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Fishery Dependent Information Needs

Estimation of Standing Crop of Oysters in the James River, Virginia, Using Commercial Fishing Records

FINAL REPORT

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INTRODUCTION

Background

Virginia was the leading producer of oysters, *Crassostrea virginica*, as recently as the late 1950's, when landings of market oysters from the 243,000 acres of public grounds was about 700,000 bushels (Hargis and Haven, 1988). Beginning about 1960, a major decline in market oyster production occurred, principally the result of two oyster pathogens, *Haplosporidium nelsoni* (MSX) and *Perkinsus marinus* (Dermo). These pathogens have essentially decimated productive oyster grounds in the main stem of Chesapeake Bay as well as the lower portions of all the major rivers. Market oyster landings from public grounds had declined to 328,338 bushels in 1985-86. Remaining populations of commercially harvested oysters are harvested from public grounds located in isolated, upriver areas because the pathogens favor salinity in excess of 12 ppt. The most notable of these is in the James River.

The James River Fishery

The James River has historically provided 75% of the seed[1] oysters planted on leased bottoms in the private sector of the industry; during the 1950's seed oyster harvest from public beds averaged over 2.0 million bushels per year (Hargis and Haven, 1988). There are biological reasons why the James River is well suited as a seed producing area. First of all, recruitment of oysters in the James River has been generally high and consistent (Andrews, 1951, 1983; Haven and Fritz, 1985). Secondly, predation (mainly by oyster drills and crabs) is relatively low (Hargis and Haven, 1988). Thirdly, growth is slow, probably due to factors associated with the prevailing low salinity (Andrews, 1951). Thus the James River is a system that is capable of producing large numbers of small, slow growing oysters. Since most of the best oyster growing areas in the state are now unproductive due to disease, however, the demand for seed has diminished steadily since about 1960. Seed harvest from public grounds during the 1986-87 harvest season was only 200,917 bushels, the lowest since 1930-31 (Hargis and Haven, 1988).

Beginning with the 1986-87 season, emphasis in the James River shifted from the harvest of seed oysters to the harvest of market[2] oysters, with the advent of the "clean cull" law. That year, the James River fishery accounted for 42% of the state total of market

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[1]Seed oysters are small (young) oysters that are typically sold to private planters to be placed on leased bottom for subsequent growth to market size.

[2]Market oysters are larger adult oysters that are harvested for sale to end users. In the James River, oysters are considered to be market size when ≥2.5" in shell height. Due to the relatively slow growth rate of oysters in the James River, at least 5 years are required to reach market size (Hargis and Haven, 1988).

oysters (≥2.5") harvested from public grounds. Since then, as production in other areas has continued to decline but relative effort in the James has increased, about 90% of the state total of market oyster production from public beds has come from the James River (VMRC statistics).

Oyster harvesting season on the public grounds in the James River extends from October 1 to July 1, at the discretion of the VMRC. Since the 1985-86 season, the James River has been closed on June 1. Harvesting occurs from sunrise to sunset, Monday through Friday, weather permitting. Handtongs are the only legal harvesting device on public grounds. Typically, three men work on each boat, two tongers and one culler. Harvest in the James River is quantified at the point of sale. Each tonger must sign a VMRC Buyer's Slip recording each sale (number of bushels and price per bushel). Effort is quantified as a daily count by VMRC of boats working each bar.

<u>The Problem</u>

The change in focus and intensity of fishing effort in the James presents a unique and previously unencountered situation for fisheries management (The Virginia Marine Resources Commission). The previously unexploited market oysters in the James formed the broodstock which in turn maintained the seed oyster population. That broodstock is now the focus of an intense fishery. Thus at present, the stability of both the seed resource, upon which the private oyster industry depends, as well as 90% of the public market resource, is dependent on the health of the James River oyster fishery. In spite of the fact that good harvest and effort records are maintained by VMRC, there is no available estimate of standing stock, which is essential to the management of any fishery. The Virginia Institute of Marine Science (VIMS) conducts annual surveys of public oyster shoals; these, however, are based on numbers of oysters per volume of bottom material from a few selected areas, so are not quantitative. Considering the expanse of potential oyster "bottom" and its extensive topography (Haven et al., 1981; Haven and Whitcomb, 1983), a truely quantitative sampling program would be arguably impossible.

An alternative to quantitative sampling of oyster shoals exists for providing standing stock estimates of oysters. Using harvest and effort records, it is possible to estimate initial population abundances (Leslie and Davis, 1939; DeLury, 1947, 1951). This mathematical procedure (commonly called the Leslie-DeLury method) has been used to calculate standing stocks of scallops (Dickie, 1955) and hard clams (Loesch and Haven, 1973; Kvaternick, 1982). The James River oyster fishery is a prime candidate for the application of this method to the estimation of standing stock since the fishery is well defined by area (Figure 1) and consistent, reliable harvest and effort records are available. Such an estimate has clear utility in the management of the James River resource. If the resource is to be managed as a source of seed oysters, the relationship between broodstock and recruitment is of primary importance. If the resource is to be managed as a market oyster producing area, then the relationship between available stock and harvest is of primary importance. Applicability of the Leslie-DeLury method to other other oyster fisheries in Chesapeake Bay should also be possible.

OBJECTIVES

The objectives of this project were as follows:

1. To estimate, using the Leslie-DeLury method, the standing stock of oysters in the James River, Virginia, as follows,:
   a. total oyster population (seed and market oysters combined) at the beginning of the 1979-80 through the 1985-86 seasons
   b. market oyster population (≥2.5") at the beginning of the 1986-87 through the 1988-89 seasons

2. To compare the results of the Leslie-DeLury method using both monthly and daily records of harvest and effort (market oysters, 1987-88 and 1988-89 harvest seasons).

3. To evaluate the Leslie-DeLury method as a means of estimating standing stocks of oysters in the James River as well as other oyster fisheries in Chesapeake Bay

METHODS

Theory

Developed independently by Leslie and Davis (1939) and DeLury (1947, 1951), the Leslie-DeLury method depends on the fact that as a population becomes depleted, the catch per unit effort decreases. The technique involves regressing, over a period of time, an index of current population size on an index of cumulative population depletion to obtain initial population size. Thus complete catch and effort records are essential.

By definition,

$$C(t) = q(t) \cdot N(t) \qquad (1),$$

where $C(t)$ is the average catch per unit effort during the t-th interval, $q(t)$ represents the "catchability" during the t-th interval, defined as the proportion of the population captured by one unit of effort, and $N(t)$ is the size of the population at the beginning of the t-th interval. Values of $C(t)$ are obtainable directly from the catch and effort data, but $q(t)$ and $N(t)$ are not. Assumptions that relate these functions to observable quantities are as follows:

a) $q(t)$ or "catchability" = q, a constant, throughout the sampling period.
b) The population is "closed", meaning that mortality, growth, and recruitment may be ignored.

Assumption (b) implies that

$$N(t) = N - K(t) \qquad (2),$$

where N is the size of the population at the beginning of the sampling period and $K(t)$ is the cumulative catch up to the t-th interval.

Equation (2) may now be written as

$$C(t) = qN - qK(t) \qquad (3).$$

If the assumptions are valid, the values of $C(t)$ plotted against those of $K(t)$ yield a straight line with intercept qN and slope -q. Thus if $C(t)$ and $K(t)$ are linearly related, the assumptions are supported and estimates of qN, q (and also N) can be obtained from this line.

Sampling and experimental errors complicate the decision as to whether $C(t)$ and $K(t)$ are linearly related. It has been shown, however, that if the effort is constant and if a constant mortality rate operates thoughout the sampling period, then $C(t)$ and $K(t)$ are linearly related (DeLury, 1951). Robustness of the Leslie-DeLury estimator, including the effects of changes in catchability (q), has been examined by Braaten (1969).

Procedure

The following data were obtained from VMRC records as follows. Harvest was measured as bushels of oysters (market or seed) and effort as boat counts.

1) 1979-80 through 1988-89 harvest seasons
   Monthly harvest totals
   Monthly effort totals

2) 1987-88 and 1988-89 harvest seasons
   Daily market harvest totals[3]
   Daily effort totals

Monthly data were obtained in tabular form and manually entered into a file on the VIMS Prime Computer. Daily data were obtained on floppy disks and transferred to the Prime file. Appropriate sorting and aggregating of raw data was performed with the SPSSX statistical software. From these data linear regressions of catch per unit effort (CPUE) on cumulative catch were made using the SPSSX Graphics software. In the case of the daily regressions, only days for which boat counts exceeded 10 were used. From these regressions the following statistics were obtained, also from SPSSX Graphics software:

1) R^2 or coefficient of determination (a measure of how much of the total variability in Y is accounted for by regressing Y on X)

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[3]For the 1988-89 harvest season, some of the Buyer Slips from October and November 1988 were not entered into the computer file, which in effect reduced the calculated CPUE for those days, thus incorrectly altering the resulting regression and its R^2 value.

2) P-value of R^2 (whether or not the slope of the regression is statistically different from 0, thus implying a dependence of CPUE on cumulative catch)

3) Coefficients of the regression:
   Y intercept (qN)
   Slope (-q)

4) Standard errors (SE) of the coefficients (used to calculate confidence intervals for -q and qN (and thus N)

For any regression, if the value of P exceeded 0.05, it was concluded that no relationship existed between CPUE and cumulative catch, and therefore initial population size could not be estimated. If the value of P was ≤ 0.05, the initial population size (N) was then obtained by dividing qN by q.

RESULTS

Oyster Standing Stock in the James River

Monthly total (seed plus market) harvest and effort totals and resultant CPUE and cumulative catch values beginning with the 1979-80 harvest season and continuing until the 1988-89 season (the most recent year for which complete data were available) are included in Appendix 1. Regressions of CPUE on cumulative catch using these data are shown in Figures 2-11, respectively. A summary of regression statistics for these harvest seasons are presented in Table I. In all cases P was greater than 0.05, indicating that there was no dependence of CPUE on cumulative catch. Therefore, no estimates of initial standing stock could be made for the total oyster population (seed plus market) over this time period.

Monthly market harvest and effort totals and resultant CPUE and cumulative catch values for the 1986-87 through the 1988-89 seasons are included in Appendix 2. Regressions of CPUE on cumulative catch using these data are shown in Figures 12-14, respectively. A summary of regression statistics for these harvest seasons are presented in Table II. In all cases there was a significant ($P \leq 0.05$) dependence of CPUE on cumulative catch. Thus initial standing stock estimates of market oysters could be calculated, as presented in Table IV. Estimated standing stock of market oysters from public beds in the James River decreased steadily from 612,407 ± 271,863 bushels in 1986 to 530,000 ± 107,955 bushels in 1987 to 309,583 ± 63,737 bushels in 1988.

Daily market harvest and effort totals and resultant CPUE and cumulative catch values for the 1987-88 and 1988-89 seasons are given in Appendix 3. Regressions of CPUE on cumulative catch using these data are shown in Figures 15 and 16, respectively. The statistics for these regressions are presented in Table III. Significant ($P \leq 0.05$) relationships between CPUE and cumulative catch existed only for the 1987-88 harvest season. The estimate of initial standing stock of market oysters based on this regression is 541,010 ± 99,208 bushels (Table IV). The regression based on daily harvest and effort totals for the 1988-89 harvest season was not significant, most likely due to the fact that some of the daily harvest data was incomplete, primarily in October and November 1988. Thus the calculated CPUE values for this period were artificially low, as were the cumulative catch totals, which both affected the resultant regression.

Comparison of Monthly and Daily Regressions

Monthly and daily harvest and effort data for market oysters in the James River were available for the 1987-88 and 1988-89 seasons. The regression statistics using both time intervals are given in Tables II and III. Since daily harvest data for the 1988-89 season was incomplete, however, only the 1987-88 season provides a valid comparison. Thus the value of R^2 was lower for the daily regression than the monthly regression, meaning that there was less scatter to the points. For the 1987-88 season, the value of P was lower for the daily regression than the monthly regression, indicating that there was a stronger statistical relation between CPUE and cumulative catch when the daily time interval was used.

A comparison of estimated standing stock using regressions based on the two time intervals can only be made for the 1987-88 harvest season. As shown in Table IV, they are very comparable, 530,000 bushels using the monthly totals and 541,010 bushels using the daily totals. The standing stock estimate based on the daily regression had a lower 95% confidence interval.

DISCUSSION

Oyster Standing Stock in the James River

From the 1979-80 through the 1988-89 harvest seasons, no effect of harvesting on standing stock of the **total** (both seed and market) oyster population of the James River, was seen as the regressions of CPUE on cumulative catch were not significantly different from zero. This indicates that when the seed and market oyster portions of the population are considered together, harvesting does not, at present, remove enough of the available standing stock to affect CPUE. As a result, initial population abundances cannot be calculated.

When just the market portion of the population was considered, however, definite harvesting effects on CPUE since the 1986-87 season were seen. Resultant estimates of standing stock of market oysters at the beginning of each harvest season (October of each year) declined from 612,407 bushels at the beginning of the 1986-87 season to 530,000 bushels at the beginning of the 1987-88 season to 309,583 bushels at the beginning of the 1988-89 season. These estimates were based on the assumption that all the effort in the James River since October 1986 has been directed toward market oysters (≥2.5") and that seed oysters were harvested primarily as a "by-catch". This is a valid assumption, considering the relative decline in seed harvest and the relative increase in market harvest that occurred with the advent of the "clean cull" law. The scarcity of market oysters in recent years has helped to keep the price of market oysters relatively high, providing considerable economic incentive to harvesting market oysters. A decline in demand for seed oysters has also occurred in recent years.

When the total harvest of market oysters during those years is expressed as a percentage of initial standing stock, it can be seen that in the 1986-87 and 1987-88 seasons, 56% of the initial standing stock was removed, and in 1988-89, 47% was removed (Table V). Although some recruitment[4] into the market population occurred between the 1986-87 and 1987-88 (97%) and 1987-88 and 1988-89 seasons (75%), it is obvious that unless recruitment is 100% or greater each year, standing stock will continue to decline. Thus the rate of removal of market oysters during the last three harvest seasons has exceeded natural recruitment and severely depleted the population of market oysters in the James River (Table V).

Since the total (seed plus market) oyster population in the James River has not been impacted by harvest effort, but the market portion alone has, it is reasonable to suggest that the harvest of the seed portion of the population has not been extensive enough to affect CPUE. What this implies is that seed harvest[5] in the James River may be sustainable, at least at recent levels of effort.

This study provides the first estimates of standing stock of market oysters in the James River. Information of potential use to fisheries managers now exists, as follows:

1) There are now estimates of standing stock of market oysters in the James River to compare with harvest totals. Since the beginning of the 1986-87 harvest season, the market oyster population has been removed at a rate of about 50% each year, without concomitant recruitment.

2) The harvest of seed oysters in the James River has apparently not affected CPUE. Thus seed harvest appears to be sustainable. Given the slow growth rate of oysters in the upper James River, this is biologically tenable.

<u>Comparison of Monthly and Daily Regressions</u>

Even though there was only one harvest season (1987-88) for

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[4]This is based on the fact that the initial population size in each of the 1987-88 and 1988-89 harvest seasons was greater than the difference between initial population size and harvest total from the previous season.

[5]Since the harvest of seed oysters includes basically everything brought up with hand tongs (shell, small oysters, large oysters), the number of living oysters contained in a bushel of "seed" may be highly variable. Considering the general downward trend in recruitment in the James River oyster fishery since 1960 (Haven et al., 1981; Hargis and Haven, 1988), it is unlikely that a bushel of seed today contains as many living oysters as a bushel of seed harvested 10 years ago.

which complete monthly and daily data records were available, there were some differences that are worth considering. Using monthly data, there were only 8 points on the regression, compared to the daily regressions which had up to 163. Thus there were obvious differences in the statistical degrees of freedom between the monthly and daily regressions. In general, the greater the number of degrees of freedom, the greater the statistical confidence that is obtained. This accounts for the low value of P for the daily regression for the 1987-88 harvest season. If the 1988-89 daily data set was complete, its P-value would have probably also been lower than that for the monthly regression. On the other hand, the greater number of data points associated with the daily regressions resulted in a lower value of R^2. This is not surprising given the higher variability inherent in the daily data points. This variability is due to differences in CPUE between boats and crews as well as location and weather induced differences in harvest and effort. This variability is masked in the monthly totals.

For the 1987-88 harvest season, the estimate of initial standing stock of market oysters was 530,000 ± 107,955 bushels using the the monthly regression and 541,010 ± 99,208 bushels using the daily regression. Based on the smaller confidence intervals, and smaller P-values, the daily regression probably provided a more accurate estimate of standing stock. The two estimates are so close, however, that either could be used reliably, depending on data gathering and management constraints. In the case of the James River oyster fishery, both monthly and daily time intervals thus appear to be adequate. Daily or weekly time intervals would be more important for obtaining estimates of standing stock for fisheries that have shorter harvest seasons.

Evaluation of the Leslie-DeLury Method

In this study, the assumption of low mortality, growth, and recruitment over a harvest season was reasonably well met. The James River oyster resource, especially that portion harvested since the beginning of the 1986-87 season is in an area of the river where prevailing salinity is below 15 ppt. As a result, mortality caused by the oyster pathogens *P. marinus* and *H. nelsoni* and by oyster drills, *Urosalpinx cinera* and *Eupleura caudata*, is negligible. As mentioned previously, growth of oysters is slow in this area of the James River, especially over the cooler portion of the year when harvesting occurs. Since oyster spawning is essentially completed prior to the beginning of harvest, there is no recruitment during the harvest season. Due to the combination of low mortality, low growth and low recruitment, the oyster population is essentially "closed" over the duration of the harvest season.

Corrections to account for mortality over the course of the harvest season would increase the estimates of standing stock. Kvaternik (1982) used an estimated annual mortality rate of 5% for his calculation of standing stock of clams, *M. mercenaria*. Since there is no reliable estimate of non-predation mortality in oysters, however, no attempt to correct for mortality was made in this study. As mentioned above, mortality of oysters, especially market oysters, in the upper James River is thought to be quite low (Hargis and Haven, 1988).

In addition to the assumption of absence of natural mortality, it was also assumed that catchability, or the proportion of the population captured by one unit of effort, was constant throughout the harvest season. In general, a change in catchability has the most serious effect on Leslie-DeLury estimates, with an increase in catchability producing an increase in the estimate of population size, and a decrease in catchability resulting in a decrease in the estimate of population size (Braaten, 1969). There is no way to know whether or not catchability remained constant in this study. In most practical situations, however, the assumption of constant catchability has been found to be valid (Braaten, 1969).

Braaten (1969), in his evaluation of the general robustness and predictive ability of the Leslie-DeLury estimator, found that as used in this study, has negative bias. That is, because catch is assumed to be removed at the beginning of the time interval rather than continuously, estimates of population abundance tend to be low.

Considering the general lack of standing stock estimates of oyster populations, the difficulty of obtaining these estimates via quantitative sampling programs, and the importance of these estimates to management efforts, the Leslie-DeLury estimator appears to have promise, especially when certain conditions are met. First of all, reliable harvest and effort statistics have to be available, preferrably on an ongoing basis. The estimate obtained will pertain to the area fished. In essence the watermen harvesting the oysters are doing the sampling; documentation of their effort and harvest are used to calculate the estimate of initial population size. In the case of the James River fishery, this area included several bars in the upper portion of the oyster-growing portion of the river. Even though effort was recorded on a bar by bar basis, harvest was not. The Leslie-DeLury estimator could be applied to specific bars, however, if both effort and harvest are recorded by bar. Secondly, the assumptions of a closed fishery and constant catchability have to be met. Since most of the oysters currently harvested in Chesapeake Bay from public grounds now come from isolated (upriver) populations similar the the James River fishery, these assumptions would be met.

There are also limitations to the Leslie-DeLury estimator. First of all, the estimates are only as good as the harvest and effort statistics available. A common problem with commercial fisheries is obtaining reliable harvest totals due to non-compliance by fishermen. The buyer's slip required by VMRC in the James River is an effort to remedy that situation. If appropriate record gathering mechanisms are not in place, the ability to estimate standing stock using the Leslie-DeLury method might provide extra incentive to initiate such mechanisms. Secondly, the estimate of initial standing stock obtained for any harvest season is only obtained **after** the completion of harvesting for that season[5]. Thus the Leslie-DeLury method has no predictive ability. Thirdly, to obtain an estimate of standing stock using the Leslie-DeLury method, some substantial portion of the population has to be removed via harvesting in order to obtain a statistically significant reduction in CPUE with increasing harvest. It is not known what this normally would be. A 60% reduction in population size was simulated by Braaten (1969) in his statistical evaluation of the Leslie-DeLury estimator. Significant regressions were obtained in this study with population reductions of 47% to 56%. If significant regressions are not obtained, as was the case with the total oyster (seed plus market) population in the James River, it can be inferred that harvesting is not having a substantial impact on the population.

SUMMARY

Estimates of standing stock are vital to fisheries management but are frequently difficult to obtain. This study examines the use of a statistical method (Leslie-DeLury) to estimate standing stocks of oysters in the James River, Virginia, between the 1979-80 and 1988-89 harvest seasons.

Monthly harvest and effort totals resulted in significant regressions of CPUE on cumulative catch of market oysters for the 1986-86 through 1988-89 harvest seasons. Standing stock estimates of market sized oysters based on these regressions decreased from 612,407 bushels prior to the 1986-87 harvest season to 530,000 bushels at the beginning of the 1987-88 harvest season to 309,583 bushels at the start of the 1988-89 harvest season. Market harvest totals during each of these three seasons were 47% to 56% of estimated standing stock available at the beginning of the season. Prior to the 1986-87 harvest season and the advent of the "clean cull" law in the James River, no significant regressions of CPUE on cumulative catch were obtained, probably because effort was more evenly distributed between seed and market portions of the population.

There was one harvest season (1987-88) for which regressions of CPUE on cumulative catch based on both monthly and daily harvest and effort totals were obtainable. The regression based on daily totals had a lower P-value and a lower 95% confidence interval, but a higher R^2 value. The greater number of statistical degrees of freedom afforded by the daily regression suggests that its estimate of initial market oyster standing stock of 541,010 bushels is probably more accurate than the estimate of 530,000 bushels obtained with the monthly regression. Considering the similarity in the estimates, however, both approaches appear adequate.

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[5]Conceivably, an estimate of initial standing stock could be obtained with only a portion of the harvest season completed, but this would be less reliable than an estimate based on the entire harvesting season.

Application of the Leslie-DeLury technique for estimating initial standing stock was appropriate for the James River oyster fishery. First of all, the assumptions of low mortality, growth, and recruitment over the course of a harvest season are met. Secondly, the necessary harvest and effort data exists as part of an ongoing data collection effort. The Leslie-DeLury method should also be applicable to other oyster fisheries in Chesapeake Bay where necessary data gathering mechanisms are in place.

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TABLE I

Equation variables for regressions of CPUE on cumulative total (seed plus market) oyster harvest using monthly time intervals, 1979-80 to 1988-89 harvest seasons.

Harvest Season	q	qN ± SE	R^2	P
1979-80	-.000131	121.67 ± 20.89	.264	.167
1980-81	-.000059	77.51 ± 7.37	.272	.160
1981-82	-.000001	63.69 ± 17.43	.000	.983
1982-83	.000031	60.66 ± 11.65	.090	.432
1983-84	-.000020	58.73 ± 11.60	.030	.655
1984-85	-.000006	67.13 ± 12.98	.002	.903
1985-86	-.000063	67.43 ± 9.50	.242	.316
1986-87	-.000005	36.58 ± 6.42	.012	.796
1987-88	-.000006	22.04 ± 2.87	.065	.641
1988-89	-.000017	14.61 ± 4.35	.040	.634

TABLE II

Equation variables for regressions of CPUE on cumulative market oyster harvest using monthly time intervals, 1986-87 to 1988-89 harvest seasons. Values of P <0.05 indicate a statistically significant dependence of CPUE on cumulative catch.

Harvest Season[1]	q	qN ± SE	R^2	P
1986-87	-.000054	33.07 ± 6.67	.501	.049
1987-88	-.000042	22.27 ± 2.07	.773	.004
1988-89	-.000048	14.86 ± 1.39	.711	.009

[1]Starting with the 1986-87 harvest season and the advent of the "clean cull" law in the James River, virtually all effort was directed toward the market component of the fishery. See text for further explanation.

TABLE III

Equation variables for regressions of CPUE on cumulative market oyster harvest using daily time intervals, 1987-88 and 1988-89 harvest seasons. Values of P <0.05 indicate a statistically significant dependence of CPUE on cumulative catch.

Harvest Season	q	qN ± SE	R^2	P
1987-88	-.000041	21.96 ± 1.83	.114	.000
1988-89[2]	-.000013	9.74 ± 0.87	.010	.210

[2]The daily harvest records for the 1988-89 harvest season are incomplete. See text for further explanation.

TABLE IV

Estimated standing stock (± 95% CI) of market oysters (bushels) in the James River at the beginning of the 1986-87 through 1988-89 harvest seasons, based on monthly and daily time intervals.

Harvest Season	Standing Stock (Monthly)	Standing Stock (Daily)
1986-87	612,407 ± 271,863	No Data
1987-88	530,000 ± 107,955	541,010 ± 99,208
1988-89	309,583 ± 63,737	Data Incomplete

TABLE V

Estimated initial standing stocks (based on calculations using monthly time intervals) and total harvests of market oysters in the James River, Virginia, for the 1986-87 through 1988-89 harvest seasons.

Harvest Season	Initial Standing Stock	Total Harvest	% SS Removed	Recruitment[3] bet. Seasons
1986-87	612,407	342,828	56%	
				97%
1987-88	530,000	297,781	56%	
				75%
1988-89	309,583	146,230	47%	

[3]Calculated as the increase in initial standing stock above the difference between initial standing stock and harvest total from the previous year.

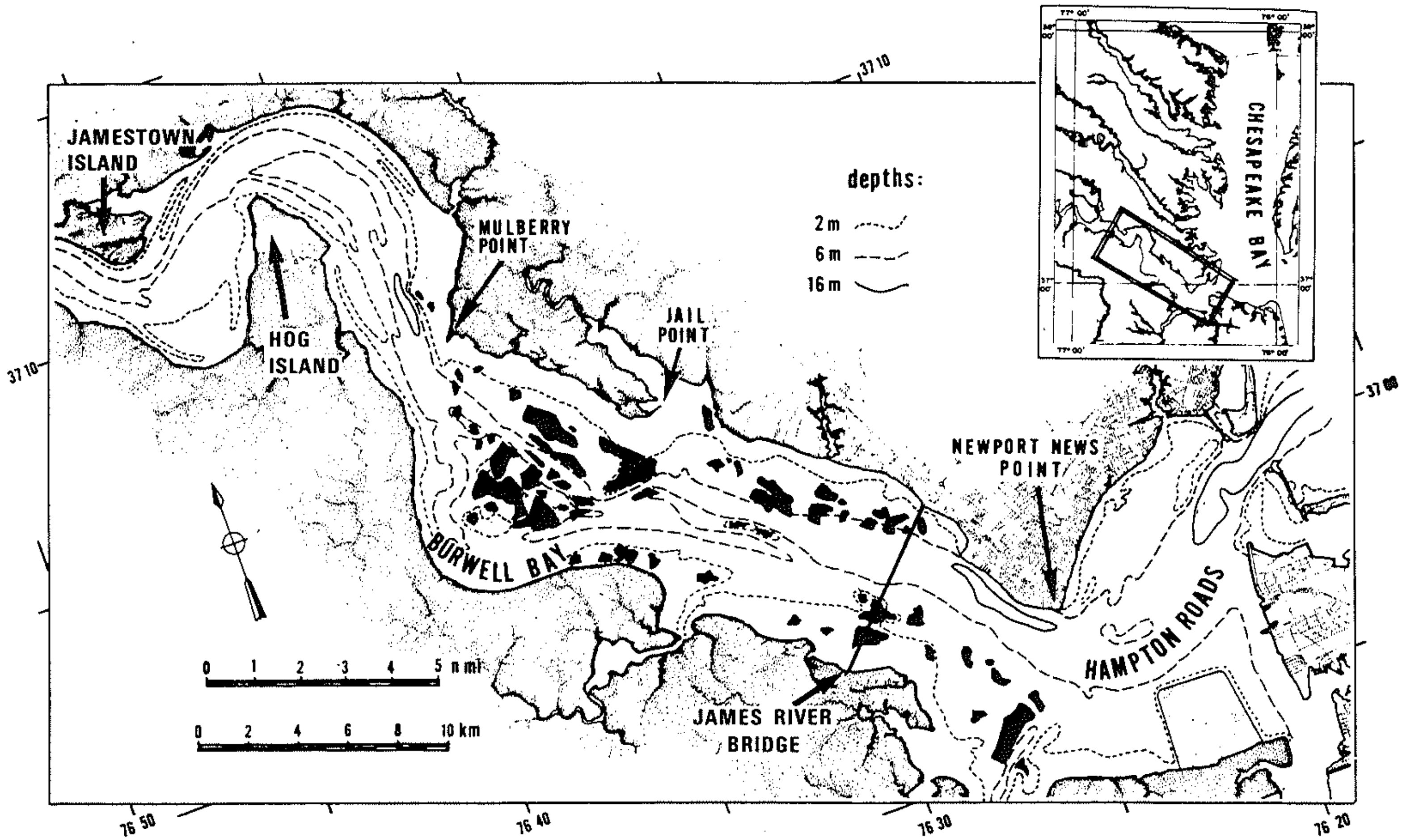

Figure 1. Map of James River, Virginia, with public oyster shoals indicated in black. In recent years, harvesting effort has been concentrated in Burwell Bay area.

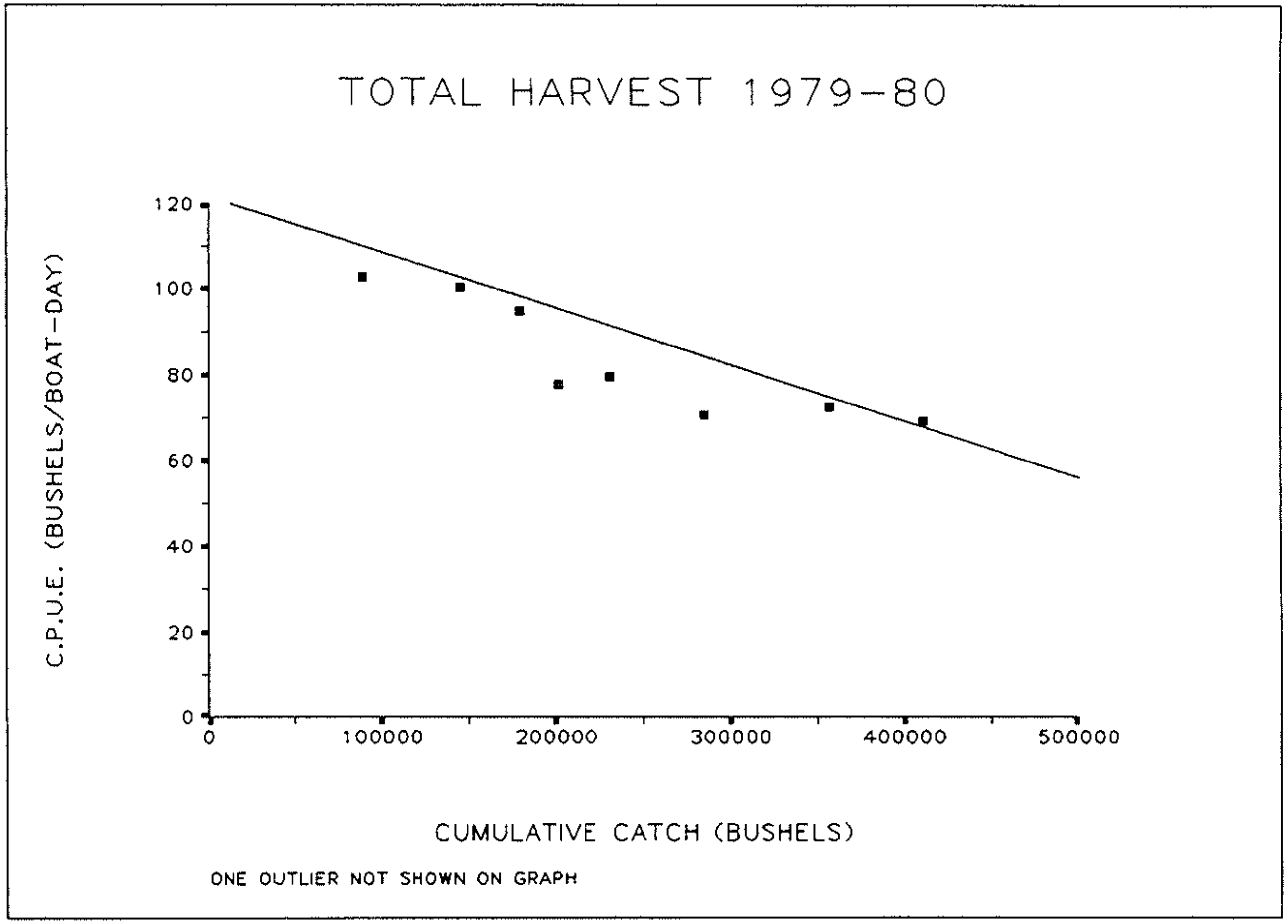

Figure 2. Regression of C.P.U.E. on total oyster cumulative catch for the 1979-80 harvest season. Points represent monthly totals of effort and catch.

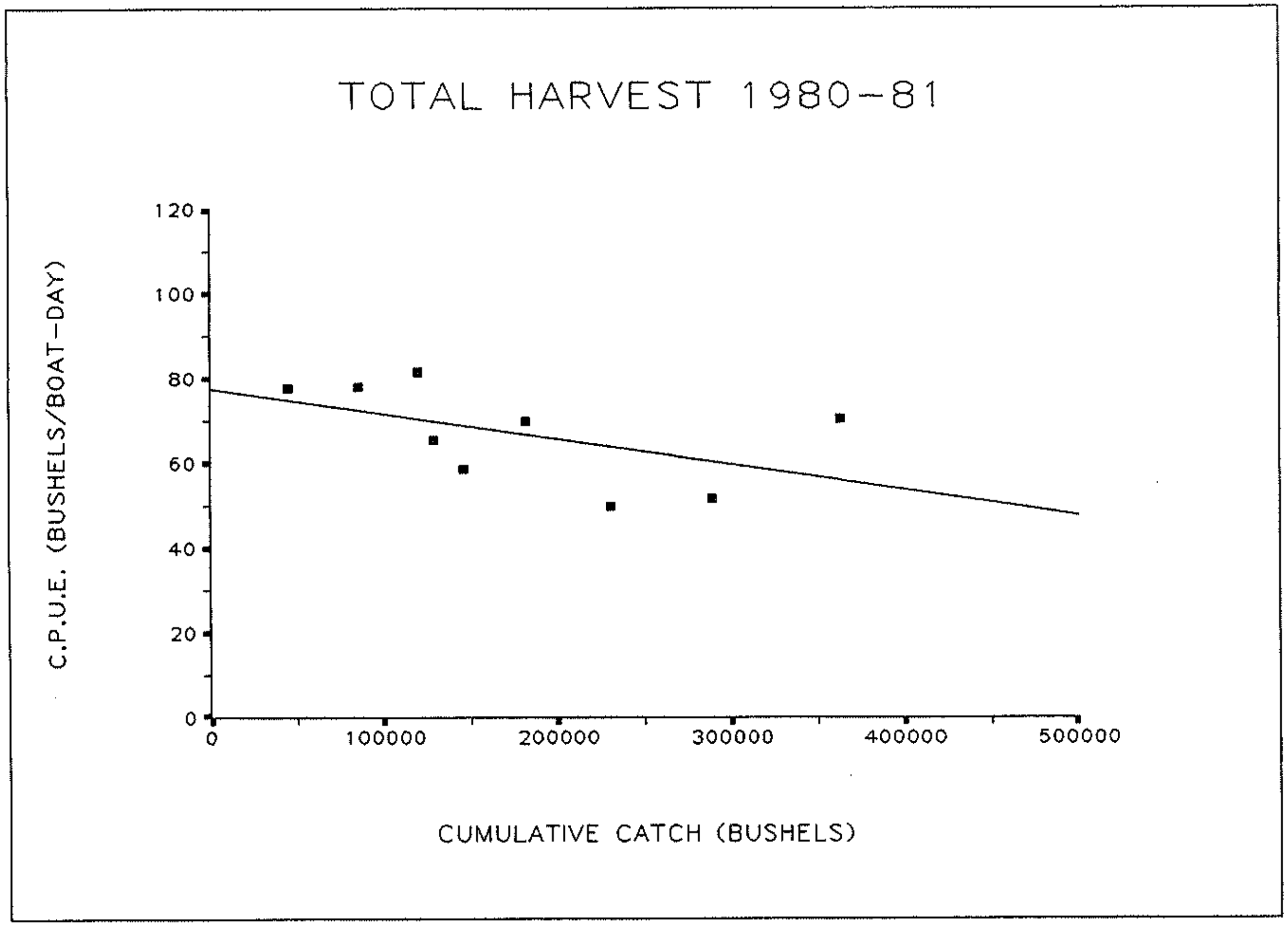

Figure 3. Regression of C.P.U.E. on total oyster cumulative catch for the 1980-81 harvest season. Points represent monthly totals of effort and catch.

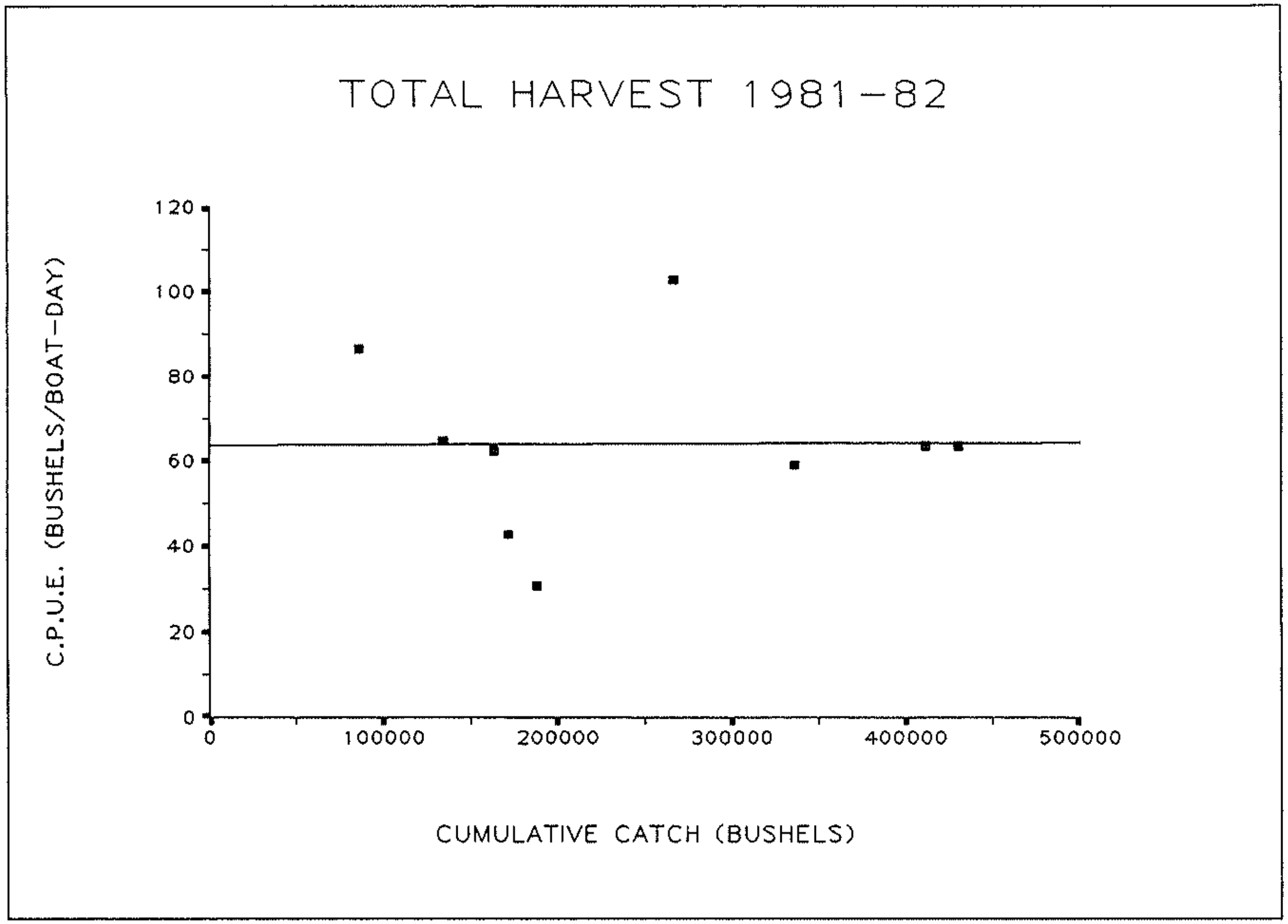

Figure 4. Regression of C.P.U.E. on total oyster cumulative catch for the 1981-82 harvest season. Points represent monthly totals of effort and catch.

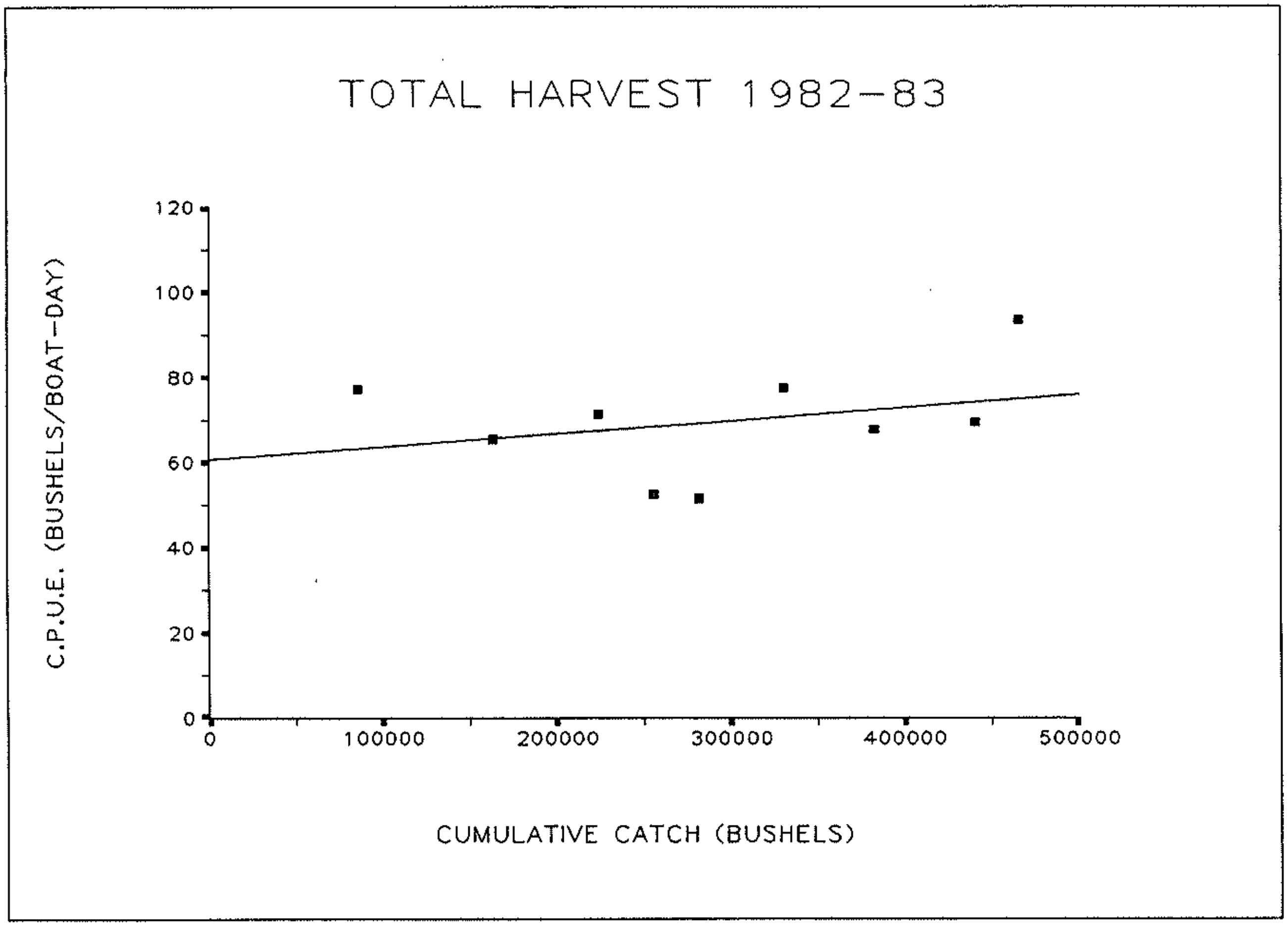

Figure 5. Regression of C.P.U.E. on total oyster cumulative catch for the 1982-83 harvest season. Points represent monthly totals of effort and catch.

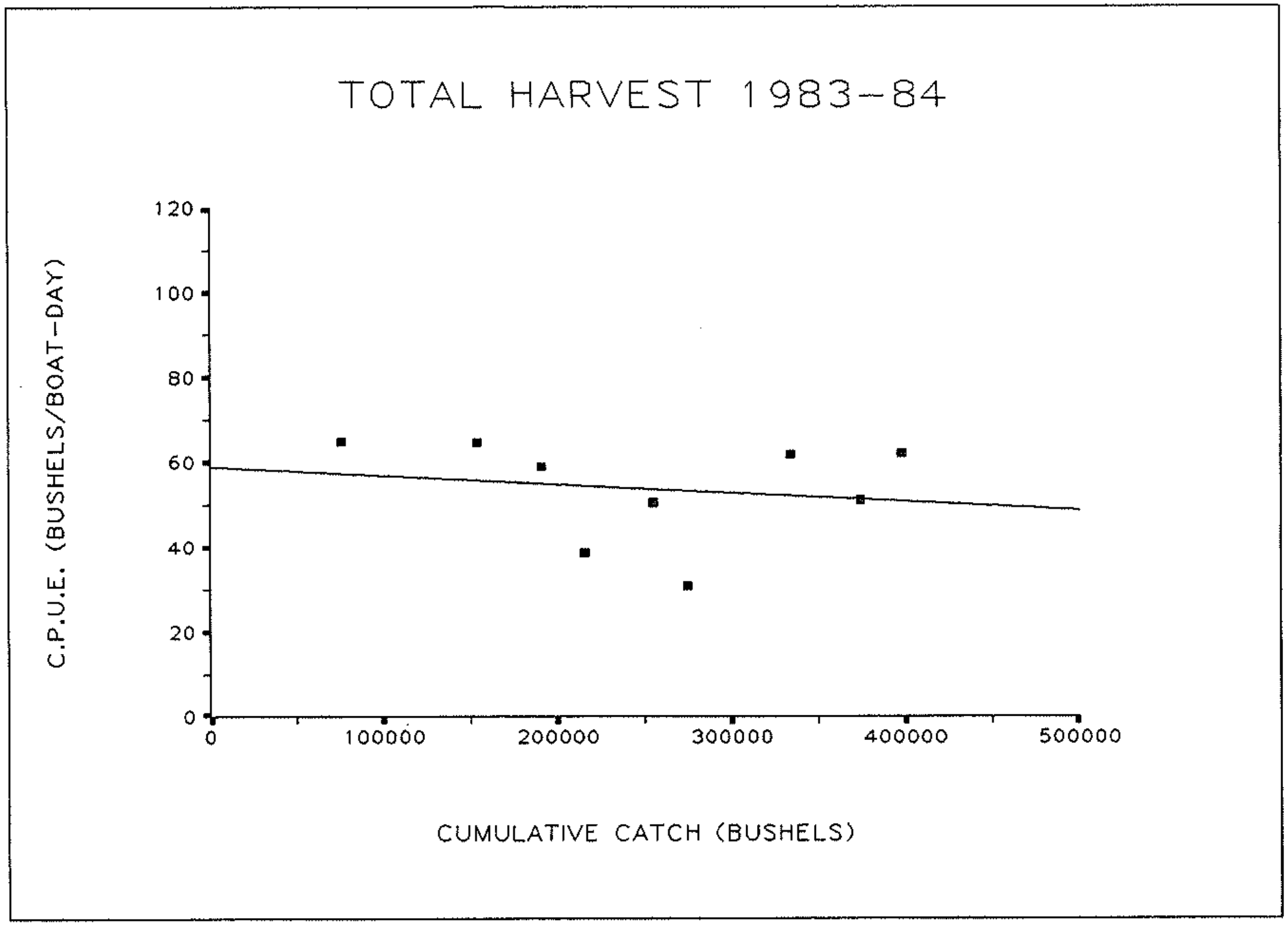

Figure 6. Regression of C.P.U.E. on total oyster cumulative catch for the 1983-84 harvest season. Points represent monthly totals of effort and catch.

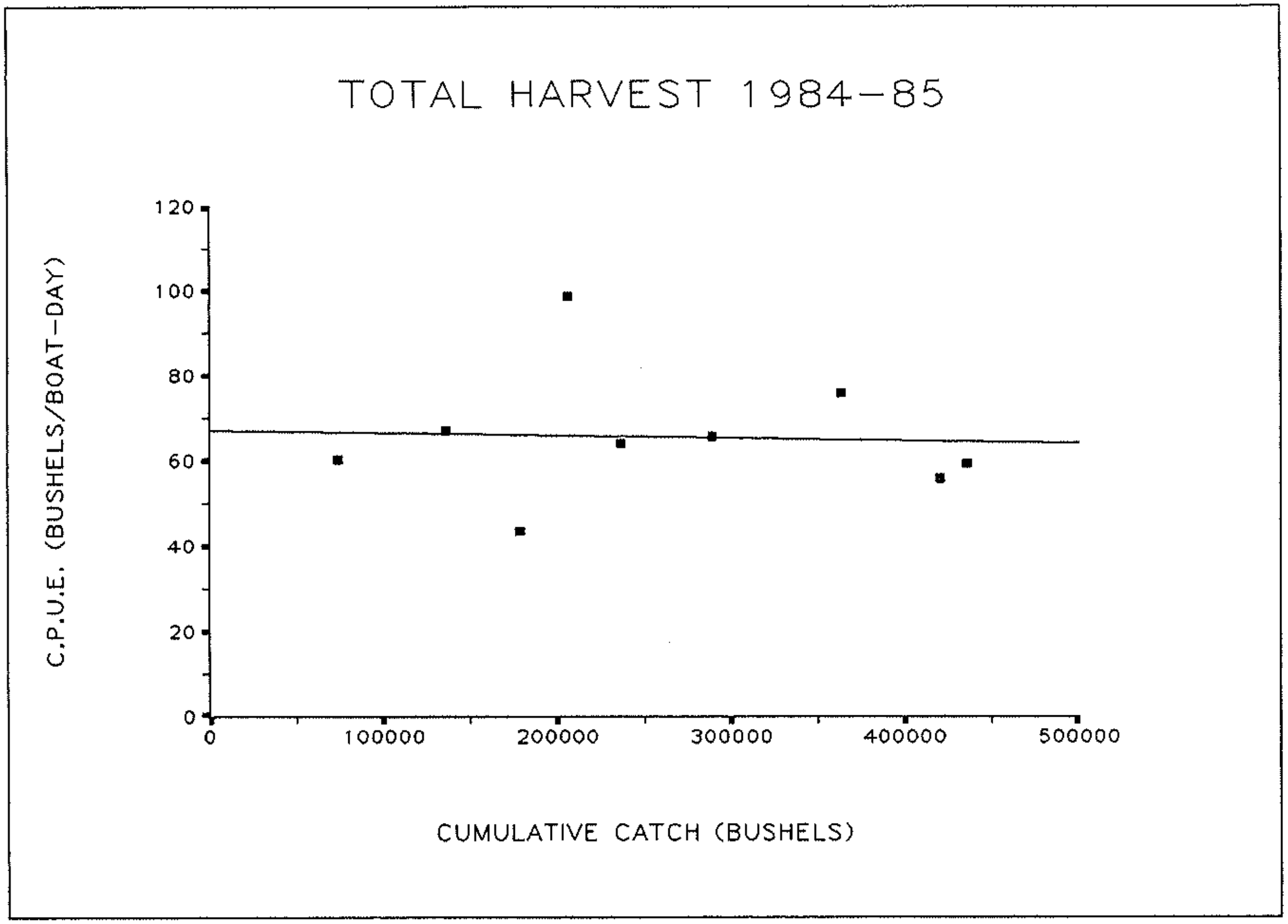

Figure 7. Regression of C.P.U.E. on total oyster cumulative catch for the 1984-85 harvest season. Points represent monthly totals of effort and catch.

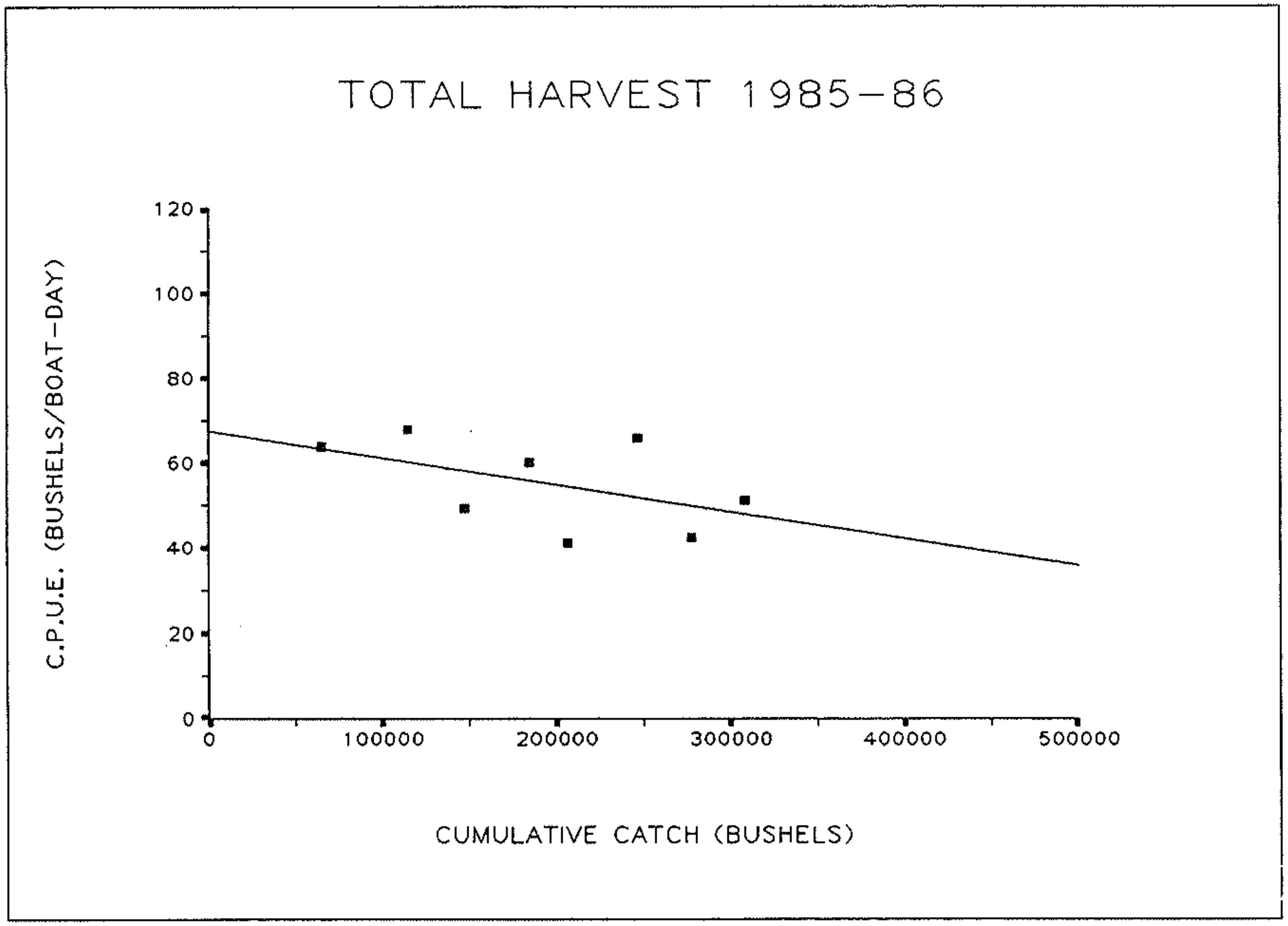

Figure 8. Regression of C.P.U.E. on total oyster cumulative catch for the 1985-86 harvest season. Points represent monthly totals of effort and catch.

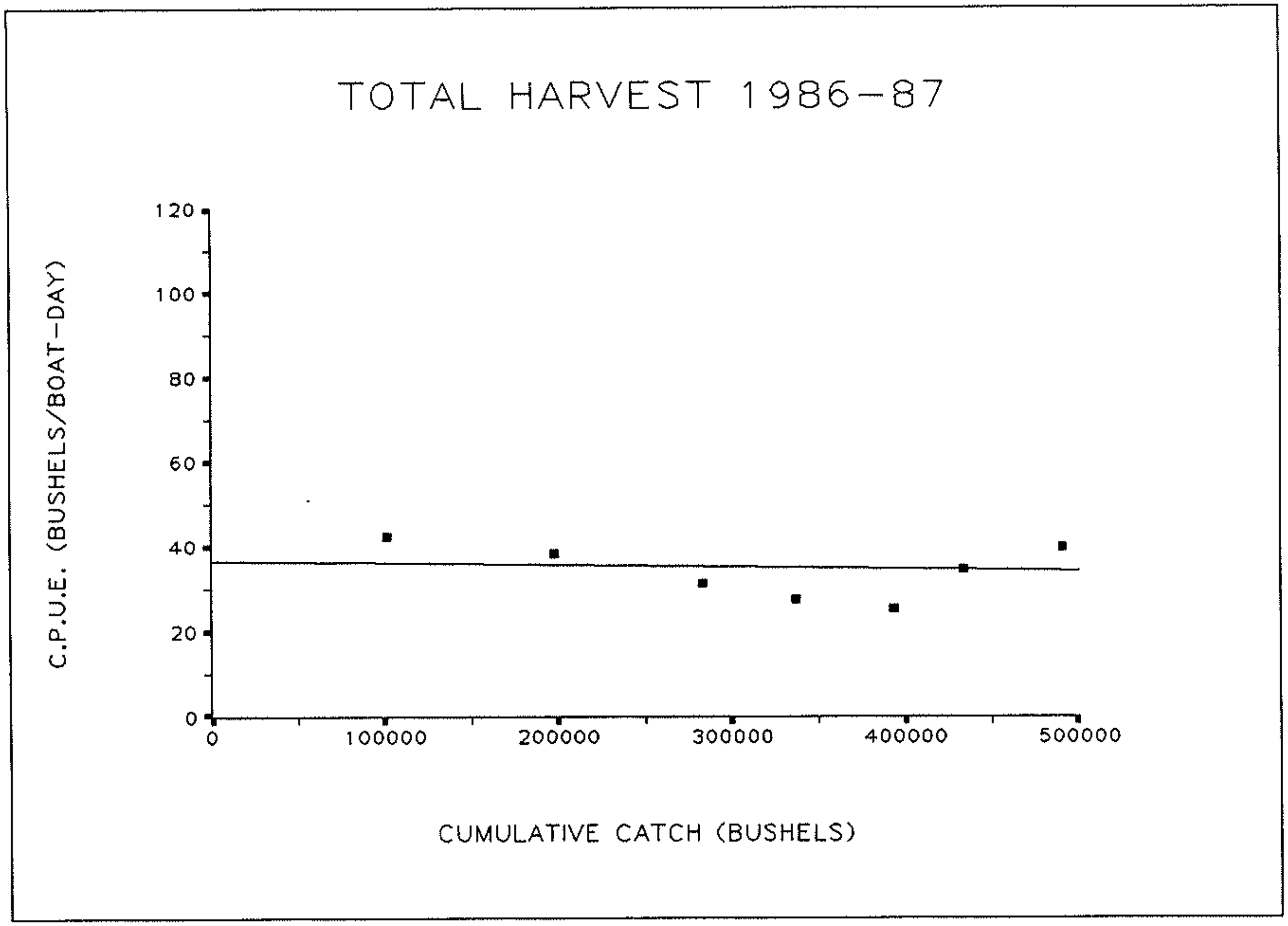

Figure 9. Regression of C.P.U.E. on total oyster cumulative catch for the 1986-87 harvest season. Points represent monthly totals of effort and catch.

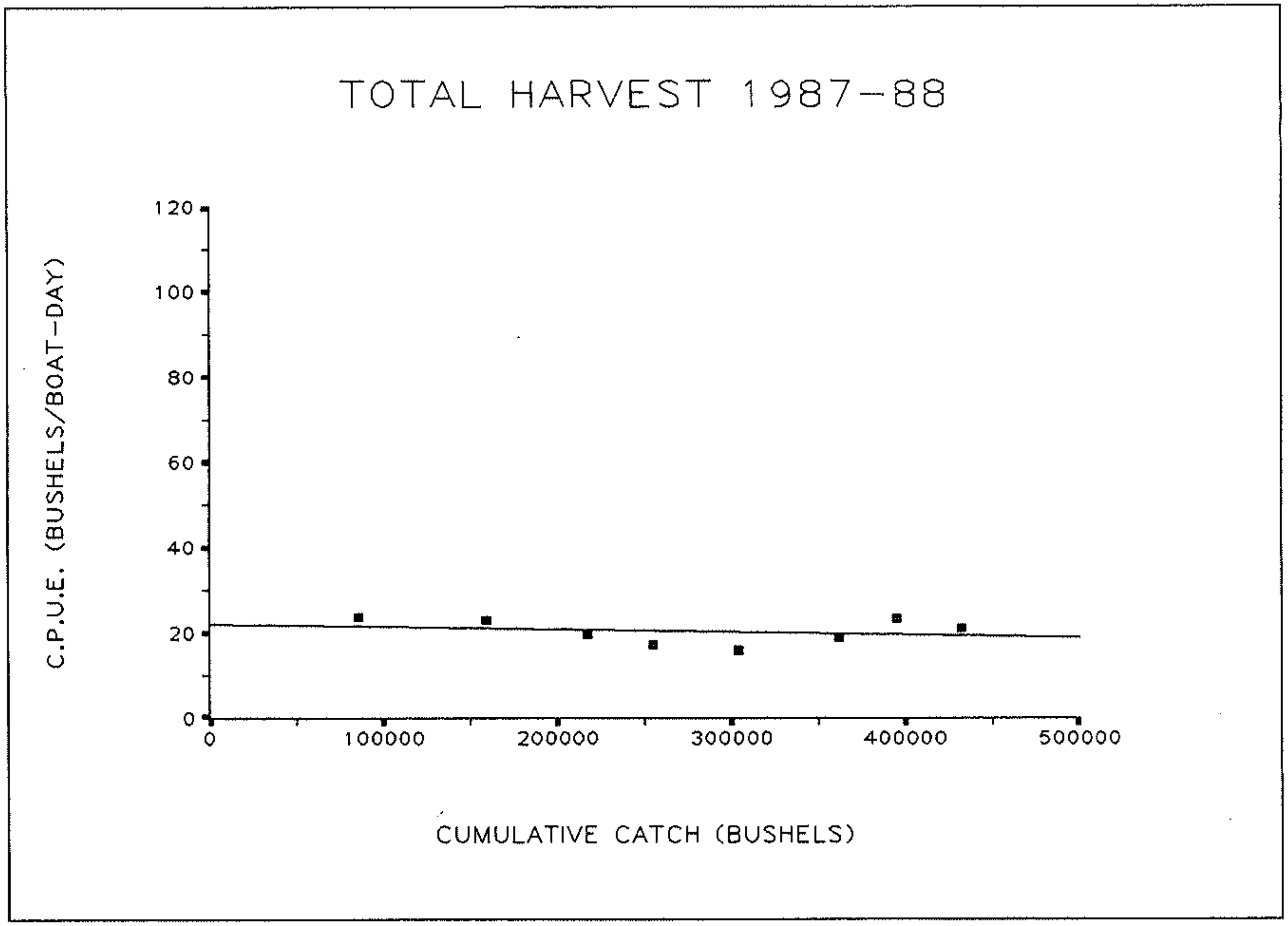

Figure 10. Regression of C.P.U.E. on total oyster cumulative catch for the 1987-88 harvest season. Points represent monthly totals of effort and catch.

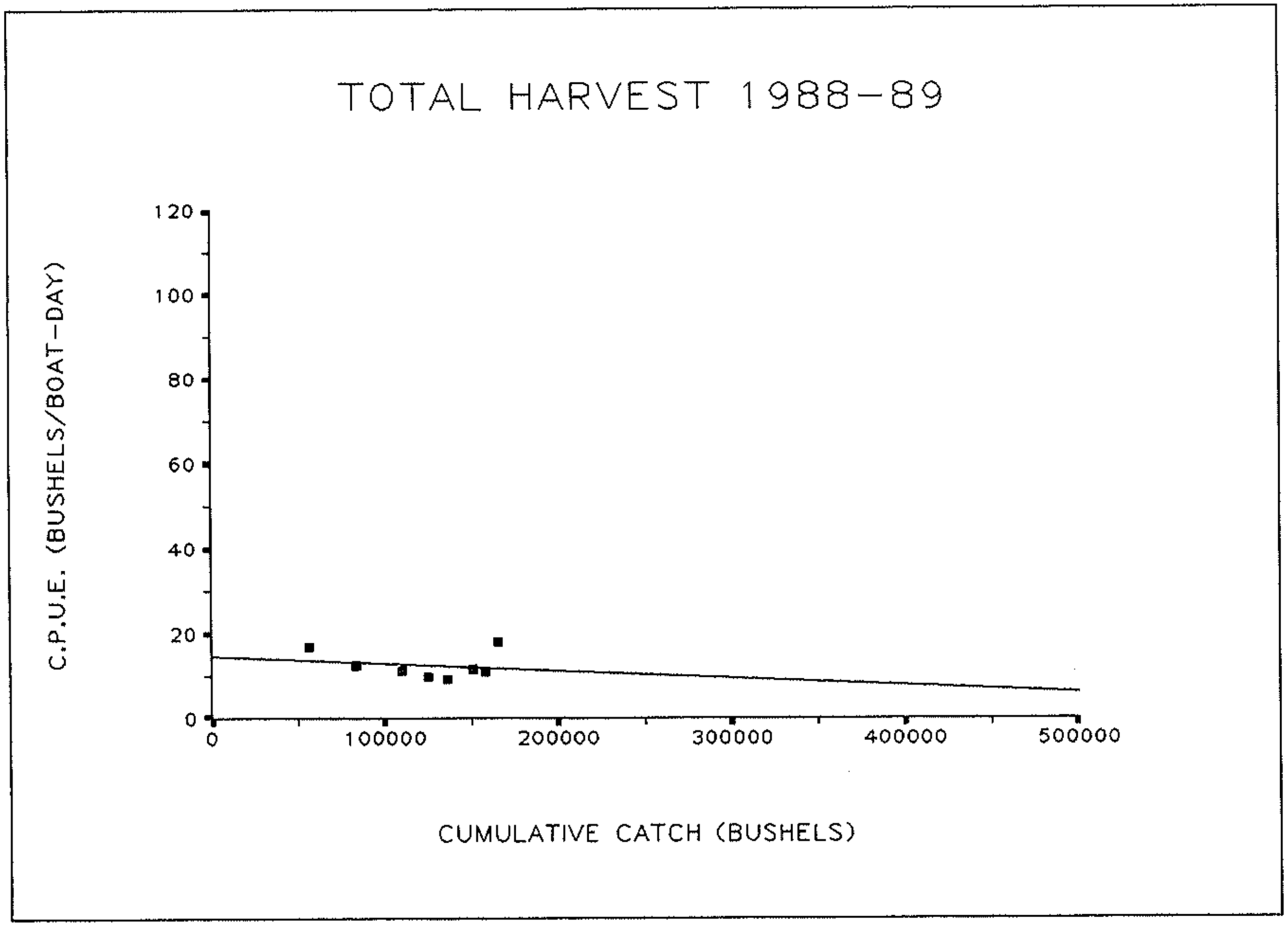

Figure 11. Regression of C.P.U.E. on total oyster cumulative catch for the 1988-89 harvest season. Points represent monthly totals of effort and catch.

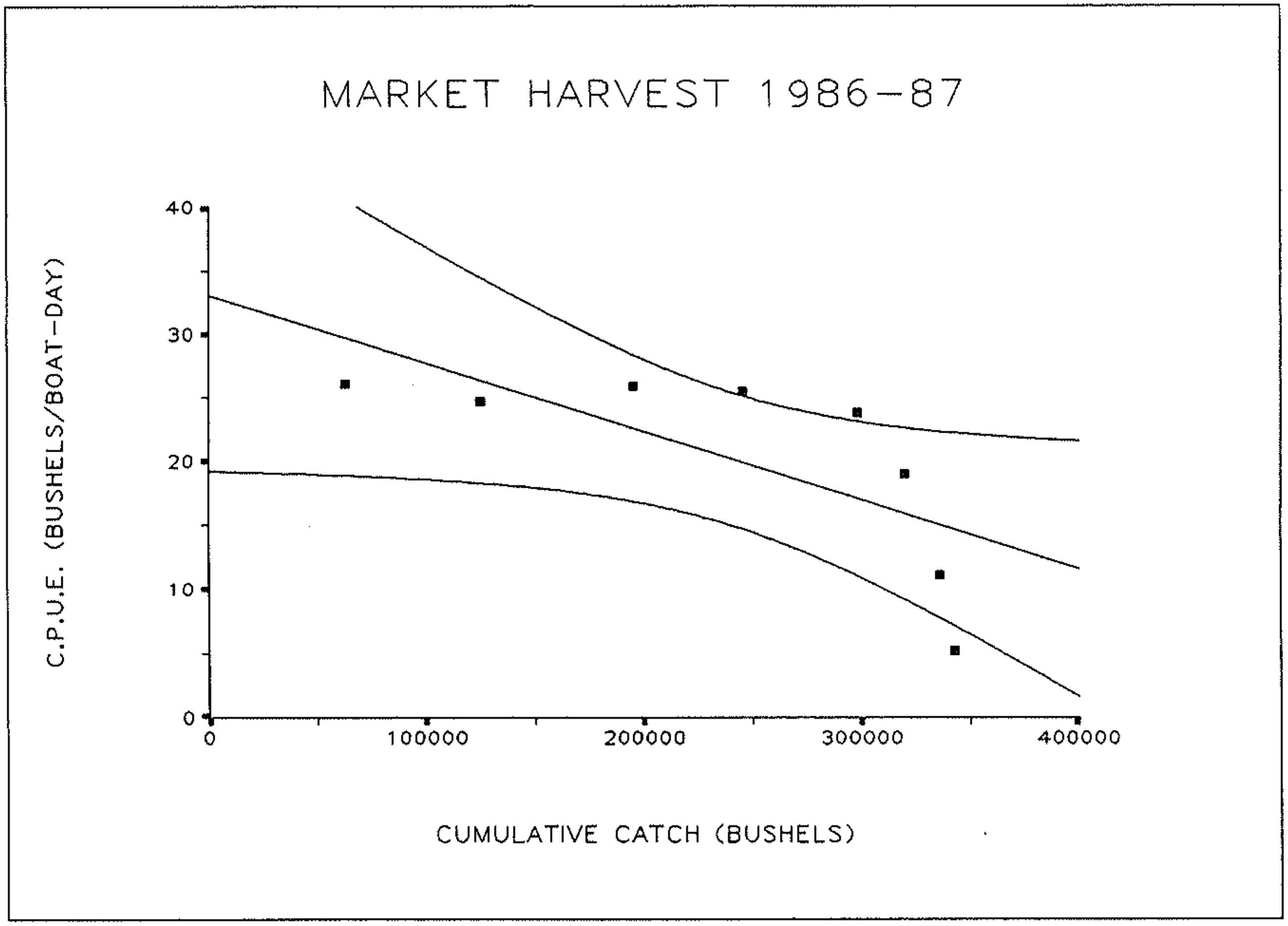

Figure 12. Regression (± 95% CI) of C.P.U.E. on market oyster cumulative catch for the 1986-87 harvest season. Points represent monthly totals of effort and catch.

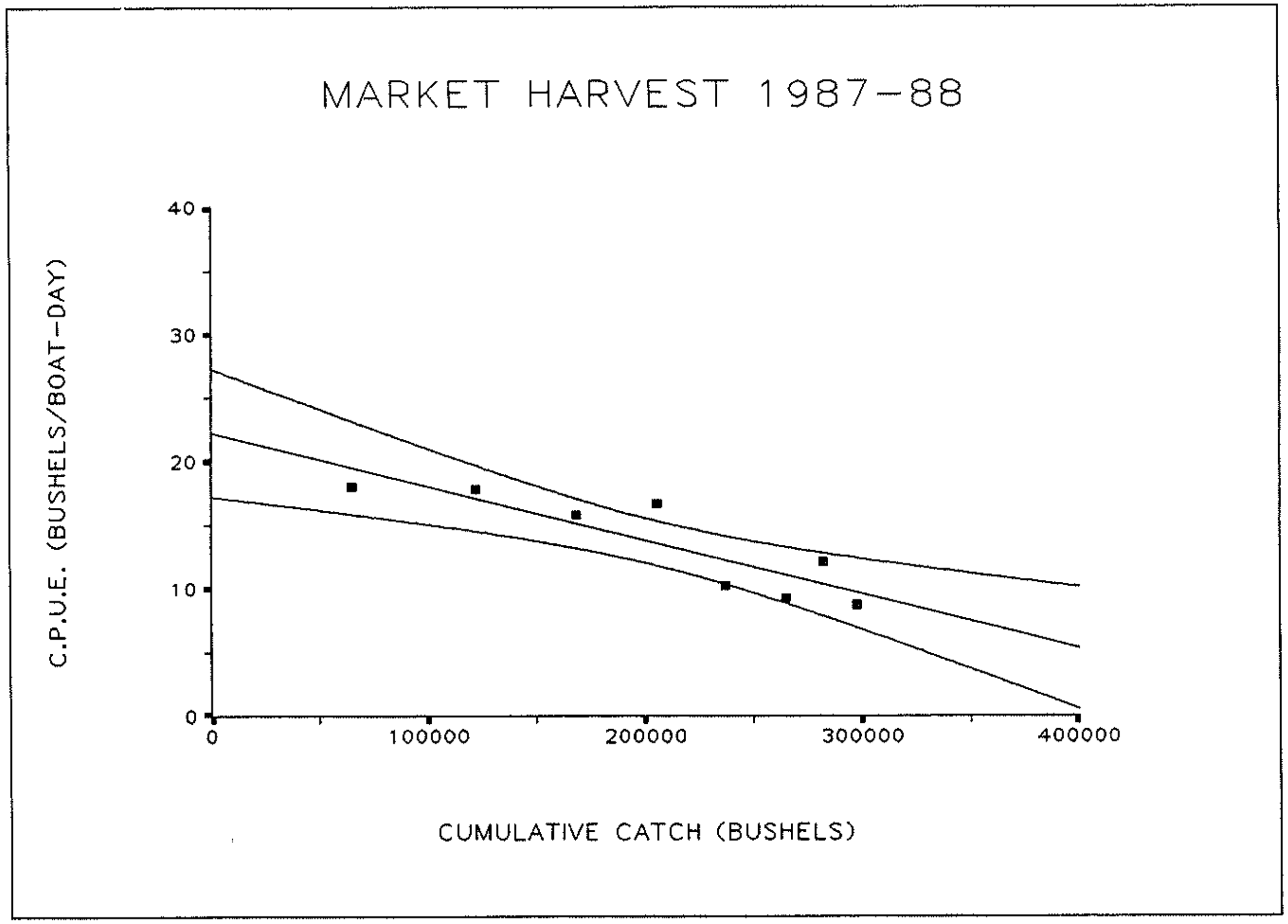

Figure 13. Regression (± 95% CI) of C.P.U.E. on market oyster cumulative catch for the 1987-88 harvest season. Points represent monthly totals of effort and catch.

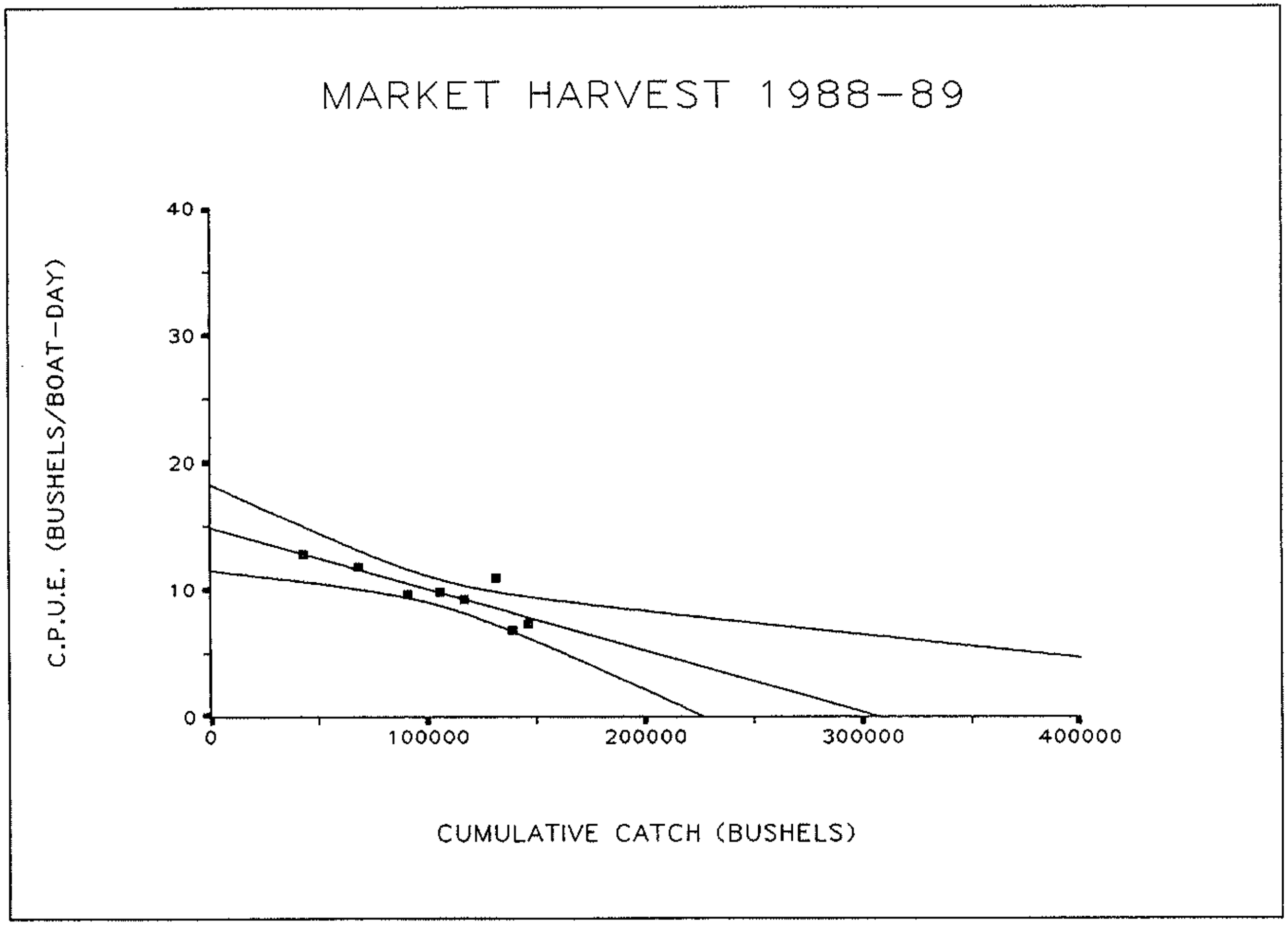

Figure 14. Regression (± 95% CI) of C.P.U.E. on market oyster cumulative catch for the 1988-89 harvest season. Points represent monthly totals of effort and catch.

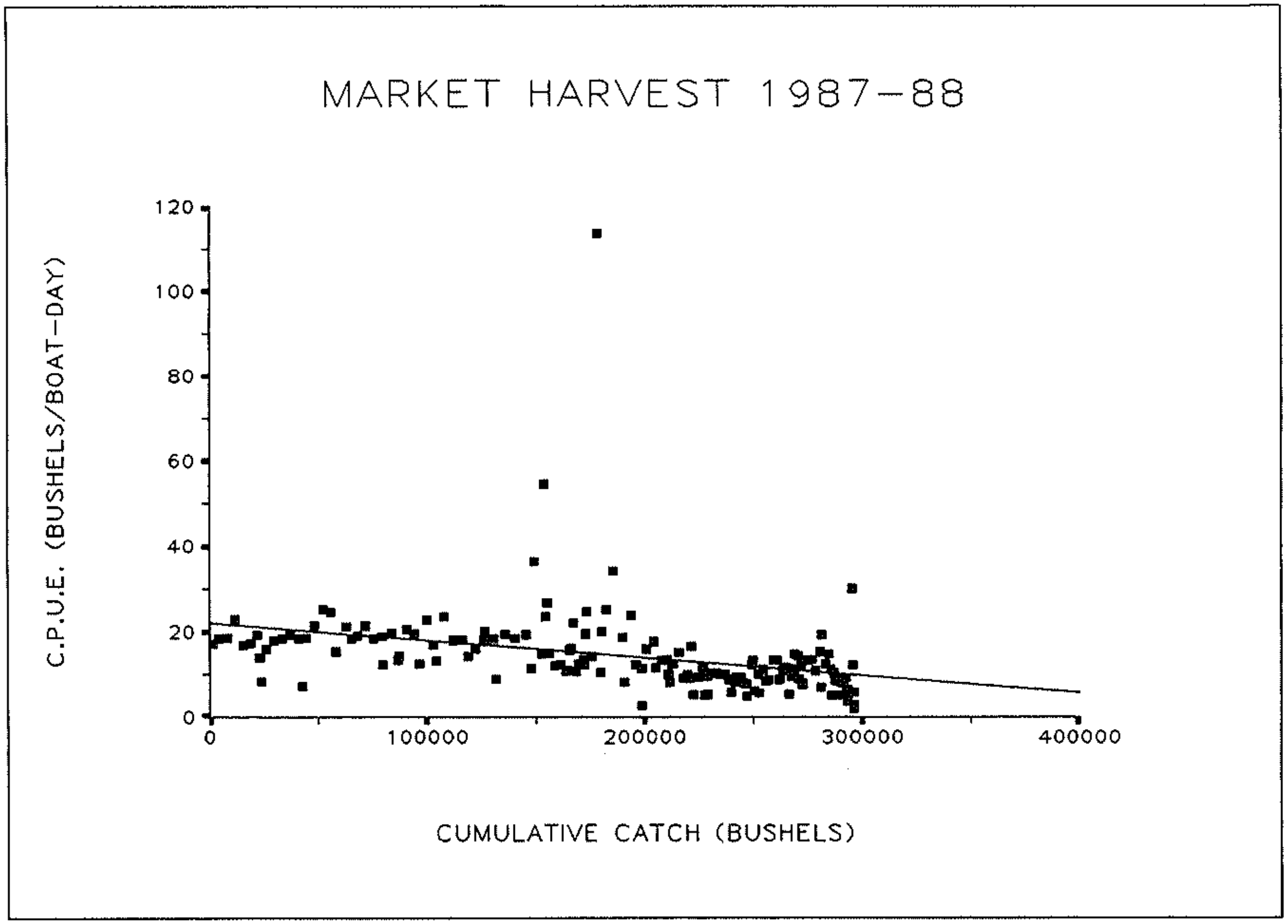

Figure 15. Regression of C.P.U.E. on market oyster cumulative catch for the 1987-88 harvest season. Points represent daily totals of effort and catch.

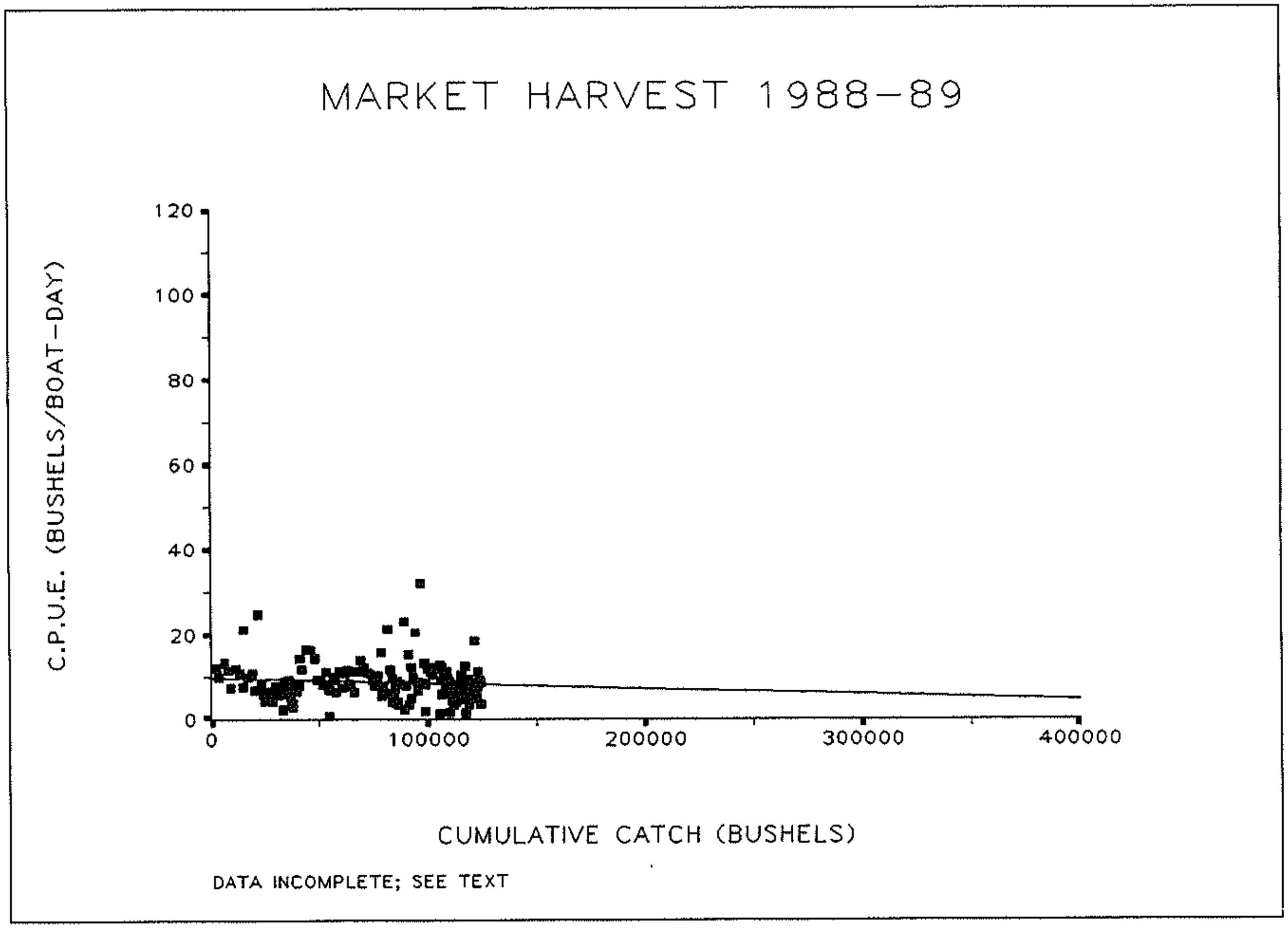

Figure 16. Regression of C.P.U.E. on market oyster cumulative catch for the 1988-89 harvest season. Points represent daily totals of effort and catch.

APPENDIX 1

Monthly totals of harvest (bushels, seed and market combined) and effort (boat days) and resultant catch per unit effort (CPUE) and cumulative catch for the 1979-80 through 1988-89 harvest seasons.

Year/Month	Total Harvest (Bushels)	Total Effort (Boat-Days)	CPUE	Cumulative Catch
79/10	88,822	864	102.8	88,822
79/11	56,048	559	100.3	144,870
79/12	33,977	358	94.9	178,847
80/01	22,656	291	77.9	201,503
80/02	9,056	60	150.9	210,559
80/03	20,383	256	79.6	230,942
80/04	53,744	760	70.7	284,686
80/05	72,175	993	72.7	356,861
80/06	53,410	770	69.4	410,271
80/10	45,239	582	77.7	45,239
80/11	40,615	521	78.0	85,854
80/12	33,970	417	81.5	119,824
81/01	9,353	143	65.4	129,177
81/02	16,878	288	58.6	146,055
81/03	35,866	513	69.9	181,921
81/04	48,554	973	49.9	230,475
81/05	58,527	1133	51.7	289,002
81/06	74,184	1053	70.4	363,186
81/10	86,111	996	86.5	86,111
81/11	48,314	747	64.7	134,425
81/12	29,289	469	62.4	163,714
82/01	8,280	194	42.7	171,994
82/02	16,349	530	30.8	188,343
82/03	78,416	762	102.9	266,759
82/04	69,712	1180	59.1	336,471
82/05	75,020	1179	63.6	411,491
82/06	18,759	295	63.6	430,250
82/10	85,698	1109	77.3	85,698
82/11	77,852	1188	65.5	163,550
82/12	60,424	847	71.3	223,974
83/01	31,854	605	52.6	255,828
83/02	25,984	504	51.6	281,812
83/03	48,518	625	77.6	330,330
83/04	52,113	769	67.8	382,443
83/05	58,092	834	69.6	440,535
83/06	24,492	262	93.5	465,027
83/10	75,960	1171	64.9	75,960
83/11	77,993	1207	64.6	153,953
83/12	36,837	625	58.9	190,790
84/01	25,054	648	38.7	215,844

Year/Month	Total Harvest (Bushels)	Total Effort (Boat-Days)	CPUE	Cumulative Catch
84/02	39,430	781	50.5	255,274
84/03	19,641	637	30.8	274,915
84/04	59,393	961	61.8	334,308
84/05	40,132	786	51.1	374,440
84/06	23,708	382	62.1	398,148
84/10	74,108	1229	60.3	74,108
84/11	62,074	925	67.1	136,182
84/12	42,521	974	43.6	178,703
85/01	27,532	279	98.7	206,235
85/02	30,569	477	64.1	236,804
85/03	52,478	800	65.6	289,282
85/04	74,047	975	75.9	363,329
85/05	57,206	1024	55.9	420,535
85/06	15,436	260	59.4	435,971
85/10	64,994	1017	63.9	64,994
85/11	49,631	731	67.9	114,625
85/12	32,908	668	49.3	147,533
86/01	37,159	618	60.1	184,692
86/02	21,667	527	41.1	206,359
86/03	40,525	615	65.9	246,884
86/04	30,891	730	42.3	277,775
86/05	30,719	599	51.3	308,494
86/10	101,811	2399	42.4	101,811
86/11	96,405	2518	38.3	198,216
86/12	84,965	2711	31.3	283,181
87/01	53,978	1966	27.5	337,159
87/02	56,198	2222	25.3	393,357
87/03	40,173	1158	34.7	433,530
87/04	56,955	1432	39.8	490,485
87/05	52,405	1298	40.4	542,890
87/10	85,867	3628	23.7	85,867
87/11	73,333	3201	22.9	159,200
87/12	57,977	2939	19.7	217,177
88/01	37,982	2216	17.1	255,159
88/02	49,018	3081	15.9	304,177
88/03	57,577	3042	18.9	361,754
88/04	33,184	1423	23.3	394,938
88/05	37,296	1775	21.0	432,234
88/10	56,798	3355	16.9	56,798
88/11	26,758	2139	12.5	83,556
88/12	26,480	2360	11.2	110,036
89/01	15,174	1554	9.8	125,210
89/02	10,987	1193	9.2	136,197
89/03	15,524	1340	11.6	150,771
89/04	11,968	1099	10.9	158,212
89/05	17,786	987	18.0	165,402

APPENDIX 2

Monthly totals of harvest (market oysters) and effort (boat-days) and resultant catch per unit effort (CPUE) and cumulative catch for the 1986-87 through 1988-89 harvest seasons.

Year/Month	Market Harvest (Bushels)	Total Effort (Boat-Days)	CPUE	Cumulative Catch
86/10	62,719	2399	26.1	62,719
86/11	62,212	2518	24.7	124,931
86/12	70,346	2711	25.9	195,277
87/01	50,139	1966	25.5	245,416
87/02	52,823	2222	23.8	298,239
87/03	21,958	1158	19.0	320,197
87/04	15,867	1432	11.1	336,064
87/05	6,764	1298	5.2	342,828
87/10	65,275	3628	18.0	65,275
87/11	57,052	3201	17.8	122,327
87/12	46,343	2939	15.8	168,670
88/01	36,965	2216	16.7	205,635
88/02	31,433	3081	10.2	237,068
88/03	28,029	3042	9.2	265,097
88/04	17,235	1423	12.1	282,332
88/05	15,449	1775	8.7	297,781
88/10	43,098	3355	12.8	43,098
88/11	25,220	2139	11.8	68,318
88/12	22,546	2360	9.6	90,864
89/01	15,174	1554	9.8	106,038
89/02	10,987	1193	9.2	117,025
89/03	14,574	1340	10.9	131,599
89/04	7,441	1099	6.8	139,040
89/05	7,190	987	7.3	146,230

APPENDIX 3

Daily totals of harvest (bushels market oysters) and effort (boat days) and resultant catch per unit effort (CPUE) and cumulative catch for the 1987-88 and 1988-89 harvest season. Only days for which effort exceeded 10 boats were considered. Harvest data for the 1988-89 season is incomplete.

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
87	10	1	1749	102	17.15	1749.00
87	10	2	2690	147	18.30	4439.00
87	10	5	3677	199	18.47	8115.50
87	10	6	3729	163	22.88	11844.50
87	10	7	3692	219	16.86	15536.75
87	10	8	3501	203	17.25	19037.75
87	10	9	2910	151	19.27	21947.75
87	10	12	1095	79	13.86	23042.75
87	10	13	899	109	8.25	23941.75
87	10	14	2197	138	15.92	26138.75
87	10	15	3461	193	17.93	29599.75
87	10	16	3655	199	18.37	33254.75
87	10	19	3924	204	19.23	37178.25
87	10	20	3817	209	18.26	40994.75
87	10	21	1635	225	7.26	42629.25
87	10	22	1776	96	18.49	44404.75
87	10	23	3964	185	21.43	48368.75
87	10	26	3990	158	25.25	52358.75
87	10	27	3522	143	24.63	55880.25
87	10	28	2339	153	15.28	58218.75
87	10	29	4664	220	21.20	62882.75
87	10	30	2446	133	18.39	65328.75
87	11	2	2889	151	19.13	68217.25
87	11	3	3379	158	21.38	71595.75
87	11	4	3934	214	18.38	75529.75
87	11	5	3733	198	18.85	79262.25
87	11	6	395	32	12.34	79657.25
87	11	9	4060	206	19.71	83717.25
87	11	10	2967	222	13.36	86684.25
87	11	12	532	37	14.36	87215.75
87	11	13	3511	171	20.53	90726.75
87	11	16	3521	181	19.45	94247.58
87	11	17	2240	180	12.44	96487.58
87	11	18	3563	157	22.69	100050.1
87	11	19	3043	180	16.91	103093.1
87	11	20	1445	110	13.13	104537.6
87	11	23	3498	149	23.47	108035.1
87	11	24	4228	235	17.99	112263.1
87	11	25	4134	229	18.05	116396.6
87	11	26	2577	181	14.23	118973.1
87	11	30	3247	203	16.00	122220.1
87	12	1	3773	209	18.05	125992.6
87	12	2	702	35	20.06	126694.6
87	12	3	3824	208	18.38	130518.1
87	12	4	1193	134	8.90	131710.6
87	12	7	4137	214	19.33	135847.6
87	12	8	4587	250	18.35	140434.1
87	12	9	4904	254	19.31	145338.1
87	12	10	2440	214	11.40	147777.6
87	12	11	1420	39	36.41	149197.6
87	12	14	3705	251	14.76	152902.1

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
87	12	15	983	18	54.56	153884.6
87	12	16	494	21	23.52	154378.6
87	12	17	725	27	26.85	155103.6
87	12	18	882	59	14.94	155985.1
87	12	21	2671	223	11.98	158655.6
87	12	22	2802	227	12.34	161457.6
87	12	23	2237	207	10.80	163694.1
87	12	24	580	53	10.93	164273.6
87	12	28	1184	75	15.79	165457.6
87	12	29	677	42	16.11	166134.1
87	12	30	1035	47	22.01	167168.7
87	12	31	1404	132	10.63	168572.2
88	1	1	981	79	12.41	169552.8
88	1	4	2237	167	13.39	171789.3
88	1	5	463	38	12.17	172251.8
88	1	6	525	27	19.44	172776.8
88	1	7	668	27	24.74	173444.8
88	1	11	2342	165	14.19	175786.3
88	1	12	2500	22	113.64	178286.3
88	1	13	1600	152	10.52	179885.8
88	1	14	420	21	19.98	180305.3
88	1	15	2143	85	25.21	182448.3
88	1	18	3285	96	34.21	185732.8
88	1	19	4382	235	18.65	190115.0
88	1	20	863	105	8.21	190977.5
88	1	21	2786	117	23.81	193763.0
88	1	22	2174	177	12.28	195937.0
88	1	25	2611	230	11.35	198547.5
88	1	26	139	53	2.62	198686.5
88	1	27	2019	127	15.89	200705.0
88	1	28	3461	196	17.66	204165.5
88	1	29	1059	92	11.51	205224.8
88	2	1	2490	187	13.31	207714.3
88	2	2	2527	187	13.51	210240.8
88	2	3	680	68	9.99	210920.3
88	2	4	570	70	8.14	211489.8
88	2	5	1042	84	12.40	212531.4
88	2	8	3161	210	15.05	215691.9
88	2	9	2182	238	9.17	217873.9
88	2	10	1700	172	9.88	219573.9
88	2	11	1199	133	9.01	220772.4
88	2	12	597	36	16.57	221368.9
88	2	15	948	182	5.21	222316.9
88	2	17	2094	224	9.35	224410.9
88	2	18	2300	199	11.56	226710.4
88	2	19	755	150	5.03	227464.9
88	2	22	1150	121	9.50	228614.4
88	2	23	273	52	5.24	228886.9
88	2	24	1927	190	10.14	230813.4
88	2	25	2118	206	10.28	232931.4
88	2	26	1708	170	10.05	234639.2

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
88	2	29	1992	199	10.01	236630.7
88	3	1	1926	219	8.79	238556.4
88	3	2	1109	192	5.78	239665.7
88	3	3	1345	167	8.05	241010.6
88	3	4	905	98	9.23	241915.3
88	3	7	1976	213	9.28	243891.3
88	3	8	1624	204	7.96	245515.3
88	3	9	1037	135	7.68	246552.0
88	3	10	509	103	4.94	247060.8
88	3	11	1866	152	12.27	248926.6
88	3	14	679	51	13.30	249605.1
88	3	17	477	78	6.12	250082.1
88	3	18	1984	197	10.07	252066.1
88	3	21	569	101	5.63	252634.6
88	3	22	1601	143	11.20	254235.6
88	3	23	1291	152	8.49	255526.1
88	3	24	1396	161	8.67	256921.8
88	3	25	2099	158	13.28	259020.8
88	3	28	1517	114	13.30	260537.3
88	3	29	1319	150	8.79	261855.8
88	3	30	1421	129	11.02	263276.8
88	3	31	1366	117	11.67	264642.3
88	4	1	1353	126	10.74	265995.3
88	4	4	197	37	5.32	266192.3
88	4	5	1118	118	9.47	267309.8
88	4	6	1185	106	11.18	268494.8
88	4	7	324	22	14.73	268818.8
88	4	11	1609	112	14.36	270427.3
88	4	14	352	39	9.01	270778.8
88	4	15	1056	85	12.42	271834.8
88	4	18	287	36	7.97	272121.6
88	4	19	289	38	7.61	272410.6
88	4	20	1441	108	13.34	273851.1
88	4	22	1421	107	13.28	275272.1
88	4	25	1614	120	13.45	276885.6
88	4	26	1455	134	10.86	278340.6
88	4	27	2265	148	15.30	280605.6
88	4	28	472	68	6.94	281077.6
88	4	29	367	19	19.30	281444.4
88	5	2	1639	132	12.42	283083.4
88	5	3	1519	103	14.75	284602.4
88	5	4	1026	91	11.27	285628.4
88	5	5	440	87	5.06	286068.4
88	5	6	846	81	10.44	286913.9
88	5	9	804	91	8.83	287717.4
88	5	10	800	95	8.42	288517.4
88	5	11	883	97	9.10	289399.9
88	5	12	491	95	5.17	289890.9
88	5	13	700	88	7.95	290590.9
88	5	16	734	87	8.44	291324.9
88	5	17	889	97	9.16	292213.4

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
88	5	18	391	66	5.92	292604.4
88	5	19	600	92	6.52	293204.4
88	5	20	235	62	3.78	293438.9
88	5	23	391	69	5.66	293829.4
88	5	24	446	79	5.64	294274.9
88	5	25	934	31	30.11	295208.4
88	5	26	406	33	12.30	295614.4
88	5	27	418	73	5.72	296031.9
88	5	30	117	61	1.91	296148.4
88	5	31	136	65	2.85	296333.9

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
88	10	3	2479	204	12.15	2479.00
88	10	4	1140	114	10.00	3618.50
88	10	5	2770	207	13.38	6388.50
88	10	6	1674	146	11.46	8062.00
88	10	7	1143	155	7.38	9205.25
88	10	10	2481	208	11.93	11686.42
88	10	11	1923	175	10.99	13609.00
88	10	12	1297	171	7.58	14906.00
88	10	13	488	23	21.22	15394.00
88	10	14	1787	181	9.87	17130.50
88	10	17	2137	196	10.90	19317.50
88	10	18	1139	168	6.78	20456.50
88	10	19	1462	59	24.77	21918.00
88	10	20	1475	181	8.15	23393.00
88	10	21	873	148	5.90	24265.75
88	10	24	743	171	4.34	25008.25
88	10	25	899	170	5.29	25906.75
88	10	26	969	189	5.12	26875.25
88	10	27	1149	175	6.56	28023.75
88	10	28	648	156	4.15	28671.25
88	10	31	1240	158	7.85	29911.25
88	11	2	976	172	5.67	30887.25
88	11	3	1298	184	7.05	32184.75
88	11	4	933	158	5.91	33117.75
88	11	7	153	66	2.31	33270.25
88	11	8	975	108	9.03	34245.25
88	11	9	840	136	6.17	35084.75
88	11	10	572	81	7.06	35656.25
88	11	11	571	61	9.36	36227.25
88	11	14	751	145	5.18	36978.25
88	11	15	508	130	3.91	37486.25
88	11	16	498	136	3.66	37984.25
88	11	17	47	17	2.76	38031.25
88	11	18	788	98	8.04	38819.25
88	11	21	529	71	7.44	39347.75
88	11	22	606	93	6.51	39953.25
88	11	23	935	120	7.79	40887.75
88	11	24	158	11	14.32	41045.25
88	11	25	1108	94	11.79	42153.25
88	11	29	1892	115	16.45	44045.25
88	11	30	2151	131	16.42	46195.75
88	12	1	2003	139	14.41	48198.25
88	12	2	932	100	9.32	49130.25
88	12	5	1428	154	9.27	50558.25
88	12	6	1262	155	8.14	51820.25
88	12	7	1413	126	11.21	53233.25
88	12	8	1109	158	7.02	54342.25
88	12	9	274	36	7.62	54616.58
88	12	12	13	18	.74	54629.83
88	12	13	307	45	6.82	54936.83
88	12	14	1328	133	9.98	56264.83

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
88	12	15	1012	110	9.20	57276.83
88	12	16	477	75	6.36	57753.50
88	12	19	1590	139	11.44	59343.50
88	12	20	1137	154	7.39	60480.91
88	12	21	1372	127	10.80	61852.41
88	12	22	1184	102	11.60	63036.07
88	12	23	937	111	8.44	63973.07
88	12	26	666	87	7.66	64639.07
88	12	27	1388	123	11.28	66027.07
88	12	28	337	53	6.36	66364.07
88	12	29	1251	111	11.27	67614.57
88	12	30	1449	104	13.93	69063.07
89	1	2	1466	120	12.21	70528.32
89	1	3	1732	156	11.10	72261.07
89	1	5	1086	102	10.64	73346.57
89	1	16	1406	153	9.19	74752.07
89	1	17	926	118	7.84	75677.57
89	1	18	1323	128	10.34	77000.82
89	1	19	1392	88	15.81	78392.32
89	1	20	303	55	5.50	78694.82
89	1	23	575	74	7.77	79269.82
89	1	24	2242	105	21.35	81511.32
89	1	25	762	125	6.09	82272.82
89	1	26	352	30	11.73	82624.82
89	1	27	745	75	9.94	83370.02
89	1	30	370	92	4.02	83739.52
89	1	31	615	126	4.88	84354.52
89	2	1	523	73	7.17	84877.77
89	2	2	912	101	9.03	85789.77
89	2	3	296	74	4.00	86085.77
89	2	6	207	61	3.39	86292.27
89	2	8	594	71	8.37	86886.27
89	2	13	2259	98	23.05	89145.52
89	2	14	190	82	2.31	89335.02
89	2	15	562	71	7.91	89896.52
89	2	16	1056	69	15.30	90952.27
89	2	17	257	75	3.42	91208.77
89	2	20	1038	84	12.36	92246.77
89	2	21	202	42	4.80	92448.27
89	2	22	702	70	10.03	93150.52
89	2	23	1127	55	20.50	94277.77
89	2	27	855	97	8.81	95132.77
89	2	28	209	31	6.73	95341.27
89	3	1	1373	43	31.93	96714.27
89	3	2	861	100	8.61	97575.02
89	3	3	887	67	13.24	98462.02
89	3	6	218	27	8.07	98680.02
89	3	10	105	58	1.81	98784.77
89	3	13	1311	111	11.81	100095.3
89	3	14	1226	110	11.15	101321.3
89	3	15	795	77	10.32	102115.8

YEAR	MONTH	DAY	BUSHELS	BOATS	CPUE	CUMCAT
89	3	16	1001	82	12.20	103116.5
89	3	17	1435	121	11.86	104551.0
89	3	20	1114	87	12.80	105665.0
89	3	21	18	14	1.29	105683.0
89	3	22	331	36	9.19	106013.8
89	3	23	415	34	12.19	106428.3
89	3	24	163	28	5.83	106591.5
89	3	27	1087	98	11.09	107678.0
89	3	28	642	80	8.02	108319.5
89	3	29	566	50	11.31	108885.0
89	3	30	526	57	9.23	109411.3
89	3	31	530	60	8.84	109941.5
89	4	3	417	64	6.51	110358.0
89	4	4	47	29	1.62	110405.0
89	4	5	532	65	8.18	110937.0
89	4	6	188	23	8.15	111124.5
89	4	7	271	63	4.31	111395.8
89	4	10	548	67	8.18	111943.5
89	4	11	86	26	3.31	112029.5
89	4	12	389	77	5.05	112418.0
89	4	13	449	74	6.07	112867.0
89	4	14	279	69	4.04	113146.0
89	4	17	522	64	8.15	113667.5
89	4	18	427	70	6.10	114094.5
89	4	19	382	58	6.59	114476.5
89	4	20	429	57	7.53	114905.8
89	4	21	502	48	10.46	115408.0
89	4	24	336	72	4.67	115744.0
89	4	25	495	56	8.84	116239.0
89	4	26	309	54	5.71	116547.5
89	4	27	663	53	12.51	117210.5
89	5	1	384	50	7.68	117594.3
89	5	2	34	22	1.55	117628.3
89	5	3	459	63	7.28	118087.0
89	5	4	673	71	9.48	118760.0
89	5	5	156	47	3.31	118915.5
89	5	8	406	47	8.64	119321.5
89	5	9	418	64	6.53	119739.5
89	5	10	100	19	5.24	119839.0
89	5	11	624	75	8.31	120462.5
89	5	12	427	68	6.28	120889.3
89	5	15	650	35	18.56	121538.8
89	5	17	87	17	5.09	121625.3
89	5	18	316	45	7.01	121940.8
89	5	19	274	36	7.60	122214.3
89	5	22	263	45	5.84	122477.3
89	5	23	250	52	4.81	122727.5
89	5	24	338	30	11.27	123065.5
89	5	25	386	49	7.87	123451.0
89	5	26	324	37	8.76	123775.3
89	5	29	342	37	9.25	124117.5