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Michael Casatagna
Virginia Institute of Marine Science

Dexter S. Haven
Virginia Institute of Marine Science

James B. Whitcomb
Virginia Institute of Marine Science

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TREATMENT OF SHELL CULTCH WITH POLYSTREAM TO INCREASE THE YIELD OF SEED OYSTERS, *CRASSOSTREA VIRGINICA* [1]

Michael Castagna [2], *Dexter S. Haven and James B. Whitcomb*
VIRGINIA INSTITUTE OF MARINE SCIENCE
GLOUCESTER POINT, VIRGINIA

ABSTRACT

A commercial-scale study was conducted on the Eastern Shore of Virginia during 1964, 1965 and 1966 to evaluate treatment of shell cultch with Polystream. Three intertidal reefs of the same approximate size were shelled with 600 to 1,000 bushels of cultch treated with Polystream; adjacent areas were shelled with similar amounts of untreated shells.

Results were evaluated for periods ranging up to 18 months on the basis of number of oysters attached per unit volume of shell; length and number of drilled oysters were also recorded. Treated shells consistently had more attached oysters than the controls at two of the plots. On the third, differences did not become apparent until the second year. Analysis suggests that treatment of cultch with Polystream by commercial growers may be economically feasible and may increase net profit.

INTRODUCTION

Certain chlorinated benzenes marketed under the name of Polystream have been reported successful in increasing production of the oyster *Crassostrea virginica* (Loosanoff, MacKenzie and Davis, 1960; Loosanoff, 1961; Davis, Loosanoff and MacKenzie, 1961; Shaw and Griffith, 1967). These authors reported a greater number of oyster spat attached to shells dipped in Polystream than on untreated control shells. It was not determined whether greater production was due to decreased predation, decreased fouling or other factors.

The present study was carried out in 1964-1966 to determine if it were economically feasible to use Polystream to increase production of oyster spat on commercially-planted shell cultch.

DESCRIPTION OF AREA

The experiments were conducted in the northeast end of Hog Island Bay near Little Machipongo Inlet. A preliminary study was started in August 1964 and extended through November 1965; three large-scale experiments were started during July 1965 and lasted through August 1966. The preliminary experiment and part of the main experiment were carried out in an area called Tug Ames Shoal near High Shoal and Argyle Shoal drains. Other tests were conducted about 300 yards west on High Shoal marsh and on Argyle Shoal near Hodges Narrows, about 3/4 mile east. All three areas are man-made intertidal oyster reefs, less than 2 1/2 miles apart (Fig. 1). The Argyle Shoal oyster shell reefs were built on 6 mil polyethylene sheets. In other beds the shell base was placed directly in the mud. Temperatures during the experiment ranged from 2 to 33.6°C and salinities from 30.2 to 35.4 ppt. The tidal amplitude was 4.5 feet and the reefs were exposed for about 90 minutes each low tide.

METHODS

In all experiments the cultch was oyster shell from shucking house shell piles accumulated during the previous fall and winter. In all studies handling of shells and application of Polystream were carried out by the crews of the oyster companies who planted the treated and untreated

[1] Contribution No. 306, Virginia Institute of Marine Science, Gloucester Point, Virginia.

[2] Virginia Institute of Marine Science, Wachapreague, Virginia.

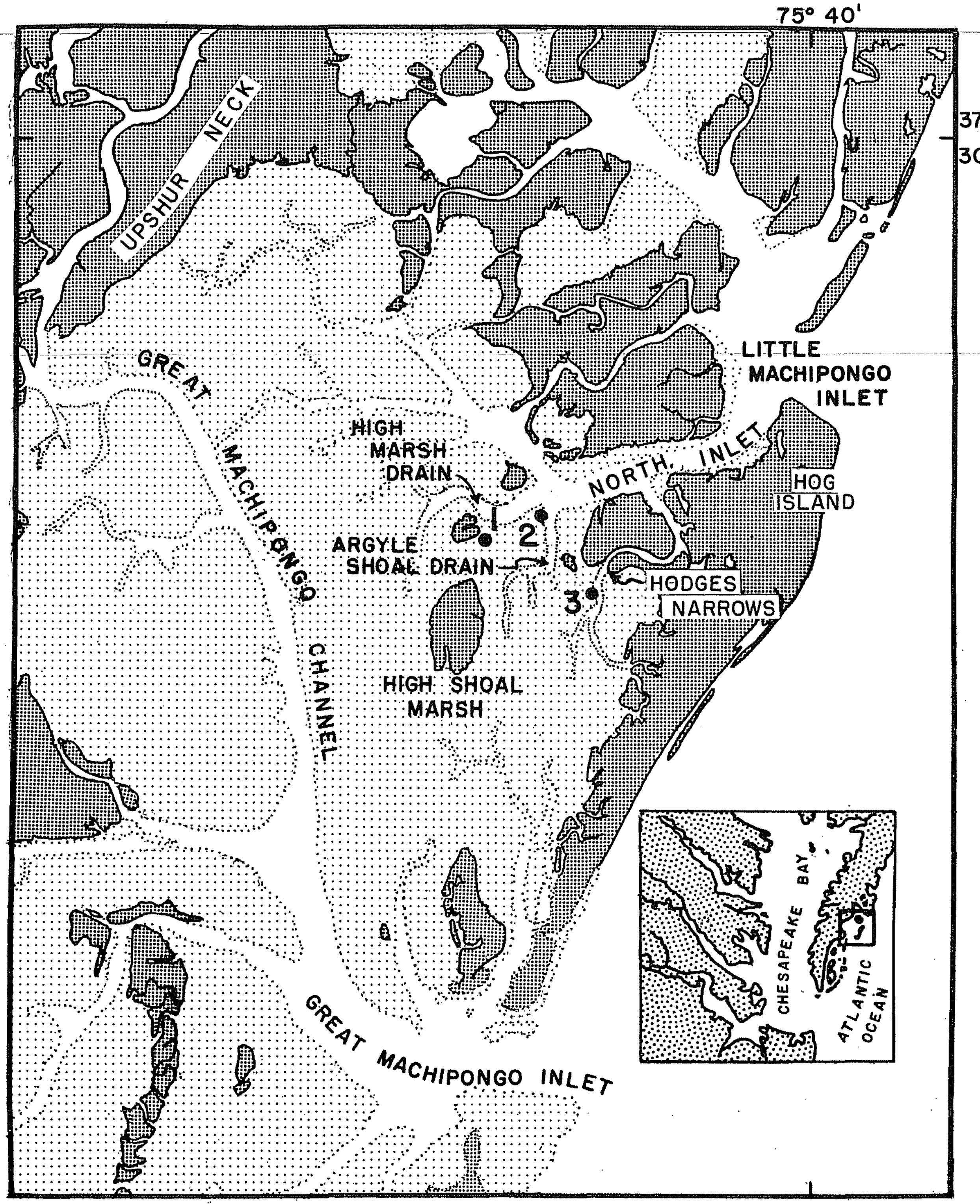

FIG. 1. *Location of test areas. (1) High Shoal Marsh, (2) Tug Ames Shoal, (3) Argyle Shoal.*

cultch on their oyster reefs. Variations in the methods employed from test to test were dictated by the equipment or procedures of each of the participating companies. Observations and evaluation of results were carried out by personnel of the Virginia Institute of Marine Science. The unit of measure used in this study was the Virginia oyster bushel equivalent to 1.397 standard bushel. Details of each study are shown in Table 1.

Application of Polystream to Oyster Shells

The shells were treated by wetting with undiluted Polystream. In the 1964 experiment, Polystream was sprayed from a commercial orchard sprayer as the shells were being transported on a conveyor. The Polystream caused rapid deterioration of the rubber belt and the rubber sprayer parts, and the method was discontinued. In subsequent experiments the shells were wetted with Polystream as they were being loaded onto barges by wheel barrows, or dumped from a truck in small (about 5 bu) batches. In this latter method each load or batch was treated by sprinkling it with Polystream using a water can fitted with a sprinkler head. Examination of treated shell piles indicated that both methods achieved complete coverage. Control shells were loaded onto separate barges and were not contaminated by the chemical.

Inhalation, long exposure, or long physical contact with the chemical are potential health hazards. Protective coats, boots, gloves and gas masks were offered to the labor force involved in handling the chemical.

Methods of Planting Cultch

Treated and untreated shells were planted in June and July to receive a possible early set. In every case, treated shells were planted within one day following application of Polystream. Two methods were used to distribute the oyster shell over the bottom. In the first, shells were shoveled from the barge into the water. During this process the laborers imparted a horizontal motion to the shovel. This technique, called "broadcasting," resulted in a rather uniform distribution of shell over the bottom as later inspection of the exposed ground revealed. In the second method, employed on High Shoal, shells were washed off the slowly moving barge with a stream of water from a fire hose. On the first low tide of the following day, the shell plantings were inspected and raked down to give level, uniform coverage. The control shells were distributed in the same manner on a nearby reef. In each case, the control and treated shells formed similarly shaped reefs and were spread at the same thickness and equally exposed at low tide.

Assessment of Oyster Drill Predation

In the preliminary experiment, a one-bushel random sample was taken from test and control plots in September 1964 and again in November 1965. Oyster spat were counted and a random subsample of 100 oyster spat was measured. In the 1965 experiment, 1/4 bushel samples were taken from five equidistant points on each test and control area at intervals of from one to four months. The shells, number of spat, and drilled spat in each sample were counted. Length of 25 oysters in each 1/4 bushel sample was taken to the nearest 0.1 mm.

Residual Polystream Assessment

A bio-assay was made of the tissues of oysters to determine the uptake of Polystream. In July 1966, after approximately one year, samples of oysters were collected from experimental and control plots. After carefully cleaning the shells to remove all visible traces of mud, the meats were removed, frozen and later shipped to Hooker Chemical Company for analysis. Samples of mud obtained from the control and experimental plots were also sent for analysis.

TABLE 1. *Details of treatment, exposure, location and sponsor of treated and untreated shell cultch on Eastern Shore, 1964, 1965 and 1966.*

Station location	Period shells on the reef	Hours after treatment before planting	Control cultch (bu)	Test cultch (bu)	Polystream applied (gal)	Sponsor
Tug Ames Shoal	6/17/64-9/17/64	24	600	600	50	H. M. Terry Co.
Tug Ames Shoal	6/29/65-8/31/66	24	600	600	45	H. M. Terry Co.
Argyle Shoal	7/7/65-8/31/66	6	700	1000	50	Ballard Fish and Oyster Co.
High Shoal Lump	7/12/65-7/31/66	24	800	800	50	H. L. and R. L. Bowen Oyster Co.

RESULTS AND DISCUSSION

Preliminary Tests

During the preliminary experiments in 1964, an extremely light set of oysters occurred about the end of July and continued through October. It was apparent on casual observation that shells treated with Polystream had more and larger seed oysters than did shells on the control area. The algae *Aghardiella*, *Gracilaria*, and *Ulva* were abundant on shells of both plots, but the quantity appeared greater on the treated shells. Sponges (*Halichondria* sp.) appeared equally abundant on shells in both areas as did a bright orange flatworm. Xanthid crabs were not observed on the treated shells although they were abundant on the control. Hard clams were observed in both areas but were only partially buried in the bottom on the treated area.

A one-bushel sample taken from the treated area on 17 September 1964 had 332 oyster spat averaging 16.0 mm in greatest diameter; a comparable control sample had 89 spat with an average size of 11.6 mm. On 3 November 1965, 18 months after the shells were planted, a one-bushel random sample gave further evidence of increased production on treated shells. There were 576 spat on shells in the bushel of treated cultch; of this total, 225 were of the 1964 set and 351 had set in 1965. The control had 189 spat per bushel, of which 18 were of the 1964 set and 171 of the 1965 set. The preliminary experiment ended when the shells were moved to a growing area shortly after the sample was taken.

Main Test

During the main studies begun in July 1965, sets were heavier at all stations at comparable periods than in the preliminary study. Results partially agreed with the preliminary study since at Argyle and High Shoals treated shells consistently had greater sets than untreated shells. At Tug Ames Marsh differences were not apparent in the initial phase of the study, but during the second year treated shells had heavier sets (Table 2).

At the end of the study during September 1966 when oysters were large enough to be harvested for seed purposes, size on the three plots ranged in mean length from 19.5 to 40.8 mm. During the study, however, there appeared to be no consistent difference in mean length at any single area between those from test and control plots.

Number of drilled spat was greatest at Tug Ames Shoal. In this location the drilled spat varied from 0.10 to 4.90% of the total number of live oysters. At High Shoal where drilled spat were least abundant, mean counts varied from 0.00 to 2.80% of the total; differences between test and control plots were not evident.

A possible explanation for greater numbers of spat on treated shells over controls, with no obvious difference in drill damage, may be due to damage by young drills. Predation by newly emerged drills is often overlooked and is difficult to assess through field experiments. Newly emerged drills appear in the nearby Chincoteague Bay of Virginia during May, June and July, and even when less than 5 mm in length, will attack oyster spat smaller than 10 mm in diameter (Carriker, 1955). Unfortunately, the right valve of a small oyster spat will usually break away from the left valve shortly after the spat has been killed, leaving no evidence of predation. If we assume the chemical is detrimental to newly hatched drills, a greater survival of the early (July) oyster set will occur, resulting in greater numbers of spat.

The treated shells in each of the three areas had different concentrations of Polystream (Table 1). This evidently made no difference in the results since the Tug Ames area had the highest concentration (650 lb per 600 bushels of shell) and showed the least difference in survival. Apparently even the lowest concentration used (650 lb per 1,000 bushels) was sufficient to show a mean difference between treated and untreated shell.

Bio-Assay Studies for Chemical Residue

Samples of oyster tissue and mud collected one year after the experiment was established were analyzed by the Hooker Chemical Company. Analysis of the three experimental areas showed less than 0.1 ppm Polystream in oysters from treated and control areas. Mud samples collected from High Shoal and Tug Ames Shoal contained less than 0.1 ppm. Mud collected from the test area at Argyle Shoal showed 0.14 ppm. Shells in this latter area were planted on a sheet of 6 mil polyethylene; all other plantings were made directly on mud substrate.

Further tests were made on 2 September 1966 to ascertain if Polystream imparted an undesirable odor or flavor to the meat of oysters. A bushel sample of oysters and attached shells was obtained from treated and control plots. The oysters were steamed and a panel of six participants was unable to discriminate between oysters taken from test plots and those taken from the control plots.

Estimate of Costs and Profit derived from Treating Cultch with Polystream

By mid-summer in 1966 oysters at the three stations were of sufficient size for harvest. Consequently, estimates of yields in terms of bushels are based on data for July, August, and September of that year.

Analysis of data from Table 2 indicates that

TABLE 2. *Total number of spat in five quarter bushels for stations in Polystream study, Eastern Shore, 1965-1966.*

	Aug. 1965	Sept.	Oct.	Nov.	Dec.*	Jan.* 1966	May*	July	Aug.*	Sept.
				Tug Ames Shoal						
Treated	225	353	1178	2267	1847	2110	1446	1513	1710	1157
Control	300	476	1199	2235	1944	2125	1528	1455	1304	1019
				High Shoal						
Treated	43	102	714	1569				1371		1165
Control	55	37	184	810				325		703
				Argyle Shoal						
Treated	103	196	1420	2736	2252	2302	1330	1612	1305	1598
Control	64	136	1250	1333	1538	1010	680	843	913	938

*Data for High Shoal not obtained.

number of spat per 1/4 bushel sample during the last three months were increased from 26 to 42%, with the last month for combined stations showing a 30% increase (Table 3). Consequently, for the purpose of calculating the possible economic value of Polystream treatment, the latter figure will be used.

To derive estimates of the cost of planting shell, harvesting oysters, and value of "seed," representatives from several oyster companies and personnel of the Virginia Marine Resources Commission were interviewed. It was found that costs vary with locality due to differences in value of the shell, transportation and labor costs. Variation in value of shell was the most significant factor contributing to differences in the cost of planting. Estimates of yields of seed oysters per bushel of planted shell were taken from the 1965-1966 experiments and from data on commercial production from industry. On the Eastern Shore of Virginia such estimates are difficult to establish since oysters are selected from the plantings by hand and only spat which has reached a preferred size is harvested. This size, locally called "brush," is about one or two inches long and from 2,000 to 2,500 filling a Virginia bushel, depending on whether they grew singly or in bunches. Oysters not attaining proper size at time of harvesting are left for another year even if new shell for the attachment of spat is to be scattered on the rock. This method of harvesting causes a wide range of estimates of production of from 200 to 600 bushels of seed per 1,000 bushels of planted shell. For the purpose of estimates, we used a return of 500 bushels at the end of 14 months in an oyster setting area. This value was chosen as typical of yields obtained by many growers in the immediate region. Cost of harvest is 30 cents per bushel and sale price is estimated as $1.50 per bushel. Calculations using these production and cost figures are shown in Table 4. They indicate that profits from planting 1,000 bushels of shell would be about $350. Treatment of shells with Polystream would add to production costs, not only for the cost of chemicals and labor, but also because of the 30% increase in yield. However, even when the additional costs are added to the base cost, profits are calculated at $384 per 1,000 bushels of planted shell. This latter figure would mean an increased profit of $34. Some of the experimental areas were selectively harvested as explained previously, and in each case the treated area had greater production.

Increasing the number of spat per shell to a given per cent does not necessarily mean an equal increase in oysters. Larger spat tend to push other spat off the shell; predation, smothering and mortality will continue to various degrees throughout the life of the oyster. If an oyster grower is interested in replanting the seed on a growing ground, he would prefer the greater number of oysters per shell, especially if they

TABLE 3. *Per cent increase in number of spat associated with treatment.*

Station	July 1966	August 1966	September 1966	Three months combined
Tug Ames Shoal	2	24	12	13
Argyle Shoal	48	30	41	41
High Shoal	76		32	59
Combined stations	42	26	30	

TABLE 4. *Comparative cost analysis and profit expectancy from planting 1,000 bushels of Polystream-treated and untreated oyster shell for seed production.*

	Cost or profit in dollars Treated	Cost or profit in dollars Control
Planting		
Planting 1,000 bushels shell at 25c per bushel	250	250
Polystream cost, 650 lbs.	111	
Shipping costs	25	
Extra labor for treatment	10	
Harvesting		
Cost of harvesting at 30c per bushel		
Yield—500 bushels untreated area		150
Yield—650 bushels treated area	195	
Total Cost Planting and Harvesting	591	400
Value of Harvest		
Value per bushel—$1.50		
Yield—500 bushels untreated area		750
Yield—650 bushels treated area	975	
Net Profit	384	350

were growing well. However, if the seed were sold, a greater number of oysters per bushel would not necessarily increase the price paid per bushel since this is primarily a function of supply and demand. Polystream treatment of shell would be of greatest value in marginal oyster setting areas or heavy predation areas where it might make a difference between survival of a year class of oysters or complete failure. This type of area is considered a greater risk and most oystermen would be reluctant to increase the cost of placing shells in these locations.

Potential Use of Polystream

Polystream showed promise in a setting area with intensive drill predation, but has several disadvantages. It degrades very slowly, having the potential of unknown cumulative effects on the entire eco-system; it is nonspecific, killing most of the benthic invertebrate community, upsetting the natural balance in treated areas; and it is a potential health hazard to the people using it (Haven, Castagna, Chanley and Whitcomb, 1966). Its use is presently restricted to experimental in most states. Although these experiments show good results, there is at present no information on long-term or repeated use in an area.

SUMMARY AND CONCLUSIONS

1. Treated cultch showed a mean increase in numbers of living oysters over control groups. In two out of three studies the difference was apparent all through the experiment; in the third, this became apparent at the end of the study.
2. Size of spat on test and control groups was similar.
3. Increased production associated with treatment was estimated at 150 bushels per 1,000 bushels of shell.
4. The study has shown that treatment of cultch by commercial growers may be economically feasible on the Eastern Shore of Virginia and may increase net profits on seed production programs.

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