Final Report

A Plan to Entrap Bay Scallop Spat Subject to Evacuation from Prime Rearing Sites, with an Emphasis on Optimizing Collection Timing and Location and a Goal of Reintroduction to Natural Nursery Areas

An Action Plan Demonstration Project for the Peconic Estuary Program

Submitted by:

John Aldred
Todd Ciccone
Craig Hassler
Thomas Dornhofer

East Hampton Town Shellfish Hatchery
159 Pantigo Road
East Hampton, New York

TABLE OF CONTENTS

Page

LIST OF FIGURES AND TABLES BY ORDER OF PRESENTATION.....i-ii

INTRODUCTION.....1-6

MATERIALS AND METHODS.....6-9

RESULTS.....9-28

DISCUSSION.....28-30

ACKNOWLEDGEMENTS.....31

LITERATURE CITED.....32-33

List of Figures and Tables by Order of Presentation

Figure 1- New York State Department of Environmental Conservation, Scallop Landings in Peconic, Gardiners, Napeague Bays. 1970-1998.

Figure 2- Suffolk County Department of Health Services, Office of Ecology, Brown Tide Cell Counts in Northwest Harbor, East Hampton, NY. 1986-1998.

Figure 3- Study Area Location, Town of East Hampton, NY.

Figure 4- Study Area Detail.

Table 1- Schedule of Timed Collector Deployments and Retrievals, Plankton Collection and Field Measurements, 1996 Season.

Table 2- Water Temperature and Bivalve Larvae per Cubic Meter by Sample Date.

Figure 5- Water Temperature vs. Abundance of Bivalve Larvae.

Table 3- Bivalve Larvae per Cubic Meter and Scallop Spat Retained on Timed Collectors by Region and Sample Date.

Figure 6- Abundance of Bivalve Larvae vs. Scallop Spatfall on Timed Collectors.

Figure 7- Total Number of Scallops Found on Timed Spat Collectors.

Table 4- Scallop Spat Retained in Long Term Collectors Spatially Differentiated.

Figure 8- Total Number of Scallops Found on Long Term Spat Collectors.

Figure 9- Average Number of Scallops Found on Long Term Spat Collectors, with 95% Confidence Limits.

Figure 10- Average Number of Scallops Found on Long Term Surface Spat Collectors, with 95% Comparison Intervals using the T-Method.

Table 5- Velocity of Water Flow (Cm/Sec) Through One Quarter Moon Ebb Tide Cycle and Through One Full Moon Ebb Tide Cycle- Napeague Harbor, 6/24/96 and 6/30/96, By Spat Collector Region.

Figure 11- Current Velocities at Three Stations Corresponding to Spat Collector Locations. Third Quarter Moon Ebb Tide, June 24, 1996.

Figure 12- Averages of the Quarter Moon (June 24, 1996) Current Velocity Data Based on Untransformed Data. 95% Comparison Intervals Derived Using the T-Method.

Figure 13- Current Velocities at Three Stations Corresponding to Spat Collector Locations. Full Moon Ebb Tide, June 30, 1996.

Figure 14- Averages of the Full Moon (June 30, 1996) Current Velocity Data Based on Log Transformed Data. 95% Comparison Intervals Derived Using the T-Method.

Figure 15- Average Current Speed Over a Quarter and Full Moon Cycle at the Three Spat Collector Locations Based on Log Transformed Data. 95% Comparison Intervals Derived Using the T-Method.

Figure 16- Overwinter Survival of Hatchery Produced and Wild Caught Scallops in Suspended Pearl Nets.

Figure 17- Average Length of Hatchery Produced and Wild Caught Scallops at Beginning and End of Overwinter Experiment.

Figure 18- Average Number of Scallops Set in Long Term Surface Collectors, 95% Comparison Intervals Using T-Method and Average Current Speed (based on log transformed data) at the Three Spat Collector Locations, 95% Comparison Intervals Using the T-Method.

Introduction

The bay scallop (*Argopecten irradians)* exhibits a population dynamic that is naturally subject to great fluctuation from year to year. This phenomenon is clearly demonstrated by NY State Department of Environmental Conservation scallop landing records (Figure 1). In decades past, periods of low population, as reflected in the commercial harvest, have caused serious concern locally. One determinative study, undertaken by the New York Ocean Science Laboratory in Montauk, NY (Austin, 1974) speaks to environmental factors and minimum standing breeding populations and makes recommendations advising strict adherence to harvest regulations designed to avoid the taking of first year class, or bug scallops.

In 1985 an algal bloom of shocking proportions was experienced in the Peconic Bay system as well as Narragansett Bay, RI. Both blooms were later found to be dominated by a golden brown alga, *Aureococcus anophagefferens* (Sieburth et. al., 1988). This so-called brown tide persisted in the Peconic system to varying degrees in subsequent years (Nuzzi, personal communication) and is illustrated by cell count data from Northwest Harbor in East Hampton (Figure 2). These blooms had particularly devastating and long term effects on the bay scallop population region-wide, as the scallop landings demonstrate. A promising rebound in landings in 1994 was followed by another major brown tide event in 1995, from which populations have yet to recover.

Bay scallop restoration attempts in the wake of these outbreaks since 1985 have primarily utilized hatchery produced scallops either directly seeded or held in spawner sanctuaries. These programs have been positively assessed (Krause, 1992; Tettlebach et.al., 1993) but the re-occurrences of the blooms and magnitude of the task of re-establishing pre-bloom populations estuary-wide have precluded all but limited local harvests for baymen dependant on the scallop as a cornerstone of their fall and winter fishery. Wild scallop spat collection techniques, used successfully as an aquaculture seed accumulation method in areas of high natural productivity (Imai, 1977; Mottett, 1979) have been attempted by shellfish managers internationally (Robins-Troeger, 1993) and in our region with varying degrees of success (Kelly, 1981,1985; Rivara, personal communication; Tammi, 1994; Turner, 1994). It was thought that local shellfish managers in the estuary not possessing the resources to either purchase or grow hatchery reared bay scallops, but wishing to enhance formerly productive areas, might benefit from a spat collection protocol spatially and temporally optimized to regional conditions; particularly spat collection practiced near the mouths of tidal creeks and harbors, capturing spatfall destined to be swept out of the inlet and into less favorable conditions beyond.

The East Hampton Town Shellfish Hatchery, a public shellfish enhancement endeavor growing eastern oyster, hard clam and bay scallop yearling seed for dispersal on public grounds, maintains a deep water (± 4m) field site in Napeague Harbor, Amagansett, NY (Figure 3). The site sits between eel grass beds in the harbor and an inlet to Napeague Bay (Figure 4). The demonstrated relationship between eel grass and bay scallop recruitment (Garcia-Esquivel et.al., 1993; Pohle et.al., 1991) and the strong tidal dynamic

Figure 1
New York State Department of Environmental Conservation,
Scallop Landings in Peconic, Gardiners, Napeague Bays. 1970-1998

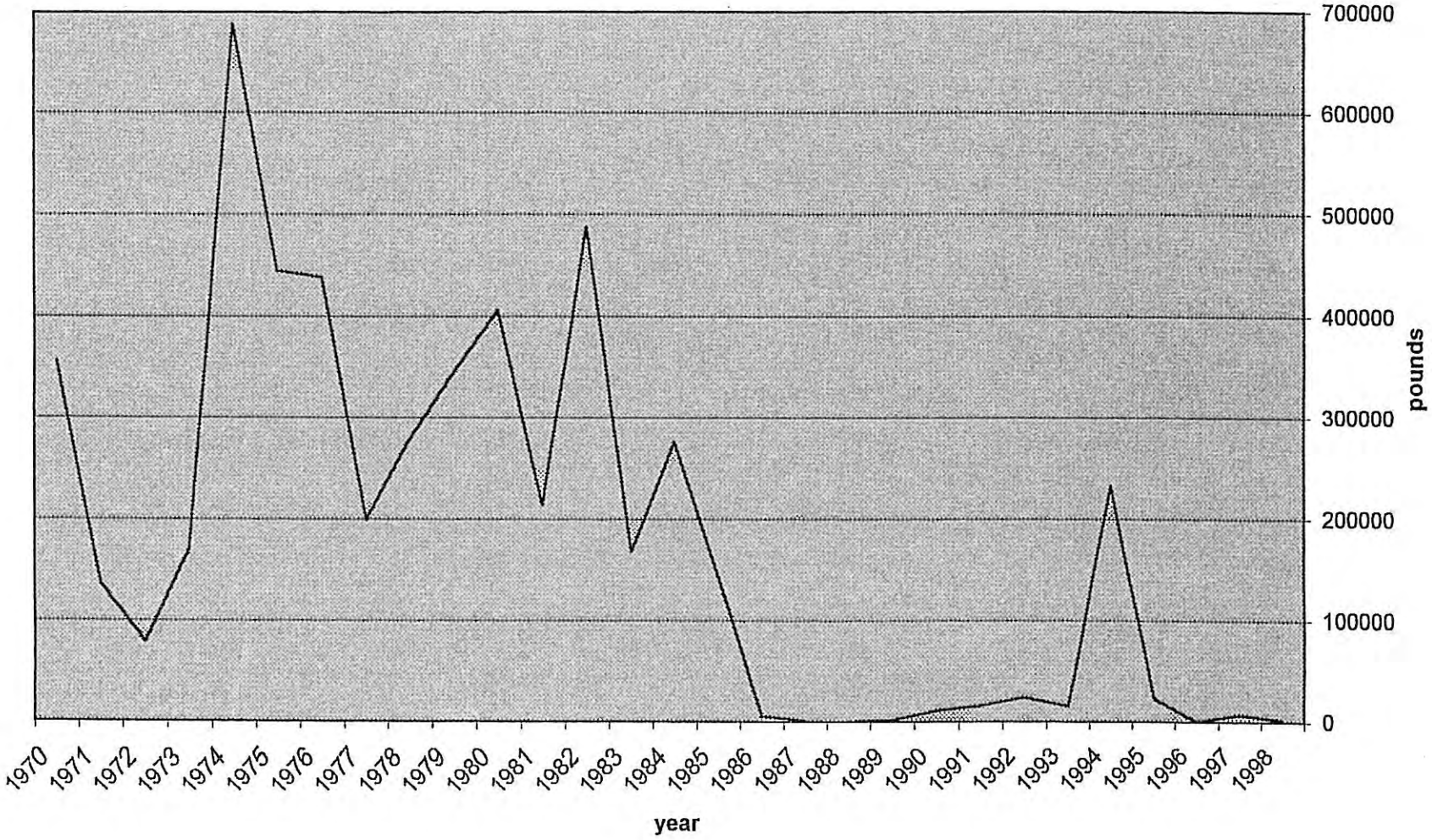
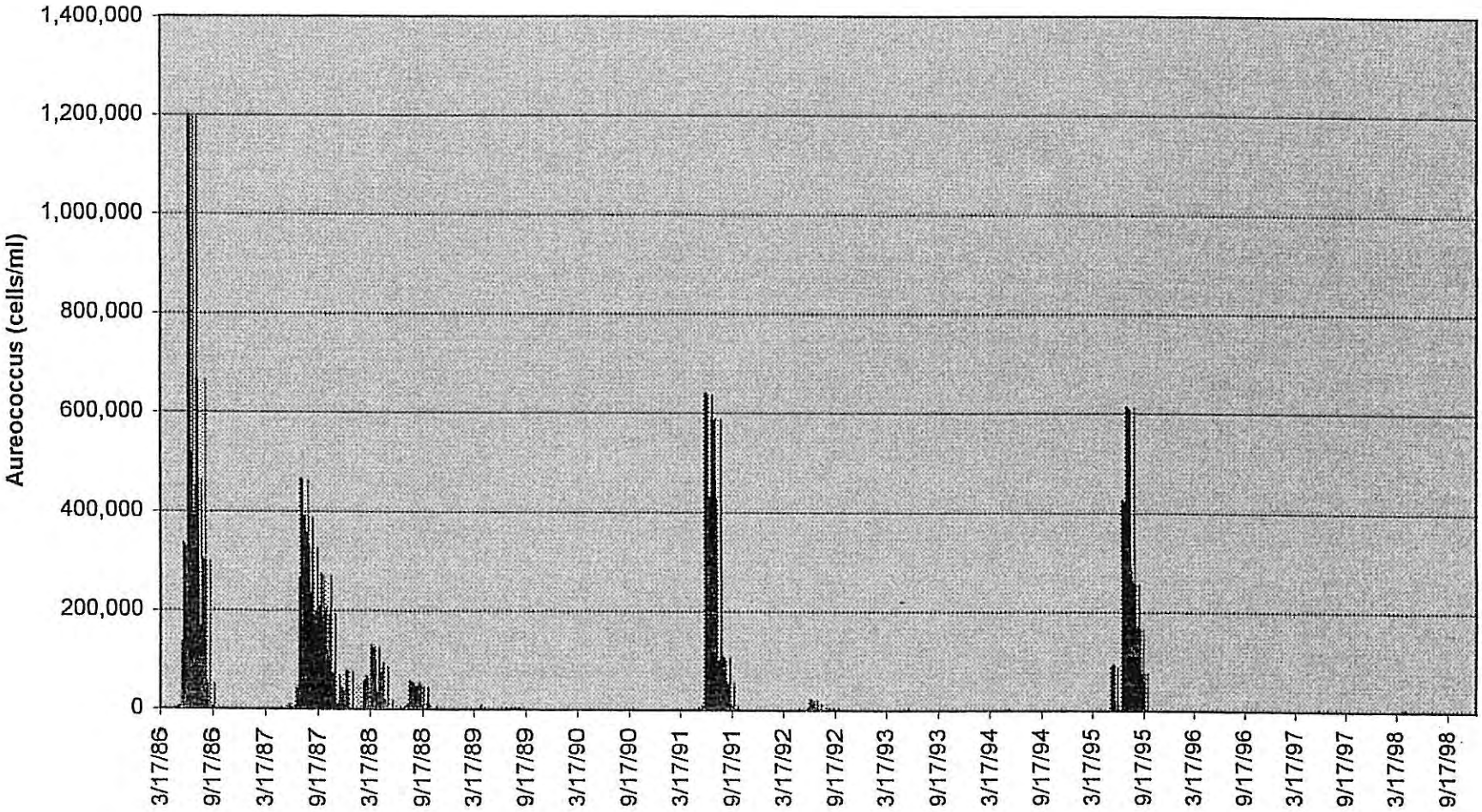


Figure 2
Suffolk County Department of Health Services, Office of Ecology,
Brown Tide Cell Counts in Northwest Harbor, East Hampton, NY
1986-1998



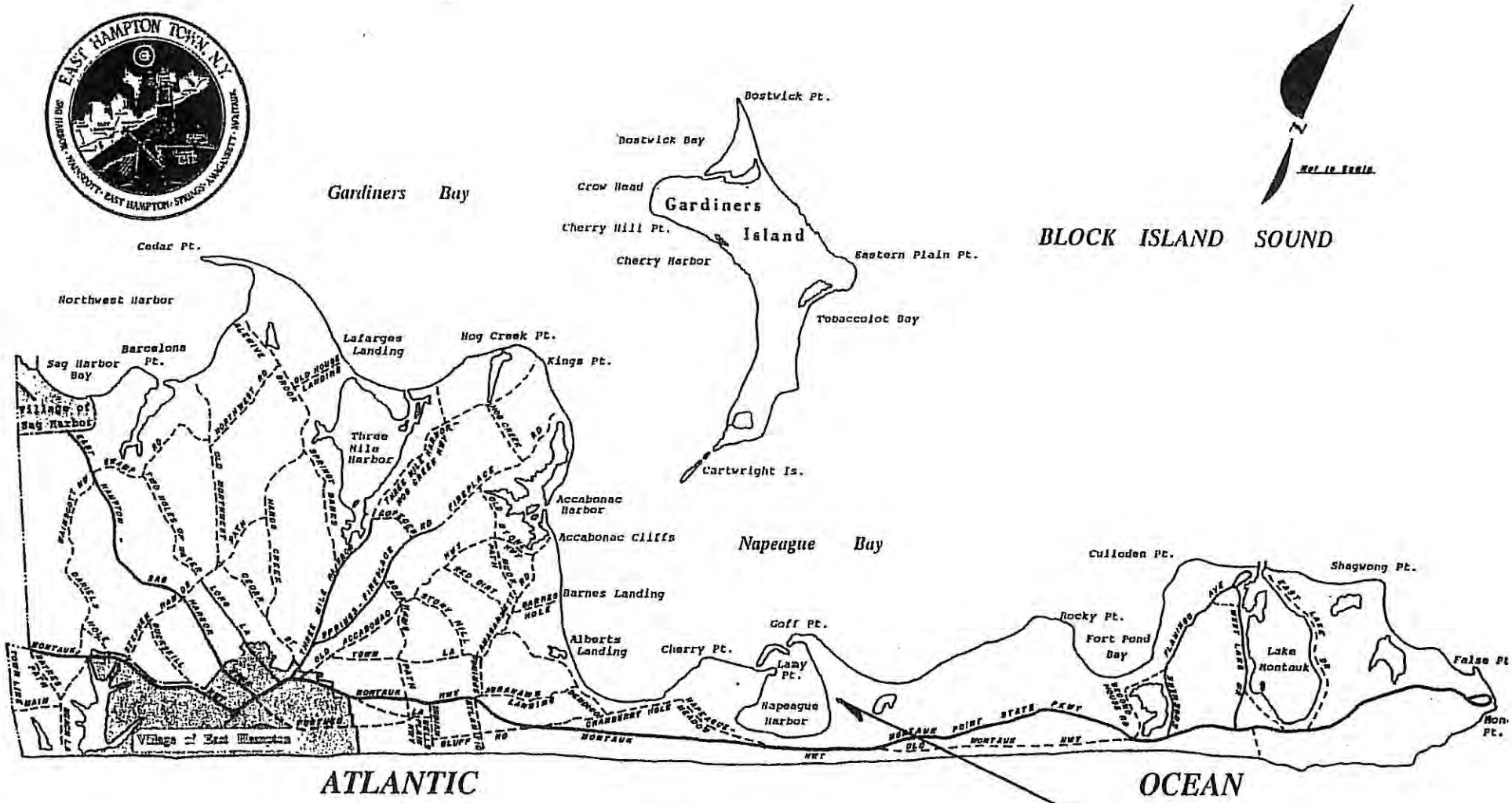


Figure 3

Study Area Location

T.D.E.H. 9/94

4.

Prepared by
The Town of East Hampton
Planning Department

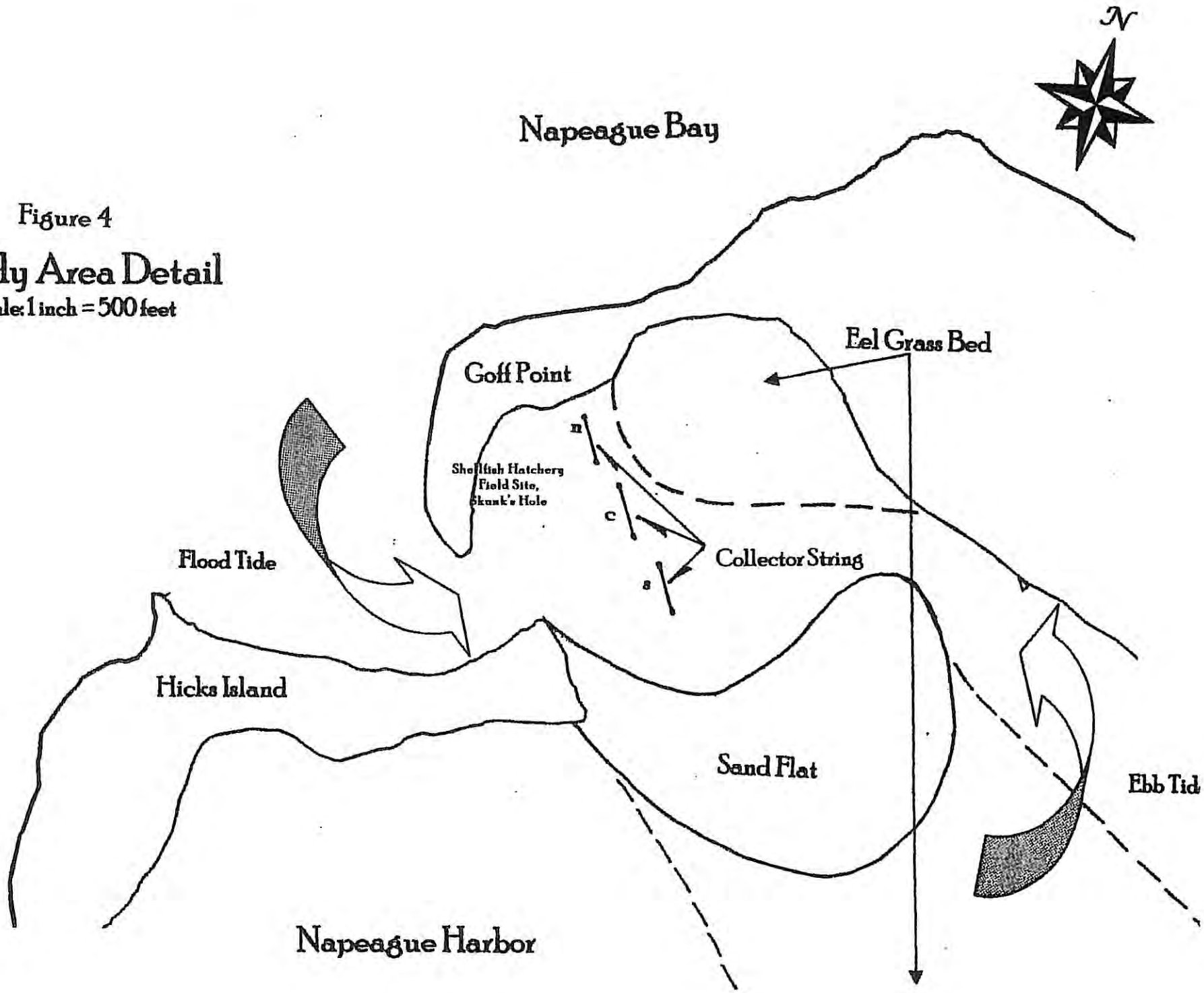
~Town of~
~East Hampton~
Suffolk County, New York

r.r.p.

Figure 4

Study Area Detail

Scale: 1 inch = 500 feet



of this harbor inlet have often resulted in bay scallop juveniles, entrained in the ebb flow, setting on shellfish grow out gear in this location.

The site is ideal to test the relationships of spat collection to temperature, depth, current speed and the relative abundance of bivalve larvae in the water column over time. Finally, it would be useful if the overwinter survival of hatchery reared and wild caught bay scallops were compared, in order to provide information on similarities or differences in vigor. The information could be used by shellfish managers in the region in assessing their options and optimizing bay scallop spat collection methods to local conditions.

Materials and Methods

Study Area and Basic Setup.
The study area was located inside the eastern inlet to Napeague Harbor in Amagansett, NY in an area locally known as Skunk's Hole. Three separate buoyed floating long lines, each approximately 30m, were deployed in early April of 1996 in an area of Skunk's Hole which lay in between an approximately two hectare eel grass bed to the east and the harbor inlet to the west. The lines were strung individually in the hole adjacent to the northern, central and southern portion of the eel grass bed in approximately 3m of water and perpendicular to the flow of the ebb tide, which courses through this area on its way to the inlet to the west (Figure 4). The core experimental period, during which data collection relating to temperature, abundance of bivalve larvae in the surface plankton, number of scallops found in both timed and long term spat collectors and current velocity in the three collection areas, began on April 29 and ended on August 26 (Table 1). Assessment of the overwinter survival of wild caught vs. hatchery reared scallops is described separately.

Temperature and Plankton Collection.
Expecting a correlation between temperature and spawning activity (Bricelj, 1987), surface (±15cm deep) water temperature was taken and recorded twice each week in the locale of the collector long lines beginning on April 29. Also twice each week, a five minute surface plankton tow was taken, traversing the entire experimental area. The tow was made in a boat traveling at two knots, with the net towed amidships in order to avoid interference by the boat's propeller wash. A 118μ mesh plankton net with a 300mm mouth opening was used. The catch was to be assessed for the presence and abundance of bivalve larvae.

Material in the plankton net and collection bottle was washed into a 5l. bucket and transported within two hours to the hatchery's laboratory for analysis. In the lab the mass of material was sieved through a 150μ USA Standard sieve thus retaining all material between 118μ and 150μ, the expected size of late stage bivalve veliger larvae. The retained material was diluted with seawater filtered to 5μ such that a 1ml sub-sample collected with a Hensen-Stempel pipette yielded approximately 50 plankters. Three replicate sub-samples were counted under the microscope in a Sedgewick-Rafter

Table 1
Schedule of Timed Collector Deployments and Retrievals, Plankton Collection and Field Measurements, 1996 Season

								Week	of								
29-Apr	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug	19-Aug	26-Aug
#1 in		#1 out															
	#2 in		#2 out														
Temp. &																	
Plankton		#3 in		#3 out													
twice	Temp. &																
	Plankton		#4 in		#4 out												
	twice	Temp. &															
		Plankton		#5 in		#5 out											
		twice	Temp. &						Temp. &								
			Plankton		#6 in		#6 out		Plankton								
			twice	Temp. &					twice	Temp. &							
				Plankton		#7 in		#7 out		Plankton							
				twice	Temp. &					twice	Temp. &						
					Plankton		#8 in		#8 out		Plankton						
					twice	Temp. &					twice	Temp. &					
						Plankton		#9 in		#9 out		Plankton					
						twice	Temp. &					twice	Temp. &				
							Plankton		#10 in		#10 out		Plankton				
							twice	Temp. &					twice	Temp. &			
								Plankton		#11 in		#11 out		Plankton			
								twice						twice	Temp. &		
											#12 in		#12 out		Plankton		
									Ebb						twice	Temp. &	
								Ebb	Current			#13 in		#13 out		Plankton	
								Current	Flow							twice	Temp. &
								Flow	once				#14 in		#14 out		Plankton
								once	Full Moon								twice
								1st Qtr.						#15 in		#15 out	
															#16 in		#16 out

counting cell and the number of bivalve larvae in the entire sample was extrapolated and recorded. The volume of water sampled was calculated using the formula:

$$M^3 = \frac{D^2 \Pi L}{4}$$

D= net diameter and L= length of the tow in meters (boat speed in knots x length of tow in minutes) (Austin et.al., 1973). Final calculations were made in order to present the number of bivalve larvae per cubic meter of water sampled.

Short-Term (Timed) Spat Collectors.

Beginning on April 29, short-term (timed) spat collectors consisting of 30cm x 30cm 7mm mesh 'onion bags' stuffed with approximately 0.4 m^2 of 7mm mesh plastic bird netting were deployed. In order to assess the difference between surface and bottom spat collection effectiveness in the short term, three surface (30cm deep) and three bottom (240cm deep) collectors were attached to each of the three long lines for a total of eighteen collectors. The timed collectors were deployed each week and left in the water for two weeks, after which they were to be removed and assessed for newly set scallop spat from the previous two week period (Table 1). The overlap of timed collectors was planned in order to assure observation of set, which might otherwise be missed if it occurred toward the end of a timed interval. Deployment continued until August 26, 1996.

The three collectors from each location (north surface, north bottom, central surface, etc.) were combined and transported live to the hatchery's laboratory within two hours of retrieval. At the hatchery, the collector bags and internal mesh were subjected to a strong wash using seawater filtered to 5μ. Material was rinsed from the mesh onto a 200μ 'catch screen'. Material retained on the catch screen was subsequently sieved through a 150μ USA standard sieve, this being the size at which bay scallop larvae will begin their metamorphosis or set. The material retained on the 150μ sieve was examined microscopically and bay scallops enumerated and recorded.

Long-Term Spat Collectors.

On June 13, 1996 sixty long-term spat collectors were deployed throughout the study area such that in each portion (north, central and south) ten collectors were deployed near the surface (30cm depth) and ten near the bottom (240cm depth). These collectors consisted of full sized onion bags (100cm x 60 cm) stuffed with approximately 4 m^2 of 7mm plastic bird netting in such a way as to maximize surface area within the collector (Ambrose et.al., 1991). These collectors were left in place until August 12, 1996, when they were removed from the water and the scallops retained in each unit were enumerated and individual shell lengths recorded. Numbers of scallops caught per portion at both surface and bottom locations were totaled for analysis of each location's catch effectiveness and comparisons with other factors.

The collected spat scallops were put into 6mm pearl nets at approximately 150 scallops per net, a standard gear type and stocking density used by the hatchery. They were then cultured alongside hatchery reared product in standard four net strings hung from float lines at the hatchery's grow out site in Skunk's Hole.

Current Velocity at Ebb Tide
The velocity of one cycle of the ebb tide's surface current through the northern, central and southern portions of the study area was observed both during a quarter moon phase on June 24, 1996 and full moon phase on June 30, 1996. Using a General Oceanics Model 2035-MK111 current meter, an attempt was made to take three readings in each of the three portions of the study area at approximately one, three and five hours into the cycle, for a total of twenty seven readings per tide cycle.

Overwinter Survival and Growth.
After removal of the long term collectors on August 12, 1996, retrieved spat were placed in pearl nets, under identical conditions, alongside juvenile scallops originating from the hatchery. On October 31, 1996 one hundred twenty collected scallops and one hundred twenty hatchery reared scallops were removed from the field grow-out site and each set placed in six 6mm pearl nets (20 scallops/net) and hung from a dock in Three Mile Harbor at the hatchery's upwelling nursery site at Gann Road in East Hampton. Sixty animals from each group were measured for shell length. The nets were hung from the dock in strings of two at a depth of approximately 200cm (water temperature 11°C).

During the winter all nets were brushed clean twice, once in mid January and once in mid February of 1997. All nets were removed on May 13, 1997 (water temperature 12°C). Live and dead animals were counted and shell lengths of sixty live animals recorded.

Results

Temperature and Bivalve Larval Abundance
Water temperature and bivalve larval abundance in the plankton over the course of the experimental period are presented in Table 2 and represented graphically in Figure 5. A peak of bivalve larvae present in the plankton (81/m^3) was seen first on May 23 as temperatures climbed above 15°C, again on July 1 (183/m^3) as temperatures reached 20°C and finally, but to a lesser extent, on August 22 (17/m^3). This small peak occurred after a high temperature of ±23°C in mid July dipped to ±19°C in early August and subsequently climbed back to ±23°C.

Bivalve Larval Abundance and Scallop Spatfall on Timed Collectors
The numbers of scallop spat found in the timed collectors across the experimental area by date is shown in Table 3. These values are plotted alongside the abundance of bivalve larvae in the plankton in Figure 6. The bivalve larvae found in the plankton which peaked on July 1 and again on August 22 are followed by peaks of set scallops in the timed collectors of 1,112 on July 8 and 245 August 26. The fact that a peak of larvae found in the plankton on May 27 is not followed by any evidence of scallop spatfall suggests other larval species were observed. In fact, during analysis of the June 4 timed collectors, observations of juvenile blue mussels, *Mytilus edulis*, and gastropods, possibly *Crepidula spp.* were made.

Table 2

Water Temperature and Bivalve Larvae per Cubic Meter by Sample Date

Date	Water Temp C	Bivalve larva per M3
29-Apr	11	0
2-May	11.2	0
7-May	11.4	0
10-May	10.2	0
14-May	11.4	0
16-May	11.6	0
20-May	14.2	0
23-May	16.7	0
27-May	16.6	81
30-May	12.4	22
3-Jun	13.6	0
6-Jun	15.5	0
10-Jun	17.6	0
13-Jun	19.6	0
17-Jun	18.5	0
20-Jun	16.5	72
24-Jun	19.5	113
27-Jun	19.9	83
1-Jul	17.6	183
4-Jul	18.4	116
8-Jul	20.7	41
11-Jul	20	12
15-Jul	19.5	22
18-Jul	23.1	0
22-Jul	21.1	7.3
25-Jul	21	4.8
29-Jul	21.5	0
1-Aug	20.3	0
5-Aug	19.4	0
8-Aug	21.3	0
12-Aug	22.2	10
15-Aug	22.5	12
20-Aug	21.9	7
22-Aug	22.5	17
26-Aug	21.9	0

Figure 5
Temperature Vs. Abundance of Bivalve Larvae

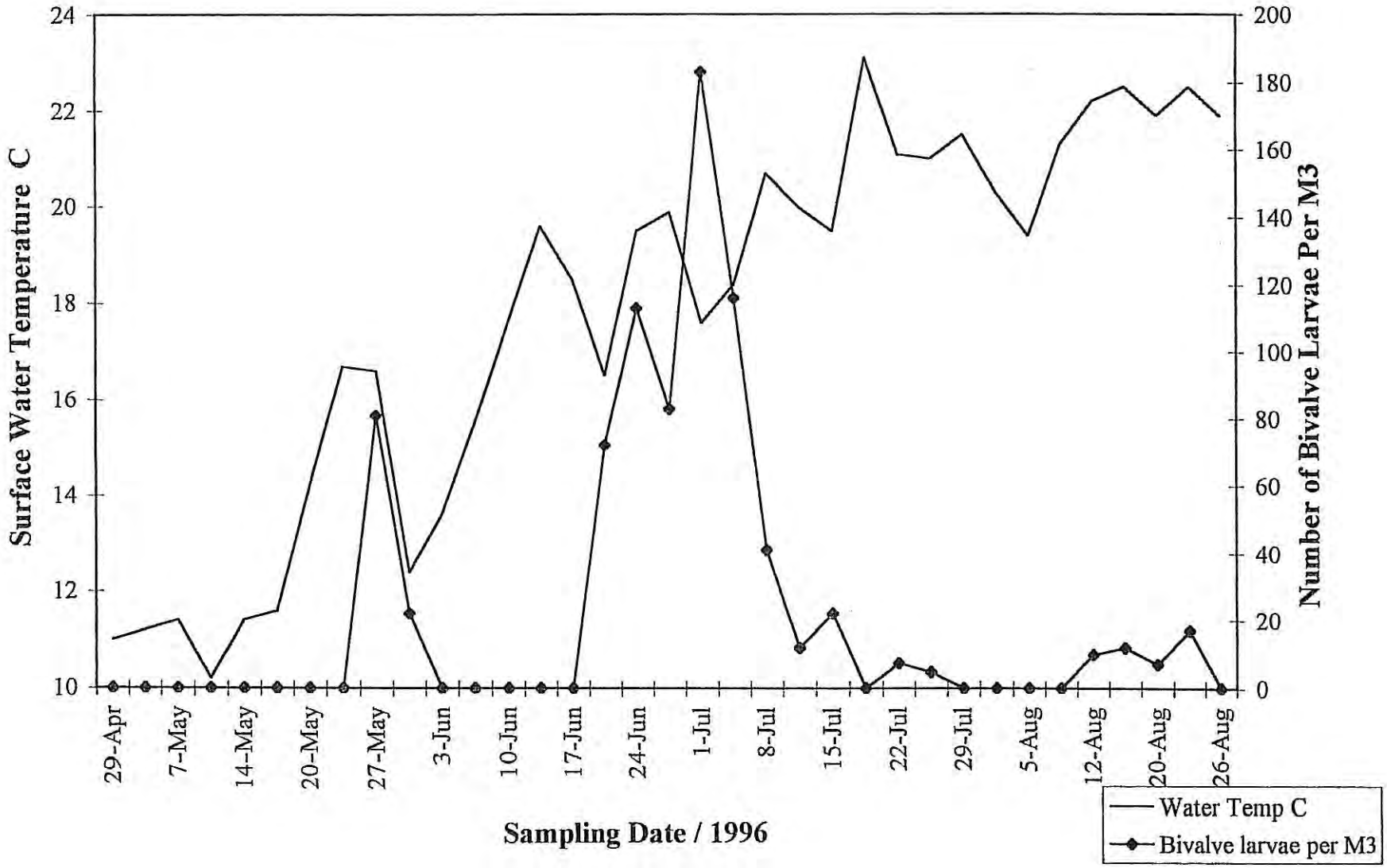
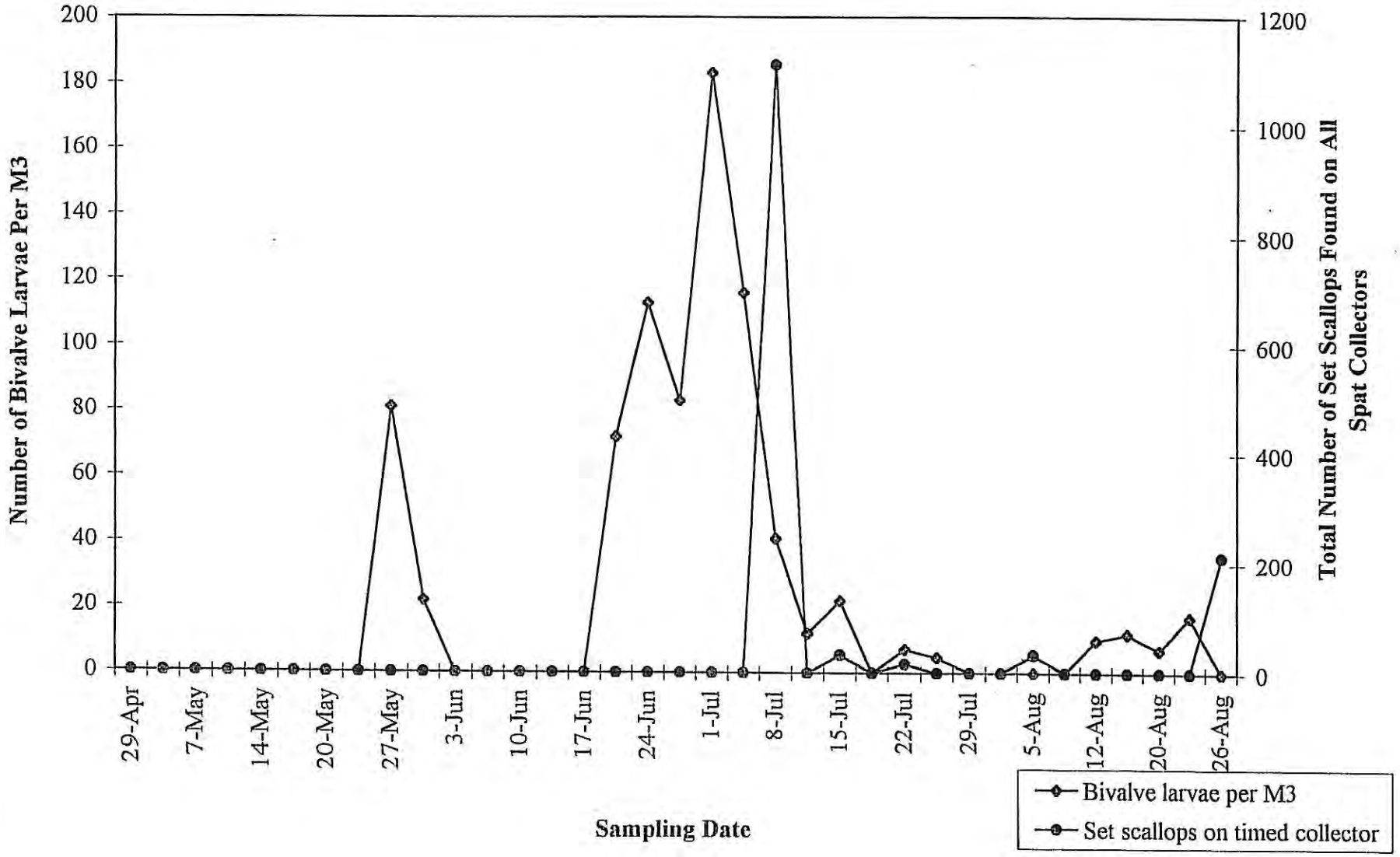


Table 3

Bivalve Larvae per Cubic Meter and Scallop Spat Retained on Timed Collectors by Region and Sample Date.

Date in1996	ivalve larva per M3	Set scallops on timed collecto north surface	Set scallops on timed collecto north bottom	Set scallops on timed collecto middle surface	Set scallops on timed collecto middle bottom	Set scallops on timed collecto south surface	Set scallops on timed collector south bottom	Total Set Scallo on Surfac Collectors	Total Set Scallo on Bottom Collectors	Total Scallop Spat by Date
29-Apr	0									
2-May	0									
7-May	0									
10-May	0									
14-May	0	0	0	0	0	0	0	0	0	0
16-May	0									
20-May	0									
23-May	0									
27-May	81	0	0	0	0	0	0	0	0	0
30-May	22									
3-Jun	0	0	0	0	0	0	0	0	0	0
6-Jun	0									
10-Jun	0	0	0	0	0	0	0	0	0	0
13-Jun	0									
17-Jun	0	0	0	0	0	0	0	0	0	0
20-Jun	72									
24-Jun	113	0	0	0	0	0	0	0	0	0
27-Jun	83									
1-Jul	183	0	0	0	0	0	0	0	0	0
4-Jul	116									
8-Jul	41	22	65	165	250	530	80	717	395	1112
11-Jul	12									
15-Jul	22	33	0	0	0	0	0	33	0	33
18-Jul	0									
22-Jul	7.3	17	0	0	0	0	0	17	0	17
25-Jul	4.8									
29-Jul	0	0	0	0	0	0	0	0	0	0
1-Aug	0									
5-Aug	0	0	33	0	0	0	0	0	33	33
8-Aug	0									
12-Aug	10	0	0	0	0	0	0	0	0	0
15-Aug	12									
20-Aug	7	0	0	0	0	0	0	0	0	0
22-Aug	17									
26-Aug	0	80	17	65	33	33	17	178	67	245
total surface/bottom		152/	115	230/	283	563/	97	945/	495	
total surface+bottom		north	267	central	513	south =	660	combined =		1440

Figure 6
Abundance of Bivalve Larvae Vs. Scallop Spatfall on Timed Spat Collectors



Larvae observed in the plankton would fall within the size range of 118-150μ. Experience in the hatchery demonstrates that bay scallops begin their metamorphosis from larval to juvenile form at about 150μ and the setting process, once underway, is completed within about a week. This seems consistent with field findings in which peaks of larval abundance are followed by peaks of scallop spat found in timed collectors about a week later.

Correlation coefficients, when calculated by taking into account the seven day lag in spatfall abundance relative to larval abundance, show fairly strong positive relationships. A correlation coefficient of .625 is achieved when looking at the data from the whole experimental period, and when only looking at the July and August period, in which all the spatfall was recorded, a stronger coefficient of .818 is achieved.

Results of Short Term (Timed) and Long Term Spat Collection

Total spatfall found on the timed collectors over the entire experimental period (see Table 3) are represented in Figure 7. The most spat collected over the entire period was in the southern portion of the experimental area, with 660 found. There was a strong predominance of surface collection activity, with 563 on surface collectors vs. 97 on bottom collectors. The central portion, with a total of 513, was more evenly balanced between surface and bottom collection success, with 230 surface vs. 283 bottom; as was the northern portion, which produced the lowest overall numbers, at 267 total with 152 surface vs. 115 bottom.

Table 4 lists and Figure 8 depicts the collection activity of the long term collectors. All three portions show more of a mixture of surface and bottom collection, although in each portion the surface collectors displayed more scallops. Again, the northern portion produced the fewest numbers, but in this case the central portion outpaced the southern portion in collection success. The average size of scallop spat retrieved from the surface collectors was 13.4mm and from the bottom collectors, 11.2mm.

A Closer Look at Long Term Spat Collection

As long term spat collection success would be the goal of a management program, an attempt was made to determine significance between collection success in the long term collectors by region and depth, later to be analyzed with respect to current flow. Figure 9 depicts the average number of scallops found on the long term collectors with 95% confidence limits. The data demonstrated heterogeneity among the variances, which were unable to be rectified by square root transformation. As a result, a non-parametric test was required to determine significance. This test showed significant differences in collection success between surface and bottom collectors, but no significance in collection success between the north, central and south regions.

Figure 10 looks at the scallop numbers found only in surface collectors by region, plotting their averages, with 95% comparison intervals derived using the T-method. In this case a one-way analysis of variance shows a significant effect of location on spatfall. The comparison intervals reveal a significant difference between the north and central regions.

Figure 7
Total Number of Scallops Found On Timed Spat Collectors.

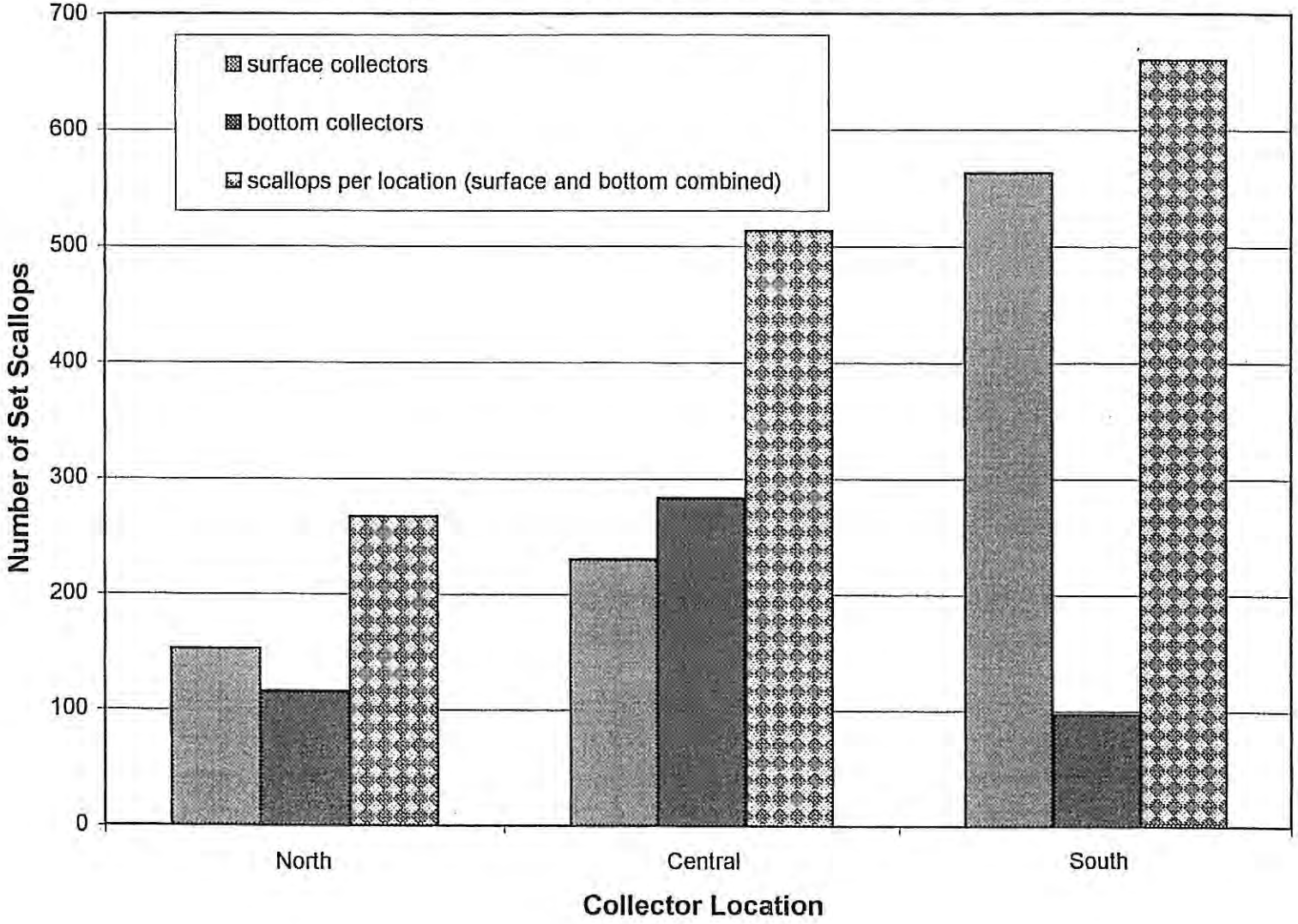


Table 4
Scallop Spat Retained in Long Term Collectors Spatially Differentiated

	North String		Middle String		South String	
Bag Number	surface	bottom	surface	bottom	surface	bottom
1	18	0	39	3	37	24
2	29	0	32	0	41	20
3	48	11	24	60	47	35
4	32	14	36	17	16	5
5	23	16	39	0	25	55
6	25	31	59	0	53	52
7	18	7	72	46	22	27
8	13	29	40	33	2	44
9	25	10	14	58	75	1
10	10	5	66	105	43	lost bag
Total	231	123	421	322	361	263
# of Dead	2	19	77	15	0	9
Total + Dead	233	142	498	337	361	272
% Dead	0.85%	13.40%	15.50%	4.45%	0%	3.31%
Average size	scallop	on top	collectors	13.4 mm		
Average size	scallop	on bottom	collectors	11.22 mm		

Figure 8
Total Number Of Scallops Found On Long-Term Spat Collectors.

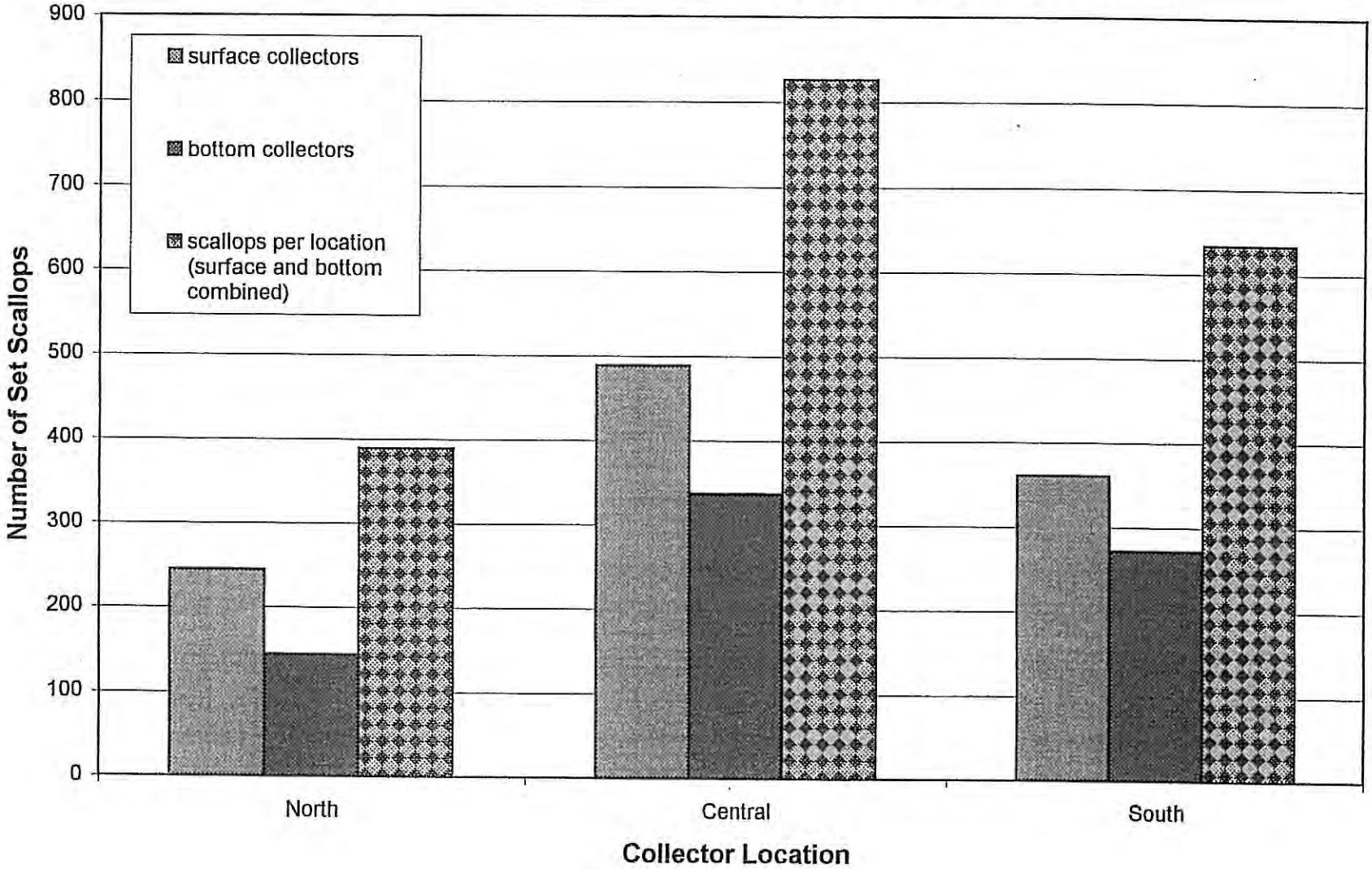


Figure 9
Average Number of Scallops Found On Long-Term Spat Collectors
with 95% Confidence Limits.

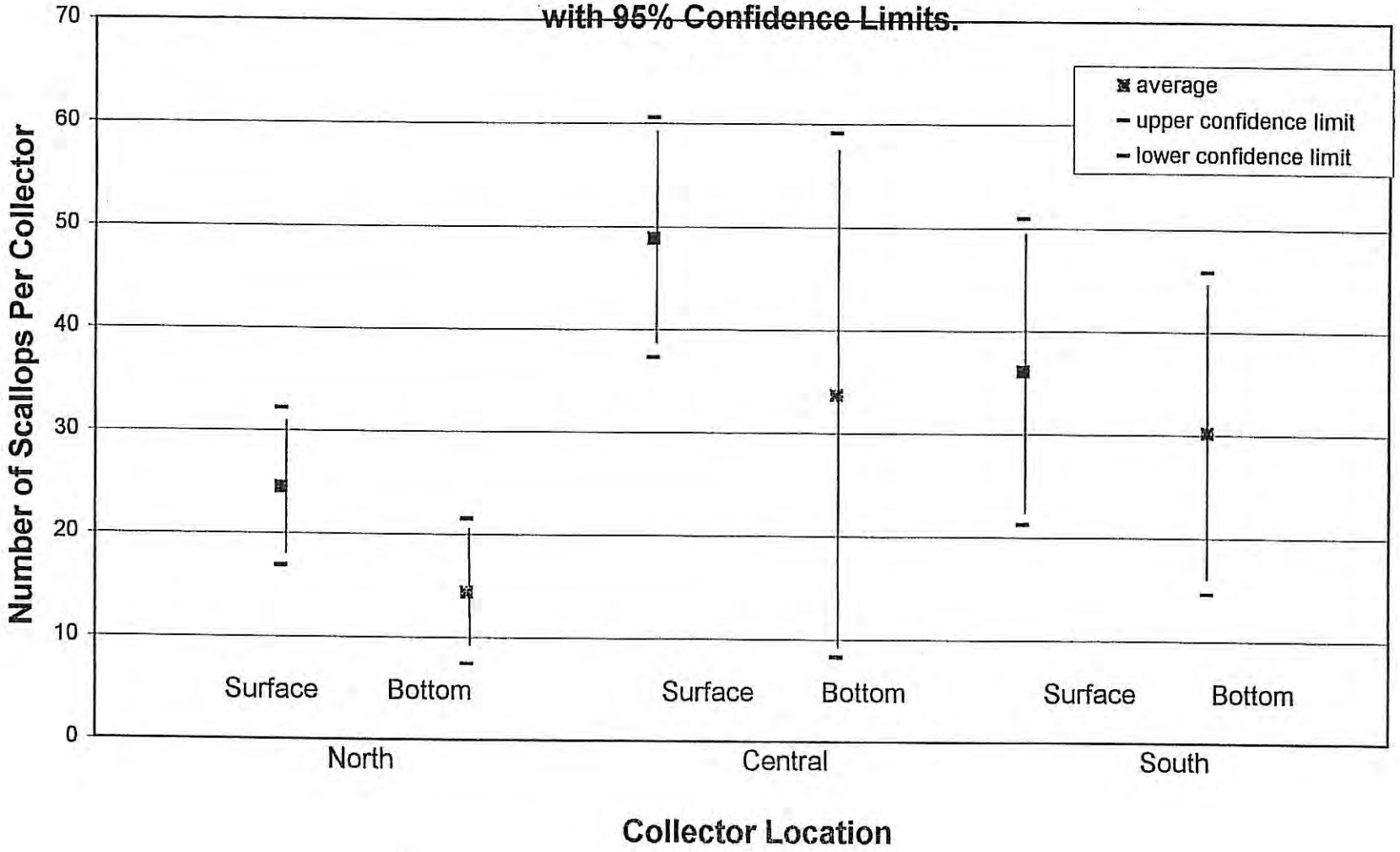
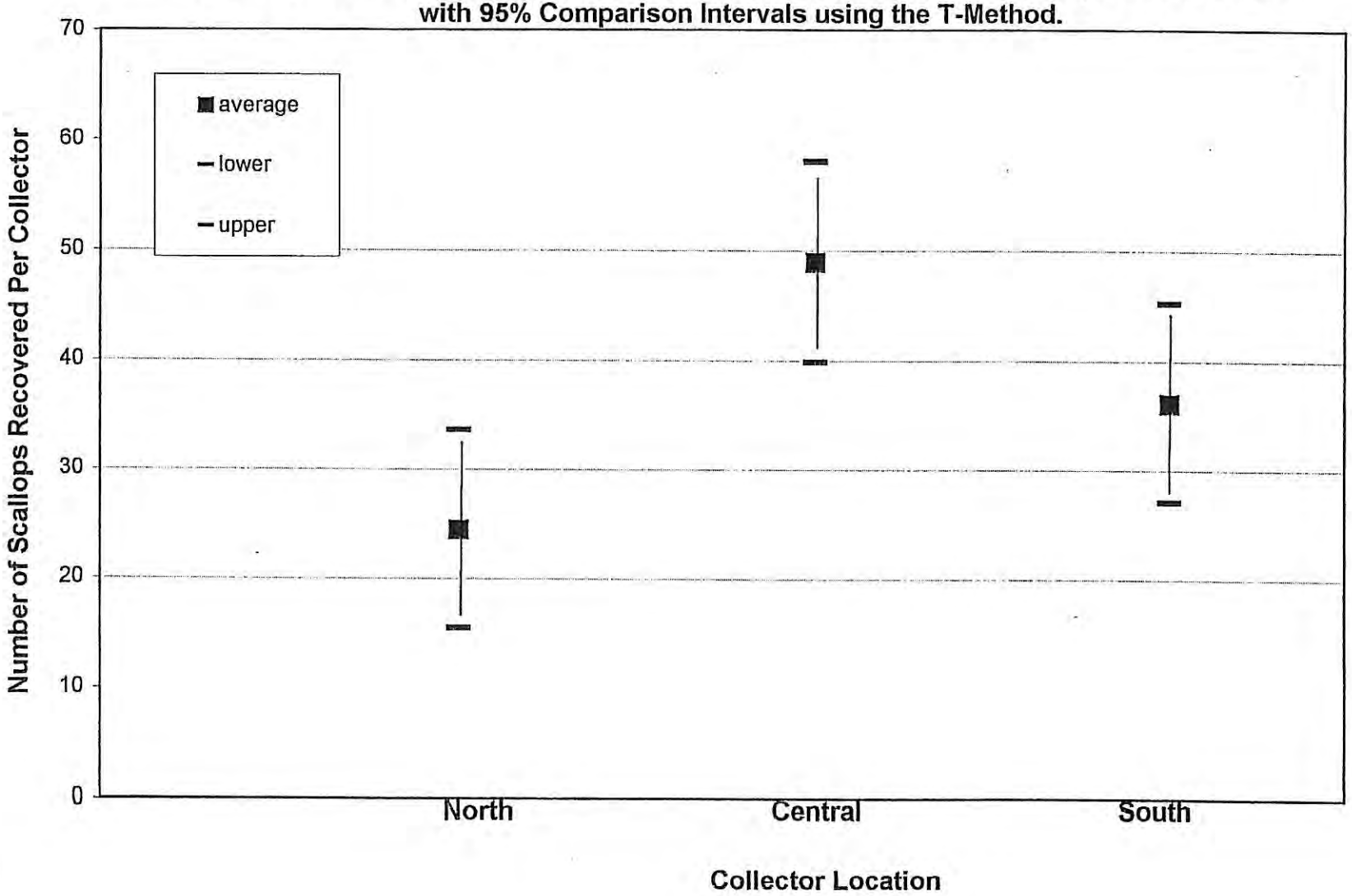


Figure 10
Average Number of Scallops Found On Long-Term Surface Spat Collectors
with 95% Comparison Intervals using the T-Method.



Current Speeds by Region and Relationships to Spat Collection
Table 5 presents ebb tide current data taken during both the quarter and full moon lunar cycles of June 24 and 30, 1996 respectively. A total of twenty four current meter readings were made on June 24 and twenty seven on June 30.

Figure 11 depicts the June 24 third quarter lunar data. Current speeds in cm/s are displayed by region within the experimental area. As one would expect in a quarter moon cycle, tidal flow rates are relatively modest, averaging .103, .189 and .184 cm/s in the north, central and south regions respectively. In an effort to determine significant differences in tidal flow between regions, a one way analysis of variance was undertaken. As seen in Figure 12, 95% comparison intervals, derived using the T-method, reveal no effect of region on current speed. There is no significant difference in flow between regions at this lunar phase.

Figure 13 represents ebb tide flow data as above, but during the full moon phase on June 30, 1996. As would be expected, the flow is considerably more active, averaging .08, .42 and .466 cm/s in the north, central and south regions respectively. Here, an analysis of variance, based on log transformed data, does show a significant effect of region on surface current speed. Figure 14 demonstrates that 95% confidence intervals derived using the T-method show a significant difference between the north and both the central and south regions. The current speed in the north region is considerably lower than that in the central and south regions, which are more similar to one another.

When the current speed data of June 24 and 30 is looked at in total, again with the ANOVA based on log transformed data, it continues to demonstrate a significant effect of region on surface current speed. Averages and comparison intervals seen in Figure 15 again show that the north region has significantly lower current speed than both the central and south regions. Thus the ebb tide averaged over one quarter moon and one full moon lunar cycle exhibits significantly lower activity in this northern region than in either the central or south thirds of the study area.

Overwinter Survival and Growth of Hatchery Produced vs. Wild Caught Juvenile Scallops
The overwinter survival success of both treatments was very high (Figure 16), averaging 89.2% for hatchery produced and 94.2% for wild caught scallops. Position of the nets in the water column did not show an appreciable difference in survival rate. Animals that were hatchery produced and wild caught respectively demonstrated 90 and 96.6% survival in the top nets and 88.3 and 91.7% in the bottom nets. The very low stocking density (20 scallops/net) and attention to net maintenance over the winter probably contributed to this success. Our experience and that of others in the region has been that in attempting to hold large numbers of bay scallops over the winter, survival rates have been considerably lower than demonstrated here.

Table 5

Velocity of Water Flow (Cm/Sec) Through One Quarter Moon Ebb Tide Cycle and Through One Full Moon Ebb Tide Cycle- Napeague Harbor 6/24/96 and 6/30/96

By Spat Collector Region

Current Speeds:(cm/s)

June 24,1996

	North	Central	South
	0.005	0.021	0.232
	0.03	0.017	0.181
	0.208	0.241	0.171
	0.06	0.202	0.084
	0.171	0.223	0.208
	0.052	0.247	0.247
	0.119	0.269	0.174
	0.181	0.294	0.178
sum	0.826	1.514	1.475
average	**0.10325**	**0.18925**	**0.184375**
variance	0.00591	0.01180364	0.002452
std dev.	0.07688		

June 30,1996

	North	Central	South
	0.039	0.222	0.216
	0.135	0.202	0.23
	0.104	0.26	0.282
	0.092	0.066	0.484
	0.015	0.201	0.41
	0.089	0.134	0.512
	0.035	0.797	0.865
	0.061	0.978	0.69
	0.149	0.917	0.505
sum	0.719	3.777	4.194
average	**0.079888889**	**0.419667**	**0.466**
variance	**0.002109861**	**0.133488**	0.046066

Figure 11

Current Velocities at Three Stations Corresponding to Spat Collector Locations.

Third Quarter Moon Ebb Tide, June 24, 1996.

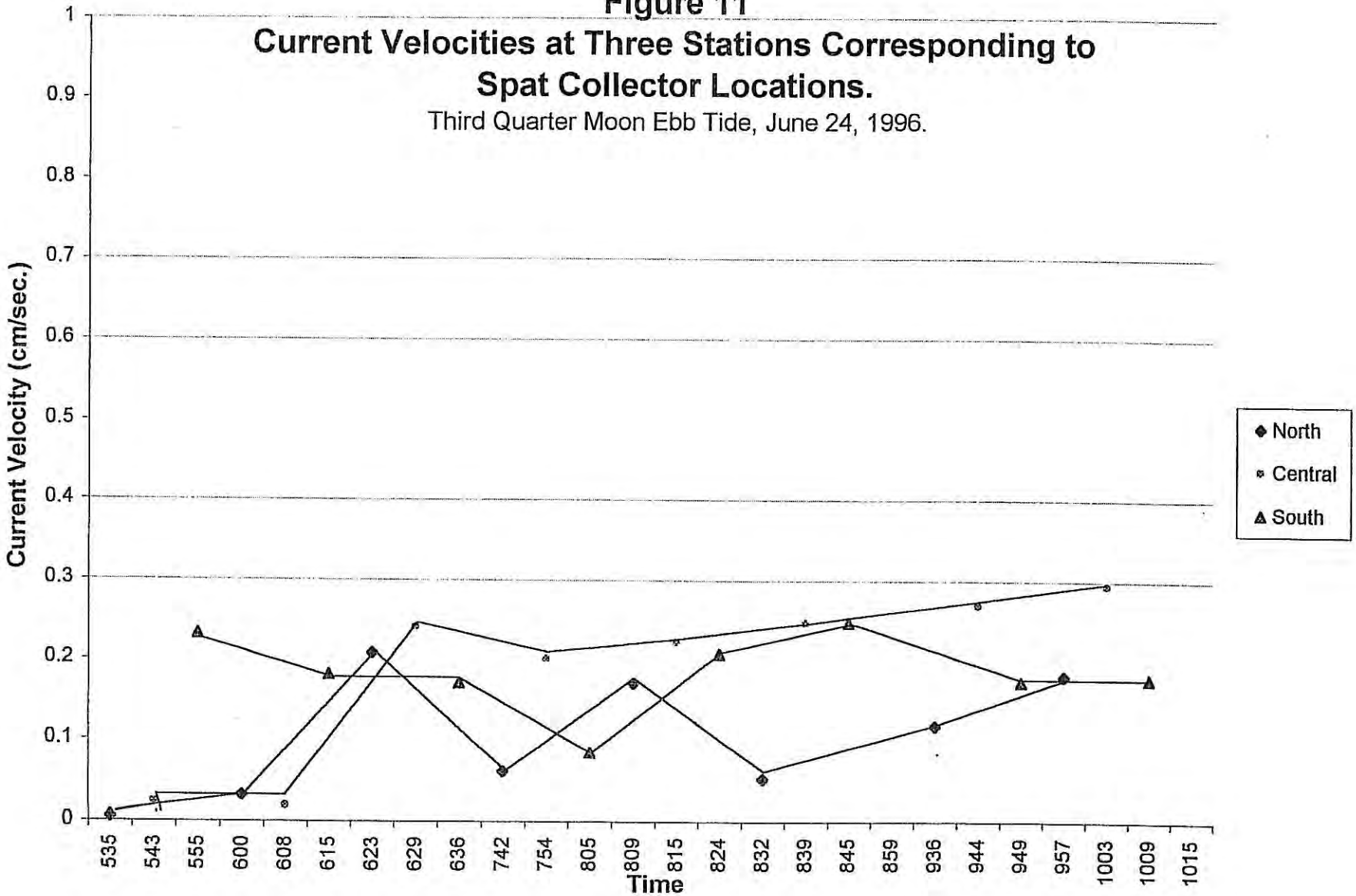


Figure 12
Averages of the Quarter Moon (June 24, 1996) Current Velocity Data Based on Untransformed Data.

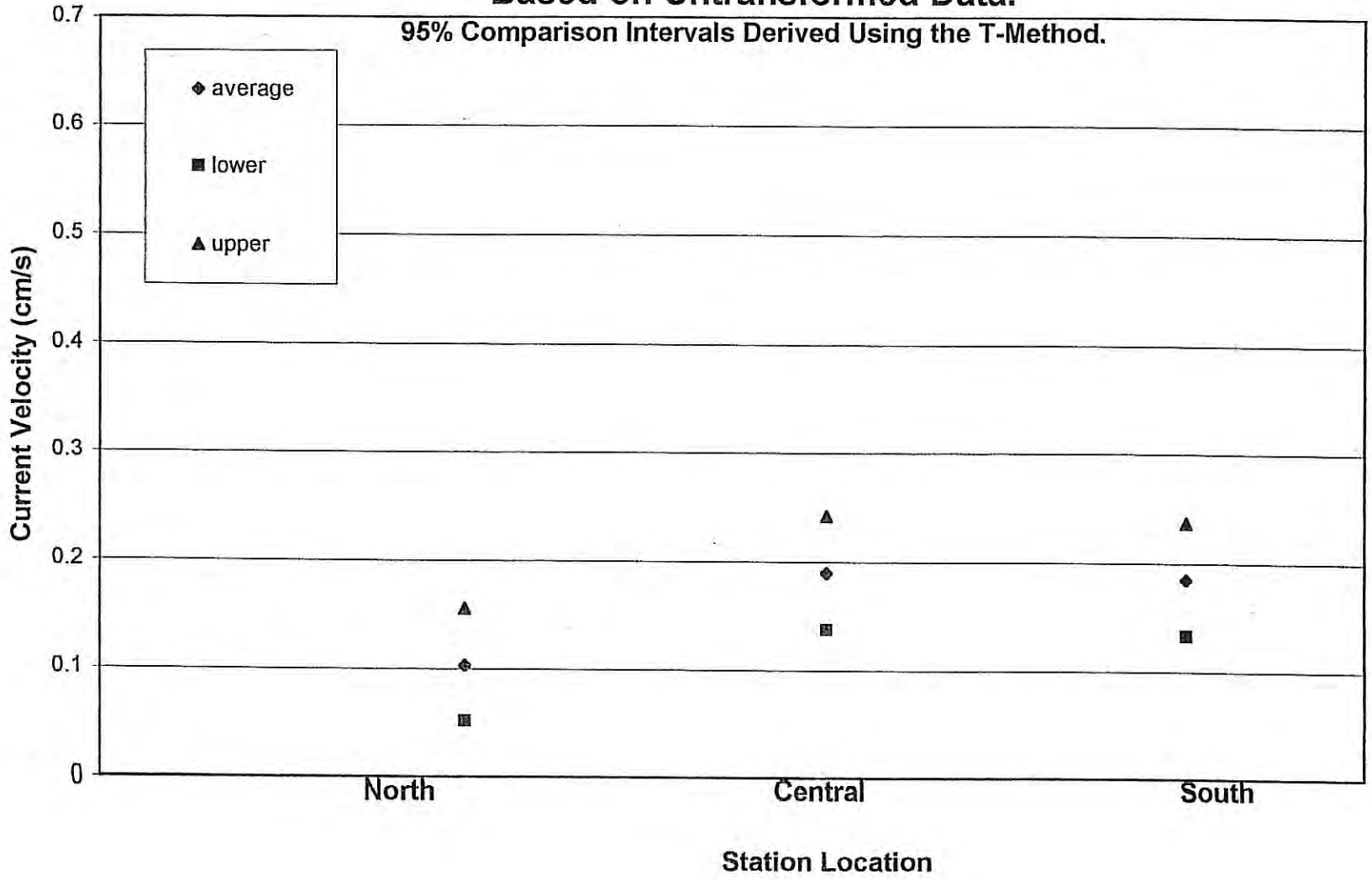


Figure 13
Current Velocities at Three Stations Corresponding to Spat Collector Locations.

Full Moon Ebb Tide, June 30, 1996.

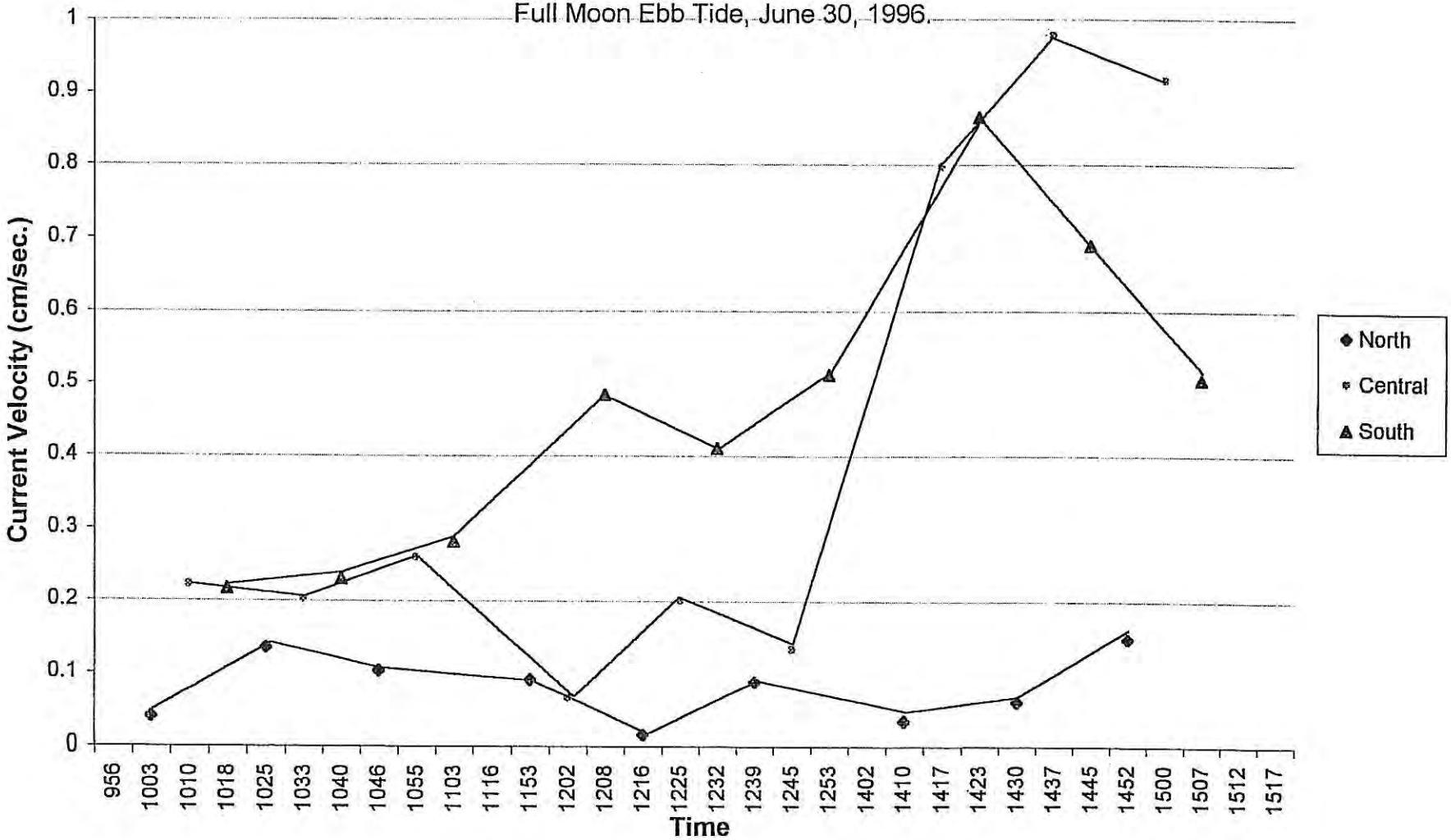


Figure 14
Averages of the Full Moon (June 30, 1996) Current Velocity Data Based on Log Transformed Data
95% Comparison Intervals Derived Using the T-Method.

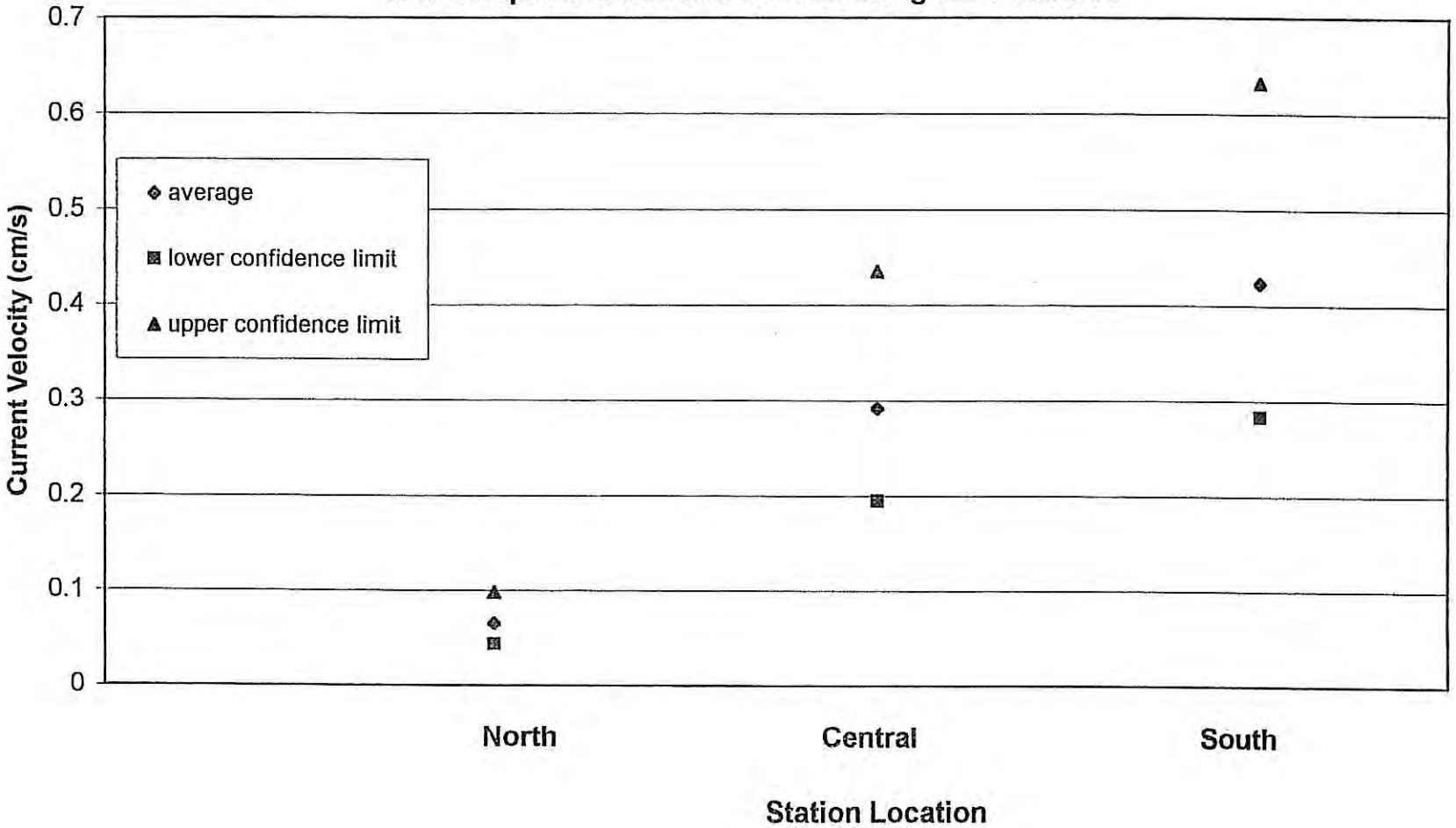
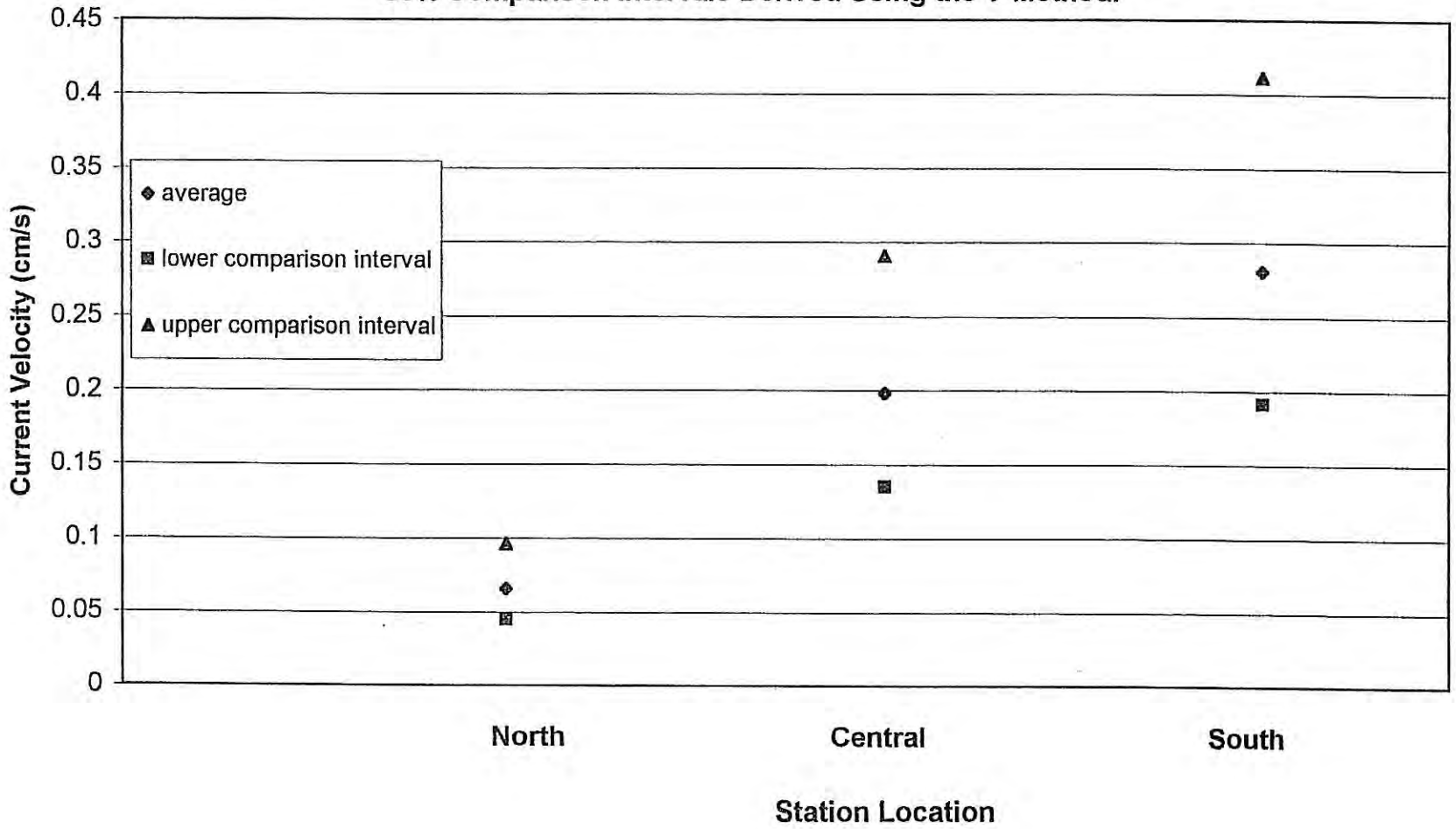


Figure 15
Average Current Speed Over a Quarter and Full Moon Cycle at the Three Spat Collector Locations Based on Log Transformed Data
95% Comparison Intervals Derived Using the T-Method.



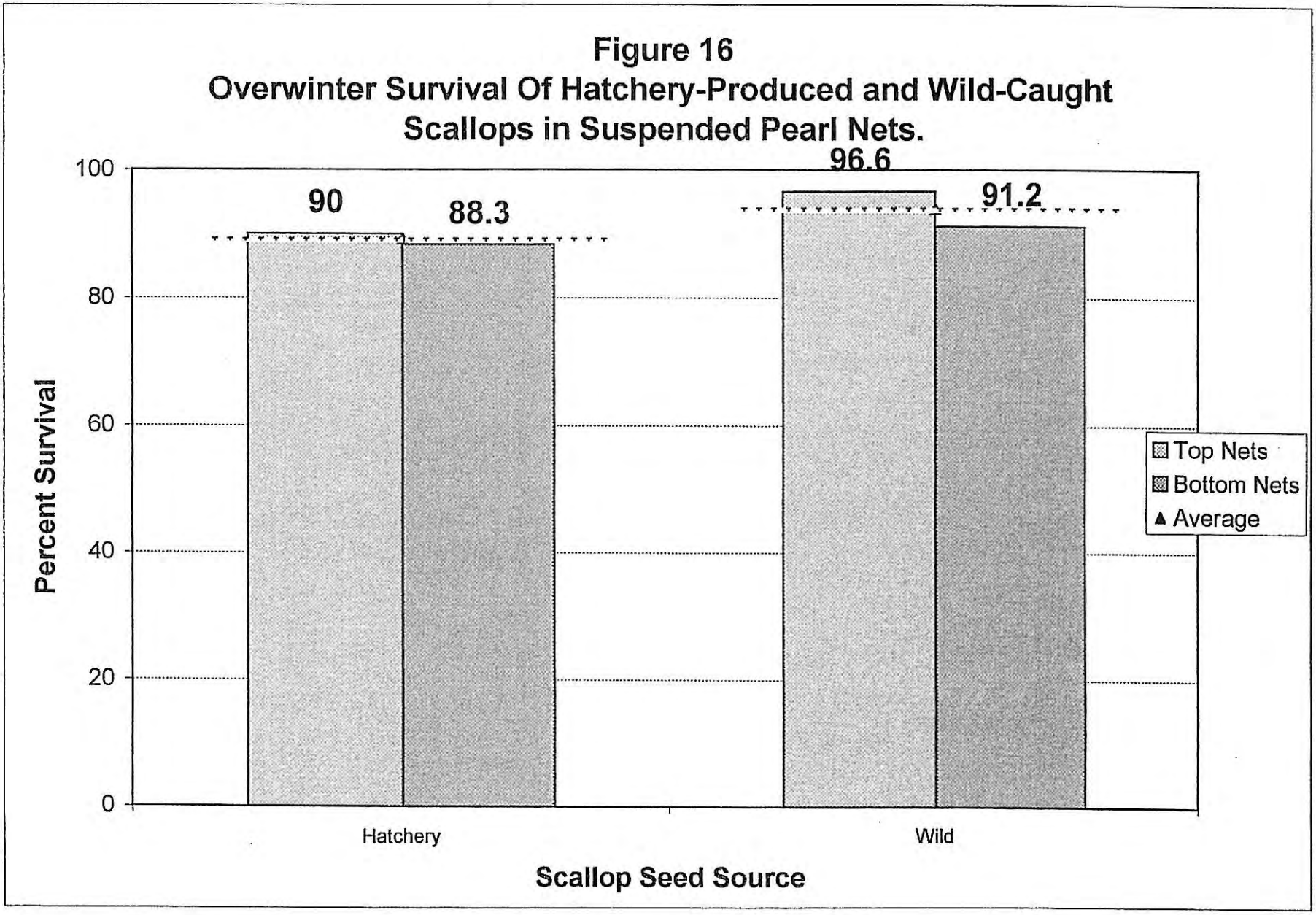


Figure 16
Overwinter Survival Of Hatchery-Produced and Wild-Caught Scallops in Suspended Pearl Nets.
Percent Survival
100
80
60
40
20
0
90
88.3
96.6
91.2
Hatchery
Wild
Scallop Seed Source
Top Nets
Bottom Nets
Average

Growth of the two treatments of scallops between October of 1996 and May of 1997 was also similar, with hatchery produced and wild caught scallops averaging a 6.2mm and 6.1mm increase in shell length respectively over the period (Figure 17).

Overwinter survival and growth did not seem to be effected by origin of the animals held for this trial.

Discussion

Following the 1995 brown tide event, 1996 was a year in which few scallop spat were found. This is reflected in the overall numbers of scallops found in both our timed and long term collectors. By contrast, in those same two years, the Town Shellfish Hatchery produced, respectively, 850,000 and 1,100,000 scallop seed for distribution. If at all possible, shellfish managers would be wise to consider hatchery production as a reliable source of product for enhancement work; which is not to say that the judicious use of spat collectors has no place.

Sampling for bivalve larvae is a simple way of assessing the onset of scallop spatfall. As this work demonstrates, a plankton collection routine, begun as water temperatures climb into the 17-18°C range and carried out near eel grass beds should signal peaks of larval activity followed in about one week by an imminent spatfall. In this way much time and labor could be saved, contrasted to placing collectors blind and subsequently having to deal with fouling, siltation and unwanted setting organisms. If the manager possesses shellfish culture capability, within a short time of spatfall the collectors can be stripped and the resulting seed grown to a larger size before dissemination into areas needing enhancement.

The results also demonstrate the superior effectiveness of surface collectors, which should be taken into account in the design of spat collector deployment regimes. Likewise, current speed seems to play a role. Figure 18 plots current speed vs. scallop set in the three collector regions in our experimental area. With matching significance, the area of lowest flow is also the area of lowest spatfall when compared to the other two regions. The relationship between the two regions of both higher flow and spatfall is less clear, however, and it seems as though an assumption of 'the more flow the better' does not necessarily hold true. We believe the lesson to be taken from this data would be to avoid areas of low tidal flow as collector sites but to experiment in likely collection areas to determine which specific parts of the tidal flow stream yield optimum results.

Finally, overwinter survival and growth data suggest no discernable difference in vigor between hatchery reared and wild caught scallops, at least within the parameters set in this trial. Significant losses in the wild might be likely, however, as evidenced by over a decade of bay scallop enhancement work in the region having shown modest, if steady progress toward stock rebounds. We believe it might be wise, regardless of seed origin, for managers to attempt, if practical, protection of juvenile seedings through at least one spawning cycle.

Figure 17
Average Length of Hatchery-Produced and Wild-Caught Scallops at Beginning and End of Overwinter Experiment.

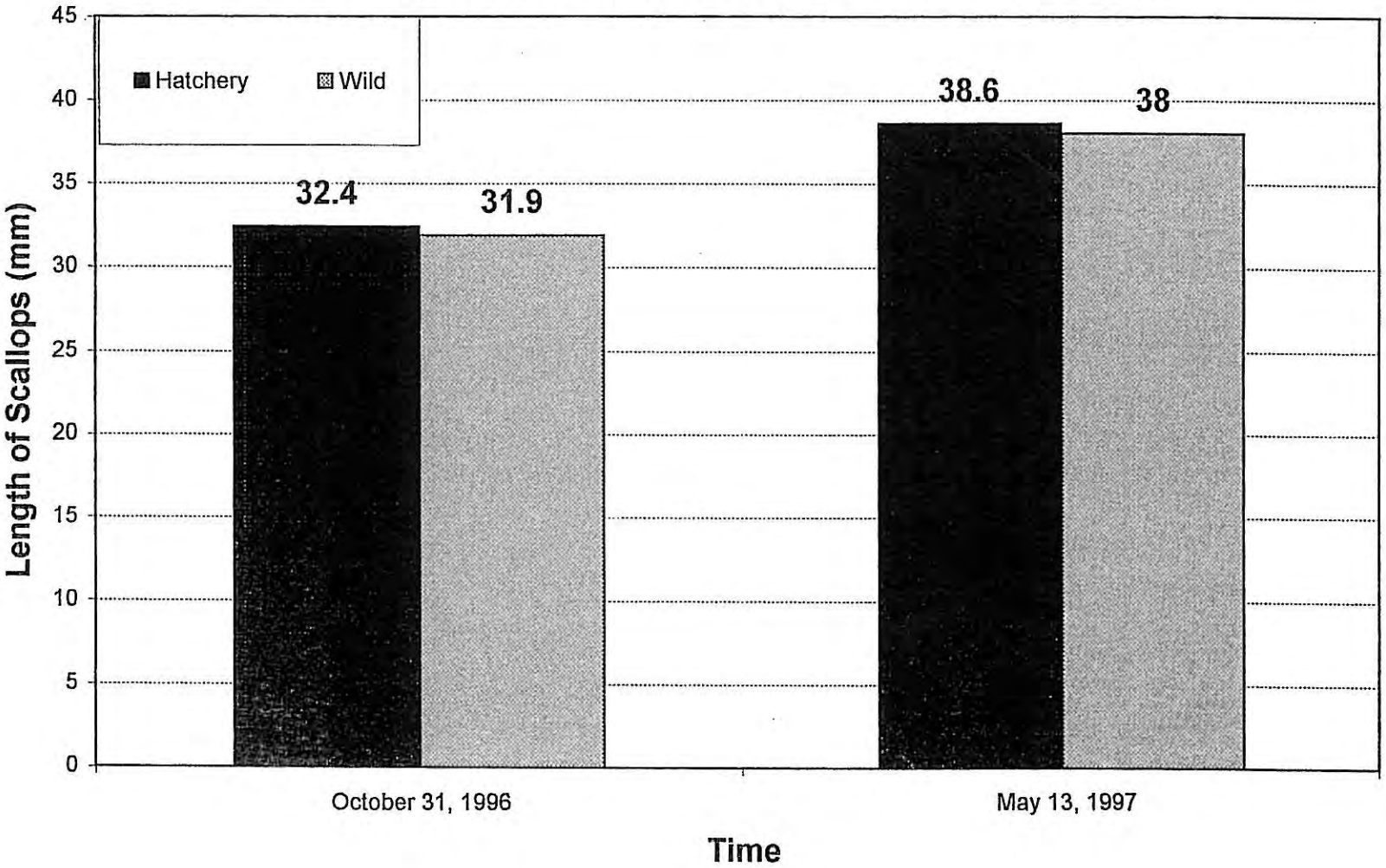
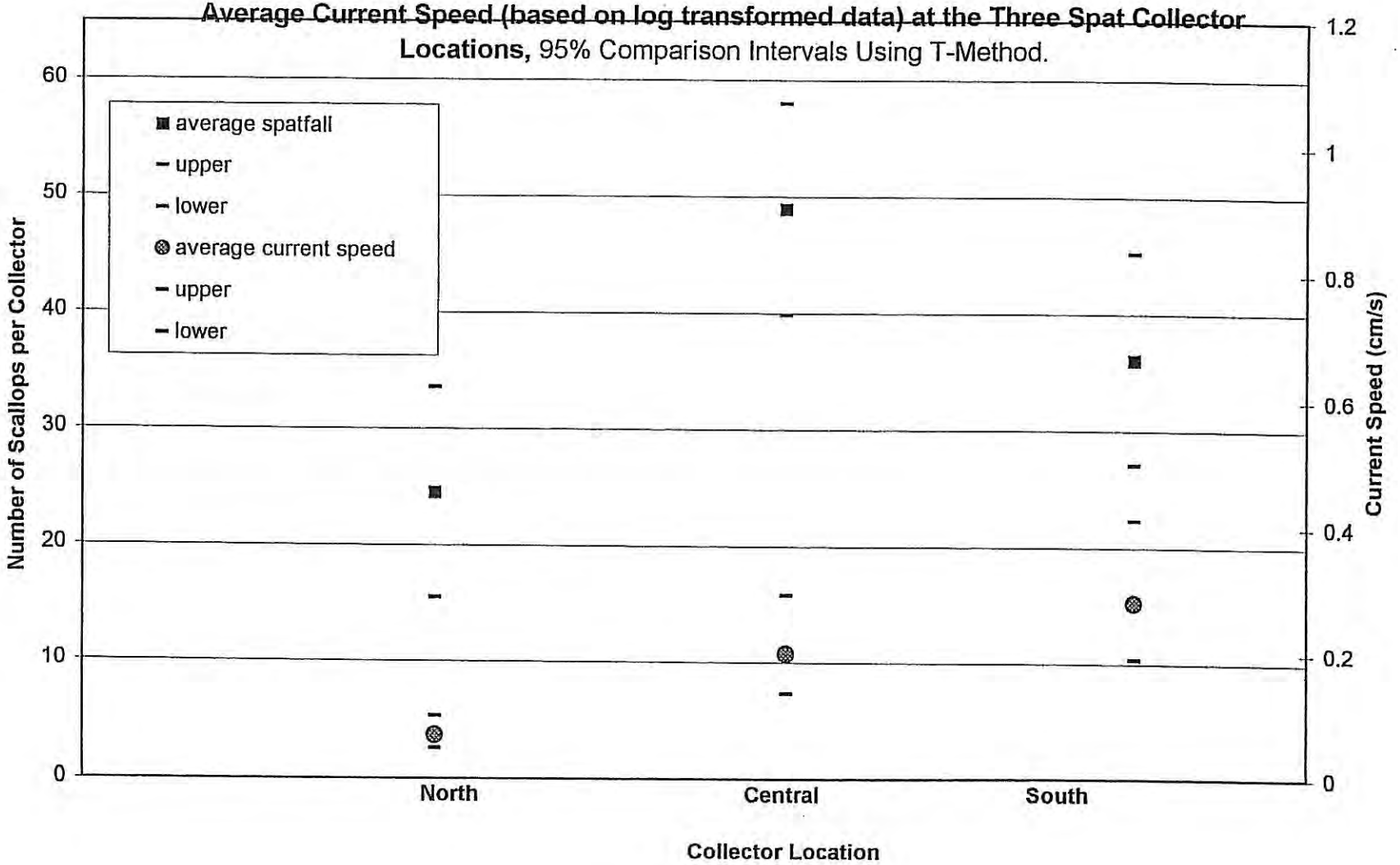


Figure 18

Average Number of Scallops Set In Long-Term Surface Collectors, 95% Comparison Intervals Using T-Method.

and

Average Current Speed (based on log transformed data) at the Three Spat Collector Locations, 95% Comparison Intervals Using T-Method.



Acknowledgements

This work was supported by a grant from the Peconic Estuary Program, USEPA. Many thanks to Vito Minei, Walter Dawydiak and Laura Klahre of the program office for their patience and administrative assistance. We would also like to thank Chris Smith and Gregg Rivara of Cornell Cooperative Extension Marine Program, Dr. Steve Tettlebach of Southampton College and Dr. Robert Cerrato of SUNY, Stonybrook for their technical assistance; Tom Drumm of the NY State Department of Environmental Conservation for providing scallop landing records, and Dr. Bob Nuzzi of the Suffolk County Dept. of Health Services, Office of Ecology for providing brown tide information. Finally, this work would not have been possible without the continuing support of the Town Board of East Hampton.

Literature Cited

Ambrose, W.G. and J. Line 1991. Settlement Preference of *Argopecten irradians (Lamarck 1819)* Larvae for Artificial Substrata. An International Compendium of Scallop Biology and Culture. Shumway and Sandifer, editors.

Austin, H. and P.M. Stoops. 1973. A Synoptic Study of the Surface Waters of Block Island Sound and Surrounding Waters. Part II. New York Ocean Science Laboratory Technical Report No. 0024.

Austin, H. 1974. A Study of the Scallop Population at both Lake Montauk and Three Mile Harbor, East Hampton, NY. Final Report by the Fisheries Oceanography Dept., NY Ocean Science Laboratory, Montauk, NY.

Bricelj, V.M., Epp, J., Malouf, R.E. 1987. Intraspecific variation in reproductive and somatic growth cycles of bay scallops, *Argopecten irradians. Mar. Ecol. Prog. Ser. 36: 123-137.*

Garcia –Esquivel, Z. and V. M. Bricelj. 1993. Ontogenic changes in microhabitat distribution of juvenile bay scallops, *Argopecten irradians irradians (L.)* in eelgrass beds and their potential significance to early recruitment. Biol. Bull. 195: 42-55. 1993

Imai, T.I. 1977. Aquaculture in Shallow Seas: Progress in Shallow Sea Culture. NOAA translation from Japanese. 616pp.

Kelly, K.M. 1981. The Nantucket Bay Scallop Fishery: The Resource and its Management. Nantucket Shellfish and Marine Dept., Massachusetts. 108pp.

Kelly, K.M. 1985. An Update on the Management of the Nantucket Bay Scallop Resource. Nantucket Shellfish and Marine Dept., Massachusetts. 43pp.

Krause, M.K. 1992. Use of genetic markers to evaluate success of transplanted bay scallops. J. Shellfish Research 11(1): 199.

Mottett, M.G. 1979. A Review of the Fishery Biology and Culture of Scallops. State of Washington, Dept. of Fisheries. Technical Report No. 39. 100pp.

Nuzzi, R., Suffolk County, NY, Dept. of Health Services, Office of Ecology. Personal Communication.

Pohle, D.G., V.M. Bricelj, and Z. Garcia-Esquivel. 1991. The eelgrass canopy: an above-bottom refuge from benthic predators for juvenile bay scallops, *Argopecten irradians.* Mar. Ecol. Prog. Ser. 74: 47-59.

Rivara, G., Cornell Cooperative Extension of Suffolk County Marine Program. Personal Communication.

Robins-Troeger, J.B. and M.C.L. Dredge. 1993. Seasonal and Depth Characteristics of Scallop Spatfall in an Australian Subtropical Embayment. J. Shellfish Res. 12(2): 285-290.

Sieburth, J.M., P.W. Johnson & P.E. Hargraves. 1988. Ultrastructure and Ecology of *Aureococcus anophagefferens* gen.et sp. Nov. (Chrysophyceae): the dominant picoplankter during a bloom in Naragansett Bay, R.I., Summer 1985. J. Phycol. 24:416-425.

Tammi, K.A., Soares, S.J., Turner, W. and M. Rice. 1994. Settlement and Recruitment of Bay Scallops, *Argopecten irradians (Lamark 1819)*, to Artificial Spat Collectors in the Westport River Estuary, Westport, Massachusetts. Shellfish Stock Enhancement Session, 1994 Meeting of the National Shellfisheries Association. USEPA Office of Water Proceedings, pp. 8-25.

Tettlebach, S.T. and P. Wenczel. 1993. Reseeding efforts and the status of the bay scallop *Argopecten irradians irradiand (Lamarck, 1819)* populations in New York following the occurance of 'brown tide' algal blooms. J. Shellfish Res. 12(2): 423-442.

Turner, W.H., Soares, S.J., 1994. The Bay Scallop Restoration Project in the Westport River, Massachusetts. Shellfish Stock Enhancement Session, 1994 Annual Meeting of the National Shellfisheries Association. USEPA Office of Water Proceedings, pp. 35-44.