Atlantic Coast of Long Island,
Fire Island Inlet to Montauk Point (FIMP), New York,
Storm Damage Reduction Project

SUBMERGENT AQUATIC VEGETATION (SAV) EVALUATION REPORT

MAY 2006

Prepared by: **U.S. Army Corps of Engineers**
New York District, Planning Division (CENAN-PL-E)
26 Federal Plaza
New York, New York 10278-0090

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Executive Summary

The Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point (FIMP), New York, Storm Damage Reduction Reformulation Study seeks to evaluate long-term solutions for storm damage reduction along the south shore of Suffolk County, Long Island. As part of this major Reformulation Study, the United States Army Corps of Engineers (USACE) is conducting studies of ecosystem function in the study area.

The overall project study area extends 83 miles from Fire Island Inlet to Montauk Point and includes three major bay systems: Great South Bay (GSB), Moriches Bay (MB), and Shinnecock Bay (SB). GSB extends a coastal distance of 33.8 miles with connections to the ocean through Hempstead Bay to the west, Fire Island Inlet and MB (at Narrow Bay) to the east. MB extends 14.4 miles along the coast with oceanic connections at GSB (Narrow Bay) to the west, Moriches Inlet and SB to the east via Quantuck Canal, Quantuck Bay and Quogue Canal. SB extends 11.2 miles coastally with connections to the ocean through MB to the west via Quogue Canal and Shinnecock Inlet, and to the east through Great Peconic Bay via the Shinnecock Canal (USFWS 1983).

This report provides a summary of data collected during a seasonal field survey conducted in the study area from May through November 2005. The field survey was designed as an ecological inventory of six submergent aquatic vegetation (SAV) beds, two in each of the three bays located in the FIMP study area. The East Fire Island and Bellport beds are located in GSB, Great Gunn and Cupsogue beds are located in MB, and Tiana and Ponquogue East beds are located in SB. This report compares some of the major findings obtained from previous surveys conducted in the same SAV beds in 2003 (reported in USACE 2004) and 2004 (never officially reported) and reflects data collected over a three-year period. In addition to the presentation of data from the 2005 sampling activities, a brief summary of results for the 2004 unpublished survey event are also presented in this report.

The following general conclusions are based on the collection and analysis of the 2005 SAV Survey data for GSB, MB and SB:

1. A significant negative correlation exists between finfish abundance and invertebrate diversity.
2. A significant positive correlation exists between invertebrate abundance and invertebrate diversity.
3. Significant differences in eelgrass height and density exist between bays and between paired stations within a bay.
4. Eelgrass density and height were greatest when water temperatures were highest, consistent with findings from the 2004 study.
5. Eelgrass density and height were greatest in SB and MB, consistent with findings from the 2004 study.
6. Finfish abundance and diversity tended to increase geographically from west to east, consistent with some findings from the 2004 study, and differed significantly between bays.
7. Finfish biodiversity increased with temperature.

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1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), New York District, is conducting a comprehensive feasibility-level Reformulation Study for the south shore of Long Island, New York, from Fire Island Inlet to Montauk Point (FIMP). The FIMP Storm Damage Reduction Reformulation Study seeks to evaluate long-term solutions for storm damage reduction along the south shore of Suffolk County, Long Island. As part of this major Reformulation Study, numerous studies involving project planning and engineering, economic analyses, and environmental studies, are being conducted in order to understand ecosystem function in the study area. This study is a continuation of a study that was initiated during 2003 in the Project Area (USACE 2004).

The overall project study area extends 83 miles from Fire Island Inlet to Montauk Point (Appendix A, Figure 1) and includes three major bay systems: Great South Bay (GSB), Moriches Bay (MB), and Shinnecock Bay (SB). GSB extends a coastal distance of 33.8 miles with connections to the ocean through Hempstead Bay to the west, Fire Island Inlet and MB (at Narrow Bay) to the east. MB extends 14.4 miles along the coast with oceanic connections at GSB (Narrow Bay) to the west, Moriches Inlet and SB to the east via Quantuck Canal, Quantuck Bay and Quogue Canal. SB extends 11.2 miles coastally with connections to the ocean through MB to the west via Quogue Canal and Shinnecock Inlet, and to the east through Great Peconic Bay via the Shinnecock Canal (USFWS 1983).

In support of the Reformulation Study, the USACE has been conducting environmental studies within submergent aquatic vegetation (SAV) beds within bays of the project area since May 2003 (with prior supporting, preliminary, studies and aerial photography analysis dating back to 2001). The primary objectives of these studies are to survey the eelgrass (*Zostera marina*) habitats of the barrier island's backbay environment and provide information on community structure, physical characteristics, and the faunal and floral use of this estuarine ecosystem. In the 2003 study (USACE 2004), further correlations were evaluated to complete a historical perspective (such as water quality, physical parameters and geospatial referencing) also associated with eelgrass beds. In combination, this information will be utilized to provide data to support conclusions in the Draft Environmental Impact Statement (DEIS). The DEIS will address potential impacts to the SAV beds based on the alternatives presented in the recommended plan as inputs to defining the spatial and temporal trends in community structure of the SAV habitats.

This, and previous SAV surveys of 2003 and 2004, defined a group of SAV beds and evaluated them based on a range of biological and physical parameters, most of which were re-evaluated during the current study. Data from the 2003 study produced multiple conclusions based on analysis of both historical geographic data and biological data collected during the 2003 sampling season. In summary, based on biological data collection, the 2003 study found that: 1) SAV distribution and abundance is correlated to bottom depth and other environmental factors such as water clarity and tidal flushing; 2) eelgrass density has a positive correlation to water temperature and distribution is usually patchy; 3) the tallest eelgrass was found in SB and MB where water clarity was best; 4) a general increase in finfish biodiversity and abundance could be seen from stations in the west to stations in the east; and, 5) invertebrate diversity and crab abundance did not vary greatly between stations and was highest at the eastern locations.

The primary objectives of 2004 survey efforts were to provide data on flora and faunal communities in the bay in support of a USACE Habitat Evaluation Procedures (HEP) study of the barrier island, and to supplement SAV data collected in 2003. Data from the 2004 study produced multiple conclusions based on analysis of biological data collected during the 2004 sampling season, and in summary the study found that: 1) SB was the most productive in terms of finfish abundance and diversity; 2) Invertebrate abundance and diversity were fairly uniform throughout five of the six SAV stations sampled suggesting no discernible spatial pattern; and, 3) eelgrass density was highest in SB.

This report provides a summary of ongoing efforts by the USACE to characterize SAV beds in the FIMP study area and includes data collected during a seasonal field survey conducted from May through November 2005. Following previous SAV study protocols and methods, the field survey was designed as an ecological inventory of six SAV beds, two in each of the three bays located in the FIMP study area: the East Fire Island and Bellport beds are located in GSB (Appendix A, Figure 2), Great Gunn and Cupsogue beds are located in MB (Appendix A, Figure 3), and Tiana and Ponquogue East beds are located SB (Appendix A, Figure 4). Major components of the field survey included the collection of finfish and invertebrates in the eelgrass beds using a seine net, eelgrass quadrat analysis, and collection of water quality data. A sampling effort of a smaller scale was also conducted during the summer of 2004 (unpublished) for which each bed was only sampled once. Results of this study and any differences in sampling methods are also reported. These studies, in conjunction with data obtained from the 2003 SAV survey (USACE 2004), will be used to provide baseline data on finfish, invertebrates and flora associated with these eelgrass habitats within the FIMP study area.

2.0 METHODS

The field surveys were designed to provide baseline data on finfish, invertebrates and flora associated with eelgrass habitats within the study area. Both inventories included six eelgrass-dominated submergent aquatic vegetation (SAV) beds located in each of three major bays local to the FIMP study area. The 2004 survey was conducted during July and August, 2004, and the 2005 survey was conducted from June through November, 2005. The SAV sites were chosen based on a review of aerial photography, groundtruthing of previous USACE SAV studies, as well as a reconnaissance survey conducted in 2005 prior to field sampling activities. As a result, two study sites were examined in each of the bays and are presented from east to west: SB contained Ponquogue East and Tiana SAV beds, MB contained Cupsogue and Great Gunn SAV beds, and GSB contained Bellport and East Fire Island SAV beds (Appendix A, Figure 1). The sampling methodology and locations of sampling activities generally follow that of the previous 2003 USACE SAV studies in SB, MB, and GSB (USACE 2004) and are detailed below. Unless otherwise noted below, the sampling methodologies used in 2004 and 2005 survey events were consistent. Data from the field survey were used to further examine physiological and environmental relationships between flora and fauna and to compare existing data from past studies to current.

The Ponquogue East and Tiana SAV sampling stations are located in SB. Ponquogue East is the easternmost station that was sampled and is located approximately 3 km (1.9 miles) south of the mainland and 12.8 km (0.8 miles) north of the barrier island (Appendix A, Figure 4). This station is located south of the Shinnecock Coast Guard Station, east of Ponquogue Bridge, and approximately 1.8 km (1.1 miles) east of Shinnecock Inlet. The barrier island shoreline supports a densely populated marsh that had only minimal disturbance (e.g., no bulkheading on the shore). This station was one of the deepest with an average depth at Mean High Water (MHW) of 0.6 m (National Oceanic and Atmospheric Administration [NOAA] Tide Chart 12351). The station was characterized by a long stretch of narrow eelgrass beds and algae. Sandy patches were found in the eastern section of the bed. A sandy beach was located south of the station along the barrier island. The station at Tiana (in SB) is located approximately 2.8 km (1.75 miles) south of the mainland, 0.4 km (0.25 miles) north of the barrier island and 4.6 km (2.8 miles) west of Shinnecock Inlet (Appendix A, Figure 4). The mainland was characterized by bulkheading. Hampton Bays, NY, is located to the north of the barrier island. Dense residential development, bulkheading and sparse patches of marsh characterized the main island shoreline. This station was one of the shallowest with an average depth of 0.3 meters (NOAA Chart 12351). Tiana was characterized as a patchy eelgrass bed with areas of algae.

There are 2 SAV sampling stations located in MB: Cupsogue and Great Gunn. The Cupsogue station is located approximately 1.6 km (1 mile) south of the mainland, to the southeast of the Moriches Coast Guard Station and is approximately 6.4 km (3.9 miles) east of Moriches Inlet (Appendix A, Figure 3). The barrier island, approximately 1 km (1.6 miles) south of the station, is densely developed and contains a large hotel docking facility. Intertidal marsh dominated by saltmarsh cordgrass (*Spartina alterniflora*), is located to the south and west on the barrier island. The Cupsogue station had patchy amounts of algae throughout the eelgrass bed. The average depth of the Cupsogue site at MHW was 0.6 m (NOAA Chart 12352). Also in MB, the Great Gunn station MB was sampled directly north of the barrier island, approximately 4.8 km (3 miles) from the mainland and 2 km (1.3 miles) west of Moriches Inlet (Appendix A, Figure 3). Great Gunn was one of the deepest stations sampled, with an average depth at MHW of 1.5 m (NOAA Chart 12352). Dense eelgrass beds with large patches of dense algae characterized this station. A Town of Brookhaven beach facility and marina is located approximately 20 m south on the barrier island.

The remaining two SAV survey stations are located in GSB and include Bellport and East Fire Island. The Bellport station is located approximately 2.8 km (1.73 miles) south of Bellport on the mainland and 0.4 km (0.25 miles) north of Bellport Beach on the barrier island (Figure 27), and is located approximately 15.5 km (9.6 miles) west of Moriches Inlet (Appendix A, Figure 2). During 2005 surveys, the station had an average depth at MHW of 0.2 m (NOAA Chart 12352). Docks and bulkheading are prominent in an area approximately 0.4 km (0.25 miles) to the southwest of the station. The Bellport station is located near a navigation channel and is characterized by patchy eelgrass beds and algae throughout the entire bed. The East Fire Island SAV bed is the westernmost station in the study area, located approximately 12.5 km (7.6 miles) east of Fire Island Inlet (Appendix A, Figure 2). The station at East Fire Island is adjacent to one of two prominent islands in this area, the other being West Fire Island. The site is located approximately 0.8 km (0.5 miles) north of the barrier island situated between Robins Rest (to the west) and Corneille Estates (to the east). According to NOAA Chart 12353, the average depth at this sampling station is 0.6 meters at mean high water (MHW). (Note: while depth measurements were not taken in the field, the published values correspond with field observations). This area is subject to heavy recreational use during summer months. East Fire Island had large areas of eelgrass with some algae.

The approximate center of each SAV bed was identified during the field survey and the location mapped using a Garmin GPSMAP 192C Global Positioning System (GPS) chartplotter to ensure that subsequent surveys were conducted in the same vicinity. All 2005 SAV sampling was conducted within the perimeter of SAV beds that were mapped and surveyed in 2003 and 2004 surveys and GPS coordinates are provided in Appendix B, Table 1. The study protocol required collections of floral and faunal species found in the eelgrass beds using a 30-foot long by 6-foot tall (1.25 inch mesh size) beach seine. The primary focus of the study was to analyze foraging finfish and macrobenthic invertebrate species that reside in eelgrass habitat. Additional elements of the study included collection of water quality data (Hydrolab DataSonde 3x), visual assessment of biota and a quantitative assessment of eelgrass height and density.

2.1 SAV Seine Survey

For the 2004 survey, all six SAV beds were sampled within a one month period that began on July 20 and ended on August 11. For the 2005 survey (June–November), the level of effort was increased and all stations were sampled monthly over a three day period for six months (despite multiple attempts, no sampling was conducted during October due to inclement weather). A 50-foot long by 6-foot tall (1.25 inch mesh size) beach seine was hauled through each of the six SAV beds and was fitted with flotation buoys on top, a lead-weighted bottom line, reinforced corners to tie to poles, and a center pocket. The net was used during the course of the 2004 survey and the first four months of the 2005 survey. A smaller net (30-foot long by 6-foot high fitted with flotation buoys on top and a lead-weighted bottom line) was used during the

September and November sampling efforts. There were no substantial differences with regards to faunal species abundance and diversity between the two nets.

During each survey, the seine net was pulled at a constant speed across five different 50-foot transects at each site. Each haul was pulled through the SAV bed in a different location, typically in a five-point radial pattern around the center of bed. The net was then lifted in the water column and the wings rolled towards the pocket to gather all organisms in the center of the net. The contents of the seine net were then transferred to a 5-gallon floating pail that had sections removed and screen inserted to allow water to easily circulate through the bucket. The animals were then transferred to the boat for processing. Finfish were sorted by species and placed in separate containers prior to obtaining weights and measurements. All invertebrates were identified and enumerated according to the methods described in the following paragraph.

Finfish and invertebrates were collected and identified to the Lowest Possible Identification Level (LPIL). Various field guides and dichotomous keys were used to identify species including McClane 1974, Gosner 1978, Robins and Ray 1986, Pollock 1998, and Able and Fahay 1998. The common and scientific names of all species identified are presented in Appendix B, Table 2 and Table 3. All finfish were counted, and measurements of length and weight were recorded for up to 30 individuals of each species (finfish were only identified and enumerated during the 2004 survey). Fish were measured to the nearest millimeter and collective weights measured to the nearest gram. Invertebrates were identified either to species or lowest practical taxonomic level. Five groups of animals were identified to higher taxonomic groupings: amphipods, isopods, polychaetes, poriferans, and tunicates. All invertebrates were ranked on a scale of abundance and, when possible, counted. Invertebrates were ranked on a scale of zero to three as follows:

Rank 0 = none
1 = number of organisms on the order of tens
2 = number of organisms on the order of hundreds
3 = number of organisms on the order of thousands

All animals were returned to the water post-processing. If any organism was found to be unidentifiable in the field, a sample was preserved in a 10% Formalin and 90% sea water solution and/or photograph was taken for post-effort analysis.

2.2 EELGRASS QUADRAT ANALYSIS

A quantitative assessment of eelgrass height and density was made in order to evaluate relative comparisons between eelgrass beds. A 1-meter (3.3 feet) squared quadrat, constructed of 1.5-inch PVC pipe and filled with water, was tossed randomly in the area where the seine net was hauled for each of the transects. The weighted quadrat sank to the bottom of the bay and a visual inspection was conducted within the quadrat for eelgrass height and density (only density was recorded for the 2004 survey). Height was measured with a yardstick to the nearest 0.5 inches. Height and density measurements were taken during each of the sampling efforts and density was recorded as percent area coverage and is ranked as follows:

Rank 0 = no eelgrass
1 = less than 25% coverage
2 = 25% to 50% coverage
3 = 50% to 75% coverage
4 = 75% to 100% coverage

For data analysis, the eelgrass height and density were averaged over the five tosses. The mean height was calculated as the sum of the five heights divided by five. The mean percent cover was calculated by first adding the five values for percent cover, then dividing by five to obtain a mean and finally multiplying by 25 percent to convert the rank value to a percentage.

2.3 WATER QUALITY (2005 SURVEY)

Water quality measurements were taken during each effort at each site for temperature, dissolved oxygen, salinity, and turbidity. All measurements were recorded at the water's surface using a Hydrolab DataSonde3 multi-parameter unit. Temperature was measured in degrees Celsius, dissolved oxygen in milligrams per liter, salinity in parts per thousand and turbidity in nephelometric turbidity units (NTU). NTU is defined as the intensity of light at a specified wavelength scattered or attenuated by suspended particles, or absorbed at a method-specified angle, usually 90 degrees, from the path of the incident light compared to a synthetic chemically prepared standard (Ziegler, 2002). Monthly means were calculated and used for data analyses. Additional measurements of tidal stage (ebb or flow), lunar cycle (percent visible), and time of day were also recorded.

2.4 GRAIN SIZE (2005 SURVEY)

Three sediment samples were taken from each SAV site using a 2-inch by 8-inch polyvinylchloride (PVC) pipe and subsequently preserved in a whirly-pac® for analysis. Samples were collected during the May and September efforts and all three core locations were randomly selected at each bed to obtain a representative sample. Each sample was sifted through a 3 mm sieve and spread into a drying tray. Samples were positioned in a $40^{o}C \pm 5^{o}$ oven for 48 ± 12 hours until dry. Oven-dried samples were allowed to cool and weighed using a Metter® PC440 scale. Samples were then placed through nested sieves using the United States Department of Agriculture (USDA) textural classes (USDA 1992). Sieve nest included sieves with openings of 2 mm (gravel size), >1 mm (very coarse sand), 0.5 mm (coarse sand), 0.25 mm (medium sand), 0.1 mm (fine sand), 0.05 mm (very fine sand), and 0.002 mm (silt). A bottom pan was attached to bottom of smallest sieve used. Sieves were placed in reciprocating shaking machine and vibrated for 15 minutes or until shaking does not produce appreciable changes in the amounts of material on each sieve. After dispersion, collected material from each sieve was weighed separately using a Metter® PC440 scale to the nearest one hundredth of a gram. Percentage of material (POM) was determined by dividing material weight per sieve size (g) by total sample weight post drying (g) for each sieve size and then multiplying by 100.

3.0 RESULTS

The following section provides the results for finfish, invertebrates, eelgrass, water quality, and grain size from the 2005 survey activities and, where applicable, the 2004 survey. A general summary is given for both surveys conducted and further analysis of temporal and spatial trends, as well as faunal and floral interactions, are reported for the 2005 survey.

3.1 FINFISH SAV SEINE SURVEY

3.1.1 General Summary (2004 Survey)

During the 2004 SAV survey, 311 finfish representing 24 species were captured, identified, and enumerated (refer to Appendix B, Table 4 for a list of all species). The Atlantic silverside (*Menidia menidia*) was the most commonly distributed species as it was found at all six SAV sites. Three additional species were found at five of the six sites. Two of these, *Tautoga onitis* (blackfish) and *Pseudopleuronectes americanus* (winter flounder) were the most abundant and represented 23.8% and 16.7%, respectively, of the total catch. The next most abundant species was *Tautogolabrus adspersus* (cunner), which represented 15.1% of the total catch. These results suggest that these three species often frequent the eelgrass habitat sampled during this time of year and observed size classes indicate that most of these individuals were in their juvenile life stage.

In terms of spatial differences, the easternmost sites in SB were the most productive. The highest finfish abundance was recorded at the Tiana station in SB (100 individuals) and the second highest abundance was found at Ponquouge East, also in SB (83 individuals). Biodiversity was also greatest at both of these stations with the highest diversity occurring at Ponquogue East (13 species) and the second most species (11) recorded at Tiana (Great Gunn, in MB, also had 11 species). The lowest levels of abundance and diversity were recorded at Bellport (in GSB) with 15 individuals across six species captured (Figure 5).

3.1.2 General Summary (2005 Survey)

Overall, 4,691 finfish representing 41 species were captured, identified, enumerated, and weighed, and a subset of 2,106 individuals were measured (refer to Appendix B, Table 2 for a list of all species). A total biomass of 24,130.5 grams (g) was recorded for all six efforts in all of the bays sampled. Fish ranged in length from 5 to 500 millimeters (mm) and a majority of finfish captured were juveniles. The smallest finfish captured was the scrawled cowfish (*Lactophyrs quadricornis*) and the largest was bluespotted cornetfish (*Fistularia tabacaria*). Most fish ranged in length from 41 to 100 mm, representing 74% of the measured catch. Further analysis within this length category indicates a fairly uniform distribution with 28% of the total measured catch representing the 41 to 60 mm category, 26% of the total measured catch representing 61 to 80 mm, and 20% of the total measured catch falling within the 21 to 40 mm category (Appendix A, Figure 6). The Atlantic silverside was the most commonly occurring species and represented 26.0% of the total catch. The next most commonly occurring species were the bay anchovy, *Anchoa mitchilli*, (16.5%), followed by Atlantic tomcod, *Microgadus* *tomcod*, (13.9%). Of the total catch, 94.3% was distributed across 11 species whereas the remaining 5.7% of the total catch was comprised of 30 species (Appendix A, Figure 7).

3.1.3 Temporal Trends (2005 Survey)

Monthly finfish abundance ranged from 69 individuals in November, to 1,480 individuals in September, and was greater than 673 for May to June (Appendix A, Figure 8). Biodiversity (Appendix A, Figure 9) followed a similar trend to finfish abundance with the greatest diversity occurring during the months of July (25) through September (23) and the lowest (6) in November. The three most abundant fish for the month of May were Atlantic tomcod, fourspine stickleback (*Apelte quadracus*), and pollock (*Pollachius virens*), each representing 46.8%, 13.5%, and 12.3% of the catch, respectively. In June, the Atlantic silverside (46.0%) was the most abundant species and the Atlantic tomcod (16.9%) was the next most abundant followed by pollock (9.7%). July had the largest catch of bay anchovy when compared to any of the other efforts, with 59.6% of the July catch attributed to that species, and 7.7% and 7.2% of the catch represented by the fourspine stickleback and the Atlantic tomcod. August's catch was mostly made up of the Atlantic silverside (61.0%), followed by northern sennet (*Sphyraena borealis*) and northern pipefish (*Sygnathus fuscus*), which were equally represented at 8.8 % of the catch. September's catch was dominated primarily by cunner (41.0%), Atlantic silverside (35.0%), and blackfish, which represented 5.9% of the monthly catch. Lastly, November's catch was similar in terms of northern pipefish and Atlantic silverside abundance (43.5% and 39.1%, respectively), whereas the combination of the remaining four species caught only contributed 17.4% of the catch. Refer to Appendix B, Table 2 for a complete list of monthly finfish abundances and biodiversity totals. These results suggest that different species use eelgrass habitat regularly at different times throughout the year and most species tend to be present during the summer and early fall months, most likely because that is when the water is the warmest. Species dominance in terms of abundance also fluctuates from month to month, an observation that may be explained by examining finfish reproductive strategies and migratory patterns.

The total monthly weights also mimicked the monthly abundance trend and ranged from 331 g in November to 10,304.5 g in September (Appendix A, Figure 10). In May, the three species that accounted for the most biomass were Atlantic tomcod (25.8%), winter flounder at 24.4%, and Atlantic silverside (13.7%). The largest biomass captures during the June effort were represented by Atlantic silverside (25.2%), grubby (*Myoxocephalus aenaeus*) at 14.3%, and blackfish (14.1%). July's largest contributor to finfish biomass was bay anchovy, which accounted for 55.7% of the catch. The next two largest contributors were blackfish (9.9%) and Atlantic tomcod (8.8%). The Atlantic silverside was once again the most dominant finfish species in terms of weight during the August sampling event, representing 44.2% of the catch, whereas northern sennet and bluefish (*Pomatomous saltatrix*) were the next largest weight catches accounting for 20.7% and 6.3% of the month's total. September was the most productive effort for finfish biomass. The cunner, northern puffer, and Atlantic silverside, were the three most abundant species in terms of weight for that effort, constituting 36.4%, 22.2%, and 14.6% of the catch. Lastly, Atlantic silverside, northern pipefish, and grubby were the largest catches of the November effort, making up 42.3%, 25.7%, and 10.6% of the entire catch. Appendix B, Table 3 provides a complete list of monthly finfish weights organized by species. Length frequency distribution also increased from May to November beginning with 35.2% of the individuals falling into the 41 to 60 mm category in May and ending with the largest percentage of individuals (39.1%) falling into the 81 to 100 mm category in November. These results support the conclusion that finfish growth (length) continued to increase throughout the sampling season and is most likely a result of foraging opportunities that are presented within the habitat. Total finfish biomass, however, did not follow the same trend as it is a better reflection of finfish abundance rather than individual size.

3.1.4 Spatial Trends (2005 Survey)

The total numbers of fish and biodiversity collected at each station during the survey (all efforts combined) are listed in Appendix B, Table 5. Total numbers of finfish collected at each station ranged from the lowest catch at Bellport in GSB (300) to the highest catch at Cupsogue in MB (1,400). In general, GSB had the lowest abundances with a combined station total of 655, while MB and SB were more productive with 2,212 and 1,884 individuals, respectively (Appendix A, Figure 11). Diversity was greatest at Ponquogue East (SB) where 27 different species were recorded and lowest at East Fire Island (in GSB) where only 12 different species were captured. Finfish biodiversity increased from west to east, but three of the stations had values of 16 species indicating relatively homogeneous diversity distributions across the middle range of the sampling area.

Total finfish abundance followed a similar trend with the exception of a dramatic increase in fish abundance at Cupsogue (in MB). The trends in species abundance and diversity are shown in Appendix A, Figure 12 and Figure 13. The Atlantic silverside was the most common capture at the three most western sites (48.2% at East Fire Island, 73.3% at Bellport, and 24.3% at Great Gunn) and the second most common capture at the fourth site furthest from the west (Cupsogue), where the bay anchovy was the most common (55.4%). In the easternmost bays, the Atlantic tomcod was the dominant species in Tiana (39.8%) whereas the cunner was the most frequently captured species at the Ponquogue East station (31.8%).

Total finfish weights for each station ranged from a low of 1,379 g at Bellport, to a maximum of 5,434 g at Ponquogue East, and did not follow any obvious geographic trend. The combined weights were lowest in GSB (4,510 g) and highest in SB (10109 g). Average weights for each bay were 2,255 g for GSB, 4,755.5 g for MB, and 5,054.5 g for SB. At four of the six sites (Bellport, Great Gunn, Cupsogue, and Ponquogue East), the most abundant fishes also contributed to the greatest amount of biomass. At the remaining two sites (East Fire Island and Tiana), individual species other than the most abundant were responsible for the largest contributions to total biomass. The northern puffer represented 57.0% of the total biomass recorded at the East Fire Island station. Similar to the previous finfish abundance comparisons, Atlantic silverside was found to be the largest contributor to total biomass at Bellport (19.4%) and Great Gunn (20.2%) SAV stations. Also similar to the abundance results, bay anchovy contributed to the largest percentage of total biomass at the Cupsogue station, representing 55.8%. For the SB sites, cunner made up the largest percentages of total biomass for each of the sites, representing 31.0% in Tiana and 38% in Ponquogue East. The total weight of each species of fish for each station is given in Appendix B, Table 6. Length frequency distribution did not follow any discernible spatial pattern; the 41 to 60 mm category was the most common at one SAV site in each of the bays (East Fire Island at 25.9%, Great Gunn at 35.1%, and Ponquogue

East at 36.2%). The largest length distribution of fishes was found in Bellport where 28.7% of individuals captured were 81 to 100 mm. The second largest length distribution of fish was found at two SAV sites (Cupsogue and Tiana) in separate bays, with 37% and 26.8% of individuals caught measuring between 61 to 80 mm at each site.

These data suggest, as did the data collected in 2003, that finfish abundance and diversity are highest at Ponquogue East station in SB, indicating that the SAV bed at the station is the most productive. Also in support of the 2003 study, decreasing trends in abundance and diversity can be seen between bays beginning at the eastern most stations and moving westward. This trend suggests that finfish habitat is less desirable or more degraded in GSB than it is in SB. Additional support for this conclusion can be added by examining the data from both the 2003 and 2004 surveys, which produced similar trends.

3.2 INVERTEBRATE SAV SEINE SURVEY

3.2.1 General Summary (2004 Survey)

Invertebrates were counted and ranked according to the scale described previously in the SAV Seine Survey methods section. Appendix B, Table 4 provides a complete list of invertebrate species that were captured. During the 2004 SAV survey, 846 individuals representing 20 species were captured, identified, and enumerated. Marsh grass shrimp (*Palaemonetes vulgaris*) was the most abundant and commonly occurring individual as it represented 38.8% of the total catch and was found at all six SAV locations. Comb jelly (*Mnemiopsis leidyi*) and green crabs (*Carcinus maenas*) were the second most commonly occurring invertebrate species as the each counted for 25.1% and 11.0% of the total catch. Comb jellies were found at each of the six SAV stations and green crabs were found at five of the six stations, with the exception being Bellport.

In terms of spatial differences, no discernible geographical trend could be established. Cupsogue station in MB had the greatest abundance of invertebrates (284 individuals) whereas Ponquouge East in SB had the lowest (39 individuals). Each of the remaining four stations recorded between 115 and 158 individuals. Biodiversity at all six stations ranged from five to 11 species, with the least diversity occurring at Ponquogue East and the most at Cupsogue. Nine species were captured at three of the stations and the remaining station had a biodiversity count of eight species (Figure 14). The relative consistency of abundance and diversity between five of six of the stations indicates a fairly uniformed distribution of macroinvertebrates and suggests that invertebrate habitat is similar (with the exception of Ponquogue East).

3.2.2 General Summary (2005 Survey)

Invertebrates were counted and ranked according to the scale described previously in the SAV Seine Survey methods section. However, in cases where significant numbers of individuals were encountered per seine (i.e., hundreds or more), the species were ranked, not counted. Appendix B, Table 3, provides a complete list of invertebrate species that were captured. Overall, a total of 1,517 invertebrates, representing 32 species, were caught and counted. The blue mussel (*Mytilus edulis*) was the most dominant species, with individual abundances numbering into the thousands during select efforts. These results are slightly misleading as the numbers are enhanced due to post-larval settlement of mussel spat on various species of algae within the eelgrass beds. Individual abundances for five species ranked into the hundreds and included green crab with 44.2% of the total counted catch, mud crab (*Panopeus herbstii*) with 15.0% of the total counted catch, spider crab (*Libinia emarginata*) with 7.2% of the total counted catch, blue crab (*Callinectes sapidus*) with 6.7% of the total counted catch, and comb jelly. Appendix B (Table 7 and Table 8) lists counts and ranks for all species by sampling date and area.

3.2.3 Temporal Trends (2005 Survey)

Invertebrate biodiversity ranged from 13 to 22 species per month, with the lowest diversity occurring during the May event and the highest during the June event (Appendix A, Figure 15). After reviewing the data, no increasing or decreasing trends in diversity could be established within a temporal framework as diversity varied randomly between efforts. The greatest invertebrate abundance was documented during the June sampling event with a count of 594 individuals, 334 of which were the green crab. August was the least productive sampling event with only 64 individuals caught and counted. Abundance trends followed similar patterns in that no obvious temporal trends could be established, but a highly significant positive correlation (both variables increase together) was found between abundance and diversity (Pearson's correlation coefficient = 0.941; $p = 0.005$).

Of the four crab species that were most abundant during the 2005 sampling season, three species, green crab, spider crab, and mud crab, were captured at each event. Additionally, four other species, lady crab (*Ovalipes oscellatus*), Atlantic seastar (*Asterias forbesi*), sevenspine bay shrimp (*Crangon septemspinosa*), and marsh grass shrimp, were also captured during each sampling event.

3.2.4 Spatial Trends (2005 Survey)

Invertebrate biodiversity ranged from 13 to 23 species per month (Appendix A, Figure 16), with the lowest diversity occurring at the Cupsogue station (MB) and the highest at the East Fire Island station (GSB). After reviewing the data, no increasing or decreasing trends in diversity could be established within a temporal framework. It is worth noting, however, that biodiversity was highest at both sites in the GSB.

Invertebrate abundance ranged from 36 to 418 individuals and was greatest at the Ponquogue East station (SB). Great Gunn station (MB) also had large numbers of invertebrates recording a count that was nearly equal to Ponquogue East (412 individuals). The least productive SAV station in terms of invertebrate abundance was Cupsogue (MB), with only 36 individuals recorded. Neither trends in abundance or significant correlations between abundance and species diversity were evidenced as a result of this study. From a distribution standpoint, six species were found at every SAV site surveyed, three of which were crabs (blue crab, green crab, and mud crab). The remaining three species found at each of the sites were the sevenspine bay shrimp, the comb jelly, and the marsh grass shrimp.

3.3 FINFISH AND INVERTEBRATE INTERACTIONS (2005 SURVEY)

Interactions between finfish and invertebrates were examined for each month and each station to expose any significant correlations. As a result, only one relationship revealed a relationship between variables. A significantly negative correlation between finfish abundance and invertebrate biodiversity at all sampling stations was revealed by a Pearson's correlation (coefficient = -0.889, $p = 0.018$). The negative relationship between variables suggests that an increase in one variable will result in a decrease in the other.

3.4 EELGRASS HEIGHT AND DENSITY

Eelgrass, is an aquatic plant that provides critical habitat for a diversity of species including, but not limited to, finfish, invertebrates, and waterfowl. The health of an eelgrass bed is better measured by density rather than height, because the stability of the plant is procured through the expansion and rooting of the rhizomes, and not the overall length of the leaves. Root sets form at the bases of old leaves and spread across the bottom substrate, and root formation is directly connected to the success of leaf growth. Eelgrass height is correlated to water temperature and the availability of nutrients. The fastest growth usually occurs during the spring and then slows during the summer when the water is the warmest; it is at this time that the leaves reach their maximum length (Cornell University 2006).

3.4.1 General Summary (2004 Survey)

Eelgrass density was measured once for each of the six SAV stations at different times throughout the sampling season. Density ranged from 25 to 80% with the least dense bed occurring at Cupsogue station (in MB) during August and the densest beds occurring at East Fire Island (in GSB) and Tiana (in SB) during July and August, respectively. Appendix B, Table 4 provides percent cover values for all six stations. Average density was highest for SB (75%) and lowest for MB (50%). GSB averaged 55% eelgrass coverage between both stations (Figure 17).

3.4.2 General Summary (2005 Survey)

Eelgrass height and density was measured at each SAV station during each sampling event (Appendix B, Table 9). The tallest eelgrass bed was found at Great Gunn (in MB) during the August event, with a mean height of 30.0 inches. The shortest eelgrass bed was located at the Cupsogue station (in MB) in June, with a mean height of 2.8 inches. Eelgrass percent cover was greatest at East Fire Island (GSB) in June (95%) and least (10%) at Cupsogue (in MB) during the same sampling event. In four of the six SAV stations, eelgrass increased in the maximum estimated coverage from the beginning of the sampling season to the end, whereas eelgrass height increased at all stations. Overall, eelgrass height and density were highest in SB (16.8 inches and 64.2% coverage). The lowest average eelgrass height per bay was found in GSB at 10.4 inches (63.3% coverage) and the lowest average bay density was found in MB at 49.6% coverage (13.0 inches).

In GSB, average eelgrass height at East Fire Island remained consistent throughout the entire survey ranging from 8.0 inches to 13.8 inches reaching its peak height in June and averaging

11.9 inches overall. As expected, eelgrass density appeared to increase throughout the study period, beginning with a maximum estimated coverage of 50% in May and ending with 75% coverage in November, reaching its peak coverage of 95% in June, and averaging 75.8% for the entire sampling period; the highest of all the SAV stations. At Bellport, average eelgrass height was the lowest of any station averaging 9.0 inches overall and ranging from 5.8 inches in May, to its peak of 12.0 inches in November. Meanwhile, eelgrass density at Bellport increased from 25% coverage in May to 60% in November reaching a peak of 90% in September and averaging 50.8% overall (Appendix A, Figure 18 and Figure 19).

In MB, average eelgrass height at Great Gunn varied greatly throughout the entire survey ranging from 10.8 inches (June) to 30.0 inches (August) and averaging 16.4 inches overall. Eelgrass density at Great Gunn ranged from 55% to 80% reaching its peak in August and averaging 65.8 % for the season. At Cupsogue, average eelgrass height was 9.6 inches overall and ranged from 2.8 inches in June, to its peak of 16.0 inches in September. Eelgrass density at Cupsogue decreased from 55% coverage in May to 30% in November, to a peak of 60% in September, and averaging 33.3% overall (Appendix A, Figure 20 and Figure 21).

In SB, average eelgrass height at Tiana reached its maximum height in August at 28.8 inches, its lowest height of 12.6 inches in June, and maintained the highest overall station average of 20.0 inches. Eelgrass density increased steadily throughout the study period beginning with a maximum estimated coverage of 30% in May and ending with 90% coverage in November. A small dip in the average coverage was seen in September from 85% obtained during the previous two efforts to 80%. Eelgrass density at Tiana averaged 71.7% overall for the entire sampling period. At Ponquogue East, average eelgrass height was 13.6 inches overall and varied greatly throughout the season, ranging from 12.6 inches in June, to its peak of 28.8 inches in August. Eelgrass density at Ponquogue East increased from 40% coverage in May to 60% in November, to a peak of 65% during the August and September sampling events, and averaging 56.8% overall (Appendix A, Figure 22 and Figure 23). Floral and faunal interactions with eelgrass height and density are discussed below.

3.5 FAUNAL AND FLORAL RELATIONSHIPS BETWEEN BAYS AND SAV STATIONS (2005 SURVEY)

The abundance and diversity of finfish and invertebrates were analyzed in conjunction with eelgrass height and density for each month and station. No significant correlations were found between any faunal and eelgrass interactions, suggesting that faunal abundance and density are not dependent on eelgrass height or density. That is, statistically, more fish are not likely to be found in an SAV bed that has taller eelgrass as opposed to shorter, although both finfish abundance and diversity was highest in SB, which had the longest eelgrass and the most percent coverage.

Analyzed by bay, eelgrass height decreases from east to west from SB through GSB, yet the mean density remains similar between the outlying bays (SB and GSB) and lowest in the Middle Bay (MB). Furthermore, mean eelgrass height and mean eelgrass density have a significantly positive correlation and tend to increase together (Pearson's correlation coefficient = 0.597, $p = <0.001$).

Multivariate Analysis of Variance statistical tests (MANOVA) were used to determine if any significant differences in faunal/floral abundances and densities existed between the bays on a whole or between paired SAV stations within each bay. Overall, there was a significant (p = 0.009) difference in mean eelgrass height from SB (16.8 inches) to GSB (10.4 inches). Finfish diversity decreases significantly between these two bays as well, with SB averaging 9.3 species per effort and GSB averaging 5.4 species per effort (p = 0.007). When analyzing paired stations within each bay, no significant difference in faunal abundance or diversity were detected, but significant differences in eelgrass height and percent coverage were found between SAV stations located in MB and GSB. Great Gunn (at 65.8% cover) had significantly greater eelgrass cover than the Cupsogue site (33.3% cover) in MB (p = 0.005). Furthermore, there was a significant difference in eelgrass height (p = 0.036) between East Fire Island (12.7 inches) and Bellport (9.0 inches) of GSB, suggesting that this discrepancy is not due to chance alone.

3.6 WATER QUALITY (2005 SURVEY)

Appendix B, Table 10 provides a summary of all water quality data collected during the 2005 SAV Survey. Temperature, salinity, dissolved oxygen and turbidity values are listed for all stations by month and are discussed further here. Appendix B, Table 10 shows both tables and plots of mean monthly values at each station.

3.6.1 Temporal and Spatial Trends

Temperatures at all stations showed an expected seasonal trend, increasing from May to August and then decreasing to the lowest observed temperatures in November, and corresponded to ambient air temperatures (Appendix A, Figure 24). Temperature values ranged from 9.79 ºC at Cupsogue (in MB) to 26.15 ºC in August at Bellport in GSB (Appendix A, Figure 25). No significant differences in temperature existed either spatially or temporally and no general geographic patterns of increase or decrease were evident.

Dissolved oxygen (DO) values ranged throughout the sampling period. The stations at SB had the greatest range; from 4.27 mg/L in September at Tiana, to 12.80 mg/L at Ponquogue (which also maintained the highest DO average of any station at 10.66 mg/L) as shown in Appendix A, Figure 26. All station values, except for one (Tiana in September), were above 4.8 mg/L, which is the EPA specified minimum criteria for chronic and acute effects on biota (USEPA 1999). It is possible that the unusually low DO reading resulted from a temporary equipment malfunction as all other recordings for the station are second highest on average. No significant differences in DO existed either spatially or temporally, and no general geographic patterns of increase or decrease were evident.

Salinity values ranged from 17.30 ppt at East Fire Island (in GSB) in June to 29.80 at Ponquogue East (in SB) in September (Appendix A, Figure 27). Variation between average site salinities was minimal at approximately 5.82 ppt. Salinity, on average, decreased by bay from east to west and although significant differences were found (refer to Water Quality Relationships between Bays and SAV Stations section below), it is unlikely that these decreases would have a negative impact on the local biota.

Turbidity values were collected 14 times out of a possible 36 due to an equipment malfunction. Turbidity ranged from 0.00 NTU at both Ponquogue East and Bellport stations during the August sampling event, to 10.80 NTU at the Bellport station (in GSB) in November, as shown in Appendix A, Figure 28. Mean turbidity at all stations for the entire sampling period was between 1.70 NTU at Cupsogue (in MB) and 5.40 NTU at Bellport (in GSB). According to Singleton (2001), the management guideline for supporting marine aquatic life is <8 NTU. Although two of the 14 turbidity values collected exceeded this guideline, none of the station or monthly averages do, and the higher values may be an artifact of the fore mentioned equipment malfunction. No significant differences in DO existed either spatially or temporally and no general geographic patterns of increase or decrease were evident.

3.6.2 Water Quality Relationships between Bays and SAV Stations

MANOVA tests were used to determine if any significant differences in water quality parameters existed between the bays on a whole or between SAV stations regardless of location. Only salinity was observed to differ markedly between two of the bay systems (SB and GSB), and no significant differences between individual stations were detected. Although the difference in salinity was significant to the 0.005 level, where SB maintained a higher average (28.6 ppt) than GSB (23.9 ppt), these values are still well within biological ranges and therefore not considered relevant within the context of this study. Due to the high variability inherent in water quality data, particularly for temperature, long-term survey data are needed in order to more effectively evaluate correlations between water quality and SAV bed health.

3.7 ENVIRONMENTAL VARIABLES AND FAUNAL/FLORAL ABUNDANCES AND DIVERSITY (2005 SURVEY)

Data were analyzed to determine if, throughout the course of this study, environmental factors (i.e., water quality, percentage of visible moon, and tidal cycle) contributed to any spatial or temporal changes in faunal or floral abundances and diversity. Only one significant temporal interaction was found to exist between these relationships. Temperature was found to have a significantly positive correlation with finfish biodiversity (Pearson's correlation coefficient = 0.955, p = 0.003), suggesting that biodiversity increases with water temperature. This is an expected observation, given that these shallow bay systems are capable of supporting tropical visitors that make there their way in from the Gulf Stream current during the warmer water months. Another noteworthy interaction that was correlated to an increase in finfish biodiversity and finfish biomass was the percentage of visible moon during each of the sampling efforts.

A positive relationship was established for both biodiversity (Pearson's correlation coefficient = 0.380, p = 0.022) and biomass (Pearson's correlation coefficient = 0.394, p = 0.021) indicating that diversity and biomass increase as the percentage of visible moon increases. Pet et al. (2005) documented increases in abundance and biomass in two grouper species (Serranidae) when full and new moon phases were observed and concluded that these aggregations coincided with spawning events. Although no correlation between percent visible moon and finfish abundance (all species combined) could be made, it is possible that evaluation of individual species with regard to moon phase may produce significant correlation but such specific analyses exceed the scope of this study. No other significant relationships between environmental variables and fauna were discovered nor were any significant interactions noted between any of the environmental variables measured and eelgrass height or density.

3.8 GRAIN SIZE (2005 SURVEY)

Specific sand characterizations for each SAV station are listed in Appendix B, Table 20, and clearly show that the samples are predominantly comprised of medium sand (i.e., size class of 0.25 mm to 0.5 mm). Tiana (in SB) had the highest percentage (65.45%) of medium sand of any of the stations sampled and the lowest proportion of medium sand was found at East Fire Island (in GSB). The second most commonly occurring size class was fine sand and East Fire Island had the highest percentage (22.21%). In contrast, Great Gunn station was found to have the lowest (10.67%) composition of fine sand sediment of any of the sites sampled. Coarse sand was the third most common sediment class found on average throughout all of the samples. Substrate composition at Great Gunn (in MB) had the highest ratio of coarse sand in its samples but it is important to note that that value may be inflated by the unavoidable inclusion of organic matter or shells into the sample. Tiana (in SB) had the least proportion of coarse sand in its samples of any of the SAV stations sampled. Only trace amount of gravel, clay, and silt were collected in the samples at each of the SAV locations.

3.8.1 Grain Size Relationships between Stations and Floral Interactions

Grain size between stations did not vary significantly and, as a result, are statistically indistinguishable from each other. Furthermore, grain size and its potential effects on eelgrass density and eelgrass height were analyzed and no statistically significant correlations could be made. Analysis of organic material (a significant indicator of substrate suitability for eelgrass growth) was not conducted as part of USACE sampling activities. Such an analysis may have revealed trends between substrate composition and eelgrass health that are not discernable based on grain size-analysis alone.

4.0 SUMMARY AND CONCLUSIONS

Sampling for the USACE 2004 and USACE 2005 SAV Surveys were conducted from late spring to early fall during 2004 and 2005 at six SAV sites located in three different bays: GSB, MB and SB. Survey collections included fish and macroinvertebrates using seine nets, quantitative eelgrass densities using a quadrat, substrate grain size using a substrate grab, and water quality data using a hydrometer. The 2004 survey and any observed trends that differ from or support the data collected during the 2005 survey are discussed first, and then the remainder of the summary focuses on the results of the 2005 survey event and explores similarities and differences between the more intensive 2003 survey.

Although the 2004 field sampling effort was limited, qualitative comparisons were made between SAV stations from year to year with regards to finfish and invertebrate abundance and density as well as eelgrass density. Results from all three sampling years have suggested that finfish abundance and diversity is greatest in SB and poorest in GSB. Eelgrass density was also highest in SB when measured during the 2004 study and further supported by the 2005 study, which demonstrated that SB averaged the greatest eelgrass density overall. Invertebrate abundance and diversity was similar across five of the six SAV stations sampled. No spatial trends or patterns similar to the ones that were established in the 2003 and 2005 studies emerged, but it should be noted that this may be an artifact of a limited sample size.

The following faunal relationships and interactions, as associated with eelgrass trends, are based on the 2005 study and comparison with data collected from the 2003 survey (USACE 2004). It is important to note that the SAV site sampling was of a discrete area and time interval (a period extending just over 5 months). General observations based on the USACE 2005 field program are described hereafter.

Eelgrass density ranged from 10% to 95% per site. The highest eelgrass density was recorded at East Fire Island (in GSB) in June and the lowest at Cupsogue (in MB) in June as well. Mean values of eelgrass density between sites ranged from 33.3% at Cupsogue to 75.8% at East Fire Island. The tallest eelgrass bed was found at Great Gunn (in MB) during the August event, with a mean height of 30.0 inches. The shortest eelgrass bed was located at the Cupsogue station in June with a mean height of 2.8 inches. Significant differences in height between SB and GSB were identified, along with statistically significant differences in eelgrass percent coverage between a set of paired SAV stations (Great Gunn and Cupsogue). Eelgrass height was greatest during August and eelgrass density was greatest during September, which corresponded with the two highest average monthly water temperatures, further supporting results reported in the previous USACE 2003 SAV study.

Collections of finfish totaled 4,691 specimens representing 41 species. Dominant species listed in order, were Atlantic silverside, bay anchovy, cunner, and Atlantic tomcod. Similar to the results of the 2003 study, invertebrate captures were dominated by the green crab and the Atlantic mud crab, and 33 species of invertebrates were captured throughout the entire study. Finfish abundance and diversity were greatest during July and September, and were generally found to increase from west to east. Invertebrate abundance and diversity were greatest in June and a significantly positive correlation was identified between the two. Invertebrate abundance generally increased from west to east, whereas invertebrate diversity followed an opposite trend, and increased from east to west. Another interesting correlation was found that suggests a significantly negative relationship between finfish abundance and invertebrate diversity, as one tends to increase as the other seemingly decreases. This finding may be attributed to local predator/prey interactions in the sense that the more finfish there are in a given area the higher the likelihood that certain species may feed on particular marcroinvertebrates, thereby temporarily decreasing overall diversity.

In comparison to the 2003 study (USACE 2004), only 28.6% of the abundance of finfish captured in 2003 was captured in 2005. However, the previous study conducted 40% more sampling than did the current study. In addition, it is not uncommon to have significant year-to-year variability in finfish populations, particularly when the comparisons are based on data from discrete one-time sample events each month (Rose 2000). Finfish biodiversity between studies was similar with 49 species from 2003 and 41 species from the 2005 study. In addition, many of the species captures were similar indicating that a majority of the same resident species inhabited the SAV beds as in previous studies, but not in the same densities. In terms of eelgrass production, an increase in both mean density and height was found at five of six of the SAV stations when compared to the 2003 study (an average increase in height of 17.7% and in density of 14.3% was seen in the five sites). Cupsogue (in MB) was the only station that decreased in both height and density by an average of 71.7% in height and an average of 24.5% in coverage.

With the exception of salinity, water quality values (temperature, dissolved oxygen, and turbidity) followed expected seasonal trends, did not vary significantly between stations, and were similar to the values reported in USACE 2004. Temperature and salinity were slightly lower on average during the current study, whereas DO and turbidity values were higher; all of which were still well within biological limits. As demonstrated in the 2003 study, an increase in finfish biodiversity was significantly correlated to temperature increase, primarily a result of the well-documented influx of tropical species that occurs in the bays during the summer months. Although significant differences in salinity were observed, none of the changes in any of the other variables seemed to have a significant impact on faunal or floral distribution. Additionally, grain size did not vary significantly between SAV stations and could not be correlated with eelgrass height or density.

Overall, in terms of assessing submergent aquatic vegetation health as determined by biological indicators, it is difficult to state that any one bed is more productive than another simply because different SAV stations ranked highest for different criteria. From the perspective of eelgrass density and height, Tiana station in SB was one of the most productive. From a perspective of finfish abundance and diversity, Ponquogue East station, also in SB, was one of the most productive. This may suggest that SB is probably the healthier bay system in this study as well as the 2003 SAV study). However, when measuring variables individually, the greatest eelgrass density was found in GSB at East Fire Island Station (Tiana in SB was second overall), Cupsogue in MB had the greatest finfish abundance (1400), and finfish diversity was the same at three of the six stations sampled (Tiana, Cupsogue, and Great Gunn all had a 16 species recorded). These findings suggest that although SB may seem to be the healthiest of the systems measured, the remaining two bays do not differ drastically in terms of production (these findings are again supported by the data collected in 2003). In general, a decrease in biological robustness was observed from east to west, and temperature was identified as a limiting factor in biological robustness. Furthermore, no clear patterns emerge as a result of this study to suggest that SAV bed health has changed markedly from what was reported in the previous 2003 study, as similar trends were found throughout.

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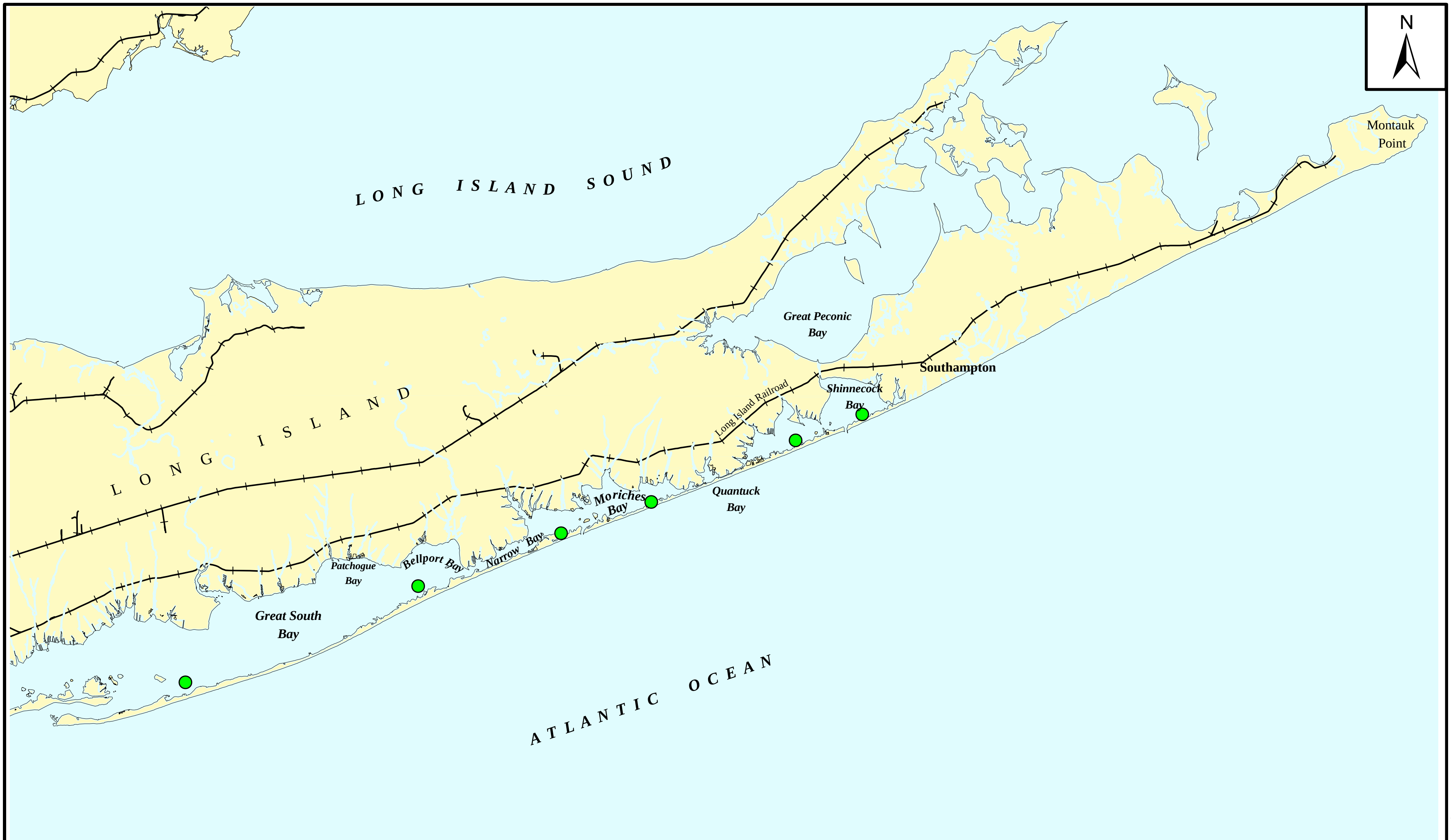
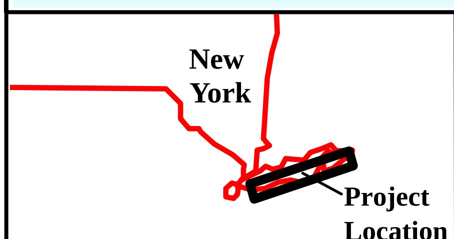
Appendix A

Figures





Source: ESRI Data and Maps, 2003;
USACE, 2004

LEGEND

Submerged Aquatic Vegetation Bed

Figure 1. Project Location for
Fire Island to Montauk Point
Submerged Aquatic Vegetation Project.

Prepared By: U.S. Army Corps of Engineers
New York District

Date: 5/06

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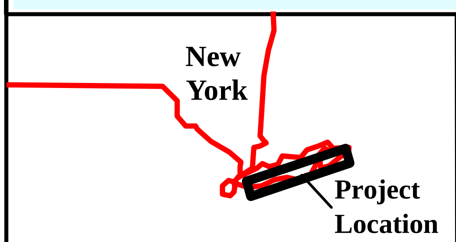

Source: ESRI Data and Maps, 2003;
USACE, 2004.

LEGEND

● Submerged Aquatic Vegetation Bed

Figure 2. SAV Sample Locations in Great South Bay Fire Island to Montauk Point Submerged Aquatic Vegetation Project.

Prepared By: U.S. Army Corps of Engineers
New York District

Date: 5/06

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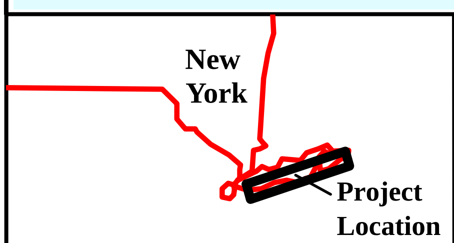

Source: ESRI Data and Maps, 2003; USACE, 2004.

LEGEND

● Submerged Aquatic Vegetation Bed

Figure 3. SAV Sample Locations in Moriches Bay
Fire Island to Montauk Point
Submerged Aquatic Vegetation Project.

Prepared By: U.S. Army Corps of Engineers, New York District

Date: 5/06

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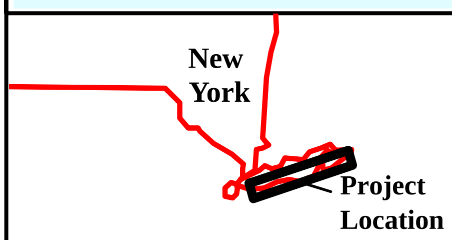

Source: ESRI Data and Maps, 2003;
USACE 2004

LEGEND

● Submerged Aquatic Vegetation Bed

Figure 4. SAV Sample Locations in Shinnecock Bay
Fire Island to Montauk Point
Submerged Aquatic Vegetation Project.

Prepared By: U.S. Army Corps of Engineers
New York District

Date: 5/06

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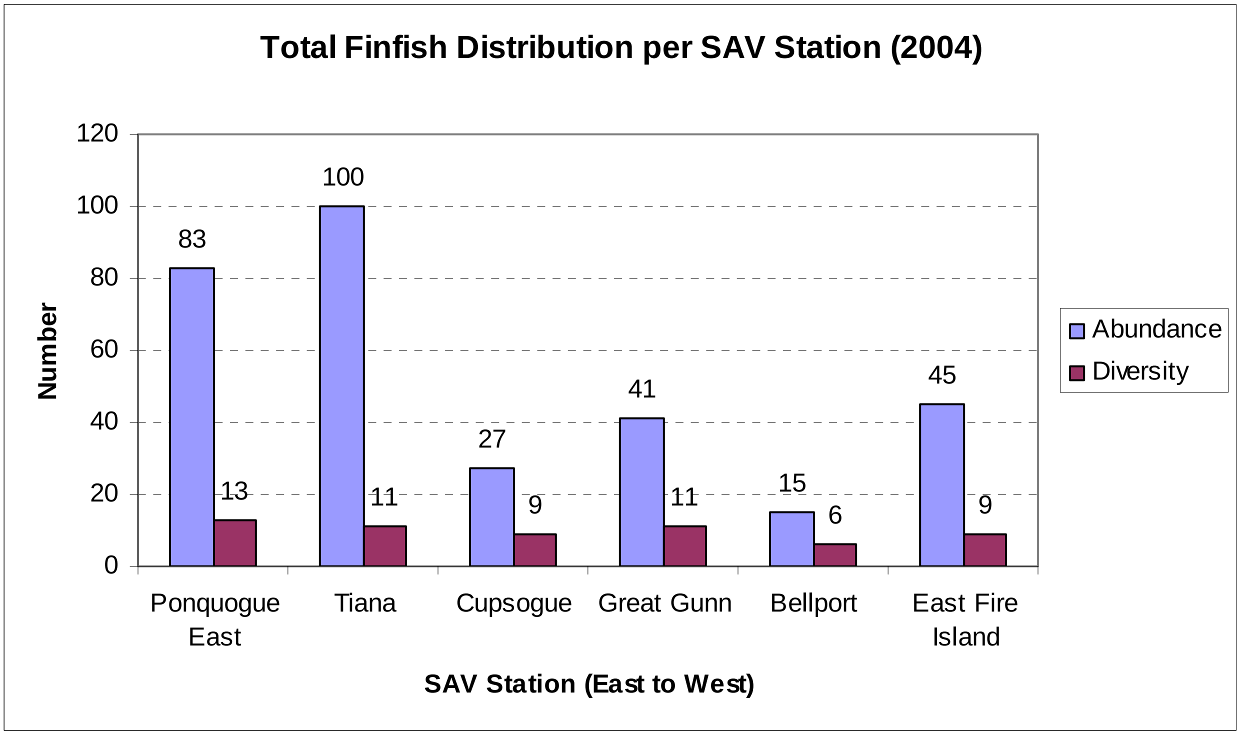


Figure 5. Total Finfish abundance and biodiversity per SAV Station sampled in 2004.

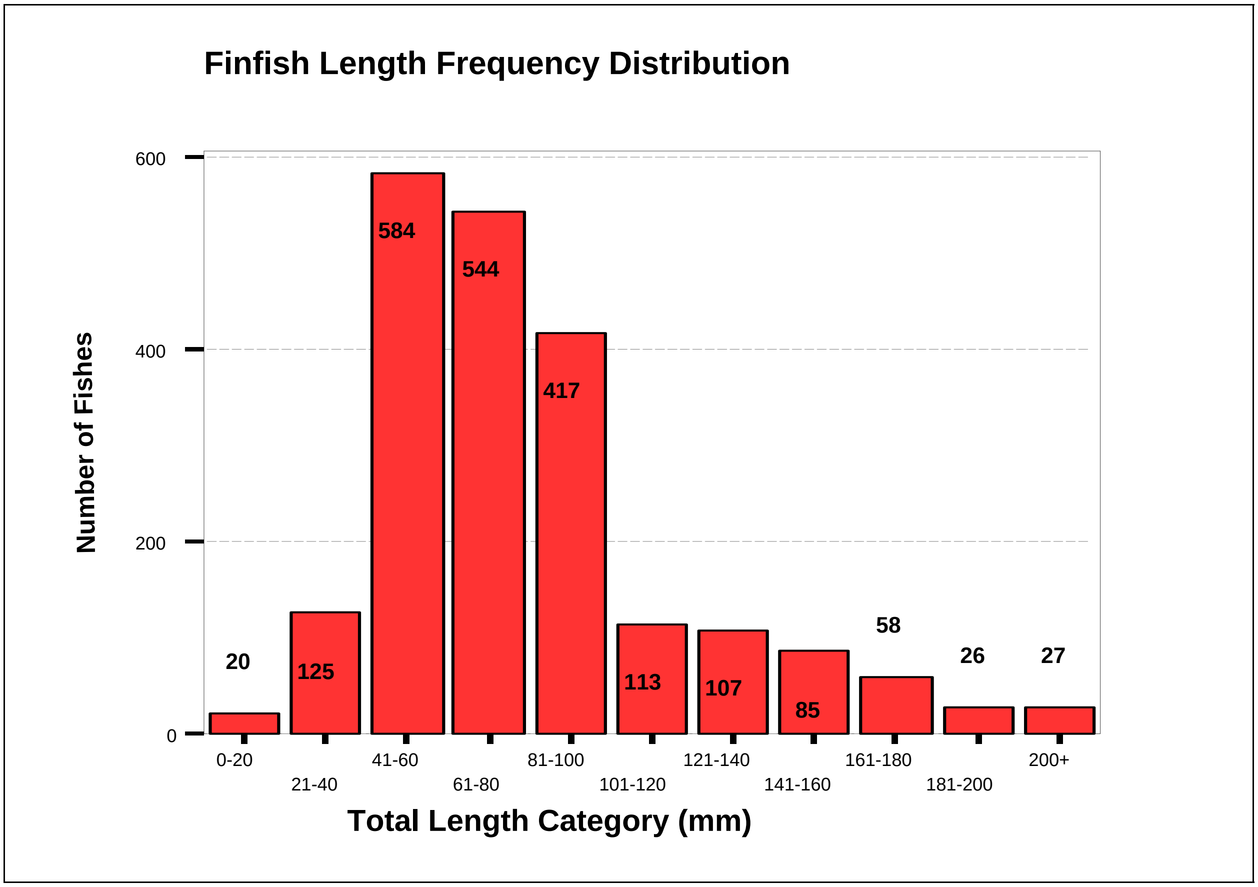


Figure 6. Length frequency analysis for the 2005 Finfish SAV Survey.
Bars indicate the number of individuals that satisfied a certain length category.

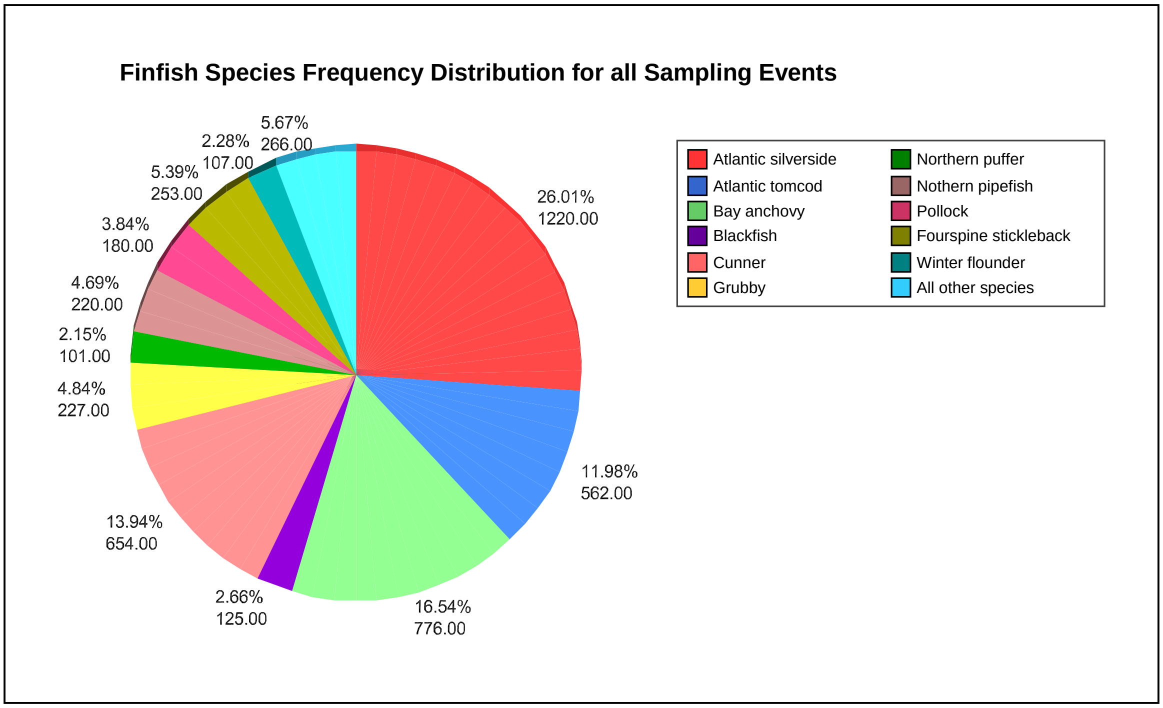


Figure 7. Individual finfish landings and percent composition of total catch for the 2005 Finfish SAV Survey.

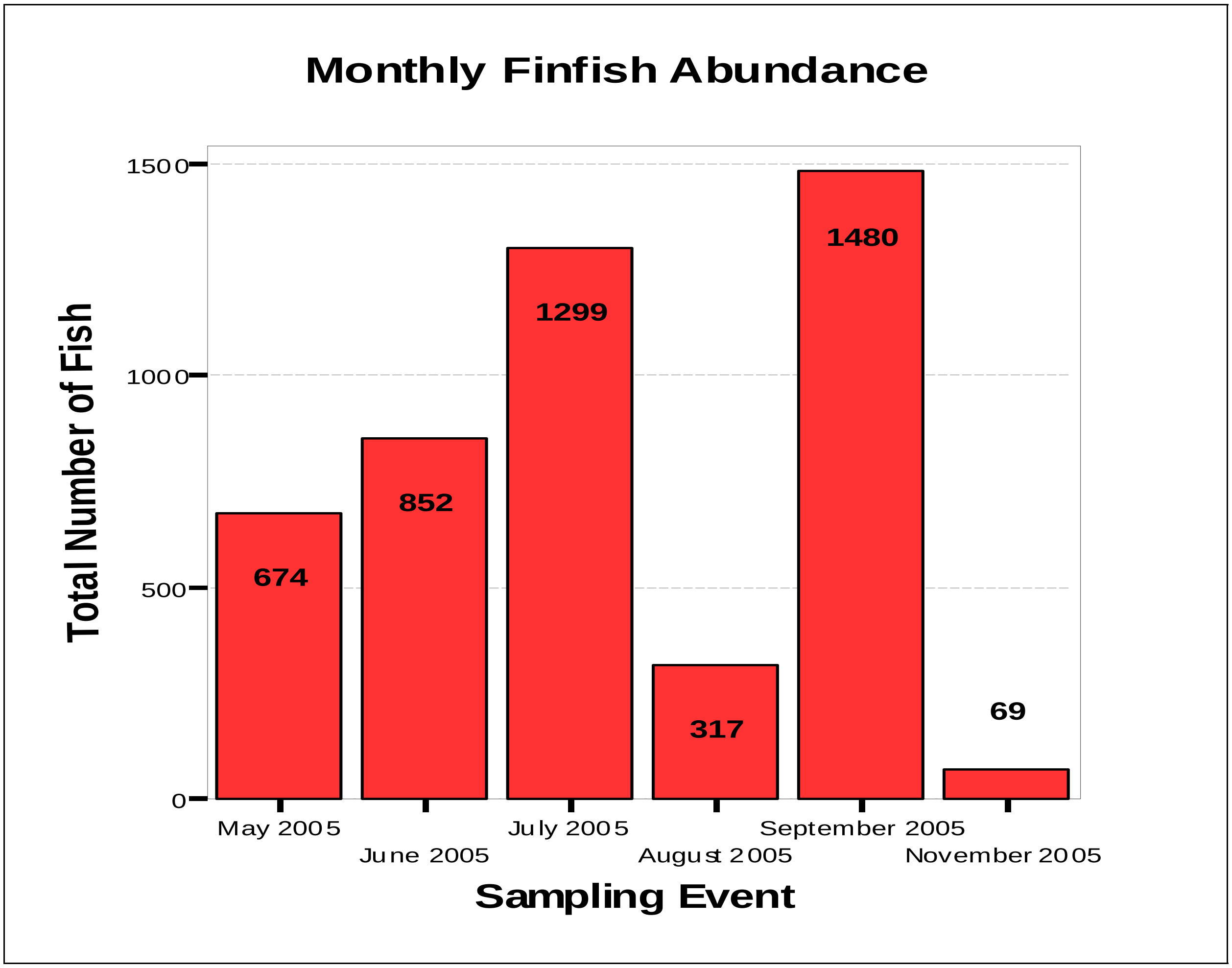


Figure 8. Total finfish abundance per sampling event for the 2005 SAV Survey.

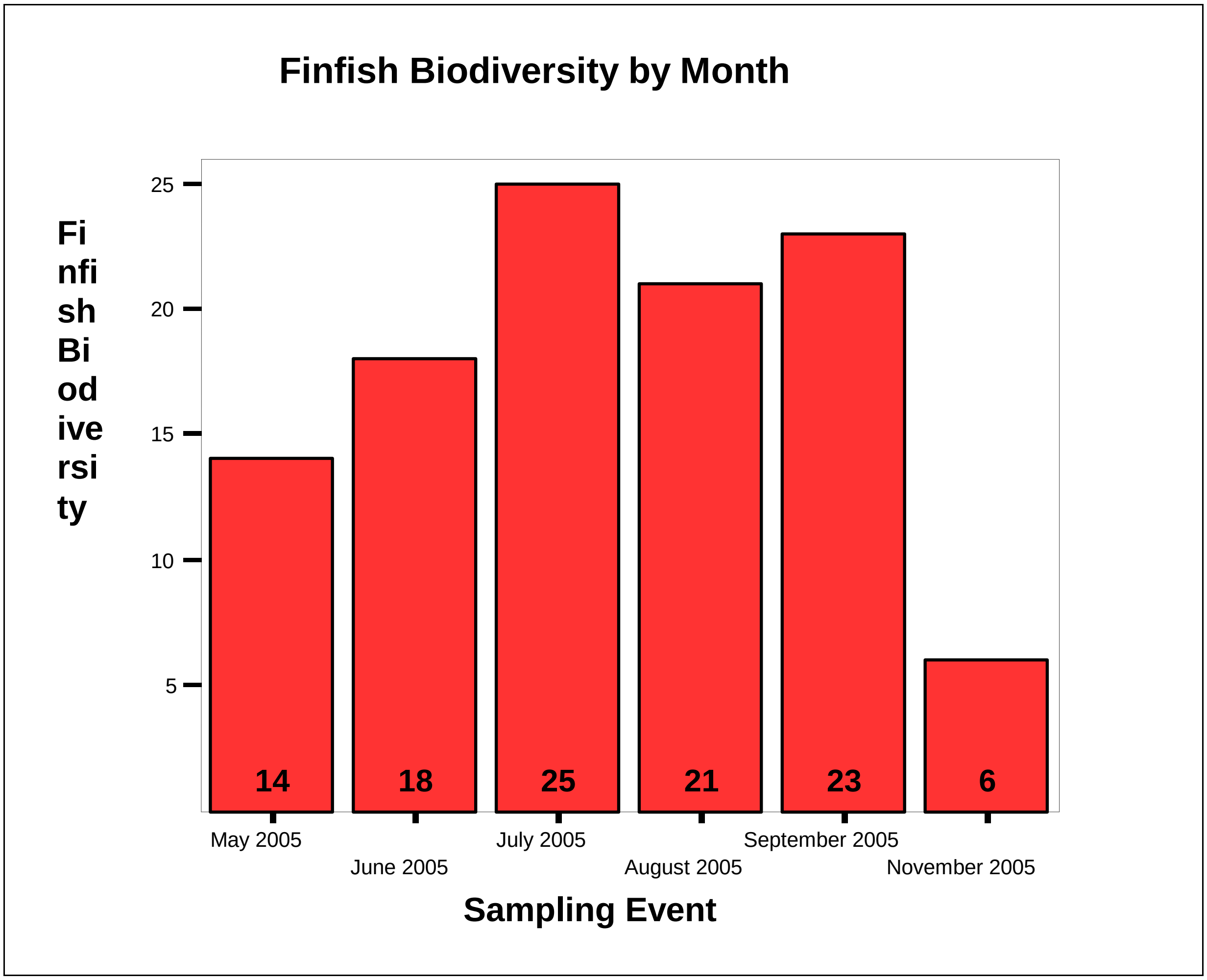


Figure 9. Finfish biodiversity for each sampling event during the 2005 SAV Survey.

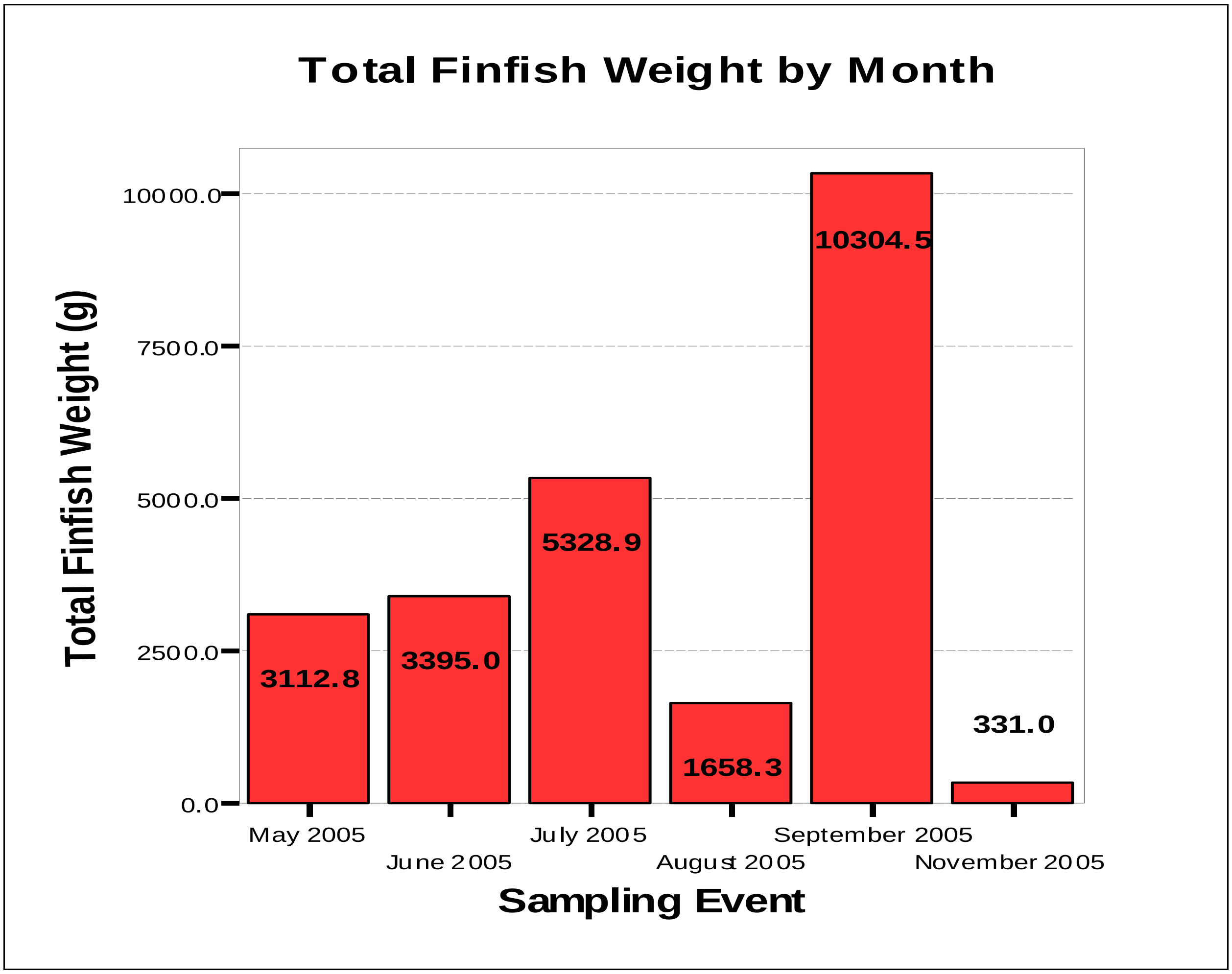


Figure 10. Total monthly biomass for the 2005 SAV Survey.

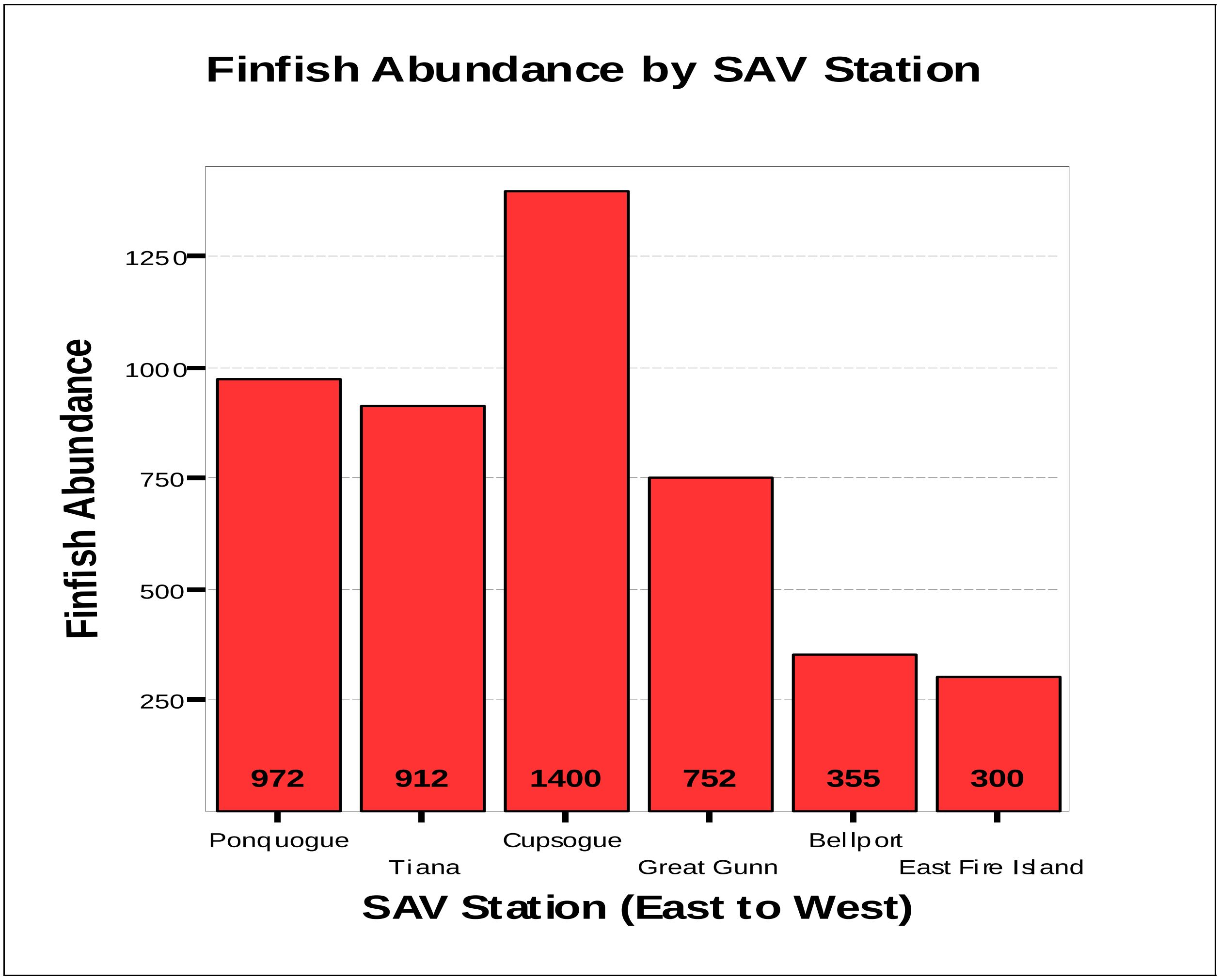


Figure 11. Total finfish abundance by SAV station for the 2005 SAV Survey.

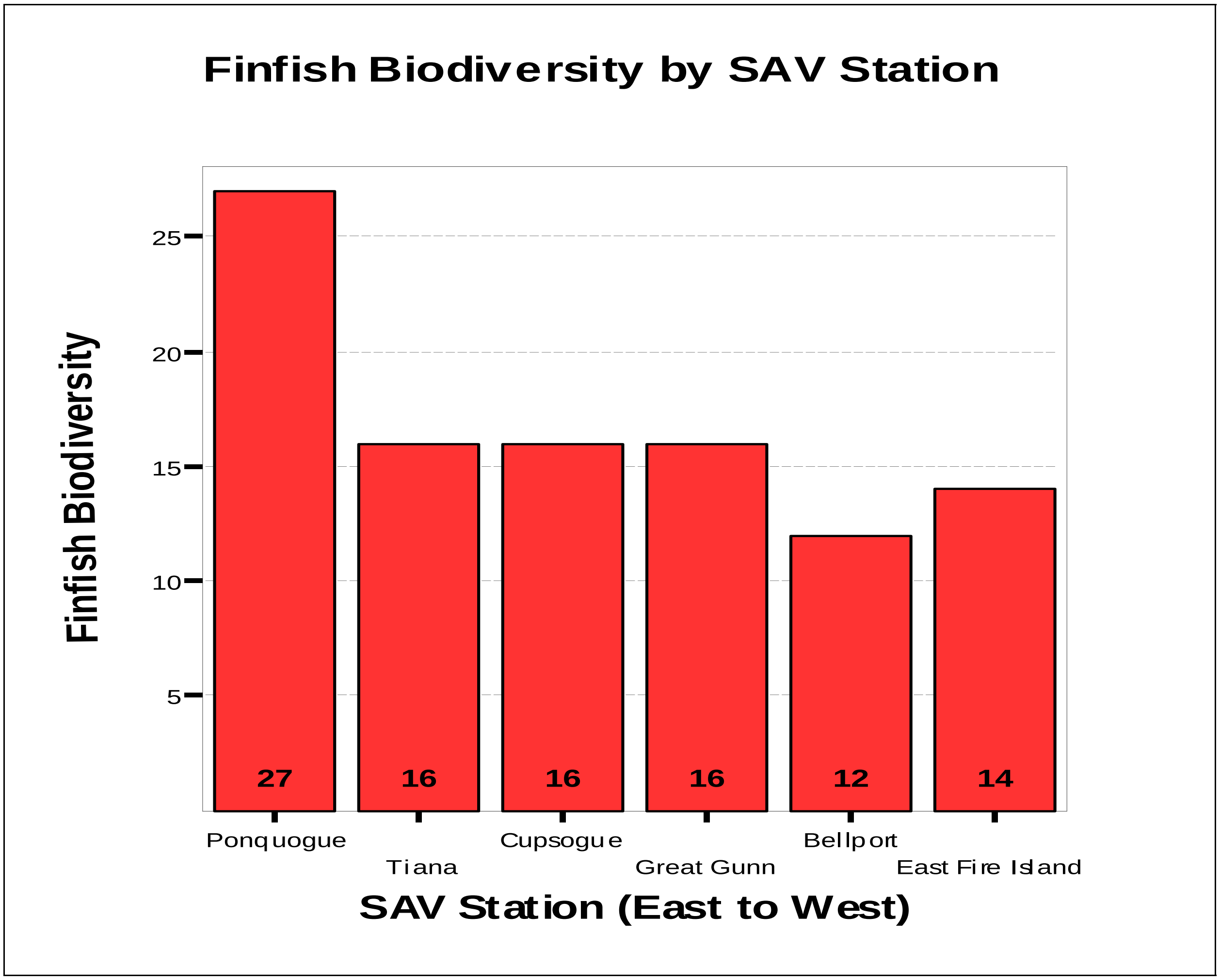


Figure 12. Total finfish diversity by SAV station for the 2005 SAV Survey.

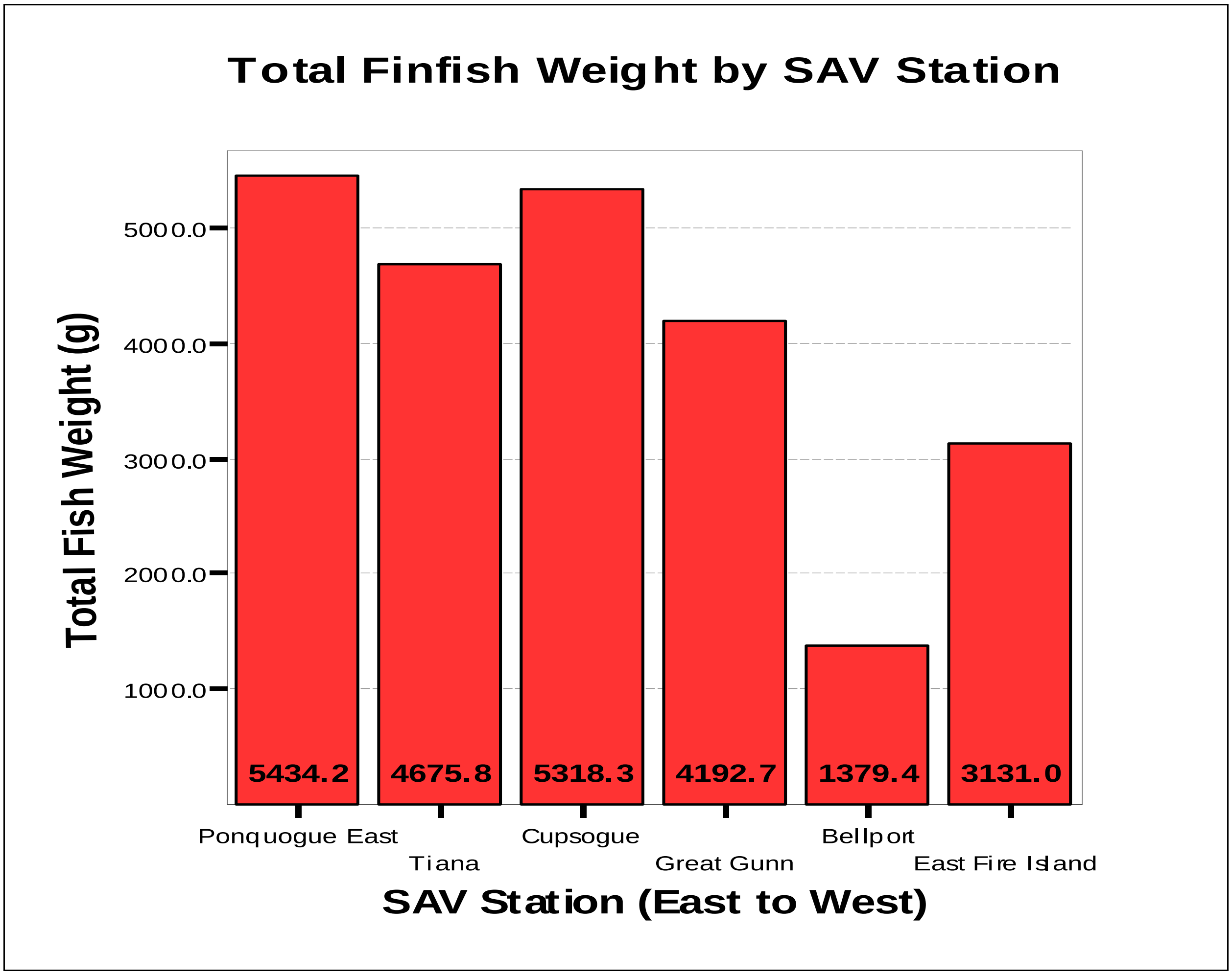


Figure 13. Total finfish weight by SAV station for the 2005 SAV Survey.

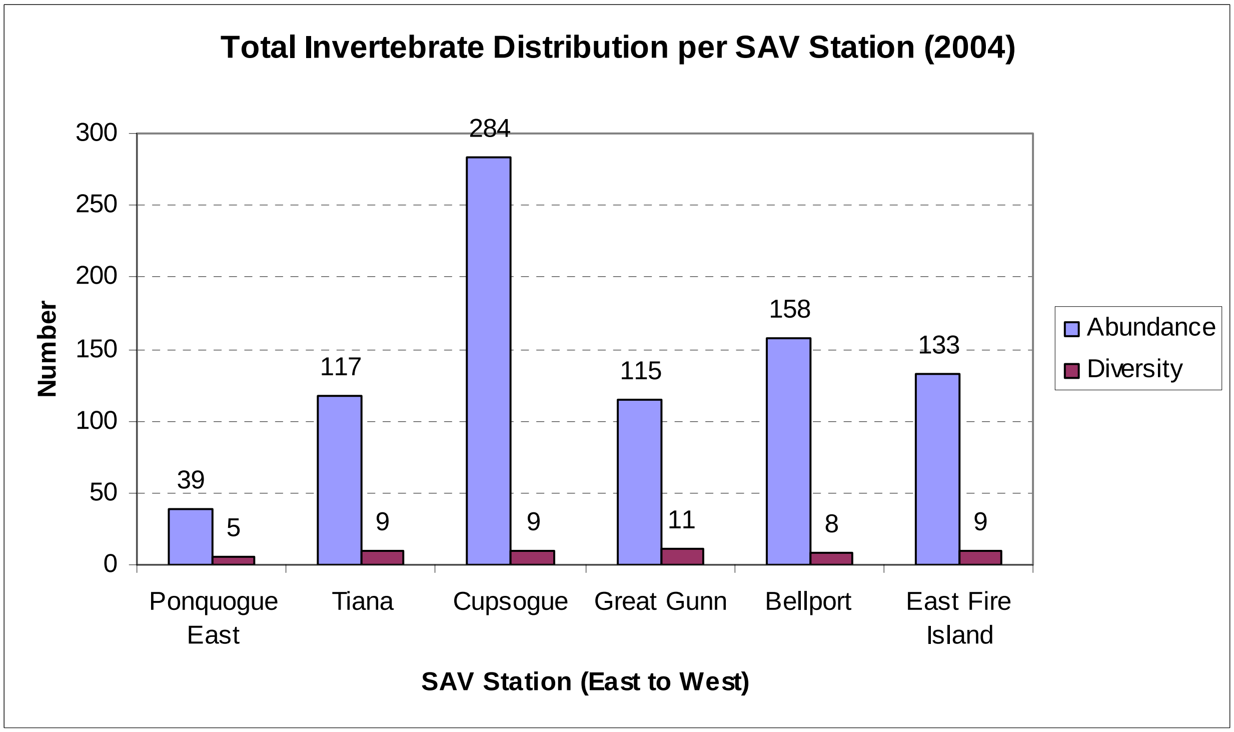


Figure 14. Invertebrate abundance and biodiversity per SAV station sampled in 2004.

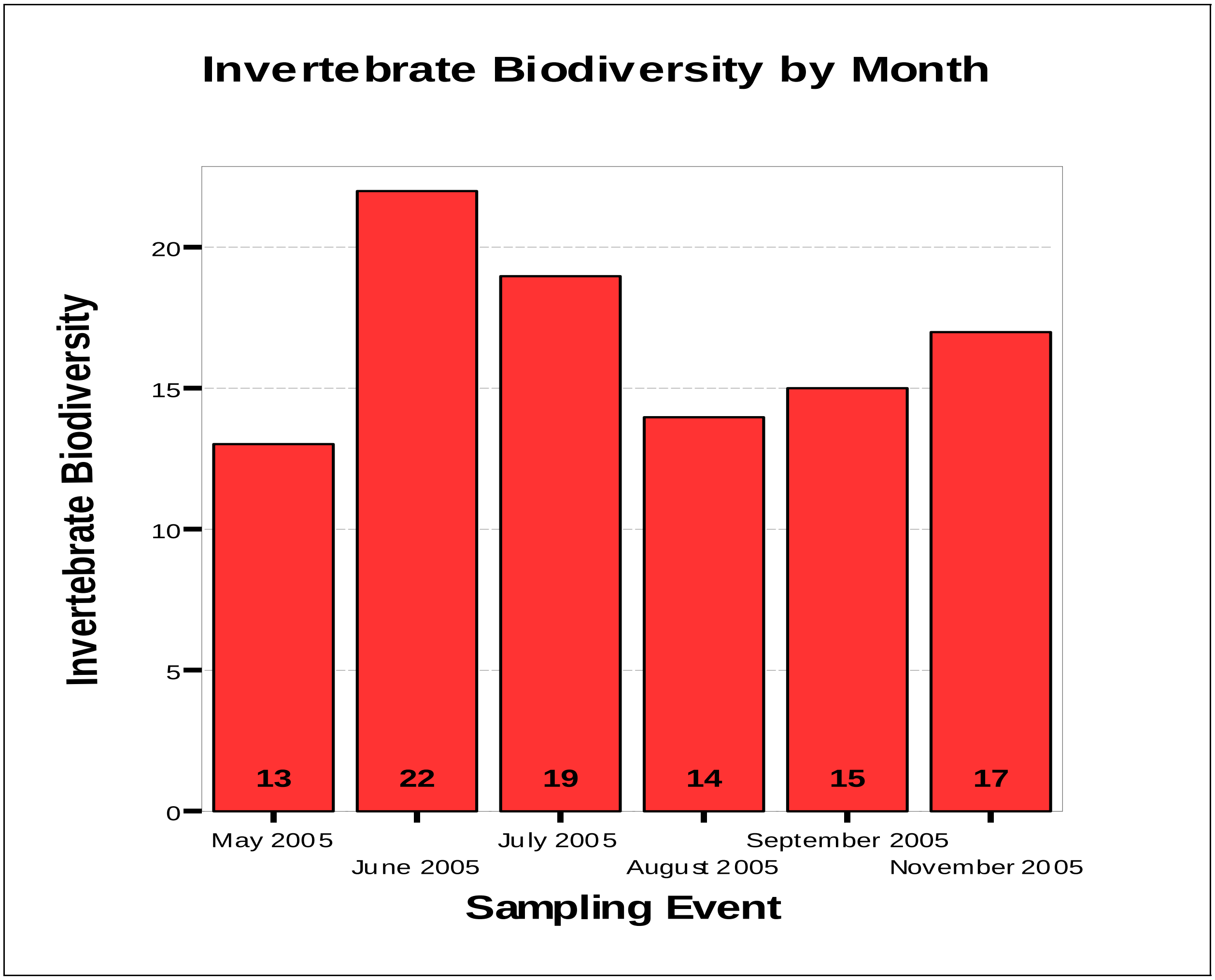


Figure 15. Invertebrate biodiversity by month for the 2005 SAV survey.

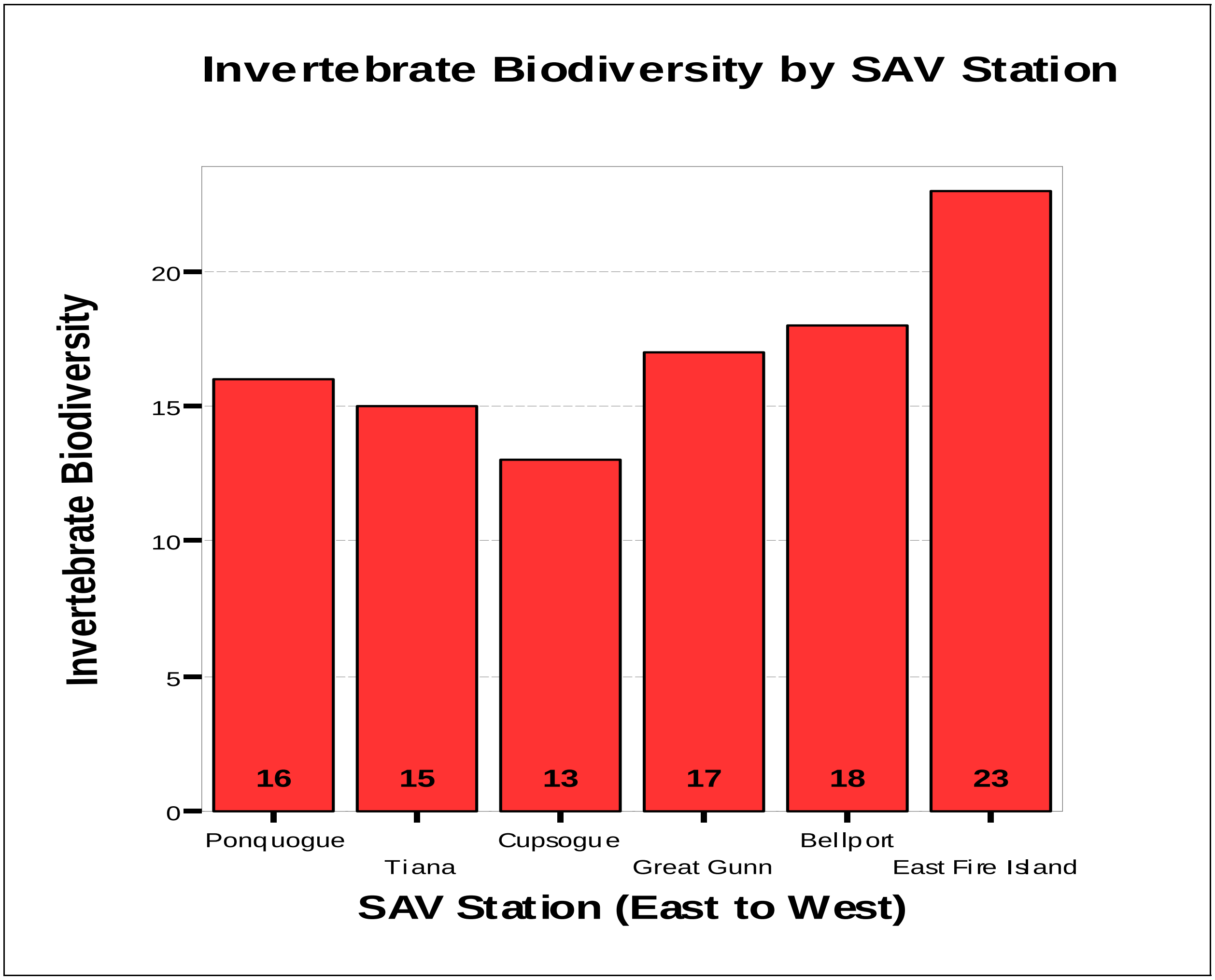


Figure 16. Invertebrate biodiversity by SAV station for the 2005 SAV Survey.

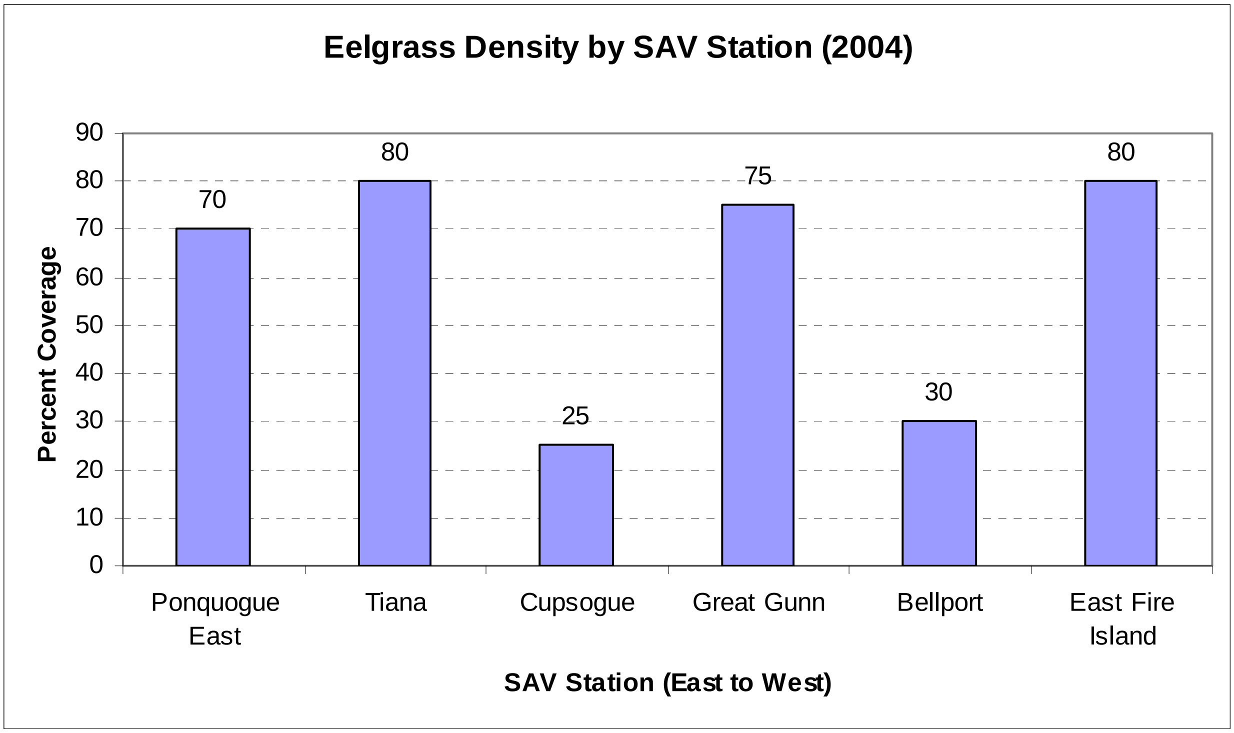


Figure 17. Eelgrass density by SAV station for the 2004 SAV Survey.

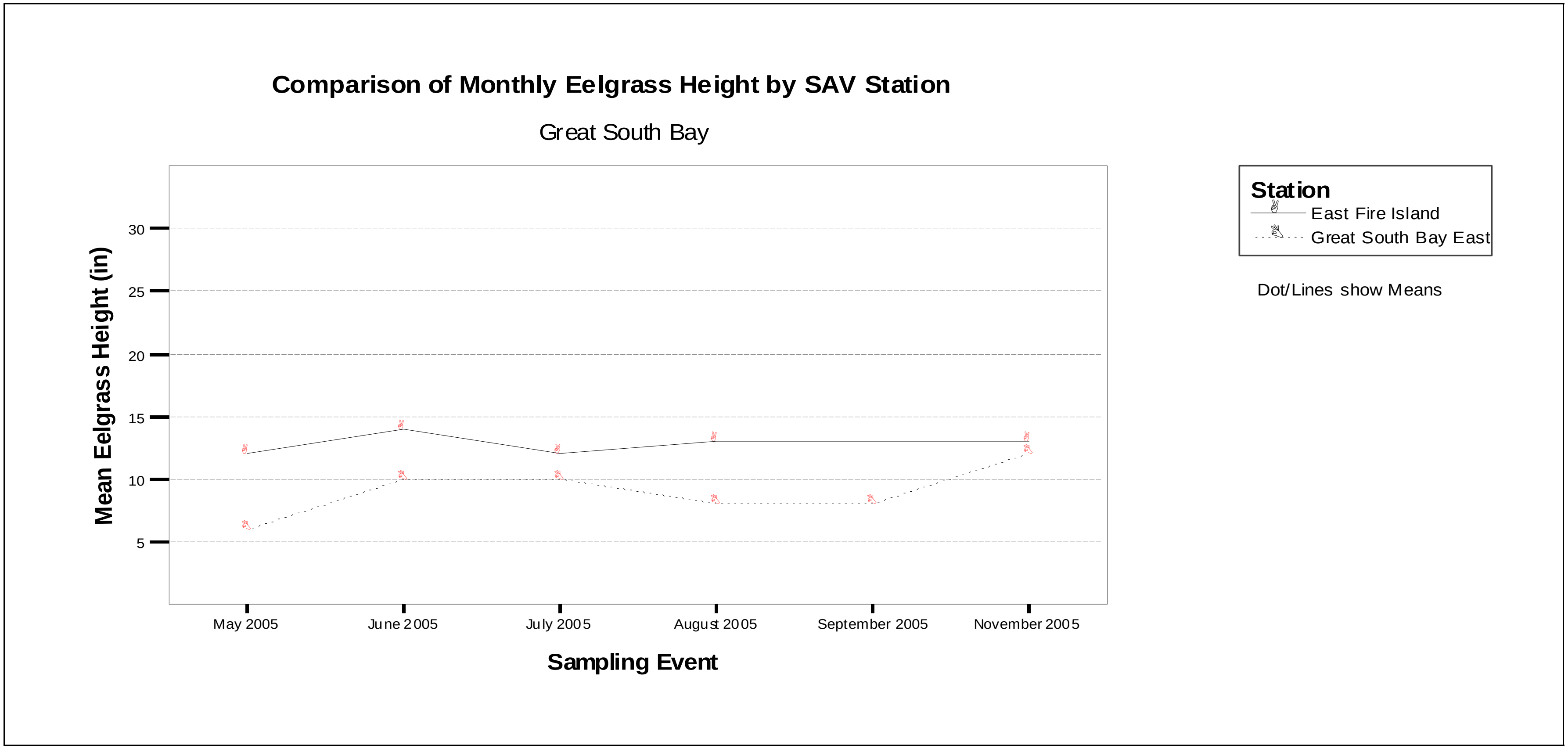


Figure 18. Average eelgrass heights for both GSB stations during the 2005 SAV Survey. Great South Bay East station is synonymous with Bellport station.

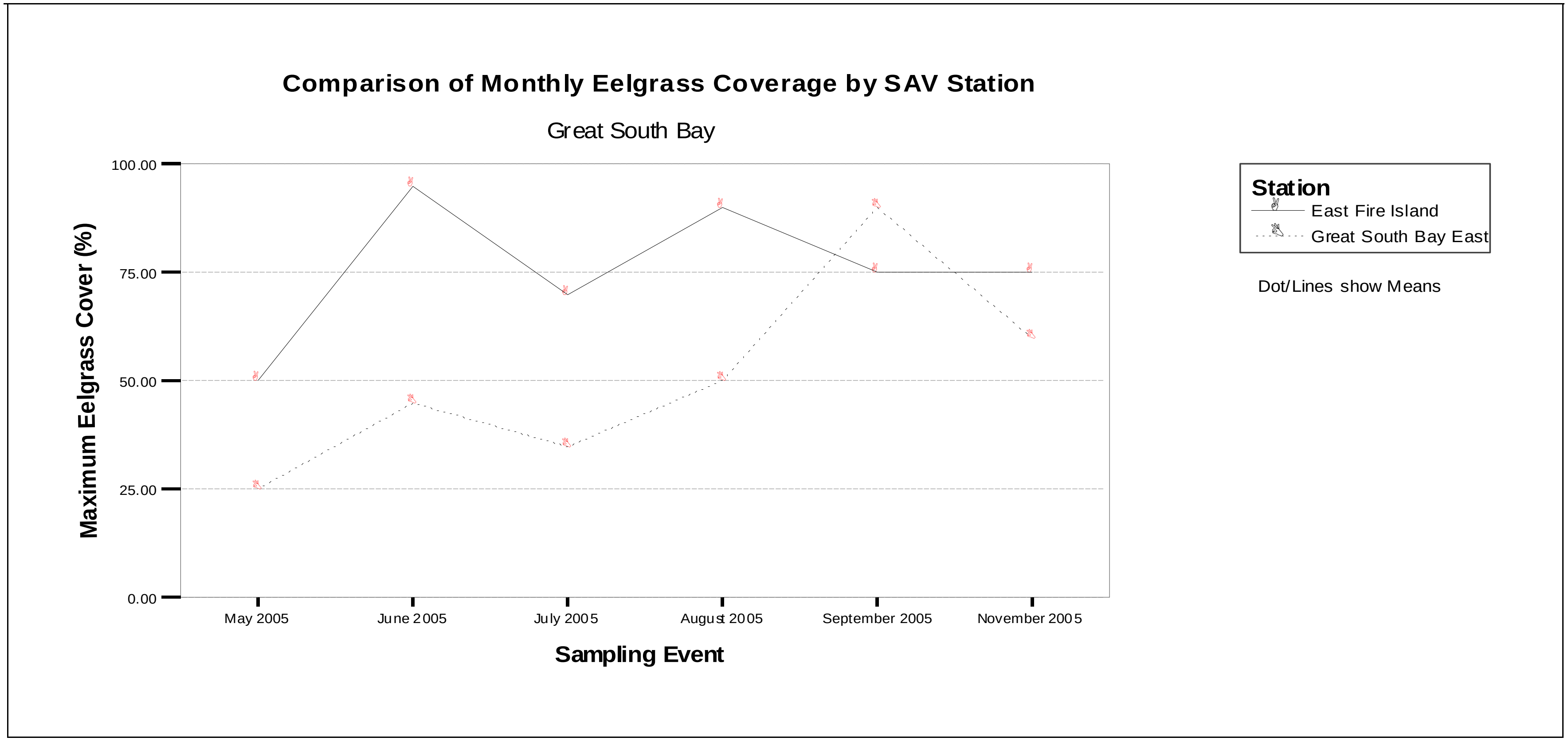


Figure 19. Maximum eelgrass coverage for both GSB stations during the 2005 SAV Survey. Great South Bay East station is synonymous with Bellport station.

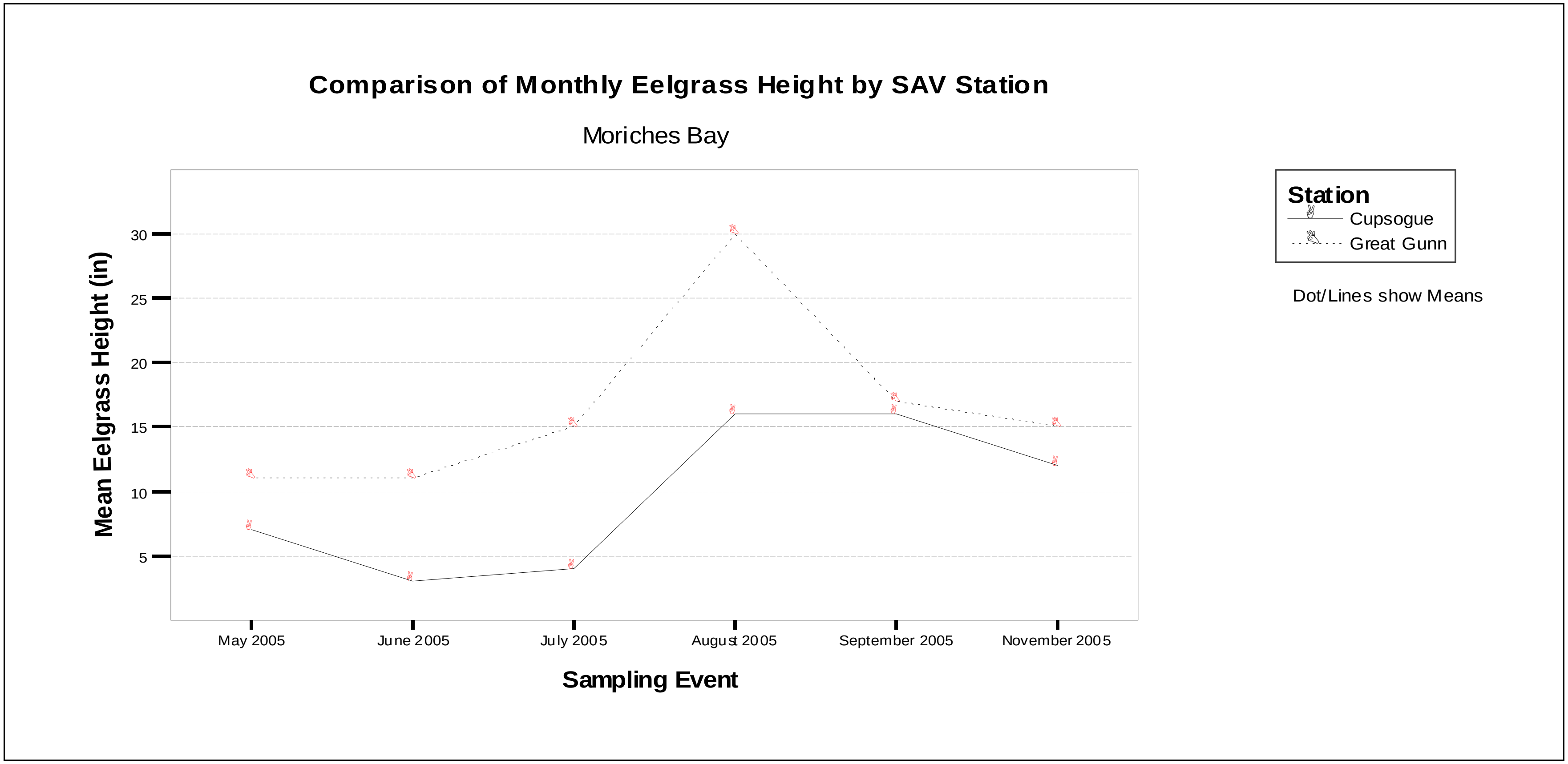


Figure 20. Average eelgrass heights for both MOR stations during the 2005 SAV Survey.

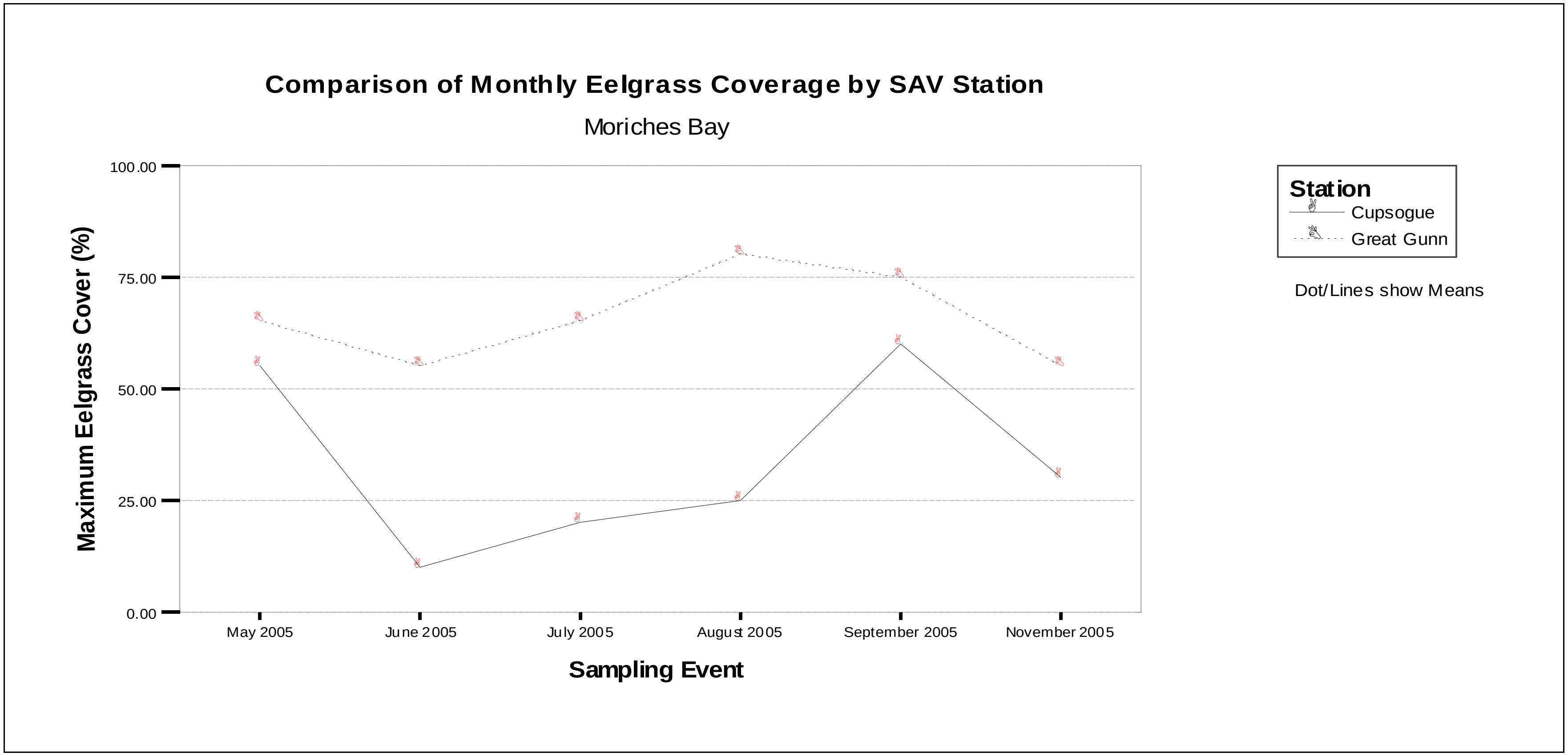


Figure 21. Maximum eelgrass coverage for both MOR stations during the 2005 SAV Survey.

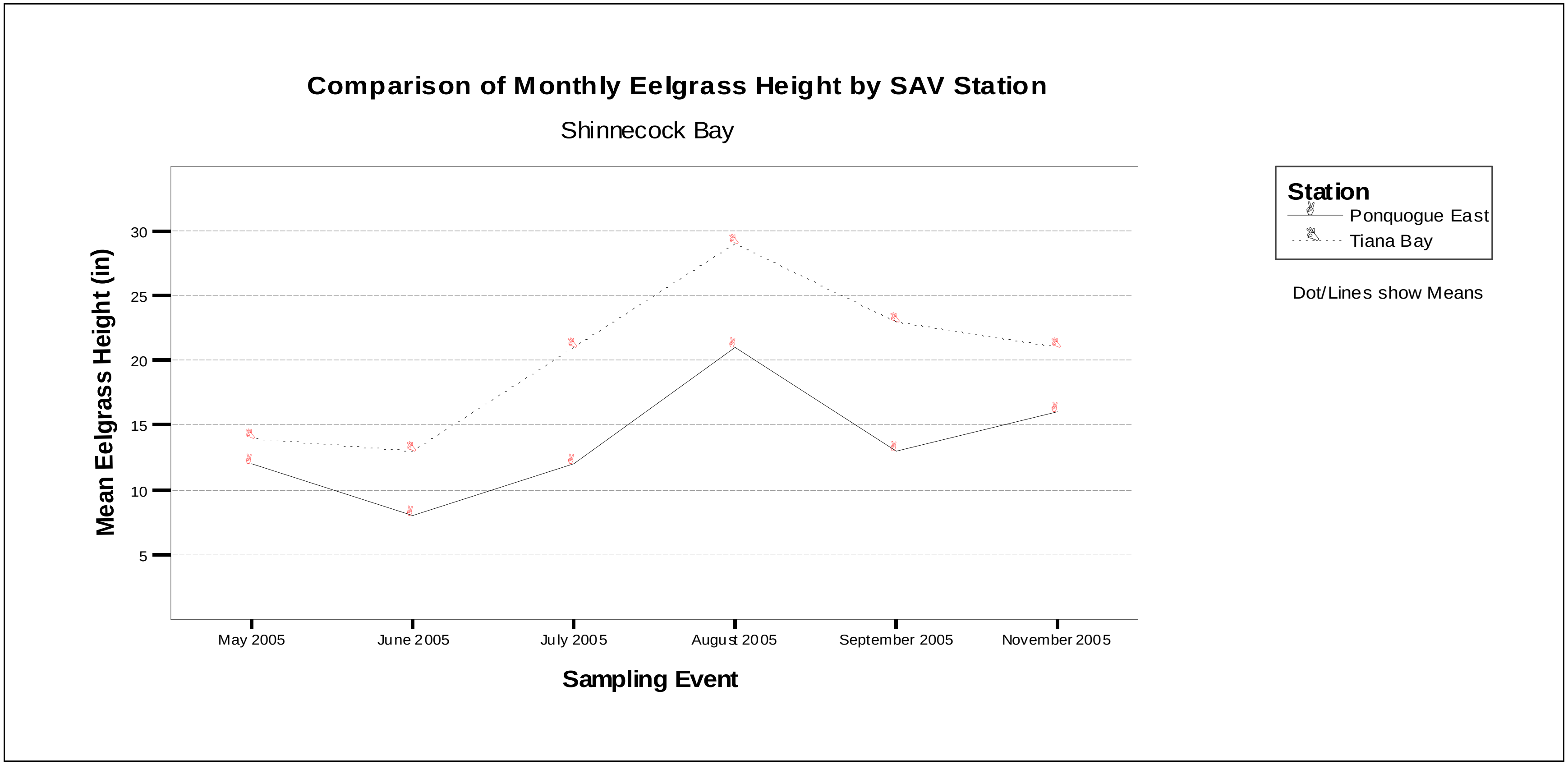


Figure 22. Average eelgrass heights for both SH stations during the 2005 SAV Survey.

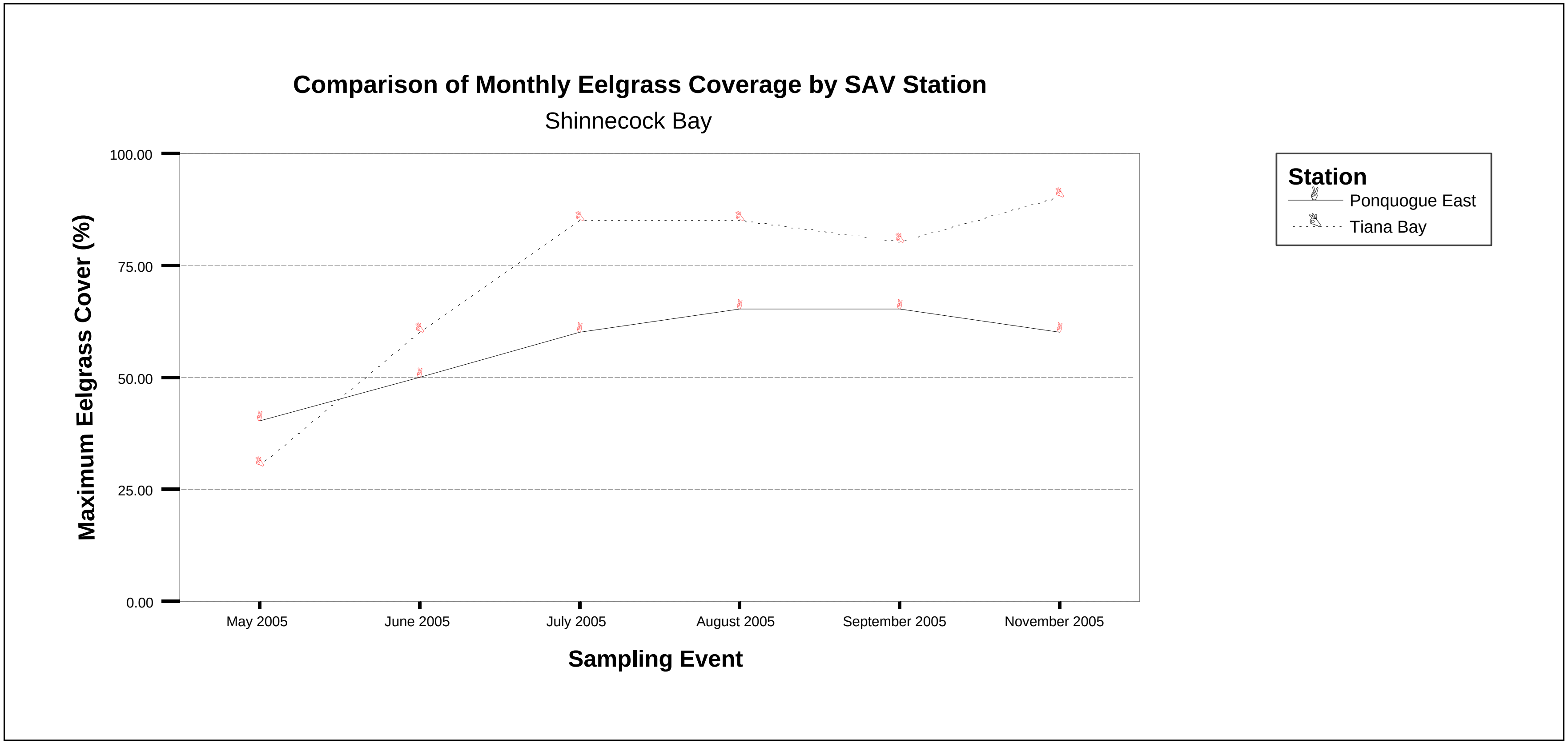


Figure 23. Maximum eelgrass coverage for both SH stations during the 2005 SAV Survey.

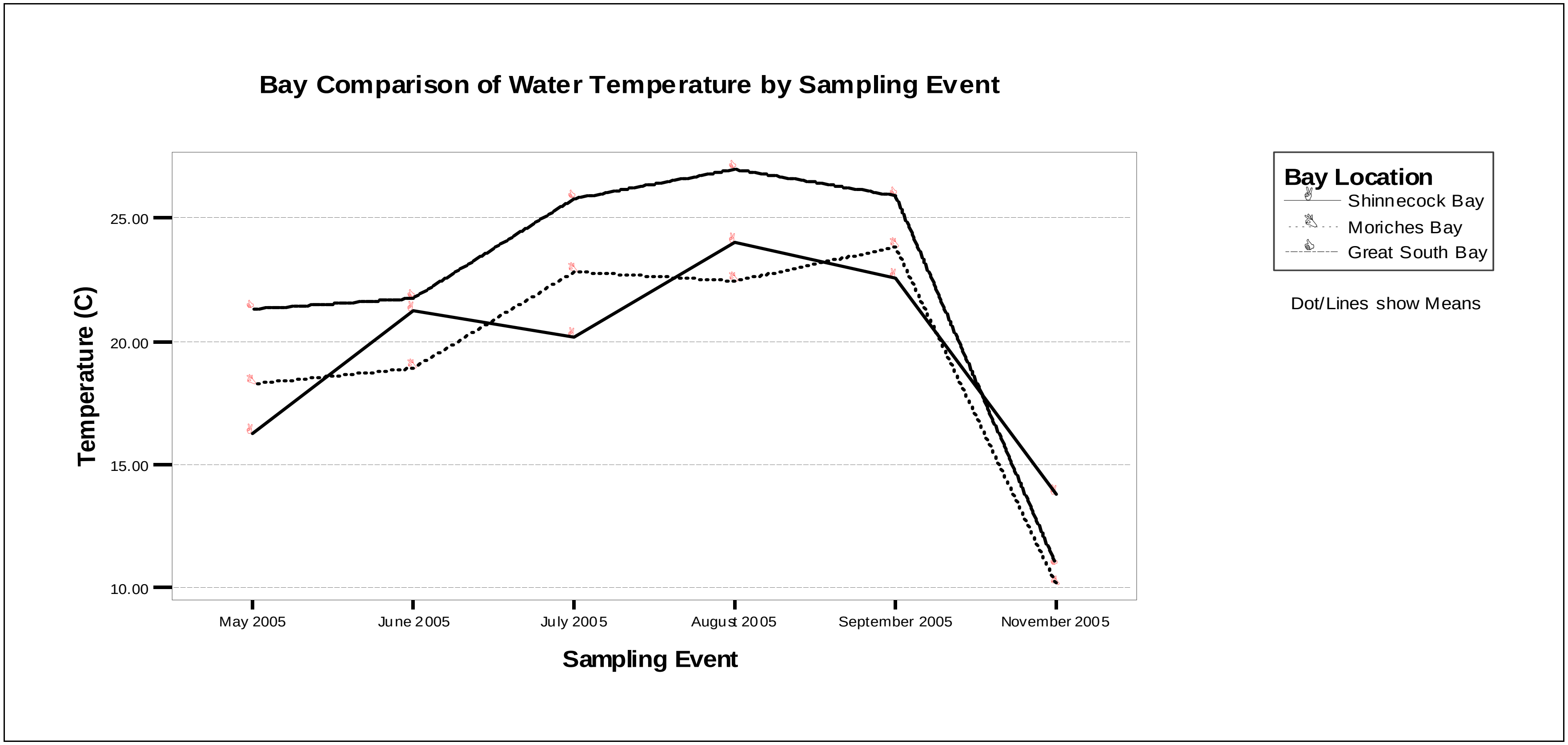


Figure 24. Temperature measurements for each bay sampled during the 2005 SAV Survey.

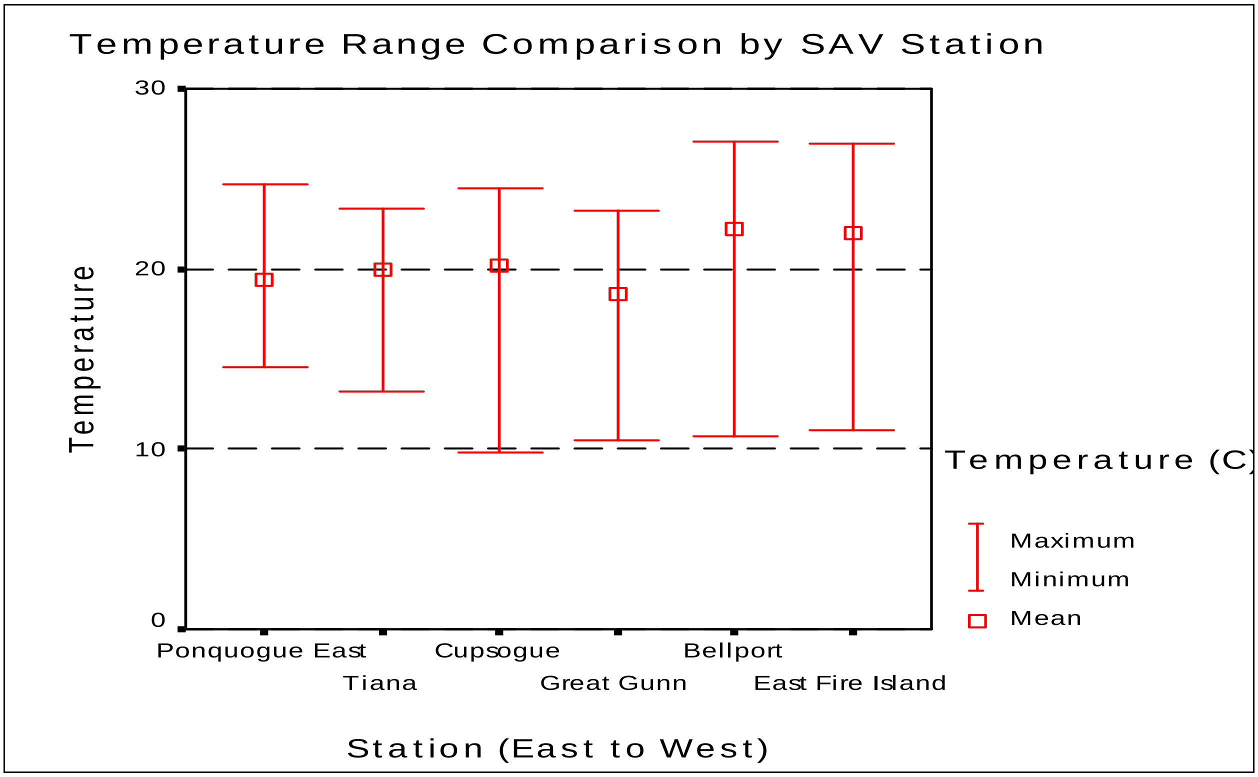


Figure 25. Temperature means and ranges for each SAV station sampled during the 2005 SAV Survey.

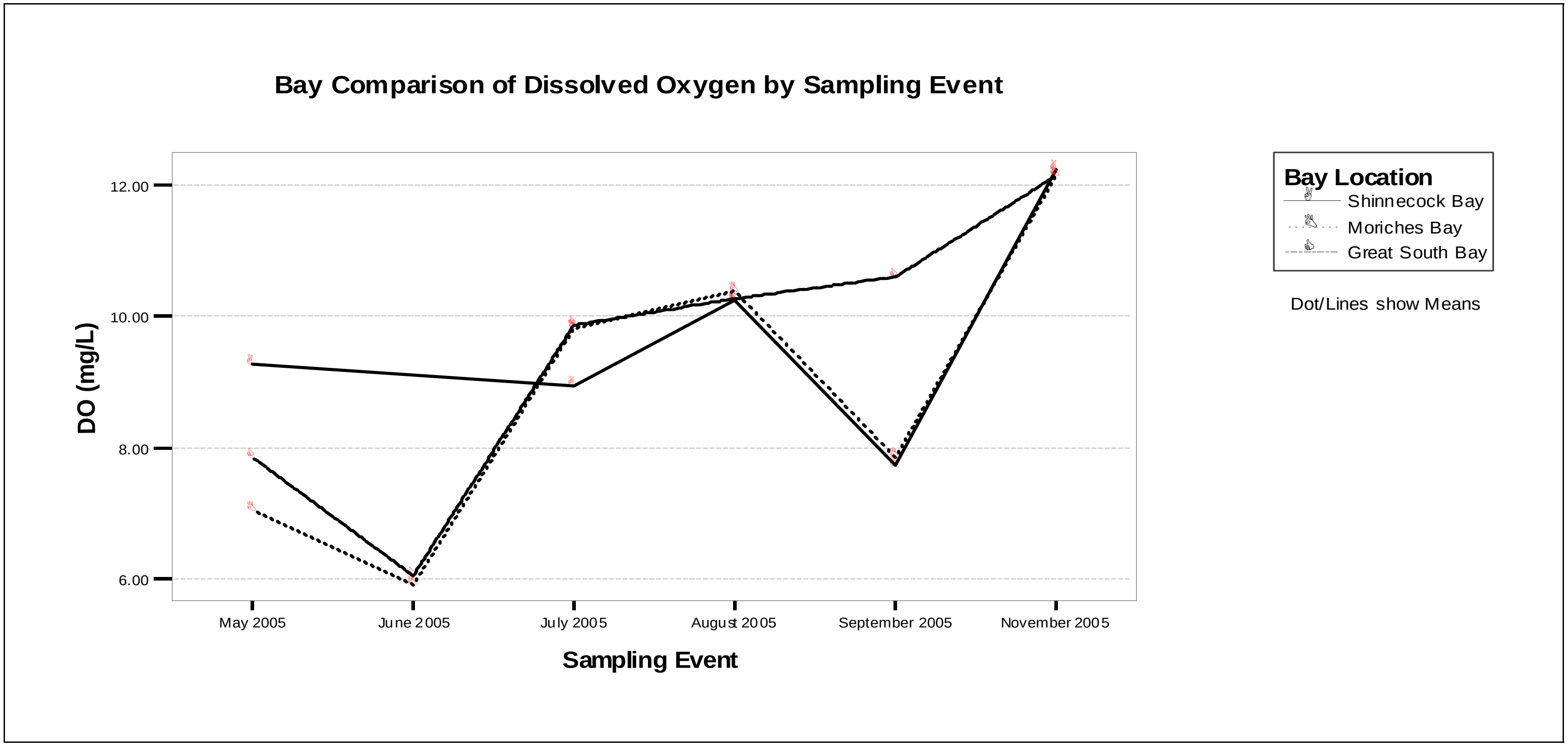


Figure 26. Dissolved Oxygen measures for each bay sampled during the 2005 SAV Survey.

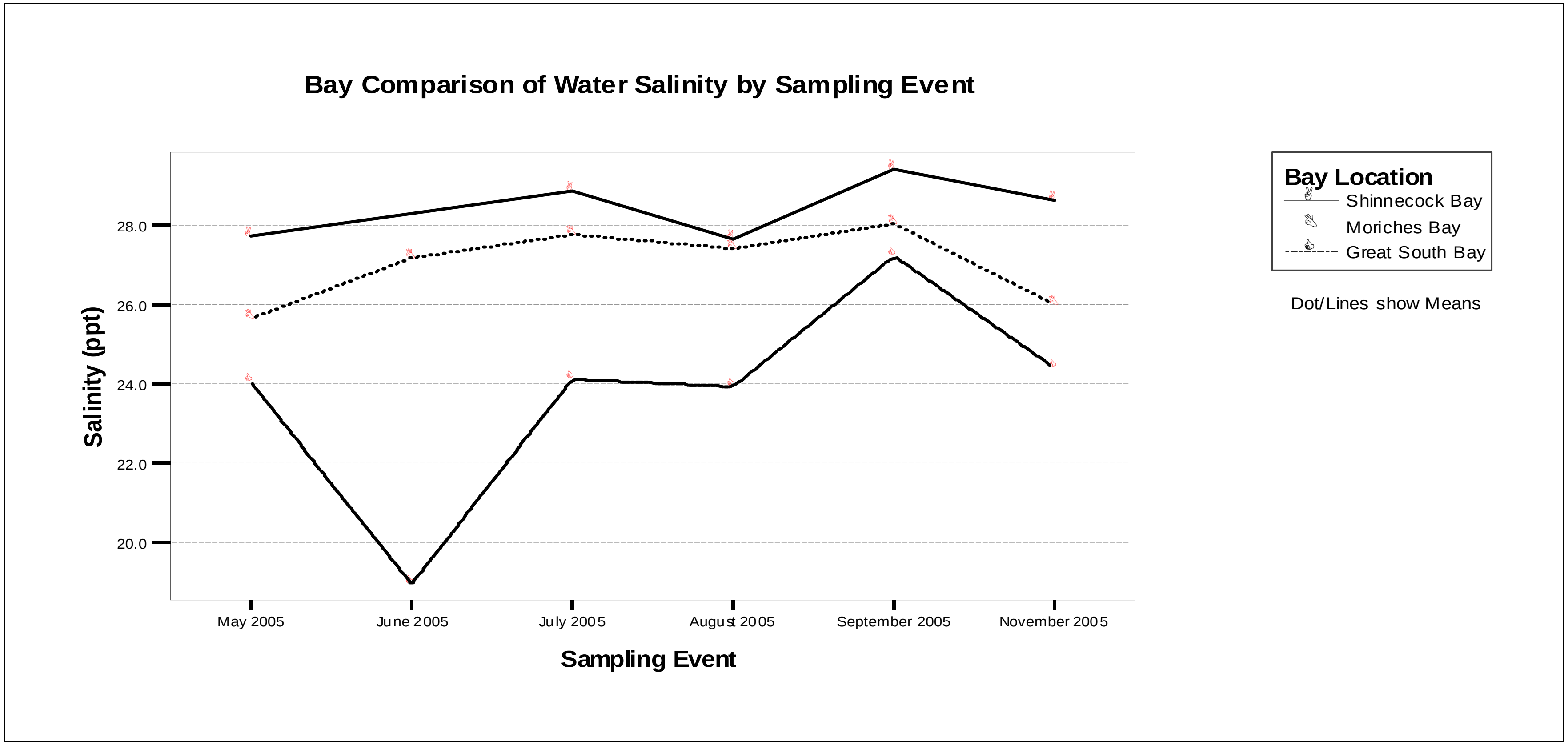


Figure 27. Salinity measures for each bay sampled during the 2005 SAV Survey.

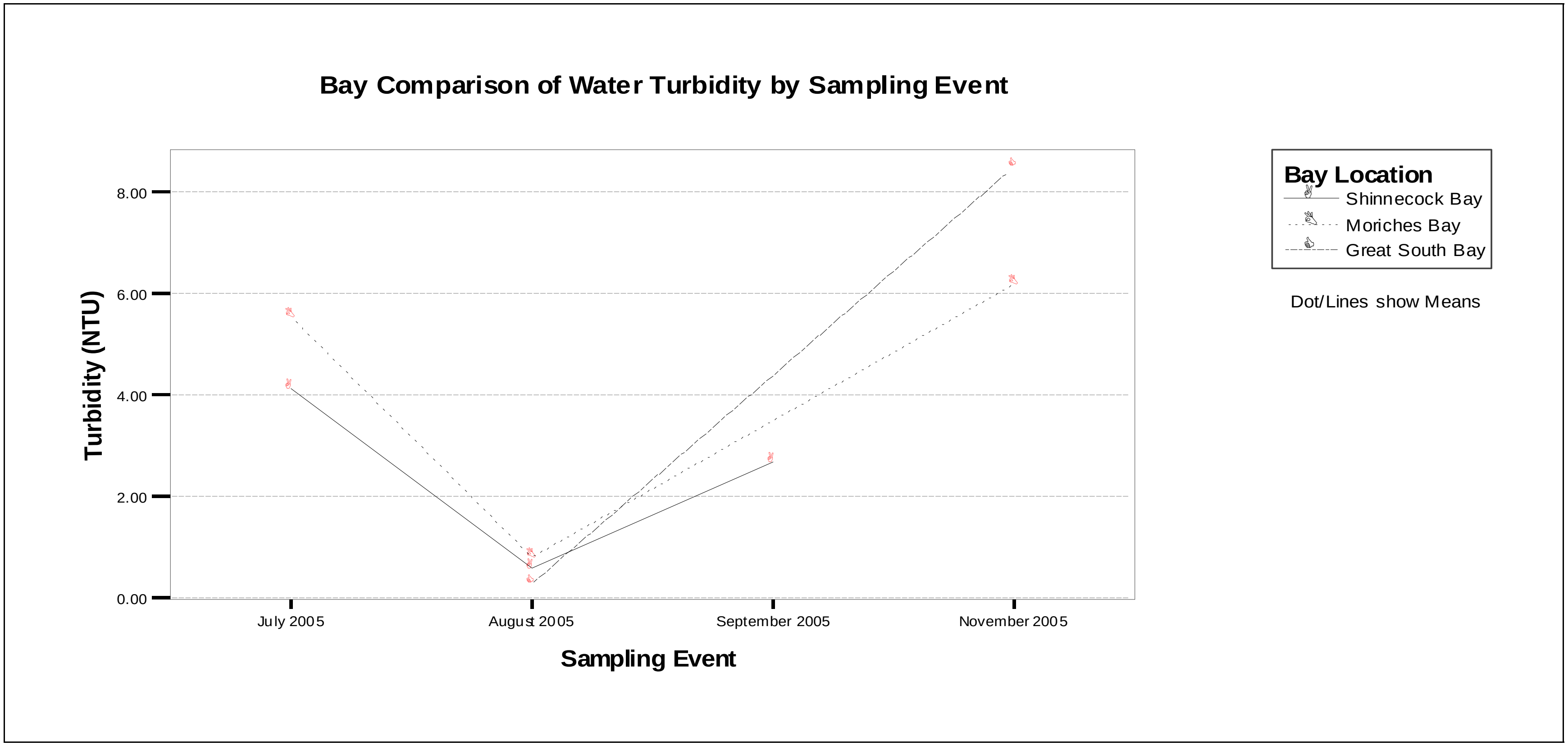


Figure 28. Turbidity measures for each bay sampled during the 2005 SAV Survey.

Appendix B

Tables

Appendix B, Table 1
Coordinate Locations for 2004 and 2005 SAV Sampling Activities

SITE	X_COORD	Y_COORD
Ponquogue East	1411335.42065	254486.27904
Tiana	1395055.38515	248618.50597
Cupsogue	1349122.04373	229797.24738
Great Gunn	1322025.28244	221406.95247
Bellport	1284196.22760	205691.34737
East Fire Island	1214037.20117	180875.30965

State Plane NAD83 New York Long Island Zone Feet

APPENDIX B, TABLE 2
Abundance of Finfish per Month (2005 data)

Scientific Name	MAY	JUNE	JULY	AUG.	SEP.	NOV.	*SPECIES TOTALS*	*PERCENT of TOTAL*
Alosa pseudoharengus		3					***3***	***0.06***
Anchoa mitchilli			774	1	1		***776***	***16.54***
Anguilla rostrata		2			2		***4***	***0.09***
Apeltes quadracus	91	43	100	2	12	5	***253***	***5.39***
Balistidae			1		1		***2***	***0.04***
Brevoortia tyrannus					4		***4***	***0.09***
Caranx hippos				1			***1***	***0.02***
Chaetodon sedentarius				1	4		***5***	***0.11***
Chilomycterus schoepfi			1	2			***3***	***0.06***
Clupeidae	12		19				***31***	***0.66***
Cynoscion regalis			1	2	3		***6***	***0.13***
Etropus microstomus		7					***7***	***0.15***
Fistularia tabacaria				3	5		***8***	***0.17***
Fundulus heteroclitus	1	8	5			2	***16***	***0.34***
Fundulus majalis	1						***1***	***0.02***
Leiostomus xanthurus			1				***1***	***0.02***
Menidia menidia	69	392	21	193	518	27	***1,220***	***26.01***
Microgadus tomcod	316	144	94	2	6		***562***	***11.98***
Micropogonias undulatus			7				***7***	***0.15***
Morone saxatilis			1				***1***	***0.02***
Mullidae			1				***1***	***0.02***
Myoxocephalus aenaeus	25	63	72	2	62	3	***227***	***4.84***
Opsanus tau	2	1	1		3		***7***	***0.15***
Ostraciidae				1	6		***7***	***0.15***
Paralichthys dentatus			1				***1***	***0.02***
Pollachius virens	83	97					***180***	***3.84***
Pomatomus saltatrix		5	37	3	5		***50***	***1.07***
Prionotus evolans				1			***1***	***0.02***
Pseudopleuronectes americanus	14	23	50	9	11		***107***	***2.28***
Selene vomer				1			***1***	***0.02***
Serranidae			2		1		***3***	***0.06***

APPENDIX B, TABLE 2
Abundance of Finfish per Month (2005 data)

Scientific Name	MAY	JUNE	JULY	AUG.	SEP.	NOV.	*SPECIES TOTALS*	*PERCENT of TOTAL*
Sphoeroides maculatus			44	6	51		***101***	***2.15***
Sphyraena borealis			1	28	28		***57***	***1.22***
Stenotomus chrysops					1		***1***	***0.02***
Strongylura marina		2					***2***	***0.04***
Sygnathus fuscus	36	23	38	28	65	30	***220***	***4.69***
Tautoga onitis	9	10	14	3	87	2	***125***	***2.66***
Tautogolabrus adspersus	9	6	10	26	603		***654***	***13.94***
Upeneus parvus				2	1		***3***	***0.06***
Urophycis chuss		12	3				***15***	***0.32***
Urophycis regia	6	11					***17***	***0.36***
Monthly Total Abundances	***674***	***852***	***1,299***	***317***	***1,480***	***69***	***4,691***	***100.00***
Total Number Species	***14***	***18***	***25***	***21***	***23***	***6***	***41***	

APPENDIX B, TABLE 3

Weight of Finfish per Month (2005 data)

Scientific Name	2005						SPECIES	PERCENT
	MAY	JUNE	JULY	AUG.	SEP.	NOV.	TOTALS	of TOTAL
Alosa pseudoharengus		2.0					***2.0***	***0.01***
Anchoa mitchilli			2,967.0	1.0	1.0		***2,969.0***	***12.30***
Anguilla rostrata		65.0					***65.0***	***0.27***
Apeltes quadracus	225.0	74.0	126.2	2.0	41.0	29.0	***497.2***	***2.06***
Balistidae			1.0				***1.0***	***0.00***
Brevoortia tyrannus					17.0		***17.0***	***0.07***
Caranx hippos				2.0			***2.0***	***0.01***
Chaetodon sedentarius				1.0	3.0		***4.0***	***0.02***
Chilomycterus schoepfi			1.0	66.0			***67.0***	***0.28***
Clupeidae	37.0		30.0				***67.0***	***0.28***
Cynoscion regalis			1.0	85.0	90.0		***176.0***	***0.73***
Etropus microstomus		10.0					***10.0***	***0.04***
Fistularia tabacaria				7.0			***7.0***	***0.03***
Fundulus heteroclitus	1.0	50.0	25.0			10.0	***86.0***	***0.36***
Fundulus majalis	4.0						***4.0***	***0.02***
Leiostomus xanthurus			n/a					
Menidia menidia	426.0	854.3	134.0	733.3	1,504.7	140.0	***3,792.3***	***15.72***
Microgadus tomcod	803.3	384.5	469.4	8.0	56.0		***1,721.2***	***7.13***
Micropogonias undulatus			29.0				***29.0***	***0.12***
Morone saxatilis			21.0				***21.0***	***0.09***
Mullidae			2.0				***2.0***	***0.01***
Myoxocephalus aenaeus	251.0	484.3	150.7	3.0	103.3	32.0	***1,024.3***	***4.25***
Opsanus tau	8.0	15.0	6.0		100.0		***129.0***	***0.53***
Ostraciidae				1.0	7.5		***8.5***	***0.04***
Paralichthys dentatus			116.0				***116.0***	***0.48***
Pollachius virens	275.0	371.8					***646.8***	***2.68***
Pomatomus saltatrix		11.0	264.7	105.0	358.0		***738.7***	***3.06***
Prionotus evolans				2.0			***2.0***	***0.01***
Pseudopleuronectes americanus	761.0	300.0	179.0	29.0	36.0		***1,305.0***	***5.41***
Selene vomer				1.0			***1.0***	***0.00***
Serranidae			1.5		12.0		***13.5***	***0.06***
Sphoeroides maculatus			72.0	68.0	2,285.0		***2,425.0***	***10.05***
Sphyraena borealis			1.5	343.0	748.0		***1,092.5***	***4.53***
Stenotomus chrysops					1.0		***1.0***	***0.00***
Strongylura marina		4.0					***4.0***	***0.02***
Sygnathus fuscus	118.0	99.0	118.0	67.0	336.0	85.0	***823.0***	***3.41***
Tautoga onitis	111.5	477.0	528.0	10.0	838.3	35.0	***1,999.8***	***8.29***
Tautogolabrus adspersus	80.0	64.0	71.0	84.0	3,754.7		***4,053.7***	***16.80***
Upeneus parvus				40.0	12.0		***52.0***	***0.22***
Urophycis chuss		69.0	14.0				***83.0***	***0.34***
Urophycis regia	12.0	60.0					***72.0***	***0.30***
Monthly Total Weight (g)	***3,112.8***	***3,395.0***	***5,328.9***	***1,658.3***	***10,304.5***	***331.0***	***24,130.5***	***100.00***

n/a = not available
Weight measured in grams

APPENDIX B, TABLE 4

Estimate of Average Number of Individuals per Tow (2004 data)		GREAT SOUTH BAY		MORICHES BAY		SHINNECOCK BAY		SUMMARY		
Scientific Name	**Common Name**	**East Fire**	**Bellport**	**Great Gunn**	**Cupsogue**	**Tiana**	**Ponquogue**	**Abundance**	**% of Catch**	**Site Occurrence**
Finfish										
Anguilla rostrata	American Eel	1		1				**2**	**0.64**	**2**
Apeltes quadracus	Fourspine Stickleback			4	1	2	1	**8**	**2.57**	**4**
Epinephelus nigritus	Warsaw Grouper						1	**1**	**0.32**	**1**
Fundulus heteroclitus	Mummichog	2			1			**3**	**0.96**	**2**
Fundulus majalis	Striped Killifish			1	1			**2**	**0.64**	**2**
Gasterosteus aculeatus	Threespine Stickleback		1					**1**	**0.32**	**1**
Hippocampus erectus	Lined Seahorse					1		**1**	**0.32**	**1**
Synodontidae	Lizardfish				1		4	**5**	**1.61**	**2**
Menidia menidia	Atlantic Silverside	1	1	2	10	1	1	**16**	**5.14**	**6**
Microgadus tomcod	Atlantic Tomcod			10		3	1	**14**	**4.50**	**3**
Mullus auratus	Red Goatfish						1	**1**	**0.32**	**1**
Myoxocephalus aenaeus	Grubby			5		2	3	**10**	**3.2**	**3**
Sphyraena borealis	Northern sennett					1		**1**	**0.3**	**1**
Opsanus tau	Oyster Toadfish	1						**1**	**0.3**	**1**
Pomatomus saltatrix	Bluefish		5				1	**6**	**1.9**	**2**
Pseudopleuronectes americanus	Winter Flounder	10		8	4	10	20	**52**	**16.7**	**5**
Icelus bicornis	Sculpin - 2-horned		2				5	**7**	**2.3**	**2**
Sphoeroides maculatus	Northern Puffer	7	5	1		5		**18**	**5.8**	**4**
Sphoeroides spengleri	Bandtail Puffer			1				**1**	**0.3**	**1**
Morone saxatilis	Striped Bass		1					**1**	**0.3**	**1**
Leiostomus xanthurus	Spot				1			**1**	**0.3**	**1**
Syngnathus fuscus	Northern Pipefish	20		5	3	5	5	**38**	**12.2**	**5**
Tautoga onitis	Blackfish/Tautog	1		3	5	50	15	**74**	**23.8**	**5**
Tautogolabrus adspersus	Cunner	2				20	25	**47**	**15.1**	**3**
Invertebrates										
Asterias forbesi	Common Sea Star			2				**2**	**0.2**	**1**
Busycon carica Egg Cases	Knobbed Whelk				1			**1**	**0.1**	**1**
Callinectes sapidus	Blue Crab	10	40		2	5		**57**	**6.7**	**4**
Cancer irroratus	Rock Crab	2						**2**	**0.2**	**1**
Carcinus maenas	Green Crab	40		30	1	2	20	**93**	**11.0**	**5**
Crangon septemspinosa	Sevenspine Bay Shrimp		20			1		**21**	**2.5**	**2**
Ctenophora	Comb jellies	5	70	30	100	2	5	**212**	**25.1**	**6**
Cyanea capillata	Lion's Mane Jellyfish		1					**1**	**0.1**	**1**
Dyspanopeus sayi	Say Mud Crab			1		2		**3**	**0.4**	**2**
Panopeus herbstii	Mud Crab	2		2				**4**	**0.5**	**2**
Hippolyte zostericola	Zoster Shrimp	50		2	1			**53**	**6.3**	**3**
Isopods	Isopods			2				**2**	**0.2**	**1**
Libinia emarginata	Portly Spider Crab					3		**3**	**0.4**	**1**
Limulus polyphemus	Horseshoe Crab				2			**2**	**0.2**	**1**
Mercenaria mercenaria	Hard Clam	3	14	4	26		10	**57**	**6.7**	**5**
Mytilus edulis	Blue Mussel			10				**10**	**1.2**	**1**
Ovalipes ocellatus	Lady Crab		2			1	3	**6**	**0.7**	**3**
Pagurus spp.	Hermit Crab Species			2	1	1		**4**	**0.5**	**3**
Palaemonetes vulgaris	Grass Shrimp	20	10	30	150	100	1	**311**	**36.8**	**6**
Tunicates	Tunicates	1	1					**2**		**2**
Eelgrass										
Zostera marina	Eelgrass (% cover)	80	30	75	25	80	70			
	TOTAL									
	Estimated Finfish Count	**45**	**15**	**41**	**27**	**100**	**83**	**311**		
	Estimated Invertebrate Count	**133**	**158**	**115**	**284**	**117**	**39**	**846**		
	Finfish Biodiversity	**9**	**6**	**11**	**9**	**11**	**13**	**24**		
	Invertebrate Biodiversity	**9**	**8**	**11**	**9**	**9**	**5**	**20**		

APPENDIX B, TABLE 5
Total Number of Finfish per Station (2005 data)

	GREAT SOUTH BAY		MORICHES BAY		SHINNECOCK BAY		SUMMARY	
Scientific Name	**East Fire Island**	**Bellport**	**Great Gunn**	**Cupsogue**	**Tiana**	**Ponquogue East**	***Species Totals***	***Percent of Total***
Alosa pseudoharengus				3			***3***	***0.06***
Anchoa mitchilli				776			***776***	***16.54***
Anguilla rostrata		2				2	***4***	***0.09***
Apeltes quadracus	41	19	127	10	42	14	***253***	***5.39***
Balistidae						2	***2***	***0.04***
Brevoortia tyrannus			4				***4***	***0.09***
Caranx hippos						1	***1***	***0.02***
Chaetodon sedentarius						5	***5***	***0.11***
Chilomycterus schoepfi		3					***3***	***0.06***
Clupeidae	21		9	1			***31***	***0.66***
Cynoscion regalis	1	3		2			***6***	***0.13***
Etropus microstomus			2	5			***7***	***0.15***
Fistularia tabacaria					7	1	***8***	***0.17***
Fundulus heteroclitus	1	12	3				***16***	***0.34***
Fundulus majalis						1	***1***	***0.02***
Leiostomus xanthurus					1		***1***	***0.02***
Menidia menidia	171	220	183	535	38	73	***1,220***	***26.01***
Microgadus tomcod		4	112	3	363	80	***562***	***11.98***
Micropogonias undulatus	3			4			***7***	***0.15***
Morone saxatilis			1				***1***	***0.02***
Mullidae						1	***1***	***0.02***
Myoxocephalus aenaeus	1		65		4	157	***227***	***4.84***
Opsanus tau	5	2					***7***	***0.15***
Ostraciidae				3	3	1	***7***	***0.15***
Paralichthys dentatus						1	***1***	***0.02***
Pollachius virens					48	132	***180***	***3.84***
Pomatomus saltatrix		3	1	7	38	1	***50***	***1.07***
Prionotus evolans						1	***1***	***0.02***
Pseudopleuronectes americanus	5		36	5	14	47	***107***	***2.28***
Selene vomer						1	***1***	***0.02***
Serranidae			1			2	***3***	***0.06***
Sphoeroides maculatus	73	3		7	6	12	***101***	***2.15***
Sphyraena borealis		4	7	2	27	17	***57***	***1.22***
Stenotomus chrysops					1		***1***	***0.02***
Strongylura marina		2					***2***	***0.04***
Sygnathus fuscus	31	22	45	33	60	29	***220***	***4.69***
Tautoga onitis	2	1	24	4	47	47	***125***	***2.66***
Tautogolabrus adspersus			132		213	309	***654***	***13.94***
Upeneus parvus						3	***3***	***0.06***
Urophycis chuss						15	***15***	***0.32***
Urophycis regia						17	***17***	***0.36***
Station Total Abundances	***355***	***300***	***752***	***1,400***	***912***	***972***	***4,691***	***100.00***
Total Number of Species	***12***	***14***	***16***	***16***	***16***	***27***	***41***	

APPENDIX B, TABLE 6
Total Weight of Finfish per Station (2005 data)

Scientific Name	GREAT SOUTH BAY East Fire Island	GREAT SOUTH BAY Bellport	MORICHES BAY Great Gunn	MORICHES BAY Cupsogue	SHINNECOCK BAY Tiana	SHINNECOCK BAY Ponquogue East	SUMMARY *Species Totals*	SUMMARY *Percent of Total*
Alosa pseudoharengus				2			***2***	***0.01***
Anchoa mitchilli				2,969			***2,969***	***12.30***
Anguilla rostrata		65					***65***	***0.27***
Apeltes quadracus	90	29	263	13	79	24	***497***	***2.06***
Balistidae						1	***1***	***0.00***
Brevoortia tyrannus			17				***17***	***0.07***
Caranx hippos						2	***2***	***0.01***
Chaetodon sedentarius						4	***4***	***0.02***
Chilomycterus schoepfi		67					***67***	***0.28***
Clupeidae	33		30	4			***67***	***0.28***
Cynoscion regalis	30	61		85			***176***	***0.73***
Etropus microstomus			1	9			***10***	***0.04***
Fistularia tabacaria					7		***7***	***0.03***
Fundulus heteroclitus	4	62	20				***86***	***0.36***
Fundulus majalis						4	***4***	***0.02***
Leiostomus xanthurus					n/a			
Menidia menidia	633	267	849	1,607	166	270	***3,792***	***15.72***
Microgadus tomcod		10	491	21	916	283	***1,721***	***7.13***
Micropogonias undulatus	6			23			***29***	***0.12***
Morone saxatilis			21				***21***	***0.09***
Mullidae						2	***2***	***0.01***
Myoxocephalus aenaeus	1		274		28	721	***1,024***	***4.25***
Opsanus tau	121	8					***129***	***0.53***
Ostraciidae				3	5	1	***9***	***0.04***
Paralichthys dentatus						116	***116***	***0.48***
Pollachius virens					160	487	***647***	***2.68***
Pomatomus saltatrix		310	40	144	237	8	***739***	***3.06***
Prionotus evolans						2	***2***	***0.01***
Pseudopleuronectes americanus	240		767	20	46	232	***1,305***	***5.41***
Selene vomer						1	***1***	***0.00***
Serranidae			1			13	***14***	***0.06***
Sphoeroides maculatus	1,785	42		253	42	303	***2,425***	***10.05***
Sphyraena borealis		160	165	43	525	200	***1,093***	***4.53***
Stenotomus chrysops					1		***1***	***0.00***
Strongylura marina		4					***4***	***0.02***
Sygnathus fuscus	153	264	104	69	151	82	***823***	***3.41***
Tautoga onitis	35	30	609	53	867	406	***2,000***	***8.29***
Tautogolabrus adspersus			542		1,446	2,066	***4,054***	***16.80***
Upeneus parvus						52	***52***	***0.22***
Urophycis chuss						83	***83***	***0.34***
Urophycis regia						72	***72***	***0.30***
Total Weight by Station	***3,131***	***1,379***	***4,193***	***5,318***	***4,675***	***5,434***	***24,130***	***100***

n/a = not available
weight measured in grams

APPENDIX B, TABLE 7

Abundance of Invertebrates per Month (2005 data)

	May		June		July		August		September		November		*Monthly*	*Percent*
Scientific Name	**Count**	**Rank**	**Count**	**Rank**	**Count**	**Rank**	**Count**	**Rank**	**Count**	**Rank**	**Count**	**Rank**	***Totals****	***of Total****
Amphipoda			1	1									***1***	***0.07***
Argopecten irradians									1	1			***1***	***0.07***
Asterias forbesi	10	1	45	1	28	1	6	1	1	1	1	1	***91***	***6.00***
Aurelia aurita	1	1	2	1						1			***3***	***0.20***
Callinectes sapidus			16	1	10	1	9	1	62	1	5	1	***102***	***6.72***
Cancer irroratus			1	1	9	1					2	1	***12***	***0.79***
Carcinus maenas	37	1	334	2	160	2	18	1	111	2	10	1	***670***	***44.17***
Crangon septemspinosa		2		1		1		1		1	1	1	***1***	***0.07***
Crepidula fornicata			5	1									***5***	***0.33***
Cyanea capillata	11	1	1	1	9	1				1			***21***	***1.38***
Dyspanopeus sayi			10	1	16	1							***26***	***1.71***
Hippolyte pleurocantha											4	1	***4***	***0.26***
Ilyassoma obsoleta				1		1					2	1	***2***	***0.13***
Isopoda			3	1							5	1	***8***	***0.53***
Libinia emarginata	23	1	9	1	9	1	3	1	13	1	52	1	***109***	***7.19***
Limulus polyphemus	19	1	4	1	5	1	1	1	4	1			***33***	***2.18***
Loligo pealei I.							1	1					***1***	***0.07***
Mercenaria mercenaria					36	1	11	1					***47***	***3.10***
Microciona prolifera	2	1						1					***2***	***0.13***
Mnemiopsis leidyi				2		1	1	1		2		1	***1***	***0.07***
Mytilus edulis		2		3		2							***0***	***0.00***
Nereis succinea					2	1							***2***	***0.13***
Ovalipes ocellatus	5	1	7	1	23	1	4	1	2	1	2	1	***43***	***2.83***
Pagurus pollicaris			5	1	2	1			2	1	9	1	***18***	***1.19***
Palaemonetes vulgaris		1		2		1	7	1		1		1	***7***	***0.46***
Panopeus herbstii	7	1	148	2	16	1	1	1	25	1	31	1	***228***	***15.03***
Polychaete spp.			1	1									***1***	***0.07***
Porifera (gold spp.)											16	1	***16***	***1.05***
Porifera (orange spp.)											56	1	***56***	***3.69***
Porifera (additional spp.)	2	1											***2***	***0.13***
Tunicata						1	2	1		1		2	***2***	***0.13***
Uca minax			2	1									***2***	***0.13***
Monthly Total Abundances	***117***		***594***		***325***		***64***		***221***		***196***		***1,517***	**100**
Total Number of Species		***13***		***22***		***19***		***14***		***15***		***17***		

Refer to SAV Seine Survey Methodology section of text for explanation of Present and Rank Values.
*Montly Totals and Percent of Total only reflect species that were counted and does not include rank data.

APPENDIX B, TABLE 8

Total Number of Invertebrates per Station (2005 data)

	GREAT SOUTH BAY				MORICHES BAY				SHINNECOCK BAY				SUMMARY	
	East Fire		Bellport		Great Gunn		Cupsogue		Tiana		Ponquogue		Species	Highest
Scientific Name	Count	Rank	Count	Rank	Count	Rank	Count	Rank	Count	Rank	Count	Rank	Totals*	Rank
Amphipoda			1	1									1	1
Argopecten irradians	1	1											1	1
Asterias forbesi					38	1			3	1	50	1	91	1
Aurelia aurita	1	1		1		1	2	1					3	1
Callinectes sapidus	12	1	59	1	3	1	2	1	25	1	1	1	102	2
Cancer irroratus	1	1					1	1	1	1	9	1	12	1
Carcinus maenas	2	1	1	1	321	2	8	1	87	1	251	2	670	2
Crangon septemspinosa		1		1		1		1			1	1	1	1
Crepidula fornicata									5	1			5	1
Cyanea capillata	11	1		1							10	1	21	1
Dyspanopeus sayi	22	1			1	1	1	1	2	1			26	1
Hippolyte pleurocantha		1		1	3	1			1	1			4	1
Ilyassoma obsoleta				2		1					2	1	2	1
Isopoda	3	1		1	3	1	1	1					7	1
Libinia emarginata	33	1	15	1	5	1			7	1	49	1	109	2
Limulus polyphemus					17	1	3	1	7	1	6	1	33	1
Loligo pealei I.									1	1			1	1
Mercenaria mercenaria	47	1											47	1
Microciona prolifera	24	1											24	1
Mnemiopsis leidyi		1		1	1	1		1		2		2	1	2
Mytilus edulis		1		1		3				2		2	0	3
Nereis succinea	2	1											2	1
Ovalipes ocellatus	10	1	1	1	9	1	9	1			14	1	43	1
Pagurus pollicaris					5	1			4	1	9	1	18	1
Palaemonetes vulgaris		1		1	1	1		1	5	1	1	1	7	1
Panopeus herbstii	143	2	15	1	5	1	8	1	44	1	13	1	228	2
Polychaete spp.			1	1									1	1
Porifera (gold spp.)	16	1											16	1
Porifera (orange spp.)	2	1	32	1									34	1
Porifera (additional spp.)	2	1											2	1
Tunicata	2	1		1			1	1					3	1
Uca minax											2	1	2	1
Station Totals*	***334***		***125***		***412***		***36***		***192***		***418***		***1,517***	
Total # of Species at each Station		***23***		***18***		***17***		***13***		***15***		***16***	***32***	

Refer to SAV Seine Survey Methodology section of text for explanation of Present and Rank Values.
*Species Totals reflect only species that were counted at each station and does not include rank data.

APPENDIX B, TABLE 9
Mean Eelgrass Height and Density by Month per Station (2005 data)

Great South Bay

Station	Month	Height (in)	Density (%)
East Fire Island	May	12.0	**50.0**
	June	**13.8**	**95.0**
	July	11.6	70.0
	Aug.	13.0	90.0
	Sep.	**8.0**	75.0
	Nov.	13.2	75.0
Mean		***11.9***	***75.8***

Great South Bay

Station	Month	Height (in)	Density (%)
Bellport	May	**5.8**	**25.0**
	June	10.2	45.0
	July	9.6	35.0
	Aug.	8.0	50.0
	Sep.	8.4	**90.0**
	Nov.	**12.0**	60.0
Mean		***9.0***	***50.8***

Shinnecock Bay

Station	Month	Height (in)	Density (%)
Tiana	May	13.6	**30.0**
	June	**12.6**	60.0
	July	21.2	85.0
	Aug.	**28.8**	85.0
	Sep.	23.2	80.0
	Nov.	20.8	**90.0**
Mean		***20.0***	***71.7***

Shinnecock Bay

Station	Month	Height (in)	Density (%)
Pon-quogue East	May	12.0	**40.0**
	June	**7.8**	50.0
	July	12.0	60.0
	Aug.	**21.0**	**65.0**
	Sep.	12.8	**65.0**
	Nov.	16.0	60.0
Mean		***13.6***	***56.7***

Moriches Bay

Station	Month	Height (in)	Density (%)
Great Gunn	May	11.0	65.0
	June	**10.8**	**55.0**
	July	15.0	65.0
	Aug.	**30.0**	**80.0**
	Sep.	16.8	75.0
	Nov.	14.8	**55.0**
Mean		***16.4***	***65.8***

Moriches Bay

Station	Month	Height (in)	Density (%)
Cup-sogue	May	7.2	55.0
	June	**2.8**	**10.0**
	July	4.0	20.0
	Aug.	15.6	25.0
	Sep.	**16.0**	**60.0**
	Nov.	12.0	30.0
Mean		***9.6***	***33.3***

Bay Averages:

	Height (in)	Density (%)
GSB	**10.5**	**63.3**
MB	**13.0**	**49.6**
SB	**16.8**	**64.2**

Minimum and maximum values are denoted in bold and italics.

APPENDIX B, TABLE 10
Mean Monthly Water Quality Data per Station (2005 data)

Great South Bay

Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
East Fire Island	May	20.69	8.34	25.00	
	June	22.00	**6.60**	**17.30**	
	July	25.23	9.42	25.80	
	Aug.	**26.90**	10.73	24.20	**0.60**
	Sep.	25.88	10.20	**28.90**	
	Nov.	**11.00**	**11.53**	25.50	**6.20**
	Mean	***21.95***	***9.47***	***24.45***	***3.40***

Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
Bellport	May	21.88	7.36	23.10	
	June	21.49	**5.50**	**20.60**	
	July	26.40	10.29	22.40	
	Aug.	**27.05**	9.80	23.60	**0.00**
	Sep.	25.88	11.00	**25.50**	
	Nov.	**10.77**	**12.73**	23.30	**10.80**
	Mean	***22.25***	***9.45***	***23.08***	***5.40***

Moriches Bay

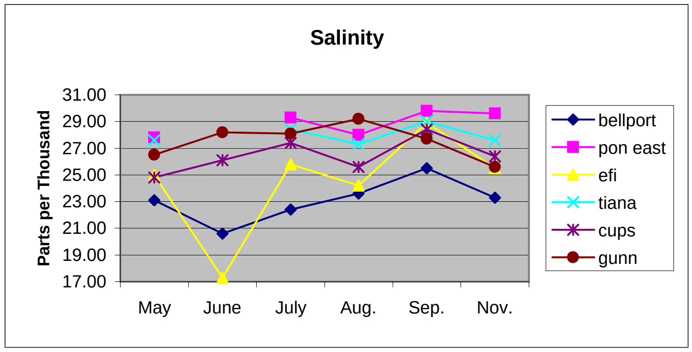
Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
Great Gunn	May	17.24	7.50	26.50	
	June	17.32	**5.97**	28.20	
	July	22.60	10.61	28.10	**9.30**
	Aug.	20.85	10.48	**29.20**	**0.00**
	Sep.	**23.21**	8.10	27.70	
	Nov.	**10.54**	**11.50**	**25.60**	6.20
	Mean	***18.63***	***9.03***	***27.55***	***5.17***

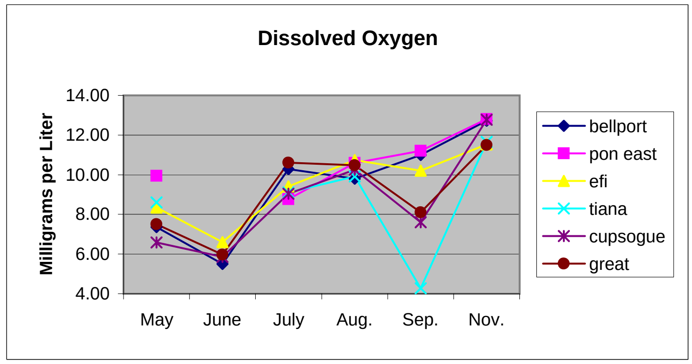
Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
Cup-sogue	May	19.27	6.58	**24.80**	
	June	20.50	**5.86**	26.10	
	July	23.00	9.04	27.40	**1.80**
	Aug.	24.00	10.26	25.60	**1.60**
	Sep.	**24.50**	7.61	**28.40**	
	Nov.	**9.79**	**12.77**	26.40	
	Mean	***20.18***	***8.69***	***26.45***	***1.70***

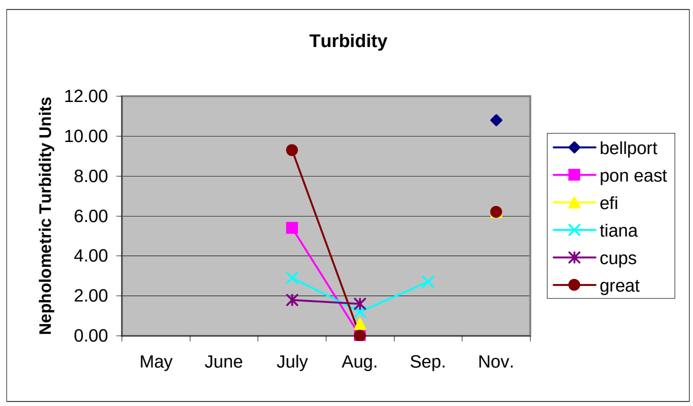
Shinnecock Bay

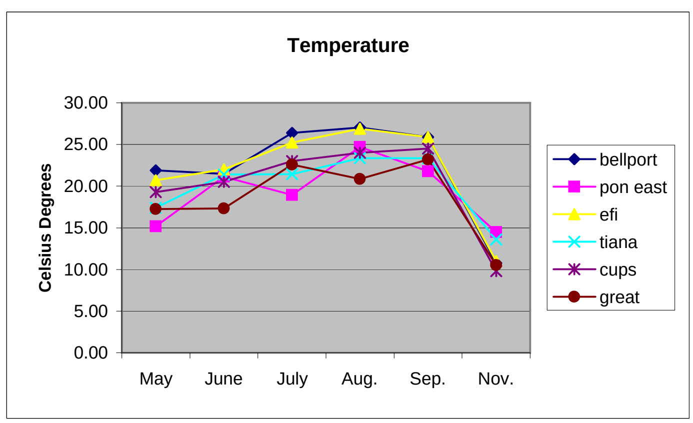
Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
Tiana	May	17.39	8.60	27.60	
	June	21.40			
	July	21.43	9.10	28.40	**2.90**
	Aug.	**23.34**	9.91	**27.30**	**1.20**
	Sep.	**23.34**	**4.27**	**29.00**	2.70
	Nov.	**13.60**	**11.65**	27.60	
	Mean	***20.08***	***8.71***	***27.98***	***2.27***

Station	Month	Temp. (^{0}C)	D.O. (mg/L)	Salinity (ppt)	Turbid. (ntu)
Pon-quogue East	May	15.16	9.94	**27.80**	
	June	21.11			
	July	18.94	**8.76**	29.30	**5.40**
	Aug.	**24.71**	10.59	28.00	**0.00**
	Sep.	21.78	11.20	**29.80**	
	Nov.	**14.50**	**12.80**	29.60	
	Mean	***19.37***	***10.66***	***28.90***	***2.70***









Maximum and minimum values denoted in bold and italics.

APPENDIX B, TABLE 11
SAV Grain Size Distribution per Station (2005 data)

	Sieve Size*							
		Sand						
Sample ID	**Gravel**	**Very Coarse**	**Coarse**	**Medium**	**Fine**	**Very Fine**	**Silt**	**Clay**
East Fire Island	0.92*	1.22	16.59	**51.07**	22.21	6.55	0.58	0.86
Bellport	0.13*	0.80*	10.18	**63.80**	22.01	2.37	0.25	0.46
Great Gunn	1.19*	1.71*	33.20*	**51.93**	10.67	0.82	0.15	0.32
Cupsogue	7.31	10.03	14.36	**51.43**	13.39	1.93	0.33	1.22
Tiana	0.36*	0.86	8.14	**65.45**	21.03	2.43	0.42	1.31
Ponquogue	0.30	1.12	18.29	**62.05**	16.34	1.54	0.10	0.27

* = weights include organic material or shells
All values represent the average percent composition of three samples for each sieve class by sampling station

Note: Gravel = anything larger than 2.0 millimeter (mm) (tray No. 10).
Very Coarse Sand = 1.0 mm (tray No. 18) to 2.0 mm (tray No. 10).
Coarse Sand = 0.5 mm (tray No. 35) to 1.0 mm (tray No. 18)
Medium Sand = 0.25 mm (tray No. 60) to 0.5 mm (tray No. 35).
Fine Sand = 0.1 mm (tray No. 120) to 0.25 mm (tray No. 60).
Very Fine Sand = 0.05 mm (tray No. 230) to 0.1 mm (tray No. 120)
Silt = 0.002 mm to 0.05 milimeter (tray No. 230).
Clay = anything smaller than 0.002 mm or collected in tray.

Appendix C

Species Lists

APPENDIX C TABLE 1
Finfish Species List (2004-2005 Surveys)

Scientific Name	Common Name
Alosa pseudoharengus	Alewife
Anchoa mitchilli	Bay anchovy
Anguilla rostrata	American eel
Apeltes quadracus	Fourspine stickleback
Balistidae	Filefish sp.
Brevoortia tyrannus	Atlantic menhaden
Caranx hippos	Crevalle jack
Chaetodon sedentarius	Spotfin butterfly
Chilomycterus schoepfi	Striped burrfish
Clupeidae	Herring sp.
Cynoscion regalis	Weakfish
Etropus microstomus	Smallmouth flounder
Fistularia tabacaria	Bluespotted cornetfish
Fundulus heteroclitus	Mummichog
Fundulus majalis	Striped killifish
Leiostomus xanthurus	Spot
Menidia menidia	Atlantic silverside
Microgadus tomcod	Atlantic tomcod
Micropogonias undulatus	Atlantic croaker
Morone saxatilis	Striped bass
Mullidae	Goatfish sp.
Myoxocephalus aenaeus	Grubby
Opsanus tau	Oyster toadfish
Ostraciidae	Boxfish sp.
Paralichthys dentatus	Summer flounder
Pollachius virens	Pollock
Pomatomus saltatrix	Bluefish
Prionotus evolans	Striped sea robin
Pseudopleuronectes americanus	Winter flounder
Selene vomer	Lookdown
Serranidae	Grouper sp.
Sphoeroides maculatus	Northern puffer
Sphyraena borealis	Northern sennet
Stenotomus chrysops	Scup
Strongylura marina	Atlantic needlefish
Sygnathus fuscus	Nothern pipefish
Tautoga onitis	Blackfish
Tautogolabrus adspersus	Cunner
Upeneus parvus	Dwarf goatfish
Urophycis chuss	Red hake
Urophycis regia	Spotted hake

Sources: AFS Spec. Pub. 20 (Fifth Ed). Common and Scientific Names of Fishes from the United States and Canada
Robins and Ray. 1986. Peterson Field Guides: A Field Guide to Atlantic Coast Fishes: North America

APPENDIX C TABLE 2
Invertebrate Species List (2004-2005 Surveys)

Scientific Name	Common Name
Amphipoda	Amphipod
Argopecten irradians	Bay scallop
Asterias forbesi	Sea star
Aurelia aurita	Moon jelly
Callinectes sapidus	Blue claw crab
Cancer irroratus	Rock crab
Carcinus maenas	Green crab
Crangon septemspinosa	Sevenspine bay shrimp
Crepidula fornicata	Atlantic slipper snail
Cyanea capillata	Lion's mane
Dyspanopeus sayi	Say mud crab
Hippolyte pleurocantha	Hippolyte shrimp
Ilyassoma obsoleta	Eastern mud snail
Isopoda	Isopod
Libinia emarginata	Spider crab
Limulus polyphemus	Horseshoe crab
Loligo pealei I.	Atlantic squid
Mercenaria mercenaria	Hardshell clam
Microciona prolifera	Red beard sponge
Mnemiopsis leidyi	Comb jelly
Mytilus edulis	Blue mussel
Nereis succinea	Clam worm
Ovalipes ocellatus	Lady crab
Pagurus pollicaris	Hermit crab
Palaemonetes vulgaris	Marsh grass shrimp
Panopeus herbstii	Mud crab
Polychaete spp.	Polychaete
Porifera	Gold sponge spp.
Porifera	Orange sponge spp.
Porifera	Additional sponge spp.
Tunicata	Tunicate
Uca minax	Fiddler crab

Sources: Weiss. 1995. Marine Animals of Southern New England and New York
Gosner. 1978. Peterson Field Guides: Atlantic Seashore
AFS Spec. Pub. 17. 1989.Common and Scientific Names of Aquatic Invertebrates from the Unites States and Canada

Appendix D

Data Form

SAV Station Data Sheet

Station	Date	Time	Tide	Moon

Gear
Seine/Snorkel

Collectors:

Temp. (^{o}c)	D.O.	Salinity	Turbidity	Eelgrass % Cover					Eelgrass Height				

	Total #	Weight(g)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)
Finfishes:												

Invertebrates:	Total Number

Invertebrates:	Rank

Snorkel:	

Notes:

Appendix E

Data