This type of regulation would keep the various groups of fishermen apart and help to eliminate social conflicts. It also might serve to increase the total use of the Florida Keys area by fishermen, thus enhancing the economic status of this area.

The elimination of fishing pressure by spearfishermen in certain areas might help to increase the catches of anglers. On the other hand the establishment of areas exclusively for spearfishing might result in an increase in the total fishing pressure there, and as has been discussed previously, this may lead to a noticeable reduction of fish such as groupers in the area, resulting in lower individual catches by spearfishermen.

Under these circumstances consideration might then be given to the placing of size or bag limits upon the spearfishermen's catch. Continuous observation of the areas would be required to determine the desirability of this.

RECOMMENDATIONS

(1) Spearfishing should be recognized as a legitimate sport activity.
(2) Species restrictions, closed seasons and gear restrictions are not believed to be useful in solving the problems of spearfishing in Monroe County.
(3) Bag limits are not recommended at present.
(4) Area restrictions, prohibiting spearfishing in certain areas, but allowing this type of fishing to have the exclusive use of other areas, is suggested as a possible control.
(5) Night spearfishing with an artificial light should be banned.
(6) Sale of speared fish should be banned, as should sale of all fish caught by sport anglers.
(7) Spearfishermen should be obliged to secure a license from the State Board of Conservation, provided other types of sport fishermen are also licensed.
(8) The information needed to decide whether conservation is being served is lacking. Catch data and biological information concerning the local habitats and the biology of the fishes found there is essential. To gather and analyze basic data would require lengthy research, but it should be started.

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Progress of Recovery of the Commercial Sponge Beds of Florida

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THIS REPORT of progress of recovery of the commercial sponge beds of Florida is a phase of the over-all investigation of the Florida commercial sponges being carried out by The Marine Laboratory for the Fish and Wildlife Service through Saltonstall-Kennedy funds. The present paper is a progress report of the work under way.

[1]Contribution No. 180, The Marine Laboratory, University of Miami.

This problem of recovery of the sponge beds is discussed under the following headings:

1. Historical background.
2. Present distribution of the sponges in the upper Gulf.
3. Sponge productivity.
4. Growth rate of the sponges.
5. Present distribution related to ocean currents.
6. Factors affecting distribution.
7. Probable distribution in five and ten years.

1. Historical Background.

Through the years 1900 to 1938 an average of 350,000 pounds of sponges were taken per year. In late 1938 a disease or blight struck the beds killing off large quantities of the wool, grass, and yellow sponges, the three principal commercial species. Production during the next eight years was maintained at a level of about one-third of the previous average, but only as a result of a substantial increase of about 50 per cent in the sponging fleet. By 1946 the number of boats working the beds was 191, of which 75 were diving boats. The remarkable increase in the price of sponges, from $2.00 per pound to as much as $30.00 per pound during the war years, was responsible for this fishing pressure. At the same time, the number of pounds taken by each boat (the return per unit effort) was reduced from a high of 6,900 pounds in 1936 to a low of 1,200 in 1947. In 1947 the sponge beds were again attacked by a disease, which this time was most effective in destroying the wool sponges, leaving the grass and yellow sponges relatively unaffected. These species were later destroyed by 1951. In 1951 the sponge fleet had reached a low ebb of only two diving boats and 26 hook boats. Production during this year was less than three per cent of both the maximum value of 1944 and maximum take of 1936. According to reports received, commercial sponges at this time were to be found only in the shallow coastal waters of less than five fathoms in restricted areas along the coast.

2. Present Distribution.

One of the necessary phases in determining the distribution of the sponges has been a survey of the sponging grounds. On the deep water survey trip made in July of this year (1956) the services of regular sponge divers and a sponge diving boat were used. Each station of the trip consisted of one or more dives on a sponge bar to determine the presence of commercial sponges in depths from eight to seventeen fathoms. A collection of a representative group of the local plants and animals was made at the same time. On this trip the primary purpose was to establish the outer limits of the growth of the wool sponges. Two other shallow water survey trips were made in the fall of 1955 in one and one-half to nine fathoms of water. In all, 88 stations were established in the area from Tampa Bay to Carrabelle, comprising well over 100 dives. The shallow water survey trips were made aboard a small 30 foot cabin cruiser with the use of light weight diving equipment, consisting of a foam neoprene suit and Desco diving mask with the air supplied to the diver by a small compressor. The diving on these trips was done by the present investigator.

From the survey stations and additional reliable information from the diving boats, the present distribution of wool sponges in the northern portion of the Gulf appears to be limited to less than 10 fathoms. The most important work-

ing beds lie on the west and north of Anclote Key and in the areas between Cedar Keys and the Steinhatchee River and in the Rock Island area. In no area are the sponges growing in commercial quantity in water deeper than eight or nine fathoms and the most productvie areas are in water less than six fathoms.

The 1955 take by the hook boats in depths from one to three and a half fathoms of water was equal to that of the diving boats in three and a half to seven fathoms of water. Catch per unit effort is still low, approximately 1,800 pounds per year per boat, which indicates overfishing is taking place even with a very reduced sponging fleet.

3. Sponge Productivity.

The eggs in a sponge are concentrated in the lower two thirds with very few eggs developing near the periphery. (Fig. 1.)

Very little has been written about sperm transfer in the sponge. It is known that sperm are produced in quantity by one sponge, released into the water to be picked up by another from the in-current water during the normal feeding process. In a very recent paper by Lord Rothschild of Cambridge, England, on "Unorthodox Methods of Sperm Transfer," he states that in the sponges examined, the sperm is taken up by one of the choanocytes or flagellated collared cells much in the same way as a particle of food. He suggests that the choanocyte picking up the spermatozoon is always the one closest to an egg cell or ovum. The choanocyte, on ingesting the spermatozoon, regresses or changes to an amoebocyte cell. The egg cell acquires both this cell and a nurse cell and, after enlargement of the ovum, the spermatozoon is transferred from the regressed choanocyte to complete the fertilization process. This process suggests that an ovum of the sponge will not enlarge unless triggered by the presence of a sperm in an adjacent sperm-holding cell, or in other words that sponge eggs are not visible to the naked eye unless sperm have been picked up from the water and have fertilized the ova.

It has been observed in the field that where wool sponges are widely scattered over the bottom the mature sponges either do not produce eggs or the number of eggs and larvae produced is very small. If the fertilization process just described, or a similar process, is the one used by the wool sponges it would explain the observed phenomenal lack of eggs in sponges in areas where the density of the population is light and the heavy production of eggs and larvae in mature sponges where the population density is high.

On the assumption that wool sponges are incapable of self fertilization, on the evidence available we can state that the density of sponges is a very important factor in productivity of the sponge bars.

When mature, the egg darkens in color and develops a circle or crown of cilia at one end and is then released into the water, where it is active for several days while being carried about by the ocean currents.

In a microscopic examination of the interior of a wool sponge the eggs can be discerned as small white spots about 0.5 mm (1/50th of an inch) in size, the larvae appearing darker in color. In the upper part of the Gulf only those sponges with a diameter of more than five and a half inches have been found to be producing eggs. (Fig. 2.)

Closer examination of the egg extracted from the sponge shows that the

FIGURE 1. Cross section of a wool sponge six inches in diameter. The sponge eggs are seen as small white dots throughout the flesh. The large canal at the left base of the sponge was made by a sponge crab, the others are either incurrent or excurrent canals of normal size. This sponge carried about 60,000 eggs. (x 2/3)

end on which the cilia will develop is again darker in color with the ring of cilia being readily identified.

4. Growth Rate of Sponge.

The third essential factor in estimating the progress of recovery of the sponge beds is establishment of the growth rate. The field work on this phase of the study has consisted of tagging and measuring sponges on productive

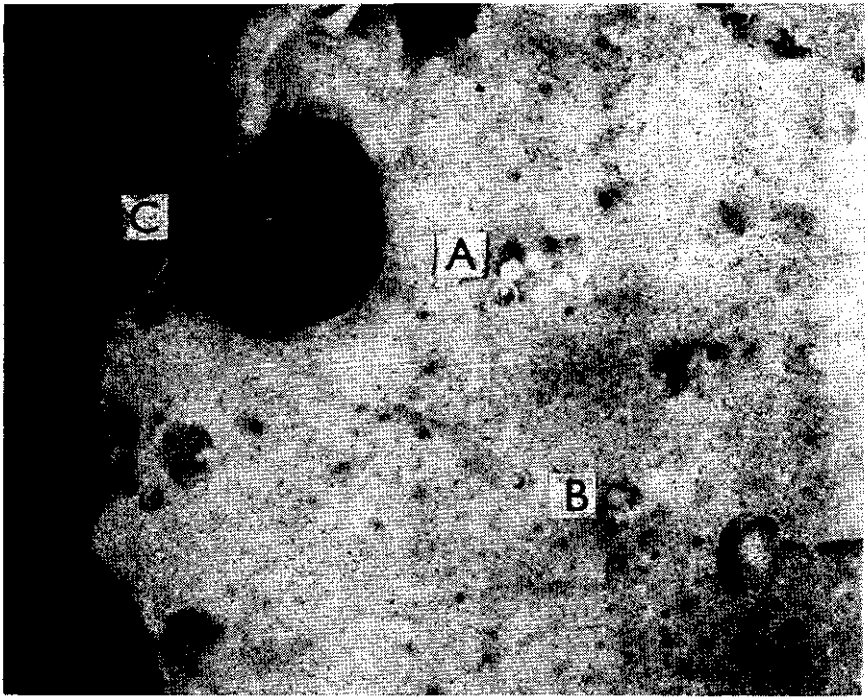

FIGURE 2. A magnified section of a mature sponge. The eggs to the right of A are fertilized growing eggs while to the right of B an egg has reached the larval stage and become darker in color. At C a section of the so called sponge "skin" covers over a subdermal canal. (x 50)

sponge bars. The sponge is tagged by wiring it to a code numbered brick and measuring its three dimensions with a measuring device, a modified sliding square. These data were then recorded on a piece of sanded plastic with an ordinary lead pencil. A number of wool, grass and yellow sponges have been tagged and measured.

From the data on growth rate collected to date, a growth curve for wool sponges has been compiled.

In the accompanying diagram the volumetric rate of increase, with growth obtained during this study, is compared with that determined by H. F. Moore and reported in the Bulletin of the Bureau of Fisheries in 1908. His four year's experiment was with the growth of cultivated sponges, starting with cuttings of about four cubic inches. For ease of understanding, the growth in volume is shown on the left hand side of the chart and in diameter on the right hand side of the chart. Moore determined the annual increase in diameter to be between one and 1.2 inches per year, with the solid line B representing an increase of about one inch per year found at Anclote Key, an island just seaward of Tarpon Springs. Dotted line A represents a rate of growth of about 1.25 inches per year, or just slightly above the maximum growth rate Moore found in his experimentation at Anclote Key. (Fig. 3.)

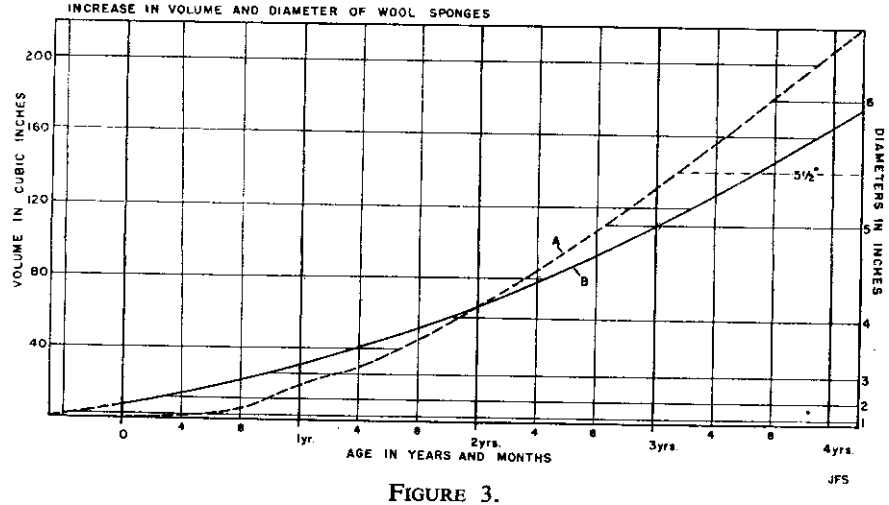

FIGURE 3.

5. Present Distribution Related To Ocean Currents.

The final factor essential to recovery of the sponge beds is the rate and direction of the distribution of sponge larvae to bring about new sponge growth. Considerable assistance in this phase of the work has been obtained from members of the Red Tide Project at The Marine Laboratory, who have been working on the current pattern of the Gulf, off the West Coast of Florida. Both the oceanographers and this author were agreeably surprised to find that the present extensions of the sponging areas fit very closely into the preliminary determination of the pattern of the currents. The most important current to sponge dispersal is a northward moving shoreward current. Just north of Tampa Bay the complete lack of sponges can be attributed to the lack of productive sponge beds upcurrent from the area and a reversed and shoreward moving current of water that prevents movement of the sponge larvae seaward. Where eddy currents move seaward along the coast at three points the distribution of the sponges is seen to be extended seaward. In the extreme northern part of the sponging area the elongated shorewise eddy and current is extending the distribution at the most rapid rate and this is reflected in the size distribution of the wool sponges in this area, with the smallest sponges being found at the leading edge of distribution. (Fig. 4.)

6. Factors Affecting Distribution.

Summarizing the factors affecting the rate of distribution we find:

(1) The water currents are of two kinds, permanent and tidal. The maximum rate of flow of the permanent current along the shore has been determined to be five miles per day, with the seaward eddy currents estimated at one mile per day. Tidal currents in the northern Gulf have been recorded at one half a knot. While the general trend of the permanent currents are northward or seaward, the tidal currents are generally running back and forth at right angles to the shore.

(2) It requires at least three years before sponges begin to produce eggs and larvae with the average sponge reaching maturity at an age of four years.

(3) The life span of the swimming larval form appears to be several days

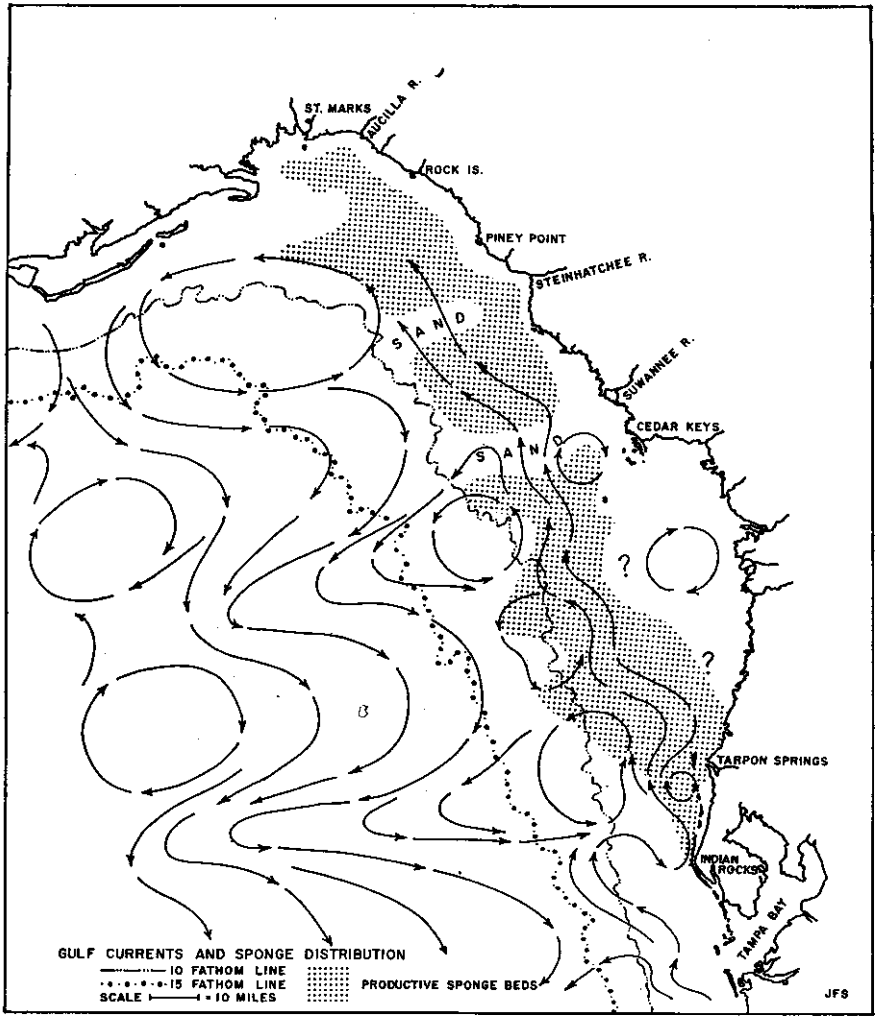

FIGURE 4. This chart shows the present distribution of the sponge beds in relation to the water currents of the upper Gulf. The current pattern shown is a preliminary determination by members of the Red Tide Project at The Marine Laboratory, University of Miami.

and for the sake of clarity we may assume that the maximum life span is four days.

Translating this into diagrammatic form and using the maximum values, a four day life span for the larval form and a current of five miles per day, the maximum distance a larva can be transported is 20 miles. Since it will require about four years for the average sponge to come into full egg productivity the maximum yearly advance of sponge distribution is about five miles.

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