7. Probable Distribution in 5 and 10 Years.

Using this knowledge and the knowledge of current direction and rate of flow we are in a position to make an estimate as to the probable distribution of the sponges five and ten years hence. The most rapid rate of distribution of the wool sponges can be expected along the path of the shore and eddy current in the north, which within a 10 year period should spread the sponges to the 12 and 13 fathom depths in the area south of Carrabelle, where the sponge beds were very productive and a considerable amount of the bottom is considered to be good sponge bottom. The area next in importance is that on either side of the quartz sand strip extending from the mouth of the Suwannee River in a WSW direction. A third Gulfward distribution is taking place west of Anclote Key and Tarpon Springs.

What value this extension of the sponging area will be is difficult to evaluate at the present time. The men presently engaged in the offshore diving are older divers who limit themselves to six and seven fathoms of depth. Since, with the exception of an area south of St. Marks and Carrabelle, the expected new grounds will be into depths greater than seven fathoms they will not be of significant value to the industry.

The greatest value of any extension in the grounds will be in spreading the fishing pressure over a greater area. Larger sponges will then be allowed to grow on all the beds, which, by increasing natural spawning, will bring about an increased density of the sponge population. This increased population and density of population, if used wisely, will result in an increased take per unit of effort, bringing about a greater and sorely needed financial return to the individual sponger engaged in this industry.

DISCUSSION

Biological Session

Discussion Leader: DAVID WALLACE

Discussion Panel: EDWIN S. IVERSEN, R. WINSTON MENZEL, ARTHUR MARSHALL, RICHARD ROBINS

Scientific Investigations of the Atlantic Coast Menhaden

FRED JUNE

Q. Olcott: Are biologists agreed on the reason for the disappearance of the menhaden from Maine?

A. June: The hypothesis is that the disappearance of the fish was caused by a general cooling of the waters there in the early 1870's, and that spawning and survival were unsuccessful due to this cooling. We are now experiencing a gradual warming in this area, and the northern population is again building up.

Mowbray (Comment): You have mentioned the occurrence of schooling menhaden at sub-surface depths. A recent investigation of mine pointed out the occurrence of schooling fish at about the 90-100 foot depth off Bermuda. Since menhaden are entirely plankton feeders, this apparent depth preference may be of some

value to the industry in locating fish by finding the depth at which plankton is most abundant.

Bullis (Comment): This depth may represent the level of the thermocline. In the Gulf of Mexico the "normal" range of the themocline falls near the 100 foot mark and to temperature sensitive organisms this might be an important barrier.

June (Comment): When menhaden were being caught below the surface, a companion vessel was taking bathythermograph readings, and we found that the thermocline and the fish occurred at the same depth.

Studies on the Life History of Spotted Sea Trout, Cynoscion nebulosus (C. & V.)

DURBIN TABB

Q. Iversen: What is known of the temperature tolerances of the spotted weakfish?

A. Tabb: There are few accurate records of the effects of temperature on the behavior of this species, but from personal observations and a search of the literature, I suspect that 48°F. is near the minimum temperature tolerated.

Q. Robins: What can you tell us about the effects of dredging and spoil disposal as it relates to the various stages of the life history that you have mentioned?

A. Tabb: The apparent value of the dredged channels to wintering and spawning trout has been a striking feature of this study. Dredging has been carried out for many years in the Indian and Banana rivers and fishing has not appeared to suffer. The building of the inter-coastal waterway, with the resulting deep channel and parallel spoil bank islands created deeps and shallows for spawning and feeding which formerly were not available. The immediate effects of dredging, particularly during spawning time, may be harmful but I suspect that the long run effects are not detrimental unless the spoil is not dumped judiciously.

Q. Marshall: What do you mean by judicious dumping of spoil?

A. Tabb: The spoil from large dredging operations, such as that involved in creating the inter-coastal waterway, may create shallow feeding areas in water which formerly was too deep to support marine grasses. This is favorable from the standpoint of the feeding juvenile spotted sea trout, as well as that of mullet and other species. Another aspect is the chilling of the water which takes place by wind mixing, due to altered current patterns. The lagoons in the study area lie in a north-south direction and the average depth is small. When the strong winter winds sweep in with rapid drops in temperature, the mixing and chilling of the river water is rapid and sometimes fatal to the trout, since the fish often have a great distance to travel before the shelter of warmer

ocean water is reached. Spoil banks or islands slow down the force of the wind and dredged channels provide the deep water which the fish seek for protection from cold. However, spoil banks can create poor water circulation and stagnation by damming off bays.

Q. Stein: Do you know the spawning habits of the spotted sea trout?

A. Tabb: This species apparently spawns in the deepest part of the channels. Eggs from plankton tows were always most numerous in areas of deep water. Small spotted sea trout can always be taken in channels until they reach a length of three to four inches. At this time, they become stronger swimmers, form into schools and spread out over the "grass flats." Studies of cell cleavage and studies of numbers of eggs available point to spawning from midnight till dawn.

Q. Clark: What causes differences in spotting in this species?

A. Tabb: This is probably just an example of aberrant color and pattern development. Red fish, which normally have but one spot at the root of the tail, often are found to have many spots. Often the spotted sea trout taken in the ocean will be quite pale until they are placed in brackish water. This causes the spotting to appear quickly.

Q. Marshall: What is the relationship between salinity and the occurrence of adult spotted sea trout in the Indian and Banana river systems?

A. Tabb: The adults occur commonly in water of eight to thirty-five parts per thousand, and are adversely affected by anything higher or lower.

Q. Menzel: Do you have information concerning sex ratio at various sizes and ages and differences in growth rate between sexes?

A. Tabb: In the zero year class the males appear to outnumber the females by about nine to one. After that the ratio of males to females drops until the fifth year when there are very few males remaining. The growth rate of males and females of the zero year class is about equal; however, the females of year class one through five exhibit a more rapid increase than do the males. The females were all mature by the time they had reached 18 inches total length while males were all mature by the time they had reached 12 inches total length.

Field and Laboratory Observations on the Growth of Some Bermuda Reef Fishes

JOHN E. BARDACH AND DAVID W. MENZEL

Q. Menzel: How did you catch your fish?

A. Bardach: In traps; diving equipment was used in observation and counting.

Q. Robins: Have you experienced any cases where a population was completely or partially depleted on a segment of reef? If so, have you observed that the fishes were replaced either by an

increase in growth rate of the young fishes or by an immigration of fishes from neighboring regions?

A. Bardach: We have not observed such depletion, but we have some evidence of movement between adjacent areas. We tagged fish on two adjacent reefs about 200 yards apart and about one hectare in size, and released them on the other reef. We then observed these fish for about six weeks, and found that groupers had a definite and strong homing tendency, while some of the predominantly herbivorous fish such as doctor fish and angel fish did not return to their home reefs but established themselves on the new reefs.

Q. Voss: In your aquarium experiments did the fish die or did you release them after the 20 to 30 days?

A. Bardach: They developed fungus growths so we released them.

Q. Voss: Were the reef areas that you examined separated by sand or grassy bottom or were they all part of the same reef?

A. Bardach: The reefs we studied most intensively were separated by sandy bottom at about fifty feet depth. However, we did make some comparative studies on unbroken larger reef areas, and we found that the isolated reefs apparently support a much larger population than the unbroken reef areas. Reasons for this seem to be the much greater amount of vertical wall space available, and the large association of gray snappers and grunts that are found in such situations.

Q. Mowbray: Was there any noticeable change in the composition of a population, particularly of larger fish, on a reef due to movements of individuals?

A. Bardach: Most of the serranids remain fairly stationary and associated with the same reefs, but over a period of a year or two there was considerable movement. It is likely that some of the rockfish of the genus *Mycteroperca* will grow to large sizes in the shallow reef environment, but this particular reef we studied was not the home base of any such animal. I have seen large specimens of *Mycteroperca* in about the same depth, but the Nassau grouper, for instance, does not seem to grow to sexual maturity in the shallow environment. I cannot say whether the individuals move out to deeper water or if there is a heavy mortality in the shallow environment.

Q. Mowbray: What kind of tags did you use?

A. Bardach: We used various kinds of tags, starting with the plastic streamer tags tied with nylon cord. These were affixed either just anterior or posterior to the dorsal fin. Some of those fish which move in and out of holes and crevices were tearing out tags. In the groupers, at least, we had a tag loss of about 30 per cent during the first three or four weeks. We switched to metal jaw tags but found that there was a decline in growth rate.

The fish on this particular reef were so tame after a while, that instead of hiding they came out to be counted. You could actually approach almost any fish to read the number

on his tag. In that manner we collected information on movements and habits of the fish.

Q. Stein: Did you notice if the snapper populations on the reef stayed there?

A. Bardach: The snappers that occur from about 50 feet, or shallower, were all gray snappers. We were able to observe several schools of these snappers on the reef for over a year. We caught several individuals out of each school and tagged them. The individuals rejoined their schools. During the day fish would cruise around the reefs and occasionally come up on the top of the reef, but more often would be found about half depth or even lower. They would be moving slowly, apparently without feeding. We caught fish on the other reefs and examined their stomachs, but I haven't seen any gray snapper stomach that was full during the day. Long and Hildebrand report the schools break up at night to feed, but I haven't done any night diving.

Problems Raised by Spearfishing in Florida Waters

JAMES MURDOCK

Q. Marshall: Anglers think that spearfishing depletes stocks which are local to a given reef, jetty or other such feature. What have the spearfishermen themselves to say on this matter?

A. Murdock: Spearfishermen have told me that there is a limit to the number of fish, and particularly large fish, that they can find. This is true of red snappers or any other fishes. Whether this fact is due to spearfishing activities is another matter.

Q. Marshall: Are the fish caught by spearfishermen of a different average size than those caught by anglers?

A. Murdock: Spearfishing is a more selective method of fishing than angling, but on the average there appears to be little difference. Occasionally spearfishermen land exceptionally large fish of 300 to 400 pounds. This size of fish is not usually landed by anglers, although commercial hook and line fishermen used to bring a few of them into Key West.

Q. Bardach: How much waste of fish takes place among spearfishermen who fish for sport? Also are speared fish readily saleable?

A. Murdock: The spearfisherman who sells his fish usually sells them to a restaurant, where after being dressed, there is no evidence of how they were caught. I have seen more waste by anglers than I have seen by spearfishermen. Spearfishermen who go on weekend trips often have a low catch. The reason his catch is low in many instances is because that is all the fish he desires to take home to consume or give to a friend.

Clark (Comment): There is considerable difference in the wastage of fish between the novice spearfisherman, as compared to the more experienced spearfisherman. The more spearfishing you do the more you appreciate the beauty of the fishes and you don't spear every fish that you see. In time spearfishermen turn into skindivers, they take up photography and they don't spear fish indiscriminately.

Q. Clark: When I first heard a proposal that spearfishing should be limited to the day-light hours, I thought it was a joke. The only extensive spearfishing I've seen at night has not been of the usual kind, under water, but has been conducted by wading in knee deep water, or from a boat where you can throw the spear down into the water. Could you tell me something more about the methods used by commercial spearfishermen who go out at night and get several hundred pounds of fish? Are they completely submerged and do they use the methods of skindivers as we think of them in general?

A. Voss: The night spearfishing that was carried out at Palm Beach was done by groups of people who used electric lights below the water. Snook around these inlets were lying under the rocks in areas where there was only a slight current. They lay in heavy concentrations, facing the current. They were from 12 to about 20 pounds in size. One person would spot them with the light and two or three others would shoot them while they lay there, held like a deer when he is spotted. This was extremely destructive. At Ft. Lauderdale, charterboatmen have for many years fished for groupers and snappers on a certain reef in about 85 feet of water. Then spearfishermen found it and began catching out the big fish. The charterboatmen then moved out to the next reef, which was in 150 feet of water. This depth effectively stopped any spearfishing and now charterboatmen are getting bigger fish than they've ever gotten and more of them. They are satisfied and there is no quarrel between the groups. I have been asked to write to the A.A.U. asking them to outlaw spearfishing as not being a sport. It is evident to me that it is certainly a sport and the conflict is a matter of economic competition.

Q. Mowbray: I would like to compliment Mr. Murdock on the most impartial presentation of the question of spearfishing that I have ever heard; I agree with him from every angle. The problem here is similar to the one in Bermuda and it is as much psycological as it is anything else. We have regulated spearfishing in Bermuda by a gear restriction. Numerous people in the Islands had for years engaged in spearfishing by the use of a straight spear propelled entirely by the hand. Then the spear gun came into being and there were several accidents. The police decided that these guns came under the firearm act and that automatically banned them from public sale. Spearfishing is still permitted by hand spear. The average spearfisherman can get all the fish he will ever require for eating purposes by that method. As a matter of fact, experienced individuals can outfish a man with a gun by three or four to one. We have also barred the use of the aqualung or other devices for spearfishing. Finally, we have a bag limit, which is two individual specimens of each species per day, plus three lobsters.

Progressive Recovery of the Commercial Sponge Grounds of Florida

JOHN F. STORR

Q. Menzel: What are the possibilities of providing cultch for sponge?

A. Storr: There is enough rock to provide a settling surface for larval sponges without having to provide artificial cultch. The scattering of cultch would be impractical anyway since the sponges should not be closer than a yard apart.

Q. Menzel: Do you expect a recurrence of the sponge disease and are studies being conducted which might point out methods of controlling the disease?

A. Storr: The sponge disease has hit in many places during the past 50 years and may be expected again. Control of the disease is difficult because of the great areas involved. Usually, the density of the sponges in producing areas is so great that, even after disease hits, enough are left for seeding and it is just a matter of time till the area is back to normal. The lack of recovery after 1938 in the Florida beds was due, I believe, to the intense fishing pressure.

Q. Menzel: Is there a possibility of transplanting sponges into the area?

A. Storr: The possibility is there, but what the practical value of it would be is another question.

Q. Marshall: Could you give a resumé of sponging activities in the Ten Thousand Islands area and your estimate of future potentials for such activities in this area?

A. Storr: Sponges were first discovered in that area about 1935. They were affected by disease during 1938 but have now recovered considerably. According to reports of the fishermen, the greatest number of sponges are being taken in the Cape Sable area west of Shark River. They are growing so thickly that the take per day is about 1,000 sponges. The difficulty of sponging in the area is the turbidity of the water which makes sponging difficult. Under clear conditions during the early winter months the take is good. They say that the number of small sponges is tremendous and that productivity during the coming year should be excellent.

Q. Robins: Would it be possible to predict, by knowing the temperature of the water, when a certain sponge bed would not be able to make up in growth the amount that had been lost during the spawning period and due to cold weather?

A. Storr: You are referring to the fact that a sudden drop in temperature over a short period of time causes the sponges to withdraw the living material, leaving the sponging fibers exposed at the edges. This has also been observed in the field. We could only predict the extent of the withdrawal by further experiments.

Q. Clark: What do you think is the survival of sponges to about 1½ inches of size?

A. Storr: I believe that about one out of every two or three thousand

larvae are able to attach to the bottom and grow to that size. It is difficult to estimate what the natural mortality of the larger sponges would be because of the fishing that takes place. However, in areas where fishing does not take place the ratio of sponges of less than three inches in size to those about seven inches in size was about three to one. Apparently the rate of mortality is high, with only about 70 per cent of the sponges growing to maturity.

Q. Farley: What is the economic outlook for the sponge industry?

A. Storr: There is a rather poor economic outlook for the sponge industry. The reason for this is that the return per unit of effort has been low and as soon as the sponges begin to return the number of fishermen increases beyond the number that the beds can support. They should be encouraged not to increase their effort and to allow these sponges to return to their normal density and then the fishermen's return would increase by three to four fold. At the present time the average share of a deckhand, who gets one of the 12 shares of the boat, is about $600 to $700 annually, that is for the 100-150 days a year that he spends on the boat. Despite all this there is a gradual increase in the productivity of the beds and the price of sponges is staying up to around $7.20 a pound on the average so there is a good possibility that this industry could come back.

Wallace (Comment): I believe that the potential for natural sponges in the United States is good, in spite of the condition which existed in Florida since 1946. During the period from 1946 up to the present time the sponge supply has come from the Mediterranean and Cuba. The market has taken about as many sponges during that period as it was formerly taking from the Florida Coast up until 1946. I believe that the domestic industry can regain that market if they can produce at a level which will fill the needs of the market and on a fairly consistent basis. The fact that the Bahamas have this year opened their beds for the first time since 1939 and had a tremendous demand for their sponges, even though they had not been in the market at all for that period, is an indication of the demand for good quality natural sponges. The natural sponges must be of good quality to compete, but the potential is there for a very important advantage for the people on the Florida west coast.

Q. Voss: Is the larvae you speak about as being in the planktonic stage for about four days the sheepswool sponge larvae or that of some other species?

A. Storr: From the literature I gather that it is the sheepswool larvae. The reference is that they spend several days in the plankton state and I have taken four days to be the maximum length of survival. It may be that the larvae live for a longer period of time, but this has not been studied.

Q. Voss: Would you care to comment on the fact that so many of the sponge bars are below the level of the general stretch of bottom?

A. Storr: I assume that over the rocky bars the wave action is turned into turbulent action and the silt is put into suspension over the bars and carried away. Thus these bars could be maintained at those lower levels without being silted over.

Q. Voss: Can we get divers to work in the deeper areas after sponges become established there?

A. Storr: When these new beds are open in a few years they will not be able to be worked except by younger divers. There is controversy at Tarpon Springs about the advisibility of bringing over young Greek sponge divers to work these beds.

Q. Mrs. Voss: Does the growth rate of sponges differ in the various areas?

A. Storr: Yes, quite remarkably. At Sandy Key the growth rate was found by Moore to be 0.8 inches while generally it was 1-1.2 inches per year at Anclote Key. The lower growth rate at Sandy Key was attributed to the fact that there was less current action and less food. My observations seem to indicate that the growth rate is higher in shallow areas where current flow is greater, but the quality of the sponges produced in these areas is not as good as those grown in deeper water. With slower growth the sponge is more solid and of better quality.

Q. Williams: Has the sponge disease been recorded in other parts of the world? Do sponge divers encounter difficulty with sharks or barracuda?

A. Storr: I do not have reports of sponge diseases in the Mediterranean. They might have some diseases, but the effects have not been serious. The divers are sometimes bothered by sharks and barracuda, but not to a great extent. I have been attacked once by a barracuda, but that was after it had been irritated. The other diver had worn white shoes, which excited the barracuda. But I don't believe that many of these animals will attack you unless you excite them first.

Q. Bardach: Have very large cubic footage aqualung units been tried by any of the divers?

A. Storr: No, they haven't. My own inclination about using them is that they would be uneconomical. I believe that light weight diving equipment, such as I have, would be useful.

Q. Wallace: Are the possibilities for sponge farming available in the Gulf of Mexico?

A. Storr: Sponge farming could be carried on very successfully in the Gulf of Mexico, from the biological point of view. From the sociological point of view it is another question entirely and whether you can supervise these beds sufficiently and make sure that no one destroys these sponges I don't know.