ARTICLES

CLAM SURVEY OFF VIRGINIA

(Cape Charles to False Cape)

By Phillip S. Parker* and Lars A. Fahlen**

The third in a continuing series of surf clam (Spisula solidissima) surveys being made by the Bureau of Commercial Fisheries was completed off the coast of Virginia between May 1965 and May 1966. Its purpose was to explore for populations of surf clam; to determine its abundance and distribution and factors affecting its populations; and to collect data on other species of shellfish. Samples were taken at selected survey sites with a 48-inch hydraulic dredge. During the survey, 1,367 stations were occupied, and catches ranged from 0 to 9 bushels of surf clams per tow. Catch rates of 1 bushel per 4 minutes of towing time were obtained at 54 stations. Abundance, distribution, and size of clams varied considerably. Relations were noted between these variations and environmental data collected. Small populations of ocean quahogs (Arctica islandica) were widely scattered.

The surveys were made by BCF in conjunction with the Sea Clam Packers Association of the Oyster Institute of North America. They have become an integral part of the overall BCF study to determine facts relating to the life history and abundance of the surf clam.

During the past few years, the surf clam (Spisula solidissima) has exceeded both the hard clam (Mercenaria mercenaria) and soft shell clam (Mya arenaria) in production (table 1). Total surf clam production in 1965 was a record 44 million pounds of shucked meats (Groutage and Barker, 1967). Over 60 vessels are now engaged in the fishery. The center of the fishery still remains off the coast of New Jersey; 96 percent (42.3 million pounds of meats) of the total landings was made in New Jersey (Groutage and Barker, 1967).

Table 1 - Annual Production of Clam Meats for Three Species of Shellfish, 1961-65

Year	Surf Clams	Soft Shell Clams	Hard Clams
1961 1/	27,502,000	7,363,000	14,604,000
1962 1/	30,854,000	9,396,000	13,295,000
1963 1/	38,586,000	9,754,000	14,529,000
1964 1/	38,144,000	11,030,000	14,925,000
1965 2/	44,088,000	11,310,000	14,470,000

1/Source: Fishery Statistics of the U. S., 1961-64.
2/Source: Office of Statistical Services, BCF, Gloucester, Mass.

The surveys are designed to locate and define within each survey area beds of surf clams, to determine the size and extent of these beds, and to evaluate their potential for future commercial harvesting.

AREA OF OPERATION

The survey was completed in Area II, which lies off the coast of Virginia from about midpoint of the eastern shore peninsula down to False Cape, Va. (fig. 1). Its western boundary extends 54 miles northeastward to a point on the southern boundary of Area III at latitude 37°22' N. and longitude 75°16' W. From this point, its northern boundary follows the south boundary of Area III seaward and extends beyond the southeast corner of Area

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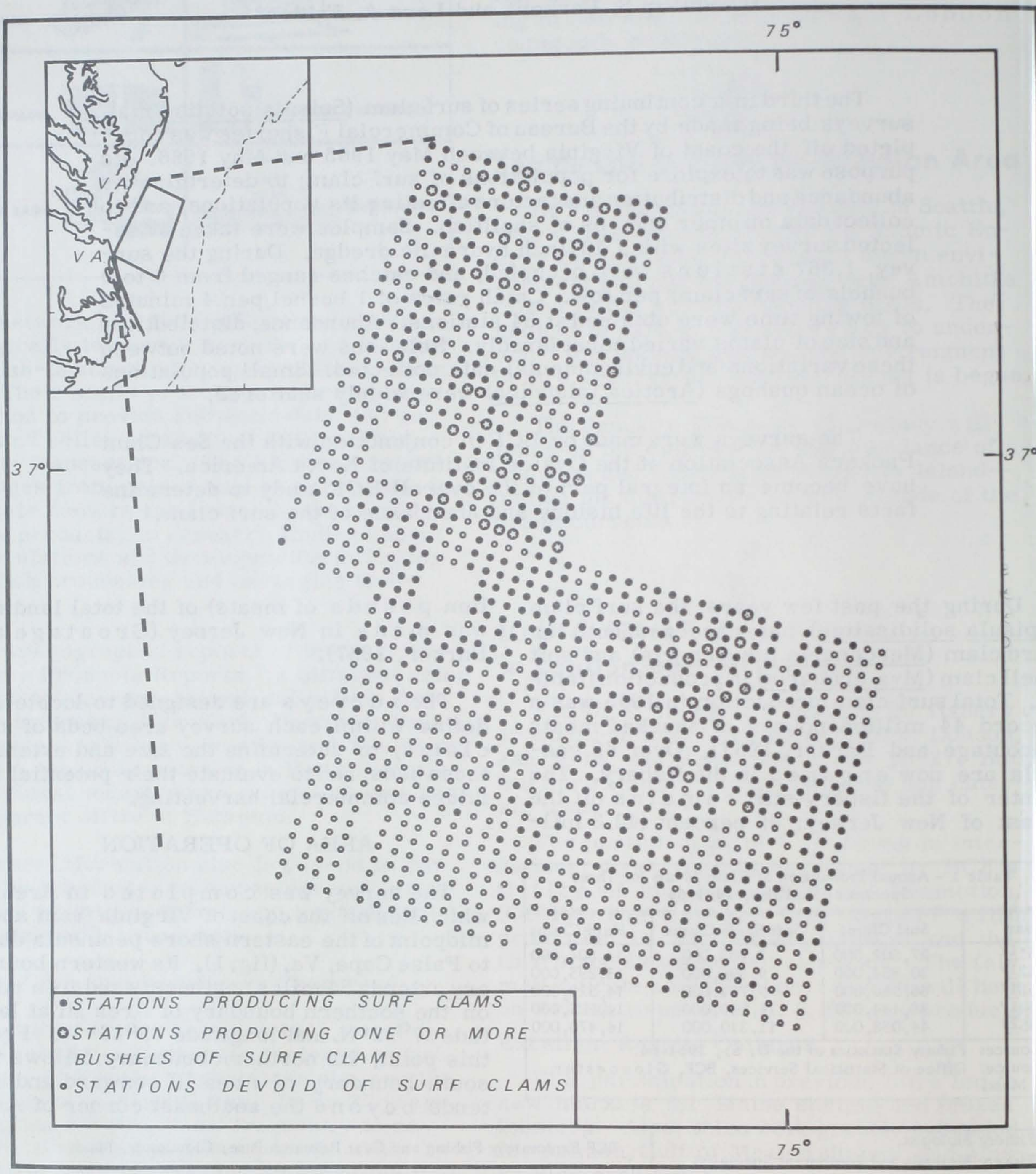

Fig. 1 - Chart of Area II showing location of individual survey stations.

III, until it reaches the 100-fathom contour at latitude 37°05' N. and longitude 74°35' W. From here, its eastern boundary runs southwestward to latitude 36°16' N. and longitude 75°02' W. Its southern boundary is formed by a line connecting this point with False Cape, Va. The area within these boundaries is 2,200 square miles. However, because of the presence of unexploded depth charges and other missiles, most of the northeast quadrant was bypassed, along with the inshore section of the southeast quadrant. About 1,400 square miles were left to survey.

GEAR AND EQUIPMENT

The survey of Area II was made from the Bureau's research vessel "Delaware," employing the same gear and equipment used in Area III and described by Parker (1967). We experimented to some extent with various manifold jet sizes on the 48-inch experimental dredge, but the resulting changes in water volume and pressure were so small that we were unable to detect any difference in the fishing efficiency of the dredge.

During one cruise, underwater television was used to observe the operation of the dredge fishing on the bottom. We were able to see that the blade of the dredge did not dig into the bottom until the water system was activated to cause the jets of water to dig a trench in front of the manifold. When the water system was shut off, the blade would rise immediately to the surface of the sea bottom. We also saw very little turbidity resulting from the hydraulic action of the manifold jets, and the turbulence caused by these jets was negligible. We failed to see live surf clams on the bottom, but saw many other forms of animal life during the period of television observation.

Attempts to take bottom temperatures with an electronic probe attached to the dredge proved unsuccessful because the transmission cable repeatedly parted between the dredge and the readout meter in the pilothouse.

Samples of material too small to be retained by the main dredge were collected in a small mesh retaining unit in the after cage of the dredge. Samples from this unit were placed in small plastic bags and frozen for later analysis shoreside.

PROCEDURE

The same general procedure was followed in the survey of Area II as was used during the 1963 survey in Areas IV and VI (Parker, 1966) and the 1964 and 1965 surveys in Area III (Parker, 1967). Each survey station was located at the intersection of predetermined grid lines running generally north to south and west to east (fig. 1). The main or north-south grid lines parallel the 1H5 Loran line in the area, whereas the secondary or station grid lines follow the 1H4 Loran line. We simplified the location of each sampling station and increased the ease of vessel navigation by employing this station system. Owing to the divergence or convergence of these grid lines in any single operational area, some discrepancies will occur in the distances between sampling stations. The discrepancies, however, are not of a magnitude that would cause concern over the reliability of the data. Each north-south grid line was positioned at a distance of 4 microseconds throughout Area II, whereas the east-west grid line interval was established at 12 microseconds.

The standard sampling tow was 4 minutes; however, because of bottom conditions in some sections, the tows were shortened. Several 20-minute simulated commercial tows were also made. Most tows were made at a propeller speed of 100 revolutions per minute, which we assumed gave a towing speed of about 1 knot. The propeller never dropped below 100 r.p.m., but, at times when strong head tides slowed the vessel, the revolutions per minute were increased to compensate for the tides.

At the completion of each tow, the dredge was hauled back aboard the vessel and dumped. The dredge was then returned to the bottom and towed to the next station, at which time the water system was activated and a sample taken.

Between stations or tows, clams and other collected material were measured. Materials were selected from the samples and saved for later analysis. Information on water temperatures, bottom sediments, and catch composition was also taken at this time.

RESULTS

In Area II, 1,421 sampling sites were occupied. Of these, 1,367 were tows of 2- or

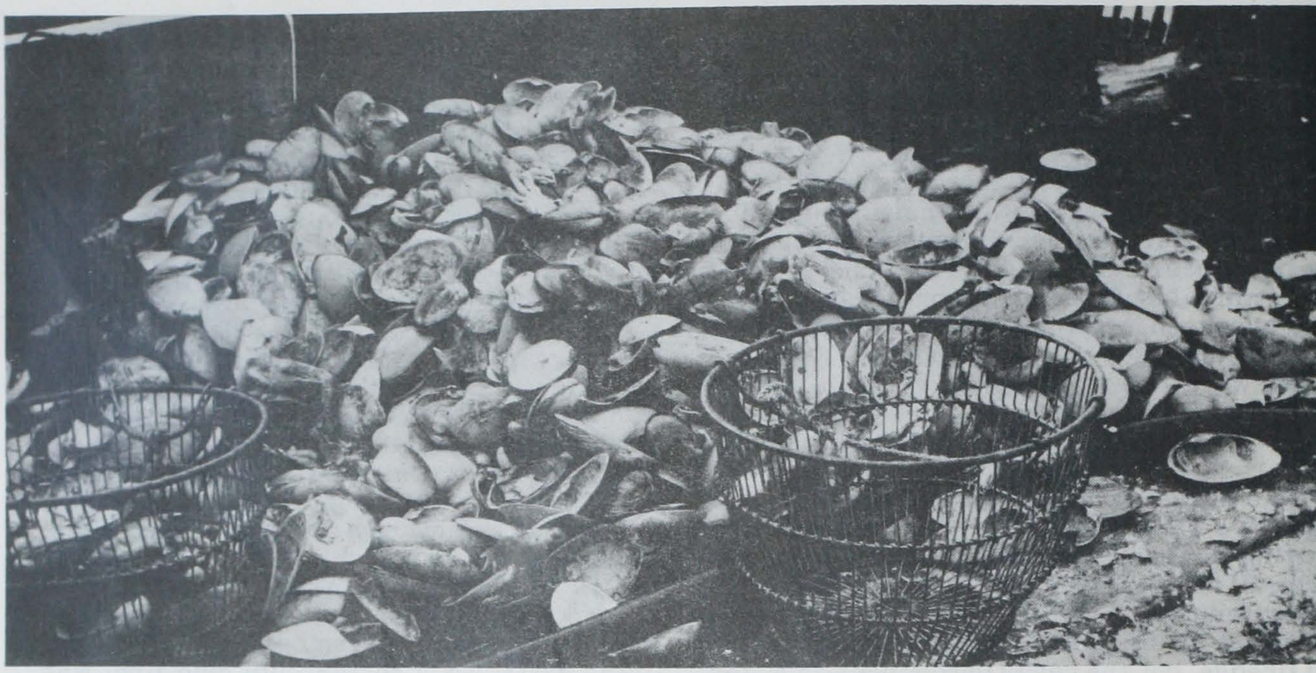

Fig 2 - Typical catch by a hydraulic jet dredge from most of the unexplored areas along the Middle and North Atlantic coast. Note the vast number of shells mixed in with the few live clams.

4-minute duration and the remaining 54 were simulated commercial tows of 20-minute duration.

Catches

Of the 1,367 tows (fig. 2), 717 took no surf clams, 596 caught from 1 surf clam to slightly less than 1 bushel, and 54 took 1 bushel or more (1.0 to 8.8 bushels).

To clarify better the results of the survey in Area II, we have subdivided the area into four sections (fig. 3) as follows: Section A--the northwest part of the area; Section B--the northeast section, which was bypassed in the survey because of the presence of unexploded depth charges; Section C--the southwest section; and Section D--the southeast part of the area.

Section A.--The most extensive populations of surf clams were in this section. The maximum catch rate of 2.2 bushels per minute of towing time, and 70 percent (38 tows) of the tows that caught 1 bushel or more per tow, occurred in Section A. The percentage of tows catching no clams was least from this section. Because of time restriction and bad weather, simulated commercial tows were not made. But, based on results in previous areas surveyed, we expect that catches in excess of 5 bushels per 20 minutes could have been taken in this section.

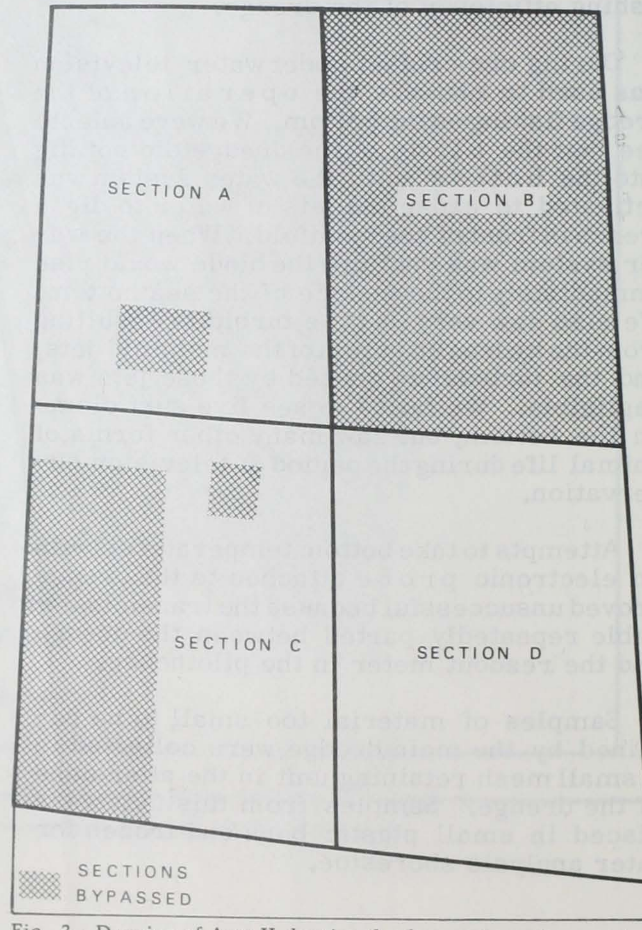

Fig. 3 - Drawing of Area II showing the four main sections and bypassed sections.

The average size of surf clams in this section was less than that in Section D, but considerably larger than that from Section C.

Section B.--Although no attempt was made to sample this section, we assume that surf clams exist there. Populations of surf clams were found north, west, and south of Section B.

Section C.--Surf clams were found in good quantities; however, the population structure in this section was different from the other surveyed sections. Here the number of clams in the commercial-size range (5 inches and above) was only 7.0 percent, compared to 81.0 percent in Section D and 65.0 percent in Section A. The percentage of surf clams in the medium-size range (3 to 5 inches) from Section C exceeded the percentage from the other two sections: Section C - 84.0, Section A - 32.0, and Section D - 18.0 percent.

Section D.--Dense surf clam populations were concentrated in about the middle of this section. However, the number and density of beds producing catches of 1 bushel or more per tow were less here than in Section A. The average size for clams taken over 4 inches (100 mm.) was much greater here than in either of the other two sections: Section D - 6 inches (153 mm.), Section A - 5.6 inches 143 mm.), and Section C - 4.6 inches (116 mm.). Between the eastern boundary of Section C and the dense beds of clams in this section, few surf clams were found. Beyond the outer edge of the dense beds, surf clams were again found in small numbers; however, they were still being taken in the tows made along the last grid line, which would indicate that they may be living beyond Area II.

Results obtained in this section from the 54 simulated commercial tows were poor. All catches took less than 5 bushels. These catches imply that the present population of

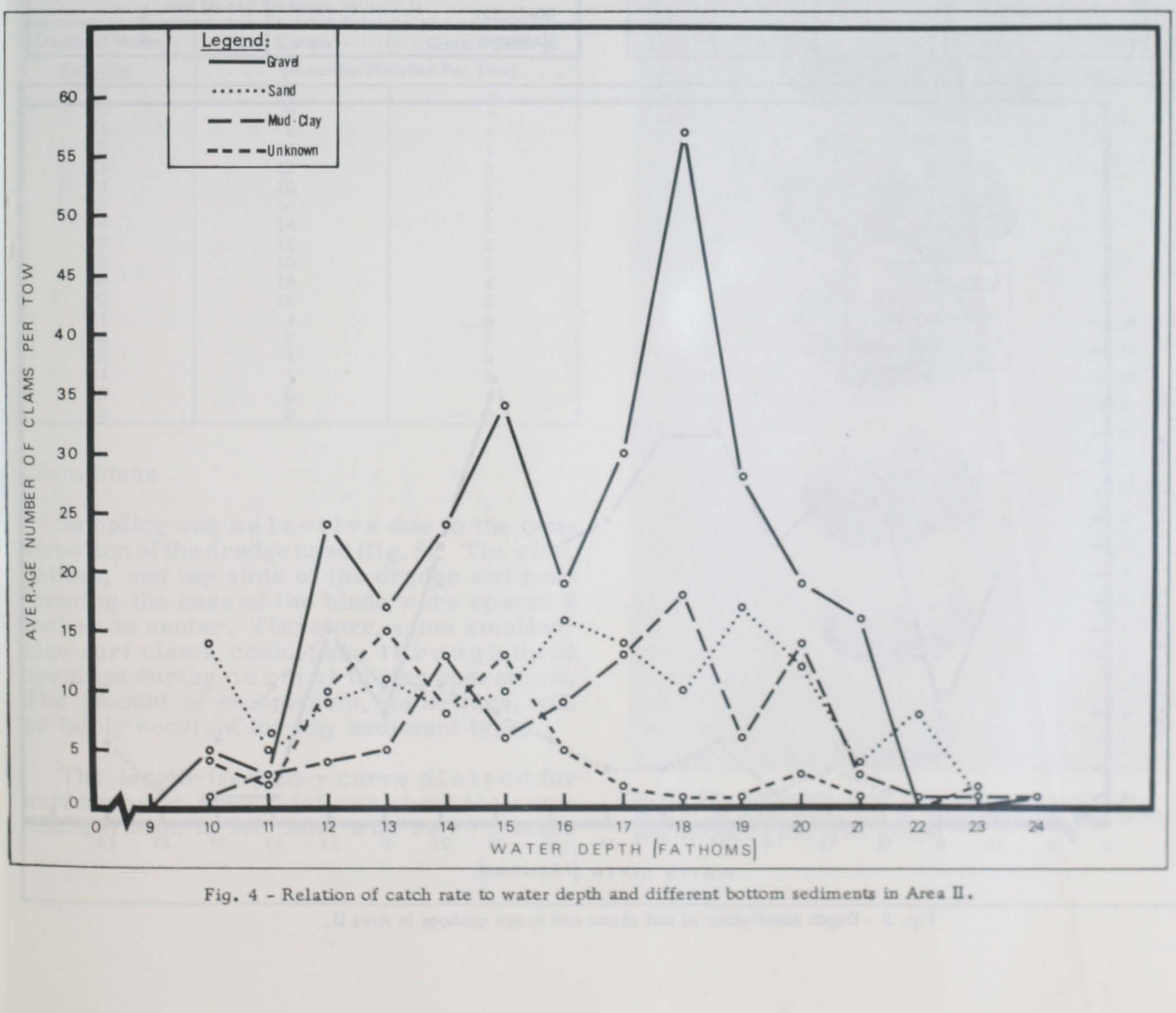

Fig. 4 - Relation of catch rate to water depth and different bottom sediments in Area II.

surf clams in this section would not sustain a commercial fishery.

Bottom Sediments

Area II data were compared to see if any relation could be found between the bottom sediments and the population of surf clams. A relation was found between the mean number of clams caught and the bottom type fished (fig. 4, table 2). The bottom in Area II was divided into four general classifications: (1) sand, (2) gravel, (3) mud, clay or a mixture of both, and (4) unknown. The types of bottom arranged with the most productive listed first are: (1) gravel, (2) sand, (3) mud-clay, and (4) unknown. The mean catch from stations with gravel bottom was 2 times that from sand, 3 times that from mud and clay, and about 6 times that from unknown sediments (table 3).

Table 2 - Catch Rate of Surf Clams by 1-Fathom Intervals for Different Sediments in Area II

Water Depth	Bottom Soil Types			
	Unknown	Mud-Clay	Sand	Gravel
Fathoms	. . . (Average Number of Clams Per Tow) . . .			
9	-	-	0	0
10	4	1	14	5
11	2	3	5	3
12	10	4	9	24
13	15	5	11	17
14	8	13	8	24
15	13	6	10	34
16	5	9	16	19
17	2	13	14	30
18	1	18	10	57
19	1	6	17	28
20	3	14	12	19
21	1	3	4	16
22	0	1	8	0
23	2	1	1	0
24	0	1	0	1

Table 3 - Mean Catch of Surf Clams Taken from Different Bottom Sediments in Area II

Bottom Sediment	Mean Catch of Clams
	Number
Gravel	25
Sand	11
Mud-clay	8
Unknown	4

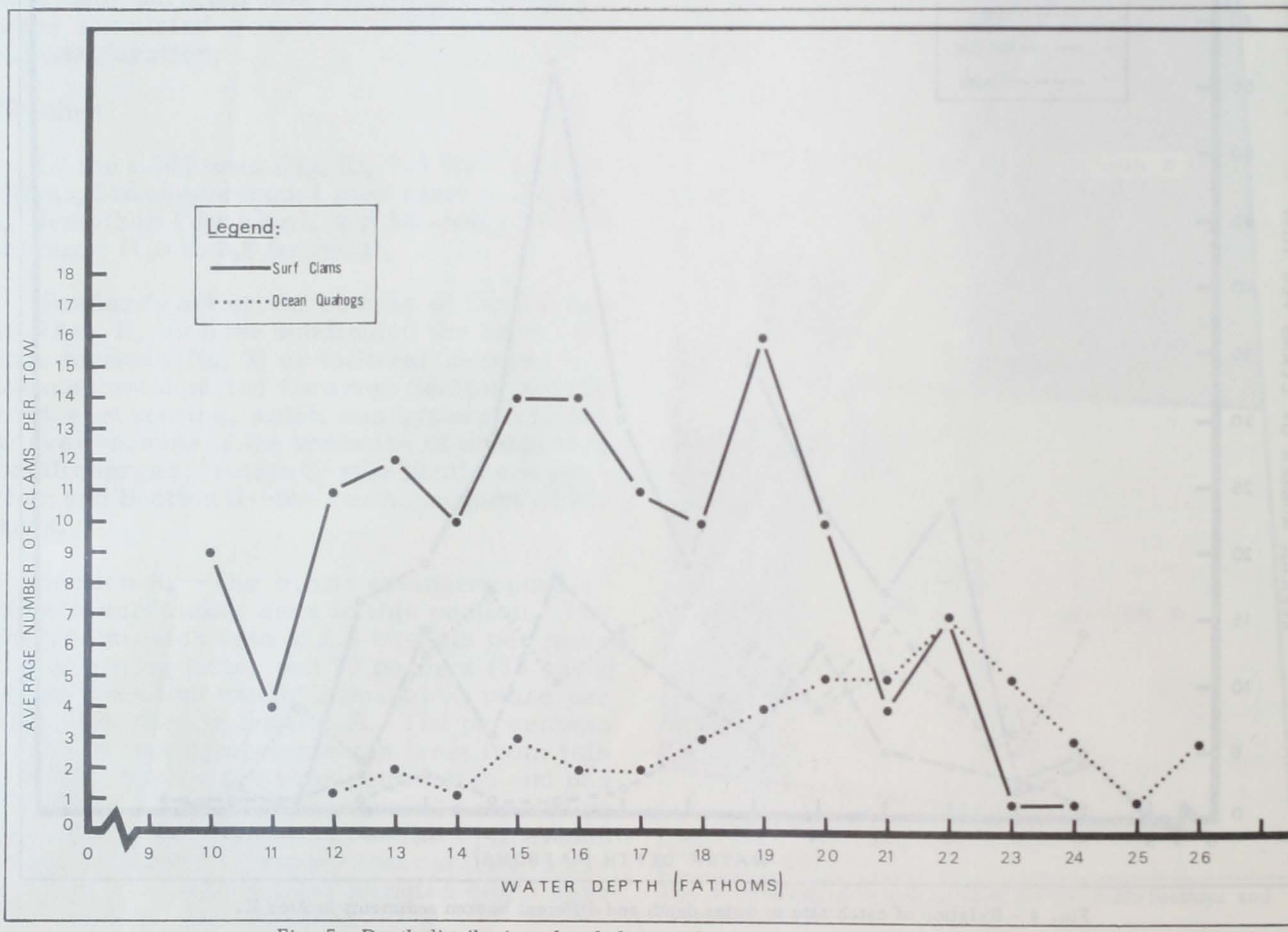

Fig. 5 - Depth distribution of surf clams and ocean quahogs in Area II.

Water Depths

Water depth and clam density data from Area II were compared to determine if any relation existed between the catch rate and the depth of water (as was found in Areas III and IV). In general, the pattern of catch rate and depth held true here as in the other two areas. The best catches of surf clams were made in those sections where the depth of water varied between 14 and 20 fathoms (fig. 5, table 4). Although the average catch in Area II was less for all depth intervals in comparison to Area III, the largest average catches were made at 19 fathoms in both areas. No surf clam was taken in either area at depths beyond 24 fathoms. The number of sites occupied in Area II in depths beyond 24 fathoms was considerably less than in Area III. The number of shallow water stations occupied in Area III exceeded those sampled in Area II.

Table 4 - Depth Distribution of Surf Clams and Ocean Quahogs in Area II

Depth of Water	Surf Clams	Ocean Quahogs
Fathoms	. . . (Average Number Per Tow) . . .	
9	0	-
10	9	-
11	4	-
12	11	1
13	12	2
14	10	1
15	14	3
16	14	2
17	11	2
18	10	3
19	16	4
20	10	5
21	4	5
22	7	7
23	1	5
24	1	3
25	0	1
26	0	3

Clam Sizes

Sampling was selective due to the construction of the dredge used (fig. 6). The side, bottom, and top slots of the dredge and rods forming the base of the blade were spaced 2 inches on center. Therefore, some smaller-size surf clams could pass through these openings during normal towing operations. The amount of escapement, we believe, will be fairly constant for any sediment type.

The length-frequency curve plotted for surf clams in Area II follows about the same configuration as for other surveyed areas

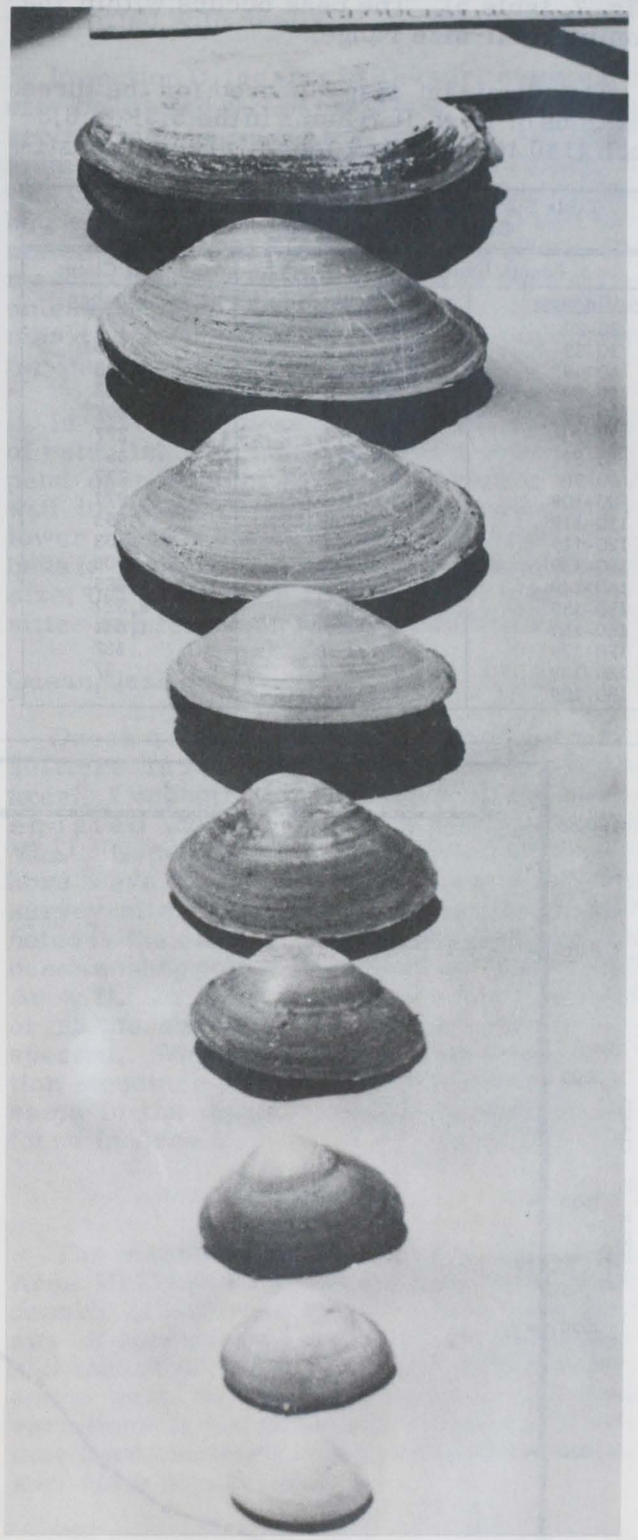

Fig. 6 - Size distribution of surf clams taken in a single tow. Most of the medium-size and all of the small-size clams could pass through the slots of the dredge.

(fig. 7, table 5). The peak occurs within the commercial-size range.

The dominant size differed for the three sections of Area II. Clams in the 5.5- to 6.3-inch (140 to 159 mm.) length groups constituted most of the catch from Section A (table 6). In Section C, medium-size clams prevail and very few clams were of commercial size. The percentage of clams in the 5.9- to 6.7-inch (150 to 169 mm.) size groups was greatest

Table 5 - Number of Surf Clams Taken in Area II in Each 10-Millimeter Length Group

Length Interval		Surf Clams
Millimeters	Inches	Number
20-29	0.8-1.1	5
30-39	1.2-1.5	10
40-49	1.6-1.9	33
50-59	2.0-2.3	83
60-69	2.4-2.7	207
70-79	2.8-3.1	277
80-89	3.1-3.5	452
90-99	3.5-3.9	777
100-109	3.9-4.3	971
110-119	4.3-4.7	593
120-129	4.7-5.1	503
130-139	5.1-5.5	908
140-149	5.5-5.9	1,895
150-159	5.9-6.3	2,521
160-169	6.3-6.7	1,641
170-179	6.7-7.0	387
180-189	7.1-7.4	37
190-199	7.5-7.8	1

Table 6 - Percentage of Surf Clams in Each 10-Millimeter Length Group for the Three Sections of Area II

Length Interval		Section A	Section C	Section D
Millimeters	Inches	(Percent)		
20-29	0.8-1.1	1/0	-	1/0
30-39	1.2-1.5	1/0	1/0	1/0
40-49	1.6-1.9	1	1/0	1/0
50-59	2.0-2.3	1	2	1
60-69	2.4-2.7	1	5	1
70-79	2.8-3.1	2	7	1
80-89	3.1-3.5	2	12	1
90-99	3.5-3.9	3	24	2
100-109	3.9-4.3	4	23	2
110-119	4.3-4.7	4	10	3
120-129	4.7-5.1	5	5	3
130-139	5.1-5.5	12	2	6
140-149	5.5-5.9	26	2	13
150-159	5.9-6.3	25	3	30
160-169	6.3-6.7	12	2	29
170-179	6.7-7.0	2	3	8
180-189	7.1-7.4	1/0	1/0	1/0
190-199	7.5-7.8	-	1/0	-

1/Less than 0.5.

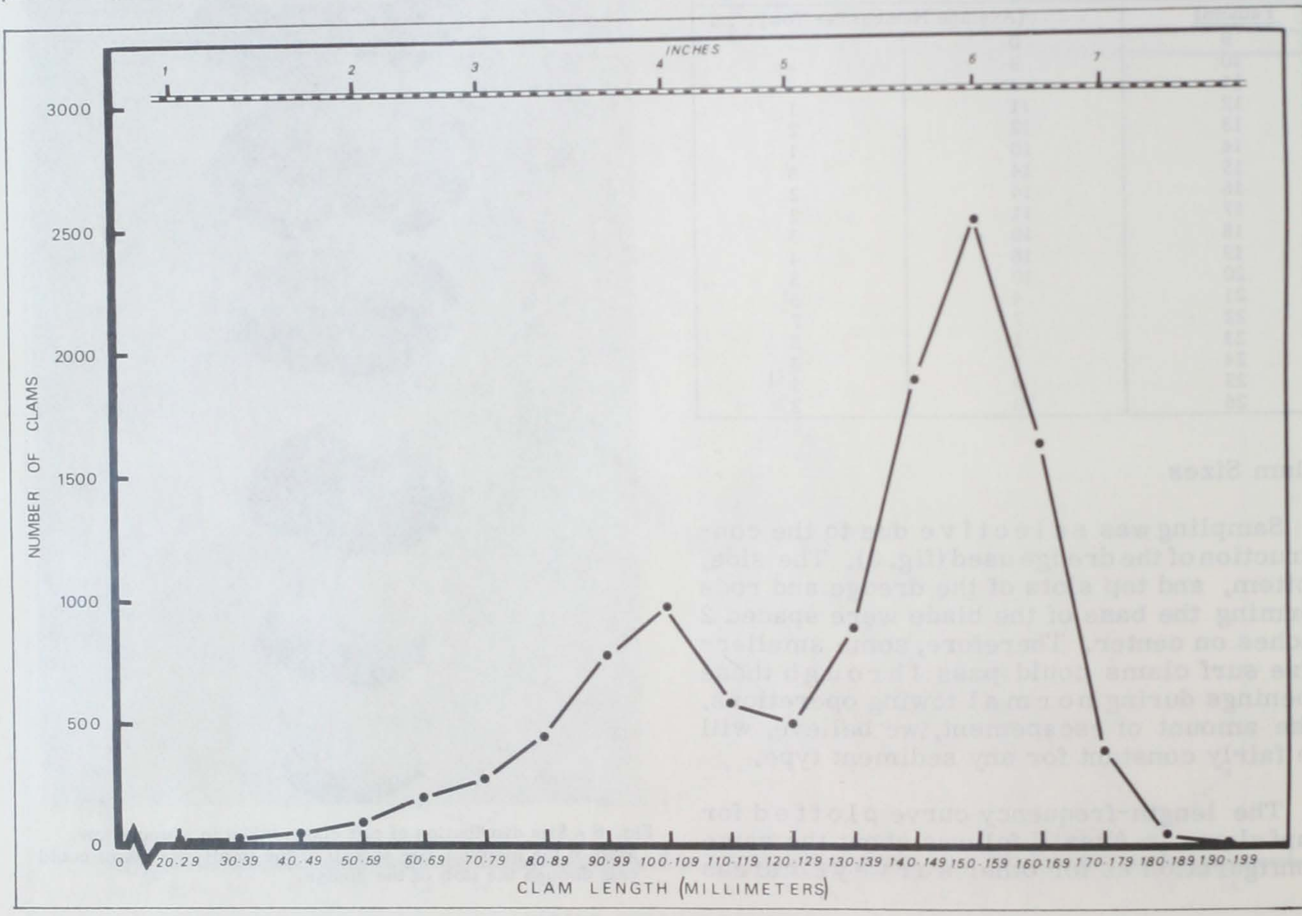

Fig. 7 - Length-frequency distribution of surf clams from Area II.

in Section D. At the same time, the relative number in the medium- and small-size groups was smallest in Section D.

Population

In Area II, the best beds of surf clams were in Sections A and D. These two sections are widely separated--A is just south of Area III, and D offshore and southeast of Section A. Because Section A is just south of Area III, the surf clam beds here are probably a southern extension of the beds in Area III, having their southern limits established by the inflow of water from Chesapeake Bay and shallower waters to the south. Their western or inshore expansion is also limited by shallow waters overlaying unproductive bottom sediments. Seaward, their range is controlled by the depth of water.

Although these beds of surf clams are in the commercial producing range, they do not equal the density of those just to the north in Area III. The structure of these surf clam beds, however, resembles closely those in Area III. Their densities in relation to bottom sediment and depth follow the same pattern as observed for Area III. Relations between the number of commercial-size clams and smaller clams seem to be the same here as in other areas surveyed. These environmental factors, therefore, appear to control the surf clam densities and possible bed expansion in Section A.

In Section C, the number of medium-size surf clams in the population may have been the result of some phenomenon that caused the spawn or larval of the surf clam to concentrate in vast numbers. Most of the clams caught here measured between 2.8 and 5.1 inches (70 and 130 mm.) long. Whether these vast numbers of medium-size clams will reach commercial size is another question.

The big difference between the surf clam population structure in Sections A and D was in their maximum size. In Section D, the mean maximum size was greater than in the other two sections. In all other respects, the length frequency curve and population structure was about the same as in Section A.

The best or largest beds of surf clams in Section D were located in its north-central part, and very few surf clams were taken offshore of this segment. Inshore of this segment, vast numbers of surf clam shells were taken in each tow, and often the bag and cage were filled with shells.

In Section D, the size of the surf clam beds may be limited somewhat by the fact that this section may be located at, or near, the optimum southern range limit of the surf clam. If this is true, the chances of an increase in the bed sizes or densities in Section D are remote. Therefore, the development of a commercial fishery in this section is unlikely--unless the price per bushel paid to the fisherman is increased sufficiently to compensate for the expected reduced daily catch.

In all sections of Area II, the possibility of establishing a commercial fishery will depend upon whether or not the price of clams will increase enough to compensate for the lower catch rates. Overall, the surf clam beds in Area II cover an area of considerable size, but within this area the surf clam densities are less than in Areas III and IV.

Ocean Quahogs

Ocean quahogs (Arctica islandica) were scattered in isolated locations throughout the area. Concentrations of this species never equaled those found in Areas III, IV, and VI.[1] Generally only one or two ocean quahogs were taken with surf clams at any one survey site. Few ocean quahog shells were noted in the catches, which indicates that the ocean quahog population was small throughout Area II. In all probability, Area II is near or at the southern limit of the range of this species. We do not assume that the population structure of the ocean quahog will be the same in the deeper offshore waters as that found in Area II.

DISCUSSION

The main differences between Area II and Area III (Parker, 1967) were in the size and density of surf clam populations. The density of surf clams in Area II was about one-half that observed in Area III. Other differences were the hydrographic and ecological variations between areas. These variations may have caused the difference in density of surf clam populations.

We assumed that one of the causes for the natural environmental conditions existing in Area II might be the flow of water from Chesapeake Bay. Its greatest effect would be felt in Section C of Area II lying directly in the

1/Originally designated as survey Areas V, IV, and I.

mouth of the Bay, decreasing as the distance offshore from the mouth of the Bay increased. If the currents were strong enough to carry the richer Bay waters offshore to Section D, where the largest-size clams were caught, this might explain at least part of the cause of this growth. To the north, in that part of Section A uninfluenced by the inflow of Chesapeake Bay waters, the surf clam population was very similar to that in Area III.

In any comparison between areas, one should keep in mind the probability that many unmeasurable environmental facts may be present in all large areas. Any one of these factors may have a tremendous effect on the total biological and physical characteristics within an area; any one factor could influence the surf clam population to a degree that would be unexplainable from the data obtained during our standard surveys. These factors may have a greater influence on surf clam populations than is realized. Therefore, before logical long-range management plans can be made most, if not all, of these factors will have to be understood and considered.

Why do we find in some areas with about the same depths and bottom sediment types dense populations of surf clams in one section and only a few or none in another? Will a small population become better populated in the next generation, or will it take many generations? Will poor producing sections ever produce sufficient clams for commercial harvesting? If they do, what will be the long-term effect of cropping on the surf clam populations?

The growth pattern of surf clams in Area II is about the same as in Area III. The young clam goes through a period of very rapid growth, after which the annual growth increment declines steadily until death. Surf clams may reach a maximum length of 8 inches or more.

SUMMARY

The third BCF surf clam survey was conducted in Area II off the coast of Virginia, between Cape Charles and False Cape, during 1965 and spring of 1966.

Out of 1,367 tows made, 717 took no surf clams, 596 caught from 1 surf clam to slightly less than 1 bushel, and 54 took 1 bushel or more.

Fifty-four simulated commercial tows made in the area produced very poor results. No tow caught 5 bushels of clams in 20 minutes.

The same relation between bottom sediments and surf clam densities was observed in Area II as in Areas III, IV, and VI. Also observed was a close relation between the size of catch and water depth; optimum catches occurred between 14 and 20 fathoms.

Owing to the dredge design, only a few clams less than 2.0 inches (50 mm.) were collected. As in all previous surveys, the dominant clam length was between 5.5 and 6.7 inches (140 mm. and 170 mm.).

Throughout the area, considerable variations were observed in the size, abundance, and distribution of surf clams. Extensive segments were almost void of the surf clam, while others had good populations.

Still smaller populations of ocean quahogs were observed in this area than in Areas III, IV, and VI.

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