

COMPARISON OF GROWTH OF FOUR STRAINS OF OYSTERS RAISED IN TAYLORS POND, CHATHAM, MASS.

By WILLIAM N. Shaw, and JAMES A. McCANN, *Fishery Biologists*

BUREAU OF COMMERCIAL FISHERIES

ABSTRACT

Former buyers of Wareham River, Massachusetts, seed oysters claim that these oysters are slow growing and have a high mortality rate. The purpose of this experiment was to determine whether Wareham River oysters are truly slow growing.

Seed oysters from Wareham River, Mill Creek, Massachusetts; Long Island Sound, Connecticut; and James River, Virginia, were suspended side by side from a Fiberglas raft in Taylors Pond, Chatham, Mass. from autumn 1958 to autumn 1960. The growth rates for all strains were determined and then compared.

At the end of 1958 the Mill Creek oyster strain was significantly larger than the other three strains.

During 1959 the growth rate of the Wareham River strain was significantly slower than those of the Long Island Sound and Mill Creek strains. During 1960 the growth rates of all strains were significantly similar. At the end of 1960 the oysters from Wareham River were significantly smaller than those from Mill Creek and Long Island Sound.

The study demonstrates that in a single environment the Wareham River oysters grow slower than oysters from Long Island Sound and Mill Creek. Further studies are necessary to determine the reasons for this apparent slow growth.

Spear and Glude (1957) demonstrated that soft clams, *Mya arenaria*, from different origins assume similar growth rates when transplanted to a new environment. Other investigators (Loosanoff, 1949; Butler, 1952; and Andrews and McHugh, 1957) had similar results with transplanting of the eastern oyster, *Crassostrea virginica*. In most cases the surviving oysters adapted themselves to the new environment and developed growth patterns similar to the native populations. Beaven (1952), however, observed different growth rates among four groups of oysters held in trays at Solomons, Md. He concluded that, in general, oyster seed from local sources grow the best.

In autumn 1956 the Bureau of Commercial Fisheries Biological Laboratory at Woods Hole, Mass., received a report from a commercial fisherman stating that he could no longer find buyers

for Wareham River, Massachusetts, seed oysters. All former customers claimed that these oysters, which were removed from Wareham River and planted on growing grounds in areas such as Long Island Sound, Connecticut or Oyster Pond River, Chatham, Mass., grew very slowly and had a high mortality rate. They further commented that in no case did they ever recover their investment. From the above report it appeared that Wareham River oysters were possibly stunted.

Since Wareham River is capable of producing thousands of bushels of seed oysters and failures in setting are rare (Galtsoff, Prytherch, and McMillin, 1930), the Bureau of Commercial Fisheries felt that this important resource should be investigated. In 1956 studies of the history and growth of the Wareham River oyster were initiated. The purpose of this paper is to report the results of an experiment which demonstrates that

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Wareham River oysters are slow growers. Further studies will be necessary to determine the causes for the apparent slow growth.

PROCEDURE

The first phase of the investigation began with the mailing of questionnaires to all known buyers of young Wareham River oysters. Each buyer was asked when the oysters were bought, where they were planted, how many years passed before they reached market size, and what was the ratio of bushels harvested to bushels bought.

The second phase of the study dealt with a growth analysis of the Wareham River oysters which were collected from the 1958 year class. For a comparison of growth rates, seed oysters of the same year class were obtained from Long Island Sound, Connecticut; James River, Virginia; and Mill Creek, Massachusetts. The shells on which the young oysters had attached were punctured and then strung on either nylon rope, nylon parachute cord, or polyethylene tubing. The strings were then suspended side by side from a Fiberglas raft (Shaw, 1960) in Taylors Pond, West Chatham, Mass. The origin, approximate time of setting, and the date of suspension for each strain are shown in table 1.

Growth of all four groups was measured as an increase in shell height (greatest dorsoventral distance) and length (greatest anteroposterior distance). Initial measurements were taken on Oct. 30, 1958. Thereafter, except for the James River stock, each strain was measured monthly during the growing season.¹ The James River oysters were measured only four times during the study. Since 80 percent of these oysters died during the winter of 1958, the authors felt that handling of these oysters should be kept at a minimum in order to prevent further possible deaths.

TABLE 1.—Origin, approximate time of setting, and date of suspension for each group of experimental oysters grown from raft in Taylors Pond, West Chatham, Mass.

Origin	Approximate time of setting	Date of suspension
	1958	1958
Mill Creek, Mass.-----	July 18-23-----	Sept. 2-26.
Wareham River, Mass.-----	Aug. 1-7-----	Oct. 7.
Long Island Sound, Conn.-----	July 28 to Aug. 3-----	Oct. 15.
James River, Va.-----	Aug. 3-21-----	Oct. 30.

¹ In Cape Cod waters the growing season generally begins in May and ends in November.

To measure growth, approximately 100 oysters from each strain were selected. The oysters were first cleaned of all foreign matter, and care was taken not to damage any new shell deposition. They were then measured with vernier calipers to the nearest 1.0 mm. Immediately after the measurements were completed, the oysters were restrung and attached to the raft.

During 1960 many of the experimental oysters,² which broke away from the strings, were placed in chicken-wire bags. Since about equal numbers of oysters from each group were put in wire bags, the final growth analysis was not considered to be affected. On November 2, 1960, the last measurements were taken. The growth rates of all four groups were then determined and compared by statistical analysis.

DESCRIPTION OF AREA

The growth experiments were conducted in Taylors Pond, West Chatham, Mass. (fig. 1). The pond is about 400 yards long and 200 yards wide. Its depth ranges from 1 to 9 feet. The bottom along the shore is sand but in deeper waters changes to mud. The pond is surrounded by high cliffs which shelter the water from strong winds. From 1958 through 1960 the salinity of the pond varied from 28.22‰ to 31.46‰; the surface water temperatures fluctuated from a summer high of 26.7° C. to a winter low of -0.1° C.; the average pH was 7.9

ANALYSIS OF RESULTS

Answers to Questionnaire

Answers from the questionnaire were received from three companies, two on Long Island Sound, Conn., and the other at Oyster Pond River, Chatham, Mass. A total of 73,540 bushels of Wareham River oysters were bought by these firms during the years 1949-54. In all cases the oysters showed poor growth and high mortality.³ In one instance a company planted 16,254 bushels in Long Island Sound in 1952 and 5 years later only 2,000 bushels were large enough to be sold. Since these oysters were grown in areas where native oysters do well, it appeared that the Wareham River strain was slow growing.

² The authors wish to thank Jay D. Andrews, J. Richards Nelson, and Gilbert Covell for contributing oysters used in the experiment.

³ Possible lack of careful treatment during transportation might explain the high mortality.

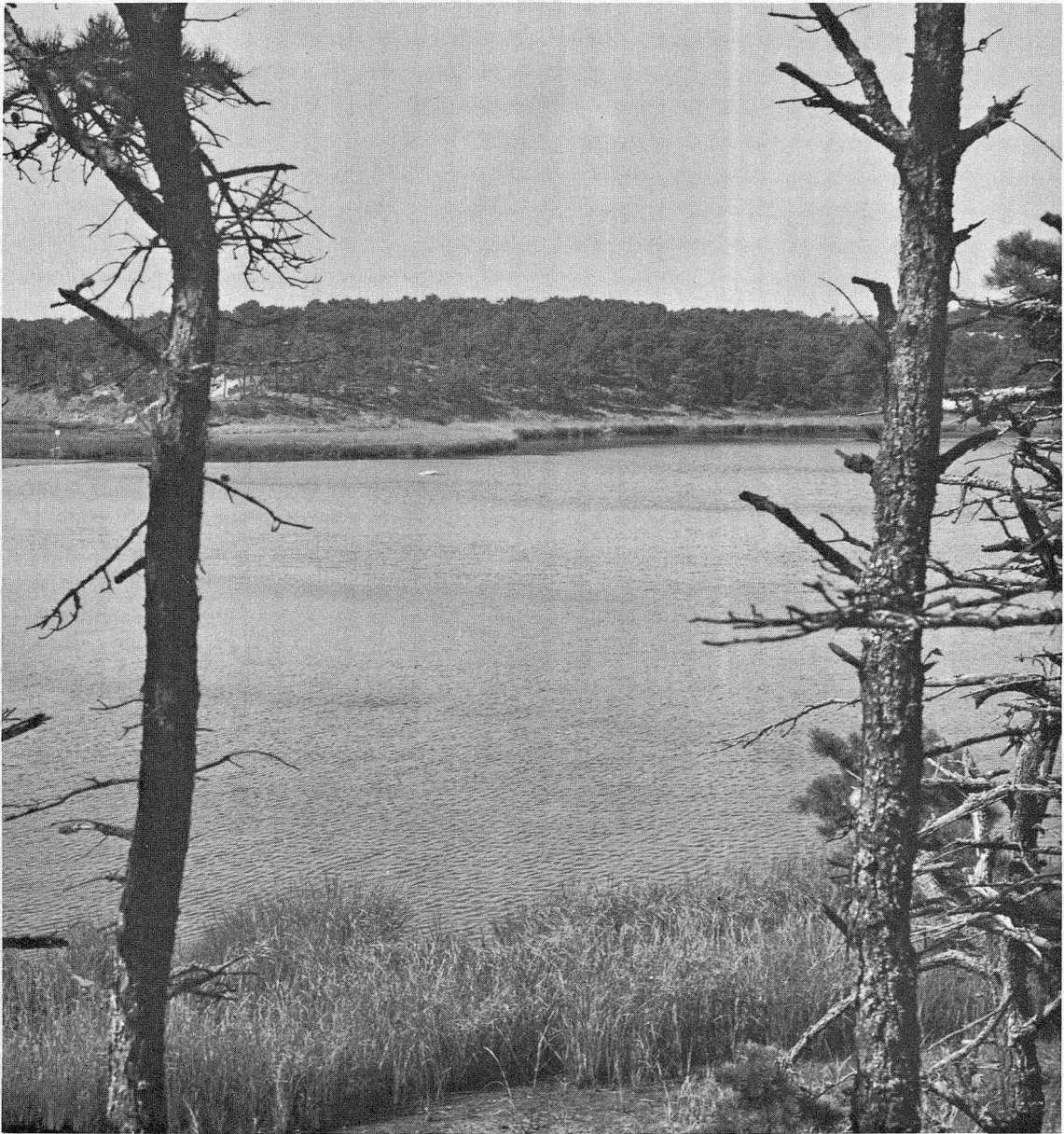


FIGURE 1.—Taylors Pond, West Chatham, Mass.

ANALYSIS OF SHELL GROWTH

As shown in table 2 and figure 2, the growth of the experimental oysters varied. An analysis of variance of the height data for November of 1958, indicated that the differences between the mean heights of the four strains were highly significant ($F=18$). Further analysis, using a modification of the Tukey Method (Snedecor, 1956), showed that a difference between the means equal to or larger than 1.99 ($Q_{.05}S_{\bar{x}}$) was signifi-

cantly different. Thus the mean height of the Mill Creek oysters was significantly greater than the heights of the other three strains by the end of 1958.

These differences in mean heights at the end of 1958 were more than likely due to the fact that the initial time of setting was not the same for all four groups. Setting in Mill Creek occurred between July 18 and 23, while setting in the other three areas did not take place until 5-29 days later

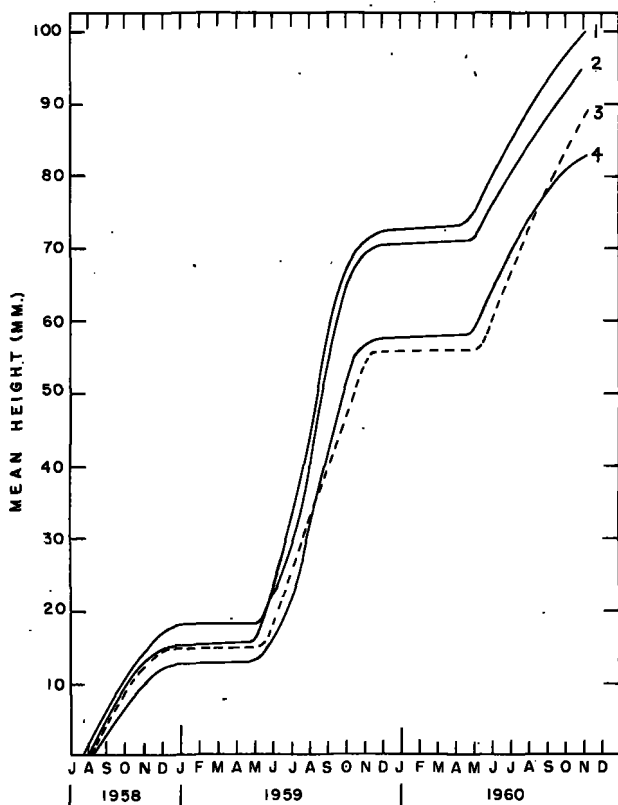


FIGURE 2.—Growth curves for strains of oysters attached to raft in Taylors Pond. Origin of oysters was as follows: 1. Long Island Sound; 2. Mill Creek; 3. James River; and 4. Wareham River.

TABLE 2.—Total yearly mean growth of experimental oysters in Taylors Pond for the years 1958, 1959, and 1960. Based on the difference between total height and initial height for each growing season

Origin	1958	1959	1960
Long Island Sound.....	mm. 15.4	mm. 57.3	mm. 26.8
Mill Creek.....	18.4	52.1	24.6
Wareham River.....	13.0	45.3	24.6
James River.....	13.9	42.4	32.1

(table 1). It is, therefore, logical that oysters with the earliest start, in this case the Mill Creek stock, were the largest at the end of the setting year,⁴ while the oysters with the latest start, in this case the Wareham River and James River stocks, were the smallest.

In 1959 the Long Island Sound oysters grew 57.3 millimeters and the Mill Creek oysters grew 52.1 mm. At the same time, the Wareham River and James River oysters grew only 45.3 mm. and 42.4 mm., respectively (table 2). From these

⁴ From time of setting to January 1 is the setting year.

data it appears that the Long Island Sound and Mill Creek strains grew faster than the other two groups. When the growth curves for 1959 are examined (fig. 2), the differences in growth are apparent.

An analysis of variance of the height data at the end of the 1959 growing season indicated that the differences between the means were again highly significant. Further analysis ($Q_{.05}S_n^2=6.50$) showed that the means of the Long Island Sound and Mill Creek strains were significantly greater than the Wareham River and James River strains, but the Long Island and Wareham River strains were not significantly different from the Mill Creek and James River strains respectively.

Assuming the growth rate of each strain was linear within a single growing season, a comparison of the growth rates of the three strains⁵ was made by using covariance analysis. This comparison during the 1959 growing season indicated that the growth rates were significantly different at the 5-percent level. Further analysis using the t-test (Snedecor, 1956) showed that the growth rates of the Mill Creek and Long Island Sound strains were significantly faster than the growth rate of the Wareham River strain (fig. 3).

An analysis of variance of the data at the end of 1960 indicated that the differences between the means were significantly different. Closer examination showed the relationship of the four strains ($Q_{.05}S_n^2=5.88$) had not changed from the previous year. An analysis of covariance also indicated the growth rate for the four strains were also statistically similar (fig. 4). It is also interesting to note that on comparing the regression coefficients for both years, the growth rates for all strains in 1960 was about one-half as fast as that in 1959.

COMPARISON OF WEIGHTS AND VOLUMES

The question arose whether the selection of shell height as measurement for comparing growth differences between oyster strains gave reliable results. To check our findings, a random sample of 25 oysters was selected from each experimental strain on November 2, 1960. The total weight, weight of shell, weight of meat and liquor, wet weight of meat, and total volume of meat and liquor were determined for each sample and then compared (table 3).

⁵ Not enough data to include James River strain for 1959.

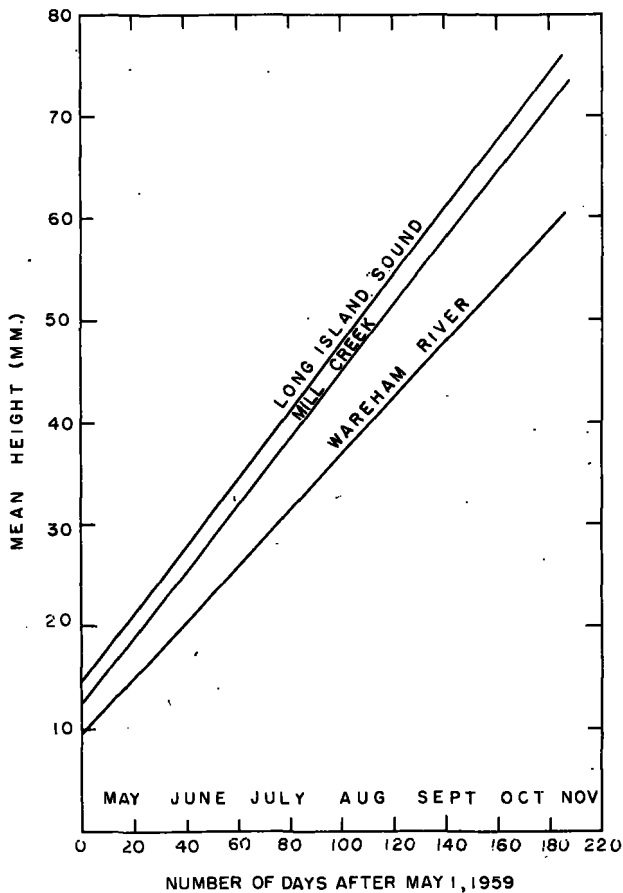


FIGURE 3.—Growth rate regressions of three strains of oysters cultured in Taylors Pond, Chatham, Mass., during the 1959 growing season.

TABLE 3.—Total weight, weight of shell, weight of meat and liquor, and weight of meat for 25 oysters selected from each strain on Nov. 2, 1960

[Measurements in grams]

Origin	Total weight	Weight of shell	Weight of meat and liquor	Weight of meat
Long Island Sound.....	2,560	1,920	637.7	370.9
Mill Creek.....	2,210	1,660	555.5	333.6
James River.....	2,010	1,560	448.1	260.8
Wareham River.....	1,830	1,370	464.4	281.3

The data clearly showed that the oysters from Long Island Sound and Mill Creek have greater weights in all categories than the corresponding weights for oysters originating in the James River and the Wareham River (table 3). Likewise, the former two strains have greater meat and liquor volumes than the latter (figure 5). The above weight and volume comparisons between strains are similar to the results obtained when the mean

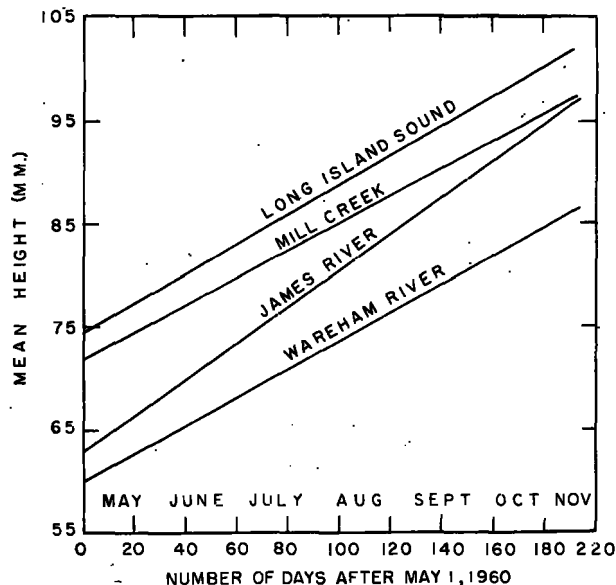


FIGURE 4.—Growth rate regressions of four strains of oysters cultured in Taylors Pond, Chatham, Mass., during the 1960 growing season.

heights for these strains were compared at the end of 1960 (fig. 2). It seems, therefore, that the use of shell height is justified in this experiment.

MORTALITY

As mentioned earlier, the James River oysters had a mortality of 80 percent during the winter of 1958. Little further mortality of these oysters was observed either in 1959 or 1960. Mortality among the other strains was less than 10 percent from the fall of 1958 until the spring of 1960. During 1960 approximately 32.5, 22.4, and 6.3 percent of the Mill Creek, Wareham River, and Long Island Sound oysters died, respectively.

The high mortality among the Mill Creek and Wareham River strains in 1960 was attributed to the fact that many of these oysters, which had originally set on bay scallop shells, broke away from the strings and fell to the bottom. The scallop shells apparently were unable to support the additional weight of the growing oysters and, consequently, fell apart. The low mortality among the Long Island Sound oysters in 1960 can probably be attributed to these oysters being originally caught on oyster shells which were able to support the additional weight.

FUTURE RESEARCH

Our study shows clearly that the Wareham River oysters grow slower than oysters originating

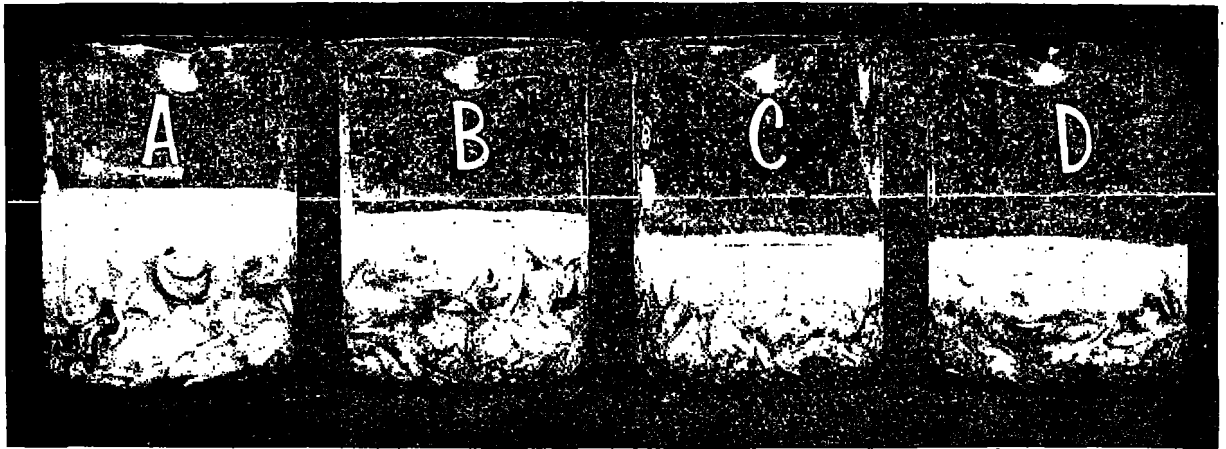


FIGURE 5.—Total meat and liquor volumes for 25 oysters selected from each strain on Nov. 2, 1960. Origin of oysters was as follows: A. Long Island Sound; B. Mill Creek; C. Wareham River; and D. James River.

from Long Island Sound and Mill Creek. The evidence suggests that the slow growth may be caused by hereditary characteristics. One should not overlook the possibility that the growth of this strain might be the results of environmental conditions which occurred during either embryonic or larval stages. The true answer must await further laboratory and field experiment.

SUMMARY

1. Former buyers of Wareham River seed oysters claim that these oysters are slow-growing and have a high mortality rate.

2. The purpose of the experiment was to determine whether the Wareham River oysters are slow-growing. The determination was made by comparing the rate of growth of this strain with the rates of growth of oysters from other areas.

3. Seed oysters from Wareham River, Mill Creek, Long Island Sound, and James River were suspended side by side from a raft in Taylors Pond, Chatham, Mass.

4. Growth for each strain was measured by monthly samples taken during the growing season.

5. At the end of 1958, the mean heights of the Long Island Sound, Wareham River, and James River strains were significantly smaller than the mean height of the Mill Creek strain.

6. During 1959, the growth rate of the Wareham River strain was significantly slower than the

growth rates of the Long Island Sound and Mill Creek strains. The average height of the Wareham River strain at the end of 1959 was significantly smaller than the average heights of the Long Island Sound and Mill Creek strains.

7. During 1960, the growth rates of all strains were significantly similar. The average height of the Wareham River strain at end of 1960 was still significantly smaller than the average heights of the Long Island Sound and Mill Creek strains.

8. A comparison of total weight, weight of shell, weight of meat and liquor, wet weight of meat, and total volume of meat and liquor showed that the oysters from Long Island Sound and Mill Creek had greater weights and volumes in all categories than the corresponding weights and volumes for oysters from Wareham River and James River.

9. Mortality among the Wareham River, Long Island Sound, and Mill Creek strains was less than 10 percent from autumn 1958 until spring 1960. Approximately 32.5, 22.4, and 6.3 percent of the Mill Creek, Wareham River, and Long Island Sound strains died, respectively, during the remainder of 1960. About 80 percent of the James River oysters died during the winter of 1958.

10. The results of the experiment indicates that the Wareham River oysters grow slower than oysters originating from Long Island Sound and Mill Creek. Further research is necessary to determine the causes for the apparent slow growth.

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