Robert Van Dolah

SOUTH ATLANTIC OCS AREA LIVING MARINE RESOURCES STUDY

Since 1979, the Minerals Management Service has funded a major research program designed to better understand the communities associated with hard-bottom habitats in the South Atlantic Bight. This study has been conducted in three phases. Objectives during the first to phases were to:

1) characterize the invertebrate and nektonic communities associated with several representative hard bottom areas from Cape Hatteras, North Carolina to northern Florida and evaluate factors which might influence community structure such as depth, latitude and season,
2) characterize the food habits of selected fish species of commercial and recreational importance,
3) conduct a limited assessment of bottom topography and substrate type, and
4) evaluate the potential effects of oil- and gas-related activities on hard bottom communities.

Sixteen areas were sampled during the first two study phases. One of the sites was located in Gray's Reef Marine Sanctuary which was established during the course of the two year sampling period.

Physical characteristics of each study site were assessed through underwater-television transects, fathometer transects, and by diver observations at those sites on the middle and inner shelf. These efforts provided information on the areal extent of each site, the proportion of bottom types within each site, and the degree of rock relief. Although these techniques also provided information on the biota present, additional sampling was conducted to assess community structure both quantitatively and qualitatively. Fishes were sampled by day and night trawls, an epibenthic sled, hook and line, and baited traps. Large benthic macrofauna and flora were sampled with trawls and a Cerame-Vivas dredge. Smaller invertebrates were sampled with either an airlift-suction sampler operated by divers (inner- and middle-shelf sites) or a Smith-McIntyre grab (outer-shelf sites). Bathymetric profiles of salinity, temperature, and dissolved oxygen were obtained using Niskin bottles, and water-clarity profiles were obtained using a transmissometer.

During the third study phase, research focused on three specific tasks. These tasks involved:

1) Experimental studies of recruitment and community development on hard substrata,

2) A study of sponge and coral distribution in relation to sediment depth over hard substratum, and

3) A continuation of the food habits study of hard bottom fishes.

Information obtained from the South Atlantic OCS Area Living Marine Resources Study can not be adequately summarized in one or two pages. However, published reports from all three study phases are available from MMS and NTIS. Additionally, Executive Summaries of each study phase will be available for review by workshop participants.

Robert Van Dolah

EFFECTS OF ROLLER TRAWLING ON A HARD BOTTOM SPONGE AND CORAL COMMUNITY

In 1982, the NOAA Santuaries Program Division funded a study designed to evaluate the effects of a research roller-trawl on sponge and coral assemblages commonly found in hard bottom habitats of the South Atlantic Bight. The study was conducted in a hard bottom site located approximately 25 km NNE of the Sanctuary.

The species selected for study were the finger sponge Haliclona oculata, the vase sponge, Ircinia campana, the barrel sponges Cliona spp., the whip coral Leptogorgia virgulata, the fan coral Lophogorgia hebes, the stick coral Titanideum frauenfeldii, and the stony tree coral Oculina varicosa. These were the most abundant large sessile organisms in the area.

Five transects were established across a trawling alley set up for the study: three in an area of high coral and sponge density, and two in an area of high coral but low sponge density. For the pre-trawl assessment, divers counted all sponges and corals in 20 replicate quadrats located along each transect (total of 100 quadrats). Quadrats measured 25 m^2 for all species except the stick coral (T. frauenfeldii), which was only counted in a 1-m^2 area within each larger quadrat. After the pre-trawl census, a 40/54 fly trawl was dragged through the alley once. This trawl is identical to the one used for research at Gray's Reef in the OCS Living Marine Resources Study and is similar to those used by commercial trawlers. After trawling operations, transects were reestablished and eight of the 20 quadrats initially censused on each transect were randomly selected for reassessment: four in the trawl path and four in control (non-trawled) areas. These same quadrats were assessed again one year later. Changes in the density of undamaged sponges and corals were evaluated statistically, and qualitative observations were made on the type of damage to each species.

Results of the trawl damage assessment study documented damage to all species counted, but only the density of barrel sponges (Cliona spp.) was significantly decreased ($P < 0.05$, ANOVA) by trawling activities. The extent of damage or loss among the other large sponges (I. campana, H. oculata), octocorals (L. virgulata, L. hebes, T. frauenfeldii) and hard corals (O. varicosa) varied depending on the species, but changes were not statistically significant ($P > 0.05$). Twelve months after trawling, no damaged sponges or corals were observed in the area and the abundance of specimens counted in the trawled quadrats had increased to pre-trawl densities or greater.

Growth rate studies were also attempted on selected species (Cliona sp., I. campana, H. oculata, L. hebes, O. varicosa) to further evaluate recovery rates. Both damaged and undamaged specimens of most species were tagged and then measured at different time intervals over a nine-month period. Measurements included maximum height for all species, as well as various diameter and circumference measurements for selected sponges. Measurements of sponge and coral specimens provided only limited information on species growth rates because of unexpected changes in sediment depths at the base of tagged specimens. Estimates of yearly increases in the size of sponges, based on changes in circumference and diameter, indicate that Cliona sp. and I. campana grow relatively slowly, suggesting that it may take several years for damaged specimens to reach pre-trawl sizes.

In another phase of this investigation, three specimens of each sponge and coral species censused in the trawl damage study were collected in the vicinity of the trawling alley for study of their associated fauna. Results of the associated fauna study indicated that all sponge and coral specimens harbored numerous commensal species, several of which have been shown to be important prey items for hard-bottom demersal fishes. Most of the species inhabiting the sponges and corals examined in this study appear to be fairly ubiquitous with respect to their association with various host species. Some have also been shown to be free-living inhabitants of sediments in hard bottom areas. Nevertheless, several species were much more abundant on sponges and corals in this study than they were in bottom samples taken in other studies. This suggests that, while few of the species collected in this study are obligate commensals of sponges and corals, many are attracted to these large macroinvertebrates, possibly as a source of food or as refuge from predation.

Based on the results of this study, previous research trawling in the Gray's Reef Marine Sanctuary (SCWMRD, 1982; Sedberry and Van Dolah, in press) may have affected the sponge and coral populations present in the area. This, in turn, could have reduced the populations of invertebrate fauna associated with these species. However, the use of a trawl roller rig, in combination with a deployment strategy which avoided trawling over the same bottom more than once, probably prevented any serious damage to the hard bottom habitat or its associated fauna.

Nick Nicholson

GRAY'S REEF NATIONAL MARINE SANCTUARY

GRNMS Reef Fish Visual Censusing Workshop

In July 1982, a NOAA-sponsored workshop was held to develop a reliable field method that would provide accurate estimates of fish abundance and characterize fish assemblages in GRNMS without using capture techniques. Ten regional experts familiar with contemporary fish censusing techniques and fish identification were invited to participate with the Georgia Department of Natural Resources, Coastal Resources Division, in the workshop. The participants' roles were to:

- o Determine the applicability of the Jones and Thompson (1978) species/time random count technique for use at GRNMS;
- o modify the technique selected for GRNMS as necessitated by the environmental constraints of the site;
- o field test the selected methodology;
- o evaluate the method's reliability and suitability for monitoring fish abundance and diversity over time; and
- o recommend future research needs related to the effective assessment of fishery resources within GRNMS.

Initially, the species/time random visual count technique of Jones and Thompson (1978), or a modification thereof, was recommended for evaluation at GRNMS. After further consideration, however, the species/time technique was considered inappropriate because the technique disregards variations in spatial distributions, overemphasizes the importance of widespread (albeit) rare fishes, and underemphasizes patchy although abundant species. Also, since fish abundance is ranked by order of encounter, quantification of community structure and between-community comparisons are often questionable.

A recently developed restricted stationary technique (Bohnsack, 1981) reduces the problems associated with other techniques. Estimates of relative abundance are based on counts of individual fish rather than order of encounter as with the species/time counts, thus reducing the problems outlined by Demartini and Roberts (1982). The Bohnsack (1981) technique similarly reduces bias due to attraction or repulsion of fish when using a transect method. A stationary diver can also more easily and accurately count fish. This method produces data on species diversity, indices of relative abundance, frequency of occurrence, fish size, and community composition.

The workshop was conducted in two phases: a methods development phase and a field testing/technique modification phase. The sequence of events is as follows.

Workshop participants gathered in Brunswick, Georgia on July 6, 1982, to determine the most appropriate methodology for censusing fish abundance and diversity at GRNMS using diver visual counts. Two project leaders were selected to coordinate the methods development phase.

The participants were first asked to determine whether the species/time random visual count technique of Jones and Thompson could be modified to fit the environmental conditions at GRNMS. The participants decided that, among other reasons, the Jones and Thompson technique was not sensitive enough for the relatively low fish diversity encountered at Gray's Reef, as compared to tropical coral reefs. Additionally, at a temperate reef the likelihood of encountering the most common species first (a premise of the Jones and Thompson technique) is low compared to the tropics. Limited safe bottom time and the number of repetitive counts required by the Jones and Thompson technique (i.e., eight) render the technique impractical for use at GRNMS. The participants agreed instead that a random point technique similar to methods developed by Bohnsack (1981) would best fit the environmental constraints at GRNMS and provide a compromise between disadvantages inherent to other visual census techniques.

During the field testing phase, the participants were divided into five teams with each team planning two 30-35 minute dives per day. Only one team counted fish at any one time with a minimum visibility of 3 m agreed upon for the performance of the counts. Upon reaching the bottom, the first team of divers moved to the ledge break and set up a boundary marker system for the first 10 minute count. The boundary markers served only to give the divers an accurate estimate of distance underwater and consisted of 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 species, numbers, and size estimates for all fish observed within a 3 m radius circle during a ten minute counting period. 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 3 m radius circle. All data were recorded on underwater 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.

At the end of the first 10 minute counting period, the diver recovered the boundary markers and swam a predetermined number of fin kicks (generated from a random numbers table) to a new location along the ledge break. Following setup and recording of the associated environmental parameters, the divers immediately 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 following the same procedures.

In order to address the question of whether or not there was a significant loss of accuracy in counting all species encountered as opposed to counting a few species, sampling was modified slightly. On the second day of the field testing phase, instead of both divers attempting to record every species observed, one diver recorded only a "core" group of nine (9) species consisting of commercially and recreationally important fish species, while the other diver continued to count all species encountered. Also, in order to obtain preliminary information for determining if significant variability exists between fishes occurring at the ledge break and over plateau areas, three of the dive teams moved their last 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.

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 were analyzed by DNR-CRD and the results returned to the participants for comment.

In addition to summary statistics, study participants recommended utilizing a simple percent similarity index to analyze the similarity 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. A Student's paired t test was utilized to ascertain significant variance between counts performed within a team. In addition, a two-tailed paired sample t test utilizing log (x + 1) transformed species counts was performed by species on the 25 most abundant species encountered to ascertain significant variance between count performed regardless of team assignment. Duncan's multiple range test was utilized to ascertain variation among fish counting stations along the ledge break and three stations on the plateau.

Forty-nine distinct species were identified by the participants during the two days of field testing at GRNMS. The five most abundant species (total number of individuals) were also the five most frequent in occurrence. The top five species in order of abundance were: *Decapterus punctatus*, *Heamulon aurolineatum*, *Halichoeres bivittatus*, *Diplodus holbrooki*, and *Centropristis striata*. *Mycteroperca microlepis* was the only other species to occur in 35 samples; however, it ranked 13th in total number of individuals observed. Two-tailed paired sample t tests were unable to detect significant (α = .01) differences in mean counts between divers for log (x + 1) transformed counts of any species. *Haemulon aurolineatum* was, however, significant at the α = .05 level.

Results from the similarity index ranged from 39 to 96 percent similarity.

Student's paired t tests on the data were unable to detect significant differences (α = .01) between counters. Duncan's multiple range test results (α = .05) indicated no statistical difference between fish counting stations.

Some interesting comparisons can be made using the summary data. The following table represents a comparison between tropical coral reef fish counts and temperate reef fish counts using Bohnsack's (1981) data and similar technique:

Comparison between tropical coral reef fish counts (Bohnsack, 1981) and temperate reef fish counts.

	Looe Key Reef	Molasses Reef	French Reef	GRNMS
Total Species Observed	105	102	92	49
Total Individuals Observed	35,500	19,422	3,332	60,128
Mean Species/Sample (± s.d.)	21 ± 4	24 ± 3	21 ± 5	16 ± 4
Mean Individuals/Sample (± s.d.)	273 ± 145	309 ± 164	212 ± 133	1718 ± 1814
Number of Samples	130	63	40	35

The total number of species observed at the coral reefs is double the number of species observed at GRNMS. The total number of individuals observed at GRNMS, however, is almost double the number of individuals observed at the coral reefs despite the fewer number of samples collected. The mean number of individuals/sample at GRNMS is almost five times higher than the coral reef fish counts. Thus, study results support the classic example of a high number of species with low number of individuals observed in the tropics and a low number of species with a high number of individuals observed in more temperate regions.

Based upon field testing, the random point censusing technique developed by the participants appears to be a reliable and suitable fish population censusing technique that could be used at GRNMS and other live bottom habitats. Based on the results of the Student t tests and knowing that visual fish censusing methods are relative estimates of abundance, it would appear that core counts are not necessary at GRNMS.

Workshop participants made several recommendations concerning future reef fish monitoring efforts at GRNMS. Assuming a limited budget and minimal personnel being available, a reef fish monitoring program at GRNMS should consider the following:

1 - Annual counts of all species encountered should be conducted during the same time period each year.

2 - An intensive series of counts by several dive teams over a short period once annually would be preferable statistically, as well as logistically, over a small number of counts made by a few individuals during several trips throughout the year.

3 - The fall season (i.e., mid-October) would be the best period for a single annual count because the largest variety of species is typically found at the reef at that time.

4 - The number of samples collected would depend on the variability in the results, number of areas to be sampled, and funding level. The number of ledges to be sampled would depend upon differences between ledges.

5 - Seasonality observations could be determined 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 are recommended.

One final aspect no previously addressed was the success in the interaction among the participants. As Gregg 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

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

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Summary of Work to Date on the Gray's Reef National Marine Sanctuary Seaweed Flora

Work to date

The present knowledge of the seaweed flora of Gray's Reef is based on collections made in June 1980, June 1982, June 1983, July 1984, August 1984 and September 1984. All data are based on samples collected by hand by SCUBA divers.

The seaweeds show a marked summer seasonality. The total number of species collected in June is 26. Individuals collected in June are generally small and often immature. The number of species collected increases through July to August when it peaks with over 60 species collected. The biomass of plants, though not measured in this study, appears subjectively to also peak during August. In 1984, the first year in which sampling was conducted throughout the summer, the September collection was made late in the month and there were very few seaweeds; only 4-5 species were collected at each dive site. There was also a comparable or greater decrease in biomass of algal material on the outcrops. The disappearance of the seaweeds may have been accelerated by the passage of a hurricane earlier in the month, but my impression is that the disappearance was mostly due to natural senescence. Among the algae remaining were the largest specimens encountered during the summer of *Botryocladia occidentalis*, an erect, red alga which despite its size was apparently unaffected by whatever turbulence the hurricane's passage caused.

The composition of the flora in the sanctuary is similar in many respects to the well known flora of North Carolina's offshore waters. As currently constituted it is comprised of about one third the number of species in the Carolina deep water flora and, considering the small area involved, the sanctuary has a relatively rich flora.

There are several noteworthy plants among the collections. On the very first collecting trip in 1981 an undescribed species of the red algal genus Dudresnaya was collected and subsequently described as D. georgiana. Two other species of that genus were collected this summer, D. crassa, which is widely distributed in warm Western Atlantic waters, and D. puertoricensis, a new species only recently collected in Puerto Rico which will be described on the basis of the Puerto Rican and Georgia specimens. This is as far as I know the only place in the world where three species of this genus are sympatric.

A species of the red algal genus Botryocladia was collected in immature condition in July of 1982. Mature specimens were collected in 1984. These collections indicated the species was undescribed in the published literature, but correspondence with other phycologists now indicates that the taxon has been collected in Puerto Rico and that they have a paper describing it in press.

Fertile collection of specimens of two species of the green alga Derbesia may help clarify the status of the species of that genus in the waters of the south eastern U.S. Although the alga is fairly common in deep water, it is rarely collected in a fertile condition and the status of the species described is uncertain. One of the species, D. turbinata has not been recollected fertile since Hoyt described it at the beginning of the century, but it may be one of the species in the sanctuary.

The green algal genus *Caulerpa* is represented by two species in the sanctuary, *C. verticillata* and *C. mexicana*. Both records are northern extensions of the range of these taxa from southern Florida.

Prospects for Further Study

Collections in 1985 should provide material sufficient, with the earlier collections, to allow a reasonably thorough systematic description of the flora of the sanctuary. Undoubtedly there will be some taxa which will not be collected. Even after a dozen or more years of sampling in comparable waters off the North Carolina my students and I occasionally turn up a previously unrecorded species there. This is because some of the rarer taxa are apparently more common in some years than others. This will probably also be true at Gray's Reef and the existence of a guide to the flora will assist workers in recognizing the presence of previously unrecorded species.

The current work is strictly taxonomic, but it can be the basis for initiating ecological studies of the vegetation. Future work could document the growth rate and biomass of plants and provide estimates of the total input of the seaweeds to the food webs associated with the outcrops. Careful study and mapping of parts of outcrops could help to determine the phenology of key species. We don't know in many cases which plants are annuals and which are perennials. We know little about the seasonal recruitment of the annual species. Several taxa should be cultured in the lab and their life histories elucidated. Initial targets for study in culture would include Derbesia turbinata, Dudresnaya georgiana, D. puertoricensis and Predaea feldmanii. All of these potentially have alternate, missing stages in their life histories.

Richard B. Searles

Duke University

<u>Community metabolism and nutrient fluxes at Gray's Reef NMS</u>

Summary for the GRNMS Resource Studies Workshop

19 & 20 February 1985

R.D. Fallon & C.S. Hopkinson

University of Georgia Marine Institute

Sapelo Island, GA 31327

A comprehensive systems approach to understanding carbon and nutrient cycling will be taken. This will consist of analysis of (a)nutrient standing stocks (b)primary production (c) community metabolism (d) nutrient uptake and remineralization and (e) horizontal fluxes through the system. Our general hypothesis is that Gray's Reef is functionally dissimilar to a "typical" coral reef in that it is not self-sustaining, requires major external organic matter inputs, and lacks efficient nutrient retentive mechanisms. A methodology will be established to evaluate total community function, which may be a useful way to measure the "health" of the reef in the future. Detailed hydrographic information will also be gathered.

Current meter arrays have been placed at Gray's Reef and "F" Reef for 7 months. These consist of two meters, one each measuring near bottom and surface currents (speed and direction) and temperature at both sites. This data collection will continue for another year. On site measurements of community function will be done in the summer of 1985, when a 4 or 5 day trip to the reef is planned. Analysis of collected samples and system modelling should be completed by summer of 1986.

A June 1982 cruise to Gray's Reef allowed us to make some preliminary investigations into nutrient dynamics and community function at the reef. During this spring tide period, turbidity was high, especially within 1-2 m of the bottom. Photosynthetically available radiation was $<50 \mu E\ m^{-2}\ sec^{-1}$ at the bottom. Interstitial nutrient concentrations (DIN and DIP) were approximately 10-fold lower in the sanctuary sediments as compared to a station 2km off of

Blackbeard Island. Overall, because of the greater water depth at Gray's Reef, the pelagic component appeared to be more important to total system function at Gray's Reef in comparison to nearshore stations. For example, based on areal values, benthic/pelagic DIN storage was 97/3 at our 2km station(5m water depth), but 25/72 at Gray's Reef(19m depth). For metabolic rates, benthic/pelagic ratios were 40/60 for our 2km site, but 10/90 at Gray's Reef. Production/respiration measurements made with benthic domes and bottle incubations indicated that Gray's Reef live bottom may be net heterotrophic. However, because of high variance in our data, we cannot make this conclusion with great statistical confidence. For the pelagic component, chlorophyll, bacterial, and nutrient concentrations were similar to values measured at our 16km nearshore station. This shows that overlying water at Gray's Reef is similar to that from the outer nearshore zone.Comparisons between bare sand and moderate to low density live bottom areas showed that interstitial nutrient concentrations peaked closer to the sediment-water interface on the live bottom. Perhaps this results from epifaunal versus infaunal dominance at the live bottom and bare sand areas, respectively.

Studies planned for 1985 will be designed to analyze community function on representative bottom types on the reef. Development of special methodology will be required in order to accurately monitor high density, rock outcrop areas. Such methods are under development. Validation of these techniques will be a primary goal of the work in summer 1985.

GRAY'S REEF NATIONAL MARINE SANCTUARY

Resource Studies Workshop Agenda

Tuesday, February 19, 1985

7:00 PM - Presentations on GRNMS research activities; past/present
9:00 PM

General
Nick Nicholson, Sanctuary Coordinator
GA DNR, Coastal Resources Division

MMS-Living Marine Resources Study
Dr. Robert van Dolah
SC Marine Resources Research Institute

Effects of a Roller Trawl on Live Bottom Habitat
Dr. Robert van Dolah
SC Marine Resources Research Institute

Reef Fish Visual Censusing Workshop
Nick Nicholson, Sanctuary Coordinator
GA DNR, Coastal Resources Division

GRNMS Hydrographic Survey 1983 and 1984
Dr. V.J. Henry
Georgia State University

Field Guide to GRNMS Reef Fish
Dr. Matt Gilligan
Savannah State College

Field Guide to GRNMS Algae Flora
for Dr. Richard Searles, Duke University
Dr. Joesph Richardson, Savannah State College

GRNMS Reef Fish Population Studies
Dr. Russel Nelson
NMFS, Beaufort Laboratory

GRNMS Community Metabolism and Current Meter Study
Dr. Charles Hopkinson, Sapelo Institute of Marine Science
Dr. Gregg Han, General Oceanics, Miami, FL
Dr. Jack Blanton, Skidaway Institute of Oceanography

Wednesday, February 20, 1985

9:00 AM - Welcome
Dr. James Harding, Director
UGA Marine Extension Service, Skidaway

9:05 AM - Presentation of the Agenda and Workshop Logistics
Art Jeffers, Sanctuary Projects Manager
NOAA Sanctuary Programs Division
and
Nick Nicholson, Sanctuary Coordinator
GA DNR, Coastal Resources Division

9:15 AM - National Research Plan
9:45 AM Herbert Kaufman, Deputy Chief
NOAA Sanctuary Programs Division

9:45 AM - Split into Subgroups. In general, the Chairman of each Subgroup will allow time for discussion of existing state of knowledge, discussion of information needs and existing or potential management related problems, and identification of proposed research topics.
We recommend advance preparation of a brief summary of the management issues and related research projects which you believe deserve emphasis at GRNMS. Such advance preparation (e.g., a list of proposed research projects which addresses items a-d below for each project) would significantly enhance participation in the Workshop.

12:00
1:30 PM - LUNCH

1:30 PM - Subgroups. Selection of four research topics of immediate im-
4:00 PM portance. Development of a summary for each of the selected research topics. This summary should provide information in the following areas:

a: Research topic
b: Statement of problem and relevance to GRNMS (importance to protection or management of GRNMS resources?)
c: Objective(s) of the proposed research
d: Status of available information
e: Description of the proposed effort (methods, schedule, etc.)
f: Research products
g: Estimated cost (also note number of on-site vessel days required)

4:00 PM - Presentation by Subgroup Chairmen of selected research topics

4:30 PM - Closing statement
Art Jeffers, Sanctuary Projects Manager
NOAA Sanctuary Programs Division

GRAY'S REEF NATIONAL MARINE SANCTUARY

Resource Studies Workshop Subgroups

<u>GEOLOGY/OCEANOGRAPHY</u> - Dr. James Harding, Chairman

Dr. Larry Atkinson
Dr. Jack Blanton
Dr. V.J. Henry
Dr. Gregg Han

<u>VERTEBRATES</u> - Dr. Dave Miller, Chairman

Dr. Matt Gilligan
Dr. Russel Nelson
Nick Nicholson
Dr. Mac V. Rawson
Dr. George Sedberry

<u>INVERTEBRATES/PLANTS</u> - Dr. Dave Gillespie, Chairman

Dr. Bill Brillhart
Dr. Robert Fallon
Allen Holbert

Dr. Joe Richardson
Dr. Bob van Dolah
David Dilen
Ray Jakubezak
Joe Schubauer
Ed Chin
Amy Edwards