Investigation on the Bay Scallop, *Argopecten irradians*, in Three Eastern Connecticut Estuaries. June 1980 - May 1981.

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CONTENTS

INTRODUCTION

Over the past twenty years, the Bay Scallop, Argopecten irradians, has decreased markedly in abundance throughout its southern New England range. The large fluctuations in scallop abundance have been attributed to several factors: disappearance of Zostera stands due to wasting disease, water quality deterioration, overexploitation and predation. Little direct scientific documentation is available to explain causative effects of population cycles. Also a literature review reveals few investigations that deal specifically with field studies of scallop population dynamics.

Since 1976, the National Marine Fisheries Service - Milford Laboratory, the University of Connecticut - Marine Advisory Service, and the Connecticut Department of Agriculture - Aquaculture Division have mutally conducted scallop seed stocking projects in the town waters of Stonington, Groton, Madison, and Clinton. Several attempts to study scallop seed dispersion, growth and survival, natural population abundance and in-situ containment rearing systems have been undertaken on an informal and cooperative basis with respective town officials and shellfish commission members.

Recently (1976 - present) scallop populations have reappeared in Stonington, Mystic, Poquonnock, and Niantic embayments in significant concentrations. An unusual occurrence of scallop mass mortality was reported in the Poquonock estuary in the winter of 1977. In other productive estuaries, local knowledge of overwintering concentrations with consequent fishing pressure, coupled with an increasing demand for the species as a recreational resource have prompted several coastal towns to seek advice on management alternatives and maricultural techniques to optimize scallop production.

The purpose of this research proposal was to implement an experimental field program, utilizing the facilities and personnel available from the two concerned agencies, that would address natural scallop population dynamics and relate to the techniques and effectiveness of hatchery seed stocking and grow-out to enhance scallop production.

Several project objectives defined in the proposal are listed as follows:

1. Investigate scallop habitat, behavior and population structure in selected eastern Long Island Sound estuaries throughout all seasons of the year.
    a. Habitat - To conduct more detailed ecological description of preferred scallop habitat. (i.e. chart Zostera densities, and macro-habitats (i.e. resident sediment depression zones, cluster association, winter Zostera mulch effect, spring epiphyte bloom). To assemble underwater photographic mosaics for typical habitat regions.
    b. Population structure: To compare data obtained in eastern Long Island Sound estuaries: scallop size and year class ratios, geographic population distribution patterns during the four seasons (spring, summer, fall, winter). To conduct sequential surveys to map changing seasonal densities, obvious during past observations 1977-79. Particular attention will be addressed to describing consistent "patch phenomena" indicating aggregate spatfall and adult overwintering concentrations.
    c. Behavior - To coordinate an in-situ study of natural scallop behavior.
        - Monitor individual scallop growth, movement, and direction employing newly developed tagging techniques. Correlate

behavior with observations of mass concentration and density. Document predator/prey interactions by use of underwater still and cinema photographic equipment.

2. Evaluate procedures and effectiveness of scallop spat collection on suspended artifical substrate.

   a. Placement of appropriate spat collectors (manila tufts, shell bags, polyethylene strips) at selected locations to determine time, area, and densities of natural spat settlement. Examine potential of this seed collection method as an alternative to hatchery seed production, and as a means to optimize estuarine scallop production.

   b. Focus on in-situ description of spat and juvenile (1 year) habitat selection (i.e. sediment surface survival, vertical distribution in Zostera stands, epiphytic fouling, predator identification).

3. Dependent on production levels and operational strategies of the National Marine Fisheries Service, Milford Laboratory, to conduct mass release of hatchery produced seed scallops from various brood lots.

   a. To monitor scallop seed dispersion, growth and survival via scheduled mass tag and recapture experiments, direct survey team reconnaissance and contained subsamples at different sites within an estuary.

   b. To evaluate seed scallop transplant effectiveness and develop approproate placement techniques suited to the particular marine environment.

   c. To attempt stock introduction in an estuary known to be presently devoid of scallop but historically productive.

4. In cooperation with the aquaculture field program of the N.M.F.S. Milford Laboratory, to investigate practical in-situ methods for caged seed scallop grow-out.
    a. To assist with modular cage and empoundment engineering aspects using a variety of aquacultural materials and techniques.
    b. Based on natural population survey, to recommend site suitability for cage grow-out, or broadcast scallop release, or spawn stock placement.
5. Regional scallop fisheries information.
    a. To compile and correlate historical and local fishing knowledge of scallop abundance and movement within certain embayments under investigation.
    b. To enlist prominent scallop fishermen and town shellfish commissions in population survey, tag recapture, and grow-out experiments where feasible.

METHODS

Scallop habitat population structure, and ecology

Field survey of natural bay scallop populations in the Poquonock, Niantic and Little Narragansett bays proceeded from May 1980 to June 1981. In each eastern Connecticut embayment general reconnaissance of scallop distribution was conducted by diver sampling and stations were selected for repetitive measurement. Scallop populations at each station were described according to: random densities (quarter meter square quadrants), distribution in relation to benthic topography/Zostera growth, shell size (length, width, depth) of respective populations, and percentage of first and second year individuals observed. Detailed ecological notes at survey stations included:

identification and intensity of principal predators; indexed underwater photography series, dorsal valve fouling characteristics, and basic hydrographic parameters ($T^{o}C$, salinity, current, and D.O. as available). The areas of investigation and location of sampling/observation stations are presented in Figures 1-3.

Extensive use of underwater observation, sampling, and photography was incorporated throughout phases of the project. Sequential underwater filming and periodic inspection of estuarine transect stations and preferred habitats was conducted in all seasons of the year. Systematic spotter scope survey was used as an effective method and alternative to dive investigation at study sites where shallow depth ($<$3m) permitted.

The cooperative dive procedures undertaken by NMFS Milford and University of Connecticut in the past were expanded toward more thorough scallop survey. It is assumed that useful underwater research techniques (i.e. photography, empoundment enclosures, in-situ measurement) were developed throughout the investigation.

Tagging Experiments

Tagging experiments were initiated on both juvenile seed and adult scallops. The juvenile seed stock received from the NMFS Milford laboratory ($\sim$40,000) were transplanted to Poquonock and Little Narragansett bays. Two release areas were chosen in each bay and a volumetric estimate of 10,000 placed at each location. 1500 juvenile scallops were tagged within each 10,000 batch release (a total of 6,000 for all four sites) with poly poxy underwater compound applied to the dorsal valve. Two different colors were used to differentiate the different release groups within each bay. Inspection of release sites on a periodic basis after tagging yielded preliminary information on; distance and direction of dispersion, diver recapture efficiency, and growth rate of hatchery stock in unconfined natural environments.

Wild adult (1 year class) and juvenile (0 year class) scallops were diver collected and tagged with individual coded markers. Each scallop was measured, identified numerically with label tape adhered to the dorsal valve, and released within a specific area. Recaptures, although limited, have given: individual movements, and growth rates. Notification of the local shellfish wardens and permit-issue officers was accomplished to encourage the return of tagged individuals as they were recaptured during the 1980-81 scallop season.

Artifical spat collectors, Zostera and dorsal valve fouling.

During July 1980 artifical spat collectors were designed and placed at stations 1, 3 and 4 within Poquonock bay. The units consisted of three substrates (manila, scallop shell, and polyethylene tape) suspending from a P.V.C. "T" assembly positioned .5 m above the bay sediment. In addition, frequent samples of Zostera were collected and scanned for evidence of natural scallop spat fall. Results of these efforts and observations on associate epifaunal fouling were summarized in the September 1980 progress report. Further, to more accurately define the microhabitat of the adult scallop, a dorsal valve fouling analysis was undertaken. The periodic record throughout the seasonal cycle identified organisms and time of maximum vulnerability to adhering predators, thus suggesting symbiotic vs detrimental relationships.

Mariculture cage enclosures

University of Connecticut divers and vessels assisted the N.M.F.S. Milford laboratory in site selection, stocking and placement of juvenile hatchery scallop cages in Stonington, Poquonock and Niantic bays. The cage locations are indicated in Figures 1-3. Field efforts were directed at comparison of natural stock/NMFS broadcast seed/caged seed growth rate and survival in the three respective bays. Additional contact with the town of Stamford, served to facilitate mariculture experiments and provide basic explanation of the cooperative NMFS/Univ. of Conn. project objective.

Efforts during the fall period were directed toward: a) quantification of adult bay scallop populations (computer analysis of length, width, depth, first annulus measurements from the three bays) b) more intensive tag/release experiments in Poquonock Bay (number tags attached to a sub-sample of natural/ hatchery 1st year and adult scallops at terminal growth), c) behavioral studies on predator interactions and scallop activities utilizing time-lapse underwater photography d) continuation of ecological observations via surface spotter and SCUBA.

Figure 1
Poquonock River estuary

Figure 2
Niantic Bay estuary

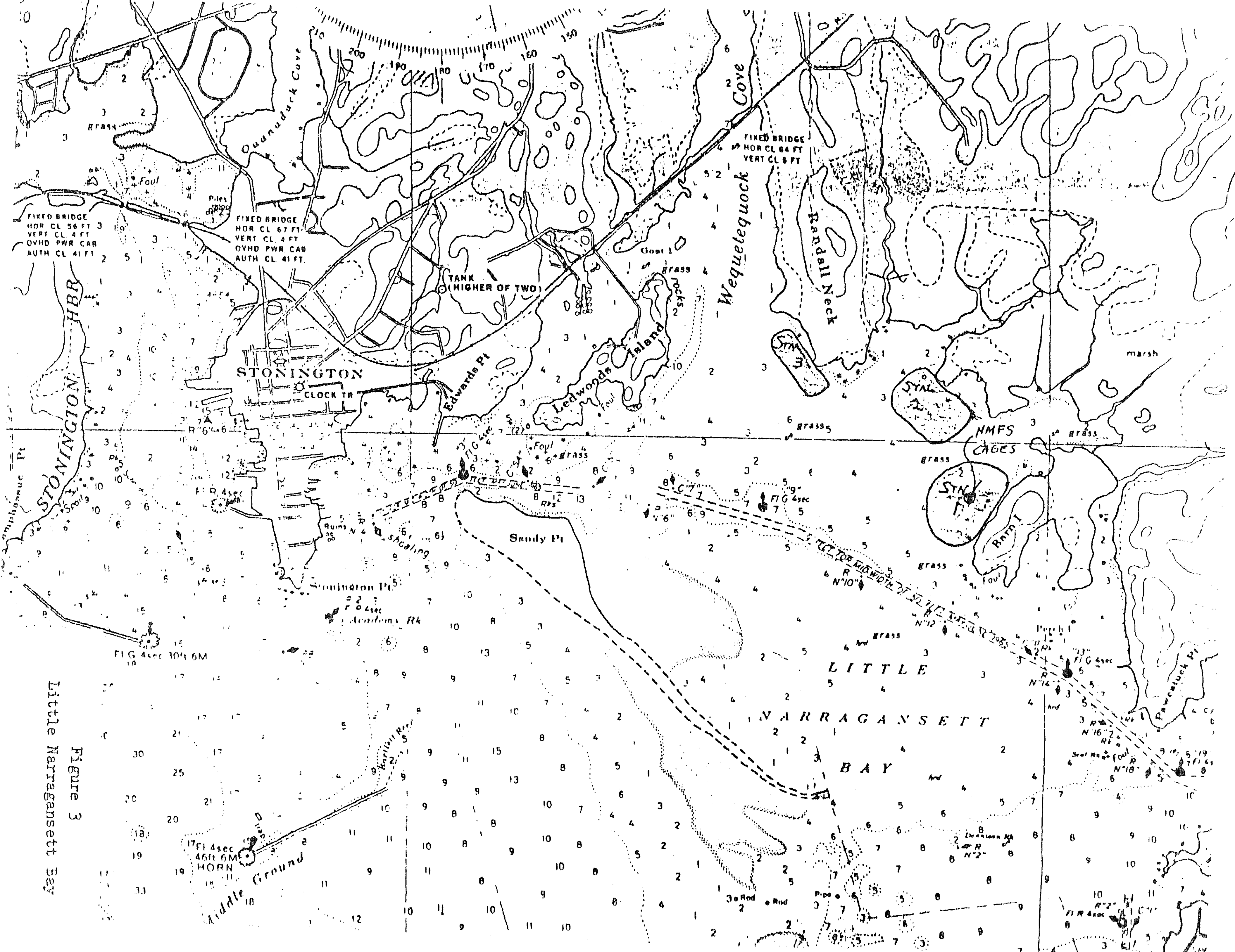


Figure 3
Little Narragansett Bay

RESULTS AND DISCUSSIONS

Natural Population Statistics - 1979 1-Year Class

Valve measurements were analyzed from natural population first year class (1979) animals taken at Poquonock River Station 1/2 A and 3 and Niantic River Station 2. Other stations were occupied and surveyed in both river systems but only these revealed a consistent supply of animals for long-term monitoring and valid statistical analysis.

Shell length was taken as a standard comparative measure, and subjected to computer analysis. Tables I,III,V list sample site, date, shell length means, standard deviation, standard error and 95% confidence interval for each sample. Figures 4-6 show graphically, growth curves for each station. Bars on points on the graph are one standard error.

Tables II,IV,VI give mean growth rates (mm/day) for the 1980 inclusive dates in the Poquonock River (Station 1/2 A, 3) and Niantic Bay (Station 2). All curves show a slight growth increase in spring as temperature and primary production increases. As spawning commences (July-August) there is a decrease in growth rate as energy is devoted to gonad production. After spawning, a dramatic increase in growth continues (mid-August to late October) when an assymtote is reached. Of particular concern would be comparison of the natural unconfined population growth data, with hatchery produced scallop seed grown-out in benthic cages at identical stations.

The mean length of populations in the Niantic River are significantly larger than in the Poquonock River. In September overlap of 95% confidence intervals occurs, and may be due to likening environmental factors in both river systems, low resolution in the sampling scheme, or mean length depression due to selective fishing after the season opening. The change in growth curve slope evident at the primary sampling station (Poquonock River Station 1/2 A) clearly shows "fishing effect" reduction in the mean shell length during late October - mid November 1980.

Natural Population Statistics - 1980 0-Year Class

In Tables VII, IX, XI the mean of total shell length between the three study areas (Poquonock, Niantic, Little Narragansett) from 17 and 19 November 1980 show Niantic River with highest mean length (48.14 mm) followed by Poquonock River (45.24) mm) and Little Narragansett Bay (37.67 mm). There is a significant difference (95% confidence interval) between Niantic and Little Narragansett Bay system but not between Niantic and Poquonock Rivers. Scallop set throughout the Poquonock estuary was extremely light in 1980, and the 0-year class samples were difficult to locate. This is reflected in the data comparison between Poquonock River and Little Narragansett Bay. A low Poquonock sample size of 17 November 1980 (N = 5) resulted in high standard error. Growth rates of animals in Niantic and Stonington are similar over the same time period.

In the Poquonock area a decrease in average size between January and April samples may be due to valve margin erosion, variance due to low sample size in January (N = 54), or mortality of larger individuals. Increase in growth in spring with low slope is apparent. Similarily for the Niantic, growth in spring is evident by a short period with steep slope then plateau due to assumedenergy input toward gonadal development.

A growth comparison between "0 Year" 1981 and "1 Year" 1980 class population may be made for the Poquonock and Niantic Bay stations. 0 year class mean shell length on 14 May 1981 ($\overline{X}$ = 47.76 mm) (Table VII) falls within the statistical range of the 1 year class mean on 15 May 1980 ($\overline{X}$ = 46.79 mm) Table III at respective and adjacent Poquonock River Stations 4 and 3. Niantic River - Station 2 comparison provides backcalculation of "typical" two year growth curve from "0 year" 4 June 1981 mean ($\overline{X}$ = 46.90 mm) to "1 year" 18 June 1980 mean ($\overline{X}$ = 53.16 mm). (Tables IX and V). The sample time difference accounts for later date higher mean.

An absence of 1979 "1 year" class scallops in Little Narragansett Bay prevented comparison of 0 to 1 year class growth curves within this estuary. Two low abundance conditions, low "0 year" class 1980 set in the Poquonock River and absence of "1 year" class 1979 adult scallops in Narragansett Bay, preclude meaningful comparison of year class ratios and growth rates between the three bay systems. Niantic Bay showed greatest consistency of recruitment and adult scallop population for the June 1980 - June 1981 observation period (Tables V, and IX).

Morphological Comparisons

To assess the degree of variability associated with the different value measurements (shell length, width, depth), morphological comparisons were determined by regression analysis of scallop populations collected from the Poquonock River and Niantic Bay. Respective samples of 323 and 301 individuals resulted in all three valve measurements (length, depth, width) for scallops ranging from 40 mm to 80 mm in the Poquonock and from 10 mm to 80 mm shell length in the Niantic. Computer summations for each shell dimension regression analysis (i.e. N, mean, variance, std. dev., coef. var., correlation) follow the appropriate Figures 10 - 15.

The least variable relationship was shell length vs shell width, with standard error of estimates of 1.4 for both the Poquonock and Niantic. A distinct separation between 0 and 1 year class may be seen in Figures 10-15. with the variation remaining relatively constant throughout the measurement range. Statistical summation sheets follow each figure.

Shell depth relationships to shell length and width result in standard error of estimates all with a 3.1 - 3.4 range for both areas. Another apparent trend from distribution patterns (Fig. 11-14) shows greater variability of scallop depth values within the 60-75 mm shell length size range.

First Annulus

In order to determine whether observed individual difference in scallop shell morphology (i.e. large 1st annulus - large terminal shell length or small 1st annulus - small terminal shell length) existed in a population, and whether cluster association could be related to environmental or genetic influence, a computer analysis and regression curve plot was conducted on populations sampled from discrete stations.

Poquonock River

Lengths to first annulus and total shell length were taken from 748 (1 year class 1979) individuals at stations 1 and 2A from 8 October 1980 to 17 November 1980 (Table XIII). First annulus dimensions from 1980 adult individuals would reflect population growth during 1979 and offer comparative "0 year" population valves for the Poquonock 1979-1980. Station 1 and 2A data was pooled because of proximity of stations (<100 m separation) at the seaward bay region and similar bathymetric and substrate conditions. No significant differences in population size parameters or subsequent lack of individuals occurred at station 1 and 2A after the harvest season opened.

Length frequency histograms, both first annulus length and total shell length for the pooled data and in each individual sample were normally distributed (Figs.16,17).The pooled total shell length distribution illustrates a depressed peak due to continued growth over the 6.5 week sampling period.

First annulus vs. total shell length reveals considerable variation within the population sample. There is not a direct relation between first and second year growth pattern. A first order linear regression of pooled data yields a correlation coefficient of .395 (significant at 697 DF). No clustering of small first annulus/large shell length or large first annulus small second year shell length was apparent in the first order regression analysis, Figure 18.

A limited data set of first annulus dimensions from station 3 (mid-bay region N = 115) indicated smaller sub-population valves resulted during the 1979 "0 year" period. Significant difference was not determined due to the further unavailability of scallop individuals at station 3.

Differences in first and second year growth (in individual 0 and 1 year class animals) may, therefore, not be distinguished by discrete point variability sample of a population. Environmental/genetic variation resulting in different shell morphology was not shown to be a sub-population or point-location characteristic.

Niantic River

Length to first annulus and total shell length was taken from 327 individuals on 14 October 1980 and 12 November 1980 at stations 2 off CampO'Neill Figs.19,20. Data was also pooled for this period. Length frequency distributions at both first annulus length and total shell show normal unimodel distribution. First annulus length vs. total shell length also show considerable scatter. First order linear regression has a correlation coefficient of .395

(significant at 697 DF). Differences of first and second year growth in individuals is again possibly due to the environmental variability within the estuary and show no signs of cluster assocation on the plot (Fig. 21).

Poquonock River vs. Niantic River

Slopes of the regression lines from both stations are the same, yet the intercept of the Niantic is higher than the Poquonock scallop population. The mean of first annulus length of Poquonock data is 42.30 mm while from Niantic data is 46.37 mm (significant difference 95% confidence). From analysis of Niantic first annulus data first year growth (1979) is greater than in Poquonock during the same time period.

Scallop Density

Mean densities from May - November 1980 Poquonock River (Table XIV) showed a gradual decline, throughout the summer (6-4-3-2) and before selective fishing would have a direct effect. The high maximum density valves (~15 per quarter meter square) illustrate considerable "aggregation or patch distribution" condition observed for bay scallop spacing. Absence of "0 year class" 1980 scallop set is reflected in the zero winter reconnaissance valves at the most seaward station 1/2A.

Density valves at mid-bay staton 3 (Table XIV) displayed more variable results throughout the sampling sequence. Mean densitites, (~ 3-4 per quarter meter square, with maximum of 11-13/.25 m^2), indicate similar population concentration at stations 1/2A and 3 with considerable sample difference. Station 4, a productive seed and adult bed the previous year, showed low stock abundance and a light set of 1980 seed obvious during winter-spring 1981.

Observations at all field stations indicated significant differences in densities due to grass habitat variations. Open rifts in *Zostera* beds (not channel margin) had the highest densities while intra-*Zostera* bed and channel margin areas had similar low densities. Conditions conducive to increased densities indicate relatively higher current flow. For example, field survey in the Poquonock River, Station 1, 14 July 1980 yielded the following mean densities per (10) .25 m^2 quadrant sample. Channel/*Zostera* margin - 1.1 scallops/.25 m^2, *Zostera* bed - 1.4 scallops/ .25 m^2, *Zostera* rift - 5.7 scallops/.25 m^2.

Comparison of densities obtained for Stations 1/2A, 3, 4 in the Poquonock, for Stations 1,2,3 in the Niantic, and Station 1 in Little Narragansett Bay demonstrates a wide range of variability (Tables XIV,IV). The "patch" phenonema contributed to the survey variance and continued to be a consistent feature of scallop distribution throughout all seasons.

Hatchery Seed Release

Point release experiments of large seed scallop volume (10,000 est.) were conducted to assess the mobility, predator attraction and survival of hatchery reared stock. After placement, a center stake and calibrated line was used for diver orientation to count seed scallop numbers within each 30° compass sector. Hatchery seed scallops were enumerated and maximum dispersion distance was recorded for each sector around the release point.

Point release at Poquonock River (Stn. 3) on 12 August resulted in initial low seed scallop mortality. Dispersion from the release point was charted (29 August) and the majority of scallops were resighted within 4.5 m of the placement site. No evidence of natural seed set, similar to hatchery seed size, was observed to confuse limits of movement. Figure 22 illustrates the release dispersion pattern in survey on 29 August. Table 16 lists quarter meter quadrant counts for observation on 29 August and 6 October.

Another point release of seed stock (10,000 est.) at Poquonock River (Stn. 1) on 12 August 1980 resulted in extreme mortality due to the green crab, Carcinus maenus. Immediately after placement five predatory crabs were attracted to the scallop cluster, numerous (50-100) dead valves were observed at the release point two hours after placement. A subsequent survey on 29 August at this station indicated no seed scallop remained within the 5 m radius.

Hatchery seed scallops (10,000 est. with 1500 dorsal tags) were also broadcast in Little Narragansett Bay at Barn Island and Randall Neck sites. Placement involved dispersed "sowing" from a vessel within a 50 x 20 m band located by land bearings. Extensive diver observation time (1-2 hrs.)

within each band at three later surveys did not produce a single recapture. Also, no evidence of mortality was detected for hatchery size seed in either band. The inability of divers to locate scallops on random search within the respective areas indicated the degree of effective dispersion within the Zostera grass habitat. However, differiential mortality or movement patterns could not be addressed by recovery efforts conducted within this aerial scale. NMFS scallop seed release efforts are numerized in Tab.17.

It appears the only realistic method to determine individual scallop activity, predation events and long-term survival within an area of the seafloor is through time-lapse underwater photography. In this technique a selected area ($1m^2$) may be surveyed by periodic (20-180 second interval) photography over a two day time. The film record may be analyzed for several important ecological conditions that influence scallop growth: movement frequency, orientation, and predation.

On 22-23 July 1981, trials of a remote time-lapse super 8 mm camera system were conducted on hatchery seed placed at Poquonock River (Stn. 3). Film footage documented several behavioral postures and events cited previously. A systematic film review to quantify interactions is to be undertaken.

Tagged Scallop Release

Natural population 0 and 1 year class scallops were tagged within Niantic, Poquonock and Little Narragansett Bay systems using polypoxy adhesive with individual code embossed marker tape. Also, a compliment of the mass hatchery seed supplied by NMFS Milford Laboratory was individually number tagged and released. In addition, color coded subsamples of hatchery seed were tagged with dyed polypoxy and released within the mass seed scallop broadcast or point release experiments cited previously.

Tables XVIII, XIX summarize the tagging records for numerical tag release within the Niantic, Poquonock and Little Narragansett. Total scallop tag numbers for the project period were 500, 1660, and 700 for the respective bays. All scallops collected from specific stations were measured for shell length and returned to the site directly or within five days. For certain samples all three measures (shell, length, width, depth) as well as shell fouling conditions were noted before release.

Individual scallop tag returns are listed in Tables XX, XXI. Specific growth for time at large in the natural environment may be calculated for recaptured individuals. Table XXII presents the chronological recapture data for animals recovered from all three bay systems. For each recapture period the day at large interval allows the following valves to be computed from the size at tagging: means size of the recapture group (n) at tagging ($\overline{X}$ mm - shell length), growth ($\Delta \overline{X}$ mm), range of growth (mm), rate (mm/day), and percentage increase per d.a.l. period.

Certain examples of exceptional growth were seen for individual returns from Poquonock River Stations (i.e. 30=40%). The trend evident in Table XXII shows an increasing growth rate from July through late October. If we were to combine percentage increases for the Poquonock River (Stns. 1 and 3) the record would give chronological valves of: 21 July (13 d.a.l.) - 2.2%, 28 July (20 d.a.l.) - 3.8%, 4 August (26 d.a.l.) - 4.7%, 29 August (50 d.a.l.) 21.8%, 6 October (90 d.a.l.) - 25.2%, 17 October (99 d.a.l.) - 29.9% 11 November (125 d.a.l.) - 35.4%.

Two important observations should be emphasized at this point. First, exceptional growth rates displayed by certain individual scallop (tag returns) suggest a condition of genetic superiority. This is reinforced by the tagging record, since movement appeared minimal and similar environmental conditions existed for the scallop populations displaying greatly different growth rates. Second, a definite acceleration in shell length occurs in all scallop populations in September to mid-November. An advantageous resource management recommendation would be to defer scallop season opening to a later date to achieve full return from the protein (adductor muscle) production period.

Since project termination, few tagged scallop returns have been recovered due to diver survey effort although station monitoring continues when opportunities occur. A consequent problem with the anticipated recapture of tagged individuals has resulted in the closure of the 1981 scallop season within the Poquonock. The effective return by fishery recaptures within the principal study area may not be realized due to the closure.

The combined effect of unintentional sewage discharge (October 1980) and pesticide contamination (May 1981) may have impacted the Poquonock River and reduced 1 year class numbers. However, intensive observations on scallop spat set dynamics at two bay stations were totally unsuccessful, presumably due to 1980 larval production or survival failure. Thus poor recruitment appears to be the major cause of the low 1981 1 year scallop population (Progress report 9-80).

Of note are the NMFS hatchery scallop seed release additions within the Poquonock, providing a total of 24,000 during the 1980 poor recruitment period. And based on observations of low scallop numbers during spring 1981, an additional 82,000 NMFS seed scallop were broadcast at Poquonock Bay stations 2-4 to augment natural production in June-July 1981.

Environmental parameters

Water temperature data drawn form laboratory records or recently published results, are presented for stations at Noank, Watch Hill, R.I. and Niantic (Figures 23-25). The general trends are believed to represent temperatures regimes for the Poquonock, Niantic and Little Narragansett Bay systems within which respective scallop populations were studies 1980-81. Specific temperatures obtained in the field were entered on Figure 23 An observed difference in water minima and maxima (i.e. $\pm$ 4°C) for shallow bay stations compared with laboratory values, indicated scallop populations would be periodically exposed to temperatures in summer exceeding 24°C and winter below -1°C. In general, temperature curves for the three bay systems were similar, both in respect to maximum/minimum valves and transition characteristics of rapid cooling and warming.

T°C, salinity, mortality

Approximately monthly field observations in Poquonock River, Groton, Connecticut have indicated localized mass mortalities of 0-year group animals occur during the colder months of the year (November-March) Fig. 23 Since increased rainfall (decreasing salinity) is common at this time and temperatures are low, a direct relationship between these conditions and survivorship was postulated.

Belding (1910) found scallops in the New England region occupying estuarine areas with salinities in the range of 14.1 - 36.3 °/oo. In South Carolina, a "distributional minimum" of 20 % was found but it was stated that scallops survived salinities of around 16.2% after heavy rains (Gutsell, 1930).

The behavioral repetoire of scallops was observed as salinities were reduced to as low as 5% (temperatures 10° - 25.0°C by Duggan (1975) and no mortality was reported. Salinities of 12-16% resulted in complete cessation of activity.

Vernberg et al. (1963) noted a complete cessation of ciliary activity in animals exposed to 12% salinity. Also noted was that cold acclimated individuals were more resistant than warm-acclimated individuals to reduced salinity conditions. Castagna and Chanley (1973) state "the minimum salinity at which bay scallops survive would appear to be about 14%."

In order to determine effects of winter temperatures and low salinities on the survival of bay scallops, experiments were performed in which salinities were reduced at varying rates at $0^{o}C$.

Scallops were collected in the Poquonock River, Groton, Connecticut, on 9 January 1981. Fifty four individuals were taken from an Agardhiella mat dominated substrate by hand net, returned to the laboratory, and placed in a flow-through unfiltered, open seawater system. The seawater system input is at the mouth of the Mystic River, Mystic, Connecticut where estuarine conditions also exist.

Experiments were performed when seawater was at $0^{o}C$.

Five groups of 10 animals each (one control, 4 experimental) were placed in fiberglass tanks and acclimated for 24 hours. When the experiment began, the seawater system was shut down. Freshwater inputs were made every hour over a simulated 6 hour tidal cycle at predetermined reduction rates (Table XXIII). After 6 hours, the seawater system was opened and the salinity regime returned to ambient within 30 minutes.

Salinity and temperature were monitored with a calibrated YSI Model 33, S-C-T meter. Temperature did not deviate more than $\pm 1^{o}C$ in experimental treatments and more than $\pm 2^{o}C$ in controls.

Immediate, 24 hour and 48 hour post exposure survivorship was noted.

No mortality was observed in any of the experimental or control treatments. Treatment number 4 subjected the experimental animals to 0% for 6 hours, the most severe, with no immediate, 24 or 48 hour post exposure effects.

No mortality was noted in animals subjected to ambient seawater temperatures of 5° C to -2°C prior to the experiment. Actvity levels were extremely reduced in all animals. Only occasionally, during casual observations, was an individual noted to be gaped (velar fold and tentacles visible) and filtering.

The evidence suggests that bay scallops, an estuarine inhabitant (generally under euryhaline conditions) is much more tolerant of low salinity regimes at reduced temperatures than previously believed. Since temperatures are low, physiological processes are at reduced levels (i.e. little or no gaping, no swimming) chronic non-fatal effects remain to be determined.

Mass mortalities observed in the field may be the result of environmental factors other than low temperatures and salinities; or may be synergistically related to these factors.

Dorsal Valve Fouling

Observational surveys of the scallop populations at Station I, disclosed very obvious differences in the fouling community of animals in the nearshore areas as opposed to animals found near the channel. A higher incidence of *Balanus* fouling and a lower incidence of algal fouling was noted on animals in the nearshore area. The most pronounced differences in physical features between the two locations are stiller waters and a thick *Zostera* mulch in the nearshore area, in contrast to swifter currents and sandy sediments near the channel.

To quantify these differences, the fouling organisms were scraped free and processed as described in the following text. After scraping, barnacles that had set on each specimen were counted by the number of test marks left on the shell. These animals were sampled and the results for the faunal component of the fouling organisms are given in Table

The most abundant organism is Corophiom insidiosom followed by Balanus balanus (tests). If only live animals are considered then Balanus was abundant only in one instance, even though all of the animals had been covered by this species at one time. Among the polychaetes the syllid Brania clavata and the phyllodocian Eteone heteropoda were most abundant.

In comparison to the channel area, where usually less than 4 Balanus per animal are found, in the nearshore environment the number of Balanus on the scallop valves are an order of magnitude higher, based on test marks. The reason for this is not clear; perhaps the calmer waters allow for a greater set of larvae onto the valves. What consequences this has on the scallops is also not known, but several hypotheses are speculated: 1) the higher incidence of barnacles may attract more Urosalpinx onto the scallops as this is a preferred food item of the gastropod. In this case, the incidence of Urosalpinx drilling into a scallop may increase or decrease depending on behavioral balance between satiation and increased activity (i.e. drilling) by the gastropod. 2.) The added weight of the barnacle shells may impede swimming activity by the scallop.

Station I

Animals that were used in this set of observations come from the channel area and Zostera bed next to it at Station I. The animals were observed live under a dissecting scope. After notes were taken on conspicuous features, the fouling was scraped off into a jar and fixed with

with 10% formalin and stained with Rose Bengal. Later the formalin was washed off and replaced with 70% isopropyl and the larval elements enumerated. Algae was placed into seawater and identified after scraping.

Observations on 5 scallops revealed that the morphology of the fouling is very similar between individuals. Most conspicuous is a heavy sediment mat that not only covers most of the dorsal valve, but also continues up onto any algae if present. This sediment mat is very spongy and granular (sediment nodules stuck together) with many (openings) invaginations. The mat is primarily composed of amphipod and polychaete tubes. Both amphipods and polychaete (spionids specifically) were observed feeding on this mat. This microtopography was more hetergenous when algae were present. The fauna would build tubes around it, and also on barnacles, both adding to the verical relief. The algae was confined primarily to the back area and margins of the valve. Sedimentation was also greatest at the margins, however, the very edge (actually a thin strip) all the way around the valve was fairly clean. The amount of sediment fouling decreased in animals taken from the edge of the Zostera bed, however the amount of attached algae increased. The tube building fauna was still present.

The orientation of the tubes on the valves is of interest. The predominant orientation was parallel to the plication, i.e. in the grooves, especially tubes deeper in the sediment mat; tubes near the surface were observed to be oriented in many ways.

After scraping the valves, they were inspected under the scope to observe degree of remaining attached material. Many small tufts of filimentous algae that were previously obscured by the sediment tubes were noted. Not only were there tufts of this algae, but many single strands covered the valve. Some of the algae was attached at the hinge and to the ventral valve. Characteristically, the ventral valve was fouled by bryozoans and Crepidula sp. only.

Seven scraping samples have been enumerated to date. Additional samples were preserved with the fouling intact on the shell and it will be photographed to get a record of morphology. The species found and densities are given in Tables XXIV a,b. The most abundant and diverse group found was the polychaetea, 6 species, followed by amphipoda (3 species). The most common and abundant polychaete was Polydora ligni, a tubiculous, surface-feeding spionid. This genus frequently fouls Mytilus and Crassostrea beds in very high densities (Kent 1979) causing increased mortality and/or lowered fecundity. The most common and abundant amphipod. Corophiom insidiosom is also a tubiculous, surface and suspension feeder. The other polychaetes are motile and are either onmivores, Etecheheterpoda, Brania clavata, or non selective deposit feeders, Notomasthus luridus, Capitella sp., and Nereis sp.

Densities of barnacles may have been higher than what was found because many dead individuals were found which were overgrown by either tube builders or short tufts of algae. Qualitively, the contribution of barnacles to total fouling is much greater in large open areas found nearer to the shore of Bluff Pt. and Station I, than in the channel or Zostera beds. In addition to thse species there was a well-developed microfaunal community including harpacticoid copepods, nematodes, foraminiferans, gastrotrichs, and ostracods.

Station 3

Observations were made on valve fouling at Station #3 on 7-19-80. Qualitative descriptions for four individuals were made by dissection scope examination. In general, though many of the same faunal and floral species were found that occur at Station I, their densities were different.

Ephiphytic components of scallop fouling consisted of the following species on the animals that were analyzed quantitatively:

Animal #1	Laminaria sp (1 stipe - 1.2 high cm) Asterocystis ramosa (several tufs - 1 cm high)
Animal #2	Polysiphonia horveyi (several plants - 2 cm high) Enteromorpha compressa (several tufts - 3 cm high)
Animal #4	Ulva (sp) (2 stalks - 6 cm high) Polysiphonia fibrillosa (2 plants - 3 cm high, heavily fouled by Polydora tubes) Enteromorpha compressa (1 tuft - 1.5 cm high)
Animal #5	Enteromorpha compressa (1 tuft - 3 cm high) Laminaria sp. (1 stipe - 3 cm high) Polysiphonia fibrillosa (1 plant - 2 cm high) Polysiphonia harveyi (1 plant - 3.5 cm high)

Besides these specimens, several others were collected at Station I to get a qualitative account of the diversity of algal species that foul the dorsal valves. The species found included Spaherotrichia divercata, a large (16 cm high) branching brown alga; many small tufts (~ .5 to 1 cm high), Chaetomorpha sp. and/or Rhizocloniom, both green alga, usually overgrown by the tube building and sediment binding activities of the polychaetes and amphipods; and Polysiphonia harveyi on 5 more individuals, some being relatively large (e.g 4 x 6 cm bush).

The algae that was found to occur most frequently on valves of animals from both groups were two species of the genus Polysiphonia: P.harveyi and P.fibrillosa. This red alga is a foliose form that ranged from approximately 1 to 6 cm in height. The bottom portions of the plant were usually heavily fouled by Polydora and/or Corophiom tubes. This animal fouling was also observed on stipes of Laminaria sp.

Besides these macroalgae, many diatoms were found on the sediment mat. Also, a very common algae epiphyte, Codium sp. was not observed on any of the individuals sampled at this time (7-9-80).

The valves of animals in this location are not as heavily sedimented as at Station 1. Tubes were scarce and primarily limited to the grooves of the shell and many of these did not have animals in them. Only one animal had moderate densities of Polydora and Corophiom. Motile fauna included Nereis sp. and various meiofaunal species. The most conspicuous species fouling valves at this station were bryozoans. Colonies usually covered at least 1/4 of the rear portion of the valve, hinge, and extended onto the rear of the ventral valve also. On one animal, bryozoans were being overgrown by Polydora. In addition to bryozoans, the sabellied polychaete Spirobis sp was found in greater incidence than at Station 1. As there was less sediment fouling on shells at Station 3, tufts of small algae were much more apparent than at Station 1. On two individuals these tufts were quite numerous almost giving the appearance of a carpet. Larger algal species included Codium sp. and Ulva sp. primarily. The Codium ranged from 3 to 9 cm in height, Ulva plants were approximated 7 to 8 cm high. Only one Polysiphonia and Enteromorpha plant was observed. The chronological record of dorsal valve fouling comparison between Poquonock River (Stations 1,3) July-August 1981 with field observations is presented in Table XXV.

Ecological Observations

Seasonal Habitat

During 1980-81 field survey of scallop populations, over thirty-five diver observation periods were directed toward descrption of scallop habitat and ecological associations. The photographic log (Table XXVI) and selected prints (photo nos. 1-27) illustrate several scallop environmental conditions; microhabitiat, dorsal valve fouling, epifaunal grazing, predation, and seasonal transition of the Zostera habitat.

Several observed conditions, not commonly recognized, strongly influence scallop population mobility and survival. In early spring (April-May - T°C 40-45) the regrowth of Zostera blades rapidly transforms the flat featureless bay bottom into a three dimensional network of niche space. Verticle growth of the Zostera blades was observed to be greatly facilitated by a tip buoyancy phenomenon caused by encapulated gas (photo no. 1). On 15 May 1980 the Poquonock Bay Zostera fronds exhibited this condition over ~ 80% of all grass bed areas.

Concurrent with increased spring faunal activities, was an apparent attraction of predator and epiphytic grazing organisms to the dorsal valves of scallop. Evidence of Pagurus longicarpus, Littorina littorina, and Urosalpinx on scallop was repreatedly documented, and often on the order of 5-3 organisms per scallop. A "shell cleaning" effect was apparent throughout the population that might have offered benefits of lower potential algal bud sites, reduced weight, and increased mobility (photo no. 4).

The dense summer strands of Zostera, covering approximately 60% of the Poquonock Bay region, offer a three dimensional matrix which appears to provide certain scallop advantages: increased primary productivity and epiphytic structural support on Zostera, predator exclusion by inhibited mobility (i.e. Asterias); a cryptic camoflage to reduce visual predation (i.e. Herring gulls); and bysuss attachment by scallop seed within a preferred vertical zone not frequented by most benthic predation (i.e. lower third portion of Zostera frond). Although periodic spat collector and Zostera examination were attempted (Progress report - September 1980) the 1980 recruitment failure throughout the Poquonock Bay prevented successful quantification of spat fall dynamics and preferred substrate. Field observations (August 1981) indicated high spat yield and a photographic record of juvenile seed attachment.

The fall Zostera disintegration (September-October) occurrs gradually while a high number of (20-30 mm) scallop remain bysally attached to the blades (Photo nos. 2,3). The thinning process may be suddenly accelerated by rapid cooling and storm turbulence of bay waters. This results in a "Zostera mulching" deposited in certain portions of the Bay (photo no. 8). The possibility exists that juvenile scallops may be transported on Zostera fragments and be concentrated in "patch clusters" that become apparent in late fall (November-December). Examples of this process, a result due to consistent hydrographic forces that deposit Zostera fragments in certain occur on the east and west bank at mid-bay and in a region to the southeast of Bakers Cove in the Poquonock Bay. Of note also is that these areas consistently produce most abundant adult scallop populations, Stations 3,4 and 2A.

A markedly apparent algal fouling occurs on adult scallop valves in late fall. Two conspicuous green algae, Ulva and Codium often may be used to detect live Argopecten totally camoflaged beneath Zostera and assorted algal mulch. Incidence of fouling generally ranges between 30-50% of the population. For example, field notes (6 Nov. 1980 Poquonock Station 2A) from 202 individuals randomly collected by spotter and net gave the following record of Codium predominance: Codium present (1-5 cm fronds) -49, Codium abundant (5-10 cm) - 25, Codium luxuriant (10-20 cm) - 8, or an overall 51% Codium fouling incidence.

Certain general aspects particular to scallop population distribution and predation pressures may be cited for the eastern Connecticut bay systems. Consistent scallop population zones may be identified within Poquonock River (previously described). The upstream settlement limits are drawn, based on two years of observation, on Figure 1. Apparent absence of scallop from the Bakers Cove or eastern pond regions within the Poquonock Bay system are unexplained. An outer sill population has been reported for all three bay regions and is indicated on Figure 1-3 by crosshatch symbols. During the 1980-81 winter season, evidence of mass 0 year class mortality in the Poquonock resulted in "windrow banks" of shell valves ($\overline{X}$ - 43mm n = 55) Locations are entered on Figure 1 and statistical data are listed on page 96. Reports have been received to date (30 September 1981) of juvenile live scallop "windrows" washed ashore at Hammonasset Beach, Madison, Conn. Hatchery seed and small numbers of adult brood stock were introduced within the lower Hammonasset in December 1978.

An unusual concentration of 3rd year adult scallop were found (4 June 81) within the central channel region of Niantic Bay. Shell fouling was extreme, with predominate coverage by red sponge (Microciona) and calcureous tube worms (Hydroides), mean size was $\overline{X}$= 64.6mm, n=50. Implications to early spawning from the abundance and size of the population are significant, since the density was high (3-4 per .25 m^2) and extended along the entire mid-channel observation transect (100 m NE-SW).

Four major predator species were commonly recorded within prime scallop habitat. Listed in decreasing order relative to their observed predatory behavior on scallop include: the green crab Carcinus maenus, the blue crab Callinectes sapidus, the starfish Asterias forbesii and the oyster drill Urosalpinx cinerea.

A subjective rank of predator species occurrence within the three bay systems during the scallop investigation period (June 1980 - June 1981) produced the following table.

	Predator level (L-low, M-moderate, H-high)			
	Carcinus maenus	Callinectes sapidus	Asterias forbesii	Urosalpinx cinerea
Niantic	L	M	H	M
Poquonock	H	H	L	H
Little Narragansett	L	M	L	L

The Niantic River scallop population was subject to intense Asterias predation during the 1979-80 winter. At temperatures greater than 8°C Argopecten readily detects Asterias and commences valve clapping retreat to avoid encounter. However, Asterias achieves greater predation success on Argopecten at lower water temperatures 4-7°C when mobility is inhibited and Argopecten becomes common prey. A similar inverse temperature relationship also exist for observed Urosalpinx/Argopecten predator/prey interaction. At water temperature $>$ 7°C Argopecten mobility effectively dislodges adhering Urosalpinx, while $<$ 7°C greater Urosalpinx attachment and boring success is evident. Responsive measures involing dredge collection and trap removal of Asterias were attempted by the Waterford-East Lyme Shellfish Commission. In addition, a small scale green crab bait fishery exists within the Niantic bay enclosure. Both efforts act to reduce predator levels on resident scallop populations, yet the degree of effectiveness remains to be determined. In contrast, the Poquonock and Little Narragansett systems have not instituted predator control measures. The Poquonock, with exceptionally high levels of decapod crustacea and drill predators may benefit from this management method.

Table I Natural population scallop shell length statistics (1979 year class) - Poquonock River, Station 1/2A, May - November 1980.

Date	N	Shell Lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval on mean -Lower/Upper Limit
15 May 80	24	43.36	4.06	.828	41 65 - 45.08
5 June 80	73	44.58	3.57	.418	43.75 - 45.41
8 July 80	100	45.60	2.91	.291	45.02 - 46.18
21 July 80	21	46.60	2.84	.619	45.30 - 47.89
28 July 80	19	47.27	2.94	.675	45.85 - 48.69
4 Aug 80 *	14	46.64	2.31	.618	45.30 - 47.97
29 Aug 80	50	53.40	2.66	.376	52.64 - 54.15
8 Oct 80	100	60.56	3.86	.386	59.76 - 61.33
17 Oct 80	250	62.21	3.92	.248	61.72 - 62.70
30 Oct 80	125	65.74	4.11	.368	65.02 - 66.48
6 Nov 80	200	63.37	4.65	.329	62.72 - 64.02
17 Nov 80	73	64.65	4.43	.519	63.62 - 65.69
	1049				

*Sample excluded from growth rate calculation.

Table II Mean growth rates (mm/day) for sequential scallop samples (1979 year class) - Poquonock River Station 1/2A, May - November 1980.

Inclusive Dates (1980)	Rate
15 May - 5 June	.058 mm/day
5 June - 8 July	.031 mm/day
8 July - 21 July	.077 mm/day
21 July - 28 July	.096 mm/day
28 July - 29 August	-.192 mm/day
29 August - 8 October	.179 mm/day
8 October - 17 October	.183 mm/day
17 October - 30 October	.272 mm/day
30 October - 6 November	-.338 mm/day
6 November - 17 November	.116 mm/day

Figure 4. Natural population growth curve by month - Poquonock River, Station 1/2A, May - November 1980.

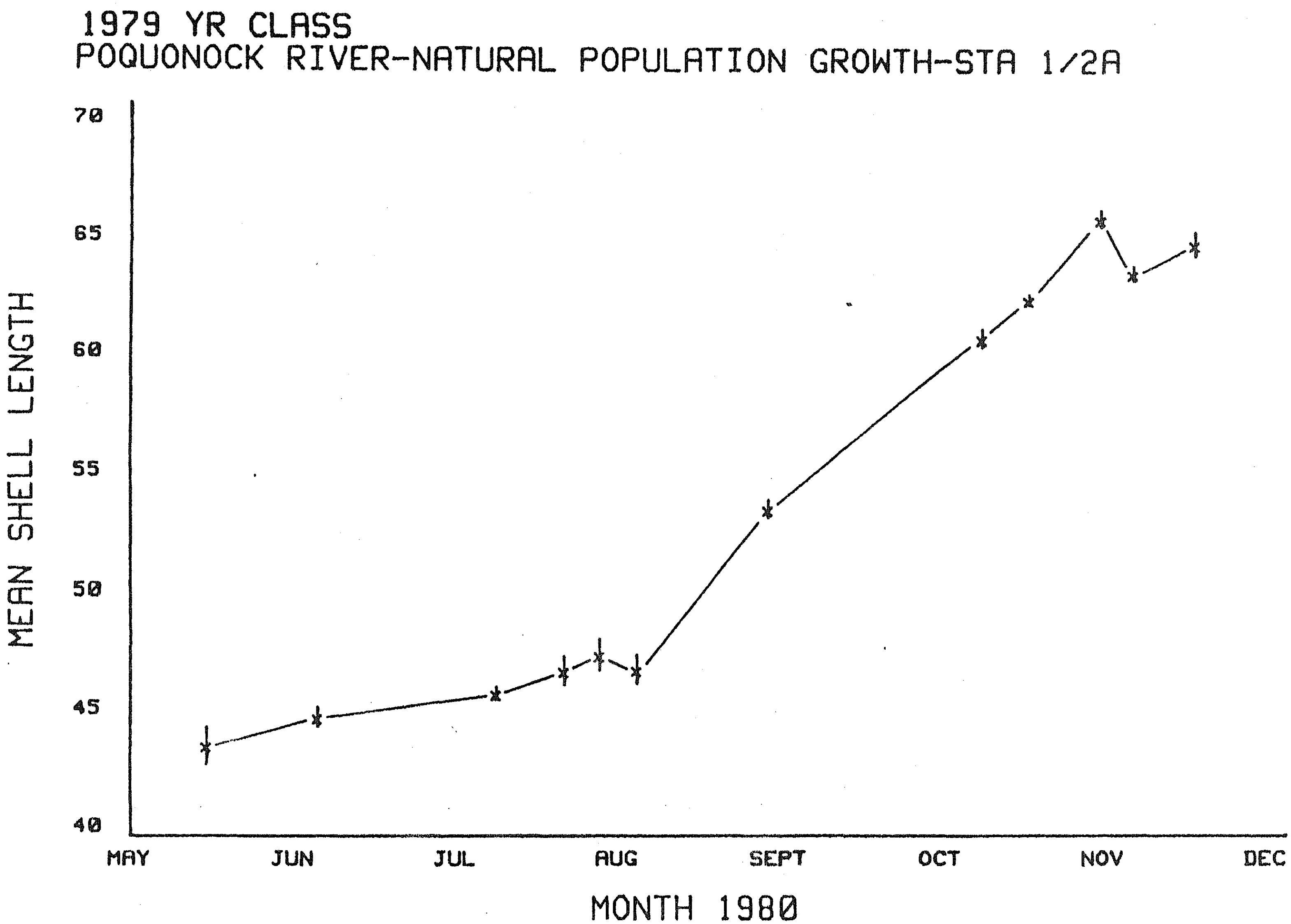


Table III Natural population scallop shell length statistics (1979 year class) - Poquonock River, Station 3, May - November 1980.

Date	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval on Means - Lower/Upper Limit
6 May 80	52	42.90	3.73	.518	41.86 - 43.94
15 May 80	27	46.79	3.31	.637	45.48 - 48.09
5 June 80*	10	45.22	3.41	1.080	42.78 - 47.66
9 July 80	100	48.04	3.02	.302	47.44 - 48.64
29 Aug 80	50	54.99	3.45	.488	54.01 - 55.97
5 Sept 80	50	56.96	3.11	.439	56.08 - 57.84
6 Oct 80	100	62.49	3.73	.373	61.75 - 63.23
17 Nov 80	63	64.13	3.48	.439	63.26 - 65.01
	452				

*Sample excluded from growth rate calculation.

Table IV Mean growth rates (mm/day) for sequential scallop samples (1979 year class) - Poquonock River Station 3, May - November 1980.

Inclusive Dates (1980)	Rate
6 May - 15 May	.432 mm/day
15 May - 9 July	.050 mm/day
9 July - 29 August	.136 mm/day
29 August - 5 September	.281 mm/day
5 September - 6 October	.178 mm/day
6 October - 17 November	.039 mm/day

Figure 5. Natural population growth curve by month - Poquonock River, Station 3, May - November 1980.

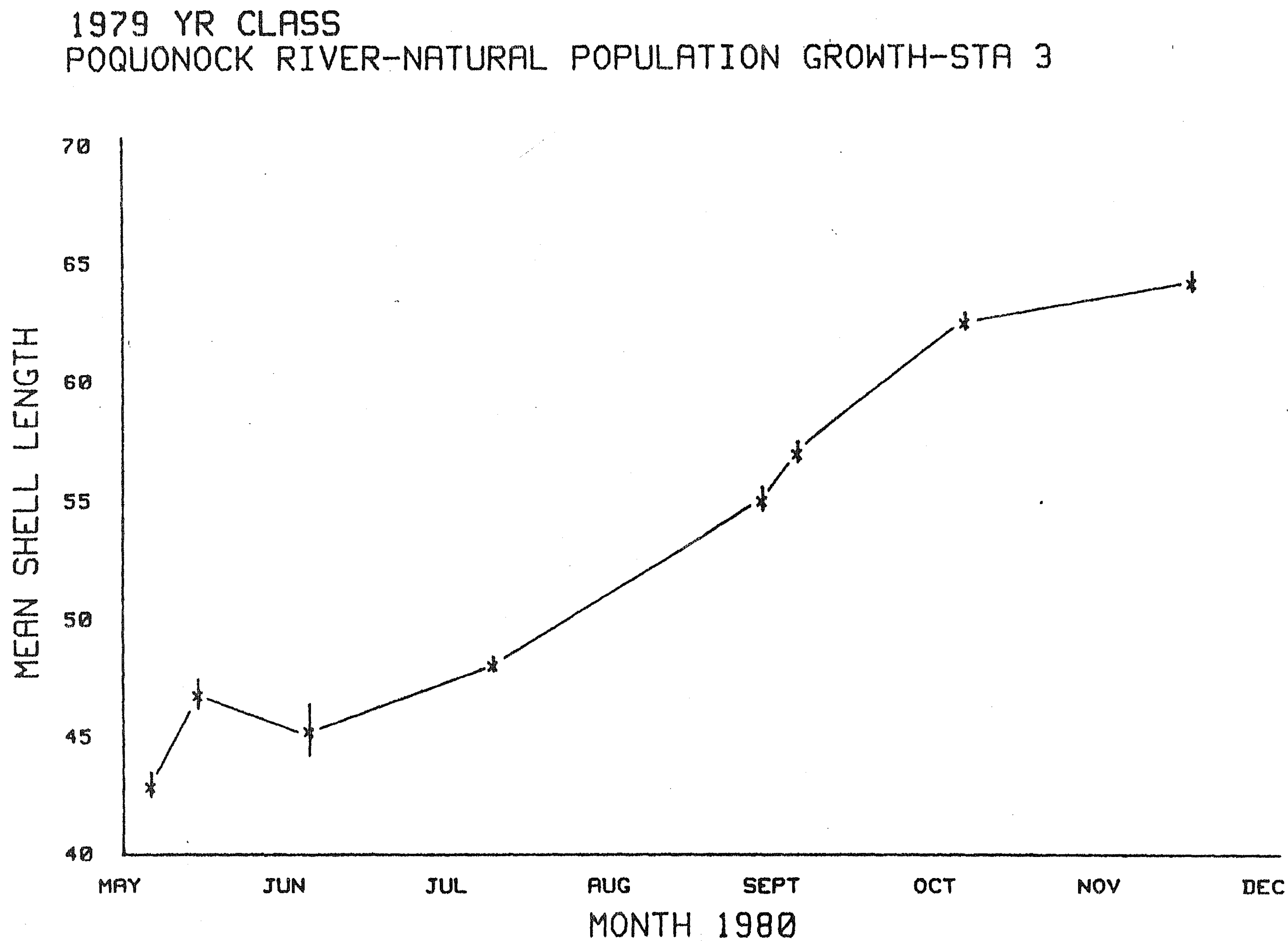


Table V Natural population scallop shell length statistics (1979 year class) - Niantic River, Station 2, June - November 1980.

Date	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval on Means - Lower/Upper Limit
18 June 80	50	50.16	3.47	.491	49.17 - 51.14
23 July 80	50	51.77	3.51	.496	50.77 - 52.77
5 Sept 80	67	57.02	3.60	.440	56.14 - 57.90
12 Sept 80	50	58.74	3.86	.547	57.64 - 59.84
14 Oct 80	100	59.08	5.92	.592	57.91 - 60.26
17 Nov 80	127	62.94	4.57	.406	62.13 - 63.74

Table VI Mean growth rates (mm/day) for sequential scallop samples (1979 year class) - Niantic River, Station 2, June - November 1980.

Inclusive Dates (1980)	Rate
18 June - 23 July	.046 mm/day
23 July - 5 September	.119 mm/day
5 September - 12 September	.246 mm/day
12 September - 14 October	.011 mm/day
14 October - 17 November	.116 mm/day

Figure 6. Natural population curve by month - Niantic River, Station 2, June - November 1980.

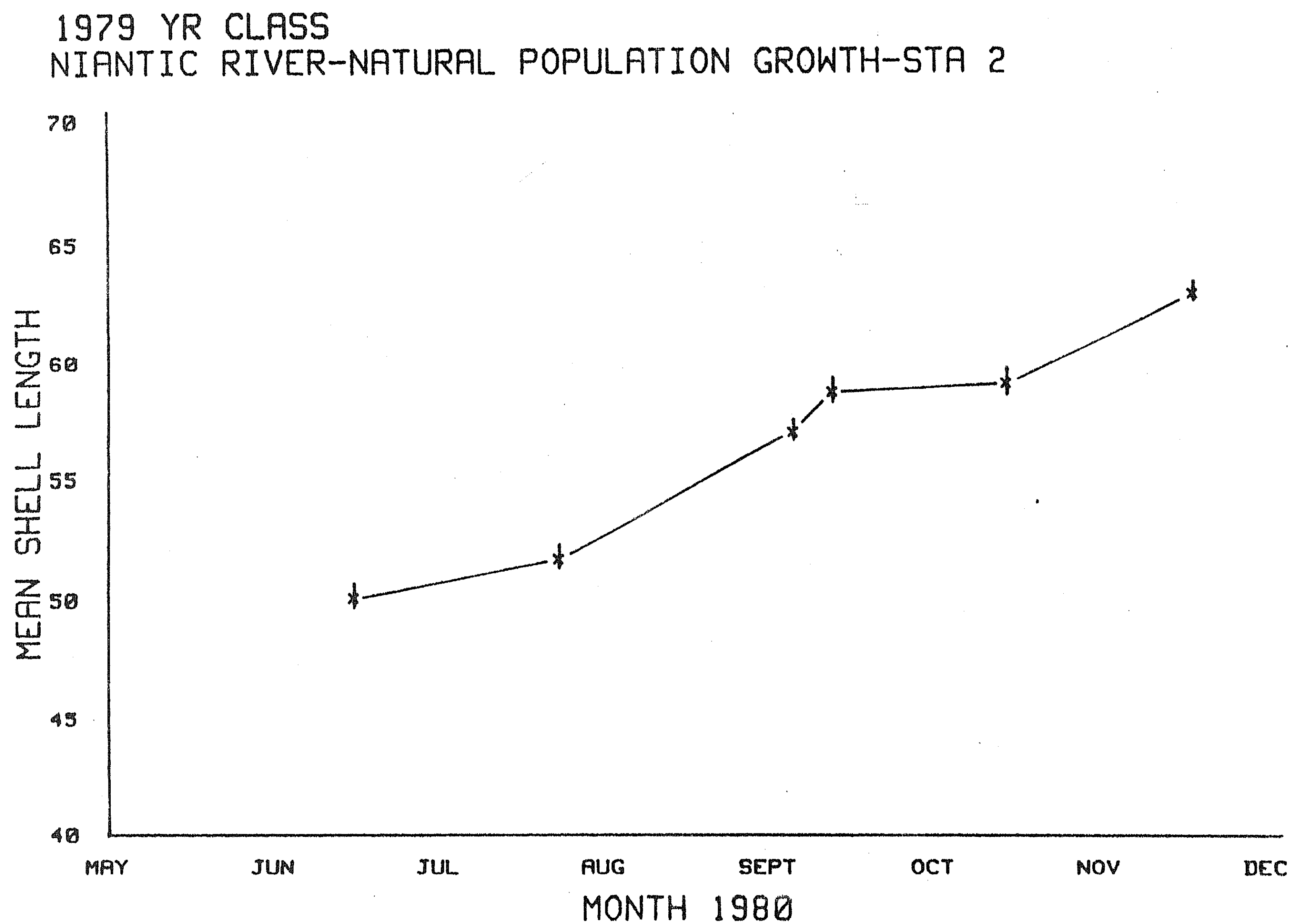


Table VII Natural population scallop shell length statistics (1980 year class) - Poquonock River, Station 4, November 1980 - June 1981.

Date	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
17 Nov. 80	5	45.24	2.62	1.170	41.99 - 48.49
8 Dec. 80	98	48.62	3.70	.374	47.88 - 49.37
9 Jan. 81	54	49.32	4.44	.605	48.11 - 50.54
20 Apr.81	100	46.45	3.99	.399	45.65 - 47.24
14 May 81	100	47.76	4.42	.445	46.88 - 48.63
4 June 81	100	47.58	4.62	.462	46.66 - 48.49

Table VIII Mean growth rates for 1980 year class scallops sampled sequentially - Poquonock River, Station 4, November 1980 - June 1981.

Inclusive Dates (1980-81)	Rate
17 November - 8 December	.16/mm/day
8 December - 9 January	.022/mm/day
9 January - 20 April	- .028/mm/day
20 April - 14 May	.055/mm/day
14 May - 4 June	- .009/mm/day

Figure 7. Natural population growth curve (1980 year class) scallop by month - Poquonock River, Station 4, November 1980 - June 1981.

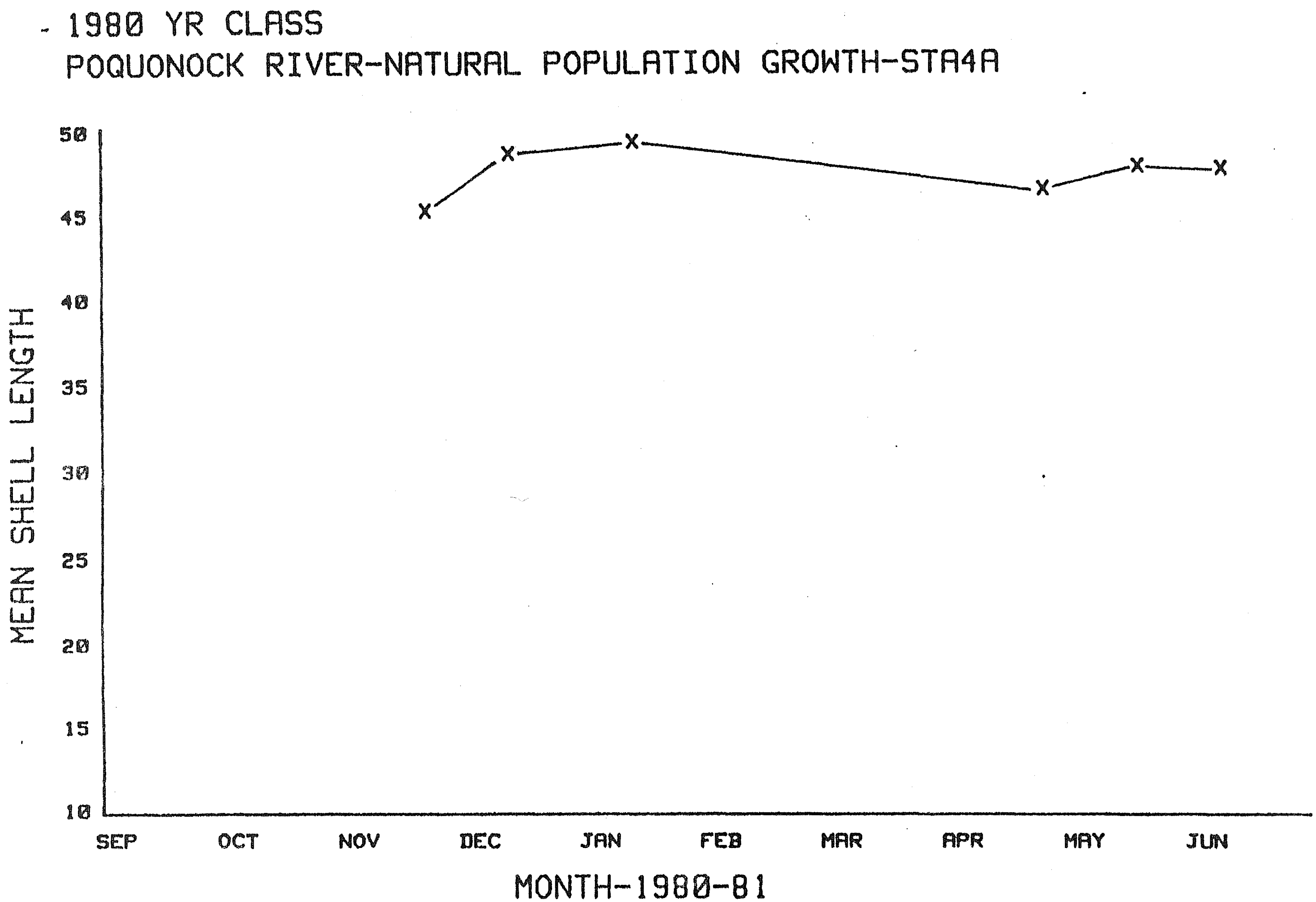


Table IX Natural population scallop shell length statistics (1980 year class) - Niantic River Station 2/2A, September 1980 - June 1981.

Date	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
5 Sept. 80	34	22.19	5.07	.869	20.43 - 23.96
17 Nov. 80	76	48.14	4.43	.444	47.25 - 49.02
26 Mar. 81	100	42.66	4.58	.458	41.75 - 43.57
3 Apr. 81	100	46.03	4.69	.469	45.10 - 46.96
4 June 81	100	46.90	4.44	.444	46.02 - 47.78

Table X Mean growth rates for 1980 year class scallops sampled sequentially - Niantic River Station 2/2A, September 1980 - June 1981.

Inclusive Dates (1980-81)	Rate
5 September - 17 November	.355 mm/day
17 November - 26 March	-.042 mm/day
26 March - 3 April	.421 mm/day
3 April - 4 June	.014 mm/day

Figure 8. Natural population growth curve (1980 year class) scallops by month - Niantic River Station 2/2A, September 1980 - June 1981.

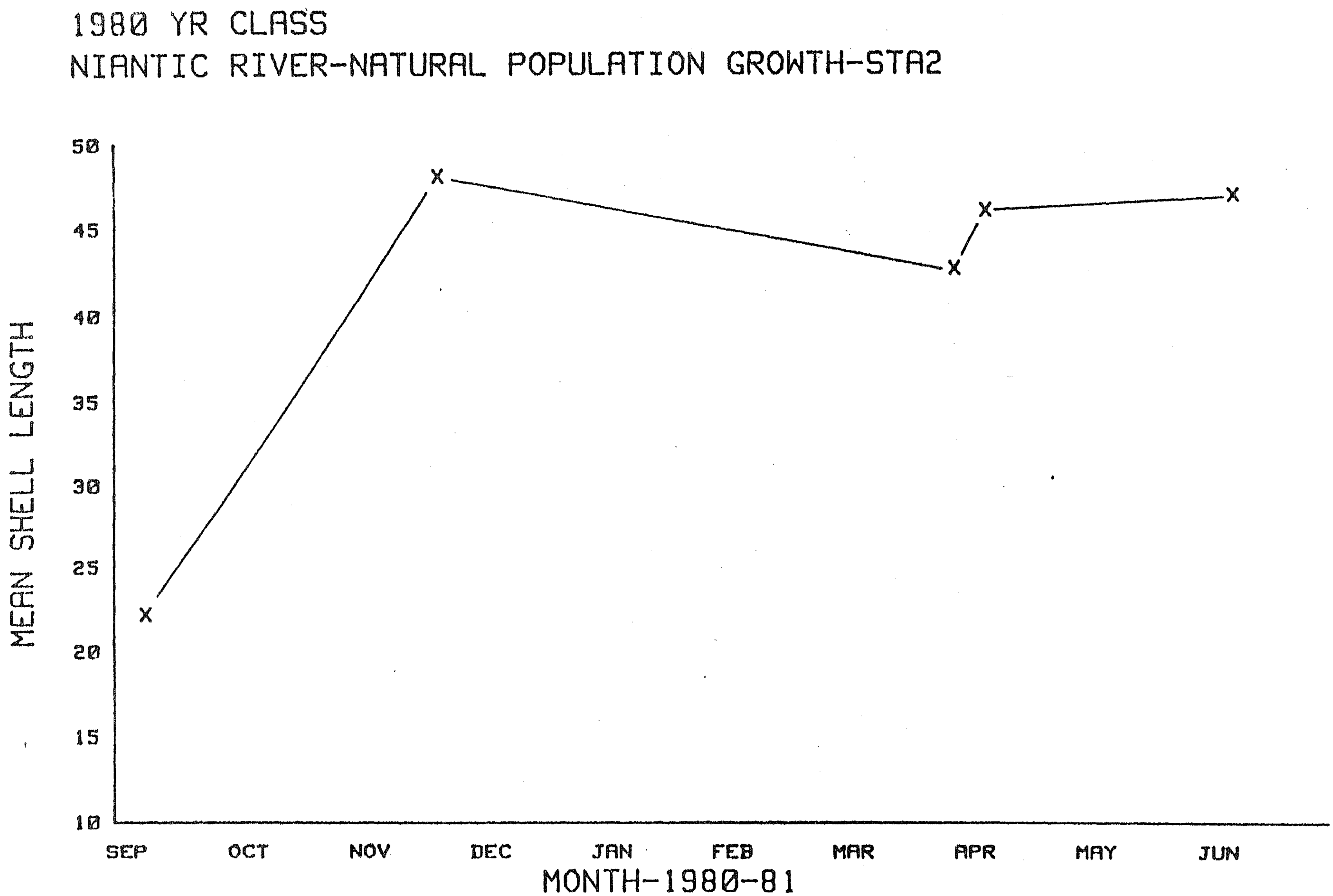


Table XI Natural population scallop shell length statistics (1980 year class) - Little Narragansett Bay Station 1, September 1980 - May 1981.

Date	N	Shell Lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
5 Sept. 80	60	11.72	2.39	.309	11.10 - 12.33
19 Nov. 80	56	37.67	3.34	.447	36.78 - 38.57
20 Apr. 81	284	38.76	3.15	.184	38.40 - 39.12
27 Apr. 81	100	40.25	3.30	.330	39.59 - 40.90
14 May 81	260	41.54	3.69	.229	41.09 - 41.99

Table XII Mean growth rates for 1980 year class scallops sampled sequentially - Little Narragansett Bay Station 1, September 1980 - May 1981.

Inclusive Dates (1980-81)	Rate
5 September - 19 November	.346 mm/day
19 November - 20 April	.007 mm/day
20 April - 27 April	.213 mm/day
27 April - 14 May	.076 mm/day

Figure 9. Natural population growth curve (1980 year class) scallop by month - Little Narragansett Bay Station 1, September 1980 - May 1981.

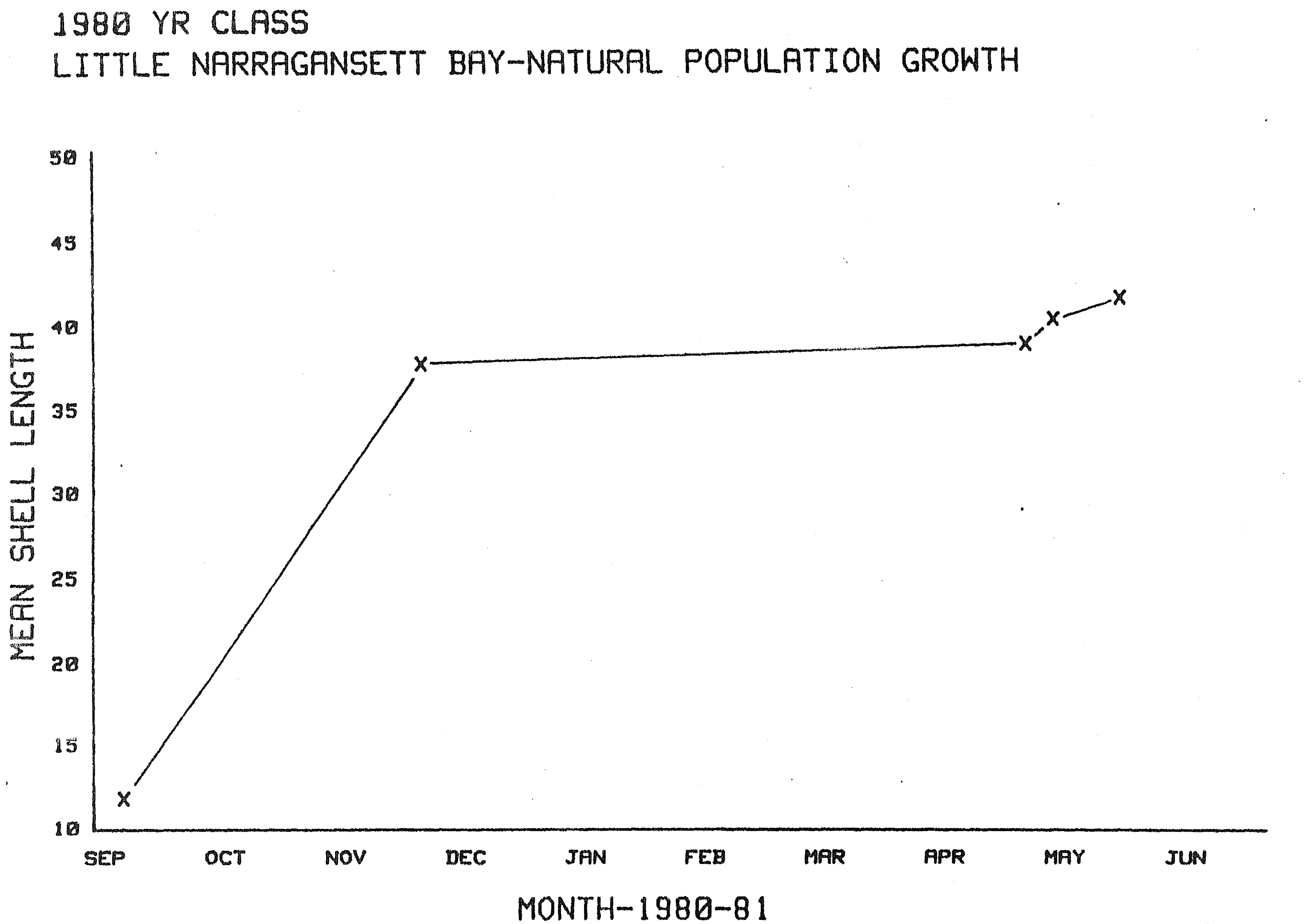
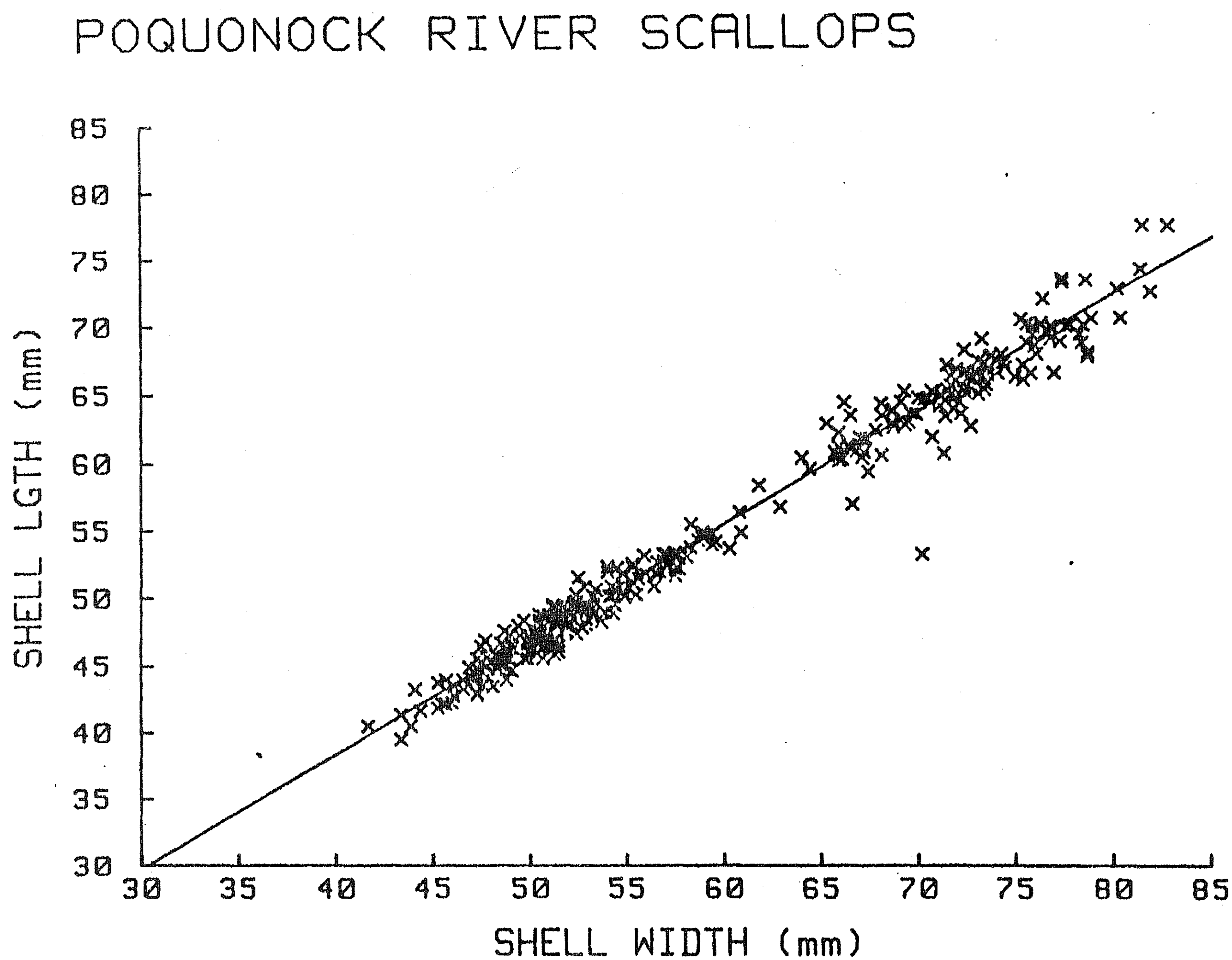


Figure 10. Regression of scallop shell length vs shell width Poquonock River (N = 323). October - November 1980.



****

POLYNOMIAL REGRESSION ON DATA SET:
MORPHOLOGICAL COMPARISONS-POQUONOCK (1980-81)

****

--where: Dependent variable = SHELL LGTH
Independent variable = SHELL WIDH

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL WIDH	323	59.61455	116.73112	10.80422	18.12346
SHELL LGTH	323	55.07028	85.70464	9.25768	16.81067

CORRELATION = .989255094099

Selected degree of regression = 2
R-SQUARED = .978630656813
STANDARD ERROR OF ESTIMATE = 1.35753396951

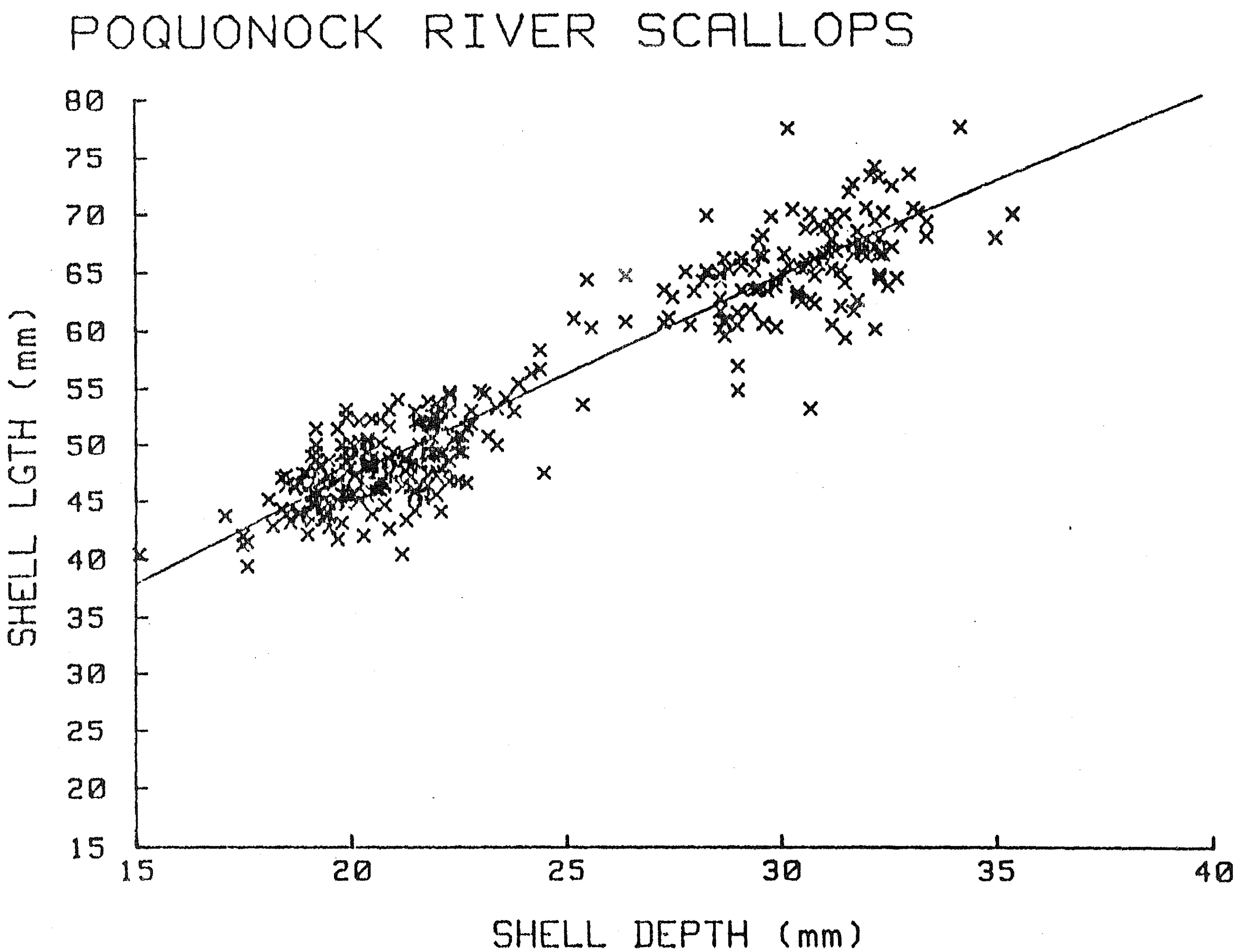
AOV

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	322	27596.89467		
REGRESSION	2	27007.16716	13503.58358	7327.36
X^1	1	27007.02874	27007.02874	14654.65
X^2	1	.13842	.13842	.08
RESIDUAL	320	589.72751	1.84290	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
'CONSTANT'	3.63234	.363234478919E+01	3.33150	1.09
X^1	.87784	.877838199298E+00	.11037	7.95
X^2	-.00024	-.243578179280E-03	.00089	-.27

	COEFFICIENT	95 % CONFIDENCE INTERVAL LOWER LIMIT	UPPER LIMIT
'CONSTANT'	3.63234	-2.92351	10.18820
X^1	.87784	.66065	1.09503
X^2	-.00024	-.00199	.00151

Figure 11. Regression of scallop shell length *vs*. shell depth Poquonock River (N = 323) October - November 1980.



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*                          DATA MANIPULATION                                *
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                    MORPHOLOGICAL COMPARISONS-POQUONOCK (1980-81)
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Data file name: DATA
Number of observations: 323
Number of variables: 3

Variables names:
1. SHELL WIDH
2. SHELL LGTH
3. SHELL DEPH

Subfiles: NONE

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*****************************************************************************
POLYNOMIAL REGRESSION ON DATA SET:
                    MORPHOLOGICAL COMPARISONS-POQUONOCK
*****************************************************************************
```

--where: Dependent variable = SHELL LGTH
Independent variable = SHELL DEPH

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL DEPH	323	24.48080	25.38075	5.03793	20.57911
SHELL LGTH	323	55.07028	85.70464	9.25768	16.81067

CORRELATION = .942216394287

Selected degree of regression = 2
R-SQUARED = .888017191146
STANDARD ERROR OF ESTIMATE = 3.10764067501

AOV

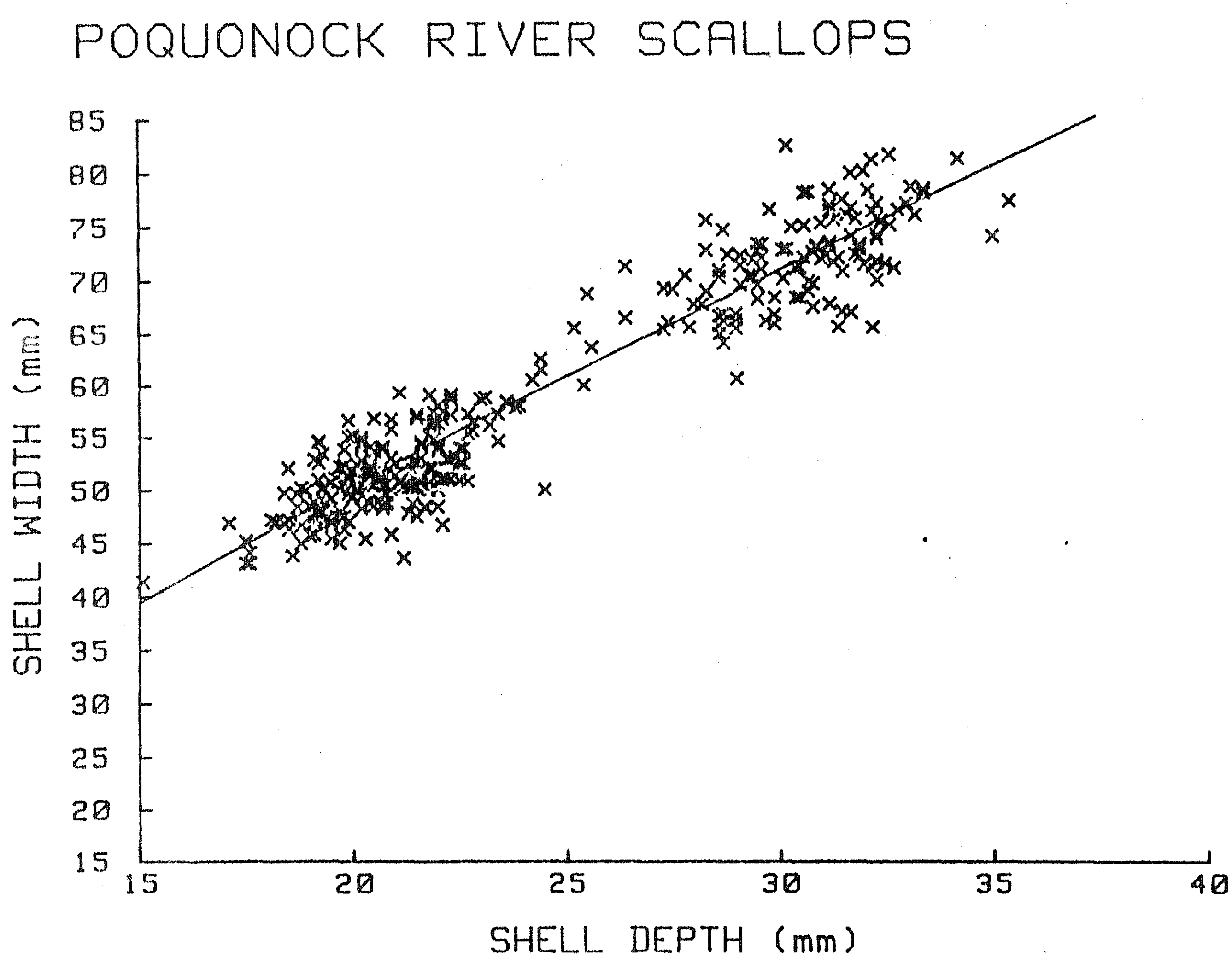
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	322	27596.89467		
REGRESSION	2	24506.51689	12253.25844	1268.79
X^1	1	24499.74302	24499.74302	2536.88
X^2	1	6.77386	6.77386	.70
RESIDUAL	320	3090.37778	9.65743	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
'CONSTANT'	7.17143	.717142611360E+01	6.63785	1.08
X^1	2.17976	.217975664221E+01	.53644	4.06
X^2	-.00875	-.874678175017E-02	.01044	-.84

95 % CONFIDENCE INTERVAL

	COEFFICIENT	LOWER LIMIT	UPPER LIMIT
'CONSTANT'	7.17143	-5.89080	20.23366

Figure 12. Regression of scallop shell width vs. shell depth Poquonock River (N = 323) October - November 1980.



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Data file name: DATA
Number of observations: 323
Number of variables: 3

Variables names:
   1. SHELL WIDH
   2. SHELL LGTH
   3. SHELL DEPH

Subfiles:  NONE


********************************************************************************
POLYNOMIAL REGRESSION ON DATA SET:
                 MORPHOLOGICAL COMPARISONS-POQUONOCK
********************************************************************************

--where:  Dependent variable = SHELL WIDH
          Independent variable = SHELL DEPH
```

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL DEPH	323	24.48080	25.38075	5.03793	20.57911
SHELL WIDH	323	59.61455	116.73112	10.80422	18.12346

CORRELATION = .953067699672

Selected degree of regression = 2
R-SQUARED = .908529157736
STANDARD ERROR OF ESTIMATE = 3.27783899522

AOV

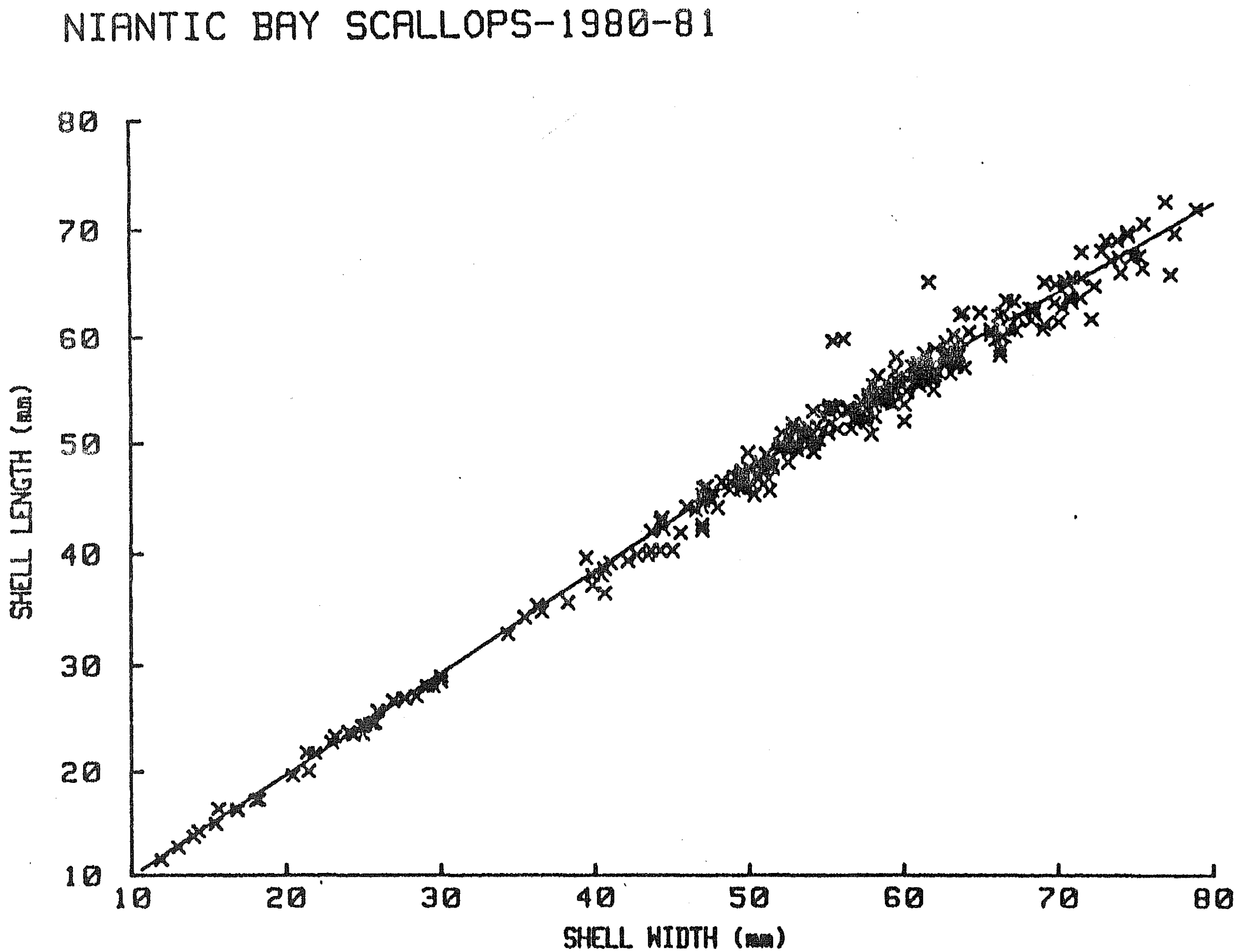
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	322	37587.42161		
REGRESSION	2	34149.26850	17074.63425	1589.19
X^1	1	34142.08488	34142.08488	3177.71
X^2	1	7.18362	7.18362	.67
RESIDUAL	320	3438.15311	10.74423	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
´CONSTANT´	3.90088	.390088001780E+01	7.00139	.56
X^1	2.50563	.250562957979E+01	.56581	4.43
X^2	-.00901	-.900744483000E-02	.01102	-.82

95 % CONFIDENCE INTERVAL

COEFFICIENT	LOWER LIMIT	UPPER LIMIT

Figure 13. Regression of scallop shell length vs. shell width. Niantic River (N= 301).



****
* DATA MANIPULATION *
****

NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS (1980-81)

Data file name: DATA
Number of observations: 301
Number of variables: 3

Variables names:
1. SHELL WIDH
2. SHELL LGTH
3. SHELL DEPH

Subfile name	beginning observation	--number of observations
1. 0-YR CLASS	1	34
2. 1-YR CLASS	35	67
3. SET #2	102	100
4. SET #2	202	100

****
POLYNOMIAL REGRESSION ON DATA SET:
NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS
****

--where: Dependent variable = SHELL LGTH
Independent variable = SHELL WIDH

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL WIDH	301	53.78771	198.89815	14.10313	26.21998
SHELL LGTH	301	50.12159	155.87923	12.48516	24.90974

CORRELATION = .993057019329

Selected degree of regression = 2
R-SQUARED = .987249351747
STANDARD ERROR OF ESTIMATE = 1.4145319353

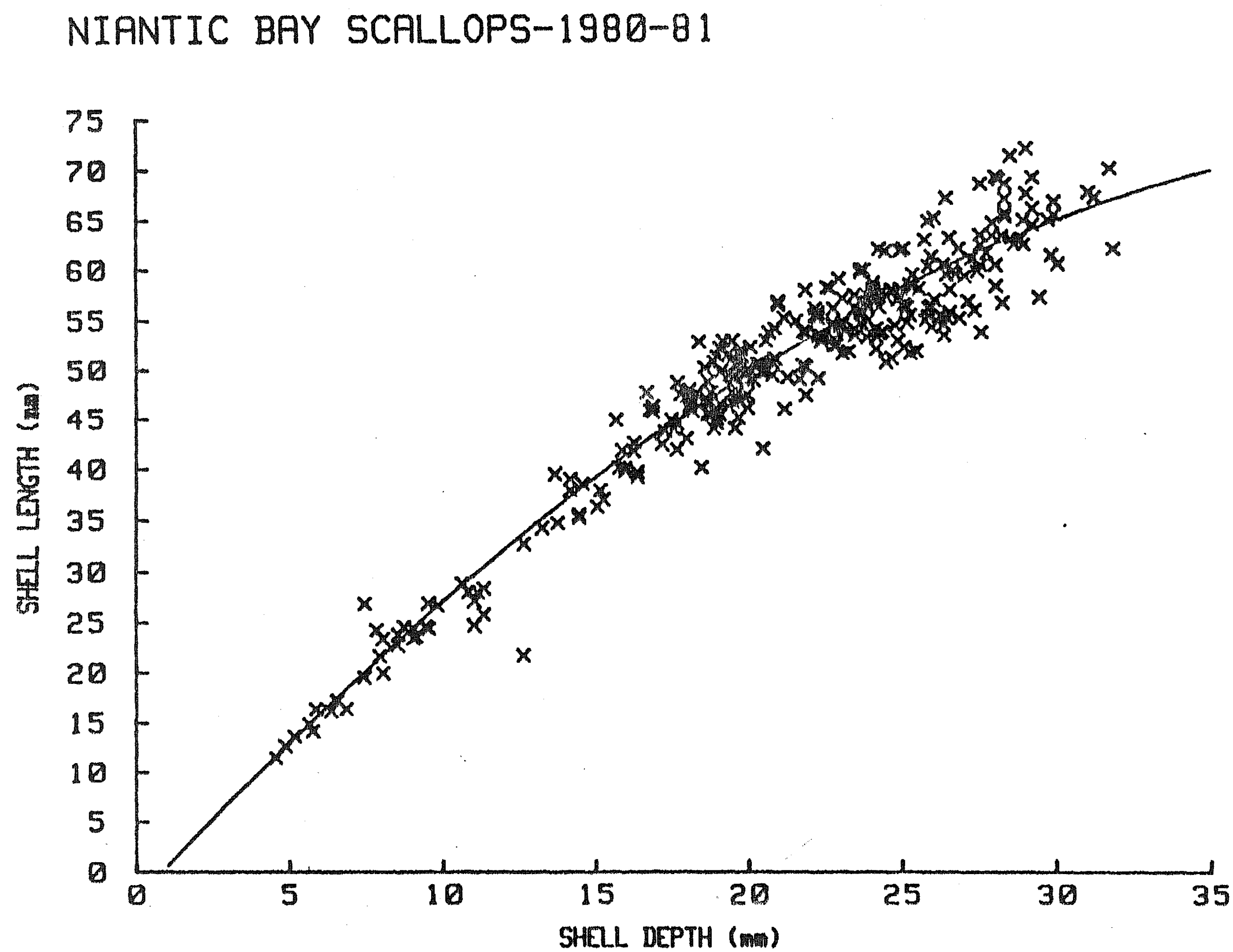
AOV

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	300	46763.76964		
REGRESSION	2	46167.50126	23083.75063	11536.68
X^1	1	46116.66398	46116.66398	23047.95
X^2	1	50.83727	50.83727	25.41
RESIDUAL	298	596.26838	2.00090	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
'CONSTANT'	-.18676	-.186761035050E+00	.68052	-.27
X^1	1.02557	.102556845922E+01	.02962	34.62
X^2	-.00157	-.157038611408E-02	.00031	-5.04

	COEFFICIENT	95 % CONFIDENCE INTERVAL LOWER LIMIT	UPPER LIMIT
'CONSTANT'	-.18676	-1.52629	1.15276

Figure 14. Regression of scallop shell length vs. shell depth. Niantic River (N = 301).



```
*****************************************************************************
+                              DATA MANIPULATION                             +
*****************************************************************************
```

NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS (1980-81)

Data file name: DATA
Number of observations: 301
Number of variables: 3

Variables names:
1. SHELL WIDH
2. SHELL LGTH
3. SHELL DEPH

Subfile name	beginning observation	number of observations
1. O-YR CLASS	1	34
2. 1-YR CLASS	35	67
3. SET #2	102	100
4. SET #2	202	100

```
*****************************************************************************
```

POLYNOMIAL REGRESSION ON DATA SET:
NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS

```
*****************************************************************************
```

--where: Dependent variable = SHELL LGTH
Independent variable = SHELL DEPH

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL DEPH	299	20.99365	36.33845	6.02814	28.71411
SHELL LGTH	299	50.03411	155.74803	12.47990	24.94279

CORRELATION = .959508775832

Selected degree of regression = 2
R-SQUARED = .93774743265
STANDARD ERROR OF ESTIMATE = 3.12429610053

AOV

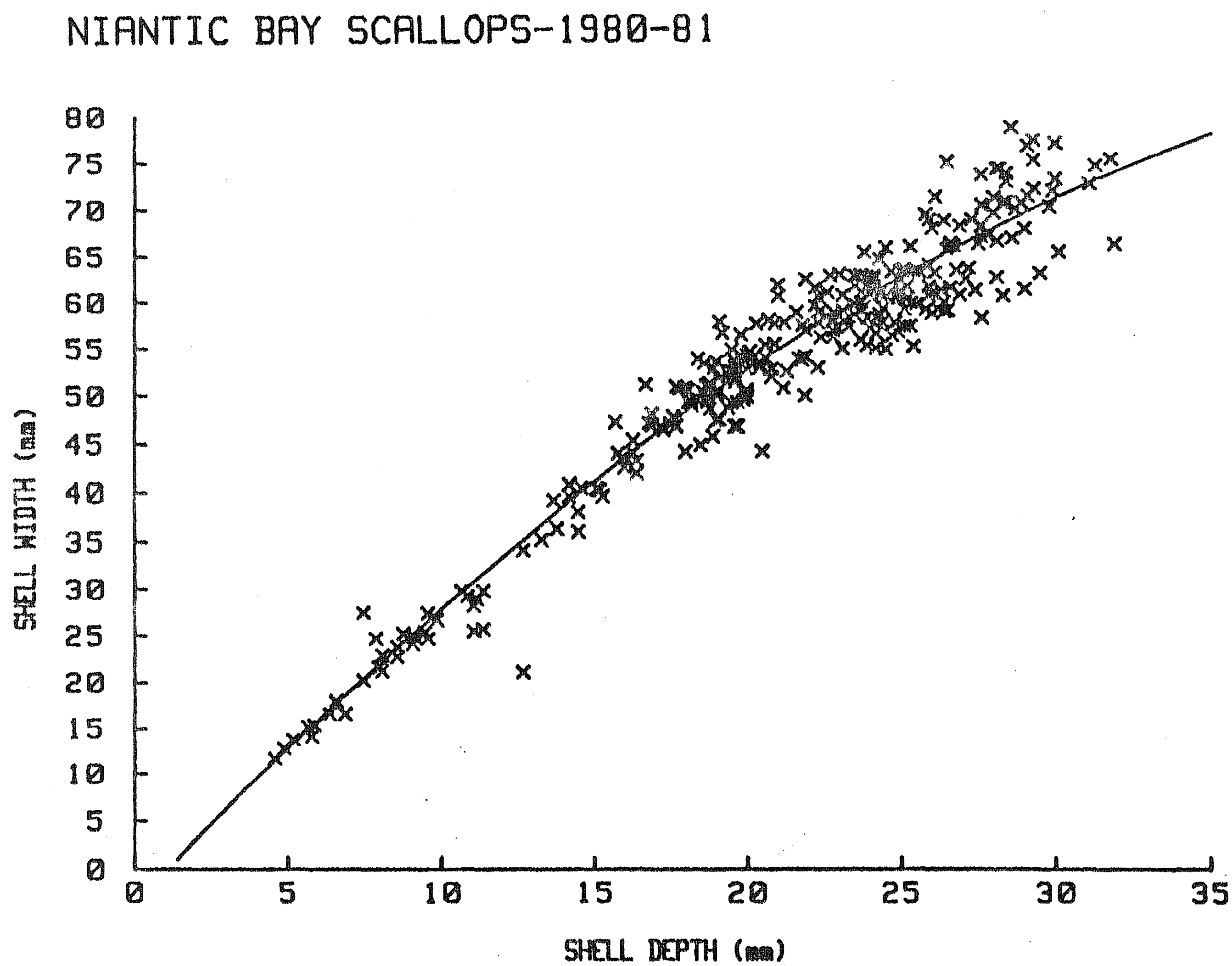
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	298	46412.91204		
REGRESSION	2	43523.58911	21761.79455	2229.41
X^1	1	42730.37657	42730.37657	4377.56
X^2	1	793.21253	793.21253	81.26
RESIDUAL	296	2889.32293	9.76123	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
'CONSTANT'	-2.79522	-.279521506720E+01	1.39764	-2.00
X^1	3.33720	.333719919038E+01	.15282	21.84
[illegible]	[illegible]	[illegible]	.00401	-9.01

95 % CONFIDENCE INTERVAL

	COEFFICIENT	LOWER LIMIT	UPPER LIMIT
'CONSTANT'	-2.79522	-5.54640	-.04403
X^1	3.33720	3.03638	3.63802
X^2	-.03613	-.04402	-.02824

Figure 15. Regression of scallop shell width *vs*. shell depth. Niantic River (N = 301).



```
****************************************************************************
*                           DATA MANIPULATION                              *
****************************************************************************
```

NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS (1980-81)

Data file name: DATA
Number of observations: 301
Number of variables: 3

Variables names:
1. SHELL WIDH
2. SHELL LGTH
3. SHELL DEPH

Subfile name	beginning observation	number of observations
1. 0-YR CLASS	1	34
2. 1-YR CLASS	35	67
3. SET #2	102	100
4. SET #2	202	100

```
****************************************************************************
```

POLYNOMIAL REGRESSION ON DATA SET:
NIANTIC BAY SCALLOPS-DEPTH/LENGTH RELATIONSHIPS

```
****************************************************************************
```

--where: Dependent variable = SHELL WIDH
Independent variable = SHELL DEPH

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
SHELL DEPH	299	20.99365	36.33845	6.02814	28.71411
SHELL WIDH	299	53.67659	198.36791	14.08431	26.23921

CORRELATION = .964706424408

Selected degree of regression = 2
R-SQUARED = .94176839041
STANDARD ERROR OF ESTIMATE = 3.41018059477

AOV

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	298	59113.63612		
REGRESSION	2	55671.35394	27835.67697	2393.57
X^1	1	55014.60704	55014.60704	4730.68
X^2	1	656.74689	656.74689	56.47
RESIDUAL	296	3442.28218	11.62933	

VARIABLE	REGRESSION COEFFICIENTS STD. FORMAT	E-FORMAT	STANDARD ERROR REG. COEFFICIENT	T-VALUE
'CONSTANT'	-3.76671	-.376671240800E+01	1.52553	-2.47
X^1	3.48305	.348304676521E+01	.16680	20.88
X^2	-.03287	-.328725144370E-01	.00437	-7.51

95 % CONFIDENCE INTERVAL

	COEFFICIENT	LOWER LIMIT	UPPER LIMIT
'CONSTANT'	-3.76671	-6.76964	-.76378
X^1	3.48305	3.15470	3.81139

Table XIII Natural population first annulus shell length dimensions (dorsal valve) - 1979 year class. Poquonock River Stations 1/2A, 3 and Niantic River Station 2. October - November 1980.

Poquonock River Station 1/2A

Date (1980)	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
8 October	50	41.94	3.06	.433	41.07 - 42.81
17 October	250	42.58	3.88	.246	42.09 - 43.06
30 October	125	42.67	3.13	.280	42.12 - 43.23
6 November	200	41.66	4.68	.331	41.01 - 42.31
17 November	73	42.75	2.98	.349	42.05 - 43.44
	748				

Poquonock River Station 3

Date (1980)	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
6 October	52	40.55	3.45	.478	39.59 - 41.51
17 November	63	36.65	3.49	.439	37.77 - 39.53
	115				

Niantic River

Date (1980)	N	Shell lgth. Mean (mm)	S.D.	Standard Error	95% Confidence Interval Lower - Upper Limit
14 October	200	46.37	4.36	.308	45.76 - 46.97
17 November	127	46.38	3.67	.326	45.74 - 47.03
	327				

Figure 16. Histogram of scallop first annulus shell length - Poquonock River population Station 1/2A, October - November 1980.

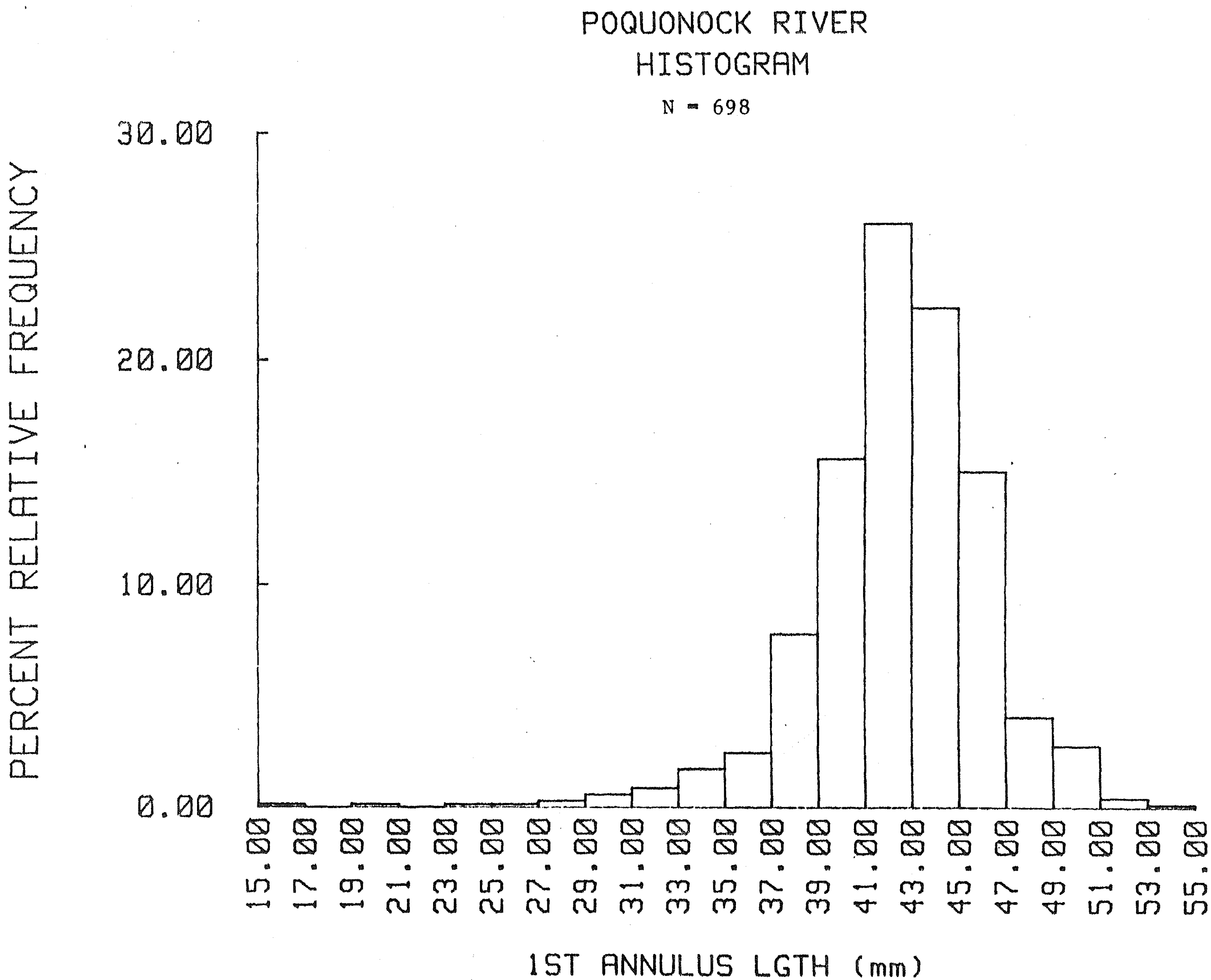


Figure 17. Histogram of scallop total shell length - Poquonock River population Station 1/2A, October - November 1980.

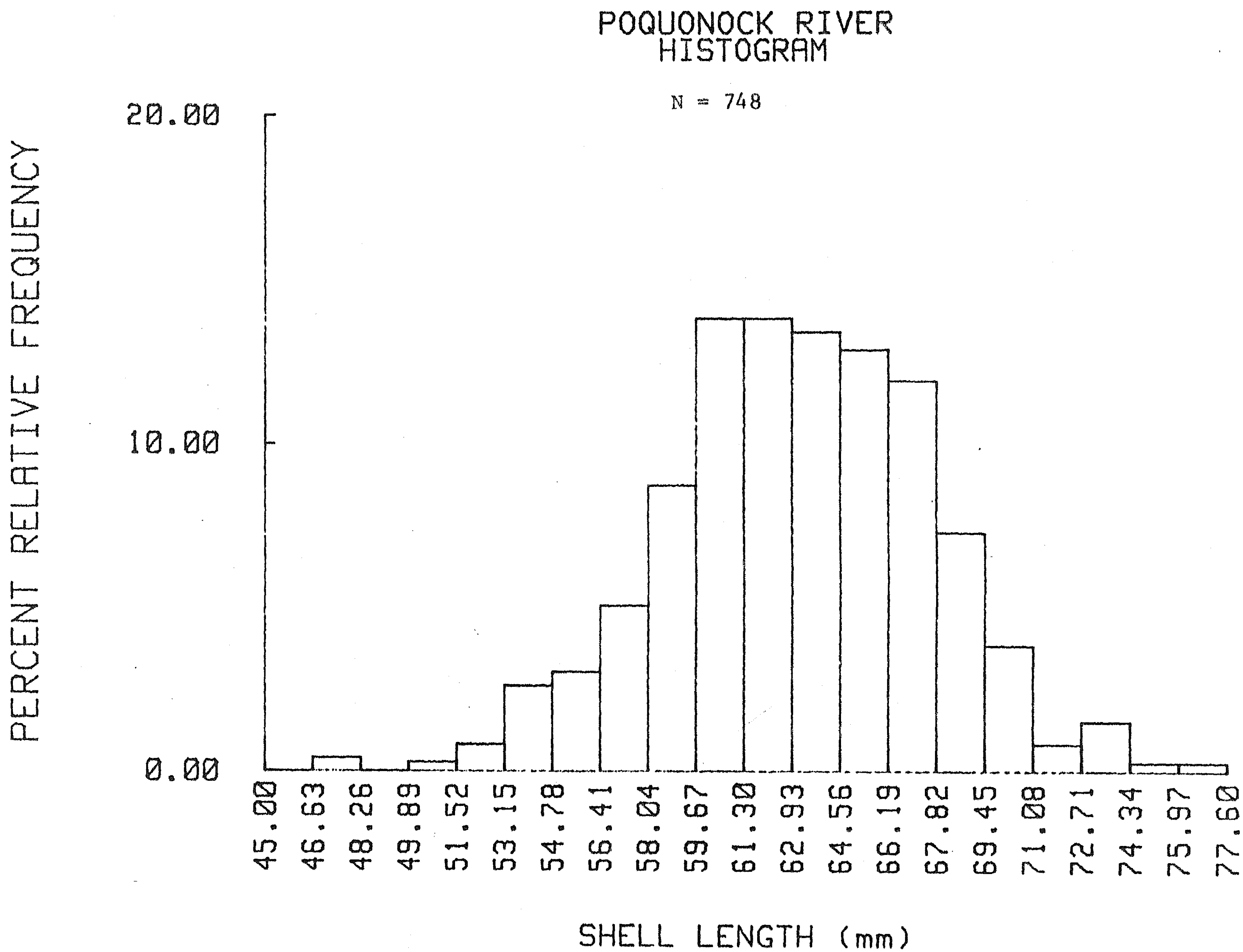
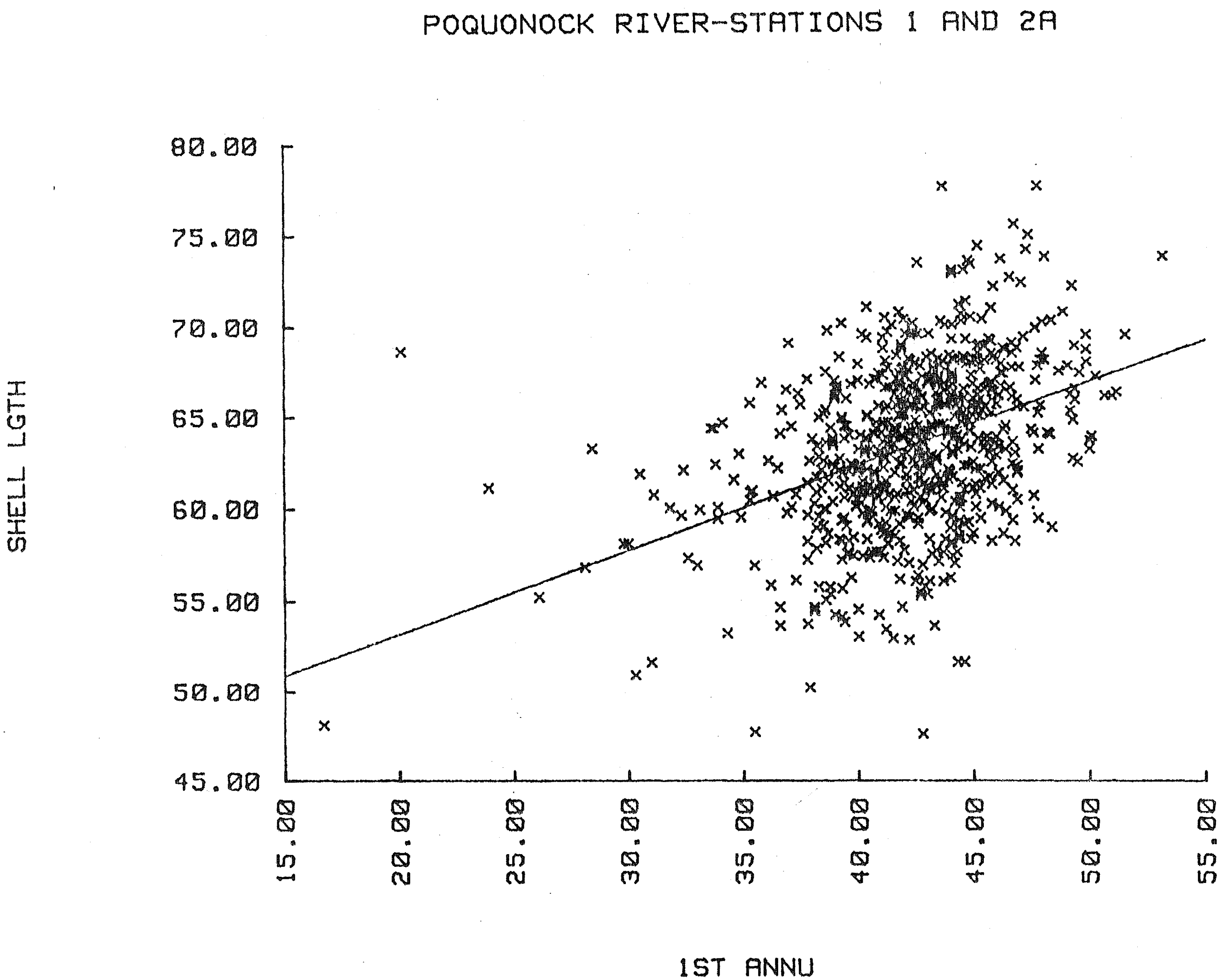


Figure 18. Regression (first order) of total shell length *vs* first annulus dimension of Poquonock River pooled population data Station 1/2A, October - November 1980.



```
********************************************************************************
*                              DATA MANIPULATION                               *
********************************************************************************
                      POQUONOCK RIVER-STATIONS 1 AND 2A
                                 (1980-81)
Data file name: PANNU1:T14
Number of observations: 748
Number of variables: 2

Variables names:
   1. SHELL LGTH
   2. 1ST ANNU

Subfiles:  NONE


********************************************************************************
POLYNOMIAL REGRESSION ON DATA SET:
                      POQUONOCK RIVER-STATIONS 1 AND 2A
********************************************************************************

--where:  Dependent variable = 1ST ANNU
          Independent variable = SHELL LGTH


********************************************************************************
POLYNOMIAL REGRESSION ON DATA SET:
                      POQUONOCK RIVER-STATIONS 1 AND 2A
********************************************************************************

--where:  Dependent variable = SHELL LGTH
          Independent variable = 1ST ANNU
```

VARIABLE	N	MEAN	VARIANCE	STANDARD DEVIATION	COEFFICIENT OF VARIATION
1ST ANNU	698	42.30458	15.15691	3.89319	9.20276
SHELL LGTH	698	63.30587	19.99545	4.47163	7.06353

CORRELATION = .395474290162

Selected degree of regression = 1
R-SQUARED = .156399915678
STANDARD ERROR OF ESTIMATE = 4.110035993

AOV

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE
TOTAL	697	13936.82592		
REGRESSION	1	2179.71840	2179.71840	129.04
X^1	1	2179.71837	2179.71837	129.04
RESIDUAL	696	11757.10752	16.89240	

REG ESSION COEFFICIENTS   STANDARD ERROR

VARIABLE	STD. FORMAT	E-FORMAT	REG. COEFFICIENT	T-VALUE
'CONSTANT'	44.08974	.44089744259GE+02	1.69879	25.95
X^1	.45423	.454232794887E+00	.03999	11.36

	COEFFICIENT	95 % CONFIDENCE INTERVAL LOWER LIMIT	UPPER LIMIT
'CONSTANT'	44.08974	40.75364	47.42585
X^1	.45423	.37570	.53276

```
****************************************************************************
*                           SUMMARY STATISTICS                              *
*                              ON DATA SET:                                 *
*                  POQUONOCK RIVER-STATIONS 1 AND 2A                        *
****************************************************************************
```

BASIC STATISTICS

VARIABLE	# OBSERVATIONS	# MISS. VALUES	SUM	MEAN
SHELL LGTH	748	0	47220.80000	63.12941
1ST ANNU	698	50	29528.60000	42.30458

VARIABLE	VARIANCE	STANDARD DEV.	COEF OF SKEWNESS	COEF OF KURTOSIS
SHELL LGTH	20.11410	4.48487	-.14369	.34173
1ST ANNU	15.15691	3.89319	-1.28216	5.38451

VARIABLE	COEF VARIATION	STANDARD ERROR OF THE MEAN	95 % CONFIDENCE INTERVAL ON MEAN LOWER LIMIT	UPPER LIMIT
SHELL LGTH	7.10426	.16398	62.80742	63.45141
1ST ANNU	9.20276	.14736	42.01520	42.59397

CORRELATION MATRIX

	1ST ANNU
SHELL LGTH	.3954743

ORDER STATISTICS

VARIABLE	MAXIMUM	MINIMUM	RANGE	MIDRANGE
SHELL LGTH	77.60000	47.60000	30.00000	62.60000
1ST ANNU	53.20000	16.70000	36.50000	34.95000

Figure 19. Histogram of scallop first annulus shell length - Niantic River population Station 2, October - November 1980.

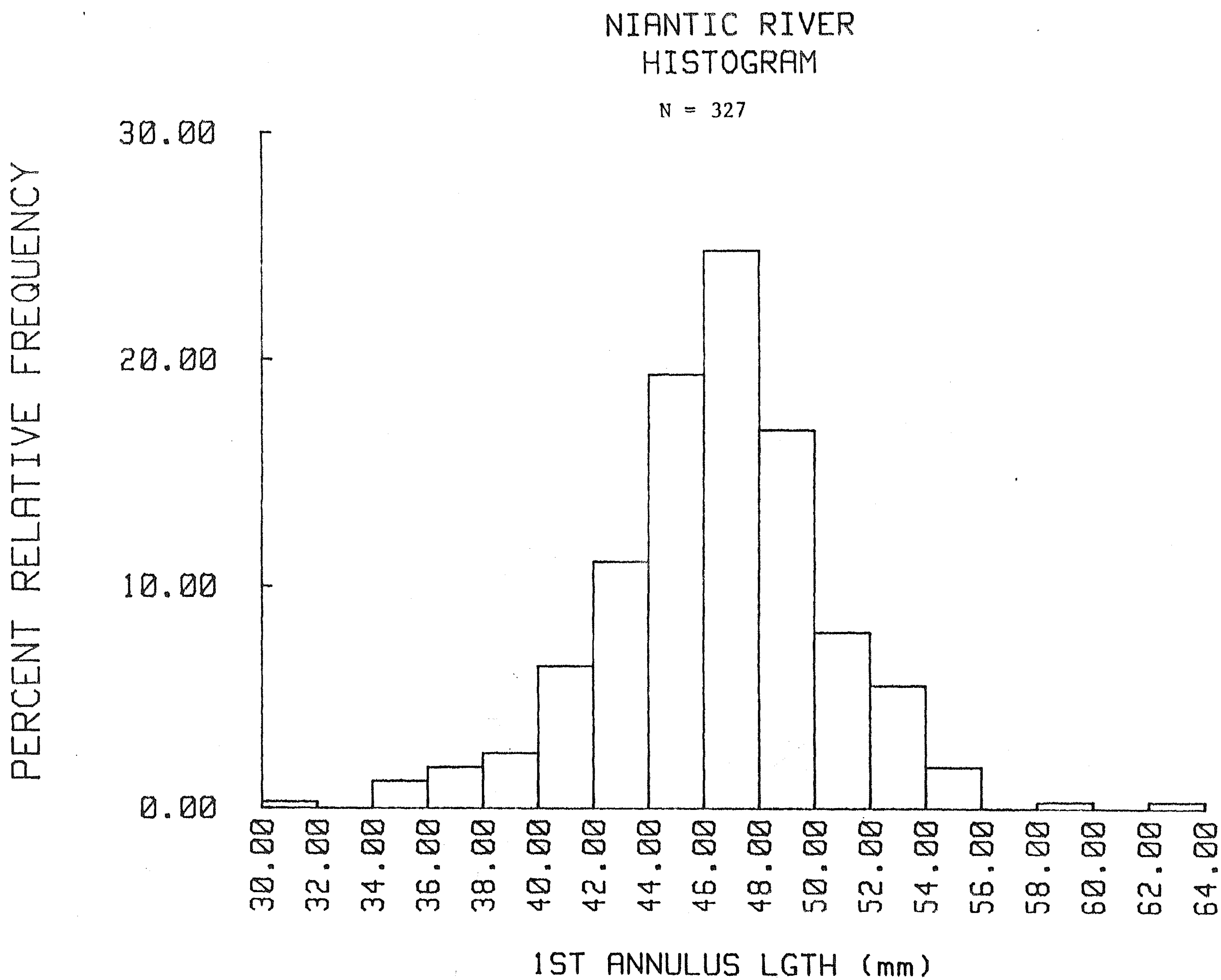
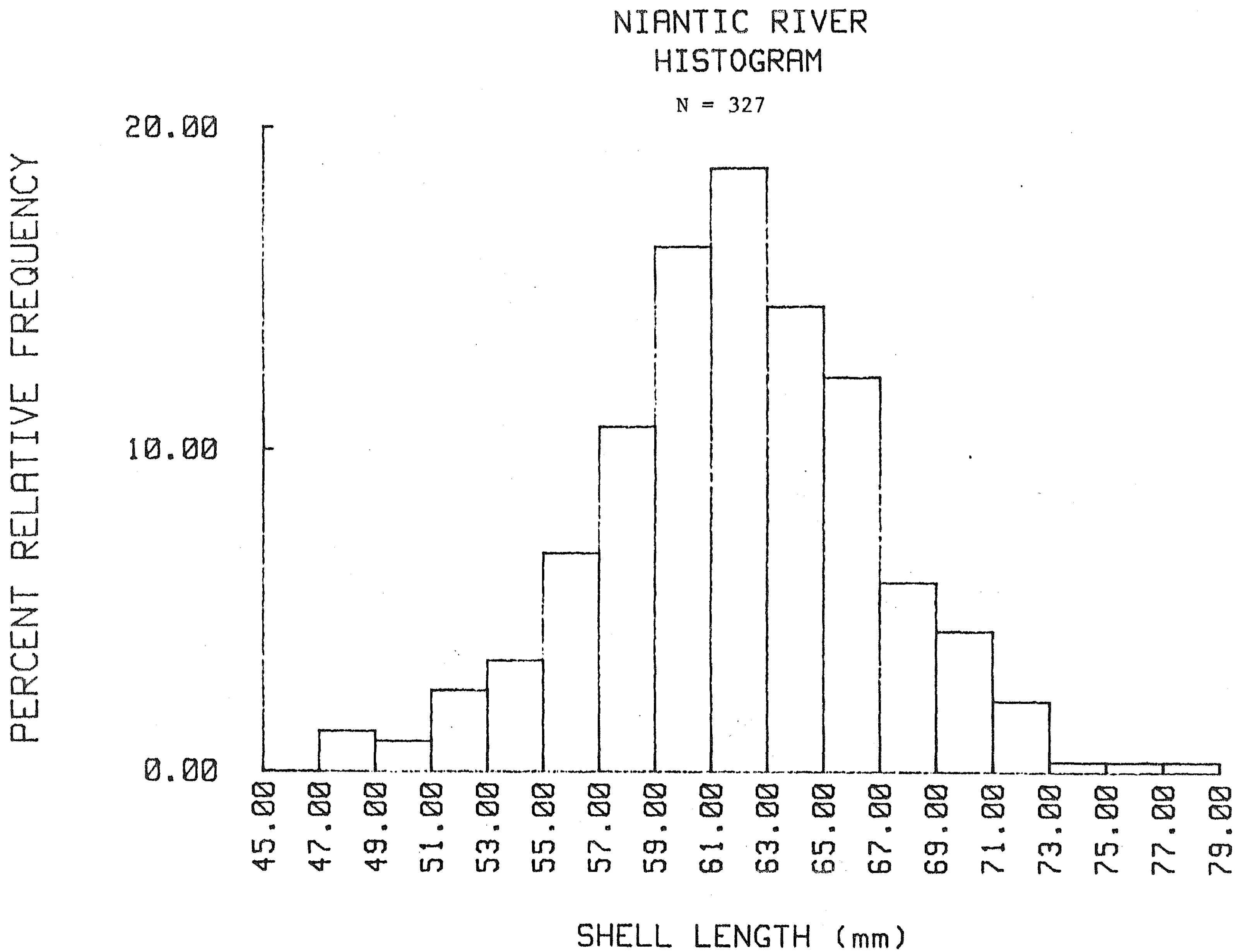


Figure 20. Histogram of scallop total shell length - Niantic River population Station 2, October - November 1980.



SUMMARY STATISTICS
ON DATA SET:
NIANTIC RIVER-STATION 2

(SUBFILES IGNORED)

BASIC STATISTICS

VARIABLE	# OBSERVATIONS	# MISS. VALUES	SUM	MEAN
SHELL [illegible]	327	0	20204.80000	61.78838
1ST [illegible]	327	0	15164.10000	46.37339

VARIABLE	VARIANCE	STANDARD DEV.	COEF OF SKEWNESS	COEF OF KURTOSIS
SHELL LGTH	24.53379	4.95316	-.10087	.33471
1ST ANNU	16.79748	4.09847	-.18613	1.54804

VARIABLE	COEF VARIATION	STANDARD ERROR OF THE MEAN	95 % CONFIDENCE INTERVAL ON MEAN LOWER LIMIT	UPPER LIMIT
SHELL LGTH	8.01633	.27391	61.24941	62.32735
1ST ANNU	8.83798	.22665	45.92742	46.81937

CORRELATION MATRIX

	1ST ANNU
SHELL LGTH	.4417786

ORDER STATISTICS

VARIABLE	MAXIMUM	MINIMUM	RANGE	MIDRANGE
SHELL LGTH	77.70000	47.50000	30.20000	62.60000
1ST ANNU	63.80000	31.80000	32.00000	47.80000

Table XIV Diver survey of scallop density determined by random .25 square meter quadrant placement, or spotter scope estimate. Poquonock River.

Station 1/2A

Date 1979 Year Class	N (.25 m^2 Quadrant Samples)	Mean Density (.25 m^2)	Maximum Density (.25 m^2)
15 May 1980	28	5.5	14
5 June 1980	21	3.8	12
8 July 1980	7	8.8	15
14 July 1980	30	2.8	9
29 August 1980	15	1.9	5
8 October 1980	21	1.3	4
3 November 1980	8	1.8	3
1980 Year Class			
8 December 1980	Diver	0	0
9 January 1981	Scope	0	0
20 April 1981	Diver	$1/m^2$	0

Station 3

1979 Year Class			
15 May 1980	5 Diver	-	20
5 June	7 "	-	8
9 July 1980	5 "	-	3
14 July 1980	11 "	4.0	8
28 July 1980	-	4-5	11
29 August 1980	15 "	1.8	6
6 October 1980	32 "	4.7	13
3 November 1980	22 "	1.9	9
1980 Year Class			
8 Decmeber 1980	- Scope	0	0
20 April 1981	- "	-	3-4
4 June 1981	10 Diver	0.6	

Table XIV (cont'd)

Station 4

Date 1979 Year Class	N (.25 m^2 Quadrant Samples	Mean Density (.25 m^2)	Maximum Density (.25 m^2)
15 May 1980	Diver	1	-
14 July 1980	"	0	0
28 July 1980	"	0	0
4 August 1980	"	0	0
1980 Year Class			
8 December 1980	Scope	* 1-2 per m^2	-
9 January 1981	"	* 1/4 per m^2	-
20 April 1981	"	-	1-3
14 May 1981	Diver	* 1 per m^2	4
4 June 1981	1 Diver	1.4	3

*Scope estimate of density per square meter (m^2)

Table XV Diver survey of scallop density determined by random .25 square meter quadrant placement, or spotter scope estimate. Niantic River.

Station 1 - N. of Boat Launch

Date 1979 Year Class	N (.25 m^2 Quadrant Samples)	Mean Density (.25 m^2)	Maximum Density (.25 m^2)
18 June 1980		0	0
23 July 1980	5	3,4	6
12 September 1980	20	1.5	5
1980 Year Class			
26 March 1981		0	0
Station 2 - E. of Camp O'Neill			
18 June 1980	10	7.5	16
23 July 1980	10	5.2	11
5 September 1980	13	2.3	6
12 September 1980	20	6.2	12
4 June 1981 (Channel)	5	2.0	4
1980 Year Class			
26 March 1981	19	1.1	3
3 April 1981	13	1.8	5
13 April 1981	-	3	6
4 June 1981	16	2.7	8
Station 3 - S. of Sandy Point			
1979 Year Class			
18 June 1980		*1/2 m^2	-
23 July 1980	7	2.1	4
12 September 1980	10	.2	1
1980 Year Class			
26 March 1981	14	1.2	4
4 June 1981	5	1.1	4

*Scope estimate of density per square meter (m^2).

Table XV (cont'd.)

Station 1 - Little Narragansett Bay

Date 1979 Year Class	N (.25 m^2 Quadrant Samples	Mean Density (.25 m^2)	Maximum Density (.25 m^2)
18 June 1980		0	0
6 August 1980		0	0
8 August 1980		0	0
1980 Year Class			
19 November 1980	9	2.3	5
20 April 1981	-	-	3
27 April 1981	17	1.6	4
14 May 1981	14	2.1	5

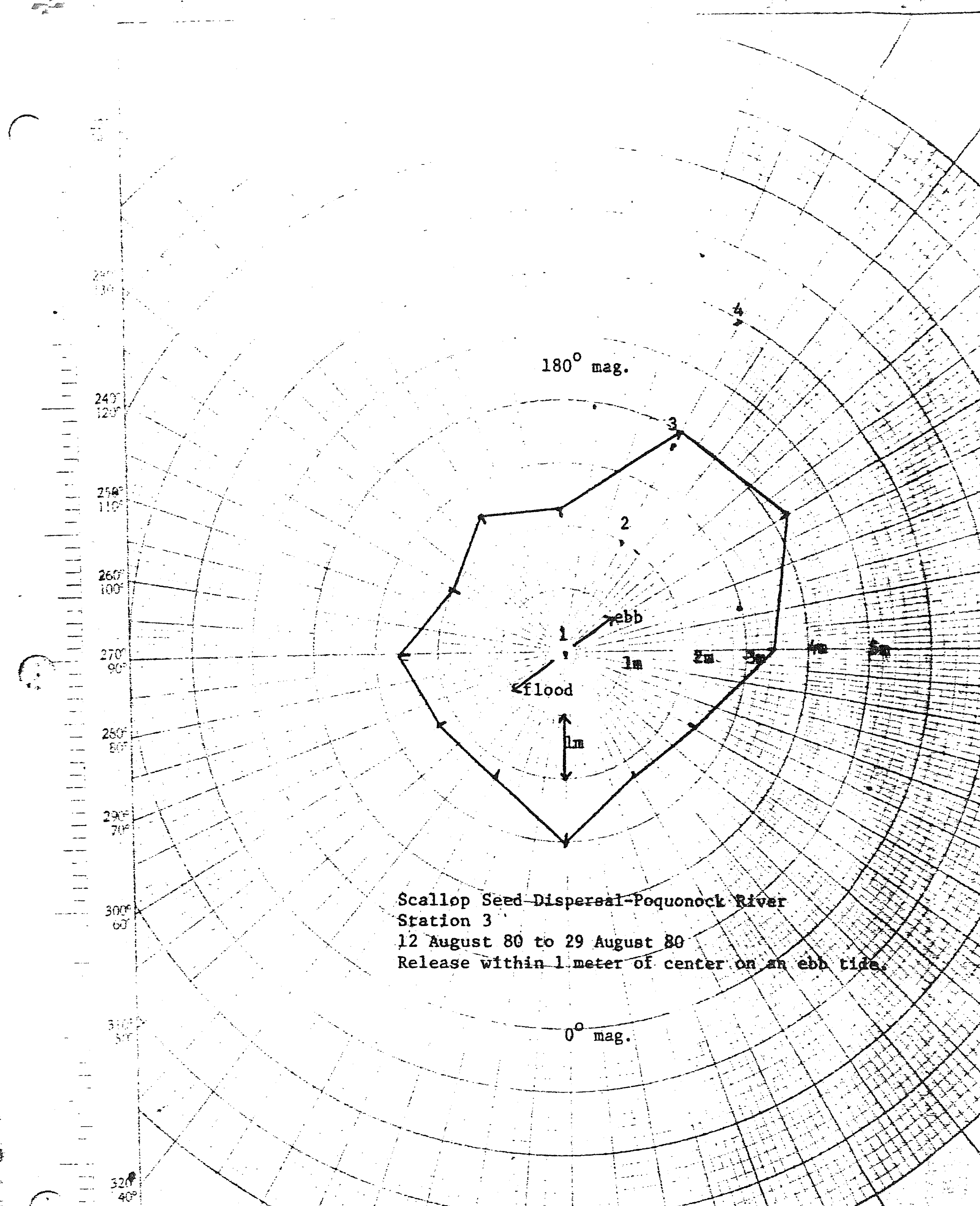


Figure 22. Disperseion limits determined in mass point release (NMFS laboratory scallop seed). Poquonock River Station 3.

Table XVI Scallop laboratory seed dispersion/predation counts for .25 meter quadrants radiating in 1 m intervals from release point, 12 August 80, Poquonock River Station 3.

Densities at location (count per 1/4 m^2 quadrant)

Location	29 August	6 October	(adults)
1 m	70, 73, 82	15, 11	0
2	50, 53	5	2, 1
3	18, 22, 28	3, 3, 4	3, 3
4	0	1	4, 3

(Great decrease in seed scallop densities observed over ~ 35 day period. Diver observations indicated intense predation on point concentration of seed ~ 20 half valves sighted).

Table XVII Laboratory (NMFS) scallop seed release: date, location, number, tag type, release method. Poquonock River, Stations 1, 2A, 3, 4, and Little Narragansett Bay Stations 1, 3. August 1980 - July 1981.

Date Released	Location	Number		Release Method
	Poquonock River			
12 August 1980	Station 3	10,000 -	1500 with dorsal tags	Point
12 August 1980	Station 1	10,000 -	1500 with lavander dorsal tags	Point
9 January 1981	Station 4A	3,000 -	200 with numbered tags	Dispersed
9 January 1981	Station 2A	500		Dispersed
25 June 1981	Station 3	21,000	shell length $\bar{X}$ 8.0 mm non-tagged	Dispersed
	2A	21,000	" "	
22 July 1981	Station 3	16,000	shell length 2-3 cm non-tagged	Dispersed and Point with time-lapse photography.
	4	16,000		
	2A	8,000		

<u>Little Narragansett Bay</u>

8 August 1980	Barn Island	10,000 -	1500 with white dorsal tags	Dispersed
8 August 1980	Randall Neck	10,000 -	1500 with red dorsal tags	Dispersed

Table XVIII Tagged scallop collection and release summary: area, date, station, number individuals, tag numbers, year class/hatchery seed, recaptures (number/%). Poquonock River, Stations 1/2A,3, 4. July 1980 - June 1981.

Date Released	Station Location	Number Released	Year Class	Tag Numbers	Number (Percent) Recapture[1]
8 July 80	Station 1	100	1-Natural Pop.	A 1 -100	45 (45%)
9 July 80	Station 3	100	1-Natural Pop.	A 101-200	17 (17%)
6 Oct 80	Station 3	100	1-Natural Pop.	401-500	18 (18%)
8 Oct 80	Station 1	100	1-Natural Pop.	301-400	6 (6%)
3 Nov 80	Station 2A	200	0-Hatchery Stock	1-100	-
				Y 1-100	-
8 Dec 80	Station 3	300	0-Hatchery Stock	W 1-100	-
				X 1-100	-
				V 1-100	1 (1%)
9 Jan 81	Station 4 A	300	0-Natural Pop.	T 1-100	1 (1%)
			0-Hatchery Stock	S 1-100	-
			0-Hatchery Stock	R 1-100	4 (4%)
14 May 81	Station 3	100	1-Natural Pop.	H 1-100	-
	Station 4A	100	1-Natural Pop.	201-300	6 (6%)
28 May 81	Station 3	100	1-Natural Pop.	G 1-100	-
11 June 81	Station 3	60	1-Natural Pop.	E 1-60	-
	Station 4A	100	1-Natural Pop.	F 1-100	-
		Total 1660			93

[1]Number and percent recapture per tagging series. Double recaptures not included.

Table XIX Tagged scallop collection and release summary: area, date, station, number individuals, tag numbers, year class, recaptures. Niantic River Station 3, 2A. Little Narragansett Bay, Station 1. April - May 1981.

Niantic

Date Released	Station Location	Number Released	Year Class	Tag Numbers	Number (Percent) Recapture
3 April 1981	Station 3	200	1-Natural Population	N 1-100	7 (7%)
			1-Natural Population	Q 1-100	3 (3%)
	Station 2A	100	1- " "	P 1-100	-
13 April 1981	Station 2A	100	1- " "	M 1-100	-
	Station 2A	100	1- " "	L 1-100	-
		Total 500			

Little Narragansett Bay

27 April 1981	W.Barn Is.	300	1-Natural Population	K 1-100	_
				J 1-100	-
				L 1-100	-
14 May 1981	W.Barn Is.	100	1- " "	A 1-100	-
28 May 1981	W. Barn Is.	300	1 " "	B 1-100	-
				C 1-100	-
		Total 700		D 1-100	-

Table XX Individual scallop tag returns (date, movement, growth) for the Poquonock River, Stations 1/2A, 3 and 4.

Tag #	Release Location Date	Shell Width	Shell Length	Recapture Date	Return Width	Return Length	Recapture Method
A 3	8 July 80 – Stn. 1	48.8	45.0	4 Aug 80	48.8	45.0	Diver
A 5	"	50.4	47.7	21 July 80	51.7	48.8	Diver
A 7	"	51.8	47.0	21 July 80	52.1	47.7	Diver
A 12	"	49.0	46.1	4 Aug 80	50.5	47.5	Diver
A 14	"	49.1	46.5	28 July 80	51.9	48.3	Diver
A 15	"	48.5	44.9	28 July 80	51.1	47.0	Diver
A 18	"	51.2	47.8	28 July 80	52.4	49.3	Diver
A 19	"	50.6	47.3	28 July 80	52.6	48.5	Diver
				4 Aug 80	52.9	48.9	Diver
A 20	"	46.7	41.8	4 Aug 80	50.6	45.3	Diver
A 22	"	47.4	44.0	28 July 80	48.3	45.2	Diver
A 23	"	47.1	43.6	28 July 80	48.7	44.6	Diver
A 24	"	47.3	43.2	21 July 80	48.7	43.9	Diver
A 25	"	44.6	41.6	28 July 80	47.0	43.7	Diver
A 26	"	54.0	50.0	21 July 80	55.5	50.8	Diver
A 29	"	47.4	45.5	21 July 80	48.7	46.4	Diver
A 30	"	51.2	47.7	4 Aug 80	54.0	49.9	Diver
A 32	"	51.1	48.1	21 July 80	52.2	48.8	Diver
A 34	"	44.4	42.8	28 July 80	44.4	43.2	Diver
				4 Aug 80	45.1	43.2	Diver
A 36	"	49.8	47.7	28 July 80	54.3	52.4	Diver
A 39	"	50.8	47.2	28 July 80	51.3	47.2	Diver
A 41	"	49.0	45.7	21 July 80	49.6	46.6	Diver
A 44	"	51.2	49.1	21 July 80	53.1	50.4	Diver
				28 July 80	54.2	51.3	Diver
A 45	"	43.7	40.4	21 July 80	45.7	41.8	Diver

Table XX (continued)

Tag #	Release Date	Shell Width	Shell Length	Recapture Date	Return Width	Return Length	Recapture Method
A 46	8 July 80 Stn 1	47.5	45.1	28 July 80	49.5	46.8	Diver
				4 Aug 80	50.5	47.4	Diver
A 47	"	48.1	43.7	21 July 80	49.3	44.6	Diver
				28 July 80	49.4	44.9	Diver
A 53	"	49.2	46.3	21 July 80	51.1	47.8	Diver
A 57	"	50.4	48.2	29 Aug 80	60.1	56.2	Diver
A 58	"	54.1	51.7	28 July 80	55.9	53.3	Diver
A 60	"	46.5	42.7	28 July 80	48.3	43.6	Diver
				4 Aug 80	48.3	43.7	Diver
A 61	"	49.5	47.6	21 July 80	51.5	49.1	Diver
A 63	"	49.4	44.5	21 July 80	50.8	46.1	Diver
A 68	"	47.7	43.9	Season	46.9	43.4	Fisherman
A 70	"	49.3	44.9	28 July 80	52.2	46.9	Diver
				4 Aug 80	53.2	47.6	Diver
A 71	"	43.0	41.4	21 July 80	44.9	42.5	Diver
A 72	"	50.9	46.9	4 Aug 80	51.3	47.2	Diver
A 75	"	49.7	46.0	21 July 80	50.3	46.4	Diver
A 78	"	42.7	40.1	21 July 80	44.0	40.7	Diver
				4 Aug 80	46.4	42.6	Diver
A 85	"	49.3	45.8	21 July 80	51.9	48.0	Diver
A 87	"	47.0	43.9	21 July 80	48.1	44.9	Diver
				28 July 80	48.6	45.7	Diver
A 91	"	47.2	45.4	21 July 80	48.8	46.5	Diver
				4 Aug 80	50.2	48.7	Diver
A 93	"	48.5	45.7	4 Aug 80	52.5	49.0	Diver
A 94	"	46.1	41.7	28 July 80	Mortality		

Table XX (continued)

Tag #	Release Date		Shell Width	Shell Length	Recapture Date	Return Width	Return Length	Recapture Method
A 96	8 July 1980	Stn 1	48.2	45.0	21 July 1980	49.5	45.8	Diver
					28 July "	50.4	46.4	Diver
					4 August "	51.2	46.4	Diver
A 97	"		52.7	49.7	21 July 1980	54.3	50.9	Diver
A 100	"		50.2	46.6	28 July 1980	53.2	49.9	Diver
A 104	9 July 1980	Stn 3	50.3	47.0	8 October 1980	69.2	63.5	Diver
A 105	"		54.4	50.8	Season	66.2	58.6	Fisherman
A 107	"		50.9	46.7	17 October 1980	67.9	61.9	Diver
	"		50.9	46.7	11 November 1980	68.0	61.8	Fisherman
A 122	"		49.5	47.4	28 July 1980	Mortality		
A 126	"		52.5	51.7	28 July "	55.7	53.9	Diver
					Season	70.9	68.0	Fisherman
A 132	"		52.1	48.7	28 July "	53.7	49.6	Diver
A 140	"		55.3	52.7	28 July "	57.5	54.3	Diver
					7 November "	76.8	70.9	Fisherman
A 143	"		48.4	44.9	7 November 1980	70.7	63.3	Fisherman (mid bay E)
A 147	"		56.5	52.0	Season	73.4	66.6	Diver
A 148	"		50.5	48.2	28 July 1980	52.5	49.8	Diver
					29 August "	59.0	55.5	Diver
A 151	"		47.2	44.0	29 August "	60.8	54.9	Diver
A 152	"		46.0	42.4	29 August "	59.9	55.4	Diver
A 156	"		47.3	45.7	6 October "	59.9	55.9	Diver
315	8 October	Stn 1	68.5	61.9	6 November "	71.4	63.5	Diver (within 10 m of rel.)
327	"	"	67.6	60.0	3 November "	68.0	62.5	Fisherman
334	"		74.0	65.7	Season	75.2	66.4	Fisherman
345	"		72.3	66.2	11 October "	71.9	66.1	Fisherman
353	"		74.0	64.6	Season	75.0	65.2	Fisherman
377	"		68.1	61.9	3rd wk.Apr.1981	68.1	61.8	Half valve on Bushy Pt.beach

Table XX (continued)

Tag #	Release Date	Shell Width	Shell Length	Recapture Date	Return Width	Return Length	Recapture Method
405	6 October 1980-Stn 3	70.9	62.7	Season	70.3	62.2	Fisherman
406	"	71.4	63.5	"	70.5	63.1	"
409	"	72.9	67.6	"	74.0	68.2	"
416	"	67.9	61.4	17 November 1980	71.3	64.3	Diver (w/i 5 m releas
423	"	66.5	60.9	Season	65.7	60.7	Fisherman
427	"	62.6	56.7	"	69.9	63.7	"
429	"	70.9	65.4	17 November 1980	75.8	69.0	Diver (w/i 5 m releas
431	"	67.1	60.2	Season	67.8	60.1	Fisherman
440	"	68.8	60.2	7 November 1980	72.2	68.2	Fisherman (mid-bay)
444	"	68.6	63.7	Season	69.6	64.2	Fisherman
449	"	73.5	66.1	"	75.0	67.3	"
451	"	66.6	60.3	"	67.8	61.0	"
452	"	72.5	66.5	"	73.3	66.8	"
459	"	63.2	57.7	"	64.2	58.5	"
461	"	72.2	64.8	"	72.5	65.1	"
468	"	68.1	61.1	11 November 1980	(no measure-only tag returned)		"
475	"	71.4	65.2	Season	70.0	64.7	"
500	"	72.3	67.2	"	72.0	67.4	"
V 53	8 December - Stn 3	44.7	39.0	4 June 1981	45.4	39.9	Diver

Figure 24. Annual water temperatures (°C surface) for 1970-71 Pawcatuck River (Little Narragansett Bay - Watch Hill Station).

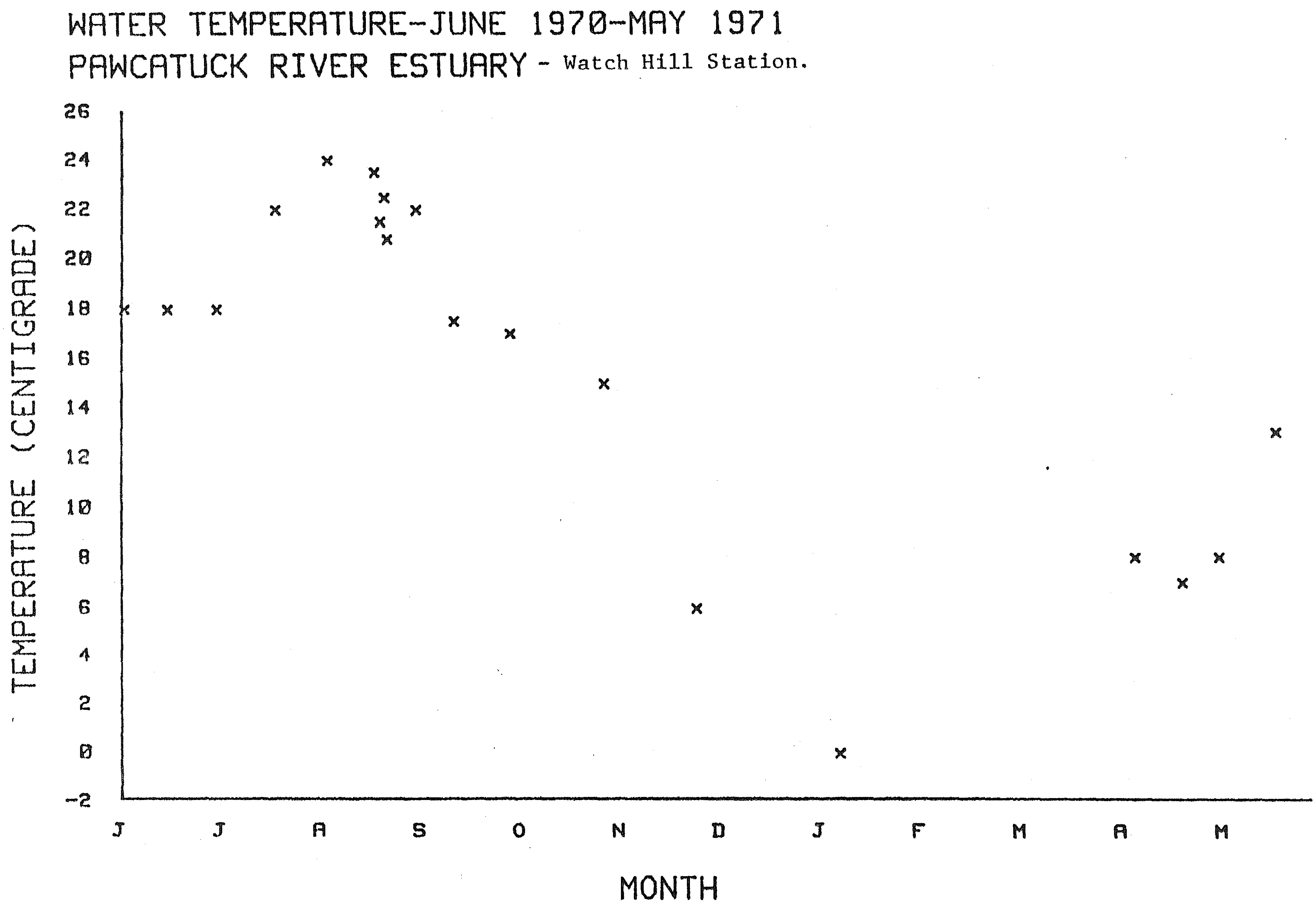
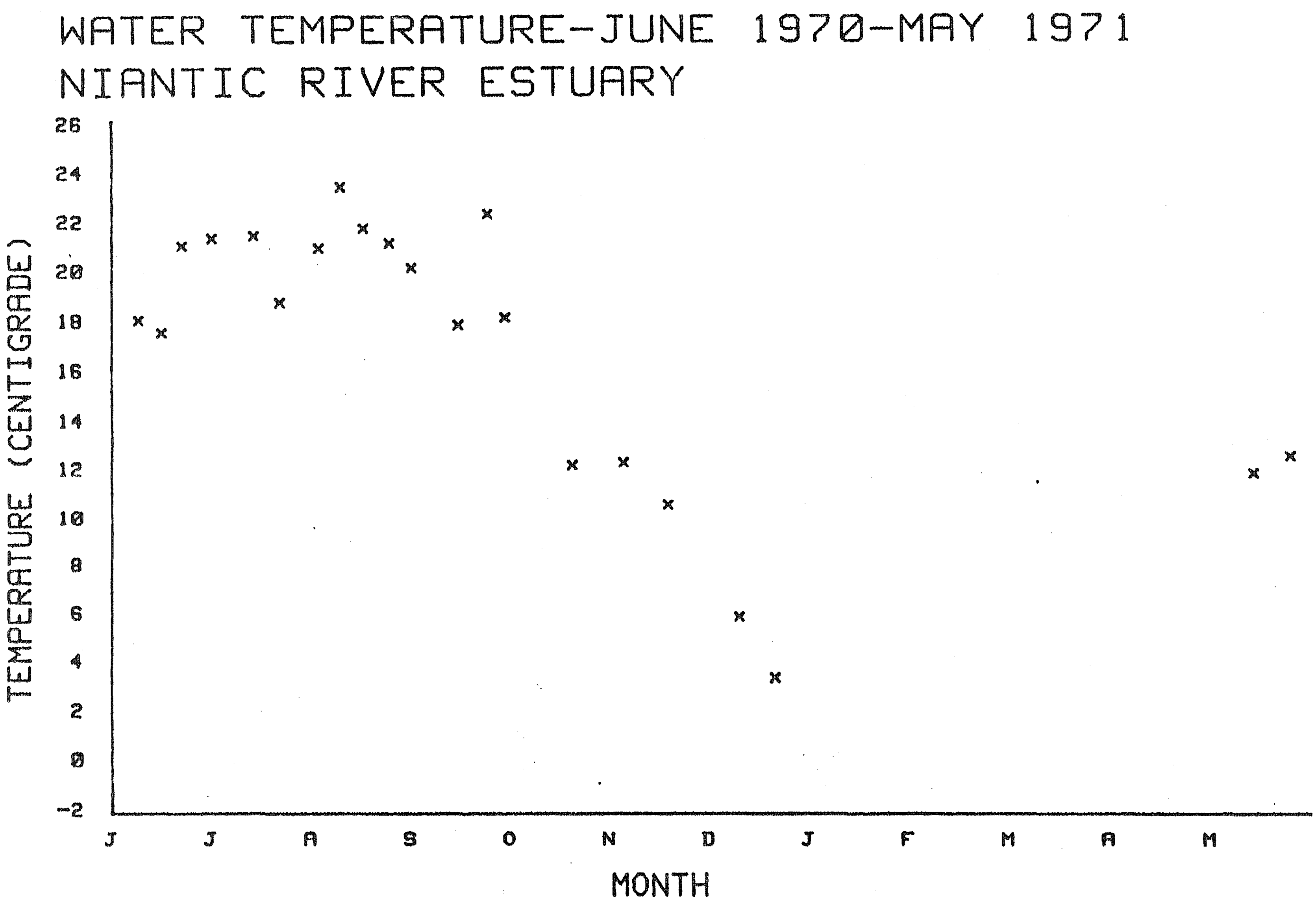


Figure 25. Annual water temperatures (°C surface) for 1970-1971 Niantic River (mid-bay station).



****
DATA MANIPULATION
****

POQUONOCK RIVER-STA2-MORTALITY

Data file name:
Number of observations: 55
Number of variables: 1

Variables names:
1. SHELL LGTH

VARIABLE # 1

I	OBS(I)	OBS(I+1)	OBS(I+2)	OBS(I+3)	OBS(I+4)
1	51.60000	44.80000	37.80000	43.00000	41.20000
6	47.80000	46.00000	46.70000	51.40000	40.10000
11	42.00000	40.80000	43.90000	47.20000	46.10000
16	46.80000	37.80000	45.00000	40.00000	36.00000
21	52.80000	44.90000	51.10000	47.50000	42.10000
26	42.90000	43.50000	36.00000	49.60000	44.10000
31	40.20000	42.00000	43.40000	44.70000	44.30000
36	40.50000	44.40000	40.60000	42.50000	47.70000
41	44.20000	36.00000	43.40000	35.10000	41.00000
46	42.10000	36.40000	37.30000	46.70000	44.80000
51	41.00000	39.10000	34.80000	37.10000	43.80000

****
SUMMARY STATISTICS
ON DATA SET:
POQUONOCK RIVER-STA2-MORTALITY
****

BASIC STATISTICS

VARIABLE	# OBSERVATIONS	# MISS. VALUES	SUM	MEAN
SHELL LGTH	55	0	2363.60000	42.97455

VARIABLE	VARIANCE	STANDARD DEV.	COEF OF SKEWNESS	COEF OF KURTOSIS
SHELL LGTH	19.11971	4.37261	.10516	-.40384

VARIABLE	COEF VARIATION	STANDARD ERROR OF THE MEAN	95 % CONFIDENCE INTERVAL ON MEAN LOWER LIMIT	UPPER LIMIT
SHELL LGTH	10.17488	.58960	41.79219	44.15690

ORDER STATISTICS

VARIABLE	MAXIMUM	MINIMUM	RANGE	MIDRANGE
SHELL LGTH	52.80000	34.80000	18.00000	43.80000

Table XXIII Salinity values at 1 hour intervals for experimental treatments.

TIME (hrs)	TREATMENT:	1_1	2_1	3_1	$4_{1,2}$
		SALINITIES °/oo			
0		29	29	26	28
1		25	19	10	0
2		21	10	7	0
3		18	0	7	0
4		15	0	4	0
5		11	0	4	0
6	Salinity End Point —	7	0	4	0

1. Control group salinities for treatments 1,2,3, and 4 are 29, 29, 26, and 28 °/oo respectively.

2. Reduction rate in treatment 4 was from ambient to 0 °/oo in approximately 10 min.

Table XXIVa. Species and densities of epizoa found on dorsal valves of scallops collected at Station 1 on 7-9-80. Poquonock River.

Species	Animal # / Size of Scallop (mm)			
Polychaetes	(45.2 - 41.6)	(41.5-38.0)	(43.8 x 41.1)	(47.5 x 45.0)
	1	2	4	5
Polydora ligni	65	28	24	41
Brania clavata	5	4	6	3
Eteone heteropoda	3	12	12	2
Notomastos loridis	0	0	0	2
Capitella sp.	0	0	1	0
Nerois sp.	0	0	1	0
Amphipods				
Corophiom insidiosone	6	31	12	13
Microprotopsus sp.	5	2	2	1
Gammarus macronatus	0	0	0	2
Hydrozoa				
Camparularia (flexuosa)	0	0	1 stalk	0
Mollusca				
Balanus sp	0	3	1	2
Unidentified spat	0	0	1	2
Total	84	80	61	68

$\bar{X}$ per animal = 73.25, standard deviation= 10.63

Table XXIVb. Species composition and density fouling dorsal valves of *Argopecten irradians* in the nearshore region of Station 1, Poquonock River.

Species	Animal # (size of animal) 1 (51.5 x 48.1)	2 (52.1 x 48.3)	3 (50.5 x 47
Polydora ligni	1	0	1
Eteone heteropoda	8	5	16
Brania clavata	15	9	12
Exogene dispar	1	2	0
Fabricia sabella	0	1	1
Sabellid sp. A	1	0	0
Ologochaete sp. A	2	4	11
Corophiom insidiosom	169	171	265
Microprotopsus	31	13	1
Balanus balanus (live) +	5 (?)	54	4
Balanus balanus (tests) +	103	128	74
Spat (Mya?)	1	1	0

Table XXV Scallop Dorsal Valve Fouling in the Poquonock River.

	July 9, 1980	July 14, 1980	July 28, 1980
Station I	- Heavy sediment and algal mat - Dominant animals: 1) *Polydora ligni* 2) *Eteone heteropoda* 3) *Corophiom insidiosom* - Dominant algae: 1) *Polysiphonia harveyi* 2) *Polysiphonia fibrillosa* 3) *Enteromorpha compressa*	Near channel *Zostera* bed and specimens similar to previous week. Near shore animals had very different fouling communities. Dominant animals: 1) *Balanus* sp 2) *Corophiom insidiosom* Dominant algae: There were very few individuals though some *Polysiphonia* present.	Near channel animals had fouling communities similar to previous week, the sediment layers are more developed the animals were harder to see. *Codium* beginning to appear on the near channel group. There was no observable change in the fouling community of the nearshore animals. *Urosalpinx* found on > 25% of the animals.
Station III	- No samples taken - Field observations show that floral fouling more evident here, than at Station I.	- Many of the same species as at Station I from 7/9/80 were present but densities were much less. - No *Balanus* - Sediment layer (mat) not well developed. - Dominant animals: 1) *Polydora ligni* 2) *Corophiom insidiosom* 3) *Cryptosula pallasiana* (bryosoan) - Dominant algae: 1) *Codiom* 2) *Enteromorpha compressa*	The degree of fouling, especially by the faunal components is much less than the previous week, only the bryozoan colonies cover the same area. Incidence of *Codium* higher ~ 40-50% of the scallop population.

Table XXV (cont.)

Scallop Dorsal Valve Fouling in the Poquonock River

STATION I

August 4, 1980

- Near channel individuals have fouling communities that have a large floral component now, especially short tufts of green algas (Chaetomorpha)
- Tube building amphipods dominant within this lawn.
- Incidence of Codium has increased again 40% of the animals.
- The few barnacles that were on the near channel animals have died off.
- The nearshore animals show no change in the fouling community.
- Urosalpinx and drill holes on 30% of the animals collected.

August 12, 1980

- No samples taken
- Deployment of seed

August 29, 1980

- Quantitative samples (scrapings) have been taken from animals on this date but still have to be processed (enumerated).
- Qualitatively: Near channel animals have a sediment algae mat that is mostly algae (Chaetomorpha).

  Domanant algae (other than "lawn"):
  1) Codium (5 cm high)
     many sporeling developing
  2) Ulva

  20% of animals have large (10cm) Codium.
- Near shore animals have a "new" set of Balanus sp, old ones have died off, no sediment layer.
- Urosalpinx on both groups.

STATION III

August 4, 1980

Crytosula pallianassa still dominant faunal fouler, 20 to 40% of valve covered on 50% of animals.

Ulva, Codium dominant floral component, Codium 6 to 10 cm high.

August 12, 1980

- No samples taken
- Deployment of seed

August 29, 1980

Quantitative samples taken, have to be processed.

Qualitatively:
- Very well developed "lawn" of Chaetomorpha.
- Many small Codioni 20% of the individuals had large Codium.
- Dominant animal: Corophiom
- The dominant bryozoan has been overgrown by the algal lawn.
- Other algae present:
  1) Ulva (short fronts)
  2) Ceramioni (short stalks)
- 40% of individuals

Table XXVI Underwater photography of bay scallop, *Argopecten irradians*, (benthic habitat, dorsal valve fouling, predators, mariculture enclosures, tagged individuals) in Niantic, Poquonock and Stonington Bays.

Date	Location	Frames/Subject	
2 August 1977	Stonington, Barn Is. (w)	10	*Codium* fouling, substrate
	Niantic Bay (NE sector)	20	Sediment, defoliated zone.
8 August 1978	Stonington, Barn Is.(w)	20	Seed placement.
	Poquonock River	10	Seed placement, cages,ether.
6 May 1980	Poquonock River (Stn 1)	25	Depressions, *Urosalpinx*, *Zostera* lantern nets.
		2 8mm	50 ft. Predation, *Zostera* blade buoyancy.
15 May 1980	Poquonock River (Stn. 1)	21	*Urosalpinx*, densities.
	" " (Stn. 2)	15	Seed shell debris.
14 July 1980	Poquonock River (Stn. 3)	5	Tagged scallops in-situ.
28 July 1980	Poquonock River	9	Habitat.
12 August 1980	Poquonock River	4	Seed/tag release.
23 July 1980	Niantic (Stn. 3)	8	Habitat.
29 August 1980	Poquonock River	9	Seed stock, tagged.
3 September 1980	Stonington, Barn Is. (w)	10	*Codium*, juveniles, algae
	Poquonock River (Stn. 3)	8	Dense *Zostera*, habitat
	Niantic (#16)	5	Cage, habitat, valve fouling.
6 October 1980	Poquonock River (Stns.1,3)	36	Tagging, underwater release, Channel habitat.
17 November	Niantic (Stn. 2) Poquonock River (Stn. 3)	36	N.M.F.S., cages, depression microhabitats, *Zostera* mulch.
8 January 1981	Poquonock River (surface) (Stns. 4,3)	7	Spotter survey, winter seed release.
27 April 1981	Poquonock River (Stn. 2A)	7	Spring predation, algal bloom
14 May 1981	Poquonock River (Stn.3)	10	*Urosalpinx* predation.

Table XXVI (cont'd.)

Date	Location	Frames/Subject	
4 June 1981	Niantic River (Stn.2)	10	Mid-channel (3 year) scallop population.
23-24 July 1981	Poquonock River (Stn.3)	20	Time-lapse system, NMFS mass seed release.

Selected prints from photographic series illustrating ecological observation and tagging procedures.

Photo No.

1 Gas bubble bouyancy on Zostera terminal blade.
15 May 1980. Poquonock River Station 1.

2 Bysuss thread attachment of 1st year scallop on Zostera, note associate Spirobis worm tubes and juvenile Littorina.
5 September 1980.Barn Island.

3 Barn Island Stonington 1st year scallop byssus thread set on Codium and Gracilarius.
5 September 1980. Barn Island.

4 Typical benthic Zostera/sediment scallop habitat.
15 May 1980. Poquonock River Station 1.

5 High density scallop bed at mid-estuary east bank.
8 October 1980. Poquonock River Station 3.

6 Resident depression and dorsal-valve fouling contribute to cryptic posture.
5 September 1980. Niantic Bay Station 2.

7 Scallop "camoflage" condition in Zostera/sediment habitat.
17 November 1980. Niantic Station 2.

8 Zostera "mulch" accumulated in high scallop density areas as result of fall die-off.
17 November 1980. Poquonock River Station 3.

9 Dorsal valve fouling represented a succession of seasonally characteristic algae. Here luxuriant Gracilarus branches accommodate an associate floral/faunal community.
5 September 1980. Poquonock River Station 3.

10 Codium fouled scallop dorsal valves were observed common at furthest seaward station.
8 October 1980. Poquonock River Station 1.

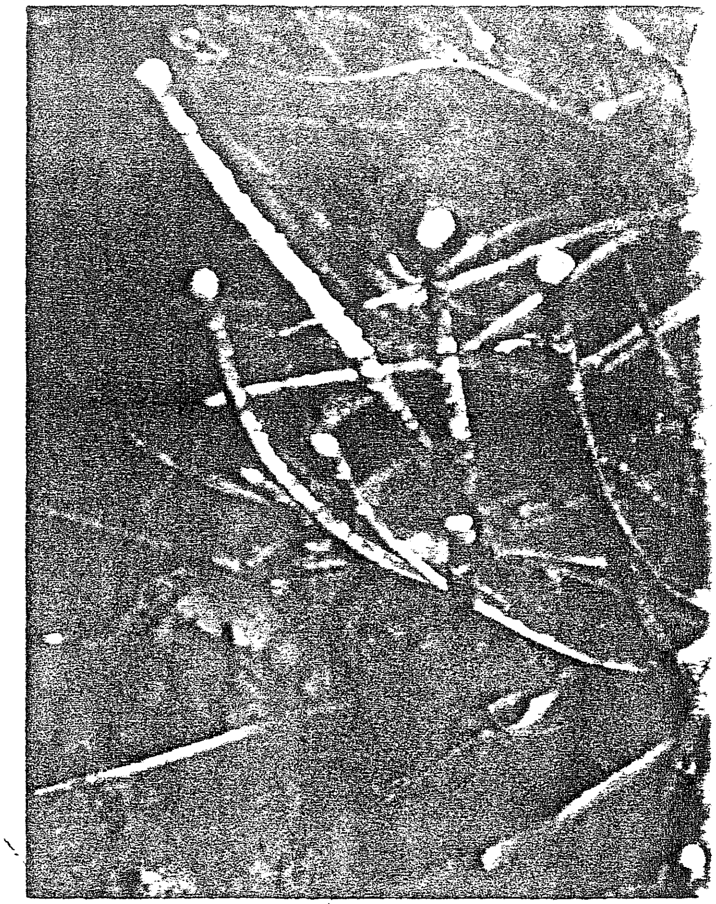
11 Scallop posture in active mid-fall season, note characteristic growth of Ulva and Codium on dorsal valve.
8 October 1980. Poquonock River Station 1.

12 Scallop dorsal valve communities, note: algal fouling (Ulva), a cryptic mid-summer condition and Urolsalpinx at hinge region.

Photo No.	
13	Epibenthic "grazing" of scallop dorsal valve fouling community (here *Pagurus longicarpus*) was commonly observed throughout season. 8 October 1980. Poquonock River Station 1.
14	*Littorina* grazes scallop dorsal valve. 8 October 1980. Poquonock River Station 1.
15	An accelerated growth margin is evident by reduced fouling at anterior scallop valve. 17 November 1980. Poquonock River Station 3.
16	*Urosalpinx* predation occurred predominately on posterior dorsal scallop valve. 15 May 1980. Poquonock River Station 1.
17	*Urosalpinx* on scallop dorsal valve near hinge despite heavy fouling deterant condition. 17 November 1980. Niantic, Station 2E.
18	Scallop at mid-channel on course sediment, predation, and *Ulva* algae characteristic of adult valve condition. 8 October 1980. Poquonock River Station 1.
19	Intensive burrowing and scallop predation by *Carcinus maenus* was noted in late fall pre-overwinter activity. 8 October 1980. Poquonock River Station 1.
20	"0 year" scallop valve shell bank accumulation from overwinter mortality. 15 May 1980. Poquonock River Station 3.
21	Scallop tagging operation - diver collection, vernier caliper valve dimensions, polypoxy adhesive, and label tape identification. 5 September 1980. Poquonock River Station 3.
22	Tagged adult scallops before release. 5 September 1980. Poquonock River Station 3.
23	Observation of tagged scallop (No. 429) in field after two months at large. 17 November 1980. Poquonock River Station 3.
24	Tagged scallop (No. 440) photographed in field after release. 8 October 1980. Poquonock River Station 3.
25	NMFS hatchery scallop culture cage fouling condition in November. 17 November 1980. Niantic Station 2.

Photo No.

26	Color, and annulus dimesnion differences noted from Poquonock River population. Three color types: white, orange-red, and brown-grey occurred. First annulus dimension ranged from .20 to .60 of terminal 1st year shell length. September - November 1980.
27	Abnormalities: radiated striations and "lipped" condition noted in Poquonock River population. September - November 1980.



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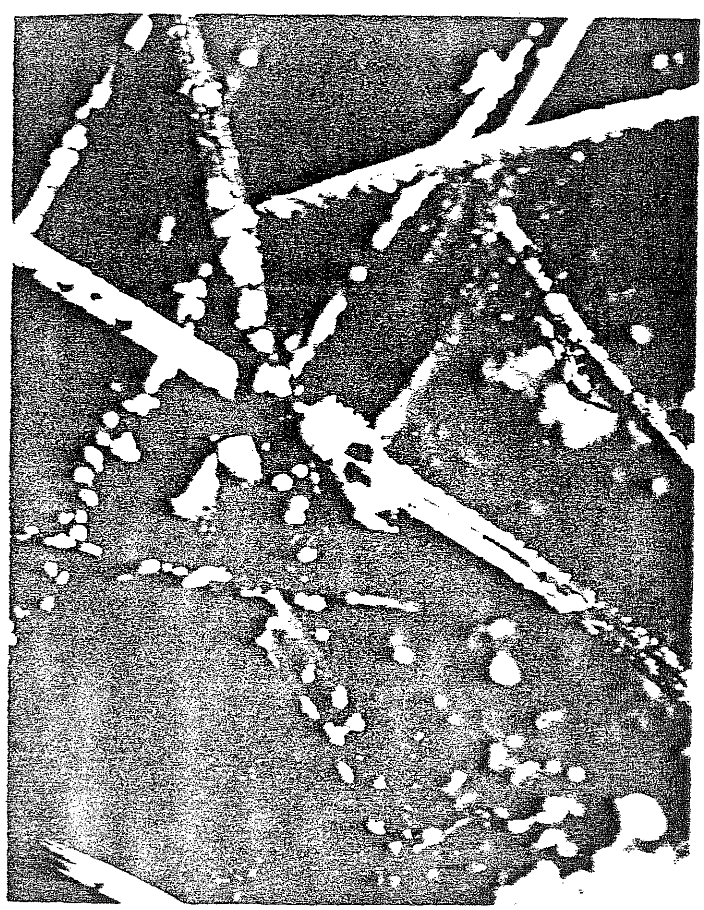

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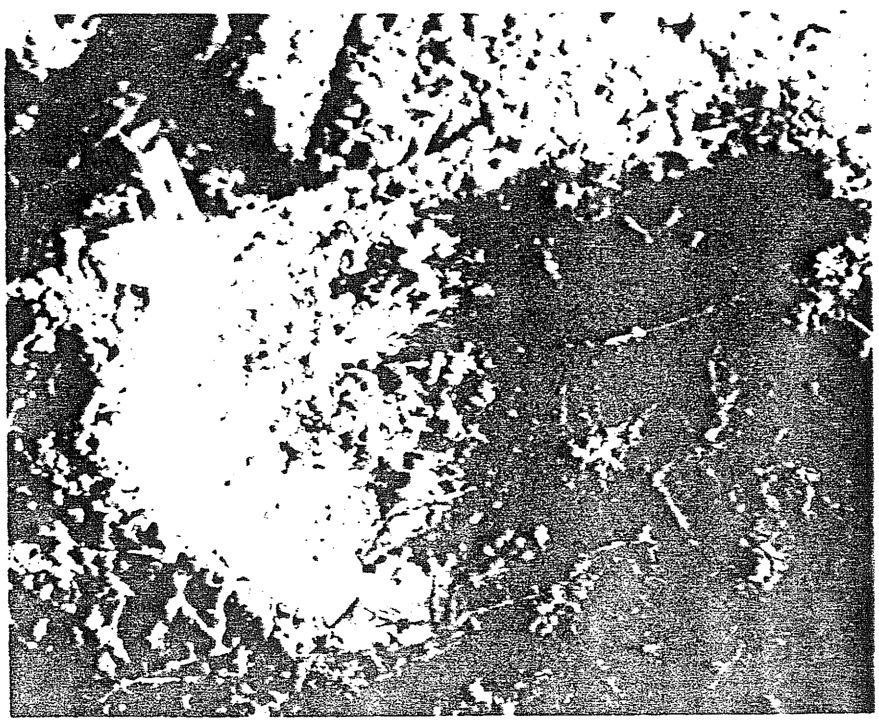

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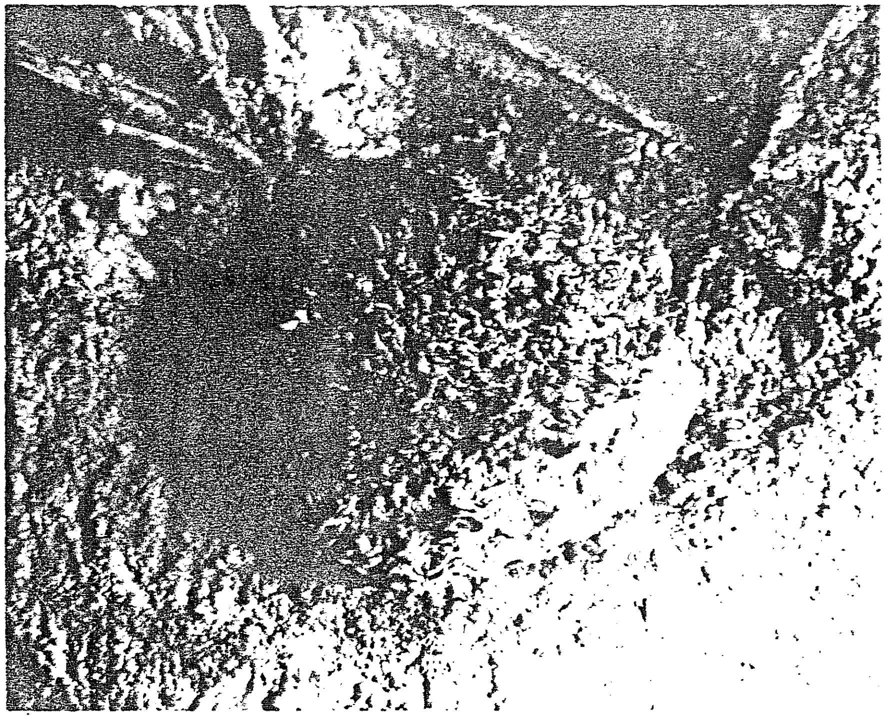

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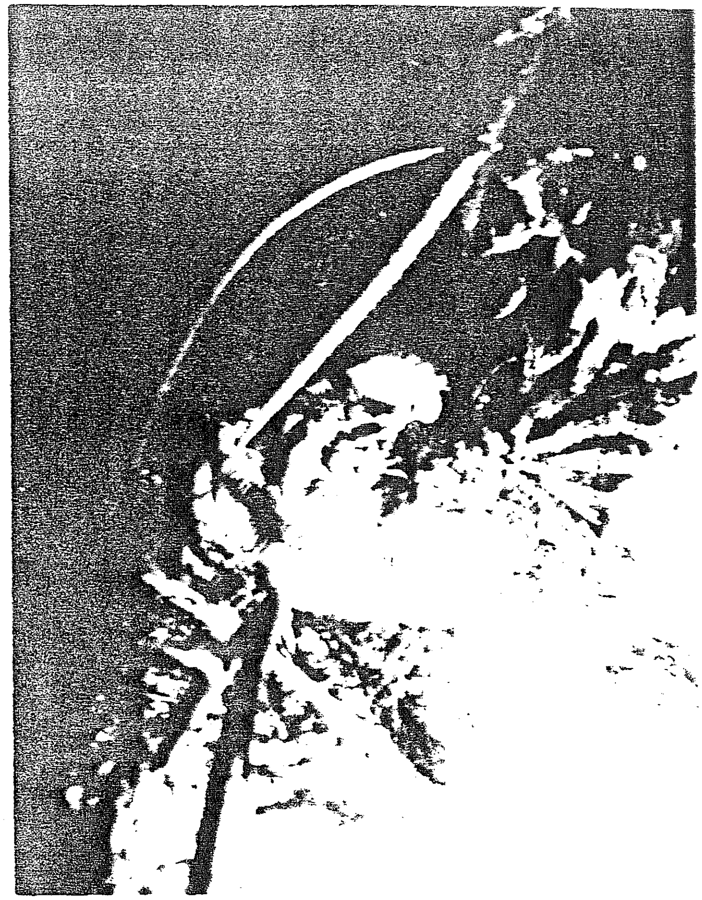

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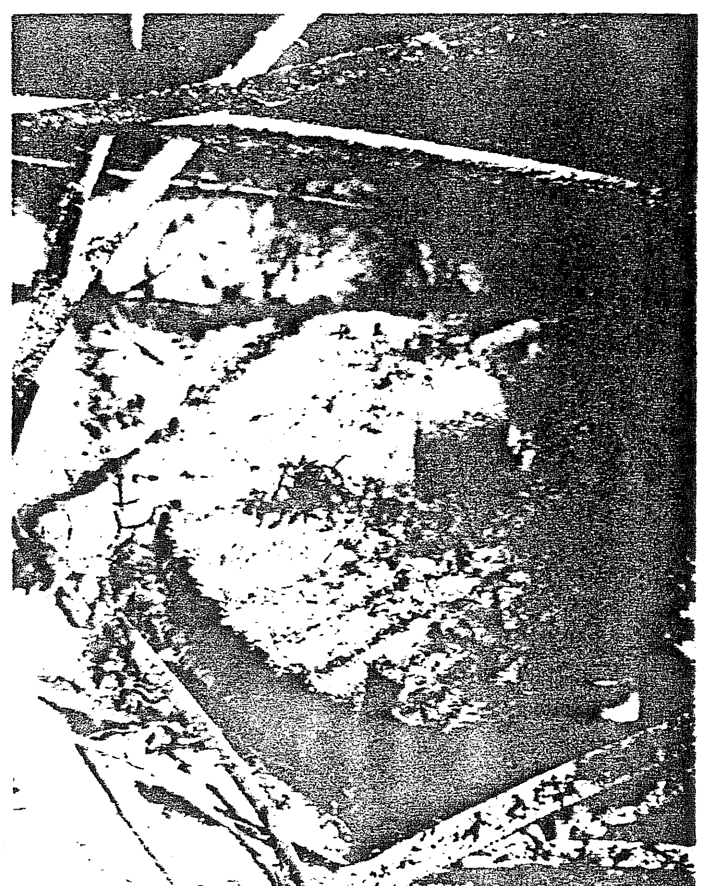

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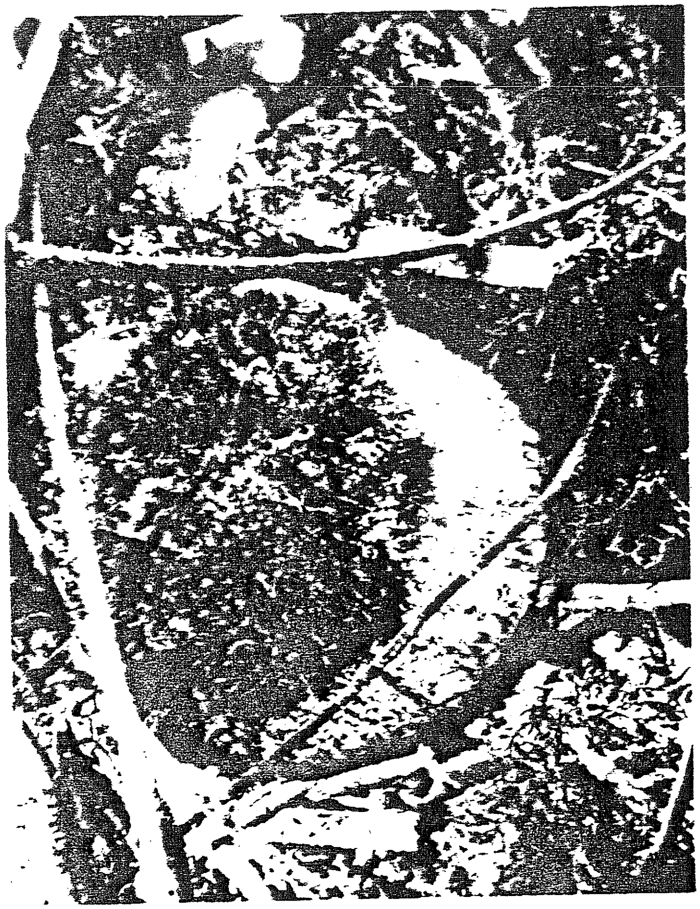

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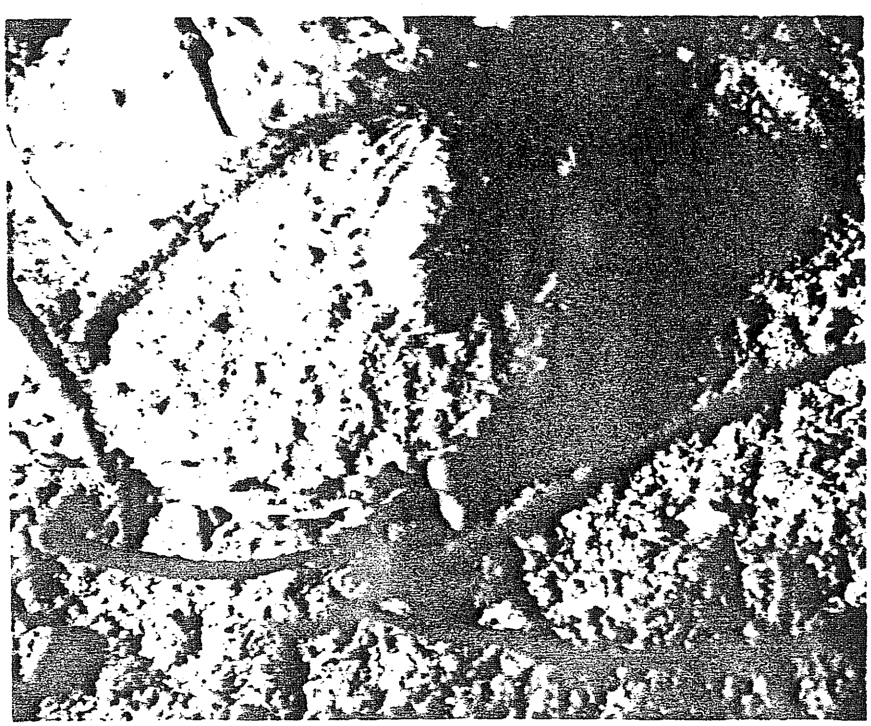

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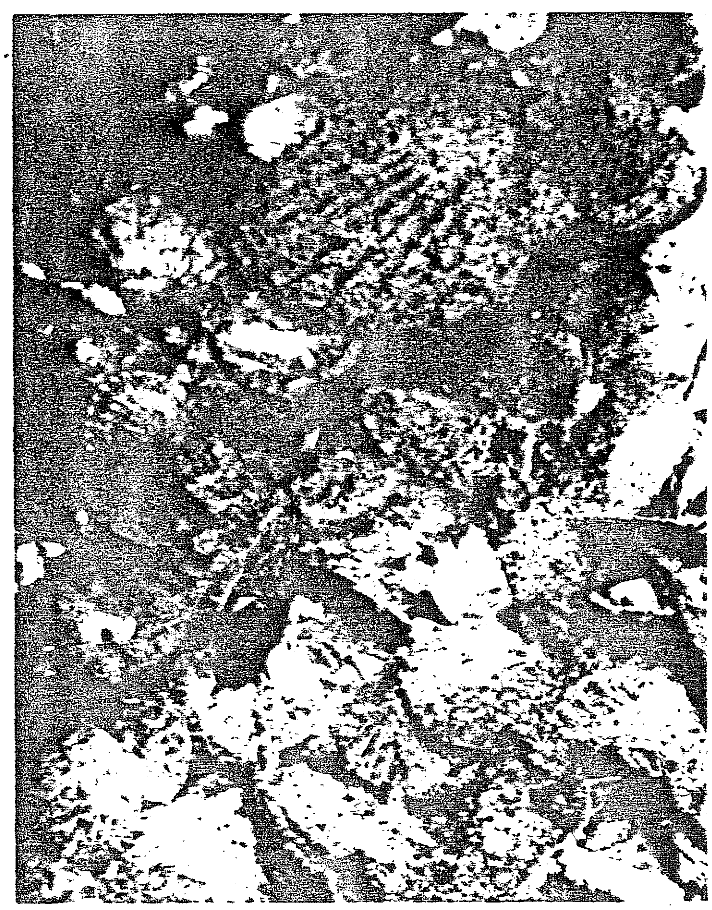

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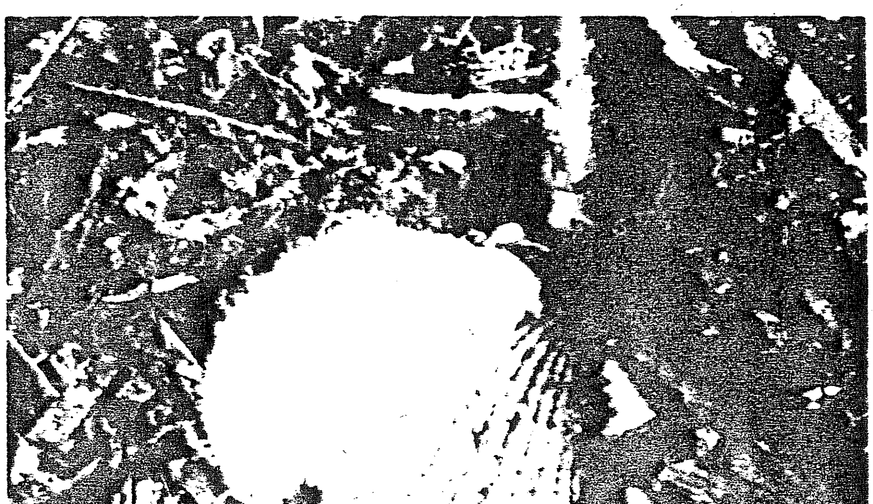

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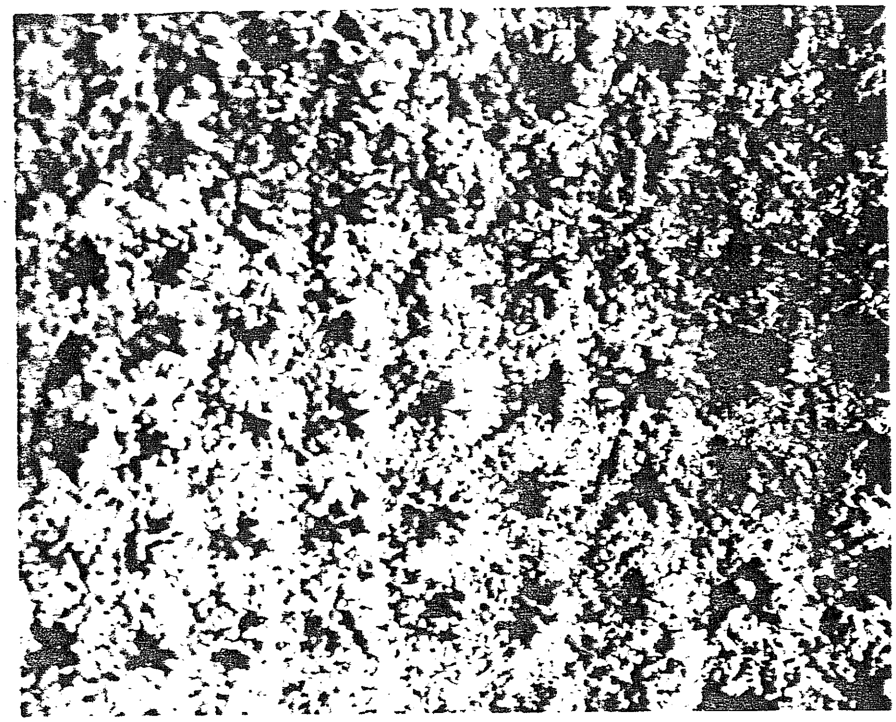

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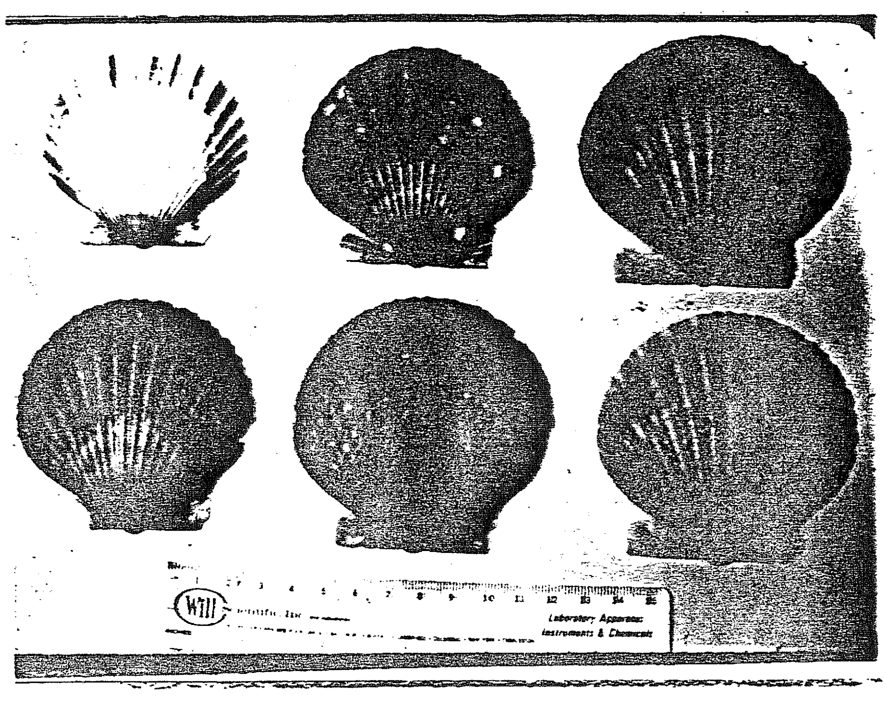

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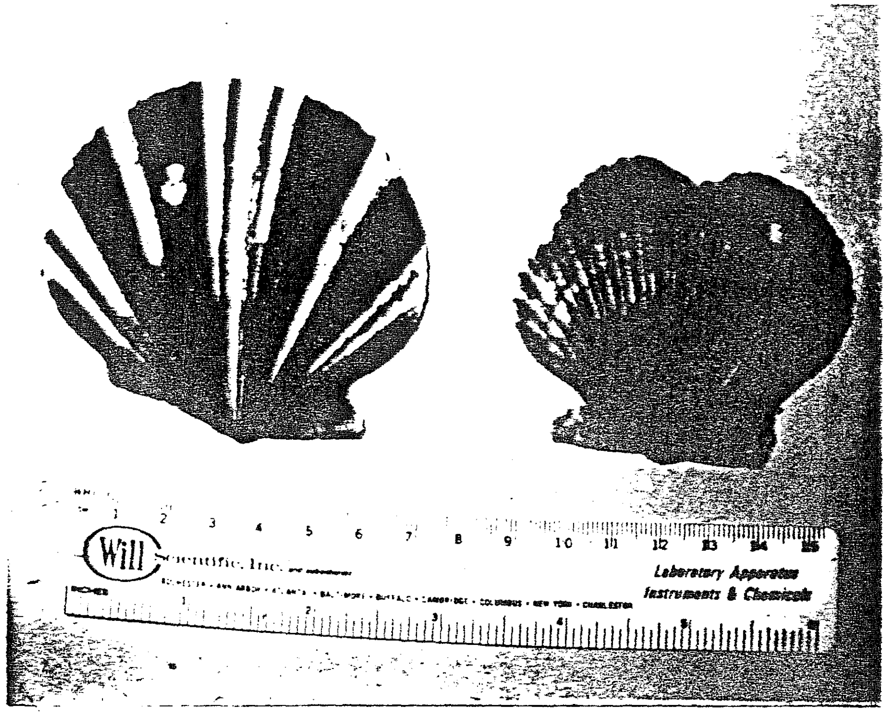
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27

APPENDIX A. Field Logs

Table A. Field survey of natural Bay Scallop population ecology - Poquonock River.

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
6 May 80	4	1.5/m^2 visual	Short sparse *Zostera* and soft cohesive organic mud.	*Urosalpinx* (on 3 of 20) *Carcinus maenus* 4 *Libinia dubia* 5 *Pseudopleuronectes americanus* - 2 *Anguilla rostrata* 1	Epiphytic algae on *Zostera*. Gas evolved forming bubbles.	Many individuals in detrital mud depressions. Several individuals vertical in substrate.
	3	Dense 1st yr. Few 2nd yr.	Large amount of shell debris. 13-23 mm shell length.	--	- -	--
	2	Sparse live scallops.	Shell debris of 2nd yr. class extensive.	--	- -	--
15 May 80	4	Low density 4-2nd yr. scallops observed in 15 minute survey dive	Sparse *Zostera* cohesive organic mud and silt.	*Libinia dubia* - 1 active. *Callinectes* - 1 active.	- -	--
	3	Max. densities 10,11,17,18 20/.25 m^2 in area 50x 50 yds.	--	*Carcinus maenus* 20 *Anguilla rostrata* 2	- -	2 *Carcinus* observed feeding on scallop. *Illyanassa* - high densities spawning? *Palamonetes* sp. abundant in school down current of *Zostera*.

Table A. (cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
15 May 80	1	Random 1/25m^2 1)2,4,0.0,1 2)3,3,1,4,2 3)3,1,0,0,1,0 4)1,4,1,3,0,2 max. 5,7,6,11,14,12	Shell debris extensive to E. Zostera extensive.	Urosalpinx - on dorsal surface of one scallop. Carcinus maenus.	Extensive epiphytic algal cover on Zostera.	Straited coloration of valves of some individuals. Water temp. 11°C. 1st yr. class dominant.
5 June 80	1	Random 1)1,2,4,5,9 2)1,1,2,5,6 3)0,0,1,0,1 Max. 10,10 12,6,2,1	- -	Urosalpinx - abundant. Anguilla 1 Carcinus maenus 4	Algae on Zostera blades now moribund and detached or sparse. Zostera growing rapidly.	Highest densities in low eel grass NW of beach. Zostera obscuring bottom.
	3	Max. /.25m^2 6,3,8,5,2, 3,4	- -	C. maenus Urosalpinx Anguilla	Zostera growing rapidly.	Zostera obscuring bottom.
	Baker Cove	none	silt bottom.	C. maenus mating Ovalipes	- -	- -
8 July 80	4	- -	- -	- -	At town scallop station. Spat collector deployed - 3 substrate types - Manilla line, scallop shell, Polyethylene strips.	

Table A.(cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
8 July 80	3	- -	- -	- -	- -	Spat collector deployed - as same as above - located along NE side of sand shoal.
	1	In center of cove 8,5,11,6,15 10,7 Aug. 8.86 Max. 15	3 m x 4 m depression zone. Surface was thick layer of *Zostera* mulch and small amount of shell debris.	*Asterias* - 2 *Carcinus maenus* 3	- -	Spat collector deployed point off west side of north cove on Bushy Pt. 100 animals tagged and released at same station. Measurements taken. Labeled A 1 - A 100 (L,W,D)
9 July 80	3	- -	- -	- -	- -	100 animals tagged and released at station established in scallop bed close to shore. Labeled A101 - A 200 measurements taken (length, width, depth).
	1	In channel Aug 2-3/.25m^2	Scallops in sand depressions. Tubes of various poly-chaetes and amphipods visible which may be source of fouling organisms.	*Asterias* *Carcinus maenus* *Callinectes*	Algae and sediment 20 animals collected.	In channel - valve openings facing current. In eel grass - valve opening orientation more random - little preceptible current.
14 July 80	4	No scallops.	*Agardhiella* mats extensive - open areas frequent with conspicuous amphipod tubes.	*Urosalpinx*	*Zostera* patches sparse.	Spat collector sample detrital material adhering to all substrates *Urosalpinx*.

Table A. (cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
14 July 80	3	Max 8 Random 4,5, 5,6,6 at center $\bar{x}$ = 4.0 at periphery 2,2,1,2, 3/.25 m^2 $\bar{x}$ = 2.0	Algal mats of same species on Stn.1 and Zostera mulch where densest scallop concentrations occur.	Callinectes 12-15 several berried females. one observed feeding on crushed scallop. Anguilla - 20 Carcinus - 6 Cyprinodon - 1 Asterias - 1	Not as heavily fouled as at Stn. 1. Few with sediment mat. Algal fouling greater and different spp. then Stn. 1. 20 animals collected.	33 tagged animals resighted 22 measured. 1 dead. Spat collector sampled - floc on shell substrate - no visible coloniztion of rope or plastic strips. High current area.
	1	Channel 0,1,3,1 2,0,0,2, 1,1 $\bar{x}$ = 1.1 Max. 9 Zostera Bed 6,0,1,1,0,0 1.4,1,3 $\bar{x}$ = 1.4 Zostera Rift 6,4,6,4,6 3,8,4,7,9 $\bar{x}$ = 5.7	Scallops occuring in sand channel, in eel grass bed and in furrows between Zostera.	Carcinus 5/m^2 ~~most abundant.~~ Anguilla 12 Tautogolabrus 1 Urolalpinx 7-8 found on 1 scallop.	- -	20° C. 27‰ ebb tid. Spat collector sampled - same conditions as Stn.4. 57 tagged animals resighted 20 measured. 1 dead - Maximum distance from dispersal point, 20 ft. to west - into Zostera bed.
21 July 80	4	- -	- -	- -	- -	Spat collector sampled Illyanassa on all substrate Shell fouled by spionid or amphipod tubes.

Table A.(cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
21 July 80	3	- -	- -	Pollachius virens Anguilla Myoxocephalus aneus Stickleback Carcinus, Urosalpinx	- -	Tide low - Zostera obscuring animals - dispersel stn. not found. Spat collector sampled 26.4° 30% ebb tide.
	1			Anguilla, Carcinus Callinectes, Pollachius v. Urosalpinx - 15 20 scallops with Urosalpinx attached.	- -	Spat collector sampled 26.5°C 31% low tide. 21 tagged scallops measured. Max distance from release point 30 feet. Scallop bed aeriel extent delineated. Chrysaora sp. very dense in high current areas - possible larvae predator Less dense in Zostera stands.
28 July 80	4	No scallops	Large Agardhiella mats.	Anguilla Fundulus Mnemiopsis Chrysaora	Zostera sparse	Spat collector sample Surface 22°C 30% Bottom 19.5°C High Tide.
	3	Increased toward shore aug. 4-5/.25m² in alg l mats- 11/.25m² periphery of bed 1-4/.25m²	Nearshore-relatively sparse Zostera. Agardhiella mats common. Carcinus burrows and mud depressions common. Decrease toward periphery of scallop bed.	Callinectes Anguilla Libinia dubia Fundulus Mnemiopsis	Balanus - upper blades. Botrylus on Zostera valves algae and sediment. Codium, Polysiphonia tubes in sediment mats, - all fouling organisms increasing.	21°C surface 29% ebb. Spat collector sampled. 5 tagged animals resighted 4 measured - 1 dead dorsal valve cracked Maximum distance to collec 5 ft.

Table A. (cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
28 July 80	1	- -	- -	Callinectes Carcinus Anguilla Asterias Urosalpinx	On Zostera Balanus and Botrylus as at Stn. 3 Valve fouling is at Stn. 3.	22.3°C surface 30% ebb tide Spat collector sampled. 20 tagged animals resighted - 19 measured 1 dead. Dorsal valve cracked lengthwise.
4 Aug 80	4	No Scallops	Agardhiella mats extensive.	Nassarius Mnemiopsis Chryiaora	On Zostera - Molgula Halichondria Spirobis Botrylus Algae	Spat collectors sampled. 26.3°C surface 26% 23.8°C bottom ebb. Polychaete (Terebellied?) egg cases extensive.
	3	- -	- -	Callinectes - 12 Menidia Chrysoara	On Zostera - much more extensive algal epiphytes Enteromorpha	Spat collectors sampled 25.2°C surface 27% Tide low - unable to survey effectively.
	1	- -	- -	Asterias, Carcinus Urosalpinx, Callinectes - 3 Mnemiopsis, Menidia, Fundulus Stickleback Brecontia	Botrylus dying off Zostera. Barnacle set greater then last sampling. All blades generally less fouled.	Spat collector sampled. 25.7°C surface. 27% flood tide 14 tagged animals resighted and measured. Max. distance 20 ft. east of collector.
12 Aug 80	3	Scallop seed dispersal at seed dispersal stn. point source 10,000 seed plus 1500 with gray dorsal tags.	In area of medium Zostera density.	Carcinus maenus seen in area but none moved into feed during 15 min. of observ. Menidia school moved in over seeded animals. (food with seed?)	- -	Tide ebbing. Animals began to disperse immediately to south (with tideal flow). Spat collector sampled - Cyanea dense at all stns.

Table A. (cont.)

Scallop Survey Summary - Poquonnock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
12 Aug 80	1	Scallop seed dispersal at dispersal stn. point source 10,000 seed plus 1500 with lavender dorsal tags.	Sparse low Zostera sand bottom.	Carcinus maenus moved onto scallops almost immediately. After 15 min. 5 crabs feeding on scallops. Menidia over seed feedingvisual cue to crabs?	- -	Tide ebbing. Dispersing of animals as at Stn. 3 - down-stream (with tidal flow).
29 Aug 80	4	No scallops	- -	- -	No evidence of spat settle-ment at any station.	Spat collector sampled. 21.6°C 33% Flood tide.
	3	Seed - 70.23,82 at Center 50,53 at 2 m 18,22,28 at 3m from stn. little movement for most individuals. Most seed attached to Zostera blades. Natural population 6,2,2,1,3,0,0,2,1 0,3,4,0,1,2	Zostera and algal mats receding.	Little evidence of predation on seed stock Callinectes - 1 Pagurus longicarpus Asterias - 2 Anguilla - 2 Menidia - 50 Cyanea - 12 Mnemiopsis	Much less epiphytic growth then previous Less Botrylus Halichondric and epiphytic algae.	Spat collector sampled. 20.6°C 29% Flood tide. Seed dispersal coverage plotted. 3 tag resightings and measured. Natural population 50 animals measured.
	1	All seed scallops dead - no live individuals observed 1,3,0,2,1,2,1,4 3,3,5,1,1,2.0		Total mortality of seed. Many cracked valves and lose tags. Evidence of crushing -(i.e. Carcinus and Callinectes) Pagurus longicarpus - Cyanea	Zostera growth stop-ped or slowed. Fouling organisms reduced as at Stn. 3.	Spat collector sampled 20.6°C 29% high tide.

Table A. (cont.)

Scallop Survey Summary - Poquonock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
5 Sept. 80	3	Some juvenile found on old inclusion. Cages approximately 50 m downstream from release point. 15 juveniles found near spat collector.	-	-	-	Growth measurements of natural population. Sample cages and terminate 1979 grow out experiment (NMFS) at mid-bay. Cage placement off N side sand shoal at mid-bay. Spat collector sampled. 24°C 28‰.

Scallop Survey Summary - Poquonock River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
6,8 Oct.80	3	Greater in clear zoster rift zones. (50) seed scallop measurements. (100) adult measurements. (w,l,d) and 1st annulus. (32) quadrants $\overline{X} = 4.7/1/4\ m^2$	Zostera rifts substrate of silt or "mulch" and 1-3 cm lower than inter- space Zostera bed sediment.	Many dead scallop seed valves (est. 25% visually) in area. Carcinus (15) Callinectes (3)	Illyanassa juveniles extensive. Scallop density greatest in Ayadhiella mats, lower in Zostera.	16°C, 25‰ Aerial extent of seed dispersion uncharted due to lost station marker. Seed bysusally attached to detrities on sediment, 10% on Zostera fronds.
	1	Distribution similar to pre- vious surveys. Periphery densities $1\text{-}2/m^2$ and to west $4\text{-}5/m^2$. (100) collected for tag and measure. (21) quadrants $\overline{X} = 1.3/1/4\ m^2$.	Search thorough for natural set (one diver hour = 7 observed and measured).	Urosalpinx occurence greater and predation noted (~ 20 scallops with 1-3 Urosal- pinx on dorsal valve). Carcinus (12) Asterias (4)	Greater associate algal fouling in Z. bed. Ulva, Codium, also Balanus.	
17 Oct. 80	2A	Spotter survey Estimate $5\text{-}7/m^2$.				
30 Oct.80	1	Spotter survey 2 recaptures/57 total sample				
	2A	Spotter collection				
	3	Spotter survey				

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
3 Nov. 80	2A	Diver observations.		Low Urosalpinx predators, observed 4 on 200 scallops. Extreme Carcinus numbers (100) 8 cm carapace.	Zostera die off at approximately (70%) substrate visible.	Tagged hatchery seed release (200) 10.8°C, 29%.
	1	(8) Quadrants $\bar{X}$ = 1.8 1/4 m^2	Scallop buried in Zostera "mulch" noted in oblique vertical position (i.e. 10 individuals).	Carcinus (10)	Halichondria (sp.) growth extension over Zostera mulch.	
	3	(22) Quadrants $\bar{X}$ = 1.9/1/4 m^2				
6 Nov. 80	2A	Spotter survey collection measurements.			Codium attachment to dorsal valve indication of scallops presence.	Of (202) individual scallops (82) (40%) had evidence of Codium growth.
17 Nov. 80	2A	Spotter survey collection measurements.				
	3	Spotter survey collection measurements (63/5:adult/0 yr. class ratio).				
8 Dec. 80	3	Spotter survey (21) adults.			Thick (10 cm) Zostera mulch in E. bay region.	0 year class tagged scallop release (300).

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
8 Dec.80	4	Spotter survey 0 yr.class aggregation. Est. 1-2/m^2 patch distribution. Greatest number in *Agardhiella* mat and *Zostera* mulch.				Limits of 0 year class concentration determined.
	2	Spotter survey - few 1 yr. class scallops remain after fishing season (32) collected.		High mortality of 0 year class animals (windrow of 3-4 cm length valves) noted to north of hummock.		
9 Jan.81	4A Spotter scope.	0 year scallop cryptic in detrital weed. Lower densities ~ 1/4 m^2 Collection (54) and measurement.			*Zostera* mulch 10-20 cm deep No *Agardhiella* algae observed.	Tag release 200 laboratory 100 natural population 3000 lab. seed broadcast.
	2A	Sampled (9) 1 year class scallops (2) died recently.			*Codium* fouling noteable. *Illynessa* on scallop valves.	500 laboratory seed released.
20 Apr.81	2A	1/m^2 collection			*Illynassa* spawning.	
	4	1-3/.25 m^2 collection		*Callinectes* (3)		
	3	3-4/.25 m^2 dense pocket collection				

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
14 May 81	3,4	0 year collection Densities $1/m^2$ with max. $4/.25\ m^2$		*Carcinus* (17) Sta 4 many juvenile.	Valve fouling by *Ectocarpus* and *Botrylus*.	Tag release (100) Stn 3.
4 June 81	4	Collection (100+) to log. (7) quadrant densities $\overline{X} = 1.4$			*Ectocarpus* dominant fouling algae.	Tag return (live and dead).
	3	(10) quadrant densities $\overline{X} = 0.6$		*Carcinus* (5) *Urosalpinx* (10+)		

Table B. Field survey of natural Bay Scallop population ecology - Niantic Bay.

Scallop Survey Summaries - Niantic River

Date	Stn	Density	Benthic Topography Substrate	Predators	Valve/Zostera Fouling	Other
18 June 80	East Side Sandy Point	None	Silt bottom - not very cohesive.	*Asterias forbesi* 4, 7, 8/.25 m^2 max. 1, 3, 1, 1/.25 m^2 random	No *Zostera*	
	West Side Sandy Point	1/.25 m^2 Visually 1/2 - 3m^2	Sand/silt bottom Bottom slopes 6-8 ft. where eel grass ends.	*Lophius americanus* - 1 *Anguilla rostrata* - 3 *Tautog onitis*- 1 *Libinia dubia* - 2 *Asterias forbesi* - max. 4, 5, 8/.25 m^2	*Zostera* fouled by bryozoans and epiphytic algae. No new eiphytic growth on scallop valves.	5 of 55 scallops observed preyed on by *Asteria*. Water temp 20.5^{o}C surface 19.0^o bottom(8ft) Scallops in warmer shallower water. No density differentiation between grass and depression zones.
	West #31 Channel Marker	None	Sandy silt bottom. Some scallop shell debris.	- -	- -	*Zostera* sparse.
	East #27-28 Marker	None	- -	- -	- -	Dense *Zostera* Surface bottom reduction in temp. 6 - 8 ft. depth.
	West of #17-19 near shore Camp Grasso	8, 9,9, 12,16/.25 m^2 1,2,5,5,8/ .25 m2 random	Dense *Zostera* over sand/silt bottom. 3-4 ft. depth. Mats of *Enteromorpha*	*Carcinus maenus* *Urosalpinx* (on 3 individuals) *Asterias* - no predation observed.	Valve fouling by *Enteromorpha*. *Zostera* fouling by bryozoans and epiphytic algae.	Highest scallop densities in mats of *Enteromorpha*. Several groups at mud depressions but not at densities as high as above.

Table B. (cont.)

Scallop Survey Summaries - Niantic River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
18 June 1980	West of #15 Marker near shore.	7,8,8,9 12/.25m^2 max.	Dense Zostera sand/ silt bottom. 3-4 ft. depth. Small mats Enteromorpha.	- -	Same as previous Stn.	Maximum densities in mud depressions. Smaller Enteromorpha mats.
23 July 80	3 Sandy Point	4,2,2,3,1 2,1 =2.14 at center 1/m^2 by inspection near periphery at bed.	Sand/silt/thin Zostera medium multh density. Enteromorpha mats.	Asterias 2-3/.25m none observed preying on scallops as in previous survey. individuals climbing Zostera blades. Anguilla Mnemiopsis	Zostera fouling upper third of plants - Ectocarpus Ceramnium hydrozoans spirobids Botrylus, Halichondria, Credpidula Terrebellid	26.6°C 26% scallop bed delineated. 46 animals measured.
	2 Camp Grasso	5,4,5,6,1, 3,3,8,5,11 = 5.10 in furrows. 2-4 in Zostera stands. Highest densities in Zostera "furrows"	Very dense Zostera silt/ detritus substrate - some sand patches. near peripheries of Zostera bed.	Asterias - very low density. Carcinus Urosalpinx on 3 of 250 scallops.	Fouled animals with Codium, Ulva, Rhodophyta, sediment mat with tubes visib. 6. Zostera blades heavily fouled with algae, hydrozoans, spirobids and sediment.	25°C 28% scallop bed delineated. 50 animals measured.
	1 Boat Ramp	At center 6,4,2,3,2/ .25 m2 = 3.40 1/m^2 by inspection at edges.	Sand/silt/ Zostera shell debris, mulch Zostera dense in center and sparse at edges.	Asterias, Carcinus Urosalpinx - 3 ind. with 3 on each. One with 12.	Zostera fouling similar to Camp Grasso. Scallops fouled with sediment and algae - primarily Ulva.	25°C 29% Scallop bed delineated. 43 animals measured.

Table B. (cont.)

Scallop Survey Summaries - Niantic River

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/Zostera Fouling	Other
5 Sept 80	2 East of #16 Channel marker.	3,1,2,2,1,1 2,3,2,3,1 6,3/.25m^2 Total 3 $\overline{x}$ = 2.31/.25m^2		Greater number of Asterias then on previous surveys	Primarily Spirobus and various algae.	New set of juveniles observed. Most (80%) attached to Zostera 0-yr class and 1 yr class measurements 28% Cage placement at #16 channel marker.
18 Sept 80	3	0,0,1,0,0,0, 1,0,0,0. Total 2 $\overline{x}$ = .2/.25m^2 Large decrease from previous sample.	Zostera bed ends 35 yds from shore - to mud bottom where Asterias densities increase (5-10/.25m^2)	Asterias densities 1/2 that of previous survey but still remain high. Chrysaora - 1 Pagurus/ 40	Algae bryozoans, Spirobis, Botrylus, Halichandria	Massive growth of Agardhiella and a filamentous sp that has covered much of the Zostera. Illyanassa juv. extensive. 21.5°C 32% Measurements of natural population 1-yr (14) 0-yr (2)
	2	6,3,4,5,6,7,9 6,5,12,6,5,4,7 10,8,7,5,6,3 Total 124 $\overline{x}$ = 6.2/.25m^2 Denser in depressions between Zostera stands.		3 of 100 with Urosolpinx attached Few Urosolpinx Asterias 1/m^2 more dense then previous surveys.	Spirobis bryozoans upper 1/3 of blades.	Sparse set of 0-yr class (80% less) compared to across channel set. High densities of 1-yr class Illyanassa ubiquitous. 20.9°C 31% Measurements of natural population (50).
	1	1,1,1,0,5,2 1,1,3,0,2,1 2,1,1,2,2,3,0 0. Total 29 $\overline{x}$ = 1.45/.25m^2 less dense then previous survey.		3 of 20 scallops with Urosolpinx attached.	Spirobis and algal epiphytes.	Few 0-yr. class observed. Measurements of natural population (19). 21°C 31%.

Scallop Survey Summary - Niantic

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
14 Oct. 80	2	2-5/m^2 spotter estimate				Spotter survey
	East Bank	1-2/m^2	Extensive scallop shell hash on sediment surface.			
	Mid-bay	1-2/m^2	*Zostera* dense obscuring "hidden" scallop populations.			
17 Nov. 80	2	Spotter collection measurement. NMFS spawning stock retained.				
26 March 81	3	Densities of 1 year 1980 class 1,1,1,0,0,1,1,2,3, 1,4,1,0 per .25 m^2. Collection and measurement		*Asterias* count low (~20 = 2 hr) 5 predation attempts observed *Urosalpinx* - (1) *Libinia* (3)	New *Zostera* shoots. Valves covered by sedimentation (~85%) *Enteromropha* (15%)	
	2A	(19) quadrant counts $\bar{X}$ = 1.1	New *Zostera* growth sand/silt interspace sediment with shell hash surface.	*Carcinus* (1)		
	2	(1) 5 m density of 0 year scallop Collection and measurement.				

Scallop Survey Summary - Niantic

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
13 April 81	2A	Winter depression posture still common (~ 80%) of population.		*Carcinus* (1)		Tag release (150) at #18 Channel marker.
	Mid-bay	3-4/.25 m^2				
4 June 81	2A	(16) quadrant counts $\bar{X}$ = 2.7 1979 year class scallops (5) quadrants mid-channel $\bar{X}$ = 2.0 Collection (100) to tag.			*Asterias* (1) *Urosalpinx* (20+) (6) predation on scallop.	14.5°C
	3	1/.25 m^2 est. scallop density.			*Opsanas tau* (14) *Illynassa* juvenile set dense.	Tag (10) recaptures

Table C. Field survey of natural Bay Scallop population ecology - Little Narragansett Bay.

Scallop Survey Summary - Little Narragansett Bay

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
19 June 80	Between W.shore of Randall Neck and Barn Is. see cht. Stns.1-7	7 scallops sighted over survey area 6 at stn.2 1 at stn.5	Hard sand bottom with thin silt veneer. Sparse Zostera beds at all stations - except 6.		*Zostera* fouling - *Crepidula*, *Nassarius* *Spirobis*, *Bryozoan* sp. Valve fouling - *Enteromorpha*, *Nassarius* sp.	Area heavily impacted, apparently by clammers. Very little silt accumulation around *Zostera* as well as generally sparse beds. Lack of apex food web organisms (i.e. *Carcinus maenus*, *Callinectes*, *Anguilla* etc.)
6 Aug 80	1 Cove, S. Barn Is.	No scallops	Soft mud/silt and *Zostera* mulch *Enteromorpha* and *Agardhiella* mats extensive.	*Callinectes* - 1 *Mnemiopsis*	*Zostera* fouling - *Spirobis*, *Halichondria* *Byrozoans*, Ectoprocts, *Terrebellid* or *Illyanassa* egg cases.	- -
	2 West side Barn Is.	No scallops	Sand bottom sparse *Zostera* stands. Algal mats sparse.	- -	- -	- -
	3 Cove N of Barn Is.	No scallops	Mud/silt bottom and *Zostera* mulch. Coarse sand over most of area.	- -	- -	- -
	4 West of Randall Neck	1-Scallop	Sand bottom - *Enteromorpha* mats extensive.	- -	- -	- -

Table C.(cont.)

Scallop Survey Summary - Little Narragansett Bay

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
8 Aug 80	West of Barn Island	10,000 animals plus 1500 with gray dorsal valve tags.	Sparse Zostera sand/silt bottom. Algal mats.sparse	Previous surveys indicated few predators present.		Scallop seed dispersal. Seed stock scattered. All animals from single batch NMFS stock. 200 animals measured.
	West of Randall Neck	10,000 animals plus 1500 with red dorsal valve tags.	Sparse Zostera sand/silt bottom. Algal mats.	Same as Barn Is.	- -	Scallop seed dispersal. Seed stock scattered.
12 Aug 80	2 W.side Barn Is.	8 seed animals resighted - no tags - 1 dead.	Extensive algal mat obscuring bottom.	3 *Callinectes* molts. *Mnemiopsis* *Brevoortia* - 1 *Menidia* - 20		No dispersal pattern noted. 30 minute survey.
	4 West of Randall Neck	12 live animals re-sighted - no tags.		3 *Callinectes* molts. 1 *Limulus* molt 50 *Menidia* 2 *Chrysaora* *Mnemiopsis*		No dispersal pattern noted. 30 minute survey.

Table C. (cont.)

Scallop Survey Summary - Stonington

Date	Stn.	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
5 Sept 80	1 West of Barn Is.	1/.25m^2			Heavy fouling by *Spirobis*.	24°C 29‰ 0-yr class (34) and 1-yr class (67) measurements. 0-yr class mostly attached to *Codium*, some on *Zostera* (seed or matural?). *Illyanassa* ubiquitous. Cage placement off Barn Island

Scallop Survey Summary - Little Narragansett Bay

Date	Stn	Density	Benthic Topography Substrate Type	Predators	Valve/*Zostera* Fouling	Other
19 Nov. 80	1	Abundant 0 year class animals, few 1 year class. Collection measurements (9) quadrants $\bar{X} = 2.3/1/4\ m^2$ adult/0 yr. class = 3/56 ratio.	Typical sand silt bottom with (10 m diam) "mulch" patch areas.	None observed	*Zostera* bed (80%) die back. *Molgula* fouling on 3 scallop valves.	NMFS grow out cages tended.
	3	2 spotter drifts - no adults observed				
20 'Apr. 81	1	Extensive 0 year class distribution. ~ $3/.25\ m^2$ est. collection.				
27 Apr. 81	1	(17) quadrant counts $\bar{X} = 1.6/.25\ m^2$ collection (est. 300 0 year class/ 30 1 year class).	Scallops commonly residing in 2 cm deep sediment depressions.	*Cancer irroratus* (5) *Carcinus maenus* (3)	*Codium* evident in tufts on 1 year class scallop. 0 year class fouling light (10% *Enteromorpha*)	Tag release (300) NMFS cages not located.
14 May 81	1	(14) quadrant counts $\bar{X} = 2.1/.25\ m^2$ collection (200)		*Carcinus* (1) *Limulus* (4)		Tag release (100) 14.5°C.

APPENDIX B.

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APPENDIX B (continued)

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APPENDIX C.

Scallop fishery status

A. Waterford-East Lyme Shellfish Commission (personal communcation) Niantic Bay.

Shellfish permit books indicate several categories for license fees: target species; daily, monthly or seasonal period; 1/2, 1, 2, or 3 bushel quantities. Estimation(Mr. Richard DuBoll) on the number, revenue and percentage attributed to the 1980-81 scallop fishery in Niantic Bay follows: Approximately 8000 permits (scallop) issued.

In excess of $25,000 generated by scallop license fees.

Of the 8000 permit types - 5% were seasonal; 95% were daily.

Of the 95%, 55% were granted for 1 bushel quantities

30% were granted for 2 bushel quantities

15% were granted for 3 bushel quantities.

B. Stonington, Conn. Little Narragansett Bay (Selectman's office personal communication).

Little Narragansett Bay suffered poor scallop recruitment during 1979 and few adult scallops were available for the 1980-81 season. A total of 188 shellfish permits (scallop) were issued during the 1980-81 season. This contrasts greatly to the permit record for 1978:

1802	Regular permits (daily)
3	Season permits
103	Senior Citizen permits
14	Senior Citizen season permits
1922	Total permits for 1978.

C. Groton, Connecticut - Poquonock, Mumford, Palmer, and Noank embayments.

Summary obtained for the 1979-1980 Groton scallop permit ledger indicate:

148	Senior citizens
1028	Residents
415	Non-resident
1591	Total

Dollar revenue (@$1.50) amounted to $2,164.50.

APPENDIX C. (cont'd.)

Attention should be directed to the statement that revenues reflect only dollars received from sale of scallop permits, not estimation of resource value. The following Sea Grant report paragraph recounts past efforts and attempts a crude economic estimate of the "documented" scallop resource.

"During 1978, M.A.S., the N.M.F.S. Milford Laboratory and the Dept. of Agriculture-Aquaculture Division stocked 200,000 juvenile scallops in Stonington and Groton town waters. Field studies on water quality, advice on establishing Shellfish Commissions, and guidance on management codes accompanied the town's recognition of valuable shellfish resources and their use. The 1979 scallop season involved sales of 1475 and 1850 licenses for Groton and Stonington respectively. The economics calculated are as follows: 1 license = 1 bushel permit = 1 gal. shucked meat @ $5 per pound = $40 scallop value per license. Therefore, recreational harvest of scallop alone accounted for $59,000 and $74,000 scallop seafood value to Groton and Stonington participants. Also, the one dollar license fee provided funds ($3325) for further shellfish commission work in aquaculture and management."

Calculations based on 1980-81 figures provided for Niantic Bay provide the following one-season scallop resource value:

a)	400 season permits	assume 50% success	400 bu.
b)	4180 daily 1 bushel		2090 bu.
c)	2280 daily 2 bushel		2280 bu.
d)	1140 daily 3 bushel		1770 bu.

1 bu. = 1 gal. shucked scallop @ $5.20/lb. (1 pt = 1 lb.)
1 bu. = $42.

a)	$16,800	
b)	87,780	
c)	95,760	
d)	74,340	
	$274,680	estimate seafood value of Niantic Bay scallop 1980-81.