The Workshop on the Snapper/Grouper Resources of the South Atlantic Bight was held on March 23-24, 1977 at the Marine Resources Center of the South Carolina Wildlife and Marine Resources Department in Charleston, South Carolina.

The purposes of the Workshop were to describe current research and development activities concerning snapper/grouper stocks of the South Atlantic Bight, to discuss and familiarize interested individuals with information available on these stocks, and to prepare an informal document outlining information gaps and needs relevant to future management and development of the snapper/grouper resources.

Since the South Atlantic Fishery Management Council has designated the snapper/grouper fishery as a high priority fishery and intends to undertake the development of a management plan for this fishery in the near future, the convening of this workshop was felt to be an appropriate and timely activity. It is anticipated that these proceedings will be useful to the South Atlantic Fishery Management Council in their formulation of a snapper/grouper management plan. In addition, these proceedings should be helpful in familiarizing individuals with the snapper/grouper resources of the South Atlantic Bight and should serve to document current activities and needs relative to the future development and management of these important resources.

We wish to express our appreciation to those individuals and agencies whose participation made the workshop a success. We especially wish to acknowledge the following: Mr. Beverly Snow, Executive Director of the Coastal Plains Center for Marine Development Services, and his staff, especially Mr. Robert Hines, for their support of the workshop as part of the Cooperative Projects Program of the Coastal Plains Regional Commission; the staff at the Marine Resources Center who contributed in various capacities; the speakers who gave presentations at the first general session; those individuals who chaired the sectional meetings during the special sessions and who also presented reports on their respective sectional meetings at the second general session; and to all participants who contributed to the workshop planning, discussions, and reports presented.

David M. Cupka
Peter J. Eldridge
Gene Huntsman
Editors
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The Snapper/Grouper resources of the South Atlantic Bight (Cape Hatteras to Cape Canaveral) form the basis of an important fishery which has both recreational and commercial components. Despite the importance of these resources to the economic and social well being of the region, only a limited amount of research has been conducted to date in studying and defining them.

Prior to this year, a mechanism did not exist whereby these resources could be effectively managed or protected from overexploitation, since the major fishing grounds are located in waters outside of State and Federal jurisdiction. With the passage of the Fishery Conservation and Management Act of 1976 (Public Law 94-265), which became effective March 1, 1977, a mechanism has been established whereby U.S. fishery resources within a 200 mile Fishery Conservation Zone can be rationally developed and managed.

I feel that a few comments concerning some of the provisions of this recent legislation are appropriate and pertinent to this workshop. While I realize that many of you are quite familiar with Public Law 94-265, others may not be cognizant of some of its provisions which are germane to the activities of this workshop.

One of the provisions contained in this piece of landmark legislation provides for the establishment of regional fishery management councils. In our region the South Atlantic Fishery Management Council has been established consisting of the States of North Carolina, South Carolina, Georgia and Florida (east coast). One of the primary functions of the Council is to prepare and submit to the Secretary of Commerce a fishery management plan for each fishery in its geographical area and to amend and refine these plans as necessary.

A decision has been made by the South Atlantic Fishery Management Council that the snapper/grouper fishery is a high priority fishery and that development of a fishery management plan will soon be undertaken.

It is now generally recognized that the traditional concept of maximum sustained yield (MSY) is seldom attainable for single species fisheries and its application is not particularly feasible when dealing with a multi-species fishery such as the snapper-grouper fishery. In addition, the concept of a MSY fails to recognize and take into consideration species interdependencies and relationships. For these and a number of other reasons which are discussed in a recent paper by Larkin entitled "An Epitaph for Maximum Sustained Yield" (Trans. Amer. Fish. Soc. 106(1): 1-11), it is apparent that the concept of MSY will not be sufficient for future management strategies. Recently in fishery management a new concept has evolved - the concept of optimum yield.

It is the concept of optimum yield which is specified as the basis for management under the Fishery Conservation and Management Act of 1976. There will be a number of national standards which must be incorporated in fishery management plans promulgated under this legislation. One of these is to prevent overfishing while achieving, on a continuous basis, an optimum yield from each fishery.

The eclectic concept of optimum yield has been defined by Philip Roedel (American Fisheries Society Symposium on Optimum Sustainable Yield, 1975) as "a deliberate melding of biological, economic, social and political values designed to produce the maximum benefit to society from a given stock of fish". According to the Fishery Conservation and Management Act of 1976, optimum yield is defined as "the amount of fish which will provide the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities; and which is prescribed as such on the basis of the maximum sustainable yield from such fishery, as modified by any economic, social or ecological factor."

It is readily apparent that in addition to traditional biological data fishery managers will also have to consider economic and social data in future management formulae developed under this legislation. Problems will arise in trying to apply definitions of optimum yield, to "real world" situations. To date, no guidelines or criteria have been established for formulating a management plan under the concept of optimum yield. Indeed as one begins to consider the concept, it soon becomes apparent that optimum yield is capable of being many things to many people; and that any criteria developed will surely depend in part on the fishery being considered...
and the individuals formulating the management regime.

Developing a management plan based on optimum yield for any fishery will be a difficult and complex task. This will be especially true for the snapper/grouper resources in our region because much of the basic biological data needed are simply not available, even for the more important and common species. The amount and quality of social and economic data available to use in any snapper/grouper management plan is even more limited. Also, fishery managers will be dealing with a multi-species fishery and not a directed fishery in which there is a single target species. Similarly, it is a multi-gear fishery; one in which there will be allocation problems between U.S. recreational and commercial interests as well as between foreign nationals and American fishermen. These are but a few of the problems which will be encountered by fishery managers and decision makers in formulating a fishery management plan for snapper/grouper resources of the region.

The workshop has two primary objectives. The first is to acquaint persons in the region having an interest in snapper/grouper resources with one another and with current research and development activities. This will be accomplished during this morning's general session. The second objective is to obtain input from knowledgeable and interested individuals and to exchange ideas on what types of information are needed concerning future management and development of the snapper/grouper resources. These informational needs will be addressed during the special sessions and the second general session.
Objective(s) of the Activity

To collect size composition, species composition, and catch and effort data on the commercial snapper and grouper fishery in South Carolina.

Brief Description of Activity

Port sampling to obtain species and size composition of the offshore demersal catch and total landings have been conducted since February of 1976. Vessel captains are interviewed after each trip to determine area fished, duration of trip (total and actual fishing days) and size of crew. Scale samples of red snapper are collected for age and growth studies by the Marine Resources Research Institute.

Presentation

Prior to 1976, commercial exploitation of snapper and grouper stocks on the South Carolina shelf was primarily conducted by transient boats landing catches in Florida ports. Only two or three local boats fished for snappers and groupers prior to 1976. Local shrimpers fishing sea bass traps in the off season for shrimp also did occasional hand lining for snapper and groupers. In early 1976, the success of a Sea Grant demonstration examining the feasibility of offshore trawling for snappers and groupers stimulated interest in commercial production of these species. In April of 1976, with the encouragement of a local seafood company, the first Florida handline vessel relocated in Charleston, South Carolina. Apparently the success of initial trips as well as favorable prices caused additional vessels to relocate in this area. Twelve hand line vessels (electric reels) were based in South Carolina during the summer of 1976.

It was initially expected that handline boats would return to Florida during winter months. However, six vessels remained and fished throughout the winter. Three additional vessels arrived in early 1977 increasing the number of handline vessels operating in the state to nine. Additional vessels may locate here later this year. We've also determined by interviews that at least four Florida based vessels regularly fished South Carolina waters during the spring, summer and fall months.

Commercial landings of snapper, groupers and porgies in South Carolina averaged 43,500 pounds during 1970-1974. In 1976, landings of these species increased to approximately 450,000 pounds. Roller-rigged trawlers operating during February through May 1976 accounted for an estimated 66,000 pounds. In addition to the 450,000 pounds landed in South Carolina, it is conservatively estimated that an additional 180,000 pounds of snapper/grouper and associated species were taken off the Carolinas and landed in Florida during 1976.

The rapid increase in commercial landings focused attention on the need for a sampling program to collect information necessary for management of these stocks. In response to this need the Marine Resources Division initiated a sampling program to monitor offshore commercial catches. When handline vessels began landing fish here, sampling was expanded to cover them. The present port sampling program is a cooperative effort between the Office of Conservation and Management (Fish Management Unit) and the Marine Resources Research Institute (MARMAP Program).

Sampling teams collect data on the area and depth strata fished through personal interviews with fishermen. This information is usually supplied in terms of a heading off Charleston or some other prominent coastal landmark with a range of depths fished; for example, 25 to 30 fathoms, 110 degrees off
the Charleston Sea Buoy. Asking more specific questions about the location usually makes the fisherman uneasy. Data concerning total trip length, actual fishing days to include search time, crew size and the number of reels and number of hooks fished are also collected. A current file on South Carolina waters which includes vessel length, power, navigational and fish location equipment, etc. is maintained which allows us to identify changes in relative fishing success.

Catch sampling is conducted as fish are unloaded. Species composition data is reported for each vessel. The poundage by species is recorded from payment records kept by the fish company for each vessel. This information is collected at the end of each month. Then, we take the data collected at the time of unloading and match it with catch data to calculate monthly catch totals and nominal catch per unit effort.

Port sampling personnel are responsible for identification of fish and must know the market names used for a particular species. In contrast to the Gulf of Mexico snapper fishery (reviewed by Carpenter) where as many as eleven species were marketed as red snappers, the fish company where we sample does not mix species. Thus, their records appear to reflect catches accurately by species.

I would like to present some of the data on species composition for handline vessels from our sampling efforts to date. Red snapper, *Lutjanus campechanus*, averaged 17.2 percent of the catch by weight during the period of May 1976 through February of 1977. It ranged from a low of 5.7 percent in August to a high of 29.8 percent in February of 1977. The silk snapper, *Lutjanus vivanus*, averaged 2.3 percent ranging from 9.9 percent in September to 0.4 percent in June. No silk snapper were landed from November 1976 through February 1977. The reason for this is unknown, but it seemed that when boats fished the Frying Pan Shoal area they caught most of their silk or "yellow eye" snapper. Perhaps the absence of silk snapper in catches indicates that vessels are not fishing in the Frying Pan Shoal area due to inclement weather. Vermillion snapper, *Rhomboplites aurorubens*, averaged 13.2 percent of the catch, ranging from a low of 3.0 percent in February 1977 to a high of 35 percent in September 1976. The gag grouper, *Mycteroperca microlepis*, averaged 30 percent of the catch, ranging from a low of 15.8 percent in February 1977 to 44.3 percent in June 1976. The scamp grouper, *Mycteroperca phenax*, averaged 10.0 percent of the catch by weight, ranging from a low of 1.2 percent in May 1976 to 20.3 percent in July 1976. Scamp have been very scarce in catches since December of last year. They were scarce in January and none were reported in February of 1977. Again, the reason for this is unknown. Speckled hind, *Epinephelus drummondhayi*, averaged 3.4 percent of the catch, ranging from a low of 1.3 percent in May to 6.2 percent in July. The red porgy, *Pagrus acadicus*, averaged

23.2 percent by weight, a minimum of 12.9 percent in September and a maximum of 35.5 percent in February of this year.

Length composition of the catch is also determined at dockside. A random sample of 50 individuals or the entire catch, whichever is less, from each species is measured. In addition to length measurements taken at the fish house, red snapper scales are collected for age and growth studies. Otoliths from groupers and snappers are not presently being collected because traditional collection methods deform the fish for marketing and the present sampling arrangement requires that we complete all samples and measurements without impeding the work of packing fish.

MARMAP personnel are working on a technique which will allow us to collect otoliths without disfiguring fish. Then we can work out some agreement where we can set fish aside, collect samples, and return them for packing.

**Comments, Questions and Answers**

Q. You point out that an additional failing of commercial fishery statistics is the fact that when you're not present, everything is called groupers. Now, apparently, processors separate catches to gag, scamp and speckled hind. However, if the catches become more diversified, through the addition of snowy and yellowedge grouper as a result of deeper fishing, they will continue to separate by species?

A. We've got people in the fish house, sampling personnel, who definitely know what is being packed and what market name is associated with it.

Q. If they aren't there, will the fish house follow through on their record keeping?

A. I found them to be very consistent in keeping records and surprisingly, they pack species by species. I haven't seen mixed species yet.

Q. Do they get the same price for each of those species?

A. Initially they were paying boats the same price for gag and scamp grouper although they were packing and shipping them separately. Now, they are paying a premium for scamp which is five cents a pound higher.

Q. Does the fish house that handles it get the same price?

A. I suspect not. I don't know what price the fish house is getting but from what I'm told
scamp commands a premium price and I suspect that they are getting a higher price for this fish.

C. You may find, particularly with some snappers since they look similar to each other, that if red snapper is getting a better price, they'll start grouping everything under red snapper; thus, you may have some difficulty with your record keeping.

C. That may be the case when it actually hits the New York market. I'm sure there's a number of species that are going for red snapper. As far as packing in the fish house at the time we get our records, they pay fishermen different prices for different species so they're always careful to know exactly what poundage they've got for each species. I suspect that when they actually hit the retail market the dealer may be getting red snapper price for all of them.

Q. Does the availability of fish house payment records to you result from strictly a cooperative arrangement?
A. Strictly a cooperative agreement.

Q. You didn't mention Warsaw or red grouper and I would like to know if they are being caught?
A. Warsaw is not one of the major species. I've got some figures on Warsaw. In February of 1977, it made up 13.0 percent of the catch by weight but for the rest of the year, it's been around 1.0 and 1.4 percent of the catch. Red grouper is very seldom encountered in the commercial catch.

Q. One of the predominant groupers in our area (Georgia) is the gray. Did you see any of those?
A. I believe the gray is what I'm calling the gag.

Q. Do you have any figures for price per pound for mixed groupers?
A. Yes, scamp now is 65c per pound to the boat and 60c for gag or gray snapper and 55c for speckled hind. Warsaw I'm not sure; I think Warsaw is about 45c.

Q. Is this the present price this month?
A. Yes. This is what boats have been paid. It's been pretty consistent throughout the year. I suspect it's somewhat higher on the New York market but this is what boats that we have been working with in this area are receiving for fish now.

Q. Are the fishermen that have moved here the better fishermen from Florida or are they just ones that are trying to scout a new area?
A. That's hard to say. We seem to have a range of fishermen.

Publications Resulting from Activity
Objective(s) of the Activity

Stock Assessment

Brief Description of Activity

The present MARMAP program includes efforts to:

1) validate aging techniques
2) identify and describe larval and juvenile stages
3) describe areas of "live bottom" habitat
4) develop sampling gear for stock assessment over untrawlable bottom areas

The future MARMAP program should include efforts to:

1) monitor population age structure from commercial fisheries and virgin stocks
2) define stocks as single or multiple through tagging, larval drift and recruitment studies
3) empirically determine potential yields in local areas
4) routinely monitor stocks over untrawlable bottom areas.

Presentation

I would like to present a brief introduction to the South Carolina MARMAP Program. MARMAP, for those of you who aren't familiar with the acronym, means Marine Resources Monitoring Assessment and Prediction. Our MARMAP Program is a cooperative effort between the National Marine Fishery Service and the Marine Resources Center here in Charleston. We like to think of the program as an integration of research efforts on adult fish stocks and ichthyoplankton. We conduct two major cruises annually between Cape Fear, North Carolina and Cape Canaveral, Florida on the R/V DOLPHIN to survey groundfish populations between 10 and 366 meters (Figure 1). Recently, we have computerized all data for rapid access and retrieval. My presentation will be a brief overview of the groundfish program. Howard Powles will discuss some of the results in ichthyoplankton research on the snapper-grouper complex.

First, our groundfish program has been evaluating techniques for assessing fish stocks, such as snappers and groupers, that are not adequately sampled by the standard MARMAP 3/4 version of a Yankee No. 36 trawl that we normally use offshore. With our sampling techniques, we are attempting to make rough estimates of relative abundance of species found in inshore sponge-coral habitats and offshore rocky outcrop habitats within the region between Cape Fear and Cape Canaveral. The gear and techniques that we have been investigating include: fishing with traps, trawls, snapper reels, and observations with TV and cameras. We have looked at the effectiveness of the local blackfish trap and a "mini-S" trap. Several local fishermen have taken blackfish pots offshore and occasionally filled them with red snapper. The "mini-S" trap is a small modification of the larger antillean "S" trap and is more easily transported and handled offshore. We have observed underwater transects with television and motion picture cameras in an attempt to enumerate fish species seen near the bottom in sponge-coral habitats. We heard this morning that good commercial fishermen have the ability to set on or near a small rocky outcrop area, do some fancy jockeying with their small boat and pull up their trawl with a sizeable catch. When we use the MARMAP half-hour trawl procedure in a rocky area, we usually leave the trawl on the bottom or pull it up ripped to pieces. We have examined the possibility of doing some site specific, short duration trawls with a URI highrise trawl. Even that may not be feasible in offshore rocky outcrop habitats. We may also conduct hook and line (snapper reel) sampling in untrawlable areas.

The study of gear for assessment of the snapper-grouper complex was initiated in June 1976. At that time, we conducted SCUBA dives to observe the response of fish populations of inshore sponge-coral habitats to several sampling methods. This work was limited to
FIGURE 1. The location of bottom trawl stations of MARMAP Cruise DP7701 conducted between January and February, 1977.
depths of 20 to 30 meters. We did not see snappers, and caught only a few groupers during the highrise trawling. In May 1977 we hope to move further offshore into areas that are fished regularly by commercial fisherman in order to find snappers and groupers and other species of rough bottom habitat.

Another aspect of the program is investigation of the life history of red snapper from the Carolina Bight. Specimens and data have been obtained through sampling the commercial catch. We hope to obtain further samples of gonads, stomachs and age-growth material by accompanying fishermen in the field. Presently, we have preliminary information on maturity, fecundity and food habits. We are attempting to validate age-growth techniques for red snapper and several groupers. We have just obtained a small Isomet slow speed saw and hope to begin thin sectioning of grouper otoliths in the near future. Obtaining large numbers of otoliths from fish species of the commercial catch will necessitate development of a technique for removal of otoliths from below the skull without disfiguring the fish or reducing its market value.

Many of the fish species that we catch in large numbers during routine monitoring may serve as food sources for offshore groupers and snappers (Table 1). Descriptions of the distribution and relative abundance and estimates of biomass and potential yield are almost complete for approximately twenty groundfish species commonly collected by the standard 3/4 Yankee trawl. Many species are of ecological importance in the shelf area, especially over sand bottom habitats where the MARMAP trawl sample effectively. Information on the distribution and abundance of forage species correlated with the food habits of snapper-grouper species may help explain the distribution and abundance of the latter.

We intend to monitor population age structures of the snapper-grouper complex by sampling commercial catches and by independent sampling of the snapper-grouper stocks with several types of gear. We hope to investigate stock relationships, define whether or not stocks offshore are single or multiple units, whether each rock cropping has its own adult population, and the degree to which there may be movement between various areas. Complimentary information from studies of seasonal movements, larvae drift, and recruitment data from commercial catches, as well as independent sampling should help define unit stocks of priority species.

An interesting point is that in 3 1/2 years of trawling between Cape Fear and Cape Canaveral, we have seldom taken juvenile snappers or groupers. Juveniles are commonly collected in the Gulf of Mexico by shrimpers. Although we collected juvenile vermilion snapper and porgies, we did not see many young snappers or any groupers in bottom trawls. I don't believe shrimpers are their main recruitment to the fishery is still unknown. Is recruitment from local spawning or are larvae or juveniles entering our area from another area?

We hope to estimate the carrying capacity of rocky outcrop habitats and potential yields of priority species in local areas, especially small relatively virgin local areas, by intensively fishing a given area with one or more gears, and then by estimating the original population size by using the Leslie-Delury method. Monitoring a heavily fished area may also indicate the rate of replenishment of stocks to these habitats.

We would like to routinely monitor and assess groundfish stocks over untraversable areas which presents a difficult problem. Present methods and sampling gears are relatively old and inefficient compared to this country's space age technology and the technological advances that are occurring in other fields. We believe, to some extent, that hardware is available for obtaining better estimates of fish abundance. Hardware might include underwater TV with lowlight level intensifiers, improved types of side scan sonar and bioacoustical methods; all have been used experimentally but few are used routinely. Presently this type of hardware is either top secret or extremely expensive.

Now, I would like to introduce Howard Powles, who will describe the MARMAP ichthyoplankton work.

I want to briefly describe some of the work we've been doing on ichthyoplankton and some of the management questions plankton studies may be able to address. As mentioned earlier, we've been sampling from Cape Fear to Cape Canaveral since spring of 1973, and we have 1973 and 1974 plankton samples completely sorted by cruises covering all seasons. We use bongo nets which sample the water column from surface to bottom and neuston nets which sample the surface layer of the sea. We're examining distribution and abundance of all groups that we can identify, not just snappers and groupers, but we do have snapper, groupers, and sparid larvae in our samples. We have some baseline data for two years, 1973 and 1974. One of the problems we face, really the basic problem, is taxonomy of larvae. It's always a problem identifying larval fish and the only species of the snapper-grouper complex that we can now identify as larvae are vermilion snapper, Rhomboplites aurorubens, and red porgy, Pagrus pagrus. The best we can do with others is to treat them at family or subfamily level. Groupers
Table 1. Species of possible forage value commonly collected by MARMAP trawling between Capes Fear and Canaveral during four seasons (Fall, 1973; Spring and Summer, 1974; and Winter, 1975).

<table>
<thead>
<tr>
<th>Name</th>
<th>Total Catch (kg)</th>
<th>Average Catch/30 Minute Tow</th>
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</thead>
<tbody>
<tr>
<td>Southern porgy</td>
<td>2,285.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Round scad</td>
<td>528.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Tomtate</td>
<td>307.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Butterflyfish</td>
<td>285.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Spanish sardine</td>
<td>260.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Round herring</td>
<td>257.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Inshore lizardfish</td>
<td>225.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Sand perch</td>
<td>183.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Spotted hake</td>
<td>148.3</td>
<td>0.4</td>
</tr>
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</table>

represent the subfamily Epinephelinae of the family Serranidae and we can identify them to subfamily. Snappers (Lutjanidae) and porgies (other than red porgy) can be identified to family, grunts also. Porgies (Sparidae) and grunts (Pomadasyidae) seem to be more important in the sport fishery than in the commercial fishery.

One of the main questions we hope to address is whether assessment of snapper and grouper stocks is feasible using ichthyoplankton surveys. This technique has been developed in California mainly for sardines and anchovies. We wish to determine if this can be done for snappers and groupers. The answer to this question is "no", because we get so few larval snappers and groupers that the amount of sampling needed to catch enough to give a statistically reliable population estimate would not be economically feasible (Table 2). For example,

Table 2. Numbers of larval Lutjanidae, Serranidae and Sparidae taken in neuston and bongo sampler tows in South Atlantic Bight in 1973 and 1974.

<table>
<thead>
<tr>
<th>LUTJANIDAE</th>
<th>Number/Station</th>
<th>Number/Station</th>
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<tbody>
<tr>
<td>Rhomboplites aurorubens</td>
<td>0.23</td>
<td>0.24</td>
</tr>
<tr>
<td>Unclassified</td>
<td>0.38</td>
<td>0.18</td>
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<table>
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<tr>
<th>SERRANIDAE</th>
<th>Number/Station</th>
<th>Number/Station</th>
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<tbody>
<tr>
<td>Anthiinae</td>
<td>0.78</td>
<td>0.22</td>
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<tr>
<td>Epinephelinae</td>
<td>0.18</td>
<td>0.27</td>
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<tr>
<td>Liopropominae</td>
<td>0.09</td>
<td>3.70</td>
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<td>Serranidae</td>
<td>0.14</td>
<td>3.46</td>
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<table>
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<th>SPARIDAE</th>
<th>Number/Station</th>
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<tbody>
<tr>
<td>Pagrus sedecim</td>
<td>0.17</td>
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<tr>
<td>Unclassified</td>
<td>0.17</td>
<td>3.24</td>
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NUMBER OF STATIONS

219

245

*Excluding single large catch of 704 specimens.
in 1973 and 1974, we got 135 snapper larvae in the bongo net and 103 in the neuston net. This is out of a total of some tens of thousands of fish larvae. Less than 1 percent of our total catch was snapper larvae. We got 39 grouper larvae in the bongo net and 67 in the neuston net during 1973 and 1974. Larvae of these groups are not abundant enough to obtain a population estimate. One interesting thing is that spur-rig larvae are extremely rare even though adults of these fishes are quite abundant. We wonder whether these larvae are not planktonic, or go to the bottom very early in their larval lives. It would be an interesting subject for some further work.

Another question we've been trying to address is that of stock identity. Are South Atlantic snappers and groupers endemic or are they an extension of Caribbean and Gulf of Mexico stocks? We can obtain some insight into this question by examining the sizes of larvae. Figure 2 represents the size distributions of larvae of the three groups that are most important; the epinephelines, unclassified lutjanids and vermilion snapper. This demonstrates that small larvae occur in our area.

If you look at the distribution of the unclassified lutjanid larvae sampled within the South Atlantic Bight (Figure 3), it is apparent that they are distributed throughout this area. The same general distribution pattern is found for grouper and vermilion snapper larvae. Two to 3 mm larvae are about three or four days post-spawning, considering the time for the egg to hatch and larvae to grow to this size. A rough average velocity for the Gulf Stream is about two knots (from Sverdrup, Johnson and Fleming); this is the velocity at the Florida Straits, not somewhat further north. We estimate that at this speed, larvae would drift about 200 nautical miles in four days. The north-south extent of the South Atlantic Bight from Cape Canaveral to Cape Fear is about 350 nautical miles. Thus, larvae in the northern end of our area probably were spawned within our area. It appears we have some spawning within the South Atlantic Bight and it seems that at least as a first approximation we can treat this as a unit stock rather than as an extended stock. We still have to decide the extent of inward drift of larvae from the Caribbean and Gulf of Mexico, and whether we have northward loss of larvae from our stocks.

The "unit stocks" of adult fishes may be isolated groups of fishes which do not necessarily reproduce themselves and which are attached to individual reefs and rocks. So sedentary are these fishes believed to be, that individual groups may be managed successfully under different schemes (on a yield per recruit basis) even though they are isolated by only a few kilometers. On the other hand, from the genetic point of view, I venture there is but one western Atlantic unit stock for each of many reef species. Given that most species have pelagic larvae and given the existence of the Gulf Stream, and various gyres and countercurrents, etc. it seems likely that there is relatively free genetic exchange between many small population units in the Caribbean, Gulf and South Atlantic area. Moreover, the same currents responsible for this exchange may, at least in some years, completely disperse larvae from a local spawning site replacing them with larvae from elsewhere. Consequently, the determination that we have spawning populations of reef fishes off the South Atlantic states does not necessarily mean that we have unit stocks of those species here.

C. I should have been more conservative in describing what conditions may be here. I do think you're quite right, that we do have incoming larval drift from south of here, and I'm sure we have larval loss from our population to the north; but I think preliminary information indicates that there is probably some retention of larvae within our area. There are good hydrographic mechanisms for keeping some larvae within the area. I think we need to design a sampling program to examine what's going out to determine the extent of ingress and egress of larvae. Your point is well taken.
FIGURE 2. Size distributions of larvae of groupers (Epinephelinae), snappers (Lutjanidae) and vermilion snappers (Romboplites aurorubens) in the South Atlantic Bight.
FIGURE 3. Distributions of smallest larvae of snappers (other than vermillion snapper) in the South Atlantic Bight, summer, 1974.
Objective(s) of the Activity

To determine the feasibility of using the URI high-rise trawl off South Carolina to fish for demersal finfish resources on "live-bottom" areas.

Brief Description of Activity

The South Carolina Sea Grant Marine Advisory Program purchased a URI 60/80 high-rise trawl which was provided, on a loan basis, to a local commercial fisherman. In return for the use of the net, the commercial fisherman provided information on areas fished, fishing effort, composition and size of catches, and operating costs. The objectives of this activity were to determine the feasibility of using this type of gear off South Carolina and, if found to be feasible, to encourage the development of finfish trawl fishery. Such a fishery could support components of the shrimp trawl fishery during the off-season for shrimp, thereby utilizing a portion of the significant latent capital and labor resources which exist during this period.

Presentation

Prior to the introduction of the University of Rhode Island high-rise fish trawl in South Carolina, there was little experience with and very little use of fish trawls here before 1973. There was a program during 1974 in which a Yankee 36 net was used by a Georgetown shrimp trawler. This boat was outfitted with a net reel and the Yankee 36 net equipped with "cookie" type rollers. Unfortunately, it never caught very many commercially valuable fish including snapper or grouper.

Last year the Sea Grant Program was approached by a group of Charleston fishermen who were interested in trawling for fish. These fishermen came to us seeking advice as to what type of gear might be better than the Yankee net. We were aware of work being done at the University of Rhode Island, primarily by Bert Hillier, in development of a high-rise trawl which has a greater vertical opening than the standard Yankee net. We contacted Bert and, after talking with local fishermen, Bert modified his net somewhat for our conditions and boats.

Sea Grant purchased a URI 60/80 net and loaned it to a Shem Creek fisherman. This particular net had a 60 foot headrope, 80 foot sweep and 8 inch mesh in the wings dropping down to a 3 inch mesh in the bag. The twine was 42 thread except for 36 thread in the 3 inch mesh sections. The sweep on the purchased net used 6 inch "cookies" - rubber discs punched out of truck tires - and was strung on ½ inch steel wire and 3/8 inch chain. The net came with standard 7'x42" Watebeke bracket hung doors. That was quite a heavy rig. The doors weighed 750 pounds each and the nets around 1000 pounds. The Sea Grant net was fished from the 65 foot trawler "Dixiana" powered by a V-12-71 G.M. on a 5.16 to 1 gear.

When we rigged the boat, one of the main considerations was to see if we could convert a shrimp trawler to fish trawling with minimum modifications. Rather than using gallow the boat was rigged with a heavy towing block on the port outrigger just inboard of the try-net block. Extra stays were added to take the increased strain from the fish net. While this may not have been the ideal rig, it was simple and it did work.

The net was fished with 20 foot bridles and 20 foot leg lines which were attached directly to the doors shrimper style, and this was somewhat different from the way Hillier designed the net to be used. Bert recommended 20 fathom leg lines based on his modeling of the net and was predicting 20 feet of vertical opening with the long leg lines. In New England they use the Danleno rig in which they hook wings to bridles and then to leg lines which are attached to doors by means of a backstrap. Shrimpers hook up the fish trawl the same way they do shrimp nets and put the leg line from the head rope to the top of the door and the one from the sweep to the bottom of the door. As you can see this will give you more head rope height with much shorter guard cables.

The fisherman using the URI high-rise trawl had a great deal of experience hand lining and pot fishing before he tried trawl-
ing and a lot of knowledge of offshore fishing grounds. When the fathometer indicated numerous fish, a buoy would be thrown over and a drag made around it. The best towing speed for the vessel was 1450 RPM. Most of the tows made earlier in the season were one half hour. Toward the end of the season he increased this to an hour.

When the net was hauled aboard at the end of the drag, the doors were pulled up to the towing block. The lazy line was used to pull the bag alongside the boat the same as in shrimping. The URI net was equipped with a splitting strap, but about the only time it was needed was with one 40 box drag.

There was one thing apparent with fish trawling offshore that was quite different from shrimping. When a shrimper goes out, he is going on a day trip and is very close to the dock. If something breaks or gets fouled in the gear, the shrimper can just come back to the dock, get on the telephone and have someone repair the net. Trawling offshore is a different matter. If a cable pops or something, the fisherman has to splice it himself or repair his nets at sea.

Our captains and crews must learn these skills if they are going to be successful offshore dragger captains. We have observed that the shrimpers that are going into fish trawling are the most progressive captains who are more willing to learn new skills and do those tasks which shrimpers traditionally have not done. In fish trawling you find that hanging up and tearing the net are the rule rather than the exception.

What makes it all worthwhile is what comes across the back deck. Last year the "Dixiana" in 17 days away from the dock, caught about 35,000 pounds of marketable fish, of which approximately 30% were red snapper, 25% vermilion snapper, and 15% groupers.

In a typical drag there was very little trash and almost no bottom growth. Occasionally a large loggerhead sponge would be brought aboard. Most dragging was done during daylight hours with little success at night. At sunset and sunrise one or two drags could be made that would yield predominately vermilion.

Fishing this year has been hampered by poor weather and boats have gotten off to a slow start. Last year we had several 100 box trips and 110 boxes on a two day trip. This year I don't think anyone has gotten 100 boxes on a trip. Most trips this year have been 30-35 boxes.

This year, as a result of the success of the initial vessel, we have 11 boats which have high-rise nets. Of these, one is the net which belongs to the Sea Grant Program which we've loaned to a Beaufort boat to try there. The other nets were made locally either in Charleston or Beaufort. Fishermen themselves are investing money and effort to get nets built. It's about $2,500 for a net. A local shop in Charleston is making the doors, copying those from New England. As more people enter the fishery, new ways of rigging are being developed. In some fishing operations, both doors are towed from one outrigger and one block. Now some boats are pulling both doors from one outrigger with two towing blocks using two tow wires and both drums on the winch. Also, some boats are pulling one door from each outrigger and using two wires. There are several boats that are rigged like old single rig boats, going from the winch to a towing block on the outrigger and then back to either a chain or what the shrimpers call a roll bar - a structure on the back that goes across the stern of the boat from which they tow.

One problem has been maneuvering the boat once it gets on the grounds. There is a very small area in which one can fish. Pulling nets from one outrigger has not been as much of a maneuvering problem as it seemed at first because boats are almost constantly in a turn the whole time they are dragging because they fish in very, very small areas.

Another problem that the fishermen have had was that the bracket door tended to snag in areas of rough bottom. In fact, the doors have been hanging up even more than the belly of the net or the sweep. The Chinese Vee door may solve this problem. We purchased a set of these doors which have been used in North Carolina. The Chinese Vee door comes to a 15 degree angle which helps it to deflect obstacles. There is a semicircular brail instead of a bracket which is hinged to tow from. The brail tends to deflect and is not as apt to be caught on the bottom as the standard New England bracket door. While spreading of the net with Vee doors is not as great as with the flat bracket door, I think it is probably going to work better for our bottom because it can fish a much rougher bottom. You are not as likely to get caught. Now we have a boat that is using our URI net and is fishing alongside another boat which is using his net but our Vee doors. Already a couple of Charleston boats have built Vee doors using our plans.

Another thing fishermen have gone to, are big rollers instead of cookies. In this area, we've been calling nets with little rubber disc roller nets, but true rollers are about 24 inches in diameter. The ones we're using now are 24 inch rollers. Rollers on the wings of the net are cone shaped rather than cylindrical. We found that we can drag a much harder bottom with these rollers, bottoms that couldn't have been trolled last year without hanging or really tugging. One can go right over it with these rollers. Thus, I expect
as time progresses, boats that do stay in the snapper/grouper fishery will probably go to rollers of one sort or another. Some people in Charleston have fabricated home made rollers out of big pieces of oak that work better than nothing. Manufactured rollers cost about $34.00 each, which are quite expensive.

A major problem for fishermen is marketing. When fishermen come in, they must unload and pack fish themselves. Also, fishing time is limited in the winter due to weather. Finally, most fish are put on consignment to New York and it may be 10 days to 2 weeks before they know the price they're going to receive.

Comments, Questions and Answers

Q. Are trawl caught fish graded or sorted by species before being placed in the ice hold of the vessel?
A. No, the catch is usually sorted and prepared for shipping after it has been unloaded.

Q. Are small red snapper and vermilion snapper culled and thrown overboard?
A. Generally they aren't and in fact, I know of at least one time this year when small vermilion snappers were bringing a very good price.

Q. What is the general condition of trawl caught fish?
A. They are usually in very good condition.

Q. Very good relative to living or relative to being eaten?
A. Relative to being eaten.

Q. Are there many discards during the trawling operation?
A. No, there are very few fish thrown back overboard. Of the boats fishing last year, most fish caught were marketable. There were very few undersize fish and very few non-market species.

Q. Are fish going primarily to the New York market?
A. Primarily.

Q. And in what form are they going? Are they dressed or shipped in the round?
A. Generally only grouper and large snapper are eviscerated.

Q. Are there any indications that roller trawls are damaging "live-bottom" areas?
A. The only indications that I have are what they bring up in bottom growth. The catches usually contain very little bottom growth but I have no way of definitely assessing what the damages are, if any.

Publications Resulting from Activity

Objective(s) of the Activity

To investigate the fishes and fisheries of the subtropical outer continental shelf of the South Atlantic Bight to determine the ultimate productivity of resident stocks.

Brief Description of Activity

Our research program which operated in North and South Carolina from 1972 through 1975 and was extended to include Georgia and Florida in 1976, consists of three major activities.

1) Monitoring of catch and effort in the headboat fishery.
2) Description of life histories and population dynamics of fish species important to the fishery. Utilizing a catch sampling program that collects data on about 9500 individual fish annually (10,000 in 1975; 9,000 in 1976), we have completed studies of foods, reproduction, age and growth, mortality, and/or have constructed yield per recruit models for red porgy, vermilion snapper, gag, red snapper and white grunt.
3) Measurement of standing stocks of fishes on a selected reef. We are conducting studies of reef fish biomass on a reef 35 miles SSE of Beaufort, N. C., through both visual assessment by divers and by mark-recapture techniques in order to guide future studies of standing stocks in the entire South Atlantic Bight. Additionally, our diving studies furnish valuable information on the ecology of these northernmost tropical reefs.

Our research program contains three subprograms: 1) a headboat survey; 2) life history studies; and 3) population and community ecology studies.

The headboat survey involves measurement of catch and effort of all headboats in the South Atlantic Bight. Reasoning that headboats represented the principal fishery on snapper-grouper stocks off the South Atlantic states, we instituted the survey to determine the magnitude and species composition of the catch, and to establish a series of annual catch per unit effort measurements to be used as an index of stock abundance. The survey covered only North Carolina and South Carolina in 1972, 1973, 1974, and 1975 but was extended to include Georgia and the coast of Florida north of Cape Canaveral in 1976.

Our measurement procedure has two phases. First, we have a member of the crew from each vessel maintain a daily record of the catch, by number of each species, number of anglers, and location of fishing. Second, port samplers weigh and measure fish during vessel unloadings to provide information on the mean size of fish caught. Multiplying the number of each species caught by the mean weight per species estimates the weight caught of each species. These catches by species are presented by time and area strata along with summaries of effort expressed in angler days.

While the headboat fishery is probably the most important snapper-grouper fishery over the entire Bight, considerable participation by private vessels in Florida, and an increase in commercial fishing in the late 1970's indicate the need for expansion of survey efforts to maintain useful information on changes in fish stock sizes, in fishing success and in their probable causes.

Even though the fish species that support the South Atlantic Bight headboat fishery have supported indigenous native fisheries for cen-
turies throughout the Caribbean region, and in the United States, and have sustained an important commercial fishery for nearly a century, we had reasonably complete life history information for only two of the thirty or more fishes important in catches. We have undertaken a series of life history studies of those fishes important to the headboat fishery. Taking species in approximate order in which they are important (by weight caught), we are attempting first to determine those life history parameters requisite to management of the fishery, such as growth rates, mortality rates, and reproductive characteristics. Secondly, we have conducted studies of foods when we were able. To this date we have conducted life history research on red porgy, Pagrus andenia; vermilion snapper, Rhomboplites aurorubens; white grunt, Haemulon plumieri; gag, Mycteroperca microlepis; tomate, Haemulon aurolineatum; and gray tilefish, Caesiochirus mirolo. Currently research is underway on speckled hind, Epinephelus drummondhayi; and snowy grouper, E. niveatus.

Materials for life history studies are collected from all major species in the headboat fishery by port samplers, and substantial collections are available for future study. The scamp, Mycteroperca phenax, and the whitebone porgy, Calamus leucosteus, are candidates for study in the immediate future.

The third facet of our research is an attempt to understand the sizes, structure and movements of reef fish populations. From 1972 through mid-1975 we tagged fish extensively from Cape Hatteras to Savannah, releasing about 5,000 tags in a search for gross estimates of population movements and sizes. The effort was, in general, unsuccessful because of a very low return rate resulting from tag loss and relatively low exploitation rates on sites where we tagged. We adjudged that we did not have the resources to conduct extensive tagging programs successfully, and that our efforts would best be expended in an intensive study of a well defined site. Accordingly we chose a reef area, the "210 rock" 28 miles SSE of Beaufort Inlet in Onslow Bay and began simultaneous tagging experiments and visual transect estimations in order to estimate seasonal populations of these reefs. This work begun in September 1975, has been successful. Tag return rates are sufficiently high for use, and our bi-weekly diving transects are offering new insights into behavior of reef fish populations.

A final portion of our research is the synthesis of results of our and others' research into a management philosophy for reef fishes (the snapper-grouper complex). Using yield per recruit models, we have estimated a preliminary maximum sustained yield for reef fishes of the South Atlantic Bight and presented the consequences of some alternate management schemes.

Publications Resulting from Activity


Huntsman, G. R. and R. L. Dixon. 1976. Recreational catches of four species...