THE MARYLAND SOFT SHELL CLAM INDUSTRY AND ITS EFFECTS ON TIDEWATER RESOURCES

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INTRODUCTION

This publication has been prepared expressly for the information of members of the Maryland General Assembly. The report contains, in as brief form as we feel to be consistent with its purpose, factual information and reasoned judgments pertaining to the soft shell clam industry and its effects on tidewater resources. Full scientific reports on the Department's soft shell clam research projects will be published as they are completed.

The report is presented in 7 main divisions:

I. Design and operation of the hydraulic clam dredge.
II. Summary of knowledge of Maryland's soft shell clam resource.
III. Development and present status of the Maryland soft shell clam industry.
IV. Potential value of the Maryland soft shell clam resource.
V. Effects of the hydraulic clam dredge on tidewater resources.
VI. Evaluation of the effects of certain proposals concerning the soft shell clam industry.
VII. Summary.

The text is arranged in consecutively numbered sections which are indexed numerically and by subject headings on page 2.

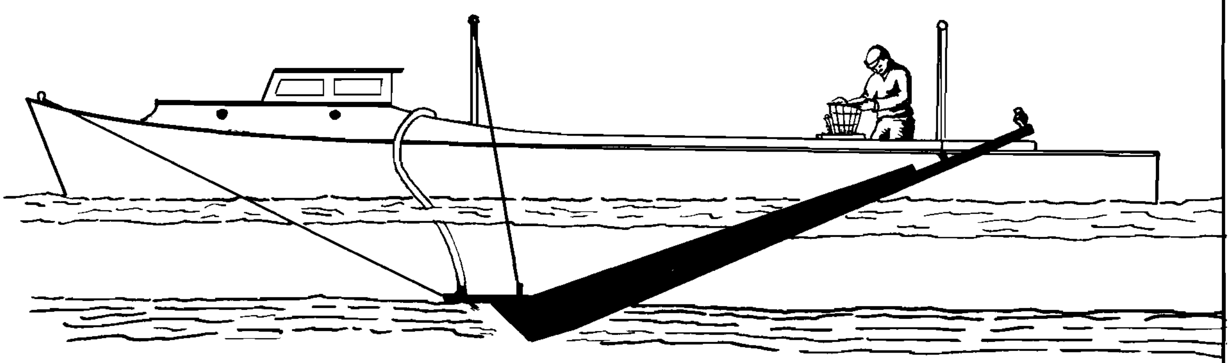

Figure 1. The Maryland hydraulic clam dredging rig.

Figure 1 is a diagrammatic representation of the hydraulic clam dredge which has made possible exploitation of Maryland's stocks of the soft shell clam (Mya arenaria). Jets of water loosen the soil ahead of the dredge, which is towed by the boat. The catch is elevated on an endless belt and culled as it nears the after end of the conveyor.

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I. DESIGN AND OPERATION OF THE HYDRAULIC CLAM DREDGE.

1. Constructional features of the hydraulic clam dredge. [1] The dredge shown in Plate 1 is in position for lowering. This dredge is 22 feet long overall, with the maximum permissible length between axles of the rollers which carry the conveyor belt (19 feet).

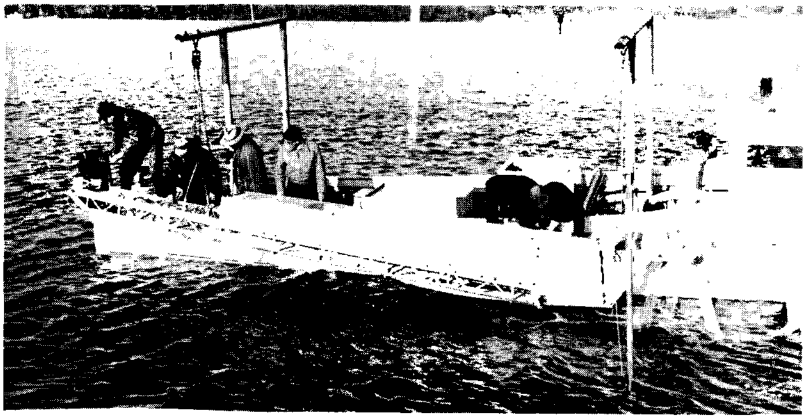

Plate 1. Hydraulic clam dredge in position for lowering.

Plate 2 shows the forward end of the dredge being lowered. The 6-inch pump intake pipe can be seen passing over the port rail of the boat. The 4-inch flexible outlet hose, over the starboard rail, carries water under pressure to the manifold at the forward end of the dredge, where it is distributed to 2 transverse rows of downwardly directed pipes of small diameter.

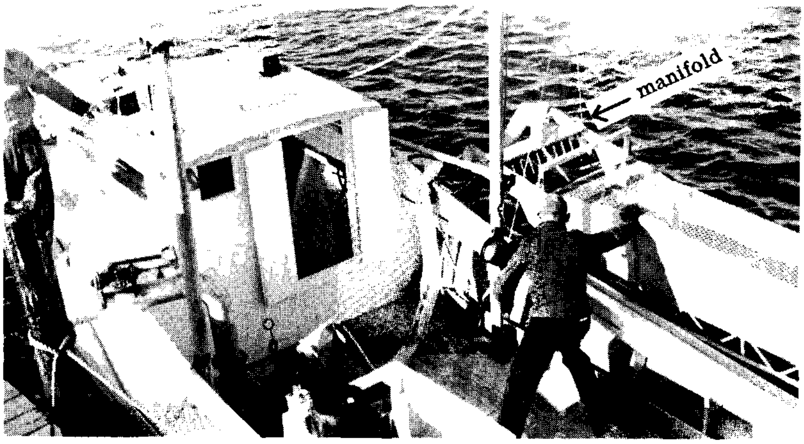

Plate 2. Lowering the hydraulic clam dredge.

Plate 3 shows a hydraulic clam dredge operating where the water is about 6 feet deep. The line by which the dredge is towed passes through a block secured just above the waterline forward and then aft to the cockpit. The greater part of the weight of the dredge is supported when in operation by fore and aft lines running to the cross-members atop the stanchions. The dredge is raised and lowered by these lines. A line from the forward end of the dredge passes through a block on the outboard end of the boom and to the cockpit, serving as an outhaul to curb the tendency of the dredge to run under the boat.

Plate 3. Hydraulic clam dredge in operation.

[1] The dredge and boat shown in the illustrations and described in the text are owned and used for experimental purposes by the Department of Research & Education. The dredge is of commercial design and size.

Plate 4 is a view from directly ahead of the scoop, or digging head, which is 30 inches wide, tapering to 20 inches aft. A maximum width of 36 inches is permitted. The scoop is constructed of 2 separate members, hinged as indicated, so that the runners will remain parallel to and resting on the surface of the soil in any depth of water where digging is practicable. It will be noted that the jet pipes are set parallel to the vertical side plates of the scoop and slightly inside those plates. The conveyor belt seen in this photograph is of 3/8-inch mesh, used for only experimental purposes. The commercially used belting is of 1-inch mesh, power driven by an air-cooled motor mounted at the after end of the conveyor.

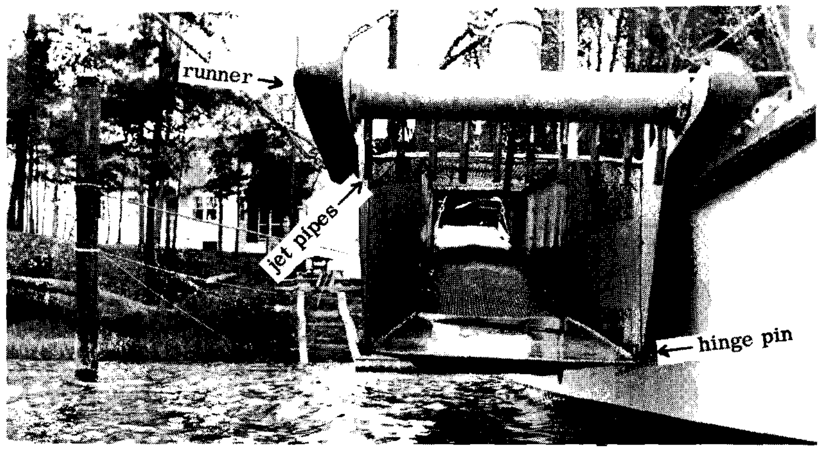

Plate 4. Clam's-eye view of the hydraulic dredge.

Plate 5 shows that the jet pipes are directed slightly backward, so that the loosened bottom materials are moved into the scoop and to the conveyor belt. A single jet is set at a greater angle to the vertical to expedite this movement. When the dredge is in operating position, the runners are resting on the surface of the soil and the forward edge of the bottom plate of the scoop is 18 inches below the soil surface. The open ends of all the jets are in the bottom. Their total cross-sectional area is equivalent to that of a pipe of 1.8 inches diameter. The flow of water is confined except where it can escape through the conveyor belt or over the sides of the conveyor housing.

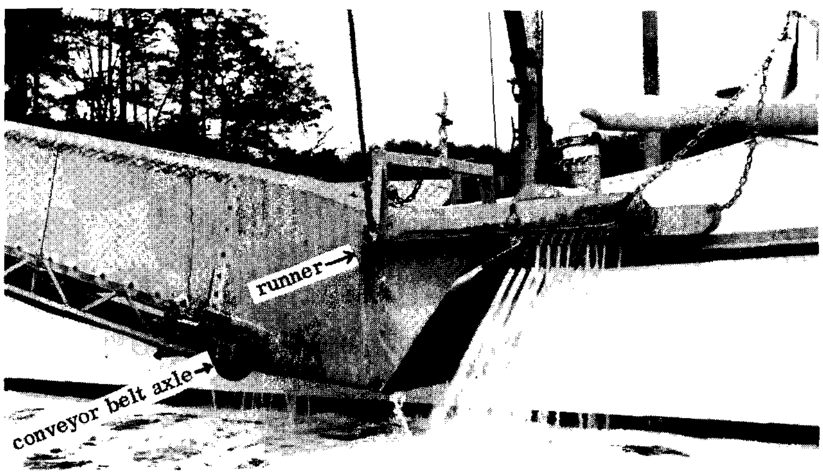

Plate 5. Side view of the forward end of the hydraulic dredge.

Figure 2, a schematic drawing of the dredge in digging position in the bottom with one side cut away, presents a simplified version of the processes involved in operation of the dredge. Currents from the jet pipes loosen the bottom just ahead of the dredge and flow aft through the scoop, carrying with them bottom materials. Everything too large to pass through the 1-inch mesh of the conveyor belt is retained on the belt and elevated to the surface. Coarse sediments, shell fragments, and other dense objects of small size fall through the conveyor belt at or near its lower end and accumulate in the trench. The finer particles of sediment are carried backward and upward in suspension and may pass through the wire-mesh top of the conveyor housing or through the conveyor belt. Observations indicate that most follow the latter course. Many are redeposited in the trench or nearby. Many others remain in suspension for relatively long periods and are carried considerable distances before settling out. This aspect of hydraulic clam dredging is considered in some detail in section 23.

A crewman stands near the after end of the conveyor and picks the marketable clams off the belt as they pass. Unwanted materials which are elevated to the surface are allowed to remain on the belt and fall back into the water at the after end of the conveyor. Most of these materials are redeposited in the trench. If there are oysters among them, there is little chance that they will survive, for in time--usually a few days to a few weeks--the trench will have filled to the level of the surrounding bottom and the oysters will be covered with several inches of sediment.

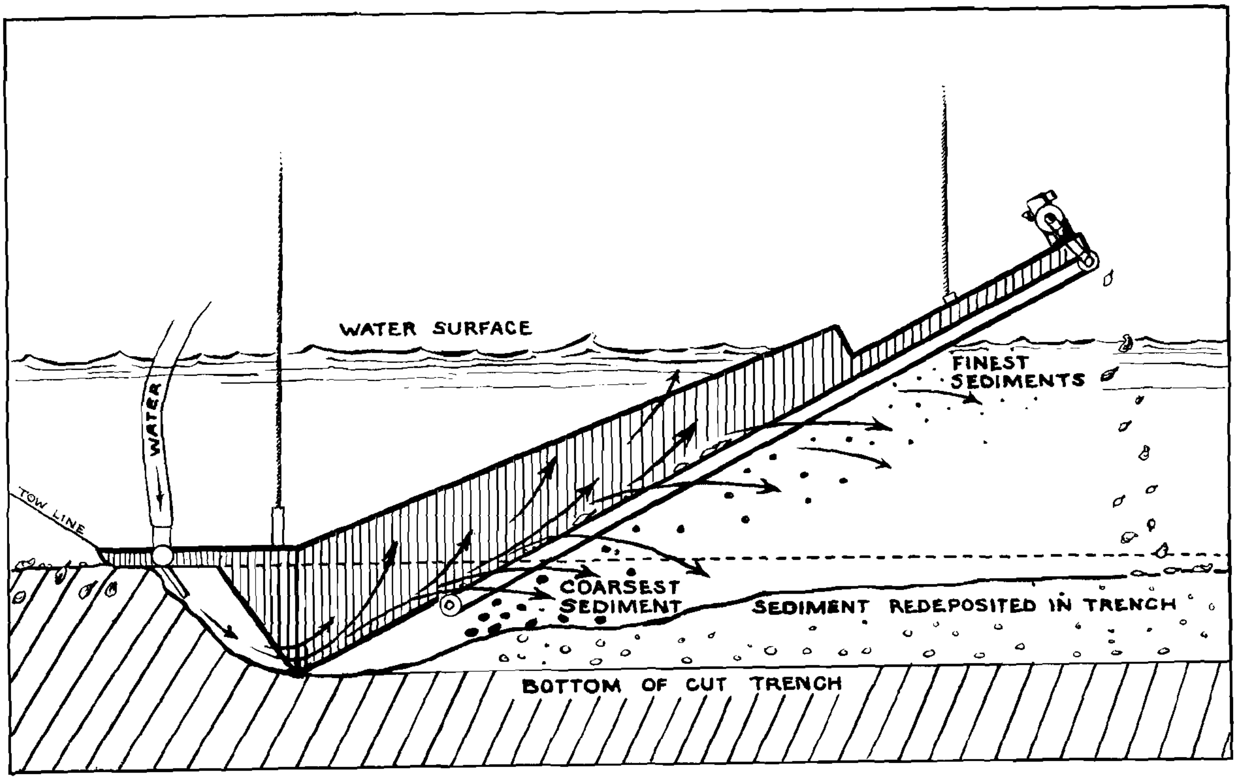

Figure 2. Schematic diagram of the hydraulic dredge in operation.

2. Operational details of the hydraulic clam dredge.

a. Operating range. Dredges now in commercial use operate efficiently in water up to about 8 or 9 feet deep, and some dredges with unusually long scoops have been used with more or less success in 10 to 12 feet of water. Minimum depth of operation is governed by the draft of the boat.

b. Rate of dredging. The rate of dredging is rather variable and is governed by many factors, including type of bottom and skill of the operator as 2 of the most important. Our data indicate that the average rate of commercial clam dredging is between 1200 and 1300 square feet of bottom per hour. At this rate, coverage of 1 acre of bottom requires about 35 hours.

c. Efficiency. The dredge catches a very high percentage of the clams in its path. Tests conducted in 1956 by the Fisheries Research Board of Canada with an experimental model of this dredge indicate that its efficiency in catching clams of marketable size approaches 100 per cent.[1] In tests conducted by the same agency in 1955 less than 1 per cent of the clams caught were broken, and breakage of clams of smaller size which passed through the conveyor belt mesh was similarly low. [2] We have determined breakage occurring in both experimental and commercial dredging, and found from 1 to about 4 per cent of the marketable clams broken.

d. Sequence of operations. The dredge is usually carried on the washboard when the boat is under way. To begin dredging, the operator lowers the dredge until the scoop is in the water, puts the pump intake pipe or hose overboard, primes the pump, and starts the pump motor, which usually is an automobile or light truck engine. He then starts the conveyor belt winding motor, lowers the forward end of the dredge to the bottom, and puts the boat engine into forward gear. Suspension of the dredge must be adjusted to suit the depth of water. There is no set pattern of dredging, and the dredges may cross and recross their own or each other's paths many times in working a productive area, much in the manner of oyster dredgers. In exploratory dredging the operator may, if the water is clear, be guided by the size and number of clam holes in the bottom. If he can not see bottom, he must lower the dredge and

[1] Unpublished data, personal communication from J. S. MacPhail, Biological Station, Fisheries Research Board of Canada, St. Andrews, N. B.

[2] Progress Report, Biological Station, Fisheries Research Board of Canada, St. Andrews, N. B.

make a trial run of a few feet or a few yards. If the trial indicates there are not enough clams for profitable dredging, the operator usually raises the dredge out of the bottom (but not out of the water), moves to a new location, and tries again.

3. Economic factors in operation of the hydraulic clam dredge. Operational costs of hydraulic clam dredging are high. The boat motor, pump motor, and belt winding motor run continuously during dredging. The cost of fuel and oil averages about $1.50 per hour. Maintenance of the rig is also expensive. Replacement of parts, particularly conveyor belts, is a major item. The conveyor belts in commercial use cost about $50 each and must be replaced frequently. Our data indicate that the average cost of maintenance and replacement of parts is about $1.40 to $1.60 per hour of operation. The total operational cost for the average boat, including wages of one crewman who picks clams off the conveyor belt, is about $4 per hour.

The price paid to the dredgers for clams has been stabilized at $4 per bushel for more than a year. At this price, the working owner of a dredging rig who hires one crewman to pick clams off the belt must catch about 1 bushel of clams per hour to meet operating expenses and must catch about 1.5 bushels of clams per hour to make a reasonable profit for himself ($2 per hour, or $16 for an 8-hour day). He can dredge, on the average, 1 acre of bottom in about 35 hours, and from this area he must take from 50 to 55 bushels of clams (35 hours x 1.5 bushels/hour). Therefore, the clam dredger must work where there are at least 50 bushels of marketable clams per acre, on the average, to make a reasonable living. This is a most important limiting factor on the fishery and will be considered further in section 15.

II. SUMMARY OF KNOWLEDGE OF MARYLAND'S SOFT SHELL CLAM RESOURCE.

4. Life history. Spawning and setting of the soft shell clam occur during the autumn months. The early life history of the species is much like that of the oyster except that clam spat do not attach permanently to cultch, as do oyster larvae. Juvenile clams may move about on the bottom and for some weeks after setting may be displaced by waves and currents. As they grow they begin to burrow into the soil, by means of the muscular "foot," and adult clams may be buried to a depth of a foot or more, the siphons extending to the surface of the soil. The ability of the clam to burrow is retained throughout life but diminishes with increasing size. The "neck" of the clam is essentially a muscular sheath surrounding 2 tubes called siphons. Water is drawn in through 1 tube and expelled through the other. From the incoming water, which passes over and through the gills, the clam receives oxygen and food. The outgoing water carries waste products. Obviously, if the clam can not extend its siphons to the surface of the soil, it will die. Unlike the oyster, it has some ability to adjust its position up or down in the bottom, and the siphons are extensible. Thus it can cope with relatively minor changes in bottom level. Growth is very rapid, and the clams reach marketable size (2 inches shell length) in about 16 to 22 months. (In Maine the time required for growth to marketable size averages about 5 years). The life span of the species is relatively short in Maryland, apparently seldom exceeding 3 or 4 years.

5. Distribution and density of populations. The soft shell clam is widely distributed in Maryland tidewater. The minimum salinity the species can tolerate is probably about the same as that which limits the range of the oyster. In general, the clam is found a little farther upstream in the tributaries than is the oyster. Clams may be found in almost any type of bottom except soft muds. Populations of commercial proportions may be found on sand flats where oysters usually will not survive severe storms. Shifting bottoms can and do wipe out clam populations at times, but the species can and often does repopulate areas very rapidly if conditions are favorable.

The density of clam populations is highly variable. We have found concentrations of marketable clams exceeding 600 bushels per acre only a short distance from areas where there were virtually no clams at all. The factors which control distribution are being studied but are by no means well understood. Since Maryland is near the southern limit of the range of this primarily cold-water species, it seems reasonable to expect that heavy mortalities may occur at times, with consequent fluctuations in abundance. The rapid growth rate and short life span of the species in Maryland should, however, operate to minimize the duration of fluctuations.

Extensive populations of soft shell clams have been observed in bottoms well beyond the operating range of the hydraulic clam dredge. These undisturbed populations may be of great importance to the fishery as brood reserves. Other brood reserves, of undetermined but possibly equal or greater size, exist in the many areas where the density of population is too low to afford profitable dredging, or intermixed with commercially important populations of oysters, where clam dredging should not occur.

6. Feeding. The clam, like the oyster, is essentially a plankton feeder, filtering out microscopic plants and animals from the water which passes over and through its gills. Suspended fragments of organic materials may also be utilized.

7. The clam as food for other animals. Clams are eaten by gulls, some species of waterfowl, crabs, bottom-feeding fish, raccoons, and probably many other predators. Usually only juvenile clams are eaten, since the adults are deeply buried in the soil. The whistling swan, however, feeds to some extent on clams of all sizes, digging holes as deep as about a foot with its bill. The cownose ray washes out quantities of soft shell clams by "wallowing" in the bottom. The relative importance of the soft shell clam in the diet of any of these predators is unknown. Analysis of the stomach contents

of 1,213 ducks of 15 species collected from 49 localities on the Atlantic Coast flyway showed that 6.35 per cent by volume of the foods present consisted of various species of bivalves. 1/

8. The clam as food for man. Soft shell clams, like oysters, are a high-protein food, rich in minerals and vitamins. The yield of clams in Maryland varies from about 10 to 13 pounds of meats per U. S. standard bushel. By way of comparison, the yield of oysters varies from about 6 to 8 pounds per U. S. standard bushel.

III. DEVELOPMENT AND PRESENT STATUS OF THE MARYLAND SOFT SHELL CLAM INDUSTRY.

9. Development of the soft shell clam fishery. The hydraulic clam dredge which has made possible the utilization of Maryland's soft shell clam resource was experimentally developed in the Eastern Bay-Miles River area during 1950 and 1951 and put into commercial use in 1952. Table 1 indicates growth of the industry.

Table 1. Number of licensed soft shell clam dredges in Maryland, by counties.

	Calendar year				
County	1952	1953	1954	1955	1956
Talbot	6	7	7	20	26
Queen Anne's	1	24	27	51	58
Calvert	0	0	1 1/	12	9
Dorchester	0	0	1	2	13 2/
Total	7	31	36	85	93 3/

1/ Three dredges licensed in Queen Anne's County operated in Calvert County approximately 1 month in 1954.

2/ Dorchester County boats licensed only to 1 November 1956; 9 of these boats did not begin dredging until July or August.

3/ Dorchester County boats not included in total.

Regulatory measures for the soft shell clam fishery, enacted by the Maryland General Assembly in 1955, became effective 1 June of that year as Section 663A and Section 663B of Article 66C, Annotated Code of Maryland. Residence requirements for dredge operators and fees for the licensing of dredges and dealers were established. Limitations were set on the dimensions of the dredge and the time for taking and landing clams. A minimum size limit of 2 inches, shell length, was adopted. Use of the dredge was prohibited on the charted natural oyster bars, and a schedule of penalties for violation of this and other provisions of the code was established. A tax of 10 cents per bushel of clams produced in Maryland was imposed on the industry, the revenue to be used for purposes of research by the Department of Research and Education. Concurrent legislation prohibited use of the hydraulic clam dredge in Anne Arundel, St. Mary's, Kent, Wicomico, and Somerset Counties as of 1 June 1955, and in Dorchester County as of 1 November 1956.

1/ Food of Game Ducks in the United States and Canada, Research Report No. 30, U. S. Fish and Wildlife Service.

10. Present status of the soft shell clam industry. Information given in this section is based on official and unofficial records, our personal knowledge of the industry gained in 3 years of investigations, and canvass of 70 per cent of the licensed clam dredgers and 65 per cent of the licensed dealers.

Vital statistics of the industry.

Number of dredges operating, December 1956	90
Number of licensed dealers, December 1956	23
Number of clam shucking houses, December 1956	4
Value of real and personal property (including boats and dredging equipment, shucking houses and storage buildings, trucks, etc.) used exclusively or primarily in the soft shell clam industry (85% in Maryland).	$600,000
Operation and maintenance costs of the industry, Fiscal Year 1957, including fuel, replacement of items of equipment, supplies, etc. (90% in Maryland).	$530,000
Annual payroll, Fiscal Year 1957, not including dredgers or crewmen (80% in Maryland).	$218,000
Dockside value of the catch in Fiscal Year 1956, based on the number of bushels on which tax was collected, and a value of $4 per bushel to the dredger.	$451,220

NOTE: Documentary and other evidence which we consider decisive indicates that tax collections in Fiscal Year 1956 accounted for less than 80 per cent of the actual catch of clams. The following estimates are based on our records for 1956 and the current year and are believed to be realistic.

Dockside value of the catch in Fiscal Year 1956 at the price of $4 a bushel to the dredger (including catch in Dorchester County). Corrected estimate:	$580,000
Predicted dockside value of the catch in Fiscal Year 1957 at the price of $4 a bushel to the dredger (including catch in Dorchester County 1 July - 1 November).	$720,000
Predicted wholesale value of the catch in Fiscal Year 1957, based on an average price of $7 per bushel to the dealer or shucker.	$1,260,000

Production in the Maryland soft shell clam fishery has thus far been controlled by out-of-state demand. Demand in Maryland is slight but increasing. Nearly all the catch is shipped to Middle Atlantic or New England states, where the local supply is nearly adequate in late spring but falls short of demand at all other times, particularly during the summer tourist season. Until 1956 practically all Maryland production was shipped as shell stock. During the past year there has been a significant shift toward processing the catch in Maryland, resulting in an increase in employment locally and a better margin of profit to the dealer through savings on freight and refrigeration.

Maryland now produces about half as many soft shell clams annually as Maine but more than all the other clam-producing states of the Atlantic Seaboard together. Maryland's production comes from about 23 per cent of the State's potential clam-producing bottom. Declining production in New England in recent years has been attributed largely to an enormously increasing population of green crabs, which prey on the soft shell clam.

IV. POTENTIAL VALUE OF THE MARYLAND SOFT SHELL CLAM INDUSTRY.

11. Factors limiting the potential value of the Maryland soft shell clam industry. The potential value of the industry is dependent not only upon supplies available but upon demand for the product. In the past 4 years demand for Maryland clams has increased steadily, fluctuating between high levels in the summer months and relatively low levels during winter and spring months. Opportunities for market development, both domestic and foreign, are considered to be excellent, but only if supplies of a product of good quality are assured.

There is as yet no indication that the soft shell clam resource is being over-exploited. Some of the catch has been taken from bottom where clam dredging is not legal, but the industry probably can produce about as many clams as it has been producing without trespass. As noted previously, there is reason to believe that abundance of clams may fluctuate rather widely in Maryland due to natural causes. We may now be at the top of a cycle, at the bottom, or somewhere in between. The short history of the industry and the limited knowledge of the soft shell clam in this area preclude any reliable estimate.

Geographical expansion of the industry to include the waters of some or all of the counties where dredging is now prohibited would increase the supply. Unlimited expansion, unaccompanied by market development, almost certainly would depress the market price and perhaps prove highly detrimental to the economy of the industry. The possibilities involved in geographical expansion of the industry are considered in Section 12.

12. Bases for estimating potential value of the soft shell clam industry. Table 2 shows the distribution of bottoms beneath tidewater where the water is salty enough to permit growth of oysters and clams and is less than 12 feet deep at mean low tide. The greater part of this area is at one time or another within the operating range of the hydraulic clam dredge. It is in this area that much of the rooted aquatic vegetation important to waterfowl grows. This is the area where conflicts have developed between the soft shell clam fishery and other interests, as well as among other interests. Not included in this area are: (1) the Upper Bay or any of its tributaries above Bodkin Point (3 miles above Gibson Island) on the Western Shore or above Tolchester on the Eastern Shore, (2) the upper reaches of the tributaries, where the water is too fresh for oysters and clams, and (3) the Potomac River beyond county boundaries.

Briefly summarizing the data of Table 2, the total area of "salt water shoals" is about 388,000 acres. Included in this area are approximately 89,000 acres of charted natural oyster bars and 44,000 acres of crabbing grounds, comprising an area of about 133,000 acres of bottoms which have been reserved under the law for the specific purpose of oystering and crabbing. The balance of about 255,000 acres (two-thirds of the total area) is classified as "barren bottom." Approximately 23 per cent of the total area of "barren bottoms" lies within the 3 counties where clam dredging is now permitted.

In Table 3 are some statistics of the soft shell clam fishery in Calvert, Talbot, and Queen Anne's Counties which are of use in estimating the potential value of the fishery in Maryland. The statistic which is important for this purpose is the average value of "barren bottom" in the area now open to clam dredging, $9.69 per acre. It is based on the catch of Fiscal Year 1956 and is considered to be a conservative estimate.

13. Estimate of the potential value of the soft shell clam industry in Maryland. Table 4 is based on the assumption that the distribution of the soft shell clam in Maryland tidewater is such that all the potential clam-producing area (the "barren bottoms in salt water shoals") may be expected to be as productive as were the "barren bottoms" in Calvert, Talbot, and Queen Anne's Counties in Fiscal Year 1956. This is intended only as a general appraisal, subject to variations which locally may be great. The presence of commercially important stocks of clams in Kent, Dorchester, and St. Mary's Counties is well established. Very little is known about the density of populations of clams in Anne Arundel, Charles, Somerset, and Wicomico Counties.

Table 2. Distribution of bottoms in "salt water shoals" 1/ in Maryland.

County	Total area 2/ acres	Charted 3/ natural oyster bars acres	Crabbing 4/ grounds acres	Actual or potential 5/ clam-producing area now classified as "barren bottom" acres
Calvert	13,800	1,800		12,000
Talbot	46,500	18,500		28,000
Queen Anne's	31,700	13,900		17,800
Total, counties now producing clams	92,000	34,200		57,800
Anne Arundel	25,400	2,800		22,600
Charles	4,100	1,500		2,600
Dorchester	122,900	19,700	11,900	91,300
Kent	17,700	4,800		12,900
Somerset	84,700	17,000	32,100	35,600
St. Mary's	32,200	6,500		25,700
Wicomico	8,800	2,600		6,200
Total, counties not now producing clams	295,800	54,900	44,000	196,900
Total, all counties	387,800	89,100	44,000	254,700

1/ Bottoms where the depth of water is not more than 12 feet deep at mean low tide and the salinity is high enough to support growth of oysters and clams.

2/ Obtained by planimetering charts of the U. S. Coast & Geodetic Survey.

3/ Obtained by planimetering all natural oyster bars or portions of bars within the 12-foot depth contour appearing on the charts compiled in the Yates Survey of 1906-11, and adding 25 per cent to each figure to account for subsequent additions.

4/ Bottoms designated as crabbing grounds, Fourth Report of the Shell Fish Commission of Maryland, 1912.

5/ Includes a statewide total of approximately 12,000 acres of bottom leased under Maryland law for the purpose of shellfish culture. About 70 per cent of this bottom now is used for oyster culture.

Table 3. Statistics of the soft shell clam fishery in Calvert, Talbot, and Queen Anne's Counties, Fiscal Year 1956.

County	Per cent of area now available for clam dredging	Per cent of total dredging effort	Estimated catch Bushels	Estimated catch Value	Average value of "barren bottom" per acre
Calvert	21%	12%	15,000	$60,000	$5.00
Talbot	48%	30%	45,000	180,000	6.43
Queen Anne's	31%	58%	80,000	320,000	17.98
Total	100%	100%	140,000	$560,000	
Average					$9.69 per acre

The need for exploratory survey is obvious, but this is a major project requiring substantial funds.

It is likely that Maryland could produce at least half a million bushels of clams annually. If there were a ready market for this production and the current price of $4 a bushel to the dredger were maintained, the dockside value of the catch would be $2,000,000 or more, and the gross value might range from $3,000,000 upward, depending upon how much of the catch was processed in Maryland. We believe it bears repeating here that a ready market for production of this magnitude does not now exist. If the industry is expanded geographically, the process obviously should be carefully considered in the light of prospective demand.

The soft shell clam resource should be looked upon as one which may be used to supplement the income from other tidewater resources whose exploitation has contributed to Maryland's economy for generations. If exploitation of the clam resource is detrimental to other resources, the extent to which it reduces the income from those resources must be deducted from its own real or potential value.

Table 4. Estimated potential dockside value of the soft shell clam fishery in Maryland.

County	Actual or potential clam-producing area now classified as "barren bottoms" acres	Estimated potential value as clam-producing bottom. dollars per year
Calvert	12,000	$60,000
Talbot	28,000	180,000
Queen Anne's	17,800	320,000
Total, counties now producing clams	57,800 acres	$560,000 1/
Anne Arundel	22,600	$219,000
Charles	2,600	25,000
Dorchester	91,300	885,000
Kent	12,900	125,000
Somerset	35,600	345,000
St. Mary's	25,700	249,000
Wicomico	6,200	60,000
Total, counties not now producing clams	196,900 acres	$1,908,000
Total, all counties	254,700 acres	$2,468,000

1/ For those counties now producing clams, the catch of Fiscal Year 1956 has been used. This figure is believed to be a conservative estimate of the productive capacity of those counties.

V. EFFECTS OF THE HYDRAULIC CLAM DREDGE ON TIDEWATER RESOURCES.

14. Basic considerations. It is convenient and logical to consider cause-and-effect relationships as "short-term" or "long-term." Short-term effects often can be observed directly or determined by experimental methods in a relatively short time. The most reliable estimates of long-term effects are obtained by observations and experiments extending over a number of years. Lacking opportunity for completion of long-term experiments, some reliance may be placed on statistical evidence such as catch records. Where statistical evidence is available, we have used data for the Eastern Bay-Miles River area, which is a geographical unit in the reporting of commercial catches of fish and crabs. This area is the only statistical unit which has been wholly open to clamming. It is the area where clam dredging was developed and where it has been most intensively practiced. Our investigations have necessarily centered around direct observations and experiments of relatively short duration designed to provide indicative if not conclusive evidence bearing upon the problems of greatest urgency.

15. Limiting factors on the effects of the hydraulic clam dredge on tidewater resources. It has been shown in foregoing sections that the clam dredger must, to make a reasonable living, work on bottom where there are at least 50 bushels of clams per acre. The total catch in Calvert, Talbot, and Queen Anne's Counties for Fiscal Year 1956 was about 140,000 bushels of clams. Dividing 140,000 bushels by 50 bushels per acre indicates clearly that the 1956 catch must have been taken from a maximum of about 2,800 acres of bottom. This leads to the following conclusions concerning clam dredging in Calvert, Talbot, and Queen Anne's Counties in Fiscal Year 1956:

(1) Of the total area of bottom open to clam dredging, the area actually dredged was about 5 per cent.

(2) Of the total area of "salt water shoals," the area actually dredged was about 3 per cent.

(3) Of the total area of bottoms beneath tidewater, including a large area of shoal bottoms in the upper reaches of the Bay and tributaries where the water normally is too fresh to support growth of oysters and clams, the area dredged was about 1 per cent.

Table 5 shows estimates of the percentage of bottoms dredged in Calvert, Talbot, and Queen Anne's Counties in Fiscal Year 1956. The extension of these estimates to future years requires consideration of the effects of hydraulic clam dredging on the clam itself.

Table 5. Estimates of the percentage of bottoms dredged for soft shell clams in Calvert, Talbot, and Queen Anne's Counties, Fiscal Year 1956.

County	% of bottom open to clam dredging actually dredged	% of "salt water shoals" actually dredged	% of bottoms beneath tidewater actually dredged
Calvert	less than 3%	2%	less than 1%
Talbot	3%	2%	1%
Queen Anne's	9%	5%	2%
Counties which permit clam dredging	5%	3%	1%

16. The effects of hydraulic clam dredging on soft shell clams. It has been shown that a very low percentage of clams is broken by the dredge. Observations indicate that a very high percentage of clams large enough to be seen with the unaided eye are able to burrow back into the bottom and continue to grow at normal rates. We have no direct evidence on the effects of dredging on clams of microscopic size. We know of no practicable way of determining the effect on clams of very small size by short-term experiment. Their distribution is highly variable at any given time, even within a small area. Because of their mobility, their distribution is continually changing. Their specific gravity is low, and they probably fare well in the sorting and deposition of bottom materials disturbed by the dredge.

We have observed in summer fairly extensive mortalities of both marketable and smaller clams within areas dredged intermittently over a period of a week or more. We have also observed in summer mortalities of as much as 20 per cent of large clams and 15 per cent of small clams in areas where no dredging had been done. It is reasonable to believe, however, that mortalities of clams are caused in the immediate vicinity of dredging operations by deposition of coarse sediments on the bottom alongside and between the trenches cut by the dredge, especially in shallow water, where the wash of the boat propeller is thought to be the major factor in displacement of these sediments. The use of a propeller guard probably would aid materially in reducing mortalities. Other possible means of improving the gear or the methods of operation are discussed in later sections.

The mortality of young clams appears to be highly variable in dredged areas. Where it is low, the area may be dredged profitably again within a few months to a year. Where it is high, about 16 to 34 months may be required for repopulation and growth of the clams to marketable size--longer if setting fails in the first spawning season after the area has been dredged. We know of areas which have produced an annual crop of clams each year since 1952. We have not yet seen a commercially dredged area which has failed to be repopulated, although such areas may exist. We have not yet accumulated enough evidence to make a reliable estimate of the average rate of repopulation of dredged areas. Indications are that it is relatively high. If so, the industry should be a continuing one. If not, the industry faces a bleak future, for even our limited knowledge of the distribution of the soft shell clam indicates strongly that the areas in which the species is found in concentrations which will support commercial dredging constitute a relatively small percentage of the area which is available to clam dredging. The fact that the industry is now producing at a high level after 5 years of growth probably is significant. Indications are strong that the soft shell clam fishery has long since passed the exploratory stage in Talbot and Queen Anne's Counties.

17. The effects of hydraulic clam dredging on oysters; introductory comments. Claims have been made that the oyster industry is declining in those counties where hydraulic clam dredging is permitted, and that the reason for the decline is the operation of the dredge. Records of oyster production are maintained for the State as a whole, but not for counties or geographical units of tidewater. It is therefore impossible to compare oyster production in those areas where clam dredging is permitted with production in those areas where clam dredging is prohibited. The establishment of cause-and-effect relationships will not be attempted, but it seems pertinent to list some factors which may have affected the oyster industry in recent years:

(1) Sets of oyster spat have been below average throughout Maryland in recent years, with a few local exceptions. 1/

(2) Heavy mortalities of oysters occurred following the hurricanes of 1954 and 1955, in Maryland and elsewhere. 2/ The heaviest mortalities occurred on shoal bottoms.

(3) The price paid to the tonger or dredger for oysters has risen substantially, due to widespread short supplies and increased out-of-state demand.

(4) Packers of shucked oysters have been caught in the pinch of rising production costs and relatively unchanging consumer prices. (Shucked oysters must compete in price with other high-protein foods.) A number of packers have gone out of business.

1/ Records of the Department of Research and Education.

2/ Fishing Gazette, July 1956; records of the Department of Research and Education.

(5) Increasing prices for shell stock have attracted additional tongers into the oyster fishery in some counties, resulting in further drains on supplies. Between 1946 and 1954, the latest year for which we have data, the number of tongers licensed in Maryland increased by 12 per cent. In Talbot County the increase in number of tongers licensed was 24 per cent; in Queen Anne's County, 34 per cent. 1/

(6) The soft shell clam industry has developed rapidly in 3 counties.

It can not be taken for granted that hurricanes, below-average sets, and increased tonging effort absolve the hydraulic clam dredge of blame for damage to oysters. In the belief that severe damage would result to oysters in the immediate vicinity of clam dredging operations, we recommended in 1954 that use of the hydraulic clam dredge be prohibited on the charted natural oyster bars. 2/ The effects of clam dredging in those counties where the industry has developed must be carefully evaluated. Instability in the oyster industry, however, is by no means limited to the areas where clam dredging is or has been practiced.

1/ Annual Reports, Maryland Board of Natural Resources.

2/ Memorandum to the Department of Tidewater Fisheries, 22 November 1954, from the Department of Research and Education.

18. Statistical evidence of the effects of hydraulic clam dredging on oysters. Oyster catch records are not kept by counties or geographical units. The only pertinent oyster statistics available are those which have been compiled by Mr. G. F. Beaven, of the Department of Research and Education, concerning the catch of oyster spat on planted shells and natural cultch. Data for the average set on natural cultch in the Eastern Bay-Miles River area are shown in Table 6. Table 7 shows the set on planted shells in the Mill Hill seed area. Data for 1944, 1945, 1950, and 1951 are not available.

The data of Tables 6 and 7 indicate that wide fluctuations in oyster set occurred from year to year in this area before the advent of the clam fishery and still occur. There is no indication that hydraulic clam dredging has had any effect on oyster sets in the area. The evidence is indicative but not conclusive.

19. Experimental evidence of the effects of hydraulic clam dredging on oysters. In 1956 we attempted an experiment designed to determine just how far from the site of hydraulic dredging operations abnormal mortalities of oysters could be expected to occur. The plan of the experiment was discussed with representatives of both oyster and clam industries. Representatives of both industries, as well as a representative of sports interests and members of the General Assembly, were invited to observe the experimental work in Cox Creek, Queen Anne's County, during August 1956.

Table 6. Calculated average sets of oyster spat on natural cultch, Eastern Bay-Miles River area.

	Before Clam Dredging			Years of clam dredging
	1940-1943 average	1944-1947 average	1948-1951 average	1952-1955 average
Number of spat per bushel of cultch	221 spat	145 spat	84 spat	108 spat

Table 7. Sets of oyster spat on planted shells, Mill Hill seed area, Eastern Bay.

	Before Clam Dredging						Years of Clam Dredging			
	1942	1943	1946	1947	1948	1949	1952	1953	1954	1955
Number of spat per bushel of planted shells	716	200	522	1724	781	101	1297	35	1056	224

20. Description and results of an experiment designed to determine the effects of hydraulic clam dredging on oysters. An experimental area in Cox Creek, Queen Anne's County, was reserved by the Department of Tidewater Fisheries for the purposes of this experiment. Figure 3 shows the location, which was selected because it was a natural oyster bar, unaffected by previous hydraulic clam dredging and with the longer axis of the bar paralleling the flow of tidal currents; current velocities were relatively high, and the depth of water was about 2 to 4 feet at mean low tide. Preliminary examination and sampling showed that (1) the bottom was shelly and hard to fairly hard over most of the area, becoming softer toward the north end; (2) oysters were present throughout the area, but considerably less numerous toward the south end and with wide variations occurring everywhere within a space of a few feet; (3) oysters grew to some extent in clusters, but more often singly and very often deeply imbedded in sediment and shell fragments, so that the only way to obtain accurate counts was to remove all the oysters, shell, and debris from the sampled area and sort out the oysters and boxes; and (4) rooted aquatic plants, principally clasping-leaf pondweed, were fairly abundant at the north end of the area and rare toward the south end.

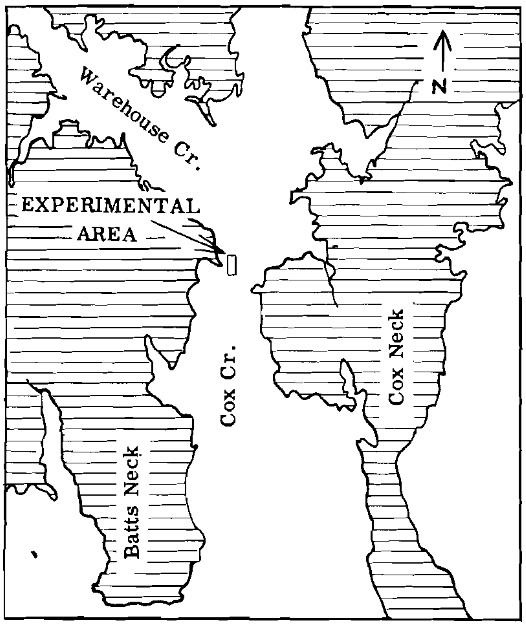

Figure 3. Location of the Cox Creek experimental area.

Figure 4 shows the plan of the experiment and the numbers of oysters obtained in samples taken before dredging and 4 months after dredging. Poles were put down to mark the area to be dredged and the lines along which samples of the oyster population were to be taken, 25, 50, 75, 100, 200, 300, and 400 feet from the edge of the dredged area. At the points indicated by circles in the diagram, 25, 50, 100, 200, 300, and 400 feet from the edge of the dredged area, sheet iron plates were set into the bottom about one-quarter inch to serve as reference planes for measurement of sediment deposition. We restored the bottom above the plates to its original level and condition as nearly as possible by replacing sediment, shell, and oysters. We feel there is no reason to believe that significant quantities of suspended sediments would have been either more or less likely to settle above these planes of reference than upon any equivalent area of the surrounding bottom.

The oyster population was sampled, before dredging, at randomly selected positions along each of the established lines, and within the area to be dredged. Using self-contained underwater breathing apparatus, we removed all shell, oysters, and debris from the 20-square-foot area inside a rectangular counting frame placed on the bottom at the position selected for sampling. The materials collected were placed in a wire basket, taken to the surface, washed, and examined. All oysters were counted in 3 categories: (1) less than 1 inch long, (2) from 1 to 3 inches long, and (3) more than 3 inches long. The samples were dumped outside the experimental area after examination. Most of the sampled areas were examined carefully a few minutes after the sample was taken to be sure nothing had been missed. In no case was more than 1 additional oyster or box found. The numbers of oysters in each sample (20 square feet) taken before dredging, and the locations of the samples, are indicated by the semi-encircled figures in the diagram (Figure 4).

A plot of approximately one-quarter acre at the north end of the area was dredged a total of 9.5 hours in late August 1956. All dredging was done on the ebbing tide, so that virtually all of the displaced sediment was carried downstream and across the experimental area. We believe the following conditions, under which the dredging was done, should have produced very nearly the maximum displacement of sediments which can be expected from hydraulic clam dredging under any but the most exceptional conditions:

(1) A full-size, commercial type dredge was used, and relatively high pump pressures (30-40 pounds) and engine speeds were maintained.

(2) The depth of water was never more than about 4 feet, and the boat was grounded a number of times. The displacement of sediments by propeller wash was observed to be very great.

(3) At least 90 per cent of the dredged area was covered at least once. We have never seen a commercially-dredged area more completely worked over.

(4) Current velocities in the experimental area during dredging ranged from 0.1 to 0.9 knots. The higher velocity is greater than the average spring velocity at strength of current of the 23 stations for which data are available in Eastern Bay, the Chester, Choptank, Little Choptank, and Patuxent Rivers within the range of the soft shell clam. [1] Among these stations, only

[1] Current Tables, Atlantic Coast, North America, 1956, U. S. Coast and Geodetic Survey.

KEY: Encircled figures are the counts of oysters in 20-square-foot areas before dredging.

Underscored figures are the counts of oysters in adjacent 20-square-foot areas 4 months after dredging.

Solid circles indicate locations of sedimentation plates.

NORTH

EBB CURRENT
velocity 0.1-0.9 knots

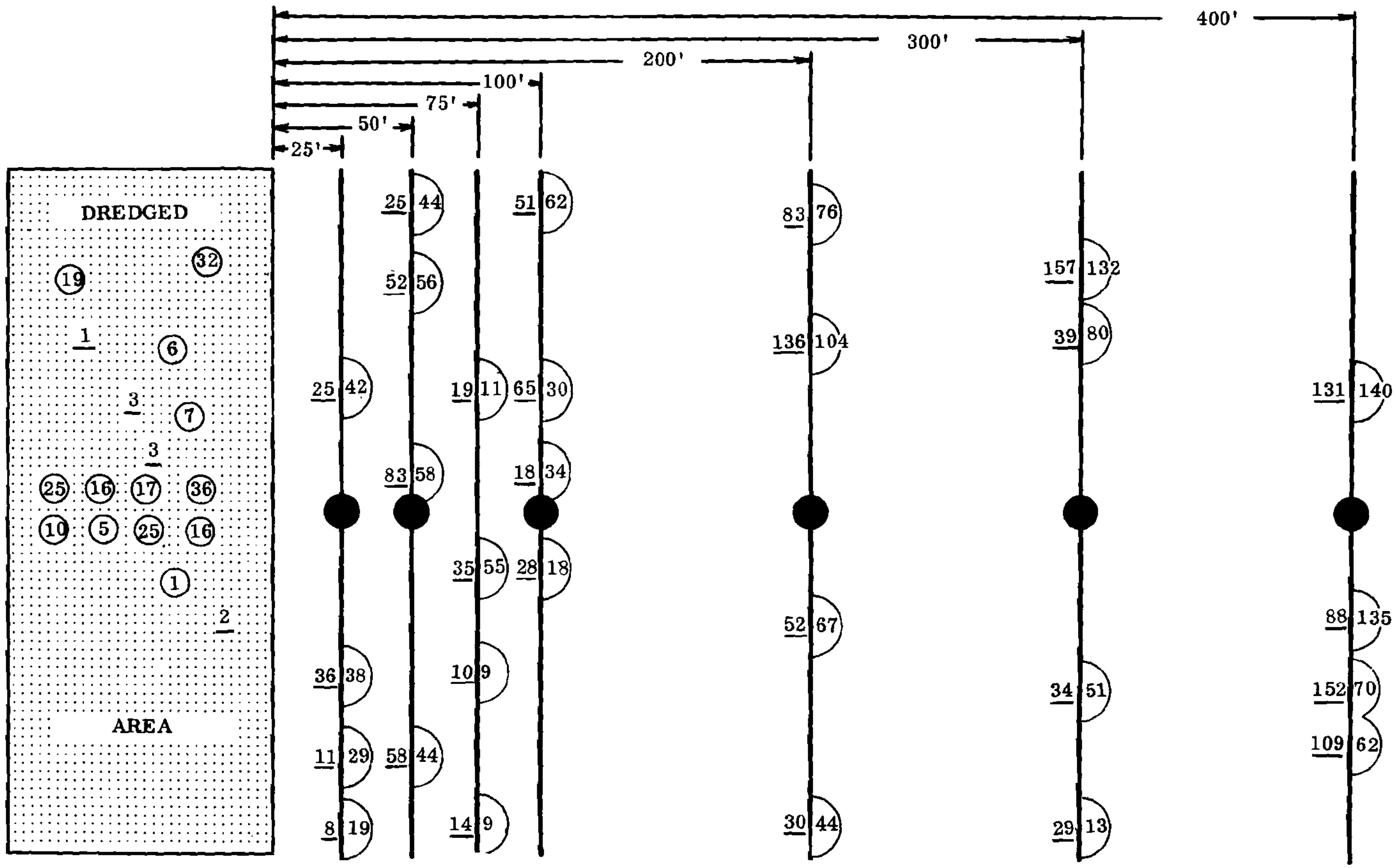

Figure 4. Plan of the Cox Creek experiment to determine extent of the effects of hydraulic clam dredging on oysters.

at the highway bridge in Kent Island Narrows and at Deep Point in the Chester River are the recorded spring velocities greater (1.4 and 1.0 knots, respectively). The results of this experiment are graphed in Figure 5.

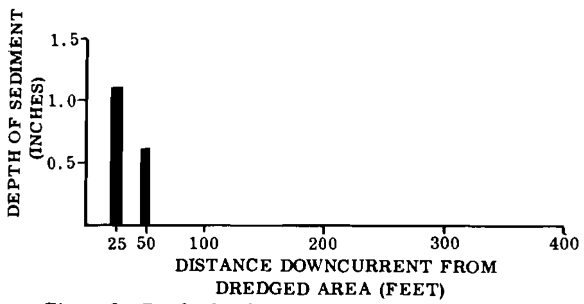

Figure 5. Depth of sediments deposited downcurrent during 9.5 hours of hydraulic clam dredging, Cox Creek, August 1956.

No measurement was made between 50 and 100 feet, but subsequent examinations of the area indicate that some sedimentation occurred beyond 50 feet. There was no discernible change in bottom level or texture at 75 feet.

The oyster population in the experimental area was resampled during periods of abnormally low tides approximately 4 months after dredging, on 19 December 1956 and 1-2 January 1957.

Plate 6 shows a biologist collecting a sample from the area inside the counting frame on January 2. The objects resting on the ice in the background are bags of bottom materials which had been collected at other sampling stations. The underscored numbers in Figure 4 indicate the locations from which the samples were taken and the number of oysters of 1 inch or greater length in each sample. Oysters less than 1 inch long were not counted, since it seemed likely at least some oysters of that size in December or January might well have been so small in August as to have been overlooked. The samples taken before and after dredging were paired to compensate for some of the great variability in distribution which characterizes oyster populations. In the dredged area, both preliminary and post-dredging sampling were completely randomized. In resampling, only 5 samples were taken in the dredged area because of the obviously great magnitude of the mortality there. Mortality of oysters in the dredged area and at distances of 25 to 400 feet downcurrent from the site of dredging was as follows:

	Dredged area	Distance downcurrent from site of dredging (feet) 25	50	75	100	200	300	400
Mortality (per cent)	92	38	-8	7	-13	-4	6	-18

A minus value in the table indicates an increase in the average number of oysters in the samples taken 4 months after dredging, not a real increase in population. Statistical analysis indicates that the fluctuations in numbers of oysters from 50 to 400 feet from the site of dredging are due to sampling variation, but that the decreases in numbers of oysters within the dredged area and at a distance of 25 feet downcurrent from the site of dredging represent actual mortalities.

Careful examination of the experimental area before dredging, during the 2-week period after completion of dredging, and again after 4 months, indicates that enough sediment was displaced and redeposited to a distance of at least 50 feet but not more than 75 feet downcurrent to cause possible damage to oyster spat. Beyond about 75 feet there has been no visible or measurable change in the experimental area.

Plate 6. Collecting bottom materials from area inside counting frame, Cox Creek experimental area, January 1957.

21. Estimates of the effects of hydraulic clam dredging on oysters, based on experimental results. The following estimates are based on dredging done under conditions which can be expected to result in near-maximal displacement of sediments and damage to oysters. (See section 23 for discussion of means of minimizing displacement of sediments.)

(1) Under conditions prevailing in much the greater part of Maryland tidewater, hydraulic clam dredging can result in severe damage to oysters within a distance of 25 feet downcurrent from the site of dredging, and may cause some mortality of oyster spat to a distance of as much as 75 feet. At distances of more than about 75 feet downcurrent from the site of operations, hydraulic clam dredging can be expected to cause no oyster mortalities by displacement of coarse sediments. Figure 6 is a graphic representation of this estimate.

(2) Where tidal currents of 1 knot or greater spring velocity occur, the effects of hydraulic clam dredging on oysters may extend to distances somewhat exceeding 75 feet. Such velocities are exceptional in Maryland tidewater, except in parts of Tangier and Pocomoke Sounds, and in the upper, usually fresh-water reaches of some of the rivers.

22. Direct observations on the effects of commercial hydraulic clam dredging on oysters. During the past 2 years we have examined a number of areas in Eastern Bay and elsewhere that have been worked intensively by commercial clam dredgers. We have looked at them from boats and from airplanes, and we have dived, using aqualung equipment, to examine them in detail. Nowhere have we observed anything that would indicate our experimental evidence is invalid.

On 12 January 1957 we made observations on 11 areas in Eastern Bay and Wye River where damage to natural oyster bars has been reported. The following is a summary of our observations:

(1) In 2 cases there was unmistakable evidence of trespass on obviously productive oyster bars plainly marked by stakes. Observed oyster mortality was very nearly 100 per cent within the dredged area on one of these bars.

(2) In 5 other cases there was unmistakable evidence of clam dredging on charted oyster bars whose boundaries were not marked. In 1 area the dredging had been done inside the charted boundaries of the bar, but so long ago (1954) that no estimate of its condition prior to dredging could be made. In 4 of the areas the

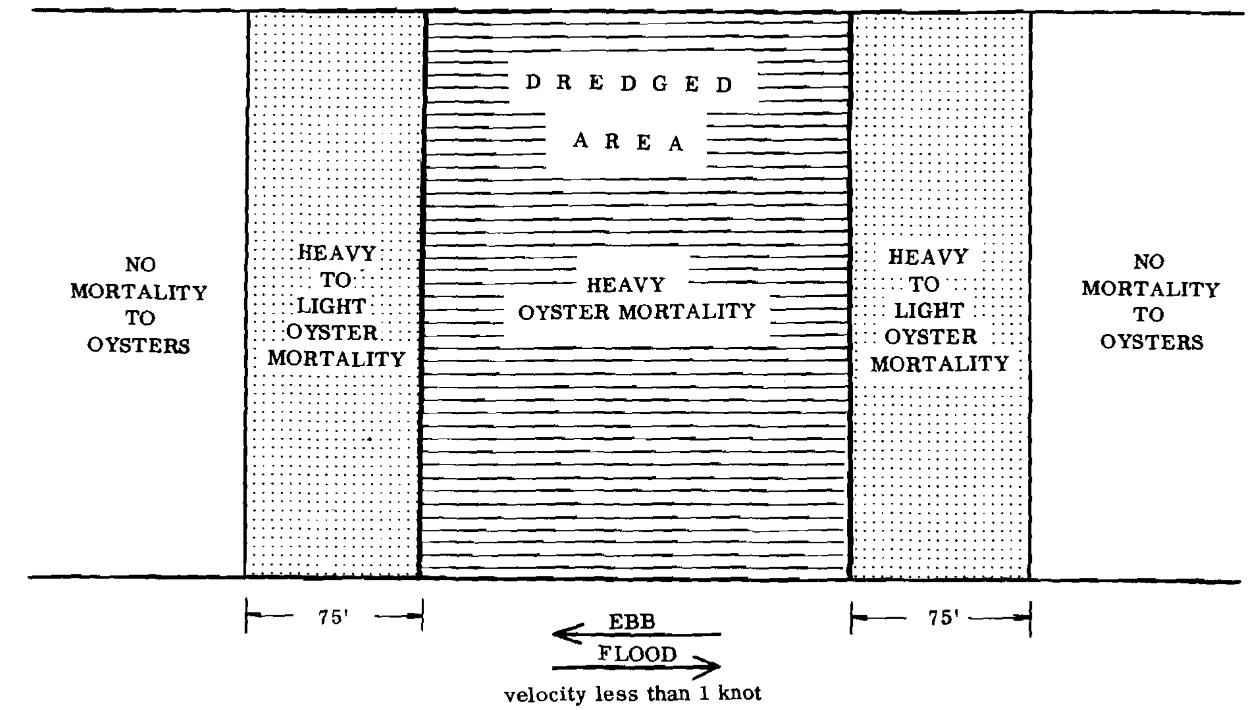

Figure 6. Estimated effects of hydraulic clam dredging on oysters, based on experimental results.

dredging had been done near the unmarked inshore boundaries of the bar. In these areas, all sandy shoals, there was no evidence that oysters have been present in commercial quantities in recent years. Their location is such that strong southerly winds might be expected to cause considerable shifting of bottoms. They are not areas where an experienced oyster planter would expect to raise a crop of oysters to marketable size consistently.

(3) In 2 other cases there was evidence of clam dredging in areas very near charted but unmarked natural oyster bars, and 1 of these areas appeared to have had an oyster population of commercial proportions within recent months. In some situations it is easy to compare position on the water with positions marked on a chart; in other situations it may be difficult or impossible unless a sextant or pelorus is used. In these 2 cases it is doubtful that trespass had occurred.

(4) In 2 areas where damage to natural oyster bars had been reported we could find no evidence of clam dredging, oyster mortality, or the existence of oysters in recent years.

Our observations indicate that, in the Eastern Bay-Wye River area:

(1) There have been flagrant violations of the law which prohibits the use of the hydraulic clam dredge on charted oyster bars.

(2) There have been violations of the same law where the circumstances were to some degree extenuating, in that the boundaries of the oyster bars were not marked.

(3) There are areas now charted as natural oyster bars where there are few if any oysters; and conversely, there are areas not charted as natural oyster bars which produce commercial quantities of oysters.

(4) Unless the State can delineate more clearly the areas open to clam dredging, enforcement of the law will continue to be difficult.

(5) If areas for oystering and clamming are allocated on the basis of surveys made 40 to 50 years ago, economic loss will result to <u>both</u> industries.

23. <u>Displacement and deposition of sediments by hydraulic clam dredging.</u> Hydraulic clam dredging creates a suspension of sediments ranging from sands to clays. If there is a current flowing, the suspension moves with it. As it moves it becomes diluted because (1) some of the particles of sediment begin to sink immediately and are redeposited on the bottom, and (2) the particles that remain in suspension are scattered by mixing with the surrounding water. A very simple experiment will illustrate this. Mix a few handfuls of gravel, sand, and garden soil with water in a bucket. Wade out into shallow water where there is a moderate current and pour out the contents of the bucket. The gravel and coarser sand will settle to the bottom almost at your feet. As the mass of turbid water moves downcurrent it will appear less and less dirty because the coarser particles are settling out and the sediments which remain in suspension, the finely divided silts and clays, are getting farther and farther apart as the water you poured out of the bucket mixes with the water moving across the beach. In a relatively short distance the suspension will be so dilute that you can no longer see it. The same thing happens, but on a larger scale, where a clam dredge is in operation. The volume of sediments placed in suspension by the dredge is many times greater, and this increase in volume will result in the deposition of a greater <u>number</u> of particles of a given size at any specified distance downcurrent. It will <u>not</u> have any effect on the <u>distance</u> those particles are displaced. The operation of 10 clam dredges may result in the suspension of 10 times as much sediment as 1 clam dredge stirs up, but the <u>distance</u> the particles are displaced will not be increased. An increase in the volume of sediments placed in suspension will also result in an increase in the number of particles of a given size which <u>remain</u> in suspension at any specified distance downcurrent. A longer time will be required for mixing of the suspension with the surrounding water and consequent dilution to the point where turbidity is no longer apparent. We have observed traces of turbidity caused by hydraulic clam dredging at considerable distances downcurrent from dredging operations. We can find no substantial reason for belief, however, that transient turbidities of the magnitude of those created by hydraulic clam dredging constitute a biological hazard beyond a distance of about 75 feet from the site of dredging under conditions prevailing in much the greater part of Maryland tidewater. Beyond that distance the deposition of sediments is a negligible factor because of the extremely small size of the particles and the very great area over which they are distributed.

Even though the effects of hydraulic clam dredging on sedimentation are relatively limited, if there is any practicable way of minimizing displacement of sediments it deserves adoption by the industry. The only controllable factor of consequence appears to be the volume of sediment placed in suspension. This can and should be minimized. The boat propeller is a major factor in stirring up the bottom sediments. The propeller wash, directed obliquely toward the bottom and unconfined in its effects, not only scours away the upper strata of sediments but in shallow water can and often does cause deep trenching. Investigators of the Fisheries Research Board of Canada, who have tested experimental models of the hydraulic clam dredge over a period of 2 years, have developed a propeller guard which deflects the propeller wash and greatly minimizes its effects. Figure 7 is a drawing of a propeller guard which they have found to be most effective. They state that the guard shown completely removes the trenching effect of the propeller, and that they can ground the boat and run the motor at full throttle without damage to sandy flats. 1/ The device is said to reduce the cruising speed of the boat by about one-third. It can be swung over the stern and carried aboard if necessary.

1/ Personal communication, J. S. MacPhail, New Brunswick Biological Station, Fisheries Research Board of Canada.

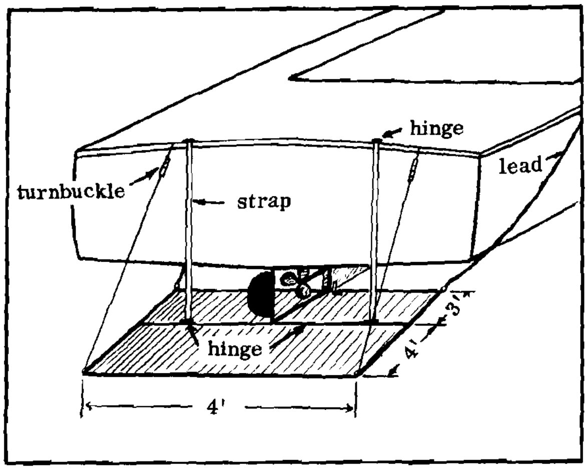

Figure 7. Propeller guard developed and tested by the New Brunswick Biological Station, Fisheries Research Board of Canada, for use in hydraulic clam dredging.

Figure 8 represents a cross-section of a typical trench shortly after dredging. The depth of cut, indicated by broken lines, may be as much as about 18 inches. The greater part of the bottom material is redeposited in the trench during dredging. In time the cut is filled by deposition of sediments and organic debris to the level of the surrounding bottom, and the materials in the trench become firm, sometimes with an apparently encrusted surface stratum. The depths of 57 trenches measured on the day of dredging ranged from 2 to 8 inches, averaging 5 inches. The depths of 50 trenches measured 4 to 6 days after dredging ranged from 1 to 8 inches, averaging 3 inches. Depth was determined by having a man stand first in the trench, then on the adjacent undisturbed bottom, and measuring the increase in distance from the top of his waders to the surface of the water. The time required for complete filling in of the trench and hardening of the bottom is highly variable. We have seen trenches fill in a few days and harden in a few weeks, and we have also observed areas where, although the trenches filled in a relatively short time, the sediments had not become compact in 4 months.

Until the trenches fill and harden they may constitute a nuisance, if not an actual hazard, to bathers. There are about 2,000 miles of shoreline in Maryland's tidewater, of which a small fraction is suitable for bathing beaches and a small fraction produces commercial quantities of clams. To the extent that these areas coincide, conflicts of interest may be expected to occur. Only exceptionally do shore owners have legal rights beyond the mean low water mark, but their traditional right to use of a reasonable extent of the beach for recreational purposes is widely recognized.

24. The effects of hydraulic clam dredging on fish and crabs. The Department has received reports, direct and indirect, that fish and crabs quit biting when clam dredging operations are begun upcurrent from a fishing boat or trotline. Details such as the distances involved have been lacking. If these reports are accurate, 2 possible explanations might be: (1) fish and crabs leave the area because of an avoiding reaction to some change in the environment caused by clam dredging, and (2) fish and crabs are attracted upcurrent to the area being dredged, as if by a chum line. This problem lends itself to experimental determination, and evidence will be sought in 1957. We have made a few observations, while dredging experimentally or observing the operations of relatively small groups of clam dredgers, which indicate that crabs, eels and some species of fish are attracted to areas where dredging is in progress, presumably by the availability of food such as clams and worms. Most of the burrowing animals which are disturbed by the dredge dig back into the bottom in a short time, but while they are exposed the dredged area is a source of food which ordinarily is much less available to fish or crabs. The possibility exists that the effects of a large number of clam dredges working in an area may be quite different. The facts can be determined only by research.

The Department has also heard reports that fishing and crabbing have declined in the Eastern Bay-Miles River area since the advent of commercial clam dredging. Statistical evidence contained in publications and records of the Board of Natural Resources and the Department of Research and Education was examined to evaluate these reports. Figure 9 shows the annual catch of blue crabs in the Eastern Bay-Miles River area as percentage of the total catch of blue crabs in Chesapeake Bay and tributaries. Great fluctuations occur in the abundance of crabs in Chesapeake Bay from year to year. Statewide production rose from 19,332,000 pounds in 1948 to 28,288,000 pounds in 1951, then declined to about 15,200,000 pounds in 1955. The Eastern Bay-Miles River share in the total catch averaged 6.5 per cent during the 4-year period immediately preceding the beginning of commercial clam dredging in the area, and 10.2 per cent during the 4-year period of commercial clam dredging for which data are available. In no year of the latter period was the Eastern Bay-Miles River percentage of the total catch as low as in 1948, 1949, and 1950.

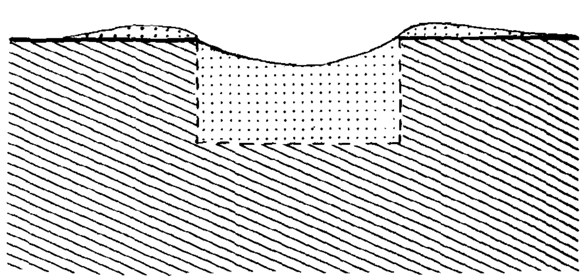

Figure 8. Cross-sectional diagram of hydraulic clam dredge trench.

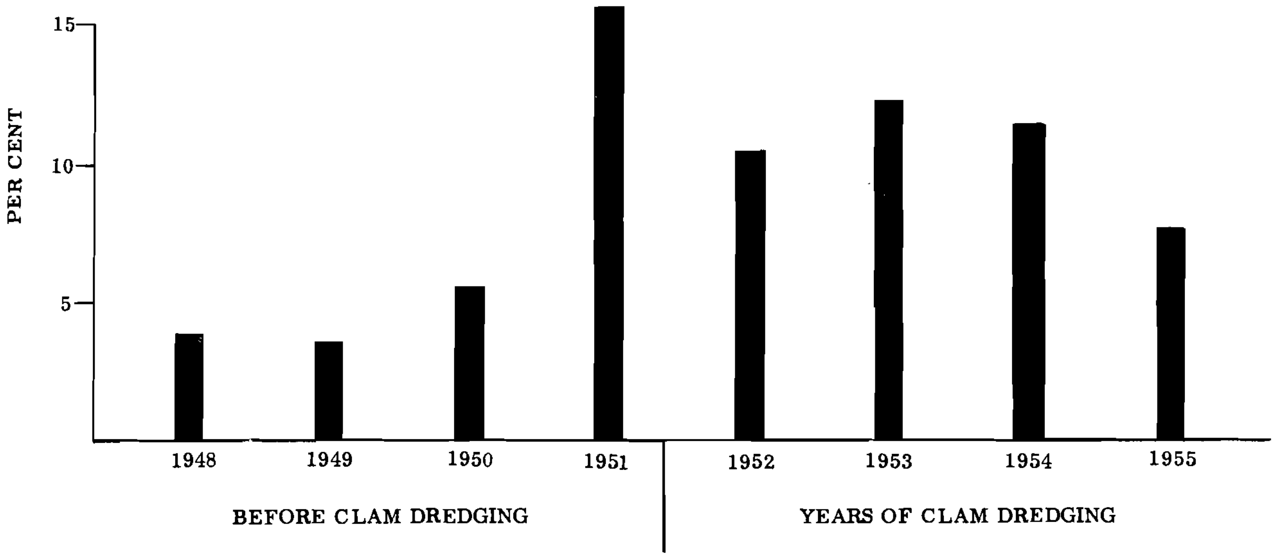

Figure 9. The annual catch of blue crabs in the Eastern Bay-Miles River area as percentage of the total catch of blue crabs in Chesapeake Bay and tributaries.

Statistical evidence concerning success of commercial fishing in the Eastern Bay-Miles River area is shown in Figures 10 and 11. The area's share of the statewide catch of striped bass and of all fish has been the same during the period of development of the soft shell clam fishery (1952-1955) as it was during the 6-year period before clam dredging began.

In summary, limited but pertinent statistical evidence does not support claims that hydraulic clam dredging has caused a decline in crabbing or commercial fishing in the Eastern Bay-Miles River area.

It should be emphasized that we do not consider evidence of this nature to be conclusive. A great number of factors affect not only the abundance but the growth, condition, and catchability of fish and crabs. Evaluation of the effects of any one factor, such as hydraulic clam dredging, is an exceedingly difficult problem. To the extent practicable, research will be directed toward solution of the problem, but the evidence at hand indicates that any effects hydraulic clam dredging may have on the success of crabbing or fishing are highly localized.

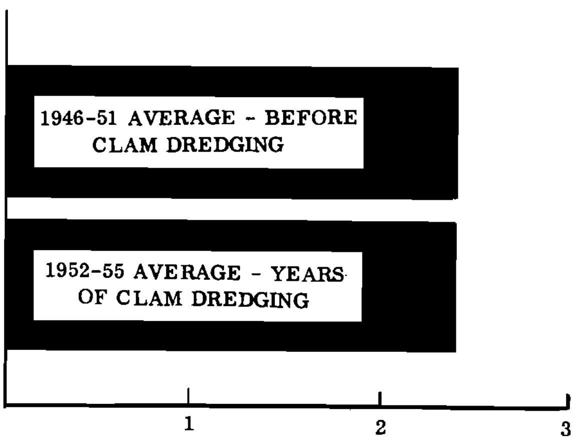

Figure 10. The commercial catch of striped bass in the Eastern Bay-Miles River area as percentage of total commercial catch of striped bass in Chesapeake Bay and tributaries, before and after the beginning of hydraulic clam dredging.

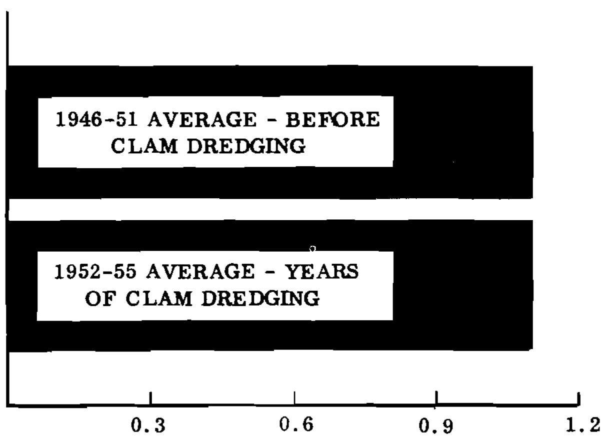

Figure 11. The commercial catch of all fish in the Eastern Bay-Miles River area as percentage of total commercial catch of all fish in Chesapeake Bay and tributaries, before and after the beginning of hydraulic clam dredging.

25. The importance of aquatic vegetation. All of the common species of rooted aquatic plants that grow in the area of "salt water shoals" have value as food for waterfowl. Eelgrass, clasping-leaf pondweed, wigeon-grass, and sago pondweed are rated good to excellent duck foods, and horned pondweed is rated fair to good. [1] All are perennial plants. Their underground root systems produce stems and leaves in spring and summer, some of which disintegrate during the autumn and winter months. The tubers, rootstocks, and seeds are the parts commonly eaten, but ducks may also eat the leaves and stems of some species.

The importance of rooted aquatic vegetation in other respects is less clear. The carp is the only marine animal of Maryland tidewater in whose diet rooted plants are reported to be of more than minor significance. The plants which are of primary importance in the basic productivity of estuaries such as the Bay and its tributaries are the microscopic plants (phytoplankton) which drift with the tides and currents. Their abundance is controlled by many factors, including the availability of nitrogen and phosphorus. It has been shown that marine muds in Mobile Bay (Alabama) are rich in these elements, and the investigators have noted the possibility that the circulation of nutrients and organic materials by dredging operations there may be effective in fertilizing the waters. [2] Clam dredging in Maryland may have a variety of effects on basic productivity, and the net result may be either an increase or a decrease in the products used by man. We have initiated studies which in time may enable us to evaluate the localized effects of clam dredging. Present knowledge suggests that the effects on the Bay as a whole, or on any tributary or sizable geographical unit of tidewater, are not of great enough magnitude to be measured.

26. Effects of hydraulic clam dredging on aquatic vegetation. The hydraulic clam dredge uproots all of the vegetation in its path, which is from 30 to 36 inches wide. In very shallow water the propeller also uproots aquatic plants. It is probable that the damage done by the propeller can be minimized or eliminated. So far as we know now, there is nothing that can be done to minimize the effect of the dredge itself. The rooted aquatic plants can propagate from rootstocks or, in some cases, from pieces of leafy stems, but we have no evidence that this often occurs.

Where dredging is exploratory, the dredge paths become repopulated in time with new growth produced from seeds or from the branching root systems of nearby plants. The reduction in abundance of vegetation is temporary and confined to a small area. Where commercial quantities of clams are found and the bottom is thoroughly covered by one or more dredges, however, the area may be more or less completely stripped of vegetation. We have initiated experiments to determine how long a time is required for revegetation of such areas. In these experiments we are fortunate in having the advice and cooperation of waterfowl habitat specialists of the U. S. Fish and Wildlife Service. Experimental areas have thus far been established in the Patuxent River and in Eastern Bay.

Plate 7 is an aerial photograph of the experimental area in the Patuxent River. The white spots are markers used for identification of the area from the air. The deeper shades of gray are vegetation. The distribution and abundance of the 5 species of rooted plants growing in plots C and D were determined by ground survey. The physical structure of the bottom was determined by extracting cores and analyzing 4-inch segments from the surface to a depth of 16 inches to determine the percentage of gravel, sand, silt, and clay. In early July 1956 plot D was worked over thoroughly with the hydraulic clam dredge. The entire area was resurveyed in late October, using the same methods employed in the initial survey. Very few plants were found in the dredged area, D. In the photographs, taken in early November, the uniform light gray tones of area D indicate the absence of vegetation. This area will be resurveyed and rephotographed periodically until conclusions may be drawn concerning the rate at which the dredged area is repopulated with aquatic plants. We may learn whether there are differences in rates of repopulation among the several species of plants. We have already learned something about the changes that took place in the physical structure of the bottom as a result of dredging. This experiment must be repeated in a number of locations where type of bottom, depth of water, and other conditions vary before estimates of average rate of revegetation of intensively dredged areas can be made.

Plate 8, an aerial view of a sandy shoal in the Patuxent River, affords the best evidence available on revegetation over a longer period of time. This flat is exposed to southerly winds, and the abundance and distribution of rooted plants has varied greatly from year to year over a long period. The hurricane of October 1954 stripped the area of virtually all visible vegetation, but apparently the underground root systems of many plants survived. The boundaries of areas A, B, and C are approximate. Area A was dredged commercially in August 1954. Coverage was neither uniform nor complete, but the vegetation was materially reduced, possibly by as much as 75 per cent. Area B was covered thoroughly by commercial clam dredgers in August 1955. Before dredging it was thinly vegetated; after dredging, only scattered plants remained. Area C has never been dredged. The aerial photograph, taken in November 1956, indicates substantial revegetation of area A in a period of about 2 years. In area B only slight progress toward revegetation was made during the first year after dredging. Whether these results are typical of what

[1] Food of Game Ducks in the United States and Canada, Research Report 30, U. S. Fish and Wildlife Service, by A. C. Martin and F. M. Uhler.

[2] Chemical and Biological Studies of the Muds of Mobile Bay, by Robert M. Ingle, A. Russell Ceurvels, and Richard Leinecker, The Marine Laboratory, University of Miami.

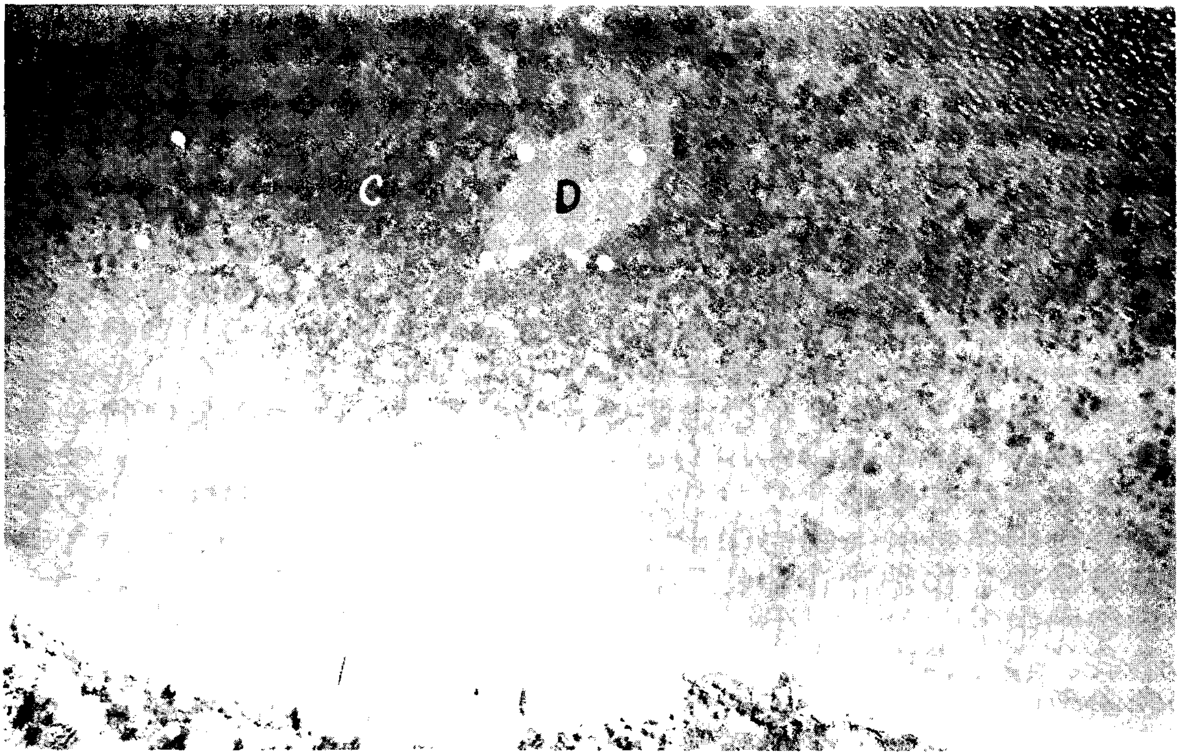

Plate 7. Aerial photograph of experimental area in the Patuxent River, November 1956.

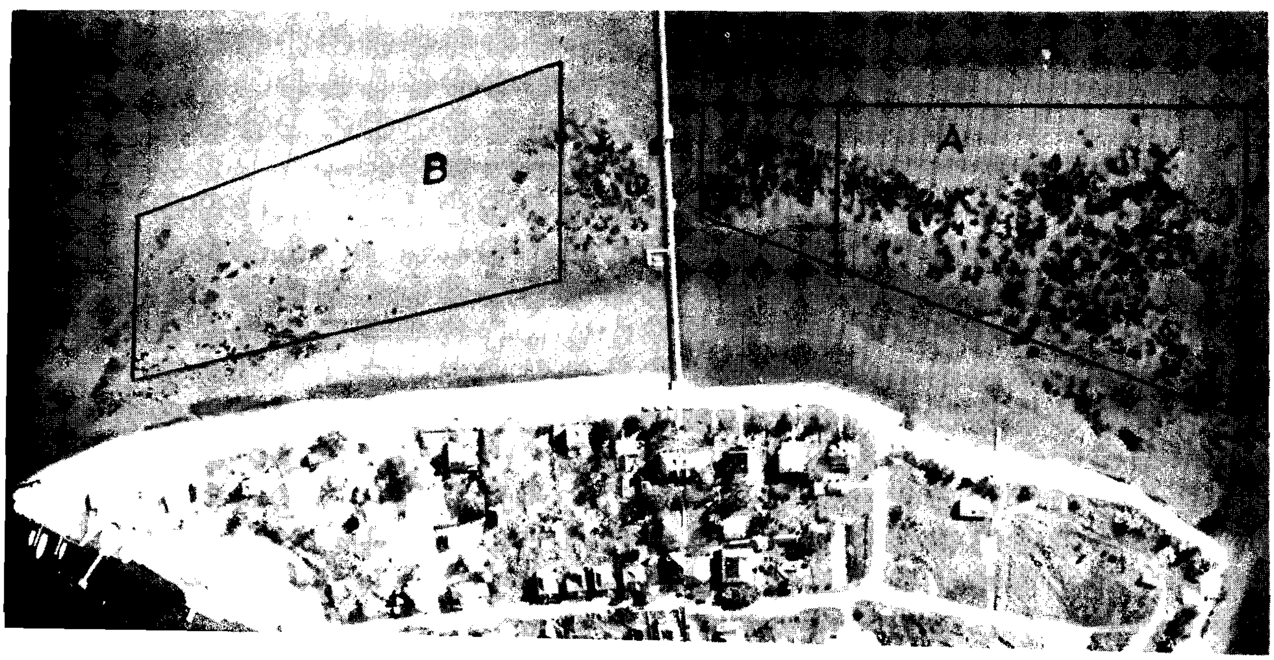

Plate 8. Aerial photograph of sandy shoal in the lower Patuxent River, November 1956.

may be expected to occur in other areas remains to be seen. It seems likely that great variation in the rate of revegetation may be expected.

Our present knowledge and estimates of the effects of hydraulic clam dredging on aquatic vegetation are summarized as follows:

(1) A fraction of the area of "salt water shoals" is vegetated. The size of this fraction varies widely from one locality to another and from one year to the next because of factors such as exposure to storm damage and type of bottom. Aerial photography of a 6-mile stretch of the Patuxent River in November 1956 showed that vegetation was much more abundant on the Calvert County side, where thousands of bushels of clams have been dredged, than on the St. Mary's side, where dredging is prohibited. This indicates merely that in this area of the river natural forces and conditions have had a great deal more to do with the distribution and abundance of vegetation than has clam dredging. Photographic evidence and the estimates of competent observers indicate that about 20 to 30 per cent of the area of "salt water shoals" is vegetated. In any area of small size the percentage may vary from zero to 100 per cent.

(2) A fraction of the area of "salt water shoals" is populated with commercial quantities of soft shell clams. Locally this fraction may be large, or it may be negligible; our observations indicate that, over all, commercial quantities of clams are found on a small percentage of the shoal areas.

(3) To the extent that areas having commercial populations of clams coincide with areas of vegetation, at least temporary reduction of the abundance of rooted plants is caused by clam dredging. If an area is highly productive, the reduction may approach 100 per cent. If the area continues to produce an annual crop of clams, it will probably be dredged periodically and will not become revegetated.

(4) Of the total area of "salt water shoals" in Calvert, Talbot, and Queen Anne's Counties, we estimate that about 3 per cent was dredged in Fiscal Year 1956 and that about 4 per cent will be dredged during Fiscal Year 1957. Some of the bottom dredged in 1956 is known to have been dredged one or more times during the period 1952-1955. Some of the bottoms dredged in 1957--probably most of them-- will be bottoms which were dredged one or more times during the period 1952-1956. In Talbot and Queen Anne's Counties the soft shell clam fishery apparently has passed the exploratory stage and is now supported largely by the annual crop of clams produced on bottoms which have been dredged at least once since the beginning of the fishery in 1952. We believe, from our own observations and those of members of the industry, that a very high percentage of the commercially productive clamming bottoms within the area open to clam dredging have been discovered and dredged at least once. Under favorable conditions new areas may become commercially productive, but sizable additions to the area of productive clam bottoms appear unlikely.

(5) Mr. F. M. Uhler, co-author of "Food of Game Ducks in the United States and Canada" and waterfowl habitat specialist of the U. S. Fish and Wildlife Service, estimates that in the Chesapeake Bay area waterfowl actually eat each year only a negligible percentage of the plants available.

(6) All the evidence indicates that the effects of hydraulic clam dredging on aquatic vegetation are negligible except on a highly localized basis. There appears to be no reason for concern that the abundance of waterfowl in Maryland tidewater will be affected or that the numbers of waterfowl frequenting the waters of Calvert, Talbot, or Queen Anne's Counties will be reduced because of hydraulic clam dredging operations.

(7) Such evidence as we have been able to obtain regarding success of duck hunting from blinds located in dredged areas is highly contradictory. We know from personal experience that clam dredging, oyster tonging, or any other activity of man in the immediate vicinity of a blind spoils shooting. This is a problem in human relations rather than biology. We have had indirect reports that hunting from a particular blind is less successful after the area in front of it has been dredged. Decisive evidence on this question is difficult if not impossible to obtain because of the widespread practice of baiting and the naturally varying distribution of waterfowl.

VI. EVALUATIONS OF CERTAIN PROPOSALS CONCERNING THE SOFT SHELL CLAM INDUSTRY.

We have attempted to evaluate some of the many suggestions which have been made concerning the soft shell clam industry. Ten of the more significant proposals, some originating within this Department and some without, are listed below. This Department makes no recommendations but believes it appropriate to include comments based on our present knowledge of the soft shell clam industry and tidewater resources in general.

PROPOSAL A: PROHIBIT USE OF THE HYDRAULIC CLAM DREDGE THROUGHOUT MARYLAND.

1. A minor fraction of the conflicts of interest in use of tidewater resources would be resolved.

2. A renewable resource of major value could not be utilized. The estimated losses to current tidewater economy would include:

a. A loss of about $720,000 gross annual income to the primary producers.

b. A loss of about $1,260,000 gross annual income to the processors and dealers.

c. A probable loss of at least $100,000 in personal property values to members of the industry.

d. Termination of employment for a seasonally varying number of shuckers, truck drivers, etc., whose annual payroll (in Maryland) now totals about $175,000.

3. About 200 dredgers and crewmen would be forced to find employment in another field. Most of them probably would return to their former occupation as oyster tongers and/or crabbers, with resultant increased exploitation of resources currently in short supply.

4. Some gains to tidewater economy through increased utilization or productiveness of other resources might be expected to result. Present knowledge indicates that these gains would constitute a minor fraction of the losses involved in neglect of the clam resource.

5. Adoption of the proposal would preclude realization of an estimated potential gain to tidewater economy of $2,000,000 to $3,000,000 gross annual income to the primary producers and $3,000,000 to $5,000,000 gross annual income to the dealers and processors. These potentials might be realized with market development and future geographical expansion of the fishery.

PROPOSAL B: <u>LEGALIZE HYDRAULIC CLAM DREDGING THROUGHOUT MARYLAND.</u>

1. Until satisfactory solutions to the existing conflicts of interest can be worked out, the present problems would be extended to new areas.

2. Major geographical expansion of the fishery without market development probably would be detrimental to Maryland's established clam industry. Demand does not now exist for the large supplies of clams which estimates indicate would become available. A steadily increasing demand for Maryland clams is anticipated, but no immediate increase of major proportions is foreseen.

PROPOSAL C: <u>MARK THE BOUNDARIES OF THE CHARTED NATURAL OYSTER BARS IN THOSE AREAS WHERE CLAM DREDGING IS PERMITTED AND ALLOW THE CLAMMING INDUSTRY TO CONTINUE UNDER EXISTING REGULATIONS, WITH STRICT ENFORCEMENT.</u>

1. Enforcement of the law probably would be greatly facilitated.

2. Continued allocation of areas to the oyster industry and clam industry on the basis of surveys conducted as long as 50 years ago can be expected to result in economic loss to both industries. There are now bottoms not charted as natural oyster bars which produce commercial quantities of oysters, and there are bottoms charted as natural oyster bars which have not produced commercial quantities of oysters in many years.

3. This proposal affords no basis for resolution of the conflicts which exist between commercial fisheries interests and the interests of sportsmen and shore owners.

PROPOSAL D: <u>RESURVEY THE BOTTOMS OF CHESAPEAKE BAY AND TRIBUTARIES, IN WHOLE OR IN PART, AND ALLOCATE AREAS FOR SOLE OR COMMON USE BY ALL INTERESTS ON THE BASIS OF OPTIMUM UTILITY.</u>

1. Present knowledge indicates that the resurvey and impartial reconsideration of use of tidewater bottoms would serve the public interest and result in a net gain to the tidewater economy.

2. Resurvey of any considerable area of bottoms would require time and substantial funds. However, developments in instrumentation and survey techniques during the past 50 years indicate that the time and manpower requirements would be considerably less, acre for acre, than those of the Yates Survey of 1906-1912, on which present management of our shellfish resources is based.

PROPOSAL E: <u>ALLOCATE BOTTOMS FOR SOLE OR COMMON USE BY AGREEMENT AMONG REPRESENTATIVES OF THE SEVERAL INTERESTS (COMMERCIAL FISHERIES, SPORTSMEN, SHORE OWNERS, ETC.) WITH ARBITRATION BY APPROPRIATE STATE AGENCIES WHERE NECESSARY.</u>

1. Present knowledge indicates that adoption of this proposal would operate in the public interest and result in net economic gains to the tidewater area. No one now knows more about the locations of the commercially important resources of tidewater than the watermen who harvest them. No one knows more about the interests of the sportsmen and shore owners than the sportsmen and shore owners themselves.

2. Areas of disagreement among the several interests might be expected. In some cases expenditures of public funds might be required to obtain the factual information necessary to impartial judgments. As compared with the cost of the resurvey contemplated in Proposal D, these expenditures probably would be minor.

PROPOSAL F: <u>PERMIT LIMITED GEOGRAPHICAL EXPANSION OF THE CLAM FISHERY.</u>

1. Present knowledge indicates that if an enforceable line can be drawn between the clam dredging fishery and commercially productive oyster bottoms, use of the hydraulic clam dredge does not constitute a significant biological hazard to tidewater resources.

2. Experience indicates that the public interest would be served by careful consideration of local conditions and planned bottom use in any area where hydraulic clam dredging is contemplated.

3. The extent to which the economic welfare of the present industry would be affected probably would be proportional to the increased supplies of clams made available. Demand is high in summer, and the market

probably could absorb a considerably increased production during a period of about 4 months. Prospects for eventual market expansion are considered excellent.

PROPOSAL G: REQUIRE THE CLAM DREDGING INDUSTRY TO ADOPT MODIFICATIONS TO GEAR OR METHODS WHEN SUCH MODIFICATIONS ARE DEMONSTRATED TO OPERATE IN THE PUBLIC INTEREST.

1. Present knowledge indicates that at least one modification to the hydraulic clam dredge is practicable and highly desirable (the propeller guard described in Section 23).

2. Other modifications of the gear may be practicable. Continued research can establish factual information concerning changes which might minimize the volume of sediments suspended, reduce the noise of operation, etc.

PROPOSAL H: MODIFY THE TAX COLLECTION SYSTEM AS NECESSARY TO GUARANTEE COMPLIANCE WITH THE LAW.

1. Present knowledge indicates that the system of tax collection can and should be modified toward greater efficiency. There is strong evidence that tax was paid on less than 80 per cent of Maryland's production in Fiscal Year 1956.

PROPOSAL I: REALLOCATE THE CLAM FUND ACCRUING FROM COLLECTION OF THE 10 CENTS PER BUSHEL TAX ON CLAMS PRODUCED IN MARYLAND AND NOW DEDICATED TO RESEARCH CONCERNING THE CLAM FISHERY.

1. The source of the funds used by this Department to support research on the soft shell clam fishery is immaterial; the need for continued research is very great. Since June 1955 clam research has been supported about equally by the Clam Fund and general appropriations for the Department. Ample precedent for the support of research in this manner exists in Maryland and other states.

PROPOSAL J: REQUIRE THE SOFT SHELL CLAM INDUSTRY TO MAINTAIN AND SUBMIT CATCH RECORDS.

1. The availability of adequate catch records in all the commercial and sports fisheries would greatly implement the work of this Department in developing knowledge which will contribute to optimal use of Maryland's natural resources.

2. No great burden would be placed on the clam industry.

VII. SUMMARY.

Maryland is now known to have a substantial and renewable soft shell clam resource capable of supporting a major fishery. This report includes basic information concerning the soft shell clam, the industry it supports, the gear used in its exploitation, and the effects of that gear on tidewater resources. In addition, we have undertaken to evaluate some of the proposals which have been made concerning the soft shell clam fishery. All available evidence has been considered--statistical records, direct observations, and the results of our own and others' research. Much of the evidence is presumptive rather than conclusive, but sufficient to support certain estimates and reasoned judgments.

The hydraulic clam dredge is a highly efficient gear. It catches almost all the marketable clams in its path and breaks very few clams, large or small. A commercial dredger can completely cover 1 acre of bottom in about 35 hours. Operational costs are high, and the dredger must work where there are about 50 bushels of clams per acre to make a reasonable living. Ninety-three dredges were licensed for operation in the waters of Calvert, Talbot, and Queen Anne's Counties as of December 1956.

The soft shell clam grows very rapidly in Maryland-about 3 times as fast as in Maine-and the life span of the species is relatively short. The depletion of spawning stocks appears unlikely in the foreseeable future. Clams are widely distributed, and population density is highly variable. An economically harvestable standing crop estimated at more than 700,000 bushels is concentrated in a very minor fraction of the total area of tidewater bottoms.

The clam dredge fishery is now confined by law to the waters of 4 counties, Calvert, Talbot, Queen Anne's, and Charles. No dredging has been done in Charles County. Dockside value of Maryland's catch of soft shell clams is estimated at $580,000 in Fiscal Year 1956 and $720,000 in Fiscal Year 1957, and the predicted wholesale value of the catch in the latter year is $1,260,000. Potential dockside value of the resource, if markets were expanded to absorb the additional quantities of clams which probably could be made available by statewide exploitation, is estimated at $2,000,000 to $3,000,000.

It is estimated that the catch of soft shell clams in Fiscal Year 1956 in Calvert, Talbot, and Queen Anne's Counties came from bottom totaling in area about 5 per cent of all the bottom open to clam dredging and about 1 per cent of all the bottom beneath tidewater in those counties. Present knowledge indicates that the industry is now sustained mainly by an annual crop of clams from bottom which has been dredged one or more times since 1952, when commercial dredging began, and that future geographical expansions within the counties where dredging is permitted will be slight.

Experimental results and observations verify our earlier (1954) prediction that virtually all the oysters in the path of the hydraulic dredge will die but that oysters a short distance from the site of dredging will be unaffected. It has been demonstrated that intensive dredging under conditions representative of the extremes observed in all but a very minor fraction of Maryland's clam-producing area can be expected to result in: (1) displacement and deposition of measurable quantities of sediments up to about 75 feet downcurrent from the dredged area; (2) essentially complete mortality of oysters within the dredged area; (3) significant mortality of oysters 25 feet downcurrent from the dredged area; (4) possible mortality of oyster spat up to about 75 feet downcurrent; and (5) no mortality of oysters or spat at distances greater than about 75 feet from the dredged area. Observations of areas subjected to intensive commercial dredging support the experimental results. The only pertinent statistical evidence available concerns oyster setting in the Eastern Bay-Miles River area, where clam dredging began and where it has been most intensively practiced. Records maintained by this Department indicate that there has been no significant change in oyster setting in that area attributable to hydraulic clam dredging.

Statistical records of the fishing and crabbing industries include catch records by geographical units of tidewater, of which the Eastern Bay-Miles River area is one. The evidence indicates that the area's share of the total commercial catch of fish and crabs has not declined since the advent of the soft shell clam fishery.

Experimental results and observations show that the hydraulic clam dredge is highly destructive of rooted aquatic vegetation within the immediate area of intensive dredging. Effective revegetation of commercially productive clam bottoms is not expected to occur, since such bottoms probably will be dredged at intervals too short to permit repopulation by plants. Three factors, (1) the limited distribution of commercially important populations of clams, (2) the wide distribution of aquatic vegetation, and (3) the fact that waterfowl actually eat a negligible percentage of the plant food that is available to them, are believed to justify the conclusion that the effect of hydraulic clam dredging on the abundance of waterfowl in the Chesapeake Bay area or the counties where clam dredging is permitted is negligible, and the effect on the distribution of waterfowl is highly localized. Factors (1) and (2) operate to minimize and localize whatever effect, if any, hydraulic clam dredging may have on basic productivity of our waters.

Final consideration of all the evidence obtained in our investigations indicates that:

(1) If an enforceable line can be drawn between the soft shell clam fishery and the productive oyster bottoms, use of the hydraulic clam dredge does not constitute a biological hazard to tidewater resources.

(2) Conflicts of interest exist in the use of tidewater resources, and some--but by no means all--of them center on use of the hydraulic clam dredge. Some result from disregard of the law or from inherent difficulties in its observance or enforcement; some are caused by gross lack of consideration for the traditional rights of shore owners, and others by the presumption of rights which have no basis in law or tradition. Still others result from misinformation and misunderstandings. Most of the conflicts related to clam dredging appear to be capable of resolution by reasoning and moderation among the special interest groups who share the economic and recreational resources of Maryland's tidewater.

(3) The public interest and the welfare of the tidewater area would be served by objective reconsideration of use of the resources of the Bay and its tributaries, based on existing conditions. Precedent exists in the Fourth Report of the Shell Fish Commission of Maryland, 1912, which summarized the information collected during the Oyster Survey of 1906-1912 and presented certain concepts of the value and use of tidewater resources known to exist at that time.

(4) Continuing research on the soft shell clam resource and the industry it supports is essential.

ACKNOWLEDGEMENTS

The Department of Research and Education gratefully acknowledges the cooperation and assistance of the U. S. Fish and Wildlife Service, the Chesapeake Bay Institute of Johns Hopkins University, the Queen Anne's County Watermen's Association, the Clam Diggers' Association of Queen Anne's County, the Department of Tidewater Fisheries, and the Naval Photographic Center, Anacostia Naval Air Station.

I am personally indebted to all the members of the staff of the Department who have contributed in one way or another to the conduct of the investigation and the preparation of this report, and especially to Dr. L. Eugene Cronin, G. Francis Beaven, and Hayes T. Pfitzenmeyer. I have been most fortunate in having the advice and cooperation of F. M. Uhler and Dr. A. C. Martin of the Patuxent Research Refuge, U. S. Fish and Wildlife Service, in studies concerning aquatic vegetation. I wish especially to thank J. S. MacPhail, of the New Brunswick Biological Station, Fisheries Research Board of Canada, for making available unpublished data and other information of very real significance.

STATE OF MARYLAND

BOARD OF NATURAL RESOURCES

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DEPARTMENT OF RESEARCH AND EDUCATION
SOLOMONS, MARYLAND

To the Members of the General Assembly of Maryland:

Maryland has probably always had soft clams, almost unharvestable because of our small tides. In recent years coincidence of New England's shortage and the invention and adaptation of a type of dredge entirely new to this area has created the possibility of a new major Maryland resource. The new industry has rapidly expanded. Present partial data suggest that it may have an economic potential equal to our crab or fish industries.

The new device is a highly efficient machine, cutting by hydraulic jets into the bottom and screening the bottom to remove the clams. The very efficiency which permits the industry to exist has caused grave concern among those who use other resources from the water and from the estuarine bottoms. These people ask if the hydraulic dredges, slowly cruising through some areas, are excessively destructive of oysters, duck food, habitat for crabs and fish, swimming beaches, and other established resources or uses.

In recognition of both the potentials and the problems inherent in this new gear, the 1955 General Assembly enacted legislation restricting the size of the dredge, licensing the dredges and the operators, defining some areas of operation, and providing other specific control of the industry. In addition, Senate Bill No. 301 provided that a tax yield of 10¢ per bushel of clams be made available to the Department of Research and Education for the purpose of making studies on clamming and the effects of dredging in Maryland.

These funds became available during the summer of 1955. Utilizing those funds and a substantial portion of the general funds appropriated to the Department, Mr. Joseph H. Manning has organized and conducted specific scientific studies designed to answer as many questions as possible within limited time and with limited facilities. Pertinent results of his research to date are presented in this interim report. In addition, other data, records, and information pertinent to legislative consideration of the soft clam gear and industry are summarized. Additional new facts and understanding will, of course, be obtained in the future. There is serious need for much more research on the biological and conservation problems involved.

As an additional service to the General Assembly, we have attempted the difficult task of predicting some of the effects of various suggested changes in regulation. As scientists, we must carefully qualify these estimates of effect, and point out that any one or combination of these may be shown to be incorrect by future learning and experience. We believe, however, that the General Assembly wishes to have before it the best possible predictions on the basis of present knowledge.

As in many problems in the conservation of natural resources, the data here indicate that the answers are not black or white, but difficult shades of gray. Present and future legislative action on this and related tidewater problems will have far-reaching effects on the economy of the State. Wise policy for the best use of the Chesapeake Bay and its tributaries must extend beyond the temporary solution of local controversies. We hope that the research efforts thus far conducted are of effective assistance in the deliberations of the General Assembly and of the many other people concerned.

Respectfully,

L. Eugene Cronin
Director