# Advances in the Off-bottom Culture of Oysters

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**Abstract**

For the past 10 years the Bureau of Commercial Fisheries has been experimenting with off-bottom culture of oysters, *Crassostrea virginica*, along the east coast of the United States. Earlier studies at Cape Cod, Massachusetts, demonstrated that when oysters are suspended off-bottom growth, survival, and quality are improved.

Further studies in Chesapeake Bay have shown that excellent oyster sets can be obtained by suspending shells from rafts. In one area in 1965 more than 20 oyster spat per shell were collected on suspended shells, as compared with 5 spat per shell for shells on the bottom.

Other studies now in progress at Oxford, Maryland, include the off-bottom culture of oysters in natural and man-made ponds. Preliminary findings indicate that natural ponds are excellent for growing and fattening oysters, and artificial ponds can be used to produce seed oysters. On the basis of recent research, the off-bottom culture of oysters appears to have commercial application along the Atlantic coast.

## INTRODUCTION

THE PRESENT DECLINE in the oyster industry along the east coast of the United States is well known (Galtsoff, 1956; Shaw, 1962; Engle, 1966). For example, in Chesapeake Bay, the major oyster producing area in the nation, production today is only about 10 percent of that in the early 1900's (Engle, 1966). To attribute this decline to one major cause is impossible and unrealistic. Such factors as poor bottom, overfishing, predation, disease, pollution, and hurricanes are a few in an endless list of causes of decline.

One of the most significant reasons for a failing industry is the lack of private farming. Up to the late 1800's no economical need for oyster farming existed. Oysters were freely accessible and abundant in most coastal estuaries. Unfortunately, as the demand for oysters increased in the 20th century the natural populations were reduced beyond their ability to repopulate. Thus, the eastern oyster has slowly begun to disappear—first in Maine, New Hampshire, and Massachusetts, then in Long Island Sound and Delaware Bay, and more gradually in Chesapeake Bay. The disappearance of oysters left many of the natural bars barren, and the bottoms are no longer suitable for oyster production. Unless modern oyster-farming techniques are put into practice oyster populations will become further reduced along the Atlantic coast.

Glude (1966) stated, "The difficulty of obtaining exclusive use of oyster lands (in the Maryland portion of Chesapeake Bay) has prevented development of private oyster farming". The major oyster bottoms in Maryland are public domain. Private leases are few and many are located where bottoms are unproductive. At this time the chances appear

very slim that private leasing will increase. Most watermen oppose the leasing of a single acre of public bars for private use. The rights to farm oysters on good bottom are accordingly limited; the industry must continue its present decline unless some innovation appears. Possibly off-bottom oyster culture can help revolutionize the industry. This method of culture can open up many areas remote from public bars.

## OFF-BOTTOM OYSTER CULTURE IN JAPAN

The Japanese began to experiment with off-bottom oyster culture in the late 1920's (Cahn, 1950). Seno and Hori (1927) determined that suspended oysters were fatter and grew faster than oysters growing on the bottom. Now over 90 percent of the oysters harvested in Japan are grown off-bottom (Glude, 1964). Rows of rafts carrying either strings of shells to catch seed or strings of oysters being grown to market size are found in many of the inlets and bays of Japan. Along the shore are rows of racks on which strings of seed are suspended for hardening.[1] A portion of this seed is shipped to the west coast of the United States. The success of off-bottom oyster culture in Japan represents the true farming of a sea product.

Among the factors that contribute to Japan's success in off-bottom oyster culture are: a need for high-protein food; a limited bottom zone suitable for growing oysters; and low labor costs. In the United States the reverse is true. High-protein food is abundant; good, potential bottom for growing oysters is extensive (though many acres are not available for private leasing); and labor costs are high. Off-bottom culture of oysters, therefore, has been limited in this country.

## OFF-BOTTOM CULTURE IN THE UNITED STATES

Several recent developments have stimulated off-bottom oyster culture. As the landings have declined the demand for oysters has increased, and so has the price. In areas such as New England the demand and price have risen enough to make off-bottom oyster culture practical. At Fishers Island, New York, shells are suspended from rafts to catch seed oysters which are later sold to planters of Long Island (Binmore, 1964; Matthiessen, 1965). Similar methods are used in the State of Washington (Steele, 1964).

## THE BUREAU'S RESEARCH IN OFF-BOTTOM OYSTER CULTURE

The Bureau of Commercial Fisheries began extensive studies in 1956 on the feasibility of growing oysters to market size by suspending them from rafts. The experiments are well documented (Shaw, 1962, 1963, 1965; Shaw and Mc Cann, 1963). These off-bottom studies at Cape Cod, Massachusetts, led to the following conclusions: (1) growth was almost twice as fast; (2) meat quality (percentage solids) was improved; (3) mortality was reduced because oysters were out of reach of many pred-

[1]In hardening, oysters are exposed to air for many hours each day. The process conditions them for shipment to other countries.

ators; (4) areas unsuitable for oyster culture because of poor bottom were made available; (5 )more oysters could be grown per unit of area; and (6) growing of oysters on rafts appeared to be commercially feasible.

Research in off-bottom oyster culture has been conducted the past several years at the Bureau of Commercial Fisheries Biological Laboratory, Oxford, Maryland. Some of these studies are unique for the United States. The research can be listed under three projects: (1) rafting of shells in natural waters for seed production; (2) off-bottom culture in artificial ponds; and (3) growing seed off-bottom to market size in a natural pond. Certain of these studies are so new that findings thus far are only preliminary.

***Rafting of Shells for Seed Production***

In the summer of 1965 five styrofoam rafts containing shell strings and bags of shells were moored in Broad Creek on the eastern shore of Chesapeake Bay, Maryland (Fig. 1). The setting on all shells was heavy (average of 25 live spat per shell), as compared with shells planted on

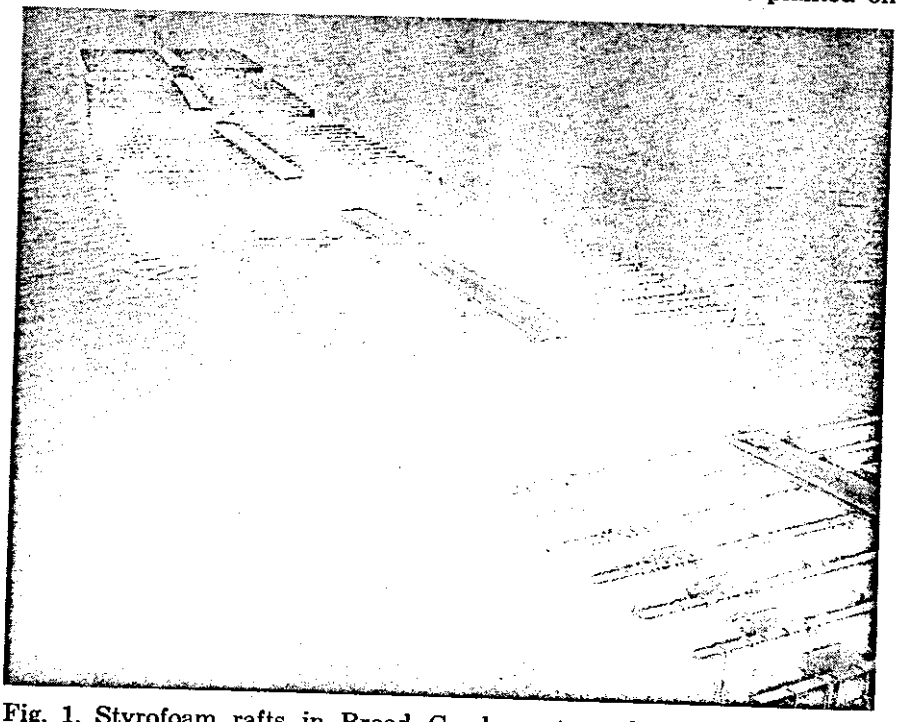

Fig. 1. Styrofoam rafts in Broad Creek, eastern shore of Chesapeake Bay, Maryland. Strings and bags of shells are suspended from rafts to catch seed oysters.

the bottom (5 spat per shell). In 1966 the Maryland Department of Chesapeake Bay Affairs rafted 1,000 bushels of shells in St. Mary's River on the western shore of Chesapeake Bay, Maryland, (Fred W. Sieling,

personal communication). Counts on the suspended shells were estimated to be over 3,000 spat to the bushel. (A count of 500 to a bushel is commercially acceptable in Maryland). The results of these two experiments, which I believe represent the first attempts to obtain seed on shells suspended from rafts in Chesapeake Bay, could mark the beginning of an expanded raft system in the bay for seed production. Similar studies are now being conducted by the Bureau of Commercial Fisheries in Tampa Bay, Florida; by the Alabama Department of Conservation, Seafood Division, in Mobile Bay (Smith, 1966); and by the State of Maine in Spinney Creek and Piscataqua River (Anonymous, 1966).

***Off-Bottom Oyster Culture in Artificial Ponds***

Four quarter-acre artificial salt water ponds were constructed at the Oxford Laboratory in the fall of 1964 (Fig. 2). The ponds are nontidal; water is pumped into them through a dual sea-water system. The depth (maximum 3¼ feet) of each pond is controlled by a series of baffles; the ponds can be drained in 24 hours by removing all baffles. Thus many environmental factors such as temperature, salinity, and animal life can be controlled.

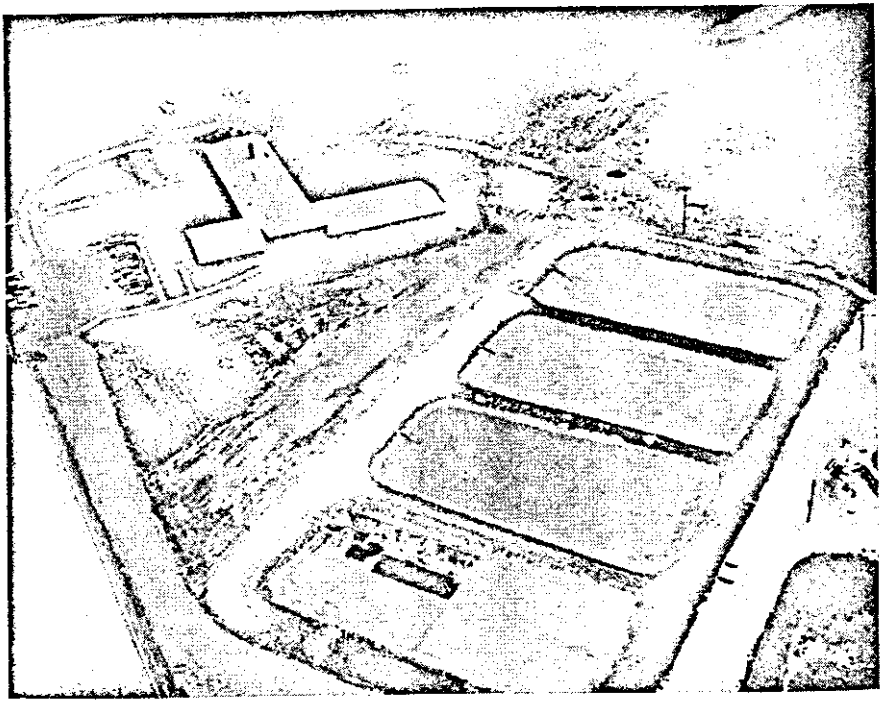

Fig. 2. Four ¼-acre artificial salt water ponds, Oxford, Maryland.

An early study was the comparison of growth and condition of seven strains of oysters suspended from rafts in an artificial pond and a natural pond. All strains grew at about the same rate in both environ-

ments (Table I). Meat quality (percentage solids) was higher in the natural pond — an indication that the oysters in the artificial pond were receiving less food. New feeding experiments in which commercial fertilizer is applied to increase phytoplankton are now underway in an attempt to improve the condition of oysters in the artificial pond.

TABLE 1

FINAL MEAN HEIGHT (MILLIMETERS) AND PERCENTAGE OF SOLIDS FOR EACH STRAIN OF OYSTERS GROWN IN AN ARTIFICIAL POND AND A NATURAL POND, MARCH 1966. COMPARATIVE STUDY INITIATED AUGUST 1964.

| | Boone Creek (natural pond) | | Quarter-acre artificial pond | |
|---|---|---|---|---|
| Strain | Mean Height | Percentage Solids | Mean Height | Percentage Solids |
| Harris Creek | 81.7 | 16.2 | 76.7 | 8.2 |
| Eastern Bay | 79.8 | 15.5 | 75.8 | 9.4 |
| St. Mary's River | 79.5 | 16.6 | 74.0 | 9.9 |
| Little Choptank (Town Point) | 85.0 | 16.6 | 78.5 | 10.1 |
| Little Choptank (Cedar Point) | 82.0 | 17.5 | 75.8 | 10.5 |
| Tar Bay | 79.9 | 17.0 | 78.2 | 10.1 |
| Broad Creek | 79.7 | 15.9 | 75.8 | 8.6 |

Another study being conducted in the artificial pond is the production of seed oysters. Several hundred strings of shells were suspended from five rafts, similar to those used in Broad Creek, in one pond. In June 1966 the water flow was stopped and the outlet plugged. Over 4 million larvae, reared to the straight-hinge stage in the laboratory, were placed in the pond. About 10 spat per string of 30 shells were caught in this completely artificial culture of seed oysters. In 1967 we plan to add over 10 million larvae to the pond to increase the setting intensity.

It is too early now to say that artificial ponds can be used commercially for seed production and rearing of oysters, but preliminary results of studies now underway have been promising.

***Growing Oysters to Market Size from a Rigid Structure***

The commercial feasibility of growing oysters off-bottom in a natural pond is being tested at Oxford. Over 2,000 strings of seed oysters representing three year classes (1963, 1964, 1965) have been suspended from a rigid structure in Boone Creek, a natural pond adjacent to the laboratory. Each string contains 30 shells and the shells are 1 inch apart. The rigid structure is 108 x 12 feet (Fig. 3). Two rows of pilings are joined by 1- by 10-inch crossbars. Resting on each pair of crossbars are five 4- by 4-inch boards. Rows of staples (3 inches apart) lie along opposite sides of the 4 by 4. One string is attached to each staple (Fig 4). The first crop of oysters will be harvested this winter (1963 and 1964 year classes), and the second crop in the winter of 1967-68 (1965 year class).

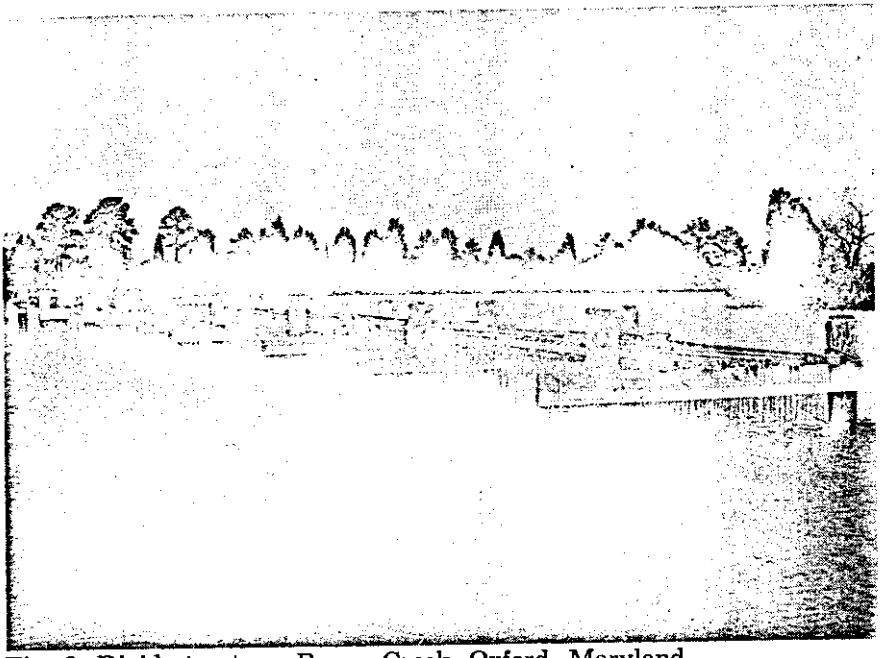

Fig. 3. Rigid structure, Boone Creek, Oxford, Maryland.

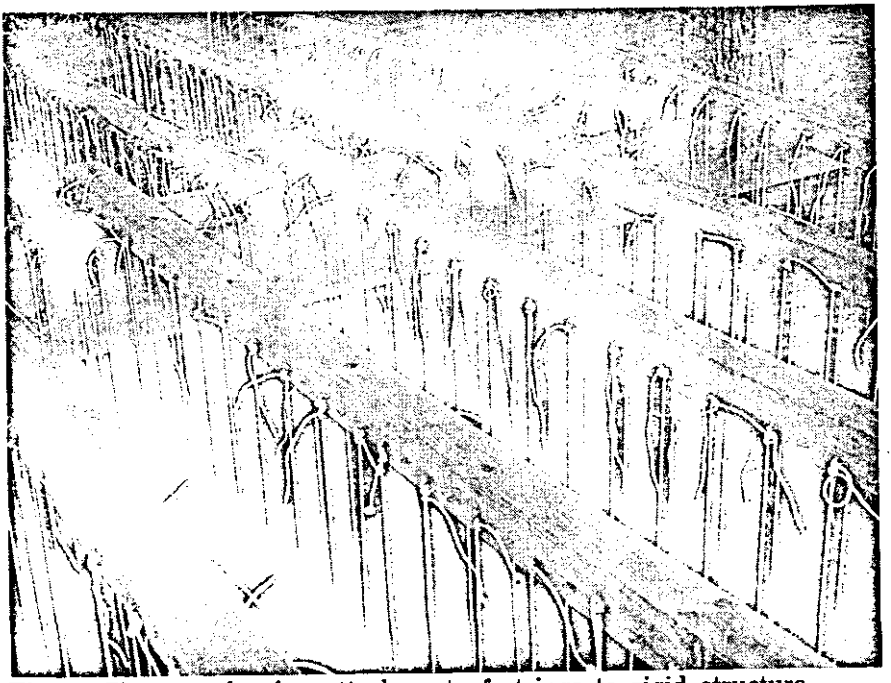

Fig. 4. Close-up showing attachment of strings to rigid structure.

Since the oysters are being grown in low-salinity water (12-16 ppt) their market value is less than that of oysters grown in saltier water. Experiments are underway to test the effects of salinity by transfer to Chincoteague Bay where the salinity averages about 30 ppt. Every 4 months samples of the suspended oysters are moved to trays in the bay (Castagna, 1964). This process, known as "salting", doubles the oyster's value. Preliminary transfers from low to high salinity have been highly successful, and growth has been excellent. A careful evaluation of the cost of transferring oysters on a commercial scale will have to be made before recommendations can be offered.

## THE FUTURE OF OFF-BOTTOM OYSTER CULTURE

We are now in a period where breakthroughs in the off-bottom culture of oysters are being made in the United States. The advances are not new. The Japanese obtained faster growth, fatter oysters, lower mortality, and greater yields per unit of area in the 1920's when they began culturing *Crassostrea gigas* off the bottom. We are simply repeating their studies with a different species, *C. virginica.*

As stated earlier the stimulus that induced the Japanese to change from bottom to off-bottom culture has not, until recently, been transmitted to the oyster industry of the United States. With greater demand for seed oysters and for high quality market oysters, a major change in culture techniques is indicated. In the future we visualize fleets of rafts carrying shells to catch oyster larvae. After setting, the seed could be planted on private leases or grown off-bottom in protective ponds and coves. Numerous shellfish hatcheries, similar to those described by Loosanoff and Davis (1963), would be located in areas of poor natural setting. The seed produced in these hatcheries would be utilized by the oyster growers of the area.

On the west coast the oyster industry has depended on the importation of Japanese seed. The cost of broken Mijagi seed has steadily increased from $3.50 per case (2.4 bushels) in 1930 to $9.50 per case in 1960 (Steele, 1964). In 1965 oyster seed production in Japan was a near failure; hence the number of cases imported into the United States was reduced. Because of the higher costs of imported seed and the possibility of further failure setting in Japan, members of the west coast oyster industry may have to produce their own seed. Several areas in the State of Washington and in Canada, if developed, could supply enormous quantities of seed if techniques of off-bottom rearing were applied.

It is more difficult to comment on the future of off-bottom culture in the Gulf States. Research has just been initiated in this area; the development of off-bottom oyster culture will depend on the outcome of these studies.

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