ledge break (the plateau area fish counts were situated only 3 m above the ledge break). Secondly, some species are known to be very curious and were possibly attracted to the divers despite sampling adjustments to discourage this behavior. Finally, the data base may have been too limited to adequately test this hypothesis.

## CONCLUSIONS AND RECOMMENDATIONS

The species/time random count method of Jones and Thompson (1978), works very well in highly diverse fish populations and situations where a diver has a long safe bottom time. However, workshop participants felt that because of the lower fish diversity within the Sanctuary, generally lower water visibilities, and the low number of replicate samples possible because of restricted safe bottom times for divers, use of the Jones and Thompson method is not effective. Instead, a random point censusing technique is recommended. Based upon field testing, the random point censusing technique developed by the participants appeared to be a reliable and suitable fish population censusing technique that could be used at GRNMS and other live bottom habitats.

It was also suggested that studies continue with one diver counting a core group of species and another diver counting all species encountered until there are enough data to adequately determine the feasibility of this technique. Sampling should also be restricted to one area until the area is well characterized, with concentration on the ledge break area for the first two years, followed by sampling on the plateau areas.

Additionally, project participants felt that employing a color videotape of some "typical" GRNMS fish counts would enhance training and subsequently improve counts. Further, sampling should consist of an intensive effort in late fall (mid-October), consisting of four to six trained divers sampling daily for approximately two weeks. By sampling during mid-October investigators should encounter most species that occur at GRNMS. Seasonality observations could be determined by spot checks made in conjunction with other activities at the reef (i.e., buoy maintenance) or as part of a directed monitoring program.

Due to the small data base obtained in the two days of field testing at GRNMS, more sophisticated data analysis was not possible. With a larger data base, multivariate methods for characterizing community structure, diversity indices and population distribution curves were recommended methods for analysis.

One final aspect not previously addressed was the success in the interaction among the participants. As Greg Waugh stated, "Gathering a multidisciplinary group is one of the most efficient approaches to problem solving . . . The greatest benefit, however, is the working relationship that results from such a gathering and the adaptation of known techniques to the particular situation at Gray's Reef."

## REFERENCES


Bohnsack, J. 1979. The ecology of reef fishes on isolated coral heads: an experimental approach with emphasis on island biography theory. Ph.D. Dissertation, U. of Miami, Coral Gables, FL. 279 pp.

Brock, V. 1954. A preliminary report on a method of estimating reef fish populations. J. Wildl. Mgt. 18: 297-308.

Harris, C. D. 1978. The fisheries resources on selected artificial and live bottom reefs on Georgia's Continental Shelf. Coastal Resources Division, Georgia Dept. of Natural Resources, Brunswick, GA.

Hunt, J. L., Jr. 1974. The geology and origin of Gray's Reef, Georgia Continental Shelf. M.S. Thesis, Univer. of Georgia. Athens, GA. 83 pp.

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

Jones, Robert S. and John Thompson. 1978. Comparison of Florida reef fish assemblages using a rapid visual technique. Bull. of Marine Science 28(1): 159-172.

Krebs, Charles J. Ecology, the experimental analysis of distribution and abundance. Chapter 7, Harper and Row, publishers, New York, NY. 684 pp.

Office of Coastal Zone Management, NOAA. 1980. Final Environmental Impact Statement on the Proposed Gray's Reef Marine Sanctuary. 175 pp.

Randall, J. E. 1963. An analysis of the fish populations of artificial and natural reefs in the Virgin Islands. Carib. J. Sci. 3: 1-16.

Robins, Richard C., et al. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society, Special Publication No. 12, 174 pp.

Smith, C. L. 1973. Small rotenone stations: A tool for studying coral reef fish communities. Am. Mus. Novit. 2412: 1-21.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Company, Inc., New York, NY, pp. 107-109.

Stone, R. B., H. L. Pratt, R. O. Parker, Jr., and G. E. Davis. 1979. A comparison of fish populations on an artifical and natural reef in the Florida Keys. Mar. Fish. Rev. 41(9): 1-11.