SUBMARINE PHOTOS OF COMMERCIAL SHELLFISH OFF NORTHEASTERN UNITED STATES

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Several thousand photographs of the sea bottom off the northeastern coast of the United States were taken as part of a joint study by the Woods Hole Oceanographic Institution, the U. S. Bureau of Commercial Fisheries, and the U. S. Geological Survey. Nearly every photograph reveals the presence of animals living in or on the bottom. Of special interest are the commercially valuable mollusks--the sea scallop (Placopecten magellanicus Gmelin), surf clam (Spisula solidissima Dillwyn), and ocean quahog (Arctica islandica Linnaeus).

Occurrence records from the photographs correspond closely with the distribution patterns for each species based on other sources. Living sea scallops were clearly apparent in the bottom photographs; of surf clams and ocean quahogs (usually buried with only the siphons exposed) only the shells of dead specimens were detected. All three species are restricted to the continental shelf, and their geographic distributions overlap considerably.

The photographs may provide clues to more efficient methods of harvesting these species.

The photographs were made at more than 300 locations between Cape Hatteras, North Carolina, and the Gulf of Maine in water depths from 2 to 1,810 fathoms (fig. 1). Single photographs were taken at 289 localities (indicated by open circles in fig. 1) mostly with a camera incorporated within a large clam-shell bottom sampler as part of a program of systematic sampling of the Atlantic continental margin (Emery, Merrill, and Trumbull, 1965). Twenty-six other sites (indicated by solid dots in fig. 1) are photographic stations where as many as 3,000 closely spaced photographs were made. These sites include: (1) remote-controlled multi-photograph camera stations in 10 submarine canyons, and one place on the open continental slope; (2) a stereographic camera system mounted on the hull of the research submarine "Alvin" (Schlee, 1967) during dives in two submarine canyons, and at two sites on the open continental slope and three on the continental shelf; (3) multi-photograph camera (two types) mounted on sleds drawn along the sea floor by research ships; (4) photographs taken with a pogo-type multi-photograph camera (Posgay, 1958); and (5) mosaic mapping of part of the continental rise in search of wreckage of the USS "Thresher" (Iselin, 1964).

The annual value of the combined sea scallop, surf clam, and ocean quahog fisheries is currently more than $16 million to United States fishermen. Sea scallops are the most valuable species, accounting for 80 percent of the total value. Surf clams constitute nearly 20 percent of the total, and ocean quahogs less than 1 percent.

Ex-Vessel Value of United States Landings of Three Species of Shellfish Taken from the Continental Shelf off Northeastern United States

Species	1945[1/]	1955[2/]	1965[3/]
Sea scallop	1,887,215	11,449,000	13,126,307
Surf clam	629,591	1,365,000	3,197,140
Ocean quahog	109,387	47,000	11,000

1/Anderson and Power, 1949.
2/Anderson and Power, 1957.
3/Lyles, 1965.

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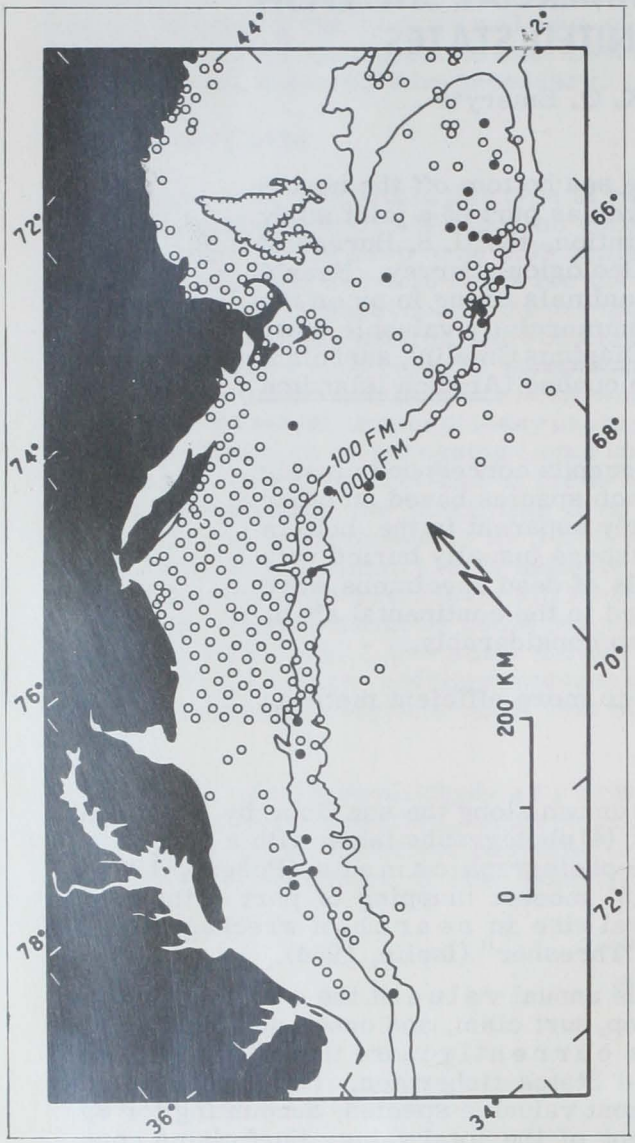


Fig. 1 - Locations off northeastern coast of United States where photographs of sea bottom were made. Open circles denote sites of single photographs; solid dots denote multi-photograph stations.

The quantity and value of sea scallop and surf clam landings have increased markedly since World War II. The value of both species has increased five-fold during a 20-year period. Ocean quahog landings, on the other hand, diminished in quantity and total value because of reduced consumer demand.

GEOGRAPHIC DISTRIBUTION

The geographic distributions of sea scallops, surf clams, and ocean quahogs along the northeastern coast of the United States are illustrated in figures 2, 3, and 4, respectively. These charts are based on literature reports, fishery data, and experimental dredgings. All sources agree in showing that these shellfish are restricted to the continental shelf, and that their areal distributions have considerable overlap. Sea scallops have been exploited throughout most of their known distribution area, but surf clams and ocean quahogs are fished only locally.

Included on each distribution chart are station marks that indicate the locations where the specimens, either living or dead, were detected in photographs of the sea bottom. The charts reveal that, with few exceptions, the records of occurrence from sea-bottom photographs fall within distributions derived from catch records and other sources.

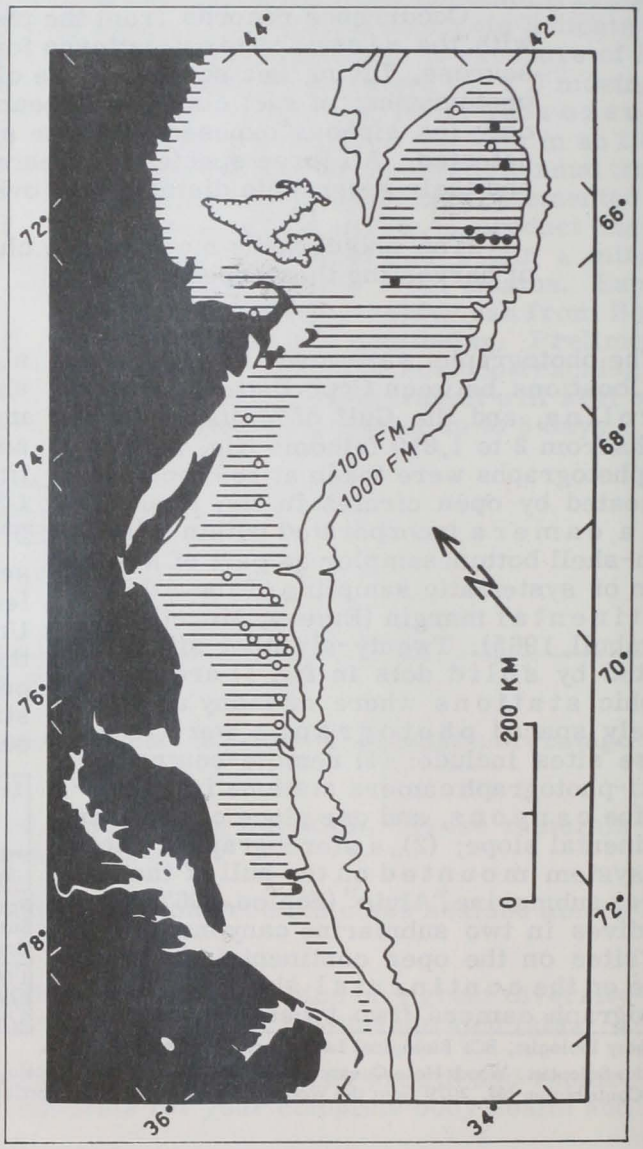


Fig. 2 - The geographic distribution of sea scallops off northeastern coast of United States. Crosshatching marks area where sea scallops have been collected. Circles and dots show locations where sea-floor photographs revealed live sea scallops or their shells.

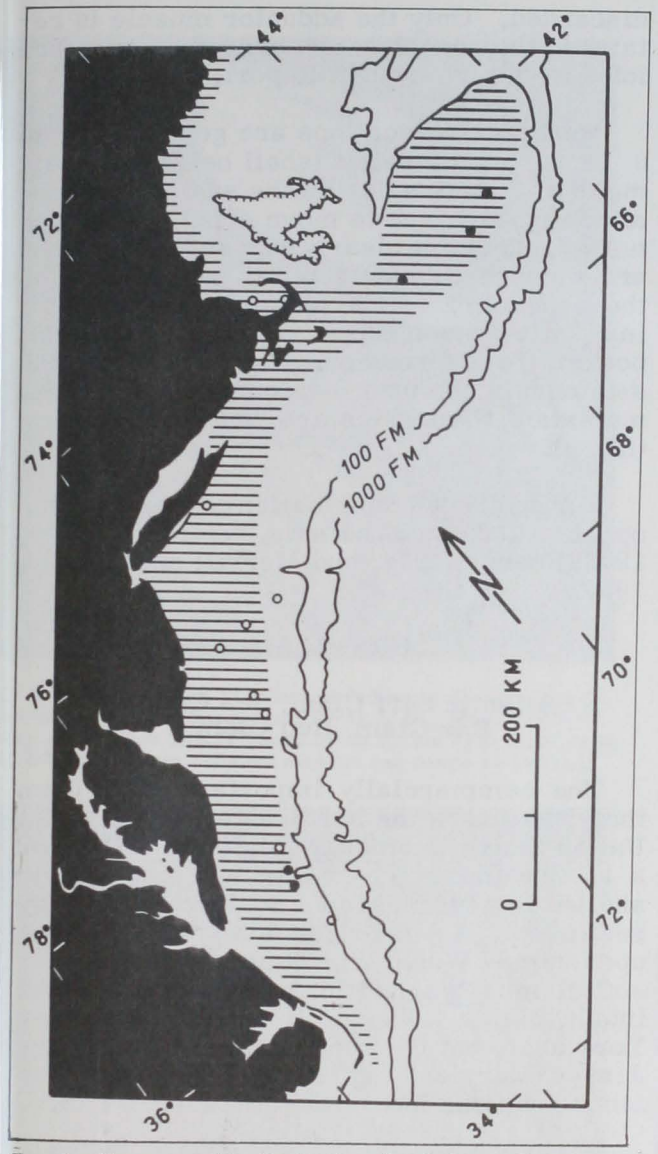


Fig. 3 - The geographic distribution of surf clams off northeastern coast of United States. Crosshatching marks area where sea clams have been collected. Circles and dots show locations where sea-floor photographs revealed surf clam shells.

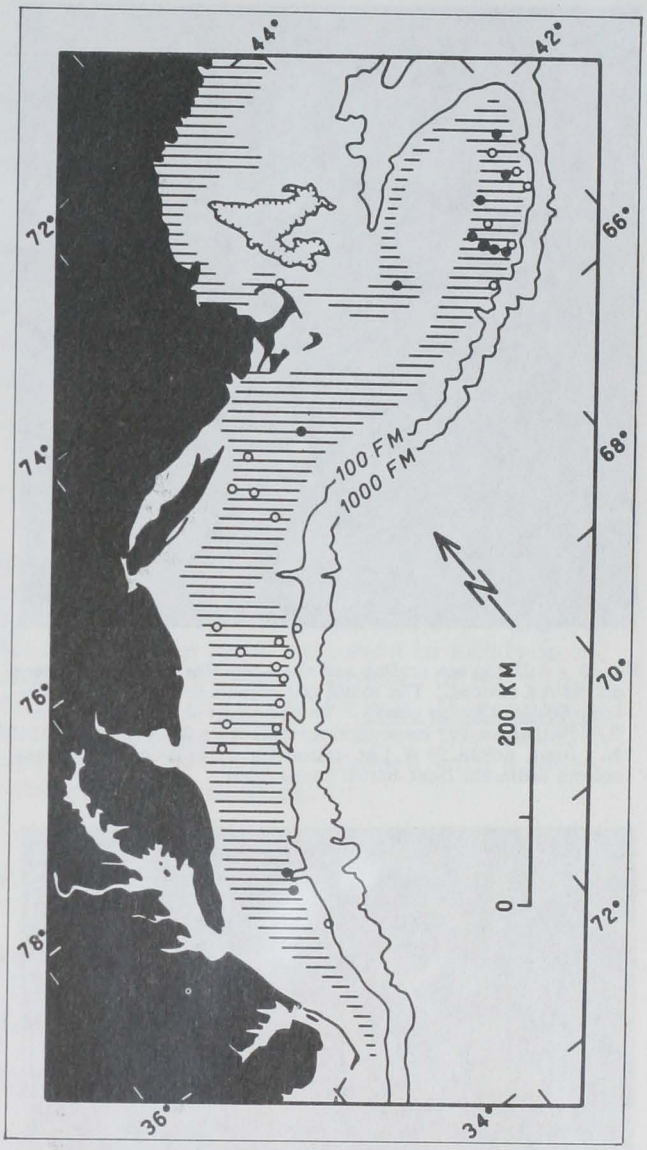


Fig. 4 - The geographic distribution of ocean quahogs off northeastern coast of United States. Crosshatching marks area where ocean quahogs have been collected. Circles and dots show locations where sea-floor photographs revealed ocean quahog shells.

SEA SCALLOP

Atlantic Deep-Sea Scallop
Deep-Sea Scallop, Giant Scallop

The sea scallop, Placopecten magellanicus Gmelin, occurs along the North American coast from the Gulf of St. Lawrence to Cape Hatteras, N. C., and is taken commercially by both United States and Canadian fishermen. This fishery became important just after World War II when increased demand resulted in substantially higher prices. The principal sea scallop stocks that were fished during this rapid expansion of the fishery were on Georges Bank, but recently a substantial part of the effort has shifted to grounds between New York and northern Virginia. The bulk of the American catch is landed at New Bedford, Mass.

Sea scallops are customarily caught with heavy steel dredges 10 to 15 feet wide operated from vessels 40 to 100 feet long. Two dredges are towed simultaneously, each attached by a separate towing warp. The

Fig. 5 - A living sea scallop and shell remains of ocean quahogs on the sea bottom. The round flat objects are live sand-dollars, Echinarachnius parma. This photograph was taken from R/V "Albatross IV" on southeastern Georges Bank (Lat. 41°13.5' N., Long. 66°38.5' W.) at station 45; water depth 45 fathoms; bottom sediment light-brown coarse sand.

Fig. 6 - Live sea scallops and shells on the sea bottom on western Georges Bank (Lat. 41°09.1' N., Long. 68°43.2' W.); photo taken by research submarine "Alvin" during dive 215; water depth 33 fathoms; bottom sediment brown pebbles.

dredges are hauled every $\frac{1}{2}$ to 1 hour, depending upon local abundance, and the contents are dumped on deck. The scallops are shucked at sea and the viscera and shells are discarded. Only the adductor muscle is retained; the muscles are bagged in 36-pound lots, iced, and brought to port.

Market-size scallops are generally $3\frac{1}{2}$ to 6 inches in diameter (shell height). Specimens of this size live on the sea bottom, unattached, and free to move about when disturbed. They are clearly exposed to view and are thus readily detected in photographs of the sea bottom. The photographs show that in relatively soft sandy bottoms they inhabit pockets or depressions (fig. 5). Where the sediment is compact, or composed of coarse materials, the pockets are small and shallow (fig. 6).

For additional information concerning this species and the fishery, refer to Posgay, 1953; Bourne, 1964; and Merrill and Posgay, 1964.

SURF CLAM

Atlantic Surf Clam, Sea Clam, Bar Clam, Hen Clam

The commercially important surf clam that inhabits the northeastern coast of the United States is Spisula solidissima Dillwyn, a large (up to $7\frac{1}{2}$ or 8 inches long) heavy-shelled bivalve most commonly found in sandy sediments. A demand for this species developed during World War II as a substitute for soft clams (Mya) and this has since developed into a major fishery. It started in the New York area, but it is centered now in the New Jersey-Maryland region; most of the catch is landed at Cape May and Point Pleasant, N. J.

The chief means of taking surf clams is with a hydraulic dredge. These dredges are 3 to 4 feet wide with a water jet system across the front, 8 to 12 feet long, and a cod end made of steel rings. Bottom materials and clams in the path of the dredge are loosened by jets of water pumped from the fishing vessel as the dredge is towed slowly along the bottom. Whole clams are bagged in bushel-size lots and brought to canneries ashore for processing.

Surf clams burrow into the sediment and position themselves with their posterior end upward so that the siphons are in contact with the overlying water. Thus only the siphons tips are exposed and visible. No living surf clam shells were evident in the sea-bottom

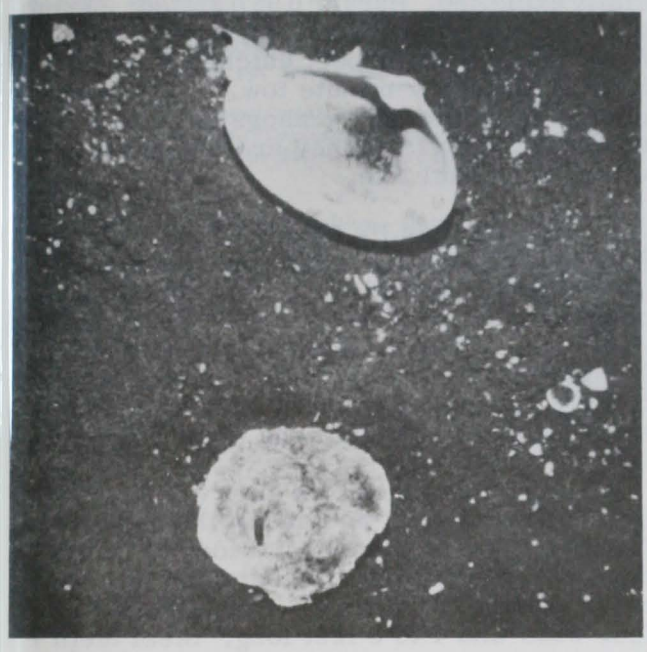


Fig. 7 - Surf clam shell (top) and eroded sea scallop shell on the sea bottom off New Jersey (Lat. 39°31.2' N., Long. 73°15.8' W.); photo taken by R/V "Gosnold" at station 1375; water depth 21 fathoms; bottom sediment medium and coarse brown sand.

Fig. 8 - Surf clam shell on sea bottom with other shell fragments and sand-dollar tests; taken by R/V "Gosnold" off New Jersey (Lat. 38°52.4' N., Long. 73°45' W.) at station 1353; water depth 24 fathoms; bottom sediment brown medium sand.

photographs; only the shells of dead specimens were detected (figs. 7 and 8).

We could not definitely distinguish in all photographs the shells of S. solidissima from a rather rare species that has a similar appearance: Spisula polynyma Stimpson. The photographic occurrence records on the chart, therefore, may include a few shells of the latter species.

For more information about the surf clam and its fishery, see: Turner, 1953; Merrill and Webster, 1964; Parker, 1966; Growlage and Barker, 1967; Parker, 1967; and Standley and Parker, 1967.

OCEAN QUAHOG

Mahogany Quahog, Mahogany Clam, Black Clam

The ocean quahog, Arctica islandica Linnaeus, occurs in North American waters from Newfoundland to Cape Hatteras, N. C. It is found at water depths between about 5 and 80 fathoms, and is most common in sandy mud substrates. Its shape is similar to the common quahog or hard-shell clam, Mercenaria (Venus) mercenaria Linnaeus, but the exterior surface of its shell is covered with a rather thick black periostracum.

The fishery for ocean quahogs began during 1953 in Rhode Island, and interest in this species has remained localized there and in

Fig. 9 - Ocean shells on the sea bottom off New Jersey (Lat. 39° 10.2' N., Long. 73°00.3' W.); taken by R/V "Gosnold" at station 1337; water depth 38 fathoms; bottom sediment brown muddy sand. Object at left is the camera tripping-weight, which has stirred up the sediment upon impact with the bottom.

Fig. 10 - Ocean quahog shells on the sea bottom on eastern Georges Bank (Lat. 41°10.2' N., Long. 66°31.2' W.); taken by R/V "Gosnold" at station 1125; water depth 52 fathoms; bottom sediment brown medium sand.

adjacent areas. The fishery has declined because of a decreasing demand for this product, rather than a reduction in the fishable stocks. Dense beds of ocean quahogs occur along large portions of the continental shelf, even in areas where it never has been commercially exploited. Parker (1967) stated: "From these sections [off Maryland], commercial fishermen can expect catches of about 15 bushels per 20-minute tow. . . ." Average market size of ocean quahogs is from 2 to 4 inches in length. They are brought to port whole, in bushel lots.

Ocean quahogs lie buried in the sediment just below the water-sediment interface, with the posterior end upward, in much the same position as hard-shell clams and surf clams. They are not visible (except for the siphons) from above the sediment surface; consequently, the photographs revealed only the shells of dead specimens (figs. 9 and 10).

Ocean quahogs can be harvested with hydraulic dredges, as used in the surf clam fishery, or by means of a toothed dredge designed specifically for catching this species. Toothed dredges range from 2 to 3 feet wide and 4 to 8 feet long. Steel teeth 7 inches long are spaced at intervals of $1\frac{1}{2}$ to 2 inches along the bottom forward edge. The retaining bag is made of 2-inch-diameter steel rings. Dredges are towed slowly along the bottom, usually by vessels 30 to 40 feet long.

For additional information, refer to: Arcisz and Neville, 1945; Merrill and Webster, 1964; and Parker, 1967.

LITERATURE CITED

ANDERSON, A. W. and E. A. POWER
1949. Fishery Statistics of the United States 1945. U. S. Fish and Wildlife Service, Statistical Digest 18, 372 pp.

1957. Fishery Statistics of the United States 1955. U. S. Fish and Wildlife Service, Statistical Digest 41, 446 pp.

ARCISZ, W. and W. C. NEVILLE
1945. Description of the Fishery. Pp. 7-14, In: The Ocean Quahog Fishery of Rhode Island. A Survey Conducted by the U. S. Department of the Interior, Fish and Wildlife Service, in Cooperation with the Division of Fish and Game of the Department of Agriculture and Conservation of the State of Rhode Island.

BOURNE, N.
1964. Scallops and the Offshore Fishing of the Maritimes. Fishery Research Board of Canada, Bulletin No. 145, 60 pp.

EMERY, K. O.; ARTHUR S. MERRILL; and JAMES V. A. TRUMBULL
1965. Geology and Biology of the Sea Floor as Deduced from Simultaneous Photographs and Samples. Limnology and Oceanography, Vol. 10, No. 1, pp. 1-21.

GROUTAGE, THOMAS M. and ALLAN M. BARKER
1967. The Surf Clam Fishery. U. S. Fish and Wildlife Service, Commercial Fisheries Review, Vol. 29, No. 2, pp. 55-58. (Also Sep. No. 780.)

ISELIN, C. O'D
1964. The Loss of the Thresher. Oceanus, Vol. 10, No. 1, pp. 4-6.

LYLES, CHARLES H.
1967. Fishery Statistics of the United States 1965. U. S. Fish and Wildlife, Service, Statistical Digest 59, 756 pp.

MERRILL, ARTHUR S. and J. A. POSGAY
1964. Estimating the Natural Mortality Rate of the Sea Scallop (Placopecten magellanicus). International Commission for the Northwest Atlantic Fisheries, Research Bulletin No. 1, pp. 88-106.

_____ and J. R. WEBSTER
1964. Progress in Surf Clam Biological Research. Pp. 38-47. In: The Bureau of Commercial Fisheries Biological Laboratory, Oxford, Maryland, Programs and Perspectives. U. S. Fish and Wildlife Service, Circular 200.

LITERATURE CITED (Contd.)

PARKER, PHILLIP S.
1966. Ocean Clam Survey Off U. S. Middle Atlantic Coast 1963. Commercial Fisheries Review, Vol. 28, No. 3, pp. 1-9. (Also Sep. No. 756.)

1967. Clam Survey Ocean City, Maryland, to Cape Charles, Virginia. Commercial Fisheries Review, Vol. 29, No. 5, pp. 56-64. (Also Sep. No. 791.)

POSGAY, J. A.
1953. The Sea Scallop Fishery. Commonwealth of Massachusetts, Department of Natural Resources, Division of Marine Fisheries. Sixth Report on Investigations of Methods of Improving the Shellfish Resources of Massachusetts. Pp. 9-24.

1958. Photography of the Sea Floor. Oceanus, Vol. 6 No. 1, pp. 16-19.

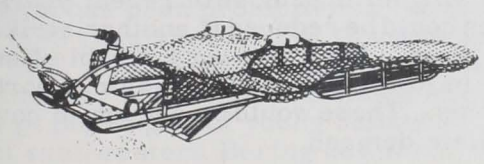
SCHLEE, JOHN
1967. Geology from a Deep-Diving Submersible. Geotimes, Vol. 12, No. 4. Pp. 10-13.

STANDLEY, MARK L. and PHILLIP S. PARKER
1967. Development of a Submersible Pumping System for a Hydraulic Surf Clam Dredge. Commercial Fisheries Review, Vol. 29, No. 6, pp. 50-55. (Also Sep. No. 793.)

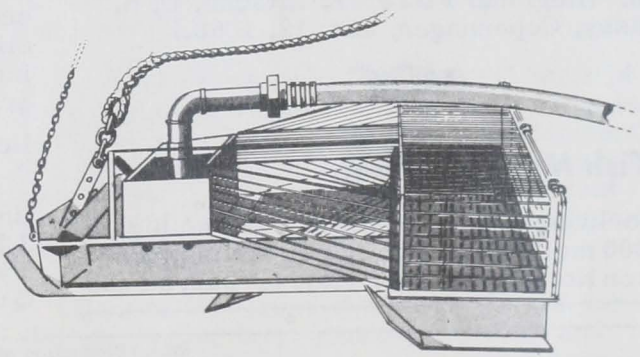
TURNER, HARRY J., Jr.
1949. The Conservation Problem Associated with Possible Development of a Sea Clam Fishery in Massachusetts. Reference No. 49-17, Woods Hole Oceanographic Institution Report for Marine Fisheries Section, Massachusetts Department of Conservation, pp. 3-22.

HYDRAULIC OR JET DREDGES

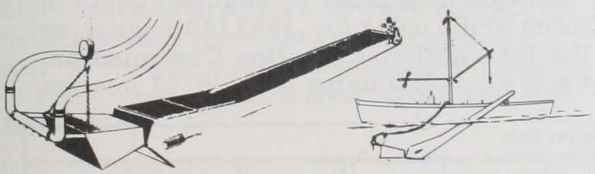
With this type of equipment, surf, soft, or hard clams are washed out of the bottom by action of jets of water from a pipe attached in front of the tooth bar. The pressured water is supplied by a high powered pump on the fishing vessel. The shellfish are then either washed on to, or collected by the tooth bar of the dredge. The Maryland type of hydraulic dredge utilizes a conveyer which brings the soft clams up to the vessel.



Hydraulic or jet dredge, surf clam



Hydraulic or jet dredge, hard clam



Hydraulic or jet dredge, soft clam

Note: Excerpt from Circular 109, Commercial Fishing Gear of the United States, for sale from the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402, single copy 40 cents.