# EXECUTIVE SUMMARY

## IMPINGEMENT MONITORING

Impingement abundance and initial survival sampling at the circulating water intake structure was conducted by diverting timed subsamples of flow from combined fish and trash troughs into fish counting pools. Sampling was scheduled during three 24-hour collection events per week from January through December. A total of 1,560 samples was collected. Sample duration can vary with fish and detritus abundance, and ranged from 1 to 3 minutes, with 61% of the collections in 2003 being two minutes. Individual finfish and blue crabs were collected from the pools by dip net and categorized as "live", "dead", or "damaged". Debris (vegetative matter) was examined for fish and any found were included in the collection. Specimens were sorted by condition category and species, and were counted, weighed and measured. Ancillary parameters, including weight of detritus in the subsampled water volume, pump and screen conditions, tide, weather, water temperature and salinity, were measured during every sampling event.

A total of 52,484 finfish and 1,343 blue crabs were taken in 1,560 samples (total sample time of 2,517 minutes) during 2003. Findings specific to target species include:

- Blueback herring. A total of 409 individuals was taken from 168 of 1,560 samples. There were two periods of abundance, one during April, and another in October; individuals were collected in all months but February of 2003. The proportion of live individuals on an annual basis was 93%.

- Alewife. A total of 85 individuals was taken from 61 of 1,560 samples. Abundance was highest in October; individuals were present during the late winter and early spring, and again in the summer and the fall. The proportion of live individuals on an annual basis was 92%.

- American shad. A total of 113 individuals was taken from 47 of 1,560 samples. Abundance was similarly high in October and November; individuals were also collected in May, August, and December. The proportion of live individuals on an annual basis was 91%.

- Atlantic menhaden. A total of 110 individuals was taken from 55 of 1,560 samples. Abundance was highest in June; individuals were also collected in May, and July through December. The proportion of live individuals on an annual basis was 88%.

- Bay anchovy. A total of 1,573 individuals was taken from 430 of 1,560 samples. Catches were generally high during April through October, with May being the month of peak abundance; individuals were present in the catch during all months but February and March. The proportion of live individuals on an annual basis was 84%.

- Atlantic silversides. A total of 627 individuals was taken from 289 of 1,560 samples. Abundance was similarly high in October, November, and December; individuals were collected in all months of 2003. The proportion of live individuals on an annual basis was 95%.

- White perch. A total of 31,131 individuals was taken from 1,152 of 1,560 samples. The catch was generally high during October through December, with November being the month of peak abundance. A secondary period of abundance occurred in March; individuals were collected in all months of 2003. The proportion of live individuals on an annual basis was 97%.

- Striped bass. A total of 2,811 individuals was taken from 556 of 1,560 samples. Catches were generally high in July through December, with similar peaks in abundance during July and October; individuals were present in the catch in all months but May. The proportion of live individuals on an annual basis was 97%.

- Bluefish. A total of 143 individuals was taken from 101 of 1,560 samples. Abundance was highest in June; individuals were also collected in May and from July through December. The proportion of live individuals on an annual basis was 82%.

- Weakfish. A total of 9,328 individuals was taken from 336 of 1,560 samples. Abundance was highest in July; individuals were also collected in May and June, and from August through November. The proportion of live individuals on an annual basis was 94%.

- Spot. A total of 14 individuals was taken from 11 of 1,560 samples. Abundance was highest in July; individuals were also collected in June and from August through October. The proportion of live individuals on an annual basis was 100%.

- Atlantic croaker. A total of 1,779 individuals was taken from 242 of 1,560 samples. Abundance was highest in January. A second period of abundance occurred in November and December; individuals were also collected in October. The proportion of live individuals on an annual basis was 78%.

## ENTRAINMENT ABUNDANCE

Entrainment abundance sampling was conducted in the Salem Generating Station's circulating water intake structure by pumping river water out of the intake bay of Circulating Water Pumps 12B or 22A into a plankton net having a 0.5-mm mesh. A typical sample filtered 50 $m^3$ of intake water. During the months of January through March and August through December, routine entrainment sampling was scheduled during three 24-hour events per week with seven collections at approximately equal intervals during each event. During the months of April through July, intensive entrainment sampling occurred during four events scheduled each week with 14 samples scheduled at equal intervals during each event. Each event monitored a complete diel period encompassing two tidal cycles. A total of 1,583 out of 1,715 scheduled entrainment abundance samples were collected during 2003. Each concentrated sample was preserved, and the ichthyoplankton identified.

For each species collected, the life stage was determined, the total number counted, and the lengths of a subsample were measured.

During the 2003 Salem Entrainment Abundance Monitoring program, totals of 1,598 fish eggs, 35,736 larvae, 4,394 juveniles, and 118 adults representing at least 26 species were collected in 1,583 entrainment abundance samples, with 77,517 $m^3$ of sample water filtered. Results specific to the target species are discussed in descending order of abundance:

- Bay anchovy - A total of 10,194 bay anchovy was collected in January and April through October, including 1,538 eggs, 7,661 larvae, 928 juveniles and 67 adults. Bay anchovy were most abundant in July, with larvae being the predominant life stage.

- Striped bass - A total of 3,931 striped bass was collected in April through July and September through November, including 31 eggs, 3,279 larvae and 621 juveniles. Striped bass were most abundant in June, with larvae being the predominant life stage.

- Atlantic croaker - A total of 2,033 Atlantic croaker, including 82 larvae and 1,951 juveniles, was collected in January and from September through December. Atlantic croaker was most abundant in November, with juveniles being the predominant life stage.

- *Morone* spp. - A total of 676 *Morone* spp. larvae (<20 mm) was collected during the months of April through July.

- White perch - A total of 341 white perch, including 237 larvae and 104 juveniles, was collected during January through July and in November and December. White perch were most abundant in June and July when larvae and juveniles were the respectively predominant life stages taken.

- Weakfish - A total of 337 weakfish, including one egg, 126 larvae and 210 juveniles, was collected during the months of June through September. Weakfish were most abundant in July, with juveniles being predominant.

- Atlantic menhaden - A total of 157 Atlantic menhaden, including 110 larvae and 47 juveniles, was taken during January, April through July, November and December. The abundance of Atlantic menhaden was highest in November, with larvae being predominant

- Atlantic silverside - A total of 114 Atlantic silversides, including two eggs, 93 larvae, and 19 juveniles, was taken during the months of April through August, October and December. Atlantic silversides were most abundant in June, with larvae being predominant.

- Alewife - A total of 82 alewife, including 81 larvae and one juvenile, was collected during May and June. The abundance of alewife was highest in June with larvae being predominant.

- *Alosa* spp. (blueback herring and/or alewife) - A total of 58 *Alosa* spp., including 57 larvae and one juvenile, was taken during May, June, and July. The abundance was highest in June with larvae being predominant

- Blueback herring - A total of four blueback herring, one larva and three juveniles, was taken during June, October, and November.

- *Menidia* spp. – A total of two *Menidia* spp. larvae was taken in entrainment abundance samples in May,

- Spot - A total of two spot juveniles was taken during in June.

## BAYWIDE TRAWLS

### Bottom Trawl Effort

The 2003 bottom trawl effort was conducted within the Delaware River Estuary, from the mouth of the Delaware Bay to near Trenton (rkm 0-211) at 70 randomly selected stations allocated from sampling Zones 1-14. The number of sampling stations designated within each of the eight sampling zones was allocated using a Neyman allocation procedure based on the proportional area of each zone and historical fisheries data. One daytime bottom trawl event was completed each month from April through November 2003 using a 4.9-m (16-ft) semi-balloon otter trawl. Eight surveys were completed, resulting in the collection of 560 bottom trawls. Target species for this project were alewife, American shad, Atlantic menhaden, blueback herring, bay anchovy, Atlantic silverside, striped bass, white perch, bluefish, Atlantic croaker, spot, weakfish, and blue crab. All finfish and blue crabs were identified to the lowest practicable taxonomic level, enumerated, and recorded on field data sheets. Length measurements for all target species were recorded to the nearest millimeter. Surface, mid-depth and bottom water quality were recorded for each sample as well as pertinent field observations such as water clarity, weather, and tidal stage.

In the 560 bottom trawls that were completed in 2003, 48,246 specimens (47,587 finfish and 659 blue crabs) were collected. Total catch per unit effort (CPUE) was 86.2 for all zones. The results for target species were as follows:

- Alewife: Eighty-three specimens were collected during the bottom trawl effort accounting for less than one percent of the total finfish catch. They were collected in every zone, except Zone 9. Most of them were captured in Zones 3, 6, 7 and 8, and they were most abundant in November. The CPUE for alewife was 0.1.

- American shad: Twenty-three specimens were caught in bottom trawls, comprising less than one percent of the total finfish catch. They were present in the April, July through September and November catches, and were captured in Zones 4, 8, 10, 12 and 13. The CPUE for American shad was <0.1.

- Atlantic croaker: A total of 9,549 specimens were captured in bottom trawls, accounting for more than 20% of the total finfish collected. They were captured in Zones 1-10, but were most prevalent in Zone 3 where more than one-third (37.3%) of them were found. The largest croaker catch was in November and the second largest was in October. These two months accounted for over 98% of the croaker caught in 2003. The CPUE for Atlantic croaker was 17.1.

- Atlantic menhaden: Only one specimen was collected during the bottom trawl effort, representing less than one percent of the total finfish catch. It was found in Zone 3 in November. The CPUE for Atlantic menhaden was <0.1.

- Atlantic silverside: Twenty-seven specimens were caught in bottom trawls, representing less than one percent of the total finfish catch. Most of them were caught in Zones 4 and 5 in August. The CPUE for Atlantic silverside was <0.1.

- Bay anchovy: A total of 10,315 specimens were captured during the bottom trawl effort, comprising 21.7% of the total finfish catch. Bay anchovy were collected in Zones 1-8 and 10 and during every month sampled. They were most abundant during November in Zones 1 through 6. The CPUE for bay anchovy was 18.4.

- Blueback herring: Five specimens were collected in bottom trawls, accounting for less than one percent of the total finfish catch. They were taken in May and November in Zones 2, 3 and 5. The CPUE for blueback herring was <0.1.

- Bluefish: A total of 10 specimens were caught during the bottom trawl effort, representing less than one percent of the total finfish catch. They were collected in Zones 2 and 4 from July through September and in November. The CPUE for bluefish was <0.1.

- Spot: A total of 11 specimens were captured in bottom trawls, comprising less than one percent of the total finfish collected. They were observed in Zones 1-4 during May, August, September and October. The CPUE for spot was <0.1.

- Striped bass: A total of 312 specimens were collected during the bottom trawl effort, accounting for less than one percent of the total finfish collected. Striped bass were caught in Zones 5-14, but were most abundant in Zones 7 and 8. Although they were present during every month sampled, they were most prevalent in July and August. CPUE for striped bass was 0.6.

- Weakfish: A total of 1,672 specimens were caught in bottom trawls, representing 3.5% of the total finfish catch. Weakfish were collected in Zones 1-8 and were most abundant in Zones 2-6. They were present during every month sampled, except April, and were most abundant in August. The CPUE for weakfish was 3.0.

- White perch: A total of 9,444 specimens were captured during the bottom trawl effort, comprising 19.8% of the total finfish catch. White perch were present in Zones 3 through 14 and were most abundant in Zones 8-10 and 14. They were taken in all months and were most abundant in August and September. The CPUE for white perch was 16.9.

- Blue crab: A total of 659 specimens were collected in bottom trawls in Zones 1-9. They were most abundant in Zones 5 and 6, and were captured in every month with peak collections in October and November. The CPUE for blue crab was 1.2.

**Pelagic Trawl Effort**

The 2003 pelagic trawl effort was conducted within the Delaware River Estuary, from the mouth of the Delaware Bay to near Trenton (rkm 0-211) at 80 randomly selected stations allocated from sampling Zones 1-14. The sampling stations were designated in the same manner as the bottom trawl effort (see bottom trawl effort section above). One nighttime pelagic trawl event was completed each month from April through November 2003 using a 4 x 6-ft (1.8 x 1.2-m) frame trawl. Eight surveys were completed, resulting in the collection of 640 pelagic trawls. Target species for this project were alewife, American shad, Atlantic menhaden, blueback herring, bay anchovy, Atlantic silverside, striped bass, white perch, bluefish, Atlantic croaker, spot, weakfish, and blue crab. All finfish and blue crabs were identified to the lowest practicable taxonomic level, enumerated, and recorded on field data sheets. Length measurements for all target species were recorded to the nearest millimeter. Surface, mid-depth and bottom water quality were recorded for each sample as well as pertinent field observations such as weather and tidal stage.

During the 2003 pelagic trawl effort, 154,391 fish and 161 blue crabs were collected in 640 samples. The total combined catch was 154,552. The highest mean density (all months combined) was collected in Zone 4 (504.3 per 1000 $m^3$) and the lowest was found in Zone 14 (1.7 per 1000 $m^3$). The results for target species were as follows:

- Alewife: A total of 142 specimens were caught in pelagic trawls in all zones. They were captured from July through November.

- American shad: 2,067 specimens were captured during the pelagic trawl effort. They were seen in all months and were found exclusively in Zones 7-14. American shad were most abundant in Zone 10 and least abundant in Zone 7.

- Atlantic croaker: During 2003, 48,516 specimens were caught in pelagic trawls in Zones 1-10. They accounted for approximately 31.4% of the total finfish collected. Croakers were most prevalent in Zone 4 where more than 57% of the total species catch was found. The highest monthly mean density was also found in Zone 4 during November (1,568.42 per 1000 $m^3$).

- Atlantic menhaden: A total of 83 specimens were collected during the pelagic trawl effort. They were seen in all months and were found exclusively in Zones 2-11. Most of them were caught in Zones 4, 7 and 8.

- Atlantic silverside: 281 specimens were captured in pelagic trawls. They were taken from June through November in the lower eight zones. Most of them were located in Zones 1-3.

- Bay anchovy: This species was the most abundant one in the 2003 pelagic trawl effort, as 100,790 specimens were caught comprising 65.2% of the total finfish catch. Bay anchovy were captured in all months and in every zone, except for Zone 13. Most of them were found in Zones 1-7. Zone 4 (27,402 fish; 293.83 per 1000 $m^3$) and Zone 5 (22,585 fish; 223.35 per 1000 $m^3$) contained the most fish.

- Blueback herring: A total of 193 specimens were collected in pelagic trawls. They were caught in every zone, except for Zone 1 in April, July and September through November. Most of them were found in Zones 8, 11 and 12

- Bluefish: Fourteen specimens were captured during the pelagic trawl effort. They were collected in Zones 1-7 from June through September.

- Spot: Only one specimen was caught in pelagic trawls. It was found in Zone 1 during September.

- Striped bass: 181 specimens were collected during the pelagic trawl effort. They were taken from June through Octoer in Zones 5-14. Zone 9 yielded the largest haul of bass.

- Weakfish: A total of 564 specimens were captured in pelagic trawls. Weakfish were collected from June through September in Zones 1-10. Most of them were caught in Zone 7.

- White perch: 355 specimens were caught during the pelagic trawl effort in Zones 6-14. They were captured during every month sampled. The most perch were found in September and the least in June. They were most abundant in Zone 9.

- Blue crab: A total of 161 specimens were collected during pelagic trawl sampling in Zones 1-7. They were most abundant in Zone 5 and least abundant in Zone 1. Blue crabs were captured from May through November. They were most abundant in September and October, least abundant from May through August.

**Ichthyoplankton Effort**

The 2003 ichthyoplankton effort was conducted within the Delaware River Estuary, from the mouth of the Delaware Bay to near Trenton (rkm 0-211) at 90 randomly selected stations allocated from sampling Zones 1-14. The sampling stations were designated in the same manner as the bottom trawl effort (see bottom trawl effort section above). Two nighttime ichthyoplankton events were completed each month from April through July 2003 using a 1.0-m diameter, 500-µ mesh conical plankton net. Eight events were completed, resulting in the collection of 720 samples and the analysis of 719 samples. Target species for this project were alewife, American shad, Atlantic menhaden, blueback herring, bay anchovy, Atlantic silverside, striped bass, white perch, bluefish, Atlantic croaker, spot, weakfish, *Neomysis americana* and *Gammarus* spp. All specimens of target species were identified to the lowest practicable taxonomic level, enumerated, and recorded on field data sheets. Length measurements for all target species were recorded to the nearest millimeter. Surface, mid-depth and bottom water quality were recorded for each sample as well as pertinent field observations such as weather and tidal stage.

During the 2003 ichthyoplankton effort, 2,171,736 fish larvae and eggs from twelve target species and three taxa that contain target species were collected in 719 samples which were analyzed. Bay anchovy (1,633,701; 75.2%) and striped bass (238,493; 11.0%) dominated the total catch. The results for target species were as follows:

- Alewife: A total of 18,803 fish larvae and eggs were collected in Zones 6-14 during the 2003 ichthyoplankton effort (sixth in abundance). The heaviest catches were in Zone 11, 12 and 14. No yolk-sac larvae were collected. Post yolk-sac larvae were found during all events, except Event 1. The highest mean densities of post yolk-sac larvae were found during Events 3, 4 and 5. Juvenile alewives were collected only in Event 7.

- *Alosa* spp.: *Alosa* spp. was used as the taxon representing two target species of that genus, alewife and blueback herring. A total of 13,536 *Alosa* spp. larvae and eggs were collected in Zones 9-14. Most of them were in Zones 11-14. Eggs and yolk-sac larvae were found in Events 1-7. Post yolk-sac larvae and juveniles were only captured in Event 8.

- American shad: 5,412 fish larvae and eggs were collected during ichthyoplankton sampling. They were taken in Zones 3 and 9-14 with the greatest catch in Zone 13. Eggs were found in Events 2-6, yolk-sac larvae in Events 3-7, post yolk-sac larvae in Events 3-8, juveniles in Events 6-8 and adults only in Event 7.

- Atlantic croaker: No croaker larvae were caught in during the 2003 ichthyoplankton effort.

- Atlantic menhaden: A total of 20,387 specimens were collected. They represented approximately 0.9% of the total ichthyoplankton catch (fifth in abundance) and were taken in Zones 1-7, 10 and 11. Atlantic menhaden were most abundant in Zone 1 and least abundant in Zones 5-6 and 10-11. Eggs were captured in Events 3-6 and yolk-sac larvae were caught in Events 3, 4 and 6. Post yolk-sac larvae found during Events 1-6 and juveniles were only taken in Event 1.

- Atlantic silverside: 182 fish larvae and eggs were captured during ichthyoplankton sampling. Most of them were found in the lower six zones. The greatest numbers of silverside were in Zone 5. No eggs were collected. Yolk-sac larvae were only taken in Event 4 and post yolk-sac larvae were found in all events, except Event 2. Juveniles were captured in Events 1 and 6, while adults were present in Events 1 and 6-8.

- Bay anchovy: This species accounted for the largest number of the ichthyoplankton caught (1,633,701 larvae and eggs; 75.2% of the total ichthyoplankton). Bay anchovy were captured in every zone. Almost of them were found in Zones 1-8 and the greatest numbers were found in Zones 1 and 2. Eggs were collected in Events 3-8 and yolk-sac larvae were taken during Events 3 and 8. Post yolk-sac larvae were taken in Events 3 and 5-8. Juveniles were captured during Events 5-8. Adults were collected in all eight events. The highest mean egg densities were found during Events 5-7. Event 8 yielded the highest density of yolk-sac larvae and the highest densities of post yolk-sac larvae were found during Events 7 and 8. The highest mean densities of juveniles and adults were observed in Events 8 and 4, respectively.

- Blueback herring: 143 specimens were collected in the ichthyoplankton sampling. They were found in Zones 6, 7 and 9-14 and most were located in Zones 9, 11 and 12. Post yolk-sac larvae were captured during Event 8. Juveniles were taken in Events 6-8.

- Bluefish: Only one juvenile bluefish was captured during the 2003 ichthyoplankton effort. It was collected in Zone 4 during Event 5.

- Clupeidae: Clupeidae was used as the taxon representing four target species within that family, Atlantic menhaden plus three members of the genus *Alosa* (alewife, blueback herring and American shad). Clupeidae larvae were found in all zones, except for Zone 4. Most of them were found in Zones 9-14. Clupeidae larvae were collected in all events. Only a few were seen during Events 1 and 2 and the highest mean densities were observed in Events 3 and 4.

- *Morone* spp.: *Morone* spp. was used as the taxon representing two target species of that genus, striped bass and white perch. A total of 139,869 of these larvae were collected in Zones 5-14. The greatest numbers were taken in Zone 8 and very few were captured in Zones 5 and 13. *Morone* spp. larvae were found during Events 3 and 5-7. Event 7 had the highest mean density and they were all post yolk-sac larvae.

- Spot: No spot were caught during the 2003 ichthyoplankton effort.

- Striped bass: A total of 238,493 specimens were collected during the ichthyoplankton effort representing 11.0% (second in abundance) of the total ichthyoplankton catch. They were taken in Zones 5-14 and were most abundant in Zone 8. Eggs were found during Events 2-6 and yolk-sac larvae during Events 2-7. Post yolk-sac larvae were collected in Events 3-8 and juveniles were found during Events 6-8. Event 4 yielded the highest mean density of egg and the highest density of yolk-sac larvae was found during Event 3. The highest density of both post yolk-sac larvae and juveniles was in Event 7.

- Weakfish: 7,886 fish larvae and eggs were collected during ichthyoplankton sampling. They were collected in Zones 1-8 and 10 and were most abundant in Zones 1 and 2. Eggs were found in all events, except the first one. Yolk-sac larvae were only collected during Event 7. Post yolk-sac larvae were collected in Events 3-8 and juveniles were found during Events 7 and 8.

- White perch: A total of 78,028 specimens were caught during the ichthyoplankton effort representing 3.6% (fourth in abundance) of the total ichthyoplankton catch. They were taken in all Zones 7-14 and were most abundant in Zone 8. Eggs were taken during Events 1-6 and yolk-sac larvae in Events 2-7. Event 3 had the greatest mean density for eggs and the highest density of yolk-sac larvae was found during Event 3. Post yolk-sac larvae were collected in Events 3-8 and juveniles were found during Events 6-8. The highest density of post yolk-sac larvae was observed in Event 7.

- *Neomysis americana*: During the 2003 ichthyoplankton effort, 16,894,133 opossum shrimp were collected. At least one million were taken in each of the lower six zones, throughout which the numbers were relatively evenly distributed. The numbers decreased from south to north through Zones 7-9. River Zones 10-12 and 14 yielded few mysids. Zone 13 had many more, but not near as many as in the lower nine zones.

- *Gammarus* spp.: A total of 4,579,228 scuds were captured during ichthyoplankton sampling. Most of them (90%) were taken in Zones 7-12 and the highest numbers were taken in Zones 8 and 9. The highest mean densities of *Gammarus* spp. were caught during Events 4-8.

**BAYWIDE BEACH SEINE**

The Baywide Beach Seine Survey was conducted on a monthly basis in June and November, and twice monthly from August through October 2003. During the design phase of the study in 1995, the perimeter of the Delaware Bay from Cape May, NJ (rkm 0) to the lower Delaware River at the Chesapeake and Delaware Canal (rkm 100) was divided into 32 equal-length regions. Each region was further partitioned into 0.1-nautical mile segments. One fixed station was established within each of the 32 regions. Eight additional stations were established at bayfront locations adjacent to PSEG marsh restoration sites. These 40 fixed stations have been annually sampled since 1995. The gear was a 100- x 6-ft (30.5- x 1.8-m) bagged haul seine with a 1/4-inch (6.25 mm) nylon mesh, identical to the gear employed by New Jersey Department of Environmental Protection (NJDEP) in their beach seine program conducted upstream of the present study. The seine was set at high tide by boat from the shore and pulled in the direction of the prevailing tidal current, wind or surf as conditions required resulting in the most effective deployment of the gear. Water quality parameters, including water temperature, salinity, dissolved oxygen and water clarity were measured with each collection.

The Baywide Beach Seine Survey yielded 22,949 individuals of 49 finfish species from 400 samples. Atlantic silverside (*Menidia menidia*), and bay anchovy (*Anchoa mitchilli*) represented 74.6 % of the catch. Nearly half (20 of 49) of the species taken were represented by 10 or fewer specimens. Only Atlantic menhaden (Brevorrtia tyrannus), bay anchovy, Atlantic silverside, white perch (*Morone americana*) and striped bass (Morone saxatillis) were taken during all sampling events, in all regions and at all beach types.

Findings specific to target species include:

- American shad, alewife and blueback herring: Totals of 117 American shad, 52 alewife and 214 blueback herring were taken in beach seine collections in 2003. American shad was taken in all regions except rkm 21-40, alewife was taken in all regions rkm 0-100; and blueback herring was taken in all regions except rkm 0-20.

- Atlantic menhaden. A total of 603 Atlantic menhaden was taken, comprising 2.6% of the 2003 seine catch. They were collected during all sampling events; abundance was highest during the second half of June. Although taken in all regions, Atlantic menhaden abundance was highest in region rkm 81-100.

- Bay anchovy. A total of 5,438 bay anchovy was taken, comprising 23.7% of the 2003 seine catch. Bay anchovy was collected during all sampling events; abundance was highest during the first half of October. Bay anchovy was most abundant in region rkm 21-40.

- Atlantic silverside. A total of 11,671 Atlantic silverside was taken, comprising 50.9% of the 2003 seine catch. Atlantic silverside was collected during all sampling events; their abundance was highest during the first half of October. Atlantic silverside catches were similarly high in regions rkm 41-60.

- White perch. A total of 195 white perch was taken in the 2003 seine catch. Individuals were taken during all collection events; abundance was similarly high in the first halves of July and November. White perch abundance was similarly high in regions rkm 61-80 and 81-100.

- Striped bass. A total of 852 striped bass was taken in the 2003 seine catch. Individuals were taken during all collection events; abundance was highest during the first half of July. Striped bass were the most abundant in region rkm 61-80.

- Bluefish. A total of 100 bluefish was taken in the 2003 seine catch. Bluefish was most abundance during the second half of August. They were most abundant in region rkm 0-20.

- Weakfish. A total of 975 weakfish was taken in the 2003 seine catch. Their abundance was highest during the first half of July. Weakfish were most abundant in region rkm 0-20.

- Spot. A total of 11 spot was taken in the 2003 seine catch.

- Atlantic croaker. A total of 469 Atlantic croaker was taken in the 2003 seine catch. Their abundance was highest in the first half of November. Atlantic croaker was most abundant in region rkm 0-20.

**FISH LADDER MONITORING**

PSEG Nuclear LLC (PSEG), as a Special Condition of its NJPDES Permit (No. NJ0005622, Part IV-B/C Special Conditions, H.4), was required to construct and maintain five fish ladders on Delaware River estuary tributaries for spawning run restoration of the alewife (*Alosa pseudoharengus*) and the blueback herring (*Alosa aestivalis*), collectively known as river herring. Alaska Steeppass fish ladders have been constructed at eight sites: at Sunset Lake and Cooper River Lake in New Jersey, and in Delaware at Silver Lake, McGinnis Pond, Coursey Pond, McColley Pond, Garrisons Lake and Moores Lake. The Biological Monitoring Program Work Plan as modified in 2000 requires that monitoring for adult passage, adult stocking, and monitoring for juvenile herring use of these sites to be performed annually until such time as self-sustaining spawning runs have been restored. From 1996 through 2003, the fish ladder monitoring program has entailed monitoring the adult usage of the fish ladders during the spring spawning run; egg and larval herring (ichthyoplankton) sampling during the late spring/early summer (1996 through 2000); and sampling during fall to assess the abundance, size and condition of juvenile herring in the impoundments. A stocking program was initiated in the spring of 1998 and continued through 2003 to provide a target number of at least five spawning run adult fish per impoundment surface acre. This stocking element was initiated to augment the herring runs at selected sites by promoting adult spawning activity within these targeted impoundments, which in turn should accelerate the rate of increase in spawning run size in subsequent years.

During 2003, adult passage monitoring, employing a fish ladder exit trap net, occurred from March 18 to June 16. Stocking occurred in late April and early May. The following lists the total numbers of adult herring counted, counted passing through the ladder, stocked, total counted spawning run adult herring, the target, and percentage of target goal achieved for each of the eight fish ladder sites:

| | Counted | Counted Passing | Stocked | Total Into Pond | Target | Percent of Target |
|---|---|---|---|---|---|---|
| **Garrisons Lake** | 34 | 34 | 0 | 34 | 430 | 7.9% |
| **Silver Lake** | 16 | 15 | 201 | 216 | 1,000 | 21.6% |
| **Moores Lake** | 652 | 510 | 0 | 510 | 135 | 377.8% |
| **McGinnis Pond** | 29 | 29 | 22 | 51 | 157 | 32.5% |
| **Coursey Pond** | 348 | 342 | 0 | 342 | 291 | 117.5% |
| **McColley Pond** | 226 | 171 | 0 | 171 | 245 | 69.8% |
| **Cooper R. Lake** | 13 | 12 | 197 | 209 | 1,000 | 20.9% |
| **Sunset Lake** | 64 | 64 | 969 | 1,033 | 1,000 | 103.3% |
| **Silver Lake (Milford)** | N/A | N/A | 0 | N/A | 143 | 0.0% |
| **Stewart Lake** | N/A | N/A | 0 | N/A | 185 | 0.0% |

In 2003, adult river herring migrated upstream to spawn in the creeks, spillpools, and ponds beginning in early March and the run continued through early June. As expected, the adult herring movement appeared to be associated with rising creek water temperature and sunny days. The occurrence of adult herring at the fish ladder sites generally coincided with reported spawning temperatures.

Monthly electroshocker sampling during September through November assessed the abundance, size and condition of juvenile herring within each of the eight impoundments. The following summarizes the number of juvenile herring observed for each impoundment:

| | Juveniles |
|---|---|
| **Garrisons Lake** | 0 |
| **Silver Lake** | 2 |
| **Moores Lake** | 0 |
| **McGinnis Pond** | 0 |
| **Coursey Pond** | 7 |
| **McColley Pond** | 1 |
| **Cooper R. Lake** | 6,606 |
| **Sunset Lake** | 173 |

Juvenile herring taken in the ponds were full bodied and appeared to be well fed and in good condition. These pond-reared herring attained a greater length (1½ times) than that observed concurrently for juveniles collected from beach seine sampling in the mainstem Delaware River. The length range of juveniles was smallest in Cooper River.

**FISH UTILIZATION OF RESTORERD WETLANDS**

To evaluate the faunal response to salt marsh restoration in Delaware Bay, fish assemblages were compared for small and large creek habitats in four restored marshes and two reference marshes, and also for treated and reference creeks within a single marsh system (Alloway Creek) from May to November 2003. Sampling was conducted monthly with otter trawls (4.9 m headrope, 6 mm mesh, n = 1459 tows) in large marsh creeks (1.79 - 2.44 m depth at high tide) and with weirs (2.0 x 1.5 x 1.5 m with 5 x 1.5 m wings, 6.0 mm mesh, n = 125 sets) in small intertidal marsh creeks draining the marsh surface. A total of 47 fish species were collected from marshes and an additional eight from nearby bay stations; of these, 32% were considered residents of salt marshes and 68% were transients. Most individuals collected were young-of-the-year. Of the target species, white perch (Morone americana) were more abundant in large marsh creeks within the upper bay during the sampling period, and were the most abundant species in large marsh creeks overall. Bay anchovy (Anchoa mitchilli) were also abundant in large marsh creeks of the upper bay, and episodically in a small marsh creek at one upper bay restored site (Mill Creek). The two remaining target species, spot (Leiostomus xanthurus) and weakfish (Cynoscion regalis), were uncommon overall despite some localized or episodic catches of relatively high abundance. Weakfish were periodically abundant at Dennis Township large marsh creeks. Spot were collected mostly in Commercial Township large marsh creeks and in small marsh creeks at Browns Run during summer. Within Alloway Township sites, fish were most abundant in large marsh creeks of the Phragmites site and least abundant in the Treated sites, with the target species white perch explaining much of this trend. However, another target species, bay anchovy, was most abundant at the Treated site.

The general abundance pattern among large marsh creeks was reversed in small marsh creeks at Alloway Creek. Fishes were an order of magnitude more abundant in weirs at the Treated site than at the Spartina or Phragmites site. In all three cases the catch was strongly dominated by mummichog, but white perch were also relatively abundant at the Treated site. Overall abundance in small marsh creeks peaked between July and September depending on site, but individual species peaked between May and October. Abundance in small marsh creeks was due to, depending on site, primarily four species - mummichog (Fundulus heteroclitus), Atlantic silverside (Menidia menidia), bay anchovy, and at Mad Horse Creek, naked goby (Gobiosorna bosc).

Fishes were more abundant in large marsh creeks of one restored salt-hay farm (Dennis Township) in the lower bay than in the reference marsh (Moores Beach) but less abundant in the other (Commercial Township). However, assemblages differed among all three and could account for the differences in abundance. Mean lengths of fishes from large marsh creeks of the two restored salt hay farms were longer than that of the reference lower bay marsh, a reflection of a compositional change in the species assemblage. Species richness in those creeks was greater or similar to that in large marsh creeks of the reference site. In small marsh creeks of the lower bay, richness was similar or higher at both restored sites versus the reference sites, but abundance at the reference site was intermediate to abundance at the two former salt hay farms. Thus, in 2003 the pattern of fish utilization of restored marshes at the former salt hay farms was similar comparison to the reference marsh for large marsh creeks and small marsh creeks, with two evaluators (length and richness) always similar or higher at restoration sites, while abundance was higher than the reference at one restoration site and lower at the other. Assemblage differences owing to a salinity gradient can explain differences in these composite measures and both large and small marsh creeks were abundantly utilized by fish and are functioning well as fish habitat.

In the upper bay, abundance and length of fishes in restoration sites (former Phragmites dominated marsh) large marsh creeks bracketed those in reference creeks, and richness was similar. In small marsh creeks, both restoration sites (Mill Creek and Browns Run) exceeded the reference site (Mad Horse Creek) in abundance and richness, and fish were biggest at the Browns Run restoration site. Within Alloway Creek, where reference and restored sites were sampled within a single river system, abundance, mean length, and richness were considerably higher at the Phragmites site than at either the Treated or reference Spartina site. Richness was similar between the Spartina and Treated site, mean length was higher at the Treated site, but abundance was lower. In small marsh creeks at Alloway Creek, the Treated site had the highest abundance and richness, and also the highest mean size of fish (although similar to that at the reference Spartina site). The reference Spartina site had the lowest richness. In all cases, the mean size measure should be treated with caution, as it is representative of a different assemblage among sites and is not fully weighted in all cases to the relative abundance of species measured. As a result of the above, in 2003 fish utilization of restored marshes in the upper bay was similar to or exceeded that in reference marshes, but large marsh creeks of untreated Phragmites marsh were also well utilized by fish in comparison to naturally vegetated reference marsh.

# CHAPTER 1 - BIOLOGICAL MONITORING ANNUAL REPORT

## INTRODUCTION

This report summarizes results of ongoing ecological monitoring programs conducted by Public Service Enterprise Group (PSEG) of New Jersey. These studies are being conducted in relation to the operation of the Salem Generating Station (SGS), a two-unit nuclear power plant. The basis for conducting these studies is the New Jersey Pollutant Discharge Elimination System (NJPDES) Permit No. NJ0005622 issued by the New Jersey Department of Environmental Protection (NJDEP), with an effective date of September 1, 1994. This permit allows the SGS to discharge cooling water into the Delaware River in accordance with NJPDES Regulations N.J.A.C. 7:14A-1 et. Seq.. In 2001, the NJPDES Permit for the SGS was renewed with an effective date of August 1, 2001. Custom requirement G.6 of the renewed permit provided for the continuation and expansion of the studies included in the report.

## STUDY AREA

The Delaware Estuary is a continuum of environments: freshwater, tidal fresh water, tidal brackish water and marine. The characteristics of these varying environments determine species composition and abundance, temporal and spatial distribution, functional dynamics and resiliency of the population and communities in this system.

The study area extends from the mouth of the Bay to River Mile 211, just south of the fall line in Trenton, NJ. Approximately 308 square miles of tidal marshes surround the Estuary, which play a significant role in water exchange and retention, and in chemical and biological functions within the system. An important interactive component of the Estuary is the contiguous ocean water of the Middle Atlantic Bight (Cape Cod to Cape Hatteras), which exists outside the entrance to the Bay. Pape and Garvine (1982) established that bottom ocean water from at least 40 km offshore is involved in residual flows into the Bay.

The Delaware Bay is composed of three regions: a shallow flats area on the New Jersey side, a central channel and alternating shoals with zones of deep water on the Delaware side. The deep water ranges from 12 - 90 feet with a deep hole reaching 143 feet at the mouth of the Bay off Lewes, DE. The deep zone is interspersed with long, finger like shoals 0 - 12 feet deep, which radiate out to the west and north from the mouth of the Bay. Broad expanses of shallow flats from 9-17 feet deep extend from the deeper water to the shoreline. Beyond the shoreline and extending up the many tidal creek tributaries are wide expanses of salt marsh.

The water movements within the Delaware Estuary affect the occurrence, distribution, and abundance of organisms both directly (as a result of net water transport, turbulent mixing, and exchange of water among the system's components) and indirectly (as a result of its influence on biologically important water quality parameters such as salinity, temperature, dissolved oxygen, and turbidity). Tidal circulation, freshwater discharge from the drainage basin and upstream impoundments, wind-induced flushing, and salinity-induced density gradients are major forces that influence the water circulation patterns in the system and result in its highly dynamic physical and chemical environment.

Tidal transport of water between the ocean and the Delaware Estuary dominates flow and circulation throughout the Estuary (Polis and Kupferman, 1973). The total flux during each tidal cycle, 11.02 billion cubic yards, is equivalent to about 23- 24 percent of the standing volume of the Estuary measured at mean tide level. Tidal flow past the Salem Station is approximately 448,000 to 472,000 cubic feet per second.

Current speed and direction throughout the Delaware Estuary are primarily dominated by the tide. Surface tidal currents generally are directed along the longitudinal axis of the Estuary except in near shore areas of river bends and coves. At maximum ebbing or flooding tide, local currents at any point within the Estuary may reach speeds of 3.3 to 4.3 feet per second (Polis and Kupferman, 1973).

Salinity in the Delaware Estuary varies from fresh water at Trenton (River Mile 132), to typical ocean water concentrations of about 34 parts per thousand on the continental shelf off the mouth of Delaware Bay. Variables such as freshwater discharge, tidal phase, basin morphology, and meteorological conditions affect salinity. In the vicinity of Salem, salinity ranges seasonally from about 0.5 to 20 parts per thousand.

## SALEM GENERATING STATION

### Location

Salem Generating Station is located on a peninsula known as Artificial Island on the eastern shore of the Delaware Estuary, 50 miles northwest of the mouth of the Bay and 30 miles southwest of Philadelphia, PA. Artificial Island was created from the deposition of dredge spoil material by the Army Corps of Engineers during the first half of the last century. It is bordered by the River on two sides and by extensive marshes and uplands on the other two sides. The Salem Units 1 and 2 are identical pressurized -water reactors; each with a net rated electrical output of 1,162 Mwe. Units 1 and 2 began commercial operation in 1977 and 1981, respectively.

The Station was sited on the Delaware Estuary to take advantage of the large volume of relatively low temperature cooling water. This once through cooling water is used to condense the steam produced by the Units during the process of electric generation. The rated flow for both units with all twelve pumps operating is 3,168 million gallons per day. Under Special Condition IV-B/C.H. I of the 1994 NJPDES Permit, Salem is limited to "...a monthly average rate not to exceed 3,024 million gallons per day". Water is withdrawn from the River through a shoreline intake structure divided into 12 intake bays. Each bay is 11.5 feet wide at the entrance with a designed water depth ranging from 31 - 50 feet depending on tide (and factors influencing tides). This configuration results in an average intake bay entrance design velocity of 0.87 feet per second at mean high tide and 1.0 foot per second at mean low tide.

## Intake System

The traveling screens are equipped with buckets to catch most impinged organisms and prevent them from becoming re-impinged. Each screen basket base is fitted with a lip, which creates a water-filled bucket. The screens rotate continuously to minimize the time during which organisms may be impinged. Estuarine organisms are captured in the water-filled buckets at the base of each ascending screen panel to prevent re-impingement. The buckets are emptied into a sluiceway (part of the fish return system) behind the screens, which return the fish to the Estuary north of the circulating water intake system (CWS) intake on flood tide and south of the CWS intake on ebb tide, to prevent re-impingement.

In June of 1996, PSE&G, in compliance with Special Condition IV-B/C.H.2 of the 1994 NJPDES permit, completed the installation of six newly modified traveling screens into the Unit 2 intake system. Composite material was used in place of stainless steel for the construction of the fish buckets. This reduced the weight of each screen by 100 pounds (6,200 pounds total). Composite material was also used to construct the individual basket frames, further saving weight. The lighter weight has enabled the maximum speed of the traveling screens to double from 17.5 to 35 feet per minute. The leading edge of the bucket is formed into a hydrodynamic inward bending shape that eliminates turbulence in the bucket, which could damage fish. New screen mesh with a flat smooth mesh face and 0.25 x 0.5-inch openings has been installed. The size of the wire in the mesh was reduced from 12 down to 14 gauge, increasing the open area by 25 percent. Mounting and structural hardware for the basket have been relocated behind the new screen mesh. Eight spray nozzles were added to the inside spray wash headers to provide a more efficient and even spray pattern. Debris shields were added to the above the spray nozzles to keep them free of debris. Fish and debris trough flap seals were redesigned to maintain a closer fit to the traveling screens. All of these modifications were designed to improve fish survival on the traveling screens.

## Discharge

Both CWS water and service water systems (SWS) water are discharged through six 10-foot diameter pipes (3 per unit) which extend 500 feet into the Estuary. Water depth at the discharge is approximately 31 feet to the centerline of the pipe. When Salem is operating at full load, approximately 16 billion BTU/hr are released into the Estuary. The discharge pipes were designed to minimize the thermal effect on the Estuary by maintaining the discharge velocity at about 10 feet per second.

Heated effluent from the cooling water discharge is characterized by a difference in temperature ($\Delta T$) from the ambient River water and results in a thermal plume. The $\Delta T$ normally varies from approximately 15°F to 21°F depending upon the CWS flow. Thus, the discharge water temperature can range from about 45°F in winter to about 100°F in summer. The $\Delta T$ is reduced by approximately one-half between the time the CWS water is discharged through the pipes until it reaches the surface approximately 40-50 seconds later. This is due to the fact that the water discharged (at 10 feet per second) is turbulently mixed with ambient River water. During this time, the plume buoyantly rises in the water column. The characteristics of the thermal plume are determined by convective spread, mass transport by ambient currents, diffusion and dispersion, and loss of heat to the atmosphere. These processes are affected by the temporal and spatial variations within tidal cycles, meteorological conditions, and plant operations

## MONITORING PROGRAMS

Custom Requirement G.6 of the 2001 NJPDES Permit required PSEG to develop and implement an "Improved Biological Monitoring Work Plan" (IBMWP) for the Delaware Estuary. The results presented herein are from programs conducted per the approved 2000 Biological Monitoring Work Plan.

This report contains a separate section for each of the Biological Monitoring Work Plan (BMWP) programs that were performed during 2003. Programs discussed include; fish utilization of restored wetlands, elimination of impediments to fish migration, bay-wide trawl survey, beach seine survey, entrainment abundance monitoring, and impingement abundance monitoring.

## CHAPTER 2: IMPINGEMENT MONITORING

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# IMPINGEMENT MONITORING

## INTRODUCTION

Impingement monitoring is conducted annually as stipulated in the New Jersey Pollutant Discharge Elimination System (NJPDES) permit issued for the Salem Generating Station (SGS), and will continue through the term of the permit. The specified monitoring was performed in 2003 as described in the Procedures Manual for Biological Monitoring Program for the Delaware Estuary (PSEG 2002). The objectives of this monitoring program are to estimate the temporal occurrence and abundance of each fish species impinged at Salem Units 1 and 2, and to estimate their initial survival. These estimates are important parameters for assessing the effects of Salem on the Delaware Estuary's fish populations.

During 2003, there was a refueling and maintenance outage at Salem Unit 2 from October 11 through November 17, 2003. During the outage, the number of operating circulating water pumps in the Circulating Water Intake Structure (CWIS) was 4 to 9. However, during the other months, 83% of the impingement samples were collected when 11 or 12 circulating pumps were in operation. This chapter presents the overall results of sampling and specific findings regarding the occurrence of SGS finfish target species: blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic menhaden (*Brevortia tyrannus*), bay anchovy (*Anchoa mitchilli*), Atlantic silversides (*Menidia menidia*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), and Atlantic croaker (*Micropogonias undulatus*).

## MATERIALS AND METHODS

Impingement abundance sampling during 2003 was scheduled three days per week during January through December. Sampling consisted of ten (10) samples taken at approximately 2½-hour intervals during each 24-hr period. The 24-hr sampling event provided for monitoring over a complete diel period and two full tidal cycles. The three 24-hr periods were chosen randomly within the seven-day weekly sampling time frame. During 2003, all of the 1,560 scheduled samples were collected.

Organisms impinged on the continuously rotating traveling screens at Salem are lifted from the river in water-filled buckets or troughs fitted at the bottom of each screen panel (Figure 2-1). These buckets provide a temporary environment during the vertical transport of the screen, and are designed to prevent most organisms from falling back into the screen well and becoming re-impinged. As the bucket travels over the head or top sprocket, organisms slide onto the screen face and are spray-washed into the fish trough by a low-pressure spray. The screen continues its downward movement and debris on the screen mesh is washed into the debris trough by a high-pressure wash. These fish and debris troughs converge and discharge to the Delaware River either to the north or south of the CWIS depending on tidal current direction to reduce re-impingement. To collect impingement samples, a timed sub-sample of total flow from the converged fish and debris troughs was diverted into the appropriate north or south fish counting pool (Figure 2-2) as dictated by tide and trough discharge direction. Sample duration ranged from one to three minutes and was dependent largely on specimen and detrital abundance. Sample duration was two minutes for 61% of the collections in 2003. At the end of the timed interval, trough flow was returned to the river discharge mode, and the sample was allowed a 5-min acclimation period before the pool was drained. As the pool was drained, debris (vegetative matter) was examined for finfish and blue crab, and any found were included in the collection. The condition of the specimens collected was determined according to the following criteria:

| | |
|---|---|
| Live - | Swimming vigorously, no apparent orientation problems, behavior normal |
| Dead - | No vital signs, no body or opercular movement, no response to gentle probing |
| Damaged - | Struggling or swimming on side, evidence or indication of abrasion or laceration |

Specimens in each category were sorted by species, and the total number and weight of each was determined. All specimens or a representative subsample (at least 100 specimens) of each species, drawn equally from each condition category, if possible, were measured to the nearest millimeter. Weights were determined to the nearest 0.1 g with an Acculab® Model 121 electronic scale.

The following parameters were recorded with all samples: the number of pumps and screens in operation, screen speed, tidal stage and elevation, air temperature, sky condition, wind direction, wave height, water temperature, and salinity. Air and water temperatures were measured with a field thermometer, and salinity was measured using a refractometer. Detritus taken with the sample was weighed to the nearest 0.1 kg with a Chatillon® suspended scale.

## RESULTS AND DISCUSSION

Collection totals of 52,484 finfish of 56 species and 33 families, and 1343 blue crab were taken in 1,560 samples (2,517 min sampled) at the Salem CWIS during 2003 (Table 2-1). All SGS designated finfish target species were taken, and summaries on the period of occurrence and abundance (expressed as a density in terms of the number/million cubic meters of intake water or $n/10^6m^3$), initial survival (species catches of < 5 individuals in a given month are not considered in the discussion), length, and inferred age for each of these species are presented below in phylogenetic order. Target species include: blueback herring, alewife, American shad, Atlantic menhaden, bay anchovy, Atlantic silverside, white perch, striped bass, bluefish, weakfish, spot, and Atlantic croaker.

**Blueback herring** - A total of 409 specimens was taken in impingement samples during 2003; collection frequency was 168 out of 1,560 samples (Table 2-1). They were collected during all months except February (Figure 2-4). During their period of occurrence, monthly mean water temperatures and salinities ranged from 2.9 to 27.2 ºC and from 2.7 to 6.9 ppt, respectively (Figure 2-3). Blueback herring exhibited two periods of abundance with early spring and fall seasonal peaks in monthly mean density of 125.80 and 102.09 in April and October, respectively (Figure 2-4). During the other months in which they occurred, monthly mean densities ranged from 0.57 (May) to 77.81 (March). Annual percent live, dead, and damaged were 93, 5, and 2, respectively; monthly (≥ 5 specimens taken) initial survival (percent live and damaged) ranged from 75% in August to 100% in September (Tables 2-1 and 2-2). Length range was 38-278 mm FL, and specimens ≤ 98 mm comprised over 98% of the individuals measured (Figure 2-5).

**Alewife** - A total of 85 specimens was taken; collection frequency was 61 out of 1,560 samples (Table 2-1). They were collected in March and April, and in July through December, when monthly mean water temperatures and salinities ranged from 6.1 to 27.2ºC and from 3.6 to 5.9 ppt, respectively (Figures 2-3 and 2-6). Alewife was most abundant in October, with a monthly mean density of 24.92. During the other months in which they occurred, monthly mean densities ranged from 0.81(December) to 17.53 (April) (Figure 2-6). Annual percent live, dead and damaged were 92, 3 and 5 respectively; monthly (≥ 5 specimens taken) initial survival ranged from 71% in August, to 100% in April, July, September and October (Tables 2-1 and 2-2). Length range was 48-113 mm FL (Figure 2-7).

**American shad** - A total of 113 specimens was taken; collection frequency was 47 out of 1,560 samples (Table 2-1). They were collected in May and August and again in October through December; during the months in which they were collected, monthly mean water temperatures and salinities ranged from 6.9 to 27.2ºC and from 3.6 to 5.4 ppt, respectively (Figures 2-3 and 2-8). American shad abundance was similarly high in impingement samples during October and November, with a monthly mean densities of 55.47 and 42.22, respectively; while during the other months in which they occurred, monthly mean densities ranged from 0.57 (May) to 4.07 (December) (Figure 2-8). Annual percent live, dead and damaged were 91, 8, 1; monthly (≥ 5 specimens) initial survival ranged from 80% in December to 96% in December (Tables 2-1 and 2-2). Length range was 48-138 mm FL (Figure 2-9.

**Atlantic menhaden** – A total of 110 specimens was taken; collection frequency was 55 out of 1,560 samples (Table 2-1). They were collected during May through December, when monthly mean water temperatures and salinities ranged from 6.9 to 27.2ºC and from 2.7 to 5.9 ppt, respectively (Figures 2-3 and 2-10). Atlantic menhaden was most abundant in June, with a monthly mean density of 43.43 (Figure 2-10); during the other months in which they occurred, mean densities ranged from 0.59 (August) to 8.04 (May). Annual percent live, dead, and damaged were 88, 11, and 1, respectively; monthly (≥ 5 specimens) initial survival ranged from 88% in June and October, to 93% in May (Tables 2-1 and 2-2). Length range was 28-103 mm FL (Figure 2-11). In June, when 75% of the total catch was taken, the modal length was 53mm FL.

**Bay anchovy** - A total of 1,573 specimens was taken; collection frequency was 430 out of 1,560 samples (Table 2-1). They were collected in all months of 2003 except February and March (Figure 2-12). During their period of occurrence, monthly mean water temperatures and salinities ranged from 2.9 to 27.2ºC and from 2.7 to 6.9 ppt, respectively (Figure 2-3). Bay anchovy exhibited two distinct periods of abundance; one in the spring, and the other in the summer and early fall. A spring peak occurred in April and May, with monthly mean densities of 227.89 and 390.90, respectively (Figure 2-12). Density declined markedly in June, and then increased to a sustained secondary period of abundance during July through October, when mean densities ranged from 82.85 to 96.67. Annual percent live, dead, and damaged were 84, 14, and 2, respectively; monthly (≥ 5 specimens) initial survival ranged from 52% in November to 95% in May (Tables 2-1 and 2-2). Length range was 13 to 93 mm FL, however individuals ranging from 63 to 73 comprised 53.7% of the subsample measured (Figure 2-13).

**Atlantic silverside** - A total of 627 specimens was taken; collection frequency was 289 out of 1,560 samples (Table 2-1). They were collected in all months of 2003 (Figure 2-14). Monthly mean water temperatures and salinities ranged from 1.9 to 27.2ºC and from 2.7 to 9.9 ppt, respectively (Figure 2-3). Atlantic silverside abundance was similarly high during October through December, with mean densities ranging from 107.26 to 140.05 (Figure 2-14). In the other months in which they occurred, monthly mean densities ranged from 0.57 (May) to 43.20 (August). Annual percent live, dead and damaged were 95, 4 and 1, respectively; monthly (≥ 5 specimens) initial survival ranged from 90% in February, to 100% in July (Tables 2-1 and 2-2). The length range was 28-108 mm FL, however individuals ranging from 53 to 73 comprised 58.5% of the subsample measured (Figure 2-15). During the winter and spring months (January through June), modal lengths (frequencies > 1) ranged from 73 to 93mm FL. While during the summer and fall (July through December), modal lengths ranged from 48 to 73mm FL.

**White perch** - A total of 31,131 specimens was taken; collection frequency was 1,152 out of 1,560 samples (Table 2-1). They were collected in all months of 2003, when monthly mean water temperatures and salinities ranged from 1.9 to 27.2ºC and from 2.7 to 9.9 ppt, respectively (Figures 2-3 and 2-16). White perch were modestly abundant during early spring, and very abundant in late fall and winter months, with seasonal peaks in monthly densities of 1,515.74 and 12,137.59 in March and November, respectively (Figure 2-16). Mean densities in October and December were 5,685.66 and 5,401.80, respectively. In the other months they occurred, mean densities ranged from 18.31 (June) to 850.74 (January). Annual percent live, dead, and damaged were 97, 2, and 1, respectively; monthly (≥ 5 specimens) initial survival ranged from 94% in June to 100% in May (Tables 2-1 and 2-2). Length range was 23-278 mm, however individuals ranging from 58 to 68 comprised 52.8% of the subsample measured (Figure 2-17). Monthly modal lengths ranged from 38mm FL in July to 113 mm FL in March, May and June.

**Striped bass** - A total of 2,811 specimens was taken; collection frequency was 556 out of 1,560 samples (Table 2-1). They were collected in all months of 2003 but May (Figure 2-18). During their period of occurrence, monthly mean water temperatures and salinities ranged from 1.9 to 27.2ºC and from 2.7 to 9.9 ppt, respectively (Figure 2-3). Striped bass abundance in impingement collections during 2003 had three distinctive features: bimodal peaks during summer and early fall, with monthly densities of 604.21 in July and 622.99 in October; a protracted period of relatively high mean densities July through December, with values (excluding peaks referenced earlier) ranging from 99.27 to 249.14, and relatively low abundance in the remaining months, with densities ≤ 29.75 (Figure 2-18). Annual percent live, dead and damaged were 97, 2, and 1, respectively; monthly (≥ 5 specimens) initial survival ranged from 96% in September to 100% in January, March, April, June, October, and December (Tables 2-1 and 2-2). Length range was 18-453mm FL, however individuals ranging from 43 to 58 comprised 52.1% of the subsample measured (Figure 2-19). Modal lengths ranged from 23 mm FL in June to 98 mm FL in April.

**Bluefish -** A total of 143 specimens was taken; collection frequency was 101 out of 1,560 samples (Table 2-1). They were collected from May through October, when monthly mean water temperatures and salinities ranged from 16.7 to 27.2ºC and from 2.7 to 5.9 ppt, respectively (Figures 2-3 and 2-20). Bluefish abundance was highest in June, when the mean density was 38.72 (Figure 2- 20). Monthly mean densities in the other months of occurrence, ranged from 1.15 (May) to 19.26 (July). Annual percent live, dead, and damaged were 82, 11, and 7, respectively; monthly (≥ 5 specimens) initial survival ranged from 79% in July to 100% in August and (Tables 2-1 and 2-2). Length range was 43-148 mm TL, and individuals ranging from 48 to 68 comprised 50.4% of the subsample measured (Figure 2-21).

**Weakfish** - A total of 9,328 specimens was taken; collection frequency was 336 out of 1,560 samples (Table 2-1). They were collected during May through November, when monthly mean water temperatures and salinities ranged from 13.3 to 27.2ºC and from 3.7 to 5.9 ppt, respectively (Figures 2-3 and 2-22). Weakfish abundance was highest in July with a monthly mean density of 3,405.74 (Figure 2-22). In the remaining months of their occurrence, mean density ranged from 1.14 (November) to 1,856.42 (August). Annual percent live, dead and damaged were 94, 5, and 1, respectively; monthly (≥ 5 specimens) initial survival ranged from 93% in October, to 99% in September (Tables 2-1 and 2-2). Length range was 28-243 mm TL; individuals ranging from 48 to 63 comprised 58.4% of the subsample measured (Figure 2-23). The modal lengths increased from 28 mm TL during June to 83 mm TL in September.

**Spot** - A total of 14 was taken; collection frequency was 11 out of 1,560 samples (Table 2-1). They were collected during June through October, when monthly mean water temperatures and salinities ranged from 17.1 to 27.2ºC and from 2.7 to 5.9 ppt, respectively (Figure 2-3 and 2-24). Spot abundance was highest in July, with a monthly mean density of 5.25 (Figure 2-24). In the other months of their occurrence, mean density ranged from 0.52 (June) to 1.18 (August). Annual percent live was 100 (Table 2-1). Length range was 53-193 mm TL (Figure 2-25).

**Atlantic croaker** - A total of 1,779 specimens was taken; collection frequency was 242 out of 1,560 samples (Table 2-1). They were collected in January and October through December, when monthly mean water temperatures and salinities ranged from 2.9 to 17.1ºC and from 3.6 to 6.9 ppt, respectively (Figures 2-3 and 2-26). Atlantic croaker was most abundant during January, with a monthly mean density of 552.95 (Figure 2-26). They were secondarily and similarly abundant during November and December, with densities of 345.74 and 392.47, respectively. Annual percent live, dead, and damaged were 78, 11, and 11, respectively; monthly (≥ 5 specimens) initial survival ranged from 84% in January, to 99% in October (Tables 2-1 and 2-2). Length range was 18-253 mm TL, and individuals ranging from 38 to 48 comprised 54.3% of the subsample measured (Figure 2-27). Modal lengths were 68 mm TL in January, 38 mm TL in October, and 43 mm TL in November and December.

## LITERATURE CITED

Public Service Electric & Gas Co. (PSE&G). 1999a. Salem Generating Station, NJPDES Permit Renewal Application. Public Service Electric & Gas Co., Newark, NJ.

Public Service Electric Gas Co. (PSEG). 2002. Procedures Manual for Biological Monitoring Program for the Delaware Estuary.

Table 2-1
Annual catch statistics of finfish and blue crab taken in impingement sampling at the Salem Generating Station circulating water intake structure, January through December 2003

Number of samples = 1,560
Total minutes sampled = 2,517
Total pump volume sampled (cubic meter) = 17,576,387
Detritus mean density (kg/million cubic meters) = 951.81

| Species | | Collection Frequency | Initial Percent | | | Total Number Collected | Mean density (n / $10^6$ $m^3$) |
|---|---|---|---|---|---|---|---|
| | | | Live | Dead | Damaged | | |
| Blue crab | *Callinectes sapidus* | 430 | 99 | 1 | 0 | 1343 | 76.41 |
| **Lampreys - Petromyontidae** | | | | | | | |
| Sea lamprey | *Petromyzon marinus* | 11 | 100 | 0 | 0 | 13 | 0.74 |
| **Freshwater eels - Anquillidae** | | | | | | | |
| American eel | *Anguilla rostrata* | 42 | 92 | 2 | 6 | 49 | 2.79 |
| **Herrings - Clupeidae** | | | | | | | |
| American shad | *Alosa sapidissima* | 47 | 91 | 8 | 1 | 113 | 6.43 |
| Blueback herring | *Alosa aestivalis* | 168 | 93 | 5 | 2 | 409 | 23.27 |
| Alewife | *Alosa pseudoharengus* | 61 | 92 | 3 | 5 | 85 | 4.84 |
| Atlantic menhaden | *Brevoortia tyrannus* | 55 | 88 | 11 | 1 | 110 | 6.26 |
| Gizzard shad | *Dorosoma cepedianum* | 142 | 91 | 2 | 7 | 370 | 21.05 |
| **Anchovies - Engraulidae** | | | | | | | |
| Striped anchovy | *Anchoa hepsetus* | 2 | 0 | 50 | 50 | 2 | 0.11 |
| Bay anchovy | *Anchoa mitchilli* | 430 | 84 | 14 | 2 | 1573 | 89.50 |
| **Carps and minnows - Cyprinidae** | | | | | | | |
| Carp | *Cyprinus carpio* | 3 | 100 | 0 | 0 | 3 | 0.17 |
| Eastern silvery minnow | *Hybognathus regis* | 70 | 97 | 2 | 1 | 293 | 16.67 |
| **Bullhead catfishes - Ictaluridae** | | | | | | | |
| Channel catfish | *Ictalurus punctatus* | 63 | 81 | 6 | 13 | 85 | 4.84 |
| White catfish | *Ameiurus catus* | 1 | 0 | 100 | 0 | 1 | 0.06 |
| Brown bullhead | *Ameiurus nebulosus* | 24 | 80 | 3 | 17 | 30 | 1.71 |
| **Toadfishes - Batrachoididae** | | | | | | | |
| Oyster toadfish | *Opsanus tau* | 5 | 40 | 40 | 20 | 5 | 0.28 |
| **Goosefishes - Lophiidae** | | | | | | | |
| Goosefish | *Lophius americanus* | 1 | 0 | 100 | 0 | 1 | 0.06 |
| **Cods - Gadidae** | | | | | | | |
| Spotted hake | *Urophycis regia* | 100 | 99 | 1 | 0 | 1040 | 59.17 |
| Silver hake | *Merluccius bilinearis* | 2 | 50 | 50 | 0 | 2 | 0.11 |
| **Cusk-eels - Ophidiidae** | | | | | | | |
| Striped cusk-eel | *Ophidion marginata* | 55 | 98 | 1 | 1 | 225 | 12.80 |
| **Needlefishes - Belonidae** | | | | | | | |
| Atlantic needlefish | *Strongylura marina* | 7 | 100 | 0 | 0 | 9 | 0.51 |
| **Killifishes - Cyprinodontidae** | | | | | | | |
| Mummichog | *Fundulus heteroclitus* | 22 | 100 | 0 | 0 | 28 | 1.59 |
| Striped killifish | *Fundulus majalis* | 15 | 100 | 0 | 0 | 21 | 1.19 |
| **Silversides - Atherinidae** | | | | | | | |
| Atlantic silverside | *Menidia menidia* | 289 | 95 | 4 | 1 | 627 | 35.67 |
| **Stickleback - Gasterosteidae** | | | | | | | |
| Threespine stickleback | *Gasterosteus aculeatus* | 3 | 100 | 0 | 0 | 3 | 0.17 |
| **Pipefishes - Syngnathidae** | | | | | | | |
| Northern pipefish | *Syngnathus fuscus* | 48 | 98 | 2 | 0 | 61 | 3.47 |
| **Searobins - Triglidae** | | | | | | | |
| Northern searobin | *Prionotus carolinus* | 7 | 100 | 0 | 0 | 11 | 0.63 |
| Striped searobin | *Prionotus evolans* | 7 | 100 | 0 | 0 | 8 | 0.46 |

| Table 2-1 Continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Species | | Collection Frequency | Initial Percent | | | Total Number Collected | Mean density (n / $10^6$ $m^3$) |
| | | | Live | Dead | Damaged | | |
| **Temperate basses - Percichtyidae** | | | | | | | |
| White perch | *Morone americana* | 1152 | 97 | 2 | 1 | 31131 | 1771.18 |
| Striped bass | *Morone saxatilis* | 556 | 97 | 2 | 1 | 2811 | 159.93 |
| **Sea basses - Serranidae** | | | | | | | |
| Black sea bass | *Centropristis striata* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Sunfishes - Centrarchidae** | | | | | | | |
| Bluegill | *Lepomis macrochirus* | 27 | 96 | 0 | 4 | 28 | 1.59 |
| Pumpkinseed | *Lepomis gibbosus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| Redeared sunfish | *Lepomis microlophus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| Black crappie | *Pomoxis nigromaculatus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Perches - Percidae** | | | | | | | |
| Yellow perch | *Perca flavescens* | 25 | 100 | 0 | 0 | 28 | 1.59 |
| **Bluefishes - Pomatomidae** | | | | | | | |
| Bluefish | *Pomatomus saltatrix* | 101 | 82 | 11 | 7 | 143 | 8.14 |
| **Jacks - Carangidae** | | | | | | | |
| Crevalle jack | *Caranx hippos* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| Lookdown | *Selene vomer* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| Permit | *Trachinotus falcatus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Drums - Sciaenidae** | | | | | | | |
| Weakfish | *Cynoscion regalis* | 336 | 94 | 5 | 1 | 9328 | 530.71 |
| Silver perch | *Bairdiella chrysoura* | 2 | 100 | 0 | 0 | 2 | 0.11 |
| Spot | *Leiostomus xanthurus* | 11 | 100 | 0 | 0 | 14 | 0.80 |
| Atlantic croaker | *Micropogonias undulatus* | 242 | 78 | 11 | 11 | 1779 | 101.22 |
| Black drum | *Pogonias cromis* | 15 | 86 | 7 | 7 | 15 | 0.85 |
| **Butterflyfishes - Chaetodontidae** | | | | | | | |
| Spotfin butterflyfish | *Chaetodon ocellatus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Mullets - Mugilidae** | | | | | | | |
| Striped mullet | *Mugil cephalus* | 7 | 92 | 0 | 8 | 12 | 0.68 |
| **Stargazers - Uranoscopidae** | | | | | | | |
| Northern stargazer | *Astroscopus guttatus* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Gobies - Gobiidae** | | | | | | | |
| Naked goby | *Gobiosoma bosc* | 55 | 94 | 6 | 0 | 72 | 4.10 |
| **Butterfishes - Stromateidae** | | | | | | | |
| Butterfish | *Peprilus triacanthus* | 4 | 100 | 0 | 0 | 8 | 0.46 |
| **Lefteye flounders - Bothidae** | | | | | | | |
| Smallmouth flounder | *Etropus microstomus* | 3 | 100 | 0 | 0 | 4 | 0.23 |
| Summer flounder | *Paralichthys dentatus* | 39 | 100 | 0 | 0 | 44 | 2.50 |
| Windowpane | *Scophthalmus aquosus* | 29 | 100 | 0 | 0 | 56 | 3.19 |
| **Righteye flounders - Pleuronectidae** | | | | | | | |
| Winter flounder | *Pleuronectes americanus* | 17 | 87 | 4 | 9 | 23 | 1.31 |
| **American soles - Achiridae** | | | | | | | |
| Hogchoker | *Trinectes maculatus* | 592 | 99 | 0 | 1 | 1798 | 102.30 |
| **Toungefishes - Cynoglossidae** | | | | | | | |
| Blackcheek tonguefish | *Symphurus plagiusa* | 1 | 100 | 0 | 0 | 1 | 0.06 |
| **Puffers - Tetraodontidae** | | | | | | | |
| Northern puffer | *Sphoeroides maculatus* | 1 | 100 | 0 | 0 | 1 | 0.06 |

Table 2-2
Monthly percentages live (L), dead (D), and damaged (D*) for target species taken in impingement sampling at the Salem circulating water intake structure during 2003. n = number of individuals sampled. Values represent initial observed

| | Blueback herring | | | | Alewife | | | | American shad | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | n | L | D | D* | n | L | D | D* | n | L | D | D* |
| January | 2 | 50 | 50 | | | | | | | | | |
| February | | | | | | | | | | | | |
| March | 102 | 93 | 4 | 3 | 2 | 100 | | | | | | |
| April | 122 | 96 | 2 | 2 | 17 | 88 | | 12 | | | | |
| May | 1 | | | 100 | | | | | 1 | 100 | | |
| June | 2 | 100 | | | | | | | | | | |
| July | 3 | 100 | | | 5 | 100 | | | | | | |
| August | 8 | 63 | 25 | 12 | 7 | 71 | 29 | | 1 | 100 | | |
| September | 7 | 100 | | | 18 | 89 | | 11 | | | | |
| October | 127 | 97 | 3 | | 31 | 100 | | | 69 | 96 | 4 | |
| November | 31 | 84 | 13 | 3 | 4 | 75 | 25 | | 37 | 84 | 13 | 3 |
| December | 4 | 75 | 25 | | 1 | 100 | | | 5 | 80 | 20 | |
| Total | 409 | | | | 85 | | | | 113 | | | |

| | Atlantic menhaden | | | | Bay anchovy | | | | Atlantic silverside | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | n | L | D | D* | n | L | D | D* | n | L | D | D* |
| January | | | | | 3 | 67 | | 33 | 46 | 93 | 7 | |
| February | | | | | | | | | 20 | 85 | 10 | 5 |
| March | | | | | | | | | 3 | 100 | | |
| April | | | | | 221 | 88 | 11 | 1 | 1 | 100 | | |
| May | 14 | 93 | 7 | | 681 | 93 | 5 | 2 | 1 | 100 | | |
| June | 83 | 88 | 12 | | 75 | 85 | 13 | 2 | 15 | 80 | 7 | 13 |
| July | 3 | 67 | | 33 | 153 | 71 | 28 | 1 | 17 | 100 | | |
| August | 1 | | 100 | | 140 | 67 | 29 | 4 | 73 | 93 | 7 | |
| September | 2 | 100 | | | 167 | 88 | 9 | 3 | 35 | 97 | 3 | |
| October | 1 | 100 | | | 111 | 64 | 33 | 3 | 150 | 95 | 5 | |
| November | 4 | 100 | | | 21 | 52 | 48 | | 94 | 98 | 2 | |
| December | 2 | 100 | | | 1 | | 100 | | 172 | 97 | 2 | 1 |
| Total | 110 | | | | 1573 | | | | 627 | | | |

| | White perch | | | | Striped bass | | | | Bluefish | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | n | L | D | D* | n | L | D | D* | n | L | D | D* |
| January | 1357 | 94 | 1 | 5 | 39 | 97 | | 3 | | | | |
| February | 641 | 95 | 2 | 3 | 41 | 93 | 2 | 5 | | | | |
| March | 1987 | 95 | 2 | 3 | 39 | 97 | | 3 | | | | |
| April | 587 | 98 | 1 | 1 | 20 | 100 | | | | | | |
| May | 37 | 84 | | 16 | | | | | 2 | 100 | | |
| June | 35 | 77 | 6 | 17 | 13 | 100 | | | 74 | 86 | 10 | 4 |
| July | 797 | 98 | 2 | | 1035 | 97 | 3 | | 33 | 67 | 21 | 12 |
| August | 1022 | 98 | 2 | | 421 | 96 | 3 | 1 | 6 | 100 | | |
| September | 324 | 97 | 3 | | 196 | 95 | 4 | 1 | 10 | 60 | 20 | 20 |
| October | 7073 | 99 | 1 | | 775 | 100 | | | 18 | 94 | | 6 |
| November | 10637 | 97 | 2 | 1 | 87 | 99 | 1 | | | | | |
| December | 6634 | 98 | 1 | 1 | 145 | 99 | | 1 | | | | |
| Total | 31131 | | | | 2811 | | | | 143 | | | |

Table 2-2 continued
Monthly percentages live (L), dead (D), and damaged (D*) for target species taken in impingement sampling at the Salem Generating circulating water intake structure during 2003. n = number of individuals sampled. Values represent initial observed condition.

| | Weakfish | | | | Spot | | | | Atlantic croaker | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | n | L | D | D* | n | L | D | D* | n | L | D | D* |
| January | | | | | | | | | 882 | 65 | 17 | 19 |
| February | | | | | | | | | | | | |
| March | | | | | | | | | | | | |
| April | | | | | | | | | | | | |
| May | 4 | 100 | | | | | | | | | | |
| June | 3 | 100 | | | 1 | 100 | | | | | | |
| July | 5834 | 94 | 5 | 1 | 9 | 100 | | | | | | |
| August | 3137 | 95 | 4 | 1 | 2 | 100 | | | | | | |
| September | 253 | 97 | 1 | 2 | 1 | 100 | | | | | | |
| October | 96 | 92 | 7 | 1 | 1 | 100 | | | 112 | 98 | 1 | 1 |
| November | 1 | | | 100 | | | | | 303 | 96 | 4 | |
| December | | | | | | | | | 482 | 85 | 8 | 7 |
| Total | 9328 | | | | 14 | | | | 1779 | | | |

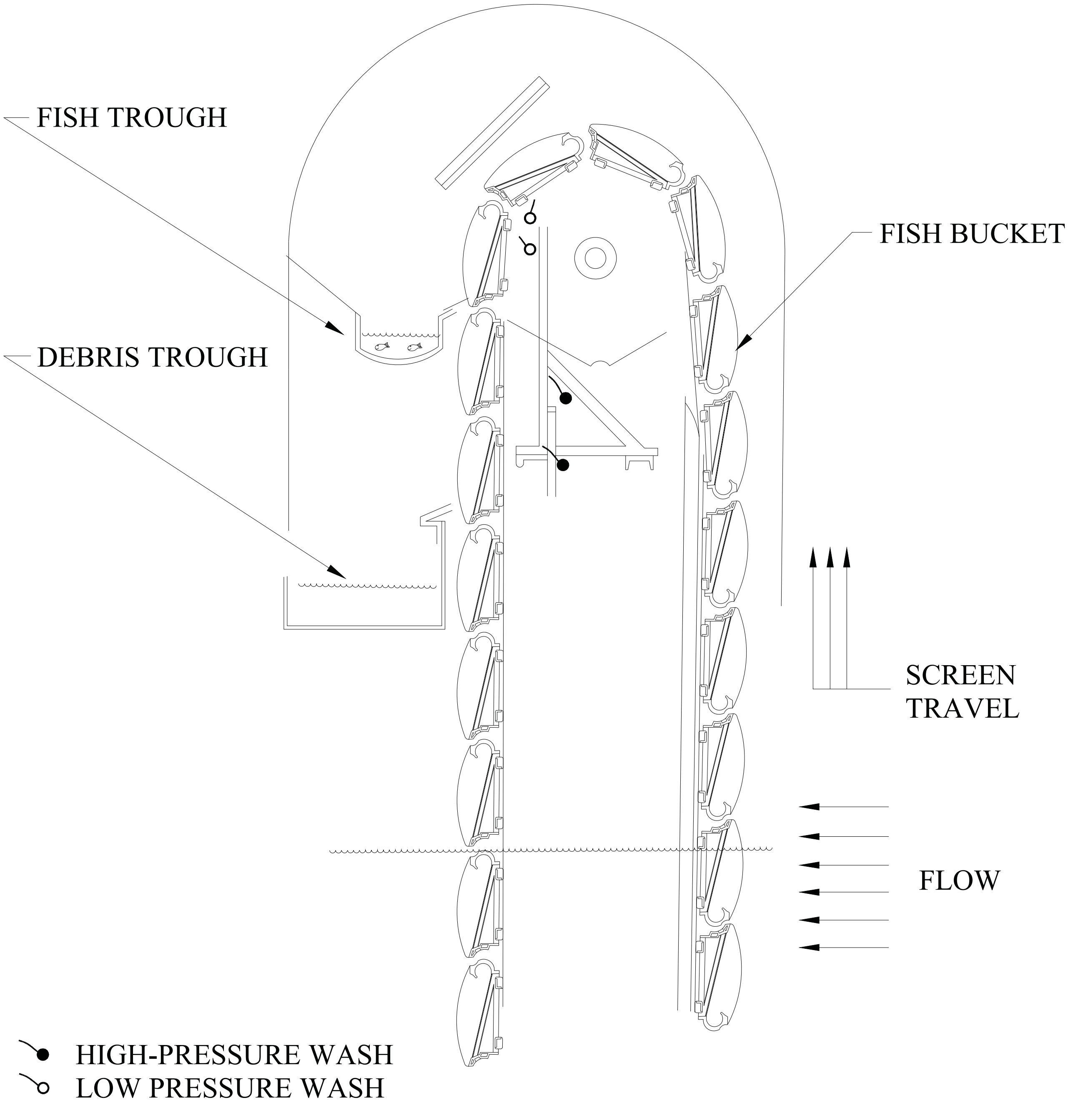


Figure 2-1. Ristroph modified traveling screen.

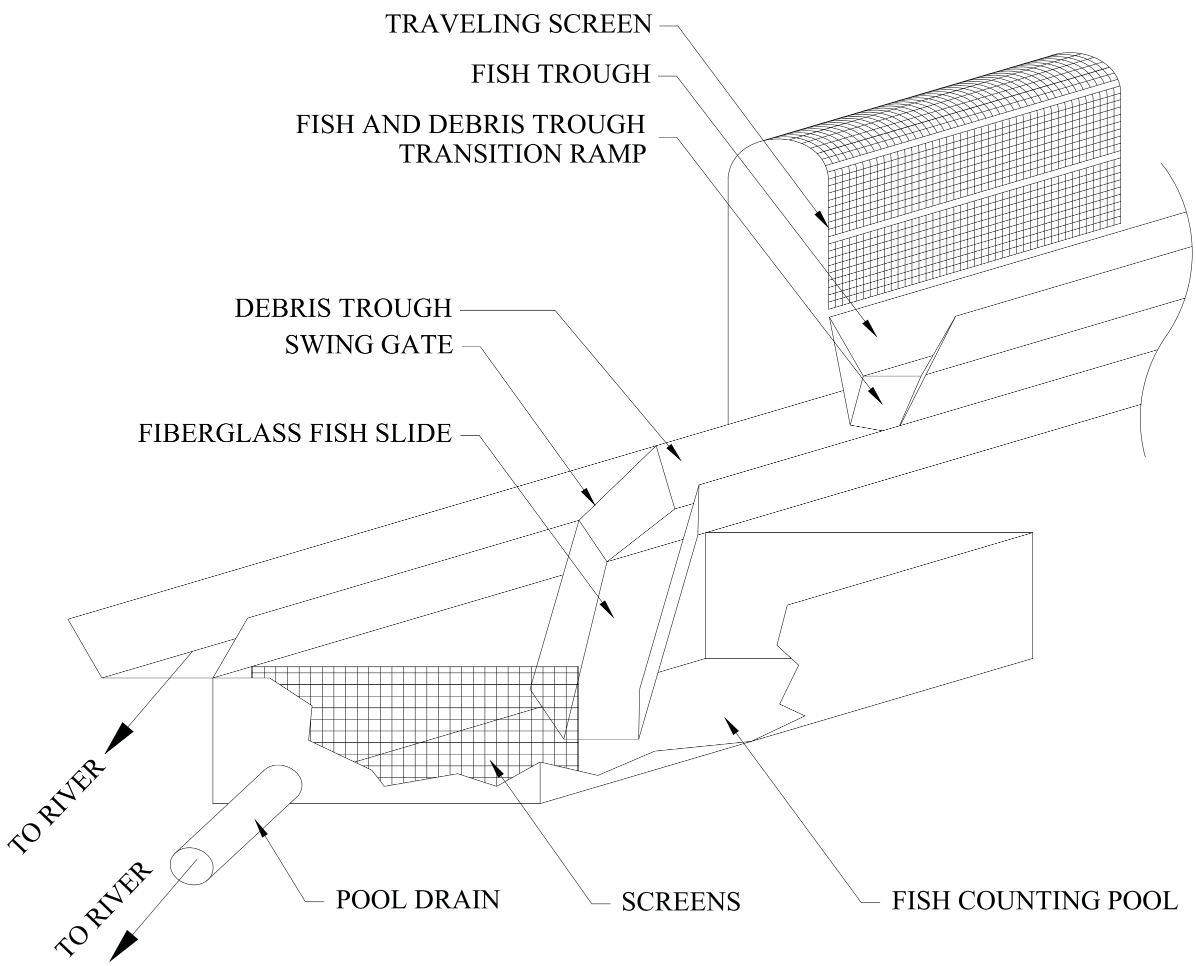


Figure 2-2. Fish counting pool.

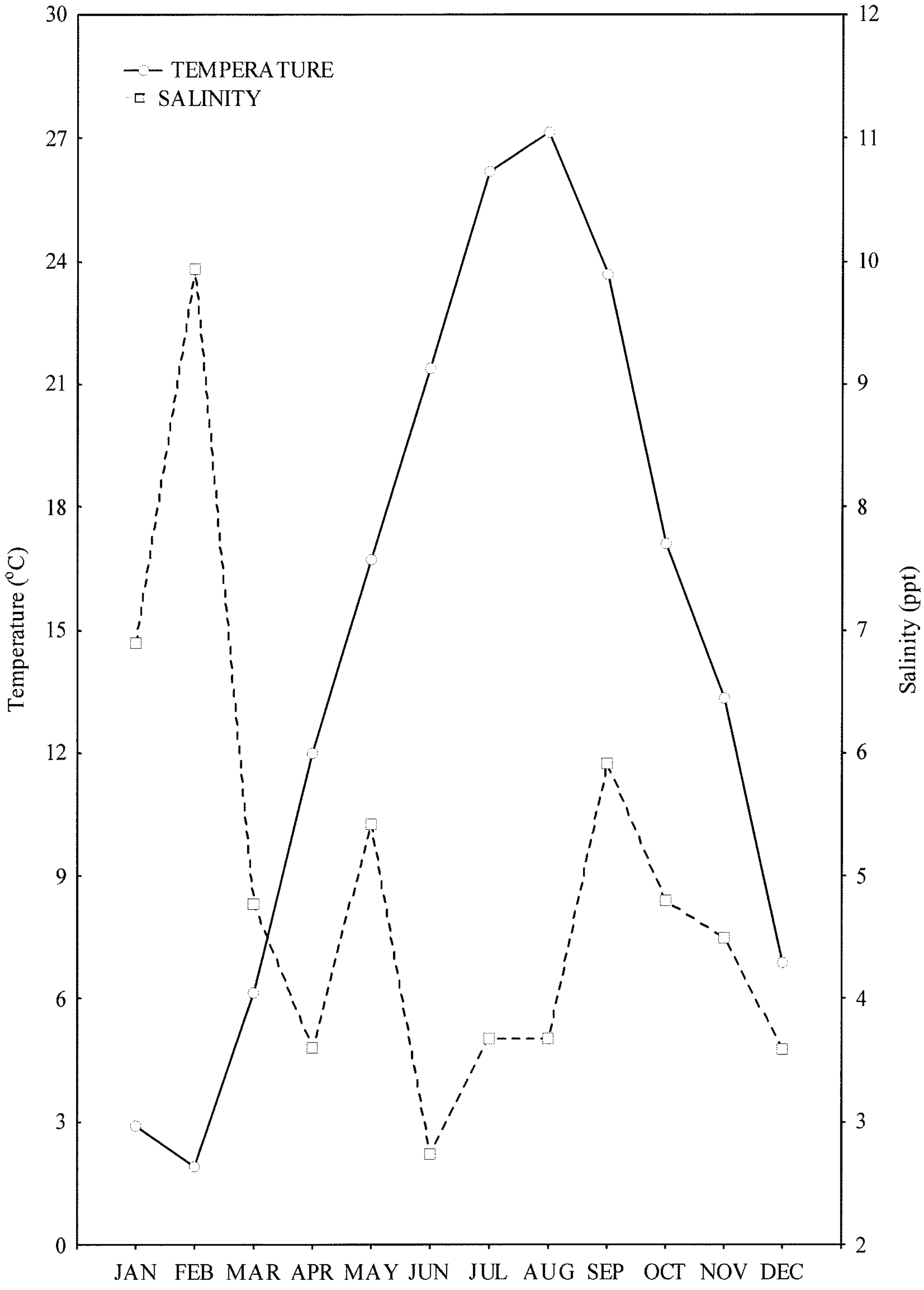


Figure 2-3. Salinity and temperature (mean) by month as observed during 2003 impingement sampling.

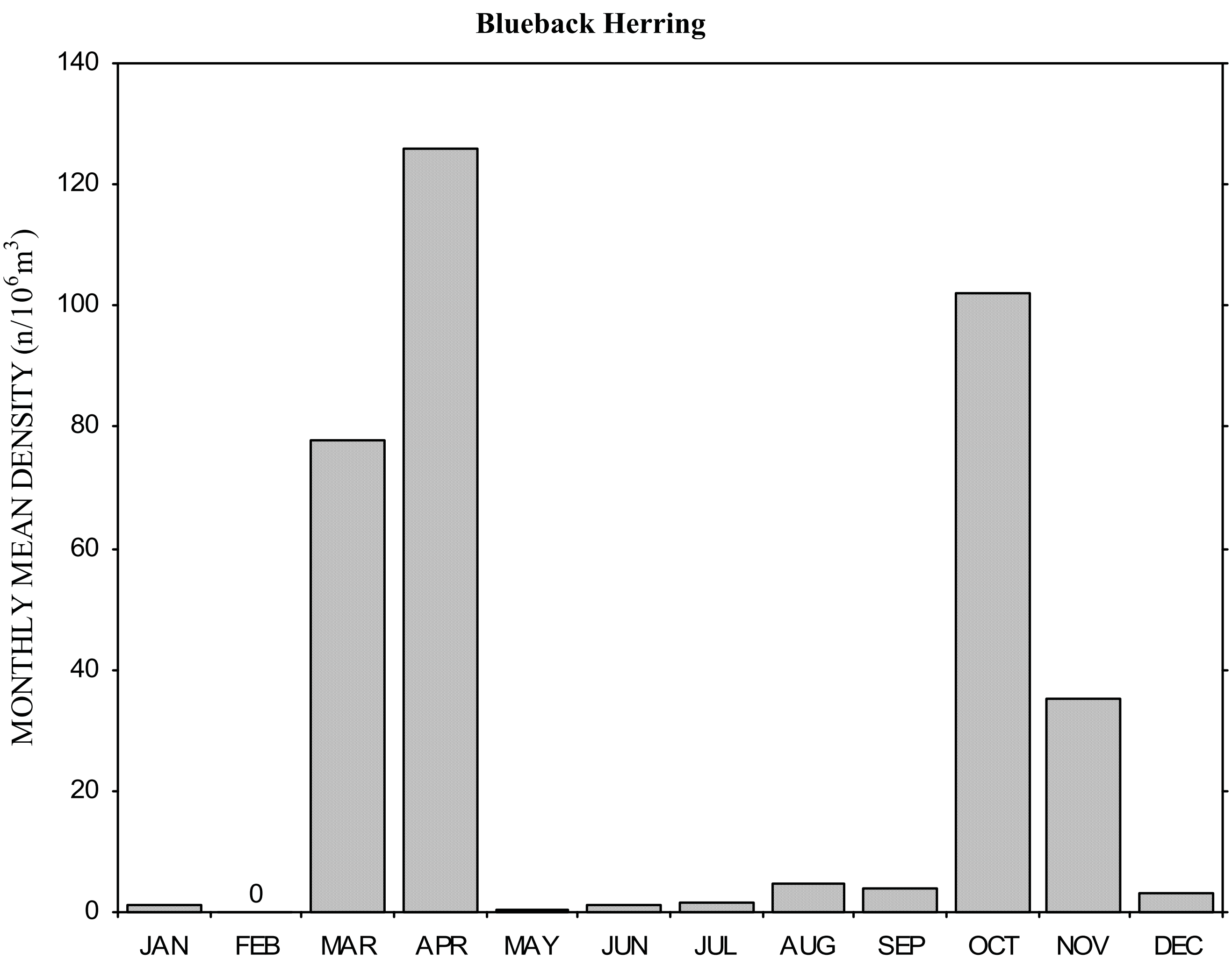


Figure 2-4. Monthly mean density (n/$10^6$ meters$^3$) of blueback herring taken in impingement sampling at the Salem circulating water intake structure during 2003.

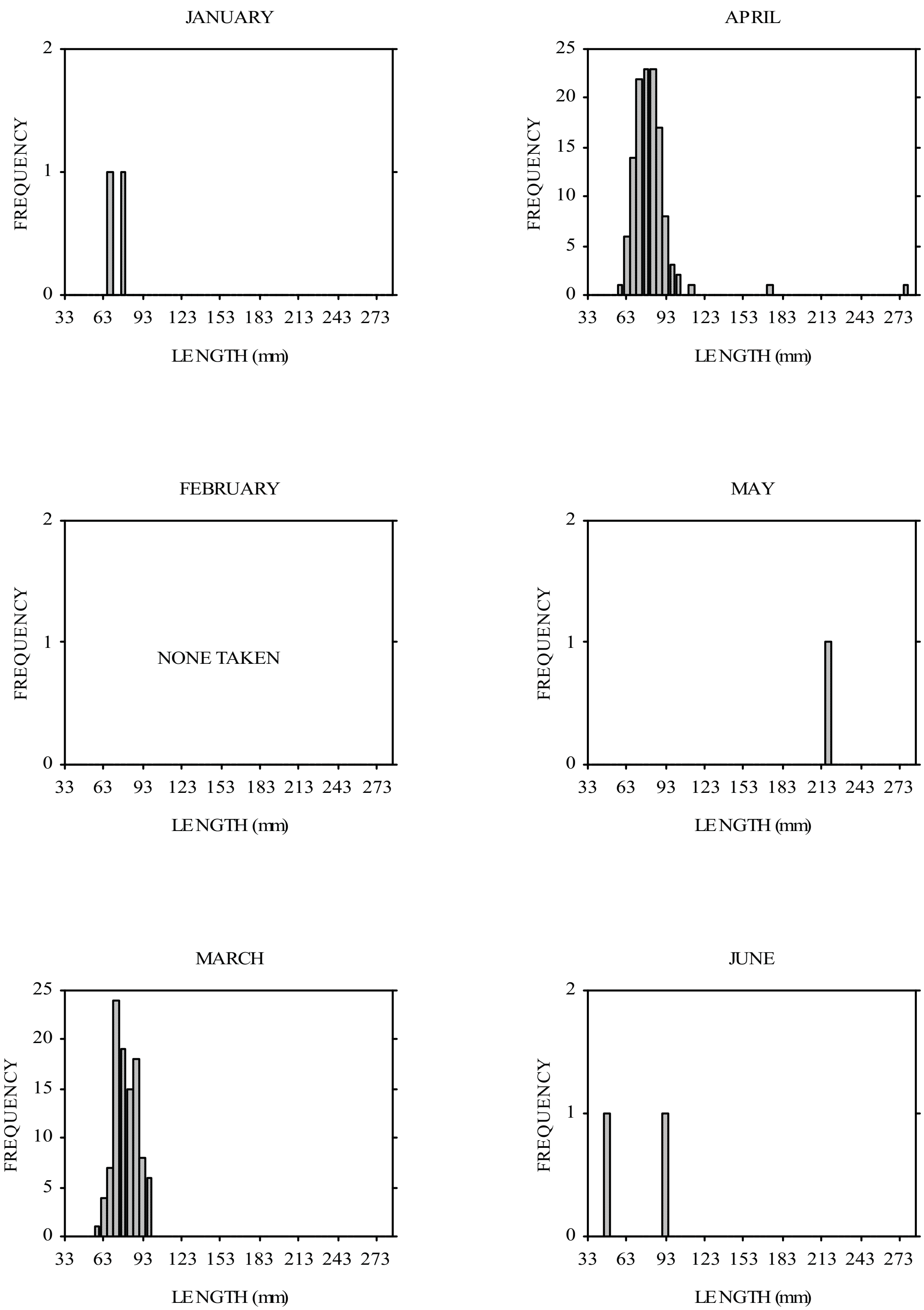


Figure 2-5. Length frequency of blueback herring taken in impingement sampling at the Salem circulating water intake structure during 2003.

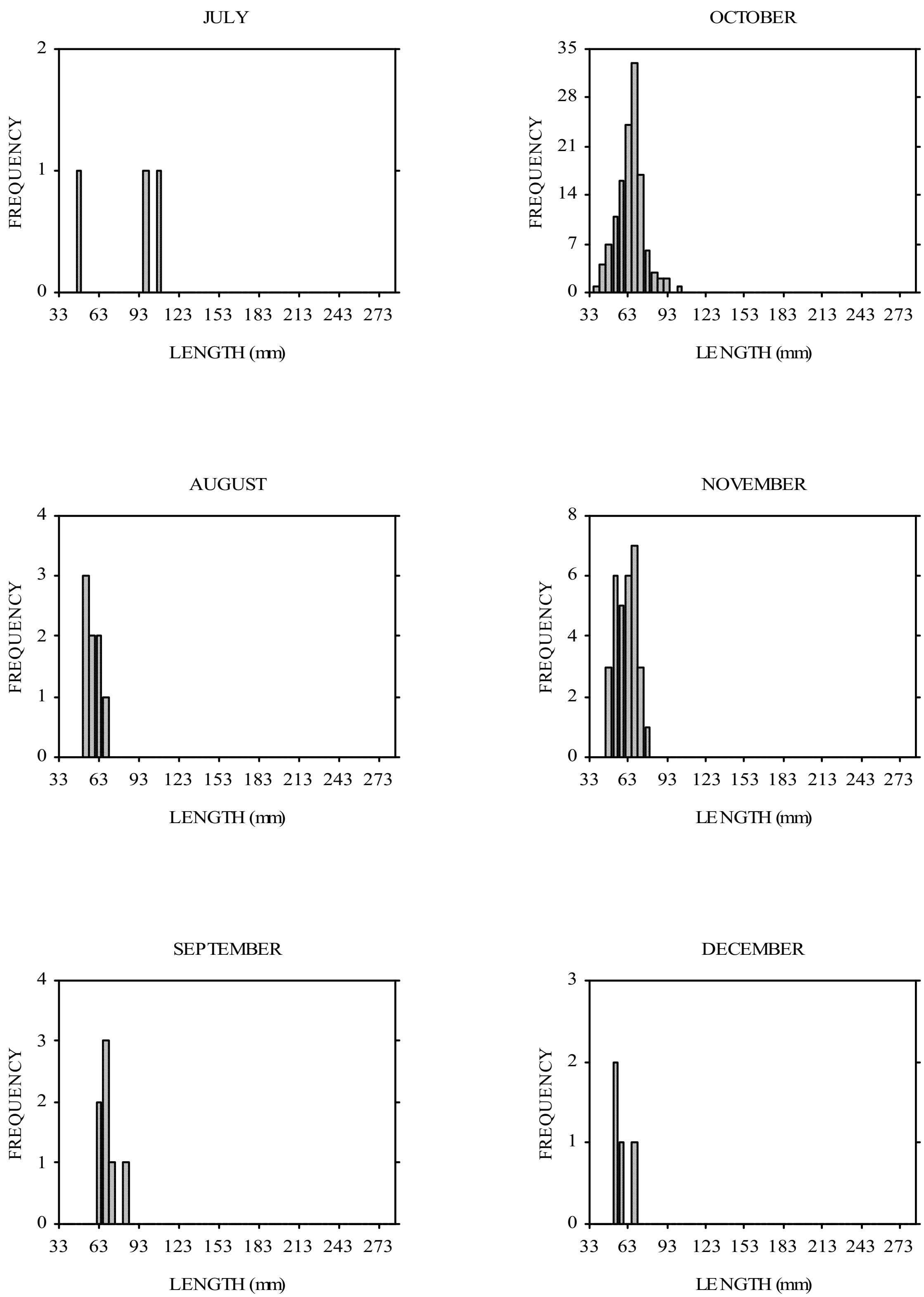


Figure 2-5. Continued.

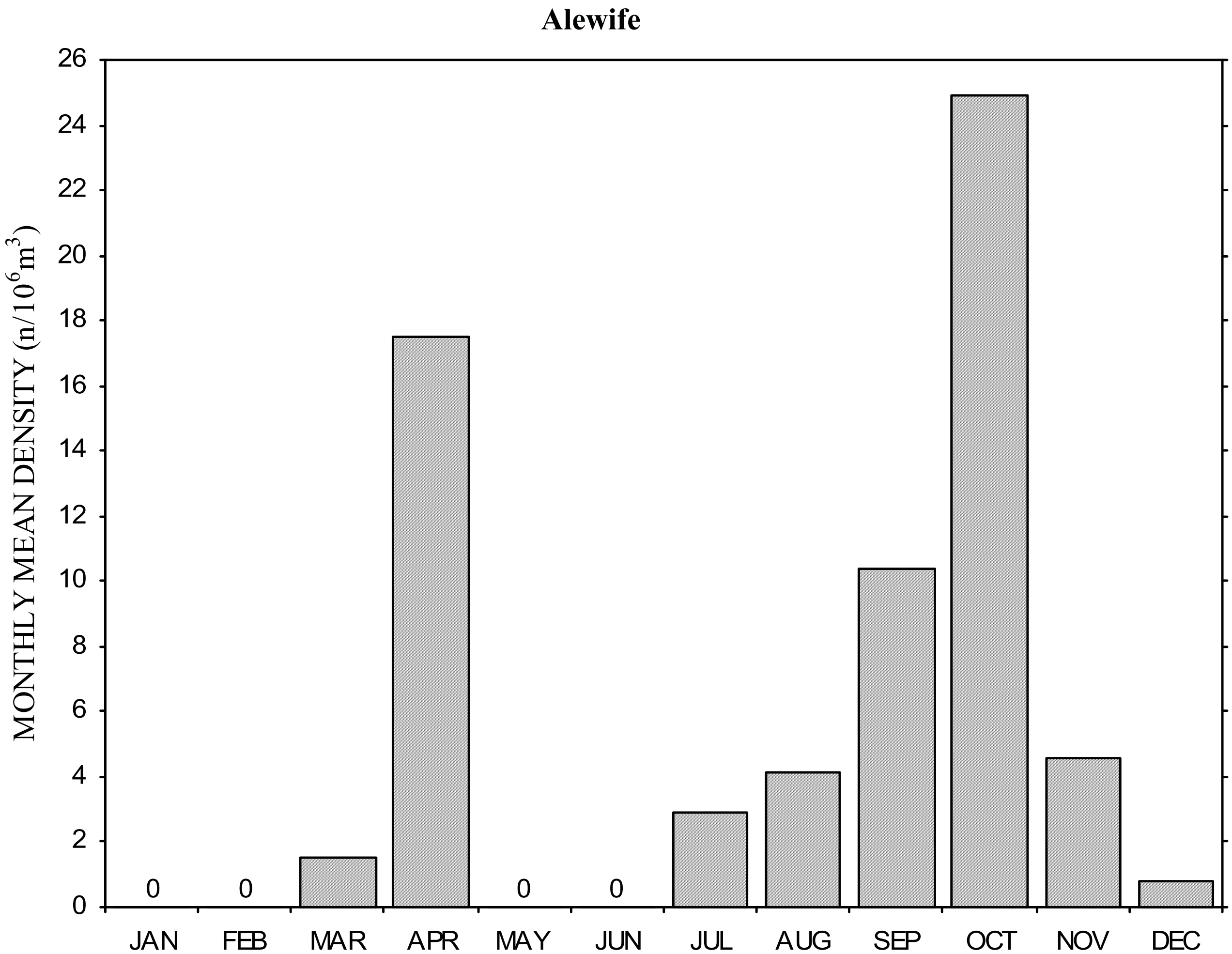


Figure 2-6. Monthly mean density (n/$10^6$ meters$^3$) of alewife taken in impingement sampling at the Salem circulating water intake structure during 2003.

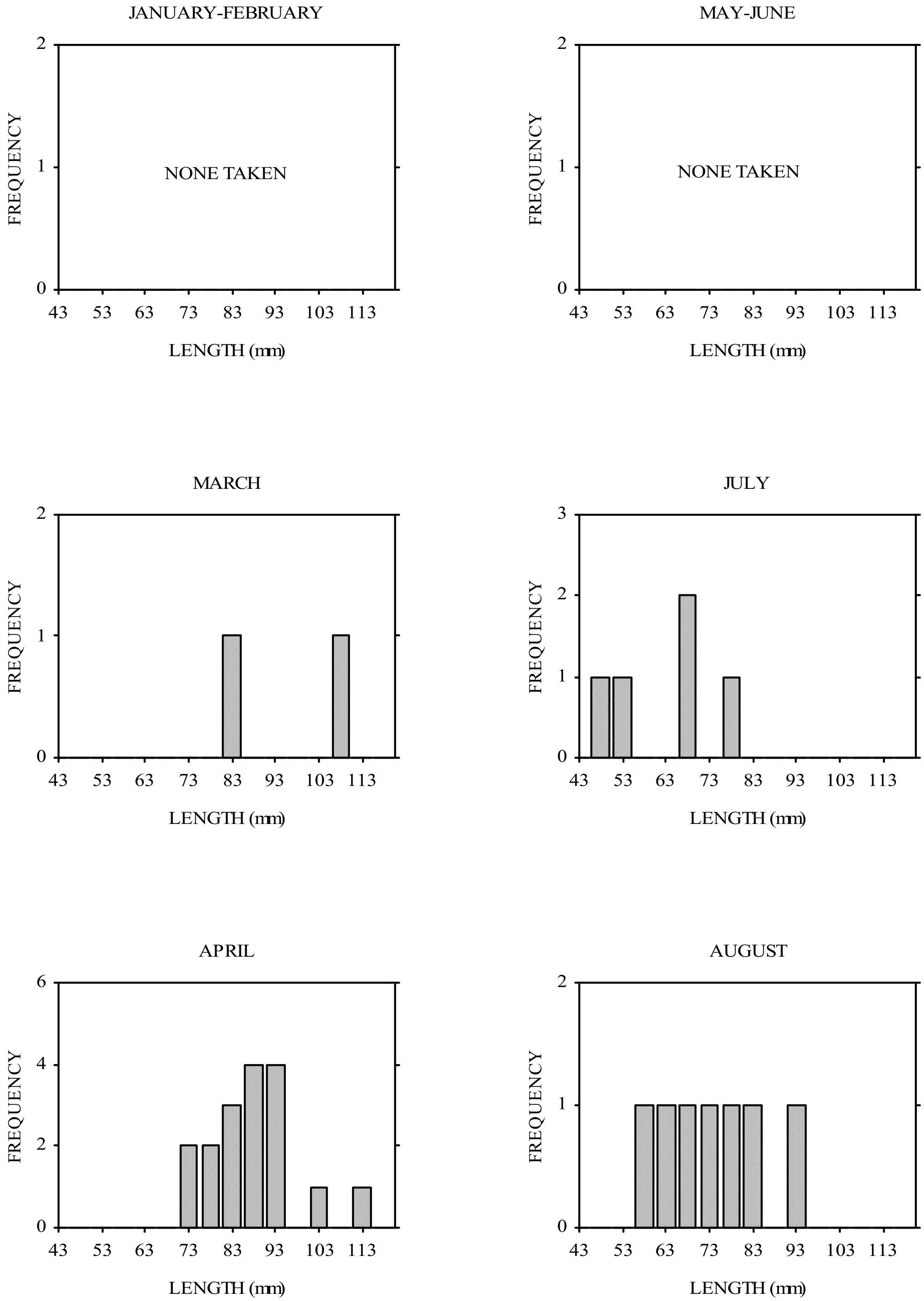


Figure 2-7. Length frequency of alewife taken in impingement sampling at the Salem circulating water intake structure during 2003.

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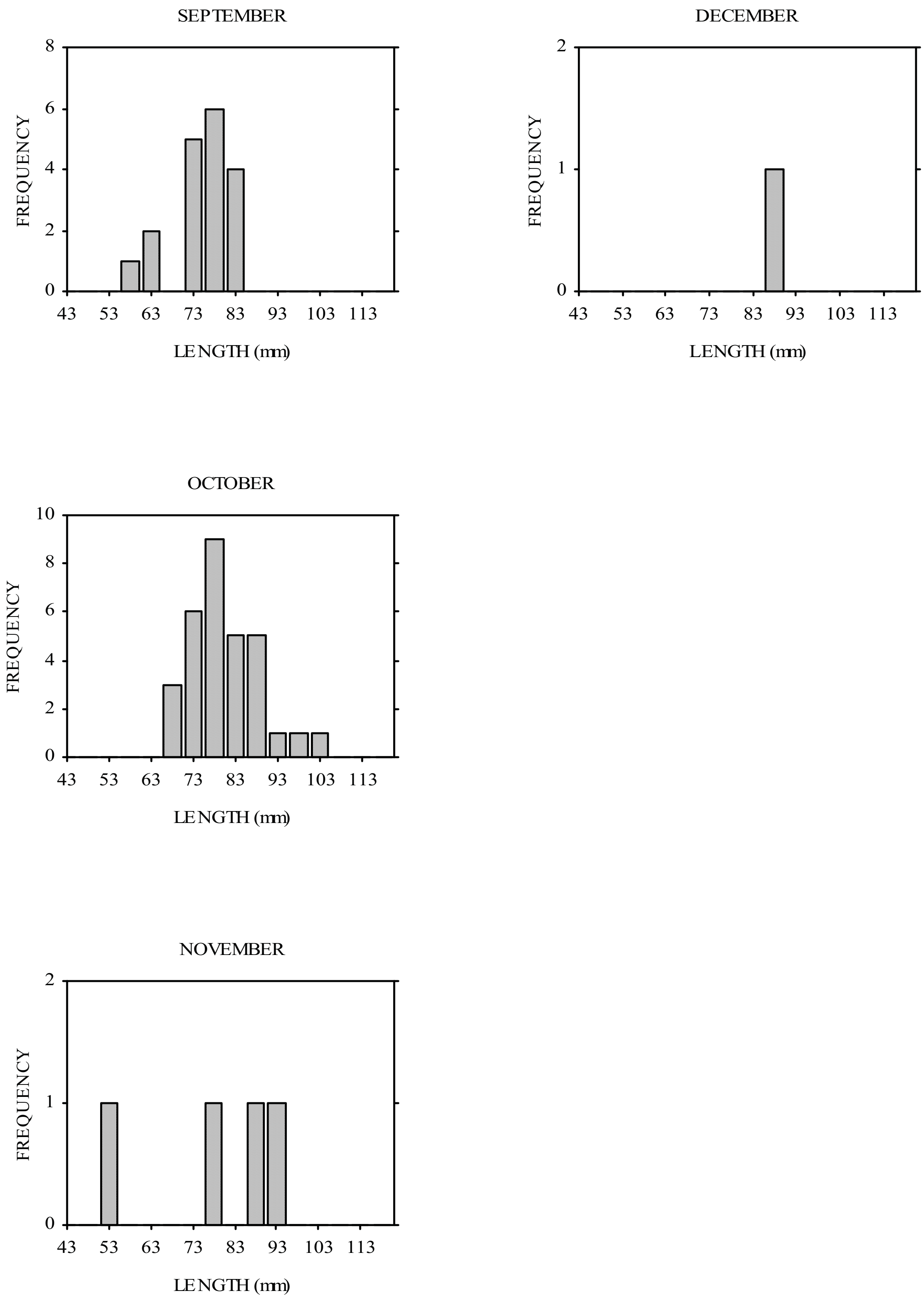



Figure 2-7. Continued.

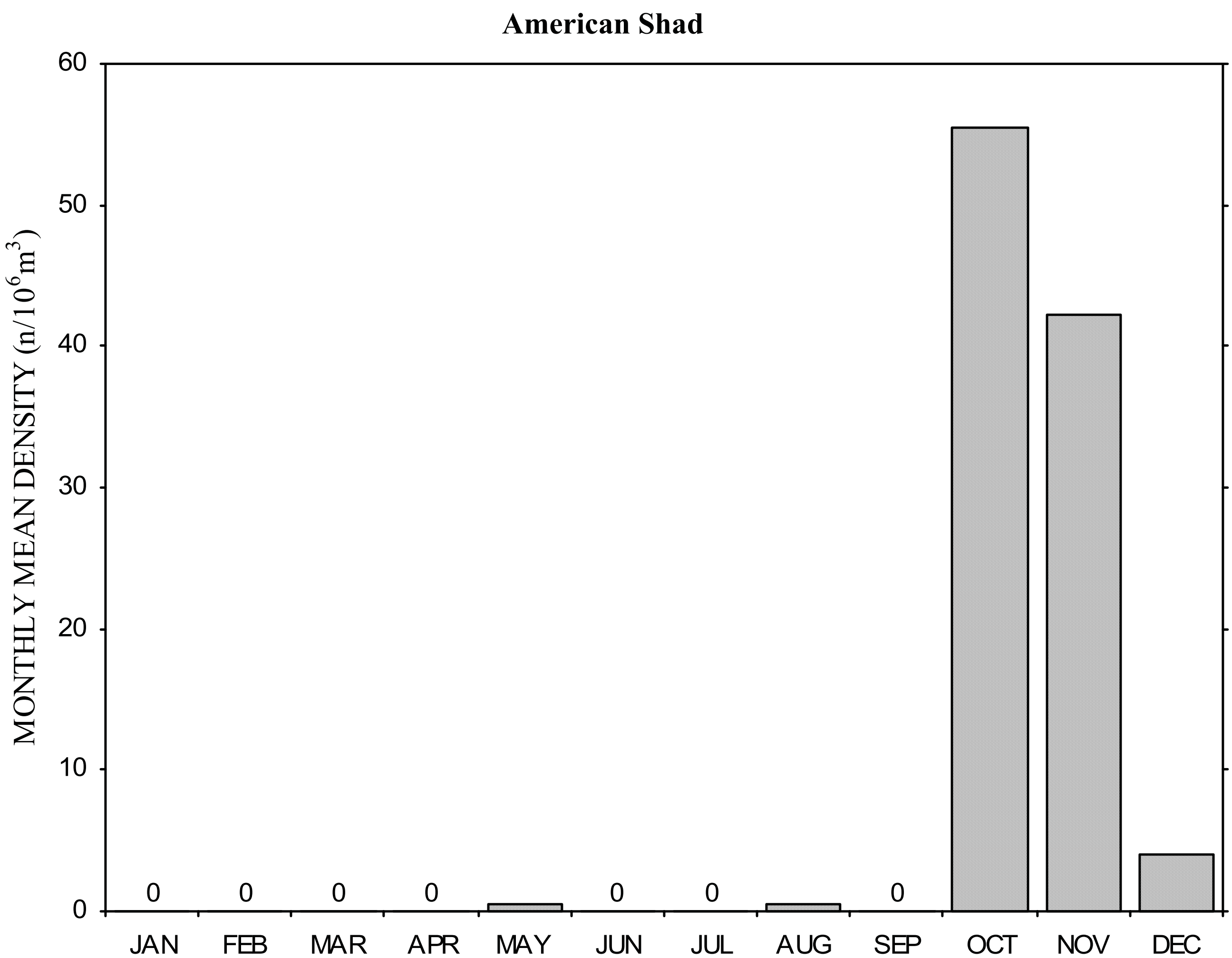



Figure 2-8. Monthly mean density (n/$10^6$ meters$^3$) of American shad taken in impingement sampling at the Salem circulating water intake structure during 2003.

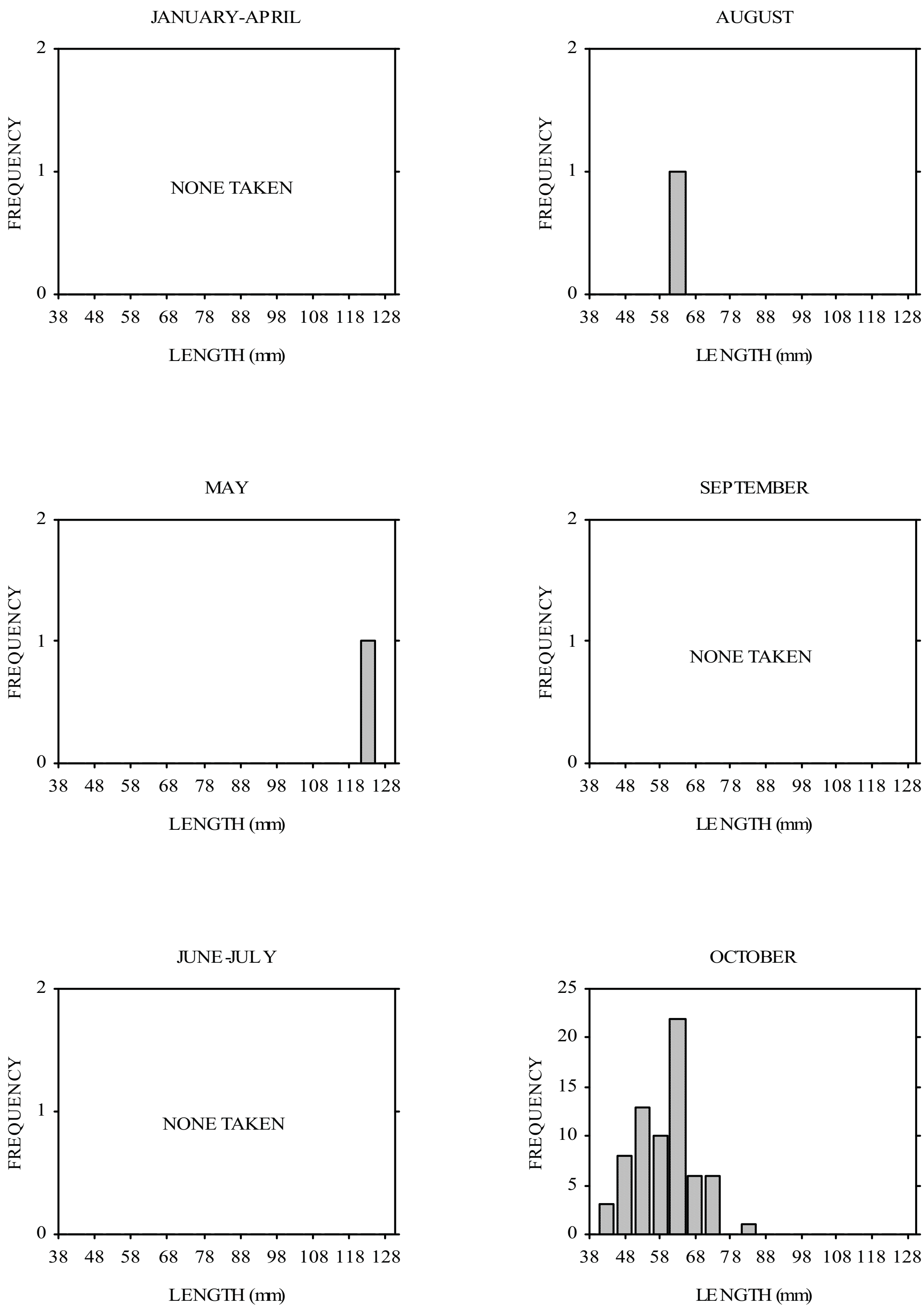
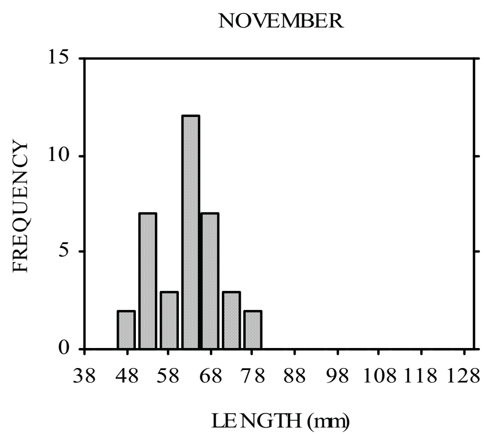



Figure 2-9. Length frequency of American shad taken in impingement sampling at the Salem circulating water intake structure during 2003.



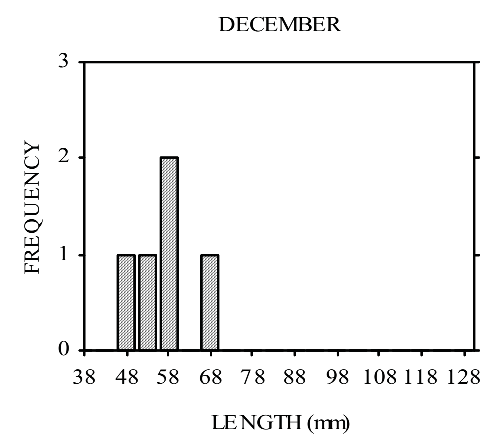




Figure 2-9. Continued.

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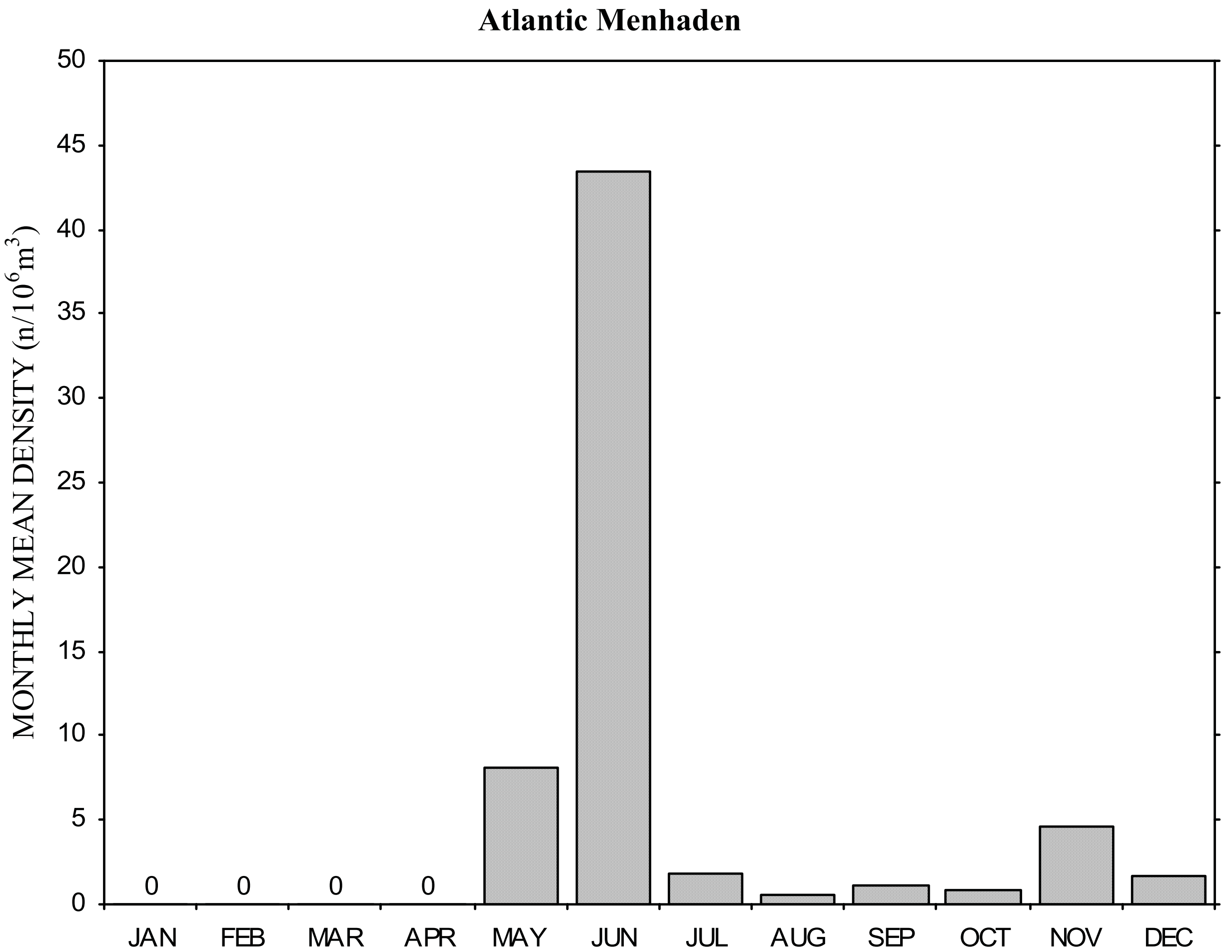


Figure 2-10. Monthly mean density (n/$10^6$ meters$^3$) of Atlantic menhaden taken in impingement sampling at the Salem circulating water intake structure during 2003.

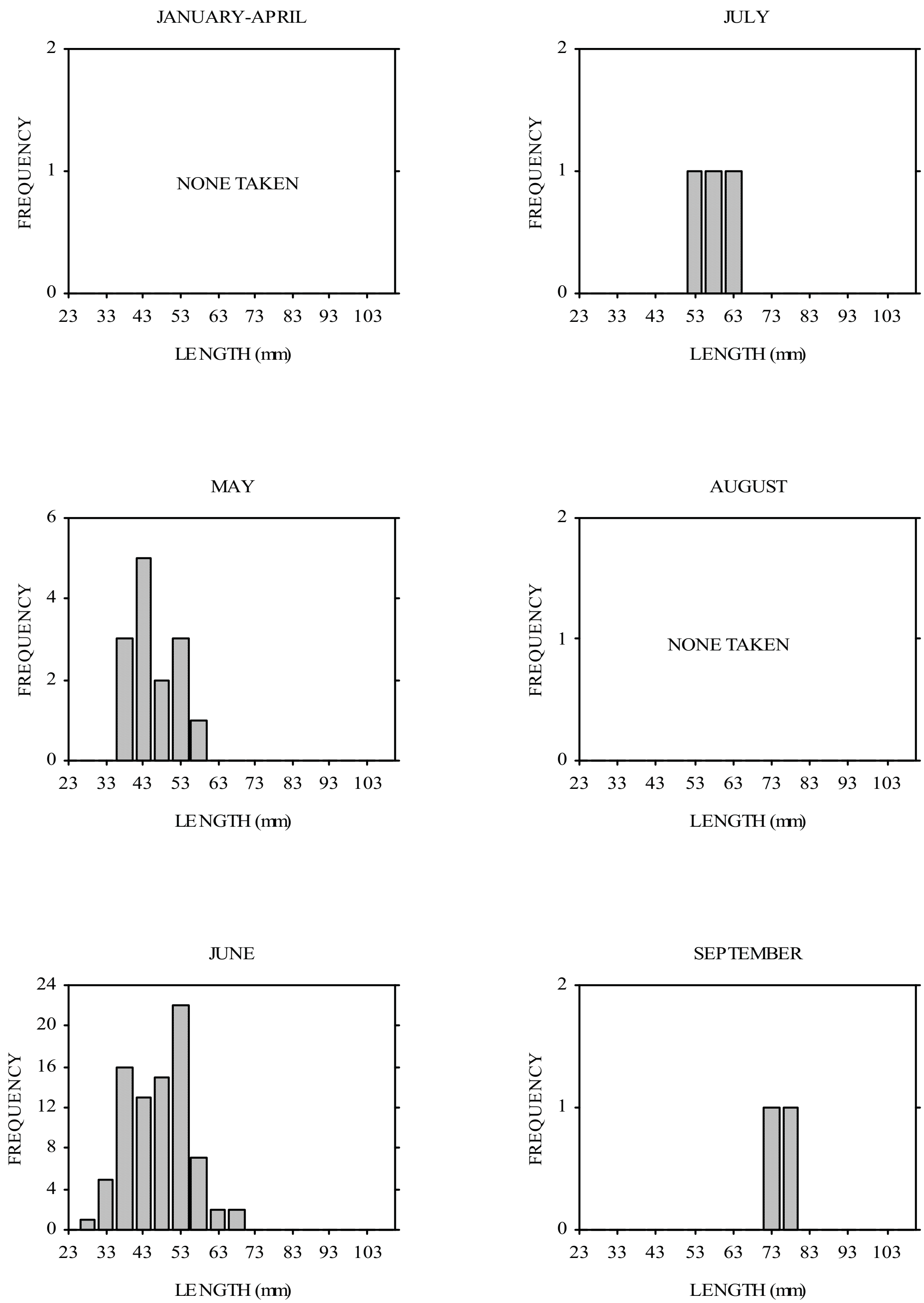


Figure 2-11. Length frequency of Atlantic menhaden taken in impingement sampling at the Salem circulating water intake structure during 2003.

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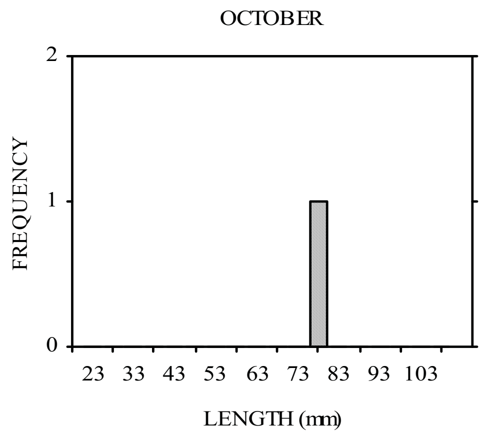


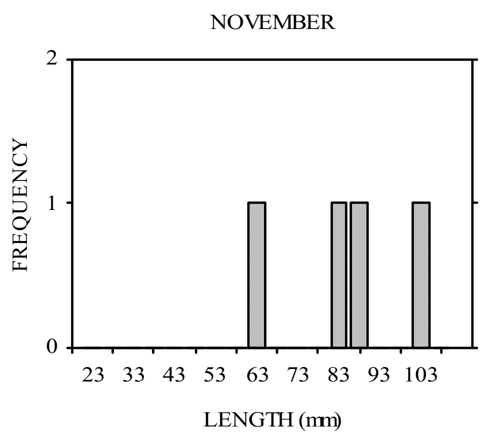


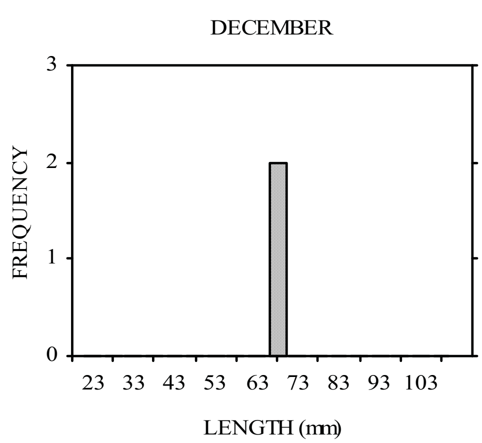


Figure 2-11. Continued.

**Bay Anchovy**

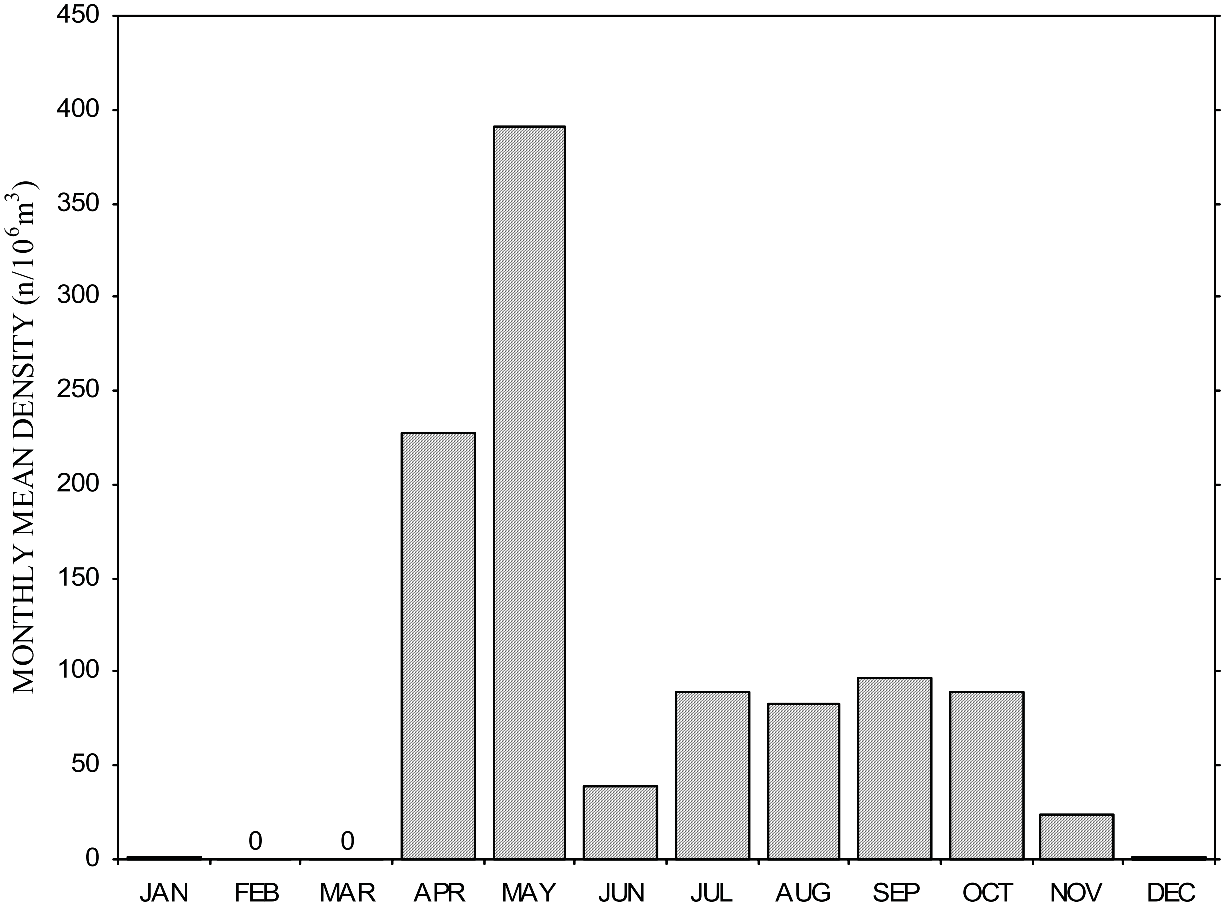


Figure 2-12. Monthly mean density (n/$10^6$ meters$^3$) of bay anchovy taken in impingement sampling at the Salem circulating water intake structure during 2003.

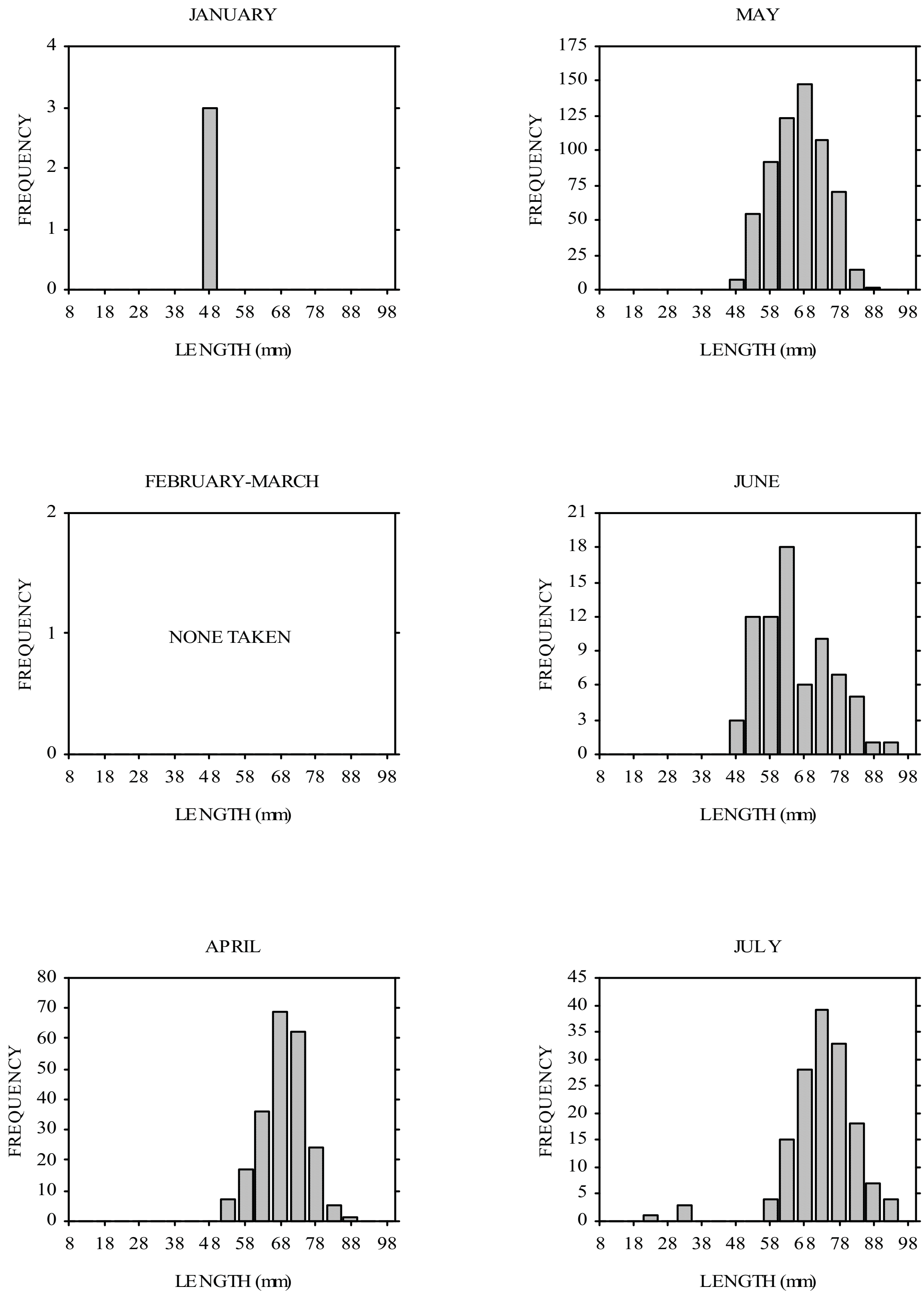


Figure 2-13. Length frequency of bay anchovy taken in impingement sampling at the Salem circulating water intake structure during 2003.

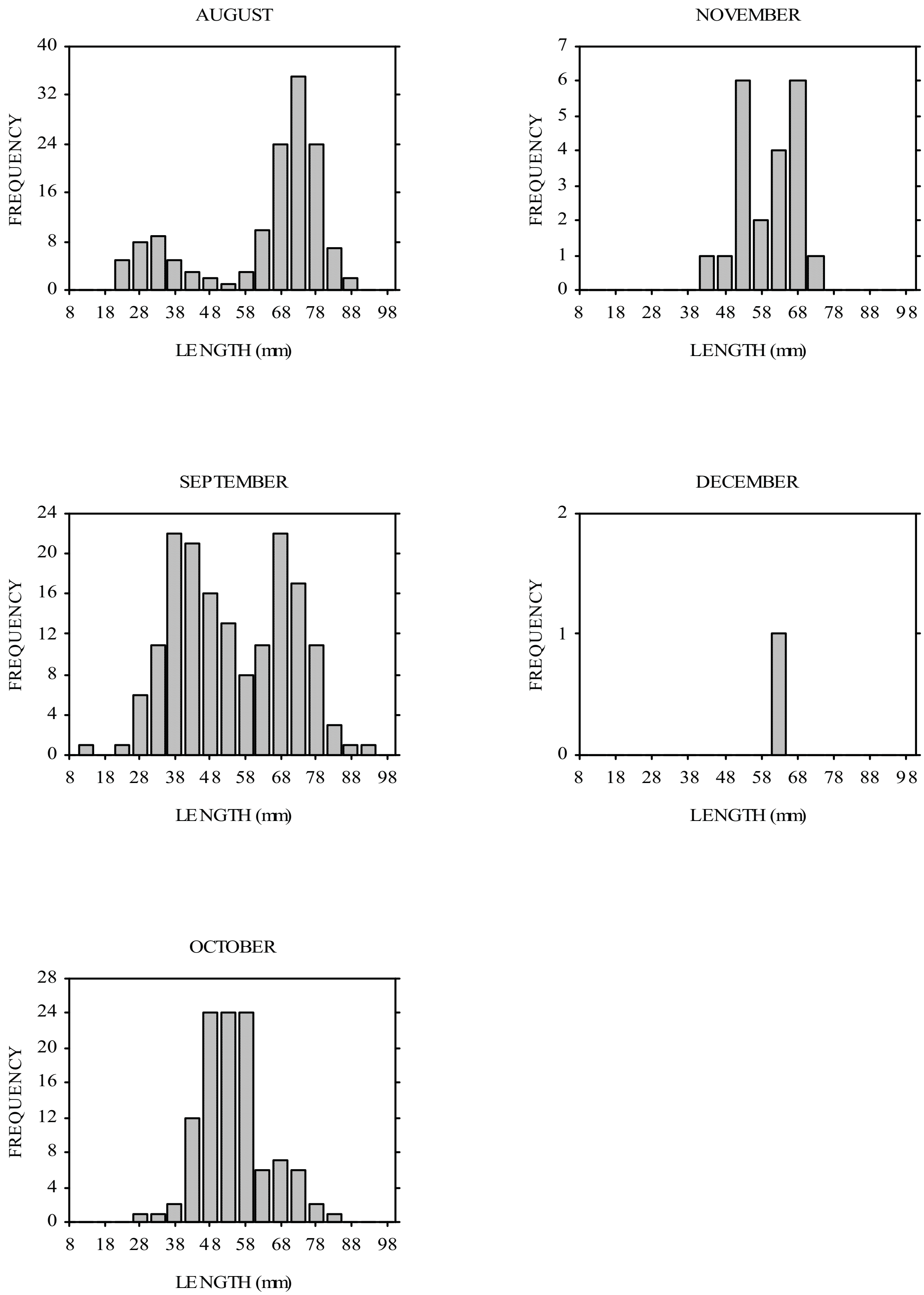


Figure 2-13. Continued.

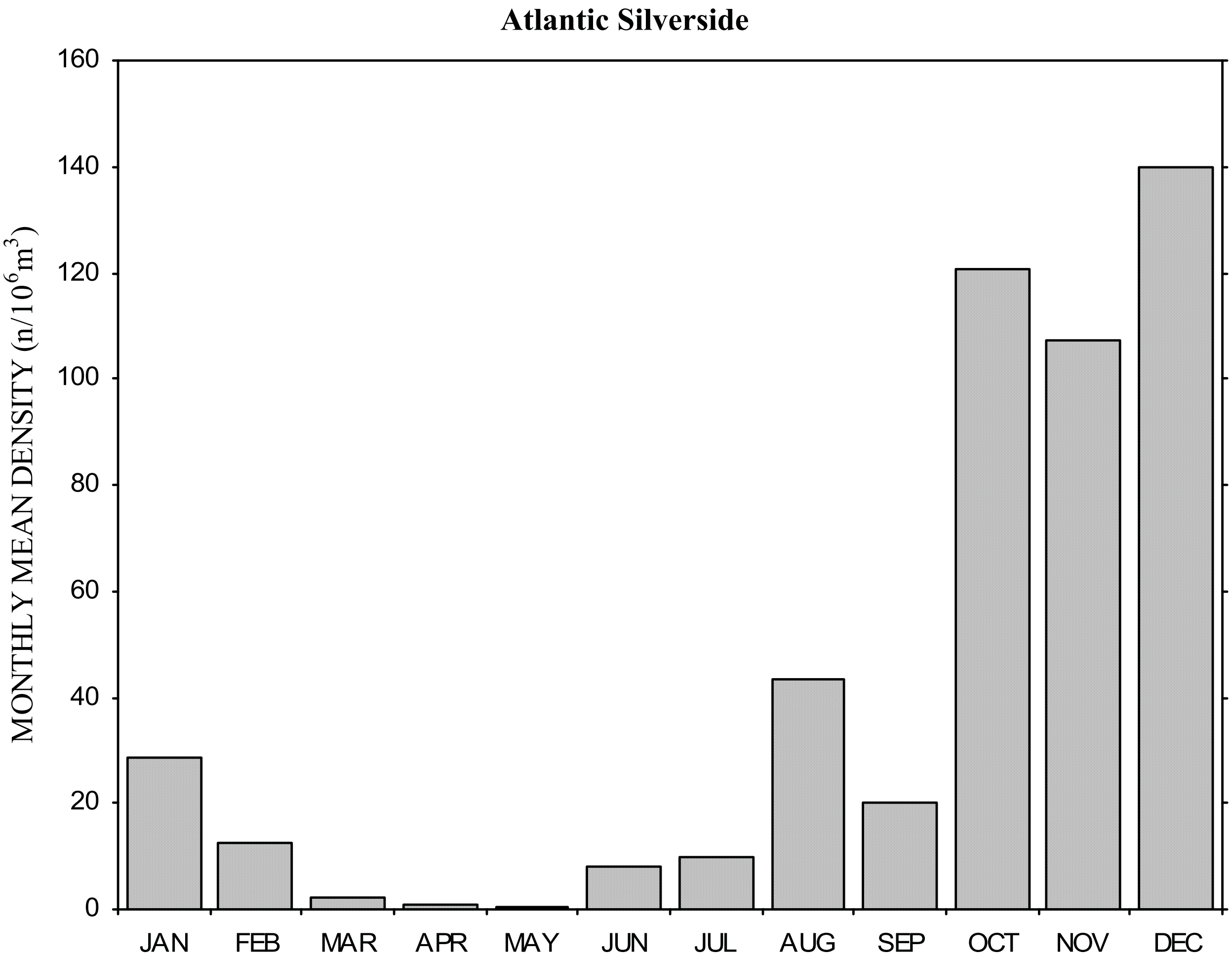


Figure 2-14. Monthly mean density (n/$10^6$ meters$^3$) of Atlantic silverside taken in impingement sampling at the Salem circulating water intake structure during 2003.

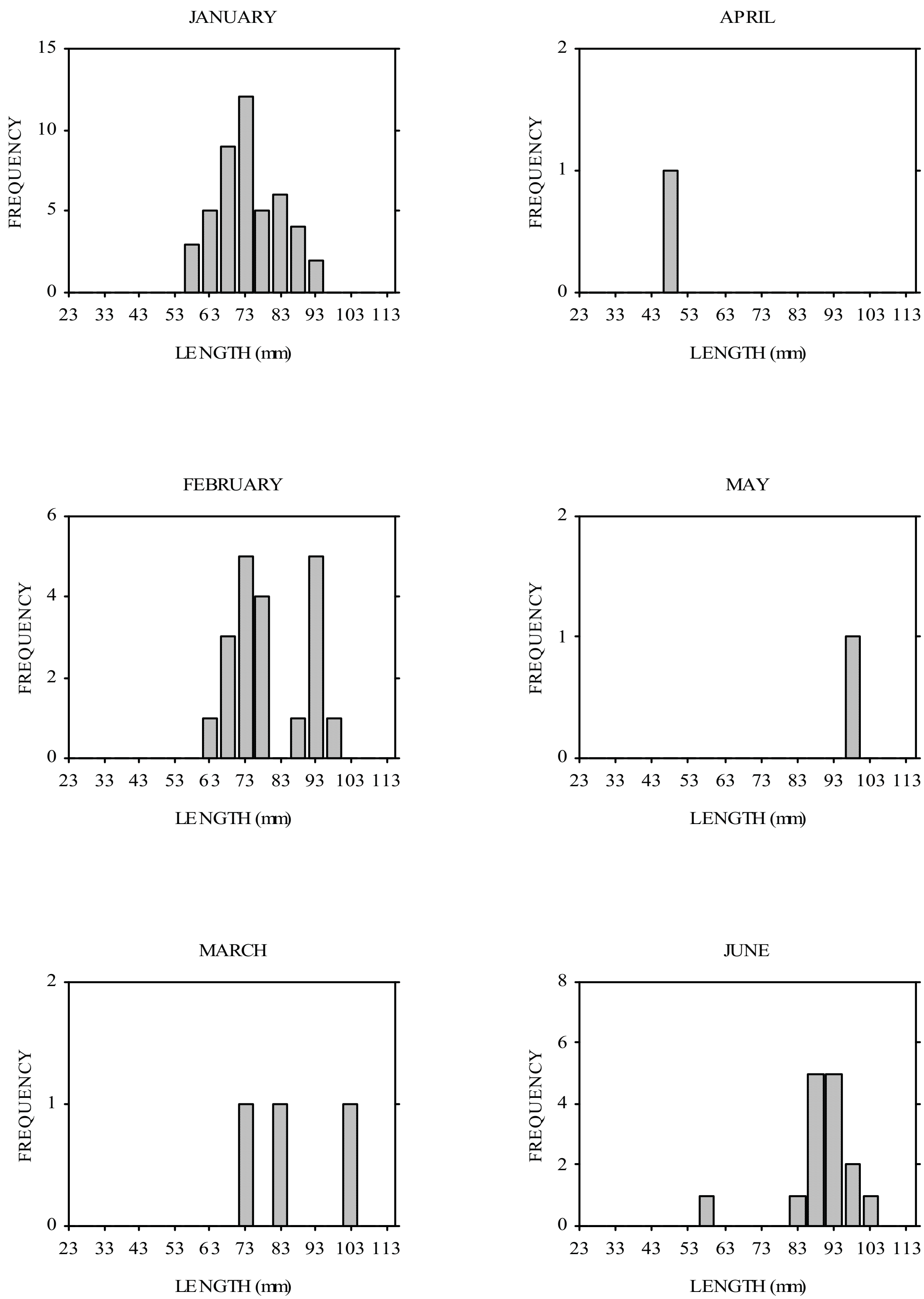


Figure 2-15. Length frequency of Atlantic silverside taken in impingement sampling at the Salem Circulating water intake structure during 2003.

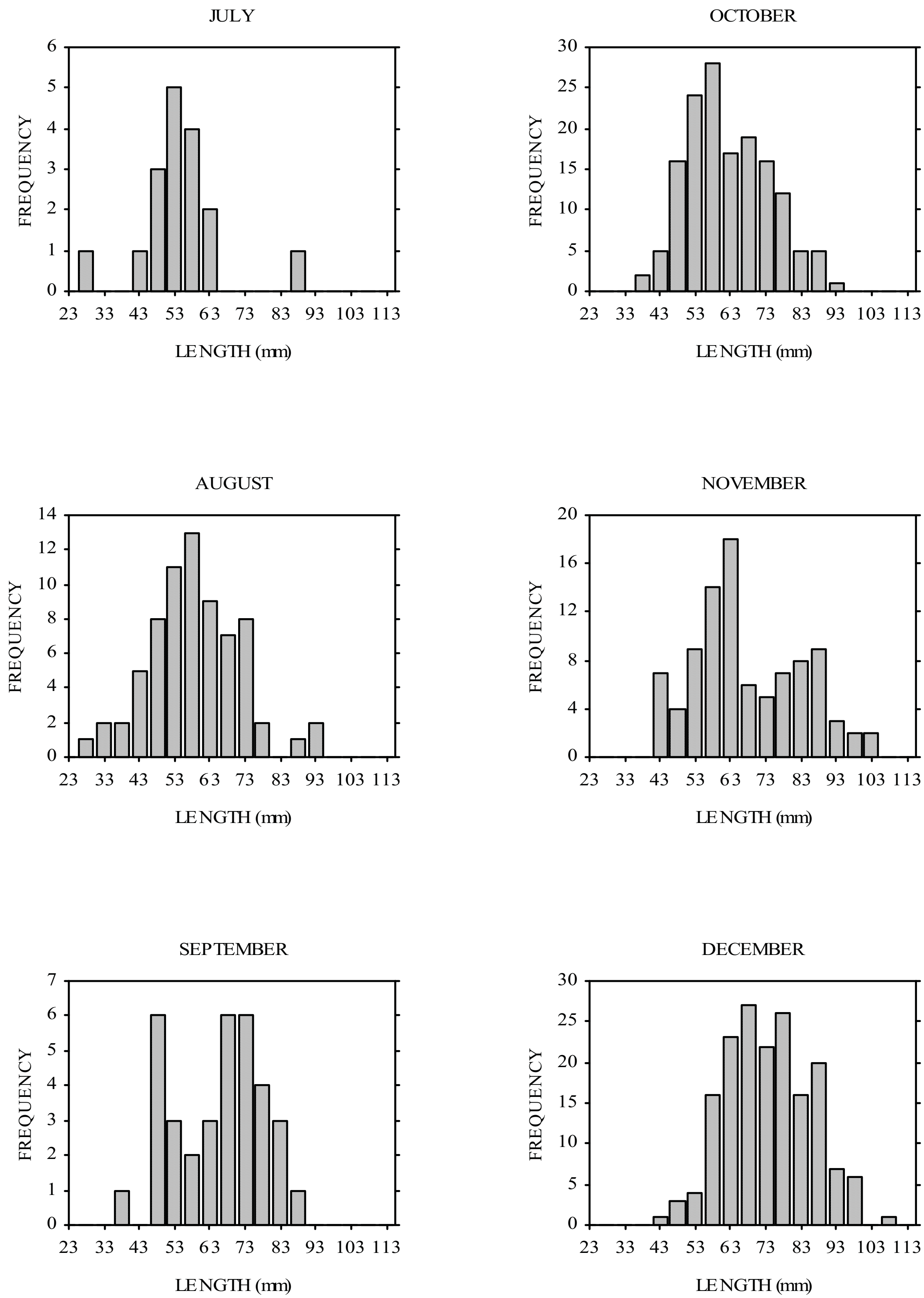


Figure 2-15.  Continued.

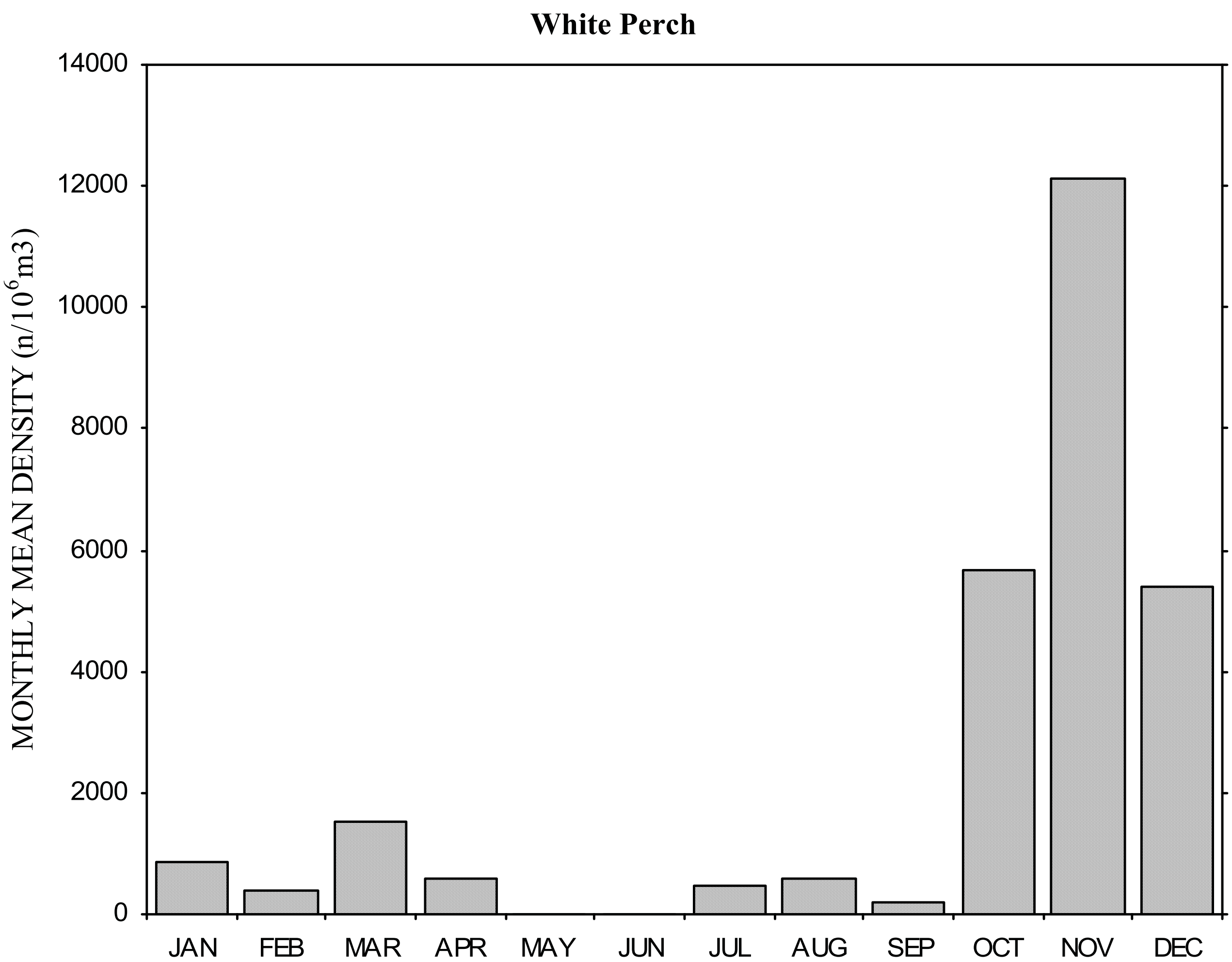


Figure 2-16. Monthly mean density (n/$10^6$ meters$^3$) of white perch taken in impingement sampling at the Salem circulating water intake structure during 2003.

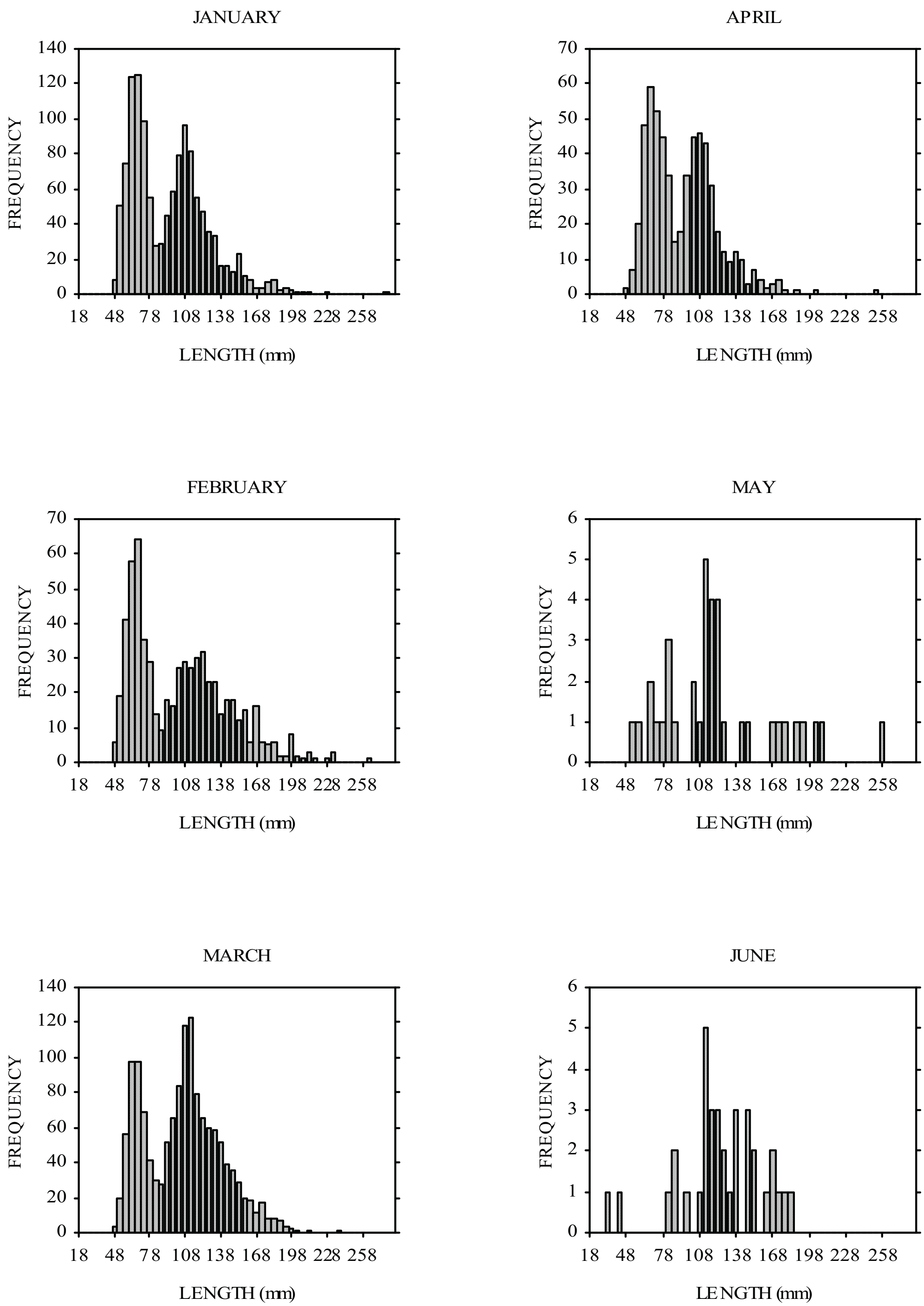


Figure 2-17. Length frequency of white perch taken in impingement sampling at the Salem circulating water intake structure during 2003.

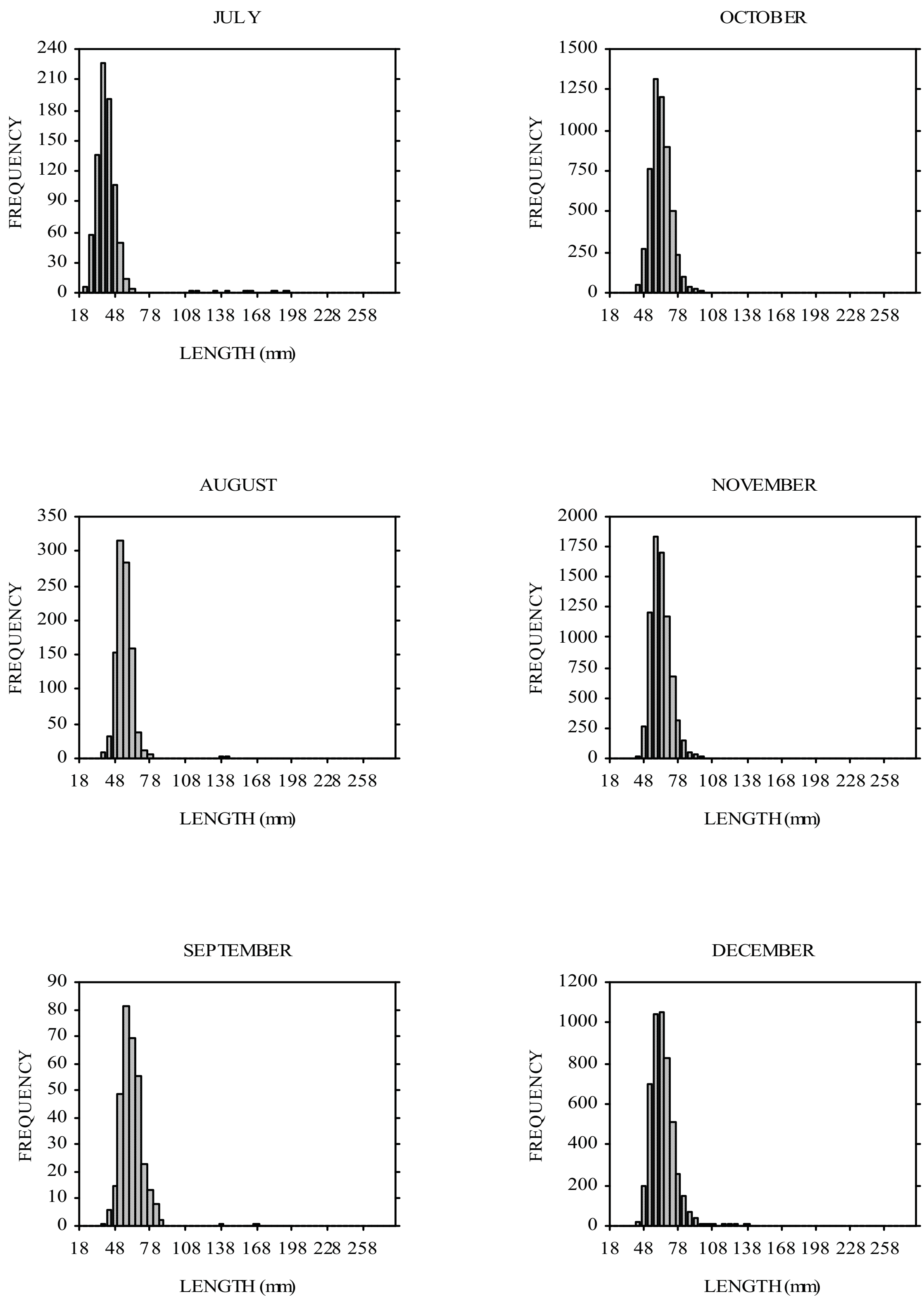


Figure 2-17. Continued.

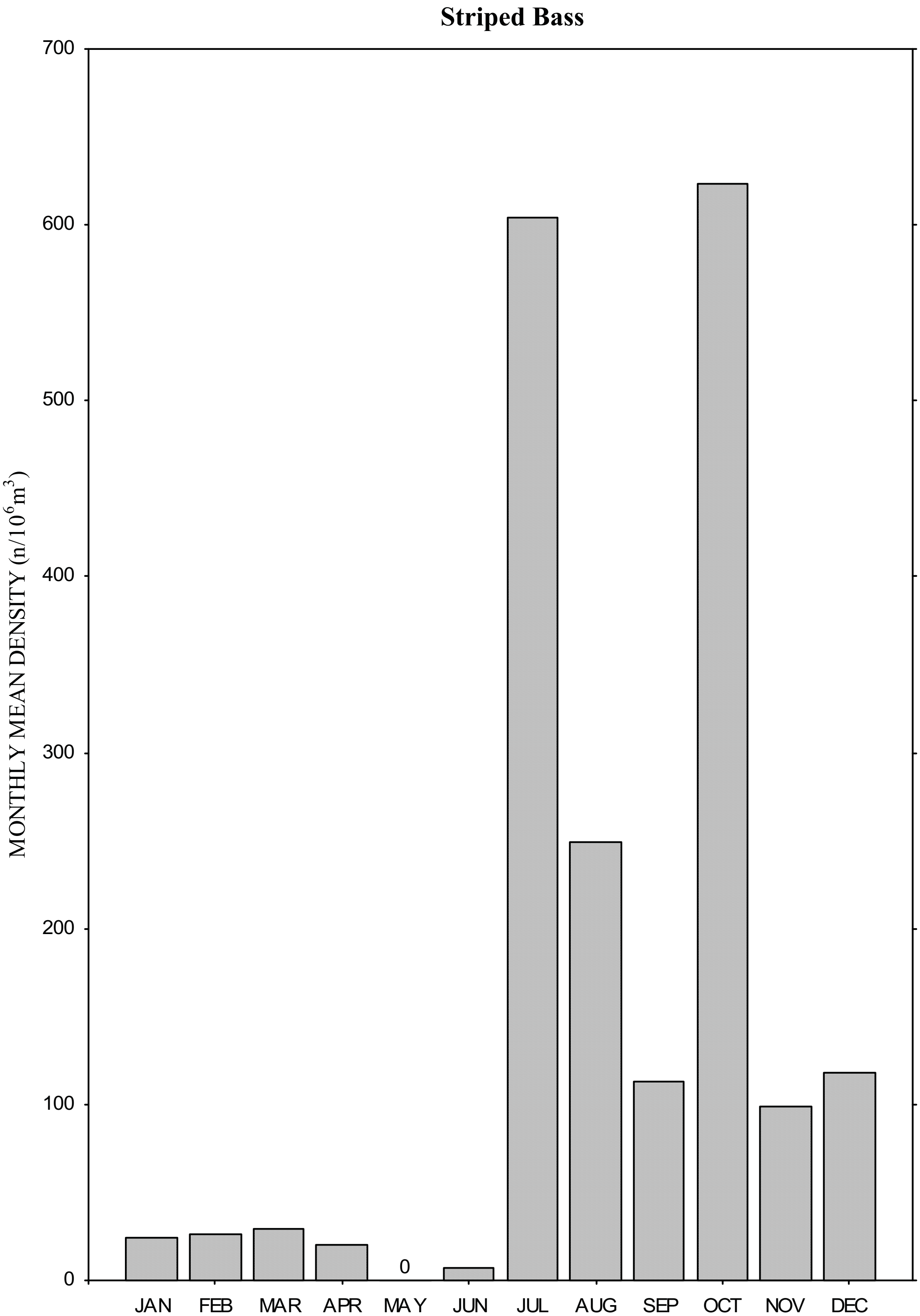


Figure 2-18. Monthly mean density (n/$10^6$ meters$^3$) of striped bass taken in impingement sampling at the Salem circulating water intake structure during 2003.

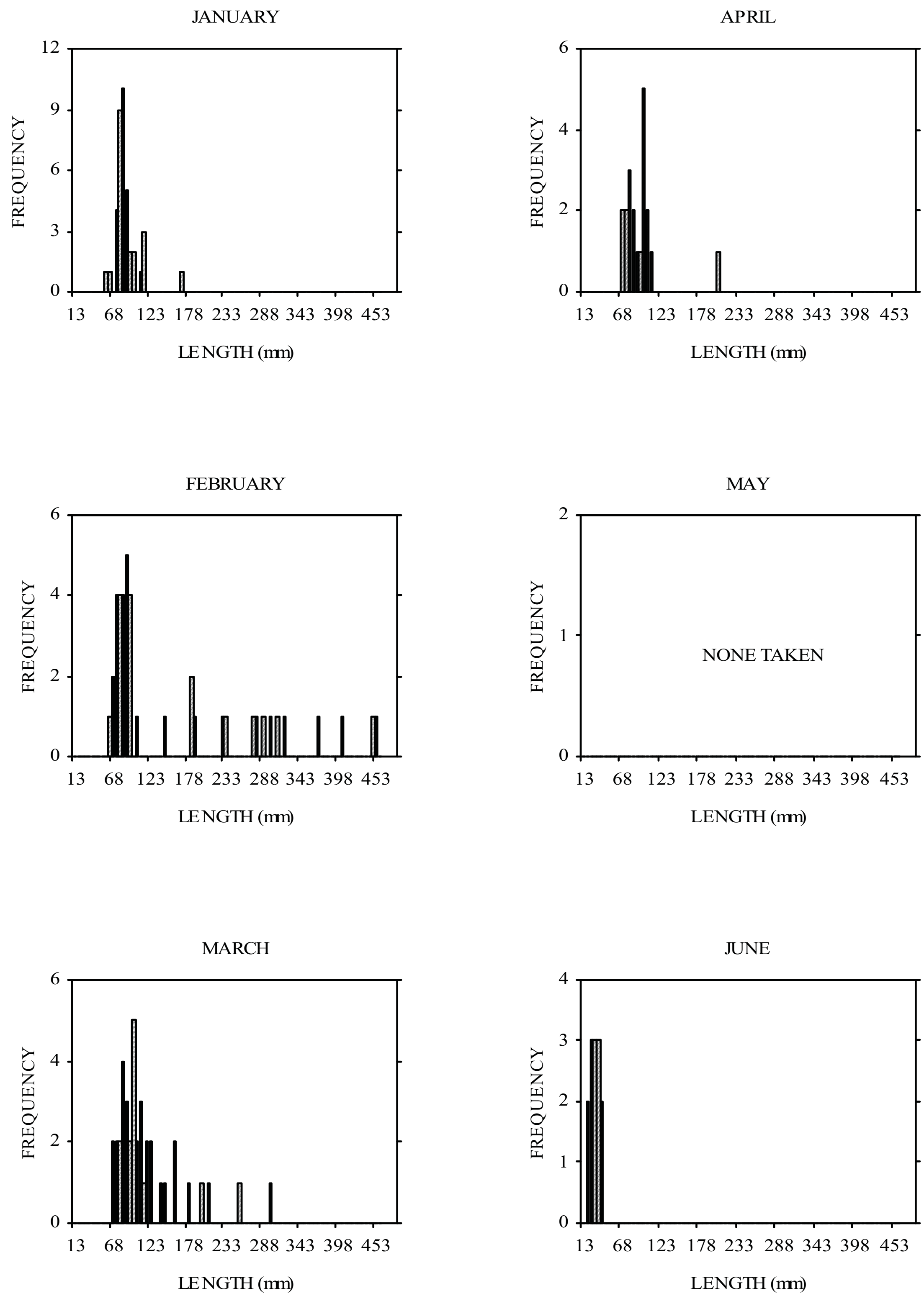


Figure 2-19. Length frequency of striped bass taken in impingement sampling at the Salem circulating water intake structure during 2003.

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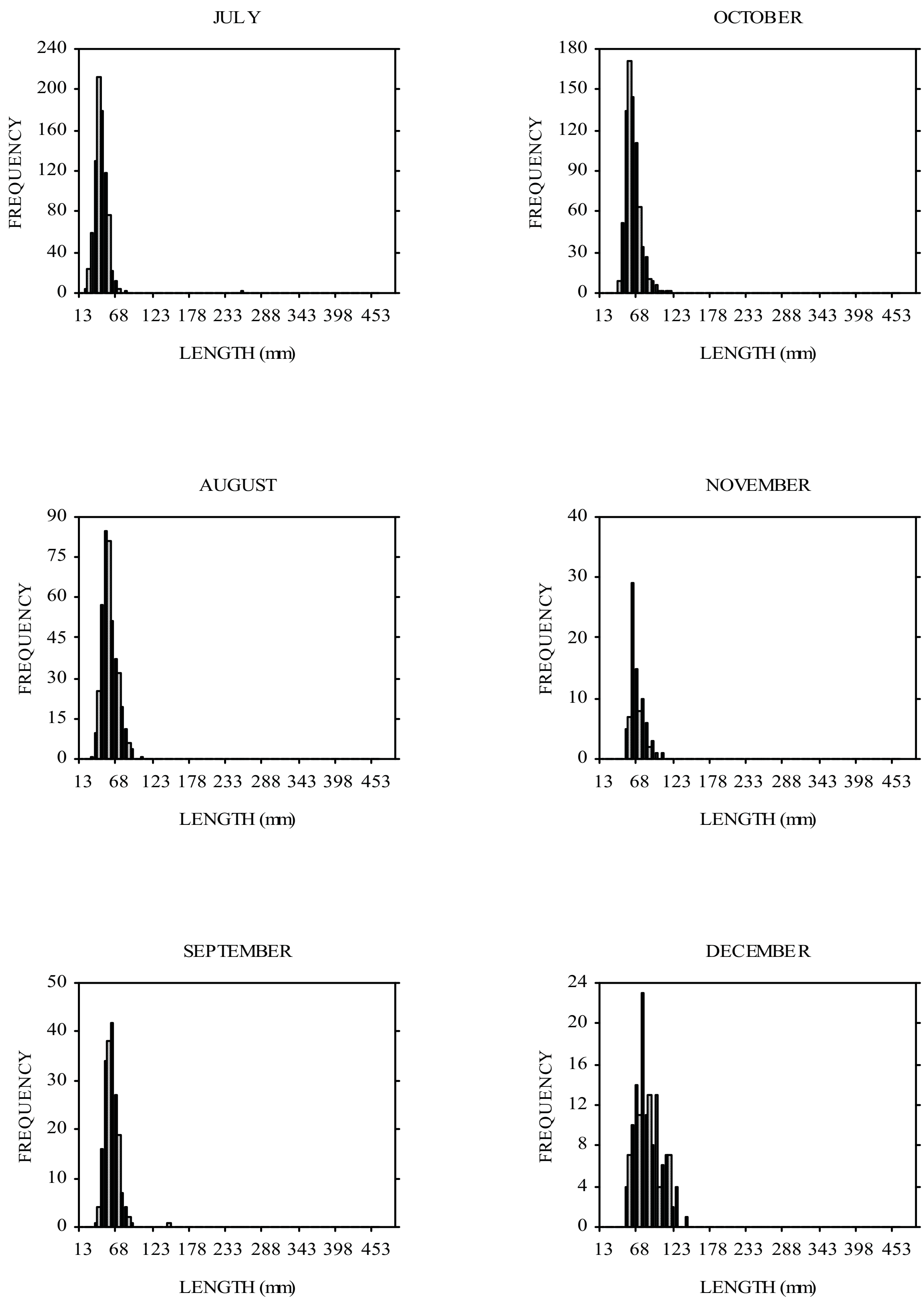



Figure 2-19. Continued.

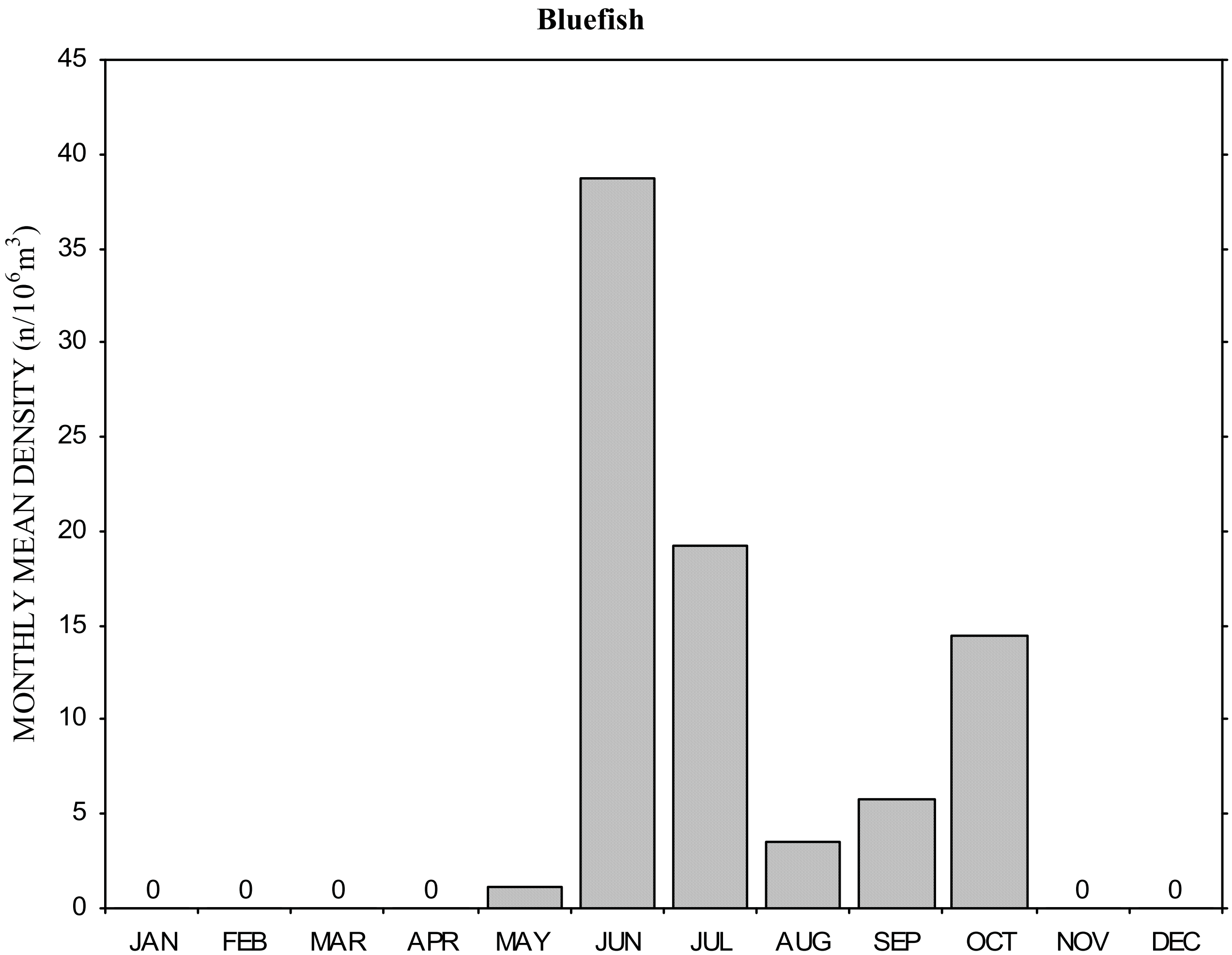



Figure 2-20. Monthly mean density (n/$10^6$ meters$^3$) of bluefish taken in impingement sampling at the Salem circulating water intake structure during 2003.

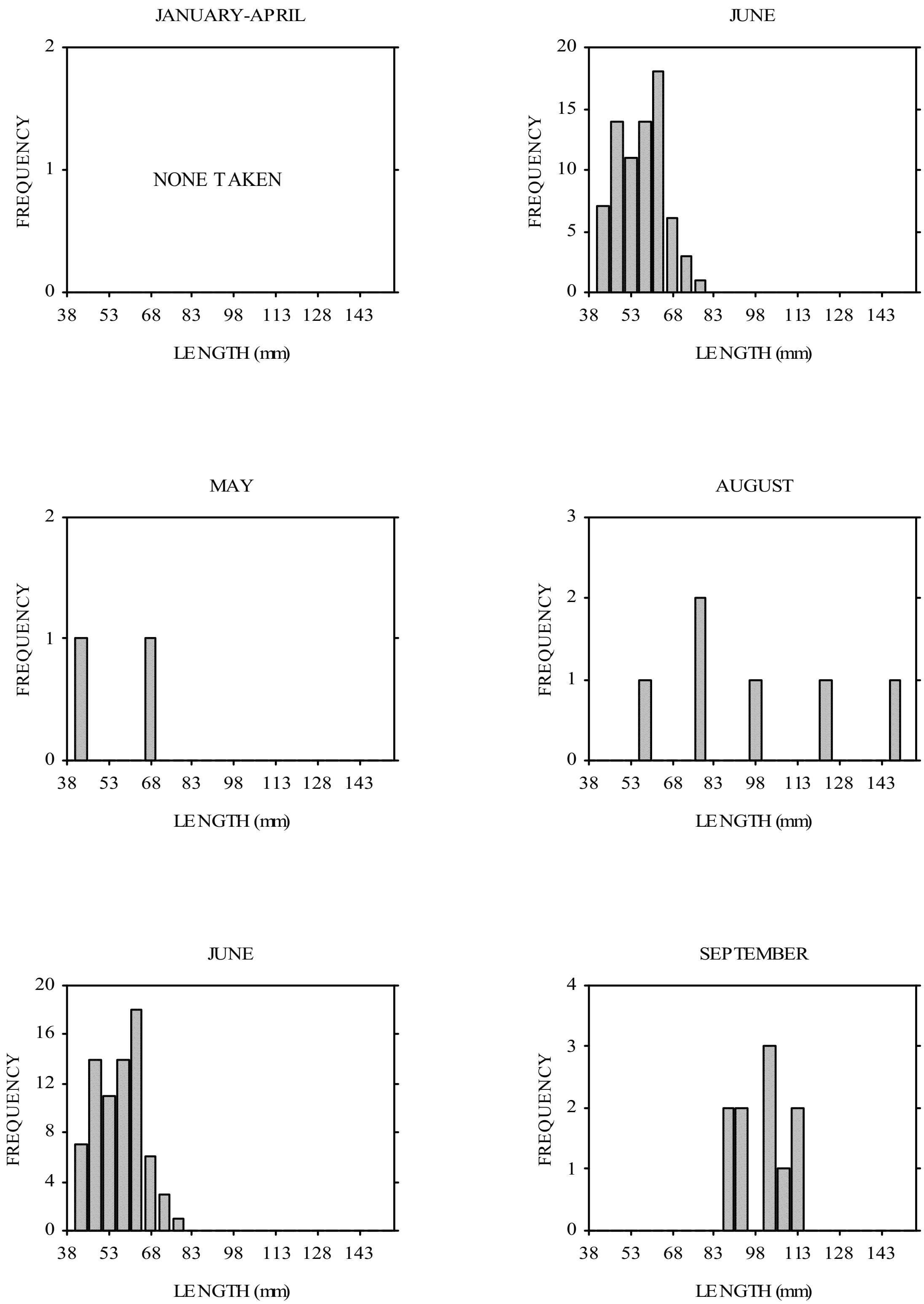
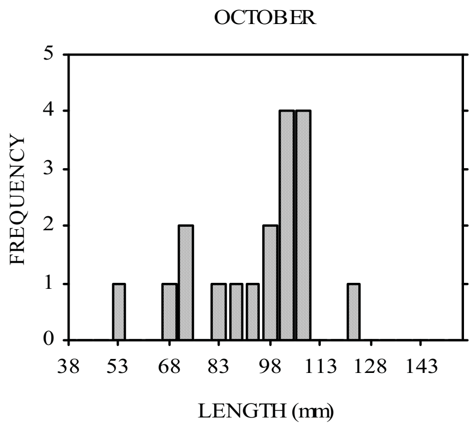



Figure 2-21. Length frequency of bluefish taken in impingement sampling at the Salem circulating water intake structure during 2003.



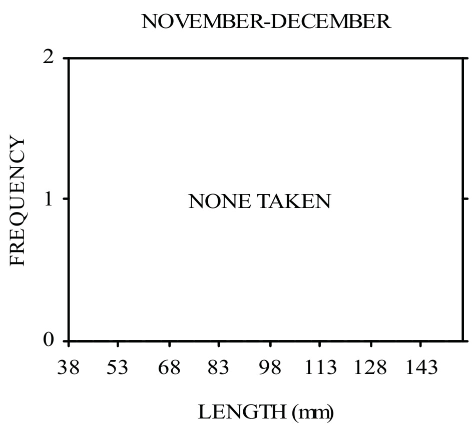




Figure 2-21. Continued.

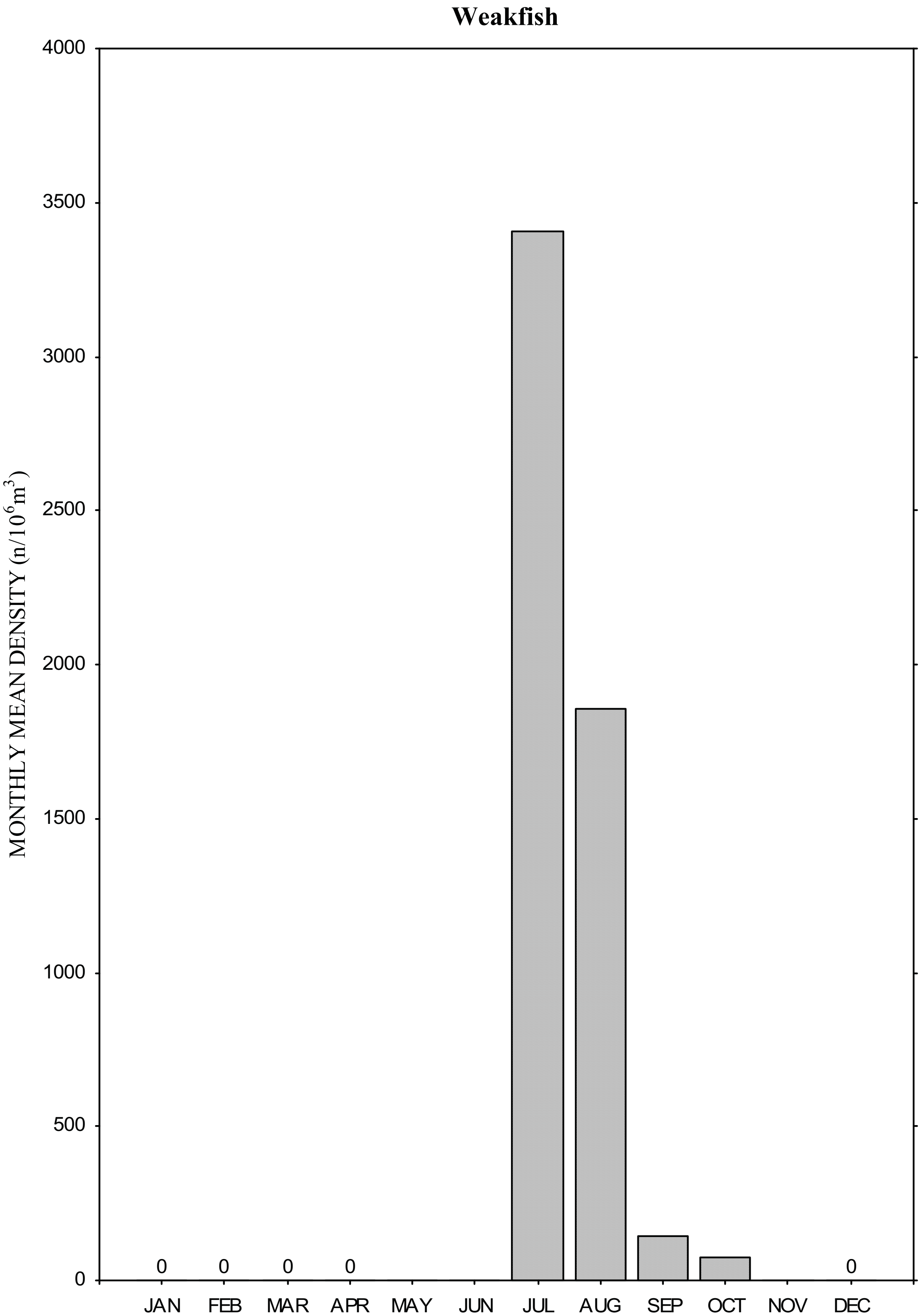



Figure 2-22. Monthly mean density (n/$10^6$ meters$^3$) of weakfish taken in impingement sampling at the Salem circulating water intake structure during 2003.

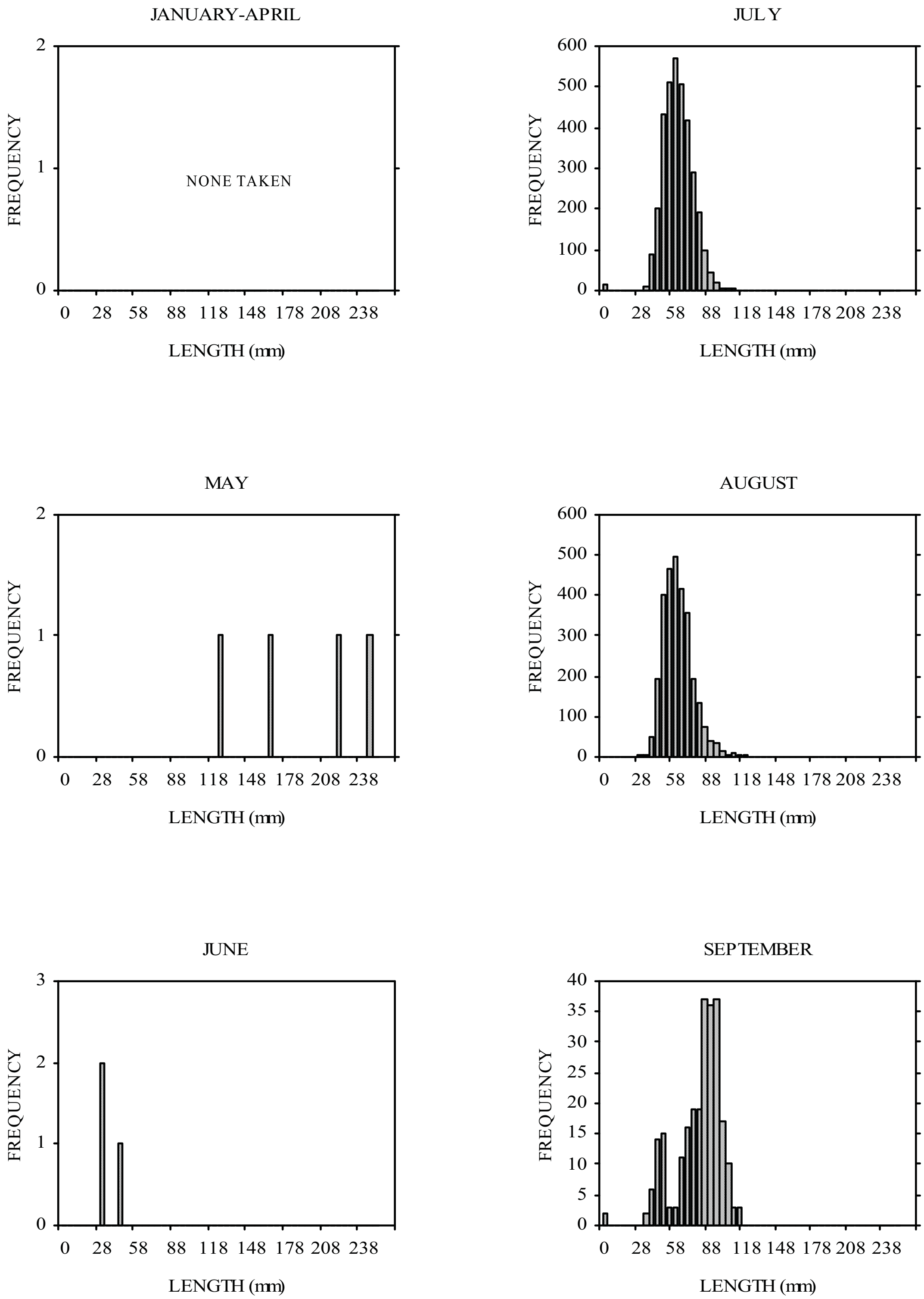



Figure 2-23. Length frequency of weakfish taken in impingement sampling at the Salem circulating water intake structure during 2003.

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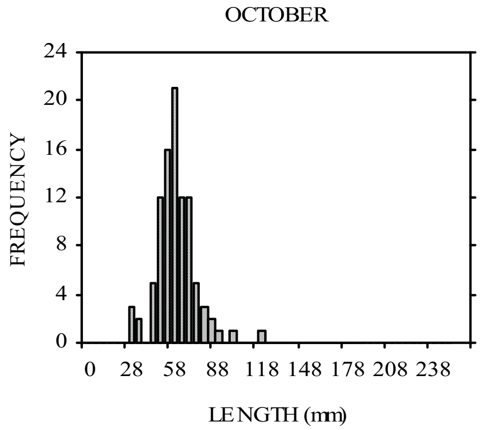


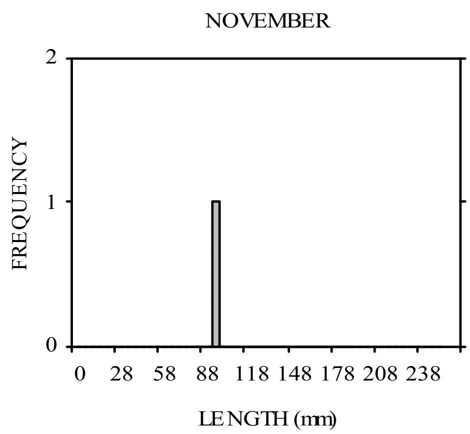


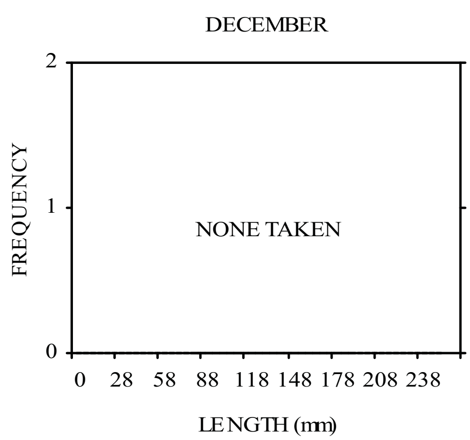


Figure 2-23. Continued.

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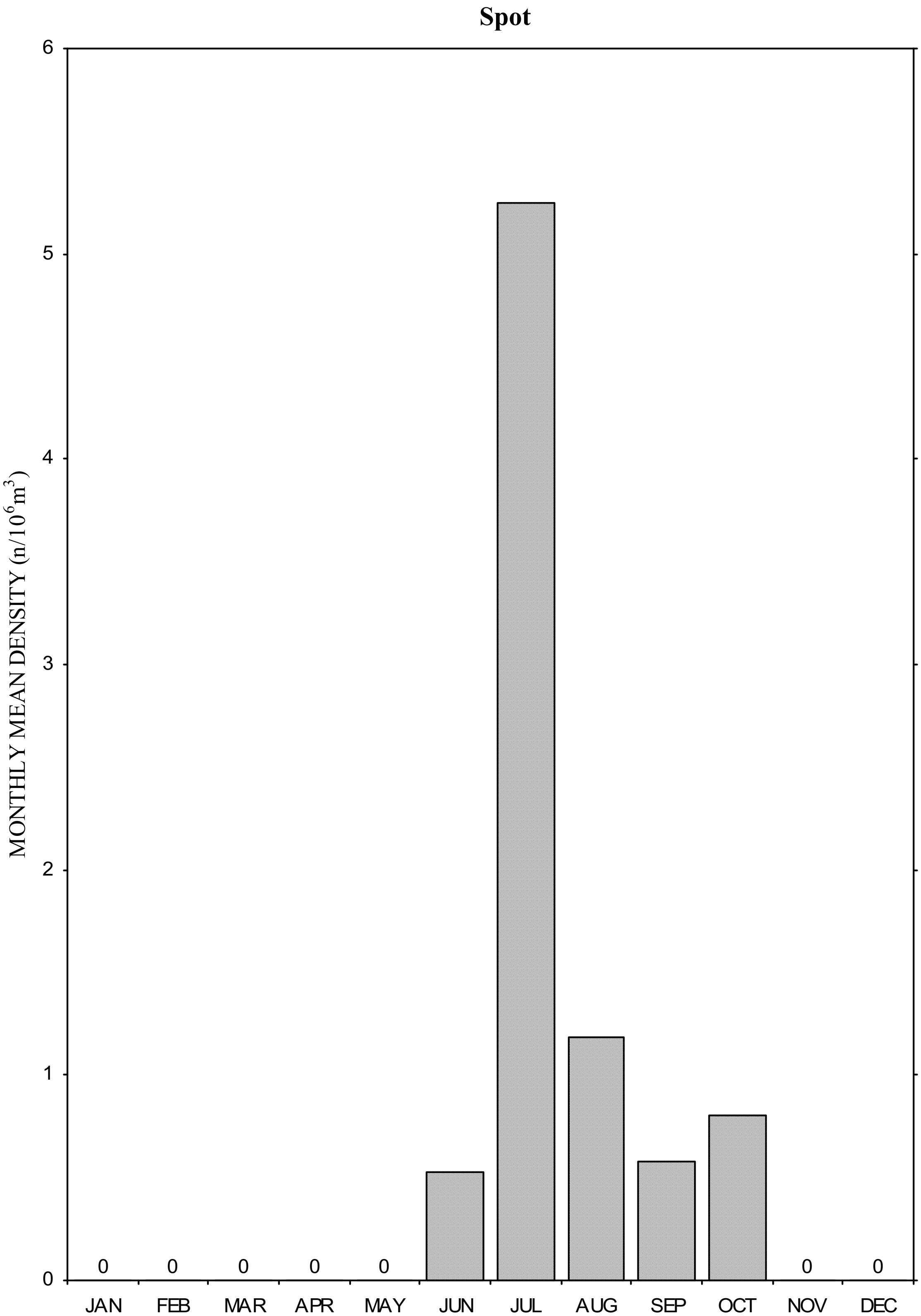


Figure 2-24. Monthly mean density (n/$10^6$ meters$^3$) of spot taken in impingement sampling at the Salem circulating water intake structure during 2003.

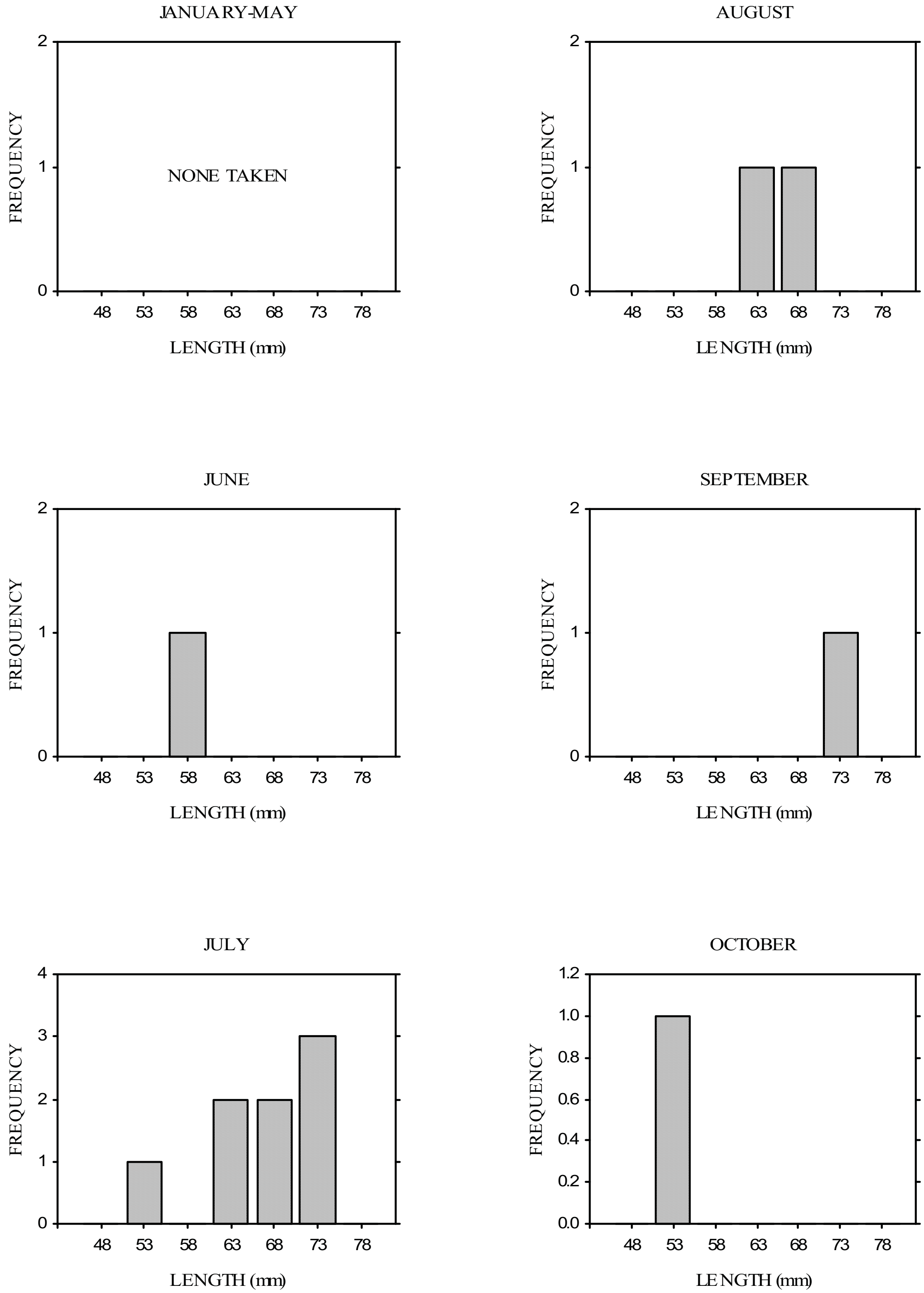


Figure 2-25. Length frequency of spot taken in impingement sampling at the Salem circulating water intake structure during 2003.

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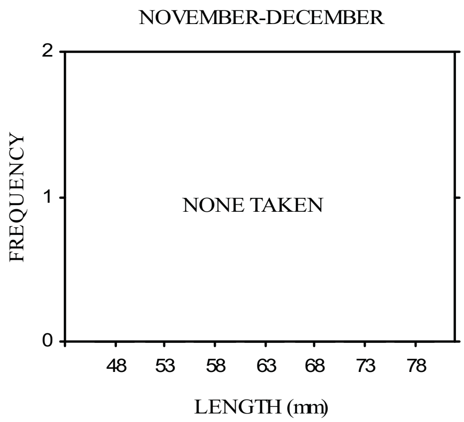



Figure 2-25.  Continued.

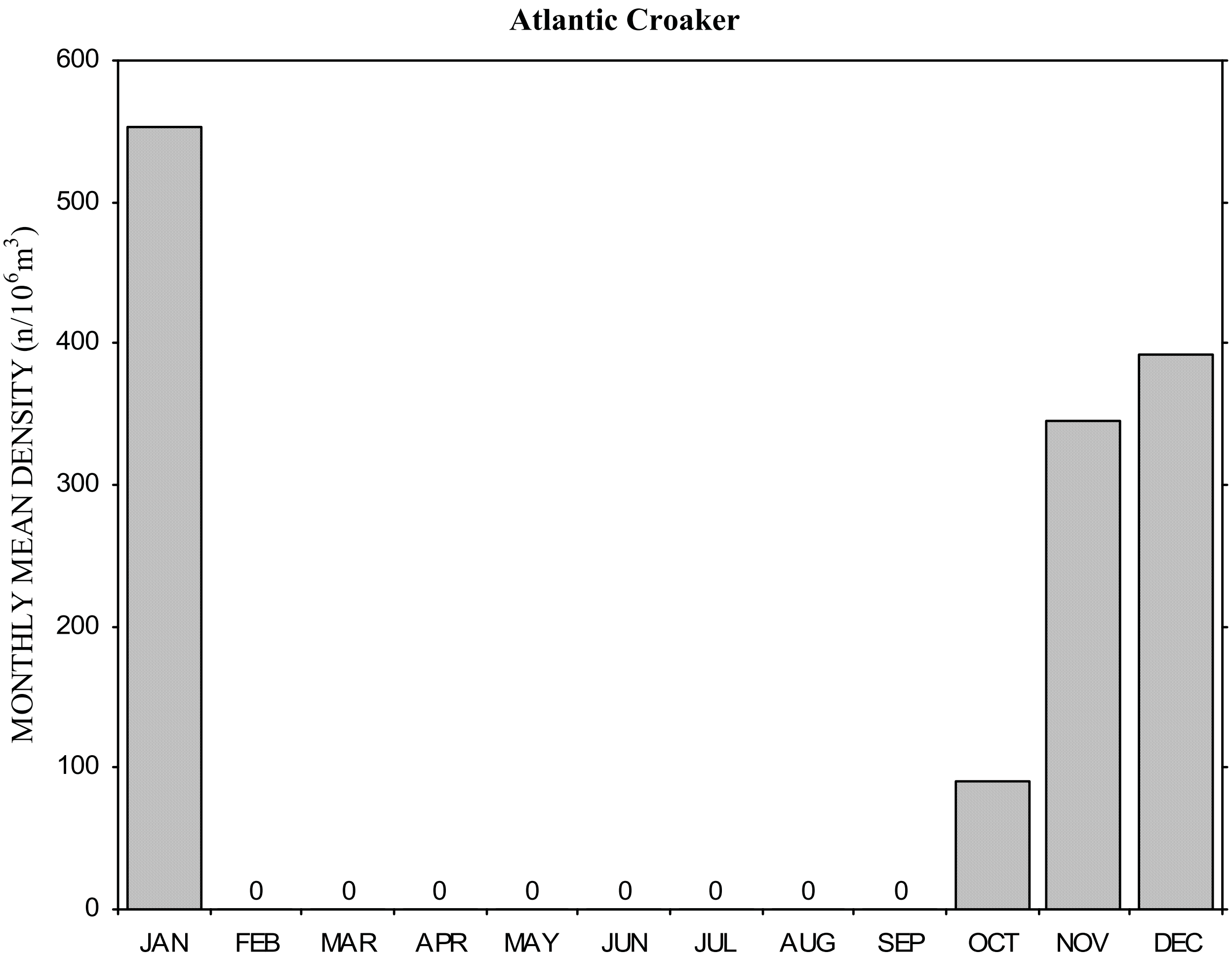



Figure 2-26 . Monthly mean density (n/$10^6$ meters$^3$) of Atlantic croaker taken in impingement sampling at the Salem circulating water intake structure during 2003.

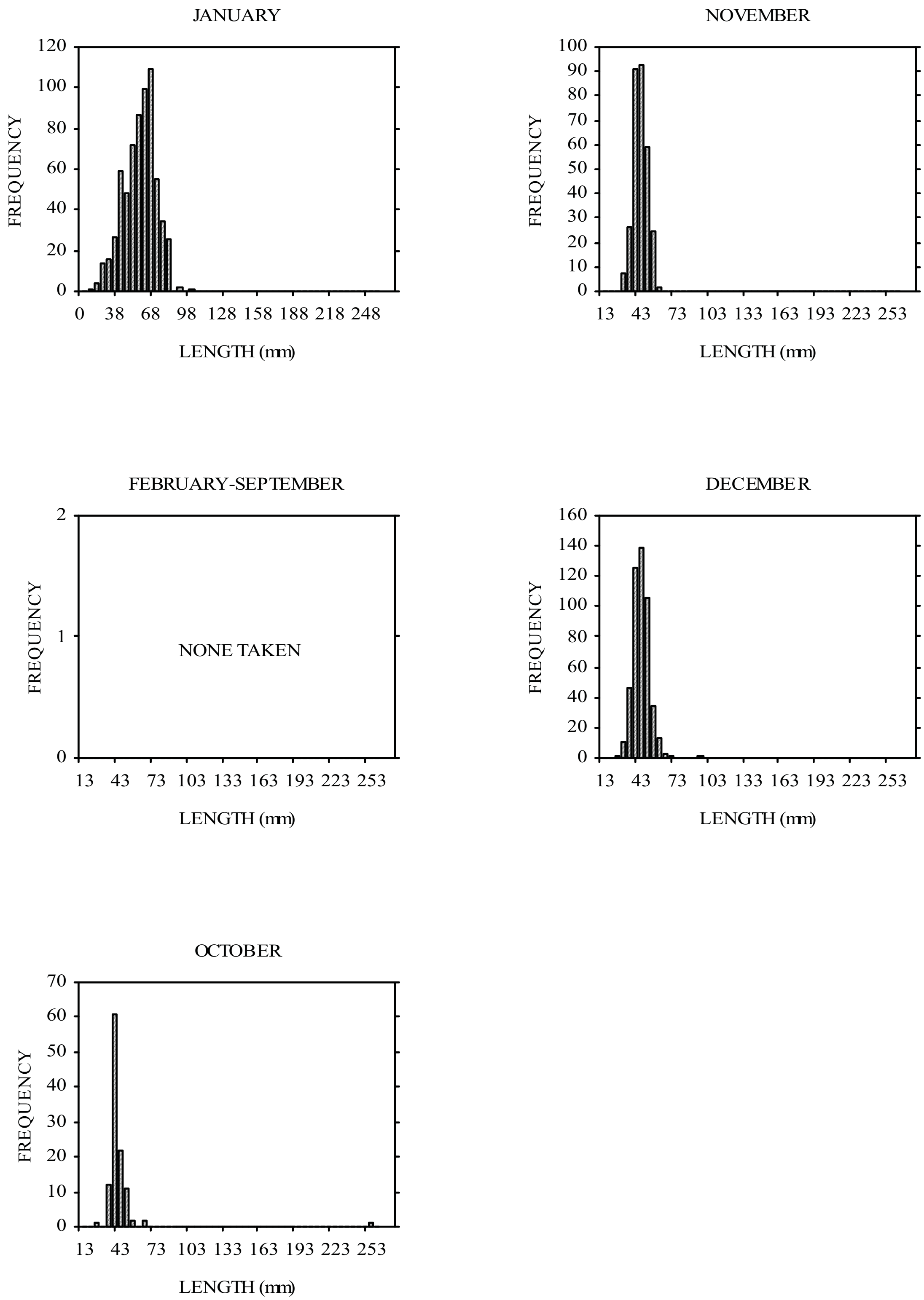



Figure 2-27. Length frequency of Atlantic croaker taken in impingement sampling at the Salem circulating water intake structure during 2003.

## CHAPTER 3: ENTRAINMENT ABUNDANCE

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

Page

## ENTRAINMENT ABUNDANCE

### INTRODUCTION

Entrainment monitoring is conducted annually as stipulated by the New Jersey Department of Environmental Protection in the New Jersey Pollutant Discharge Elimination System permit, and will continue through the term of the permit. The specified monitoring was performed as described in the Procedures Manual for Biological Monitoring Program for the Delaware Estuary (PSEG 2002). The objective of this monitoring program is to produce accurate density estimates of fish entrained through the Circulating Water Intake System (CWIS) at Salem Units 1 and 2.

This chapter presents the overall results of sampling and specific findings for the year 2003 regarding the occurrence of the Salem finfish target species: blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), and Atlantic croaker (*Micropogonias undulatus*). These species were defined in the Salem 316(b) Demonstration (PSE&G 1999).

### MATERIALS AND METHODS

In 2003, entrainment abundance sampling was divided into two periods of frequency and intensity. During the months of January through March and August through December, routine entrainment sampling was scheduled during three 24-hour events per week with seven collections at approximately equal intervals during each event. During the months of April through July, intensive entrainment sampling occurred during four events scheduled each week with 14 samples scheduled at equal intervals during each event. Each event monitored a complete diel period encompassing two tidal cycles. A total of 1,583 out of 1,715 scheduled entrainment abundance samples were collected during 2003. A total of 132 samples were unable to taken due to equipment maintenance and repair operations.

During each 24-hour sampling event, samples were collected at the midpoint of the water column in the intake bay of circulating water pump 12B or 22A, using the Paco (Model 52-6013-21-342000) fish pump and the entrainment abundance chamber (Figures 3-1, 3-2 and 3-3). The fish pump used for sampling was a 6-inch (15.2-cm), single-port impeller, centrifugal pump, and the abundance chamber consisted of a 260-gallon (1-$m^3$) cylindrical tank containing a 1.0-m diameter, 0.5-mm mesh, conical plankton net within which the sample was concentrated. The abundance chamber was filled with water during sampling, and cushioned the captured fish specimens against mechanical damage. The sample rate was approximately 1.0 $m^3$/minute. Sample volume and flow rate were determined using a Sparling Envirotech flowmeter (Model 115). Flowmeter calibration was checked and maintained within factory specifications on a monthly basis throughout 2003. Samples were preserved immediately in a 10 percent formalin/rose-bengal solution. During each sample, the following parameters were recorded:

water temperature, salinity, tidal elevation and stage, and the number of circulating water pumps and traveling screens in operation. Water temperature was measured with a field thermometer, and salinity was measured using a refractometer.

In the laboratory, all fish specimens were washed in freshwater, removed from the sample detritus, transferred to isopropanol, and identified to the lowest practicable taxonomic level, usually to species. Some specimens could not be identified to species because of the lack of identifying characteristics. Specimens that were in good condition but possessed no distinguishing characteristics were listed as 'unidentified fish', while specimens in such poor physical condition that no genus or family level identification could be made were designated as 'unidentifiable fish'.

Each specimen's life stage was determined (i.e. egg, larva, juvenile, or adult), and the total number of each was recorded. For each species, the length of up to 50 specimens of each life stage, except eggs, was measured to the nearest 1-mm. Total length (TL) was used for all larvae and those juveniles and adults without forked tails. Fork length (FL) was used for those juveniles and adults with forked tails.

Densities are expressed as number per 100 cubic meters ($n/100m^3$). A volume-weighted mean density was calculated by dividing the total number of specimens in the samples by the total sample volume filtered during a given time period. Entrainment abundance and physical-chemical data were summarized by month and/or year. Sample collection and processing procedures are described in greater detail in the Procedures Manual for Biological Monitoring Program for the Delaware Estuary (PSEG 2002).

Only those fish designated as target species in the Salem 316(b) demonstration (PSE&G 1999) will be discussed in the section. Graphic presentations of abundance and length frequency data were prepared for those target species represented by at least ten total specimens of all life stages collected.

**RESULTS AND DISCUSSION**

Totals of 1,598 fish eggs, 35,736 larvae, 4,394 juveniles, and 118 adults representing at least 26 species were collected in 1,583 entrainment abundance samples, with 77,517 $m^3$ of sample water filtered during 2003 (Table 3-1). Specimens of at least ten of the twelve target species were collected. In order of decreasing abundance they were: bay anchovy, striped bass, Atlantic croaker, white perch, weakfish, Atlantic menhaden, Atlantic silversides, alewife, *Alosa* spp., blueback herring, *Menidia* spp., and spot. Monthly mean temperatures ranged from 1.9 to 27.3°C, and salinities from 2.9 to 9.8 ppt (Figure 3-4). A summary of collection data is presented below by decreasing order of abundance for each target taxon.

**Bay anchovy** - A total of 10,194 bay anchovy, including 1,538 eggs, 7,661 larvae, 928 juveniles and 67 adults, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected in January and April through October (Figure 3-5). Bay anchovy were most abundant in July, with larvae being the predominant life stage.

Bay anchovy eggs were collected during the months of May through August when mean water temperatures ranged from 16.6 to 27.3°C, and salinity ranged from 2.9 to 5.6 ppt (Figures 3-4 and 3-5). The annual mean density (n/100m$^3$) was 1.98 (Table 3-1). The monthly mean density of eggs was greatest in June at 10.94, and ≤1.59 in other months in which they were taken (Figure 3-5).

Bay anchovy larvae (<20 mm) were collected during the months of June through October when mean water temperatures and salinities ranged from 18.5 to 27.3°C and 2.9 to 6.4 ppt, respectively (Figures 3-4 and 3-5). The annual mean density was 9.88 (Table 3-1). Monthly mean density was greatest in July at 48.19, and was ≤17.21 during the other months of occurrence (Figure 3-5).

Bay anchovy juveniles (≥20 mm) were collected in January, April, and from June through October, when mean water temperatures and salinities ranged from 2.9 to 27.3°C and from 2.9 to 6.8 ppt, respectively (Figures 3-4 and 3-5). Annual mean density was 1.20 (Table 3-1). The monthly mean density of juveniles was highest in August at 7.86, and intermediately high in July and October at 3.22 and 3.48, respectively. Densities were ≤1.64 during the other months of occurrence (Figure 3-5).

Bay anchovy adults were taken during the months of April through June with monthly mean densities ranging from 0.03 to 0.52 (Figure 3-5). Monthly mean water temperatures and salinities ranged from 12.0 to 21.0°C and from 2.9 to 5.6 ppt, respectively (Figure 3-4). The annual mean density was 0.09 (Table 3-1).

Based on the subsample of the specimens measured, the bay anchovy collected during the 2003 entrainment abundance studies ranged in length from 2 to 75 mm, and 83% were <20 mm (Figure 3-6). Modal lengths in July and August, the months of relatively high bay anchovy abundance, were 10, and 19 mm, respectively. During the other months of occurrence, catches were relatively small.

**Striped bass** - A total of 3,931 striped bass, including 31 eggs, 3,279 larvae and 621 juveniles, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during the months of April through July and September through November (Figure 3-7). Striped bass were most abundant in June, with larvae being predominant.

Striped bass eggs were collected during April and May when mean water temperatures were 12.0 and 16.6°C and salinities were 4.3 and 5.6 ppt, respectively (Figures 3-4 and 3-7). The annual mean density (n/100m$^3$) was 0.04 (Table 3-1). The monthly mean densities of eggs in April and May were 0.26 and 0.01, respectively (Figure 3-7).

Striped bass larvae (<20 mm) were taken during April through July, when water temperatures and salinities ranged from 12.0 to 26.5°C and 2.9 to 5.6 ppt, respectively (Figures 3-4 and 3-7). The annual mean density (n/100m$^3$) was 4.23 (Table 3-1). The monthly mean density was greatest in June at 18.38 (Figure 3-7).

Striped bass juveniles (≥20 mm) were collected during June, July, and September through November when mean water temperatures ranged from 11.7 and 26.5°C and salinities from 2.9 to 6.6 ppt, respectively (Figures 3-4 and 3-7). The monthly mean densities in June and July were 1.92 and 3.11, respectively, and were ≤0.11 during the other months of occurrence (Figure 3-7).

Based on the specimens measured, the striped bass collected during the 2003 entrainment abundance studies ranged in length from 2 to 52 mm, however 85% of those individuals ranged from 6 to 20 mm (Figure 3-8). In June, the month with highest abundance, the modal length was 12 (Figure 3-8).

**Atlantic croaker** - A total of 2,033 Atlantic croaker, including 82 larvae and 1,951 juveniles, was collected in entrainment abundance monitoring samples at Salem during 2003 (Table 3-1). Specimens were collected in January and from September through December (Figure 3-9). Atlantic croaker was most abundant in November, with juveniles being the predominant life stage.

Atlantic croaker larvae (<11 mm) were collected during the months of January and October through December at water temperatures and salinities ranging from 2.9 to 18.5°C and 3.6 to 6.8 ppt, respectively (Figures 3-4 and 3-9). The annual mean density ($n/100m^3$) was 0.11 (Table 3-1). The monthly mean density was highest in October at 4.45, and densities were ≤0.04 during the other months of occurrence (Figure 3-9).

Atlantic croaker juveniles (≥11 mm) were taken during January and September through December of 2003 at water temperatures and salinities ranging from 2.9 to 24.1°C and from 3.6 to 6.8 ppt, respectively (Figures 3-4 and 3-9). The annual mean density ($n/100m^3$) was 2.52 (Table 3-1). The highest monthly mean density of 43.63 occurred in November, and densities were ≤12.50 during the other months of occurrence (Figure 3-9).

Based on the subsamples of the specimens measured, the Atlantic croaker collected in the 2003 entrainment abundance samples ranged in length from 7 to 56 mm, however 80% of those individuals ranged from 11 to 23 mm (Figure 3-10). . In November the month of highest Atlantic croaker abundance, the modal length was 15 (Figure 3-10).

***Morone* spp.** - A total of 676 *Morone* spp. larvae (<20 mm) was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). They were collected during the months of April through July when mean water temperatures and salinities ranging from 12.0 to 26.5ºC and from 2.9 to 5.6 ppt, respectively (Figures 3-4 and 3-11). The annual mean density ($n/100m^3$) was 0.87 (Table 3-1). The highest monthly mean density of 5.17 occurred in June, and densities were ≤0.26 during the other months of occurrence (Figure 3-11).

Based on the specimens measured, the *Morone* spp. larvae collected during the 2003 entrainment abundance studies ranged in length from 4 to 18 mm, however 54% of those individuals ranged from 8 to 12 mm (Figure 3-12). The modal length in June, the month highest abundance, was 10 mm.

**White perch** - A total of 341 white perch, including 237 larvae and 104 juveniles was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during January through July and in November and December (Figure 3-13). White perch were most abundant in June and July when larvae and juveniles were the respectively predominant life stage taken.

White perch larvae (<20 mm) were collected during the months of April through July when mean water temperatures and salinities ranged from 12.0 to 26.5ºC and 2.9 to 5.6 ppt, respectively (Figures 3-4 and 3-13). The annual mean density (n/100m$^3$) was 0.31 (Table 3-1). The highest monthly mean density of 1.45 occurred in June, and densities were ≤0.28 during the other months of occurrence (Figure 3-13).

White perch juveniles (≥20 mm) were taken during January through March, and in June, July, November and December when mean water temperature and salinity ranged from 1.9 to 26.5ºC and 2.9 to 9.8 ppt., respectively (Figure 3-4 and 3-13). The annual mean density (n/100m$^3$) was 0.13 (Table 3-1). Monthly mean densities were similarly high at 0.51 and 0.61 in July and November; mean densities were ≤0.31 during the other months of occurrence (Figure 3-13).

Based on the subsamples of the specimens measured, the white perch collected in the 2003 entrainment abundance samples ranged in length from 3 to 103 mm, with individuals ranging from 2 to 11 mm comprising 52 % of the subsample (Figure 3-14). In June, the month of highest abundance, the modal length was 10 mm.

**Weakfish** - A total of 337 weakfish, including one egg, 126 larvae and 210 juveniles, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during the months of June through September (Figure 3-15). Weakfish were most abundant in July, with juveniles being predominant.

The weakfish egg was collected in August when mean water temperature was 27.3 and mean salinity was 3.7 ppt (Figures 3-4 and 3-15). The annual mean density (n/100m$^3$) was <0.01 (Table 3-1). The monthly mean density in July was 0.02 (Figure 3-15).

Weakfish larvae (<10.5 mm) were taken during June through August, when water temperatures and salinities ranged from 21.0 to 27.3°C and 2.9 to 4.0 ppt, respectively (Figures 3-4 and 3-15). The annual mean density (n/100m$^3$) was 0.16 (Table 3-1). The monthly mean density was greatest in July at 0.97 and densities were ≤0.06 during the other months of occurrence (Figure 3-15).

Weakfish juveniles (≥10.5 mm) were collected during the months of June through September, at water temperatures and salinities ranging from 21.0 to 27.3°C and 2.9 to 6.4 ppt, respectively (Figures 3-4 and 3-15). The annual mean density (n/100m$^3$) was 0.27 (Table 3-1). The highest monthly mean density of 1.51 occurred in July, and densities were ≤0.23 during the other months of occurrence (Figure 3-15).

Based on the specimens measured, the weakfish collected during the 2003 entrainment abundance studies ranged in length from 3 to 56 mm (Figure 3-16). During July when weakfish were most abundant, 39% of the individuals measured ranged from 7 to 12 mm, and the modal length was 11 mm. During the other months of their occurrence, catches were relatively small.

**Atlantic menhaden** - A total of 157 Atlantic menhaden, including 110 larvae and 47 juveniles, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during January, April through July, November and December (Figure 3-19). The abundance of Atlantic menhaden was highest in November, with larvae being predominant.

Atlantic menhaden larvae (<30 mm) were taken during January, April through July, November and December, when water temperatures and salinities ranged from 2.9 to 26.5°C and 2.9 to 6.8 ppt, respectively (Figures 3-4 and 3-19). The annual mean density (n/100m$^3$) was 0.14 (Table 3-1). The monthly mean density was highest in November at 0.49, with densities of ≤0.32 being recorded in the other months of occurrence (Figure 3-19).

Atlantic menhaden juveniles (≥30 mm) were collected during January, April through June, and November, when mean water temperatures and salinities ranged from 2.9 to 21.0°C and 2.9 to 6.8 ppt, respectively (Figures 3-4 and 3-19). The annual mean density (n/100m$^3$) was 0.06 (Table 3-1). The monthly mean densities were highest in January at 0.22 and ≤0.12 during the other months of occurrence (Figure 3-19).

Based on the specimens measured, the Atlantic menhaden collected during the 2003 entrainment abundance studies ranged in length from 17 to 53 mm (Figure 3-20). During April through June, individuals from 21 to 33 mm comprised 92% of the specimens measured, and the modal lengths were 26, 29 and 29 mm, respectively. During the other months of occurrence, catches were small.

**Atlantic silverside** - A total of 114 Atlantic silversides, including two eggs, 93 larvae, and 19 juveniles, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during the months of April through August, October and December (Figure 3-21). Atlantic silversides were most abundant in June, with larvae being predominant.

Two Atlantic silverside eggs were collected during April when mean water temperature was 12.0°C and mean salinity was 4.3 ppt (Figures 3-4 and 3-19). The annual mean density (n/100m$^3$) was <0.01 (Table 3-1). The monthly mean density of eggs in April was 0.02 (Figure 3-19).

Atlantic silverside larvae (< 15 mm) were collected during May through August when mean water temperatures and salinities were 16.6 to 27.3°C and 2.9 to 5.6 ppt (Figures 3-4 and 3-19). The annual mean density (n/100m$^3$) was 0.12 (Table 3-1). The monthly mean densities of larvae were similarly high in May, June and July at 0.31, 0.26, and 0.22, respectively (Figure 3-19).

Atlantic silverside juveniles (≥15 mm) were taken in June, July, October, and December when the mean water temperatures and salinities ranged from 7.0 to 26.5°C and 2.9 to 4.0 ppt, respectively (Figures 3-4 and 3-19). The annual mean density (n/100m$^3$) was 0.02 (Table 3-1).

The monthly mean density ranged from 0.07 in June to 0.04 in December (Figure 3-19).

Based on the specimens measured, the Atlantic silversides collected during the 2003 entrainment abundance studies ranged in length from 5 to 65 mm, however 65% of those ranged from 5 to 10 mm (Figure 3-20). In May, June and July, the modal lengths were 6, 5, and 8 mm.

**Alewife -** - A total of 82 alewife, including 81 larvae and one juvenile, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during May and June (Figure 3-21). The abundance of alewife was highest in June with larvae being predominant.

Alewife larvae (<20 mm) were taken during May and June, when water temperatures and salinities ranged from 16.6 to 21.0°C and 2.9 to 5.6 ppt, respectively (Figures 3-4 and 3-21). The annual mean density ($n/100m^3$) was 0.10 (Table 3-1). The monthly mean densities were 0.67 in June, and 0.01 in May (Figure 3-21).

The alewife juvenile (≥20 mm) was collected during June, when the mean water temperature and salinity was 21.0°C and 2.9 ppt, respectively (Figures 3-4 and 3-21). The annual mean density ($n/100m^3$) was <0.01 (Table 3-1). The monthly mean density was 0.01 Figure 3-21).

Based on the specimens measured, the alewife collected during the 2003 entrainment abundance studies ranged in length from 9 to 20 mm (Figure 3-22). During June, the modal length was 12 mm.

***Alosa* spp.** – A total of 58 *Alosa* spp., including 57 larvae and one juvenile, was taken in entrainment abundance samples at Salem during 2003 (Table 3-1). Specimens representing at least one of these life stages were collected during May, June, and July (Figure 3-23). The abundance of *Alosa* spp was highest in June with larvae being predominant.

Alosa spp. larvae (<20 mm) were taken during May, June, and July when water temperatures and salinities ranged from 16.6 to 26.5°C and 2.9 to 5.6 ppt, respectively (Figures 3-4 and 3-23). The annual mean density ($n/100m^3$) was 0.07 (Table 3-1). The monthly mean densities were 0. 01 in May, 0.42 in June, and 0.05 in July (Figure 3-23).

The *Alosa* spp. juvenile (≥20 mm) was collected during June, when mean water temperatures and salinities were 21.0°C and 2.9 ppt, (Figures 3-4 and 3-23). The annual mean density ($n/100m^3$) was <0.01 (Table 3-1). The monthly mean density was 0.01 (Figure 3-23).

Based on the specimens measured, the *Alosa* spp collected during the 2003 entrainment abundance studies ranged in length from 3 to 20 mm (Figure 3-24). During May through July individuals from 5 to 7mm comprised 77% of the specimens measured. The modal length in June was 6 mm (Figure 3-24).

**Blueback herring** - A total of four blueback herring, one larva and three juveniles, was taken in entrainment abundance samples at Salem in 2003 (Table 3-1).

***Menidia* spp.** – A total of two *Menidia* spp. larvae was taken in entrainment abundance samples at Salem in 2003 (Table 3-1).

**Spot** – A total of two spot juveniles was taken in entrainment abundance samples at Salem in 2003 (Table 3-1).

## LITERATURE CITED

Public Service Electric and Gas (PSE&G). 1999. Salem Generating Station 316(b) Demonstration. Prepared for Public Service Electric & Gas Co., Newark, NJ.

Public Service Enterprise Group (PSEG). 2002. Procedures Manual for Biological Monitoring Program for the Delaware Estuary.

| Table 3-1 | | | | |
|---|---|---|---|---|
| Annual summary of finfish species by lifestage, number collected, and mean density, taken in entrainment abundance collections at the Salem Generating Station Circulating Water Intake Structure, during January through December, 2003 | | | | |
| Number of Samples = 1,583 | | | | |
| Total volume filtered (cubic meters) = 77,517 | | | | |
| Life stage | Common name | Scientific name | Number | Density ($n/100m^3$) |
| Eggs | Unidentifiable egg | | 26 | 0.03 |
| | Bay anchovy | *Anchoa mitchilli* | 1,538 | 1.98 |
| | Atlantic silverside | *Menidia menidia* | 2 | <0.01 |
| | Striped bass | *Morone saxatilis* | 31 | 0.04 |
| | Weakfish | *Cynoscion regalis* | 1 | <0.01 |
| Larvae | Unidentifiable larvae | | 164 | 0.21 |
| | American eel | *Anguilla rostrata* | 81 | 0.10 |
| | Unidentifiable herring | Clupeidae | 97 | 0.01 |
| | Blueback herring/alewife | *Alosa* spp. | 57 | 0.07 |
| | Blueback herring | *Alosa aestivalis* | 1 | <0.01 |
| | Alewife | *Alosa pseudoharengus* | 81 | 0.10 |
| | Atlantic menhaden | *Brevoortia tyrannus* | 110 | 0.14 |
| | Bay anchovy | *Anchoa mitchilli* | 7,661 | 9.88 |
| | Unidentifiable minnow | Cyprinidae | 7 | 0.01 |
| | Common carp | *Cyprinus carpio* | 2 | <0.01 |
| | Mummichog | *Fundulus heteroclitus* | 4 | 0.01 |
| | Unidentifiable silverside | *Menidia* spp. | 2 | <0.01 |
| | Atlantic silverside | *Menidia menidia* | 93 | 0.12 |
| | Northern pipefish | *Syngnathus fuscus* | 1 | <0.01 |
| | White perch/striped bass | *Morone* spp. | 676 | 0.87 |
| | White perch | *Morone americana* | 237 | 0.31 |
| | Striped bass | *Morone saxatilis* | 3,279 | 4.23 |
| | Yellow perch | *Perca flavescens* | 18 | 0.02 |
| | Unidentifiable drum | Sciaenidae | 1 | <0.01 |
| | Weakfish | *Cynoscion regalis* | 126 | 0.16 |
| | Atlantic croaker | *Micropogonias undulatus* | 82 | 0.11 |
| | Black drum | *Pogonias cromis* | 3 | <0.01 |
| | Naked goby | *Gobiosoma bosc* | 22,891 | 29.53 |
| | Summer flounder | *Paralichthys dentatus* | 6 | 0.01 |
| | Windowpane | *Scophthalmus aquosus* | 5 | 0.01 |
| | Winter flounder | *Pleuronectes americanus* | 5 | 0.01 |
| | Hogchoker | *Trinectes maculatus* | 46 | 0.06 |

| Table 3-1 | | | | |
|---|---|---|---|---|
| Life stage | Common name | Scientific name | Number | Density (n/100m³) |
| Juveniles | Unidentifiable juvenile | | 1 | <0.01 |
| | American eel | *Anguilla rostrata* | 11 | 0.01 |
| | Unidentifiable herring | Clupeidae | 3 | <0.01 |
| | Blueback herring/alewife | *Alosa* spp. | 1 | <0.01 |
| | Blueback herring | *Alosa aestivalis* | 3 | <0.01 |
| | Alewife | *Alosa pseudoharengus* | 1 | <0.01 |
| | Atlantic menhaden | *Brevoortia tyrannus* | 47 | 0.06 |
| | Bay anchovy | *Anchoa mitchilli* | 928 | 1.20 |
| | Spotted hake | *Urophycis regia* | 1 | <0.01 |
| | Atlantic silverside | *Menidia menidia* | 19 | 0.02 |
| | Northern pipefish | *Syngnathus fuscus* | 41 | 0.05 |
| | Striped searobin | *Prionotus evolans* | 1 | <0.01 |
| | White perch | *Morone americana* | 104 | 0.13 |
| | Striped bass | *Morone saxatilis* | 621 | 0.80 |
| | Bluegill | *Lepomis macrochirus* | 1 | <0.01 |
| | Weakfish | *Cynoscion regalis* | 210 | 0.27 |
| | Spot | *Leiostomus xanthurus* | 2 | <0.01 |
| | Atlantic croaker | *Micropogonias undulatus* | 1,951 | 2.52 |
| | Naked goby | *Gobiosoma bosc* | 391 | 0.50 |
| | Smallmouth flounder | *Etropus microstomus* | 1 | <0.01 |
| | Summer flounder | *Paralichthys dentatus* | 54 | 0.07 |
| | Hogchoker | *Trinectes maculatus* | 2 | <0.01 |
| Adults | American eel | *Anguilla rostrata* | 1 | <0.01 |
| | Bay anchovy | *Anchoa mitchilli* | 67 | 0.09 |
| | Northern pipefish | *Syngnathus fuscus* | 2 | <0.01 |
| | Naked goby | *Gobiosoma bosc* | 48 | 0.06 |
| Summary | Eggs | | 1,598 | 2.06 |
| | Larvae | | 35,736 | 46.11 |
| | Juveniles | | 4,394 | 5.67 |
| | Adults | | 118 | 0.15 |

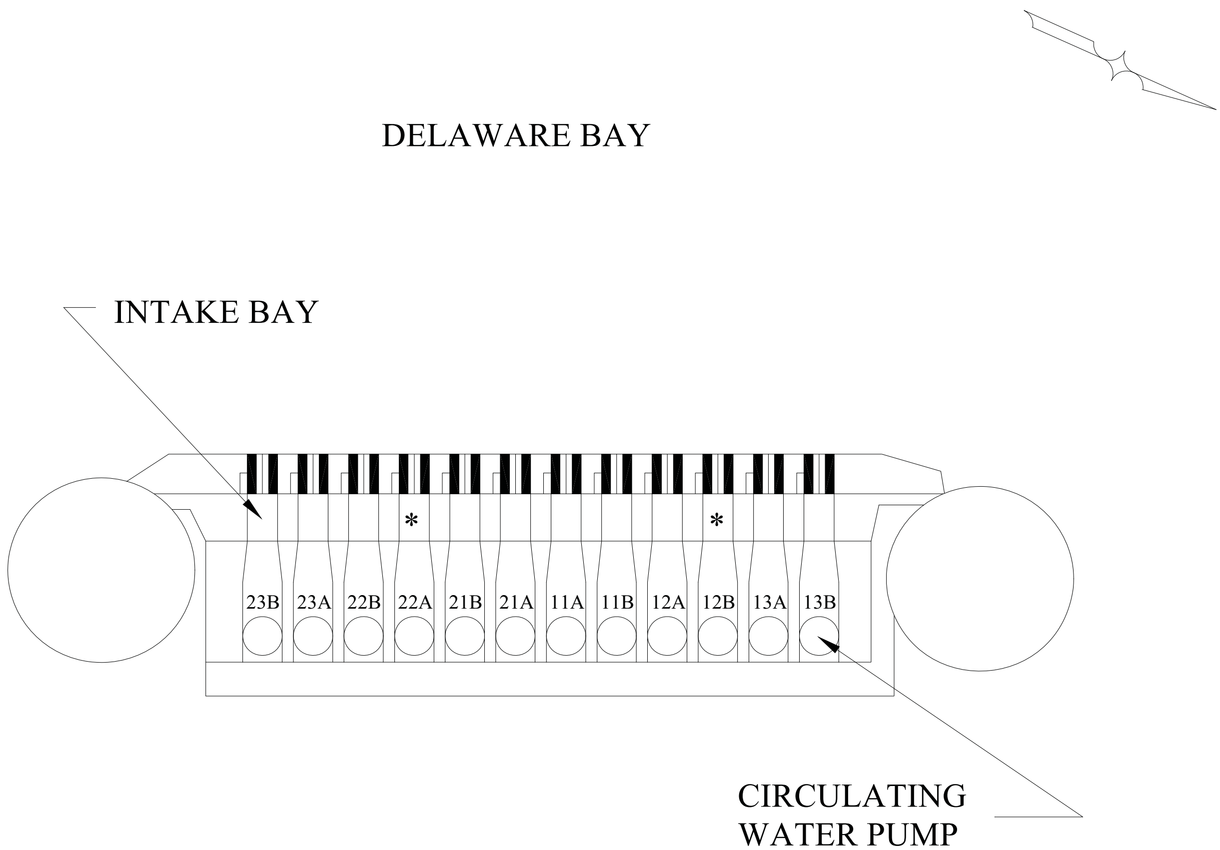



Figure 3-1. Schematic of Salem Generating Station circulating water intake structure with entrainment abundance sampling location indicated by *.

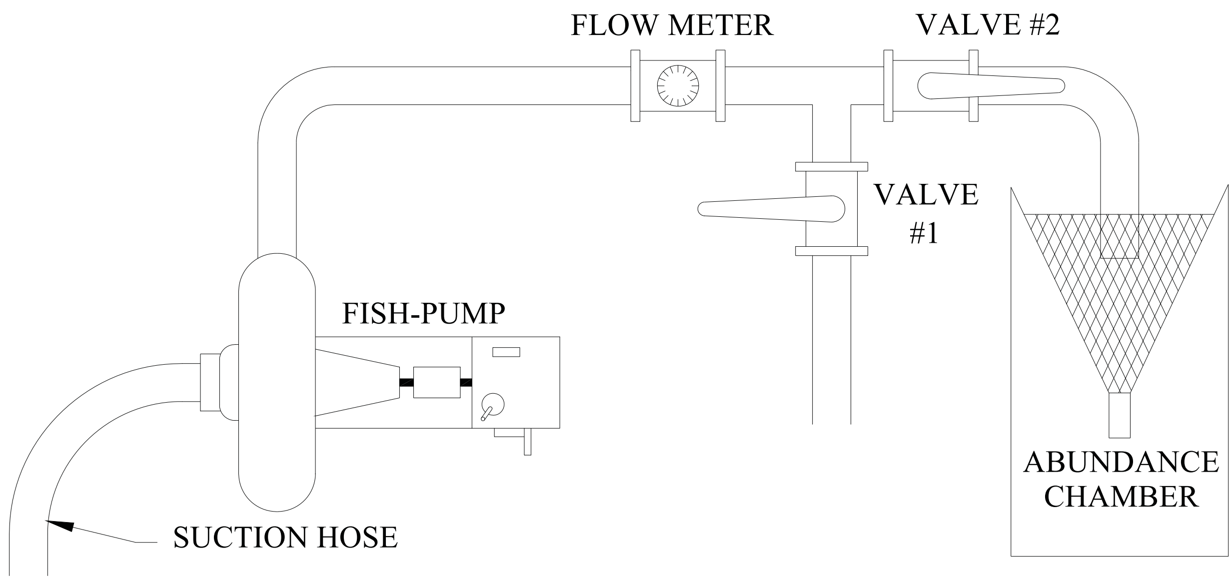



Figure 3-2. Plankton pump and abundance chamber used in entrainment sampling.

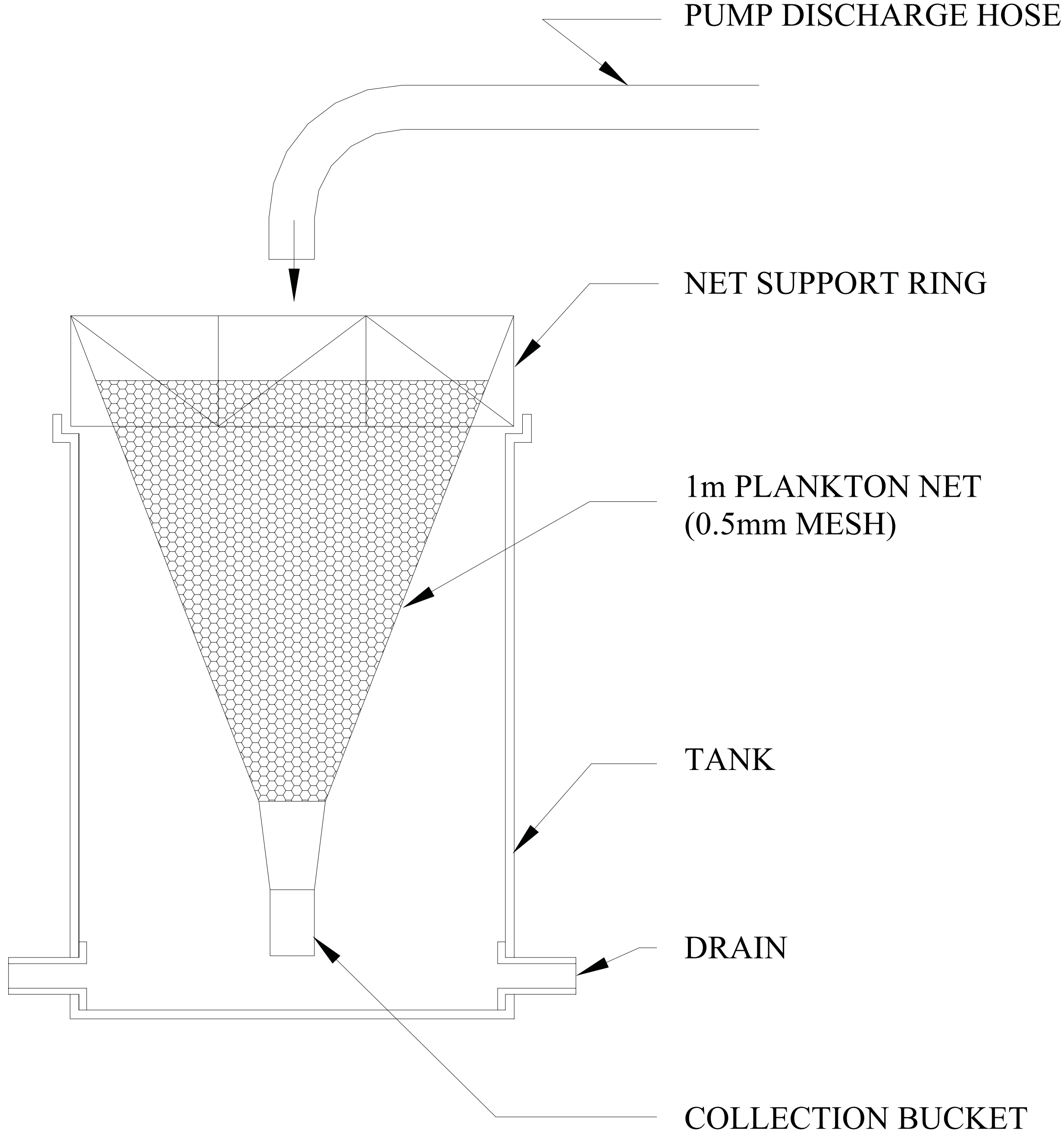



Figure 3-3. Cut away view showing entrainment collection net inside abundance chamber.

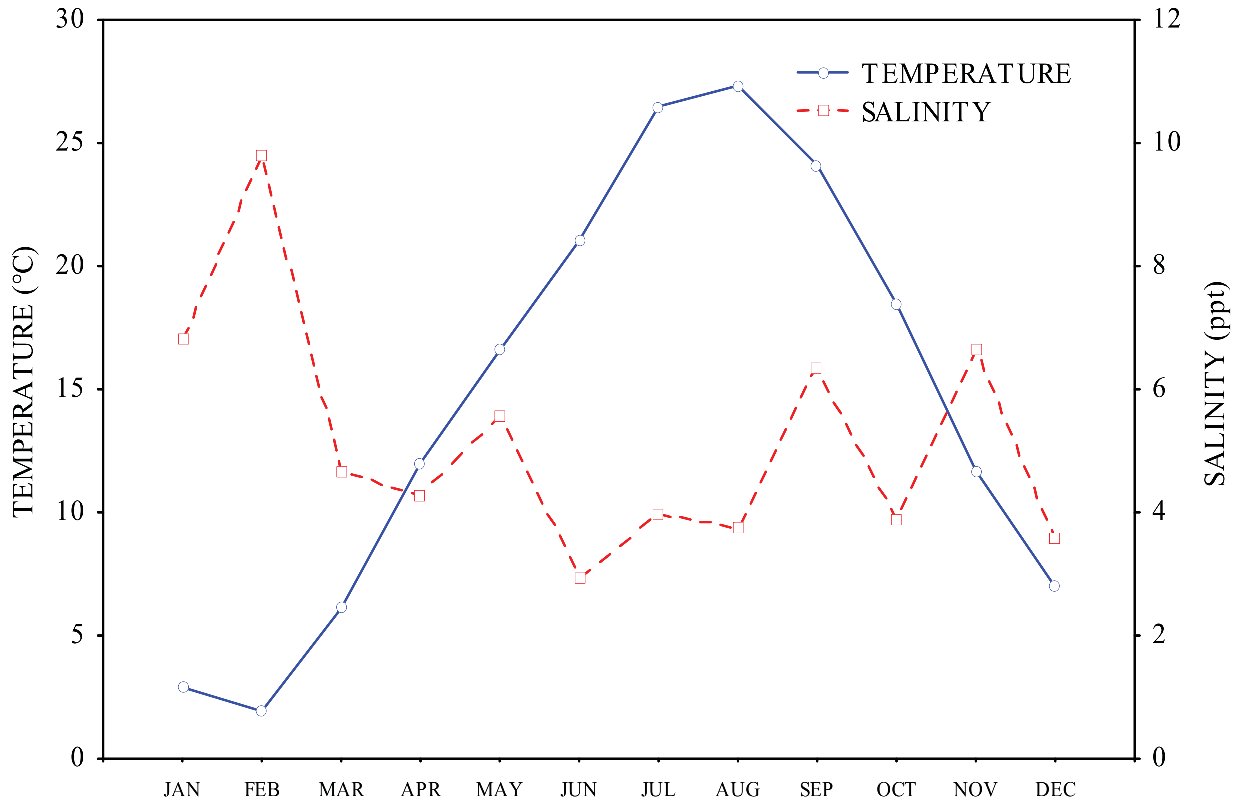



Figure 3-4. Salinity and temperature (mean) by month as observed during 2003 impingement sampling.

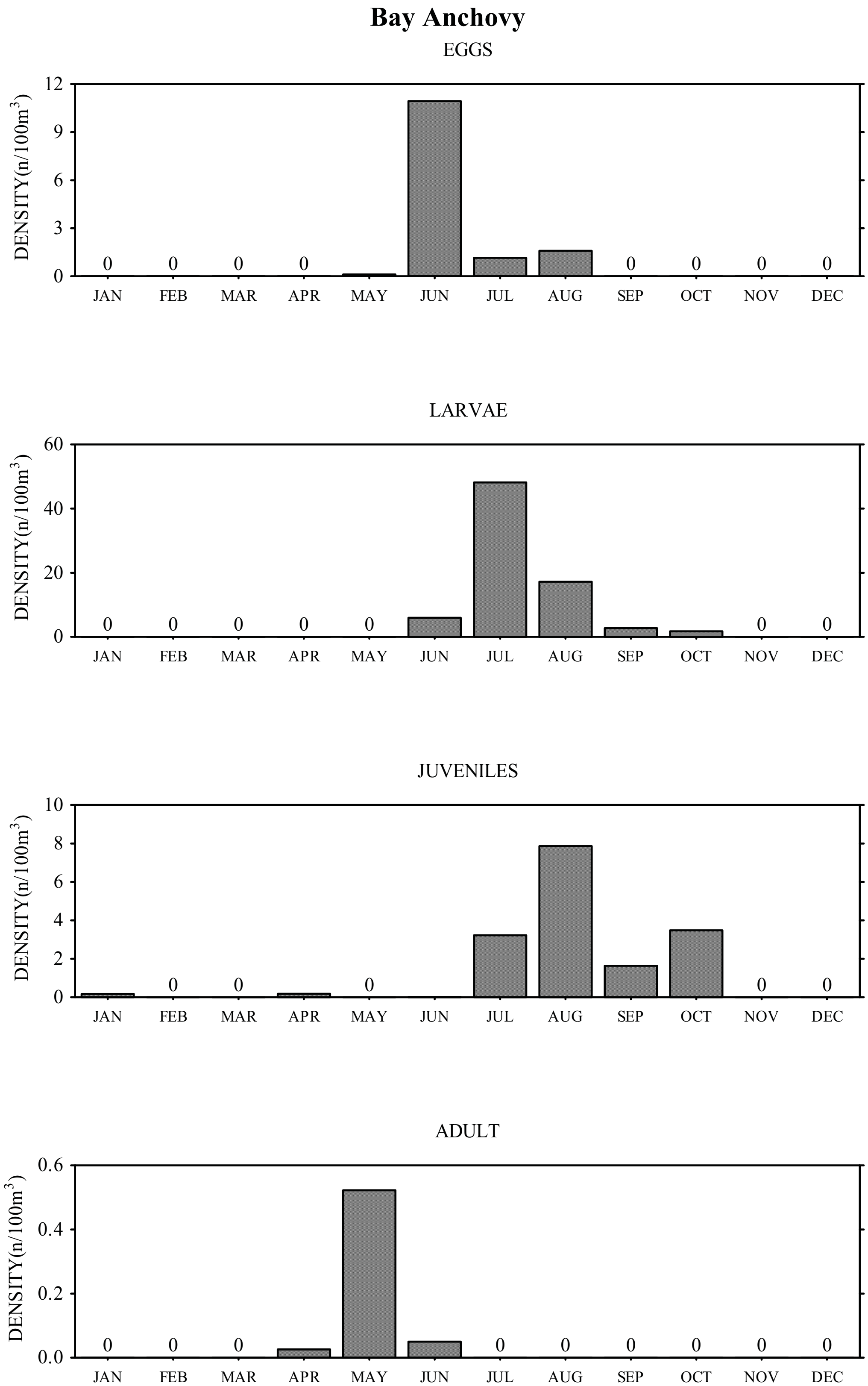



Figure 3-5. Monthly mean density ($n/100m^3$) of bay anchovy eggs, larvae, juveniles, and adults taken in entrainment sampling at the Salem circulating water intake structure during 2003.

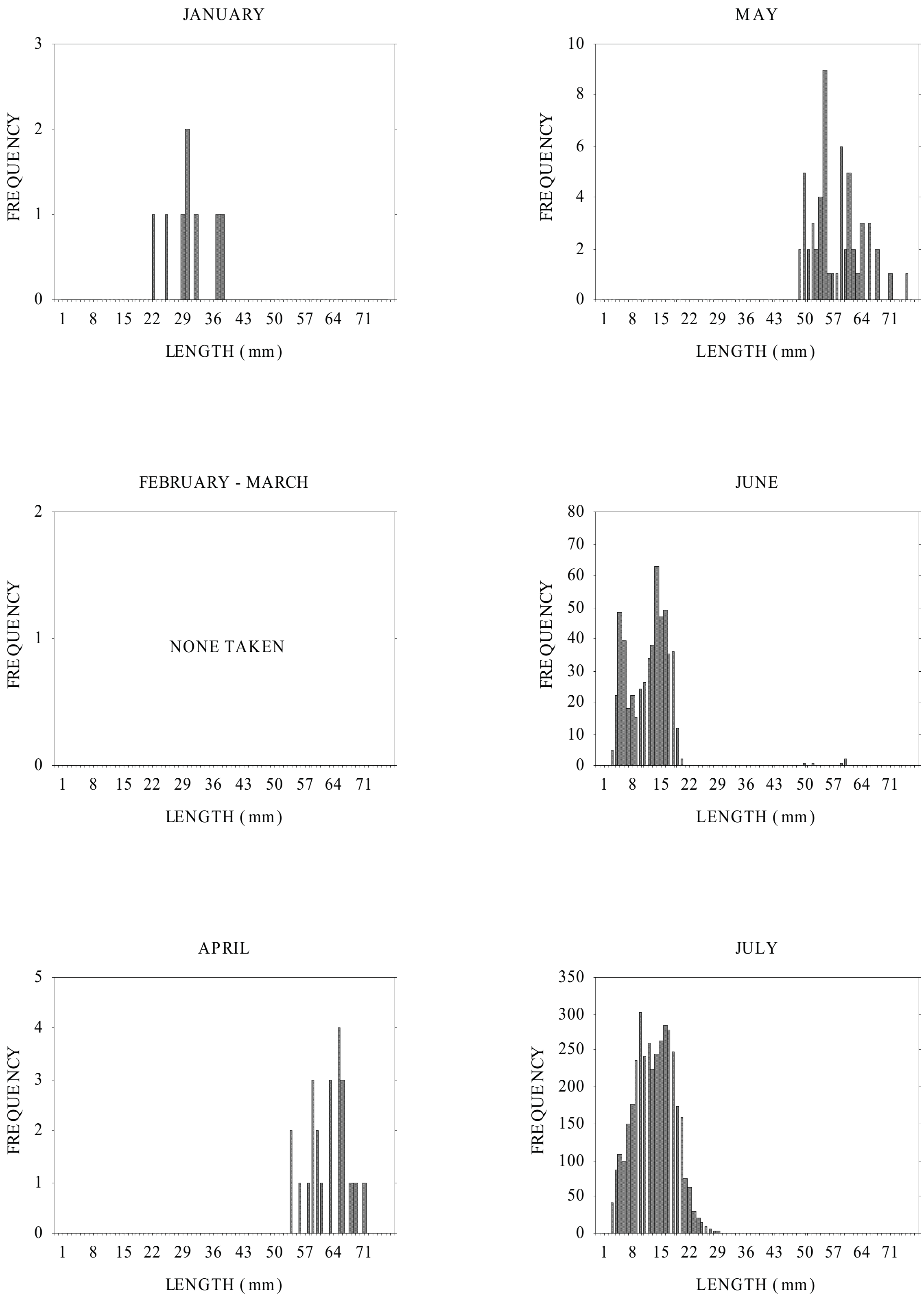



Figure 3-6. Length frequency of bay anchovy taken in entrainment sampling at the Salem circulating water intake structure during 2003.

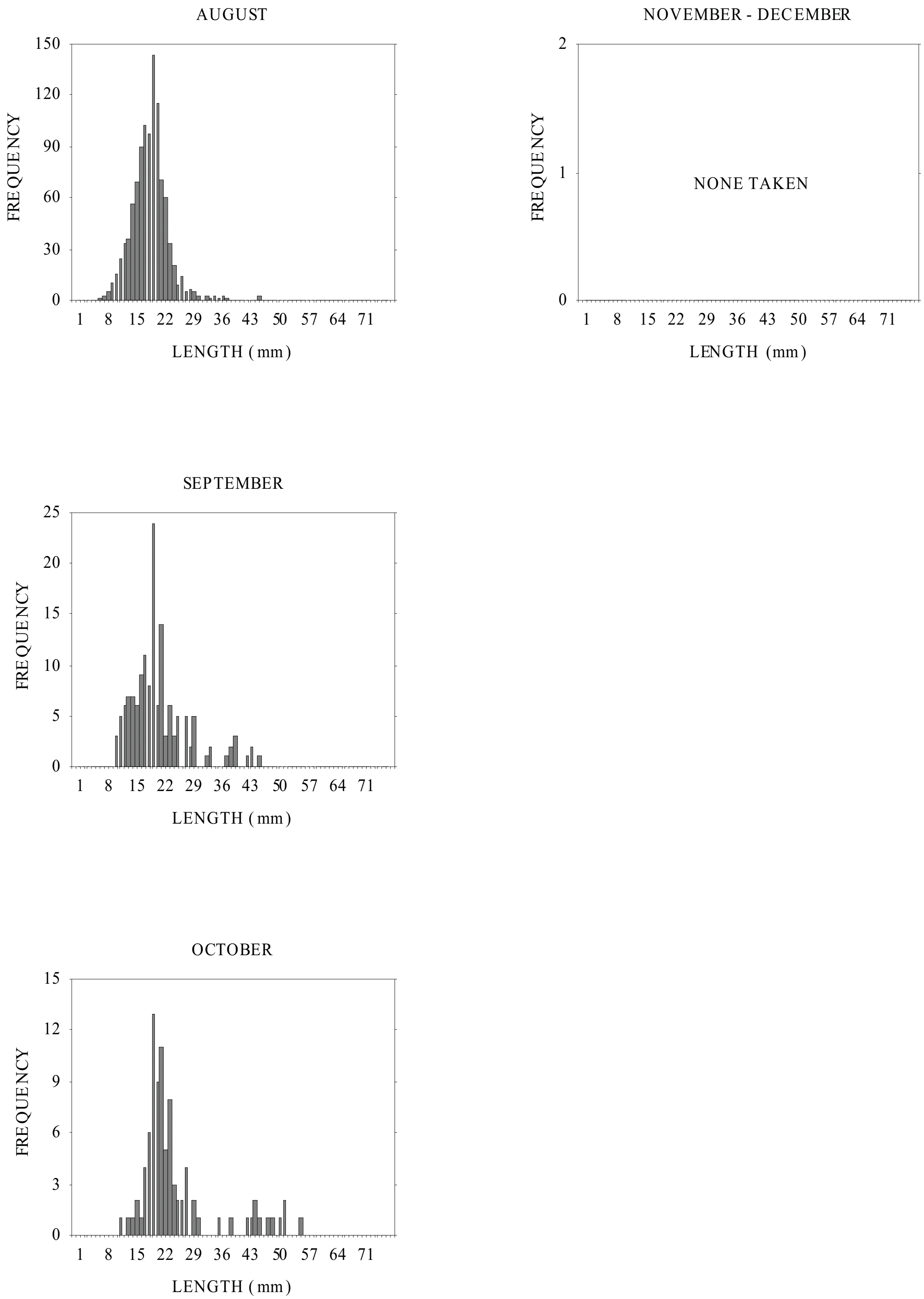



Figure 3-6. Continued.

## Striped Bass

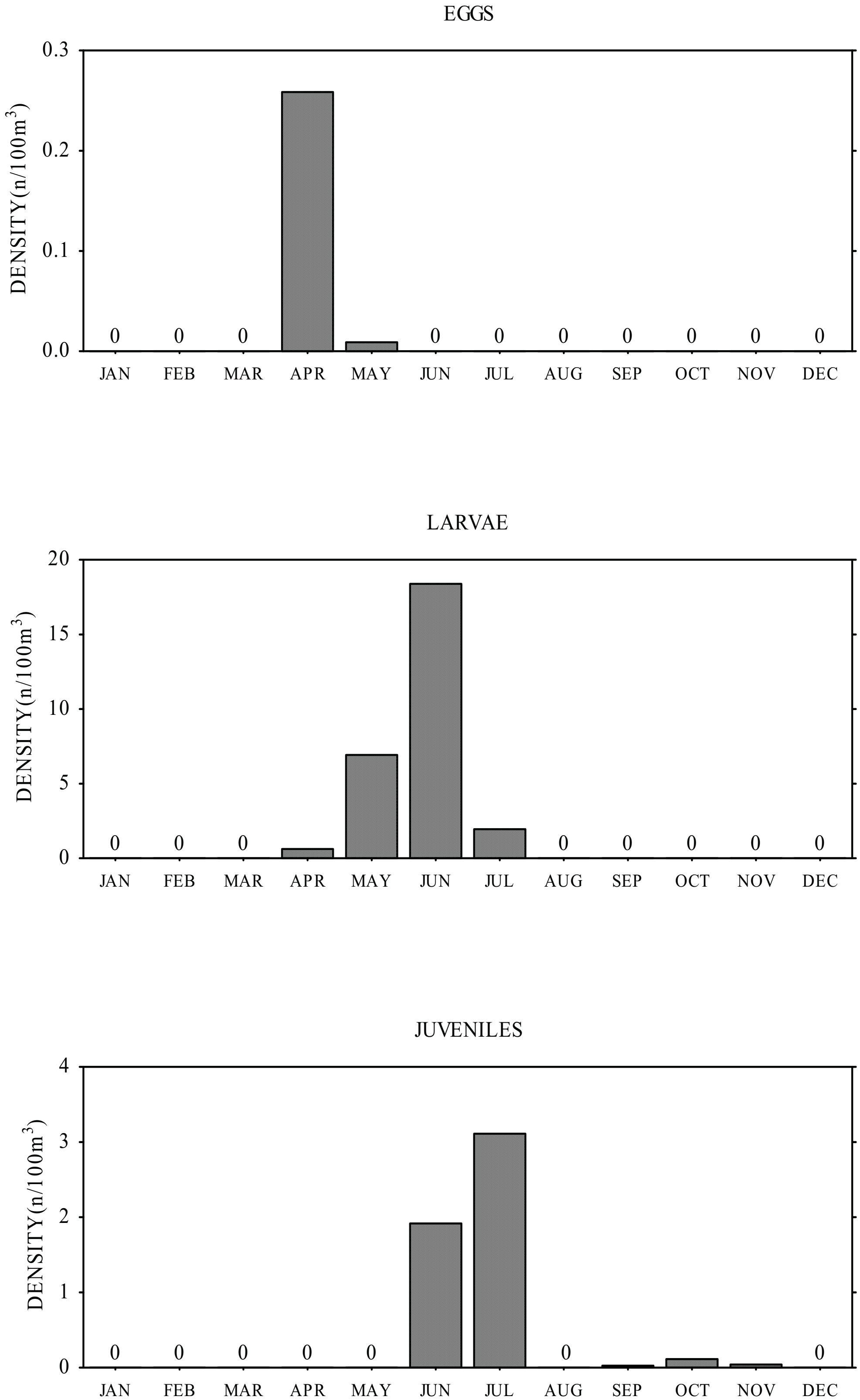



Figure 3-7. Monthly mean density (n/100m$^3$) of striped bass eggs, larvae, and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

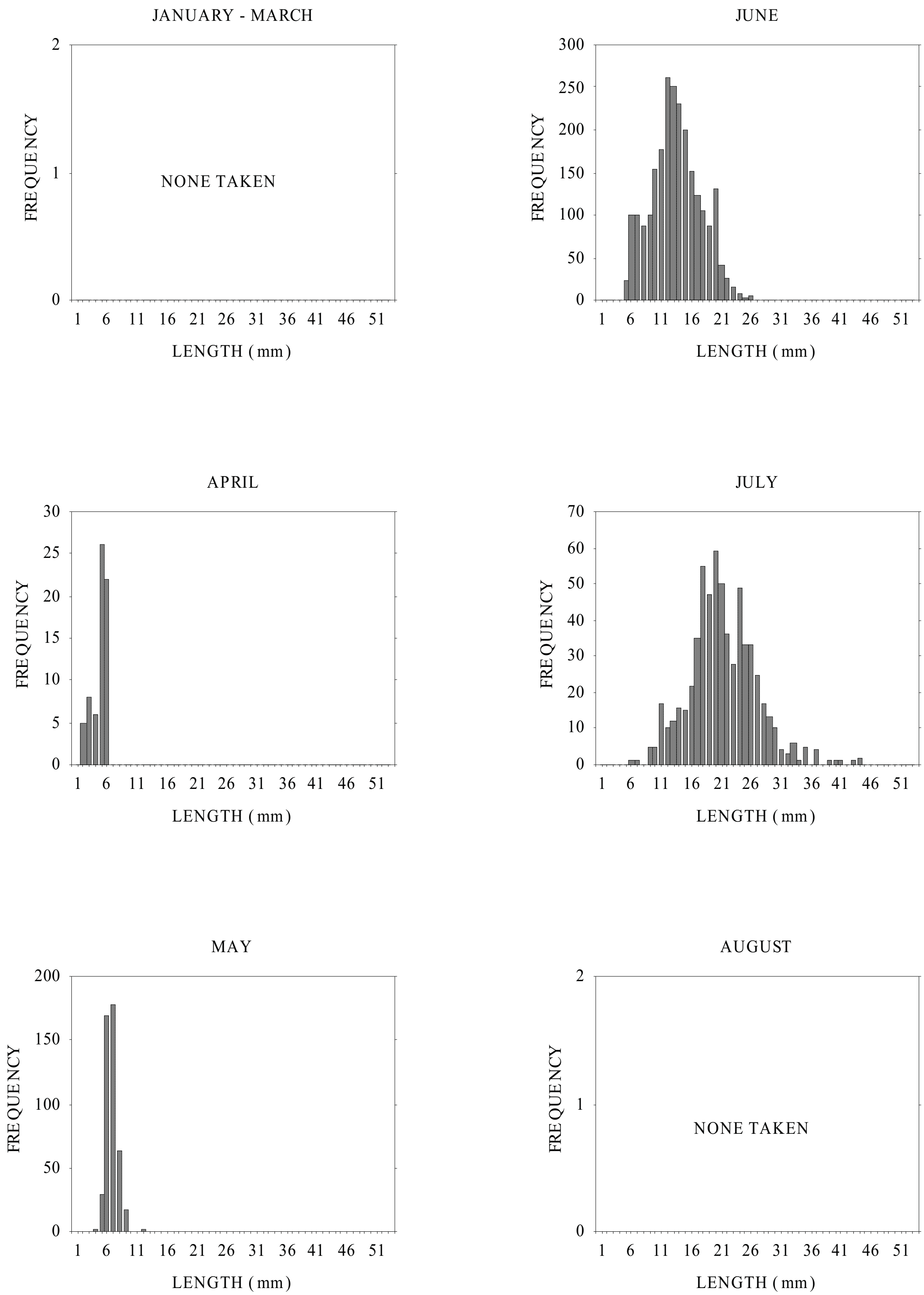



Figure 3-8. Length frequency of striped bass taken in entrainment sampling at the Salem circulating water intake structure during 2003.

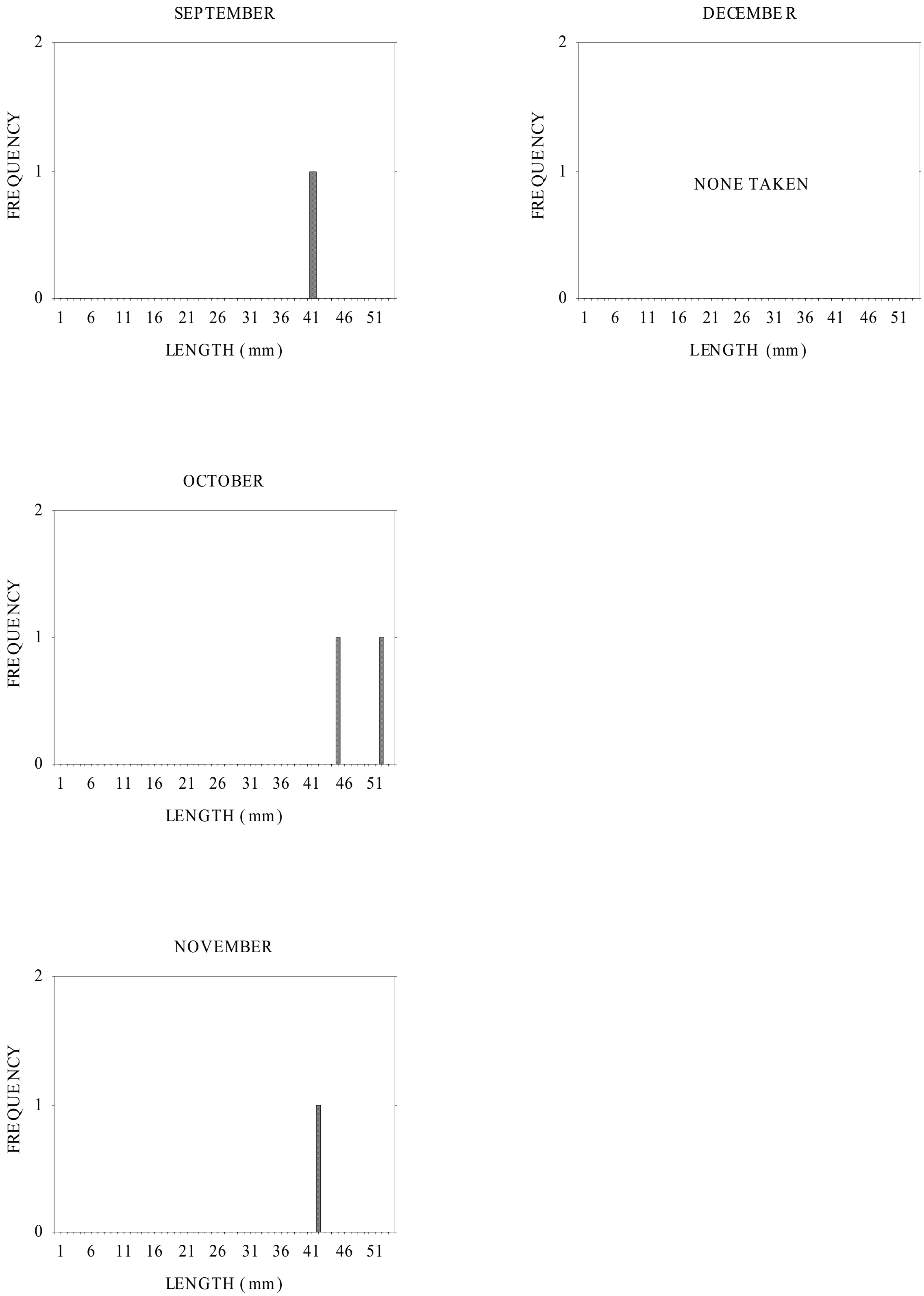
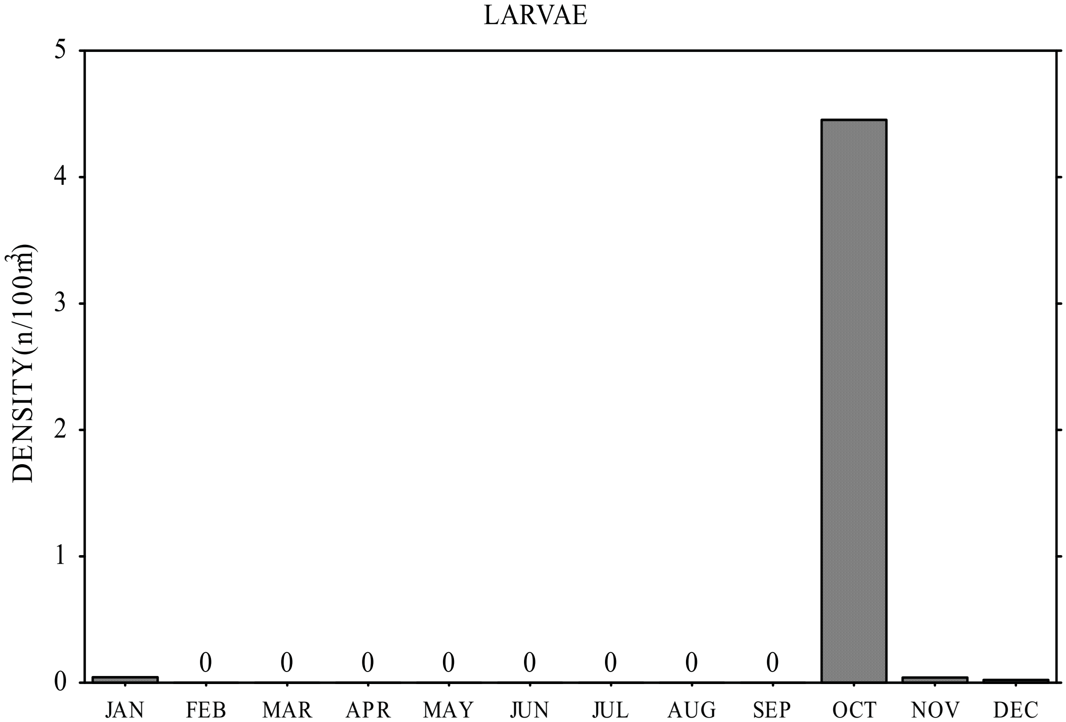



Figure 3-8. Continued.

## Atlantic Croaker



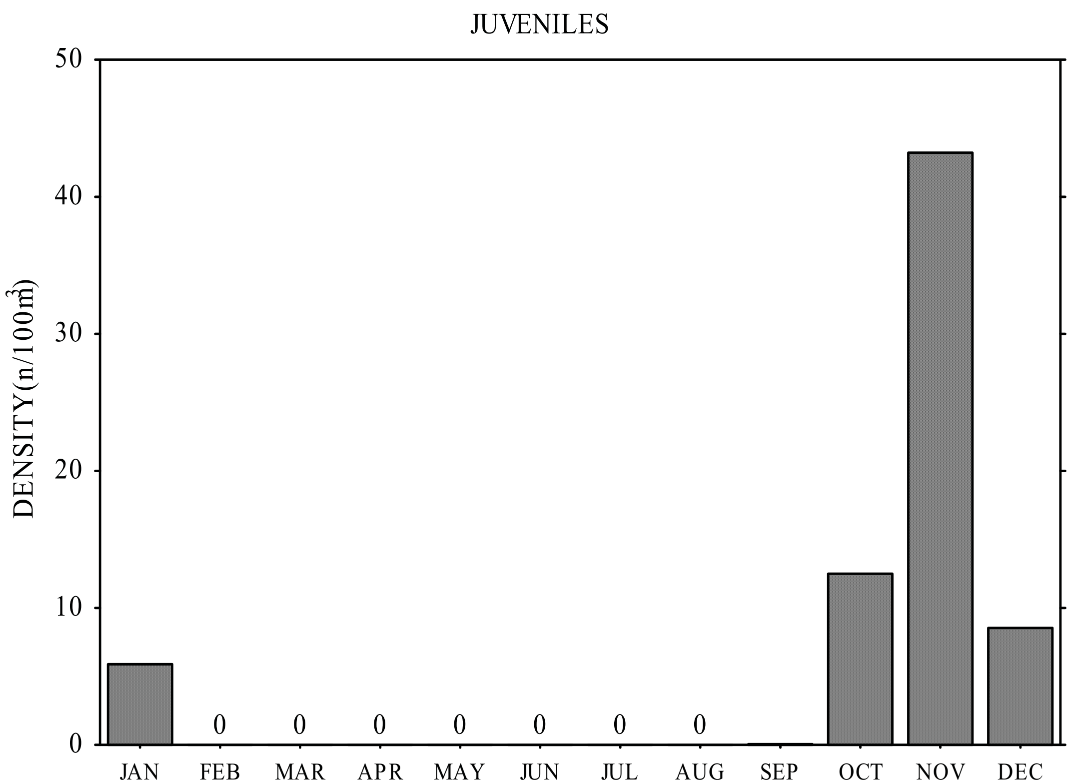




Figure 3-9. Monthly mean density (n/100m$^3$) of Atlantic croaker larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

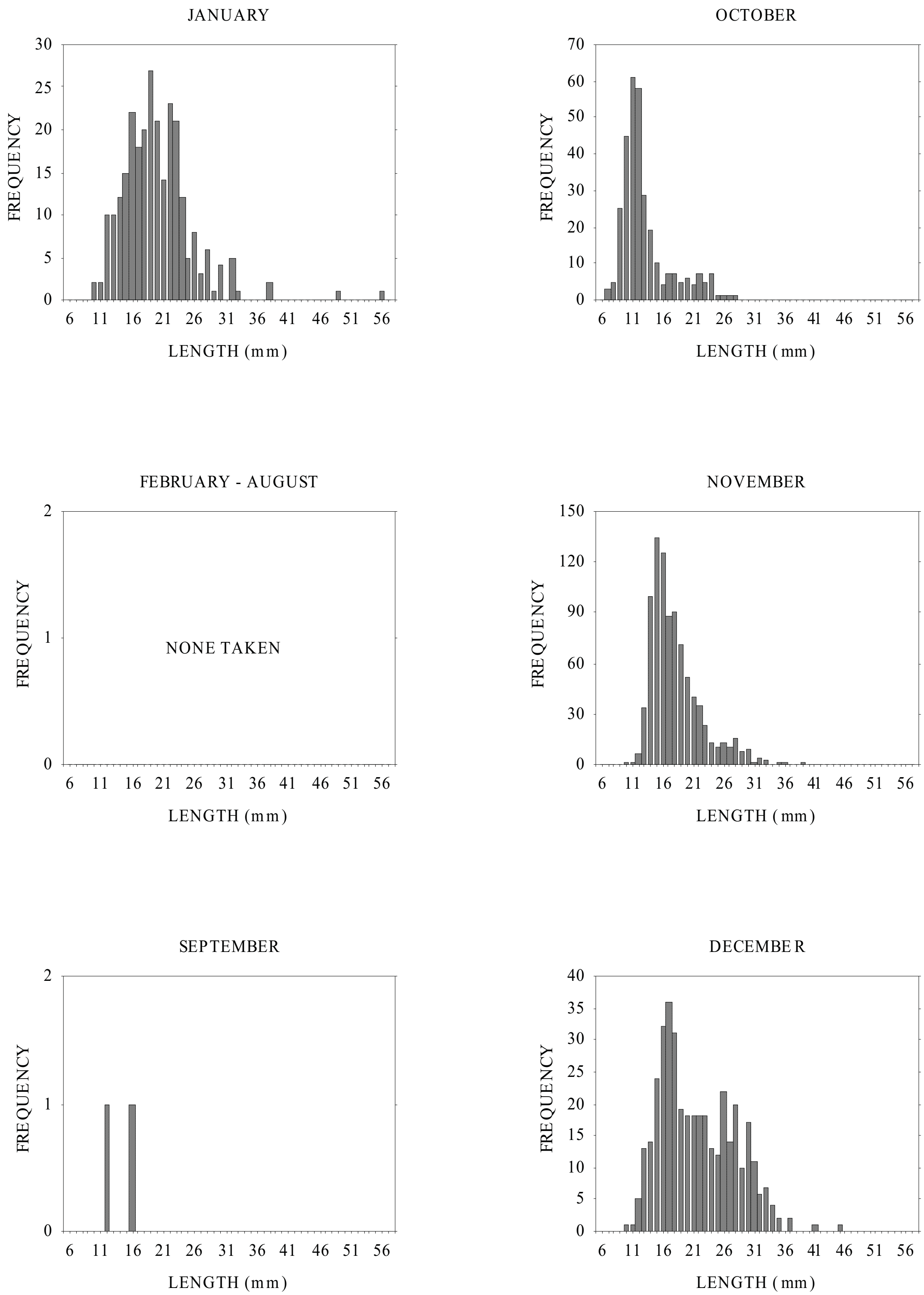



Figure 3-10. Length frequency of Atlantic croaker taken in entrainment sampling at the Salem circulating water intake structure during 2003.

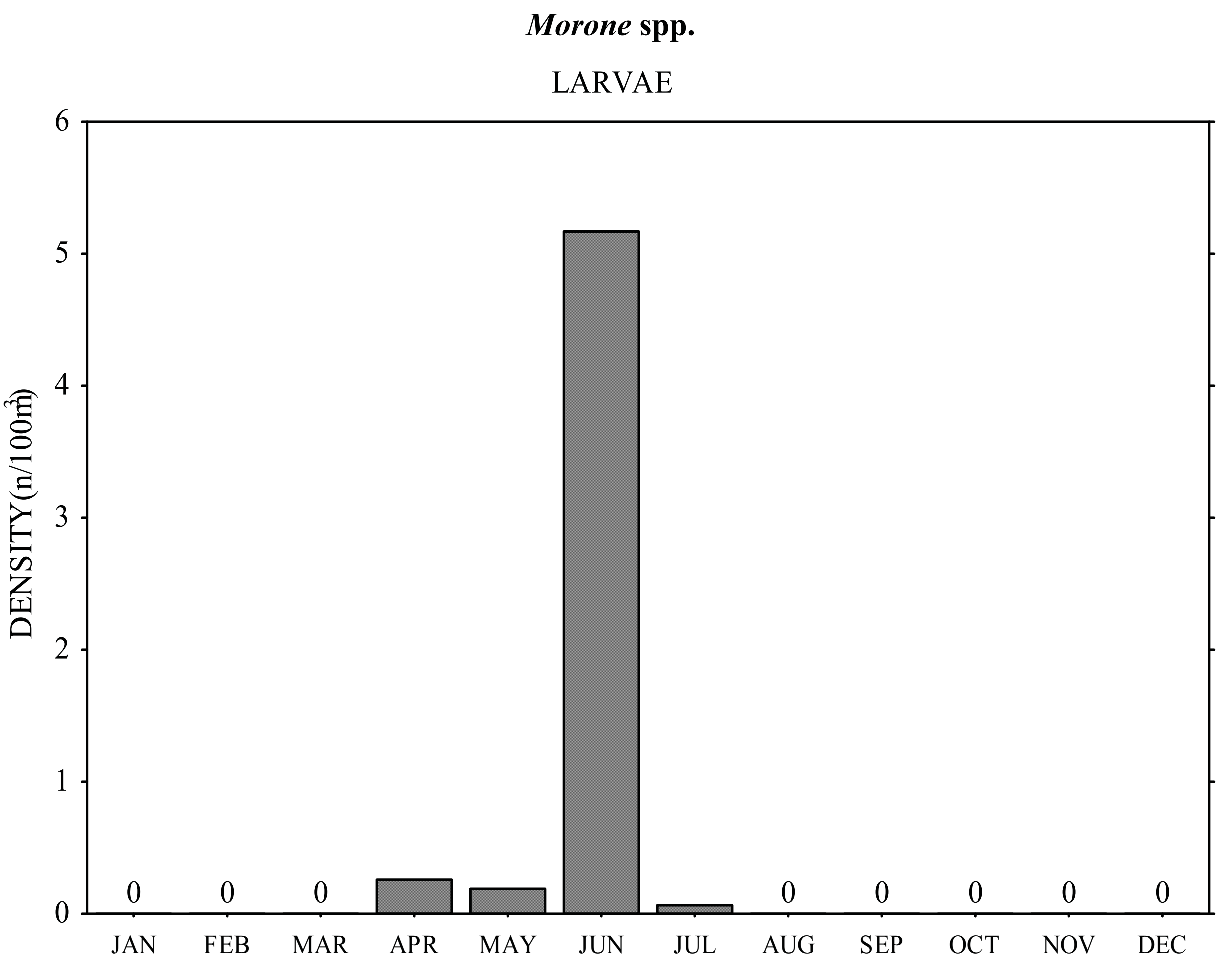



Figure 3-11. Monthly mean density (n/100m$^3$) of *Morone* spp. larvae taken in entrainment sampling at the Salem circulating water intake structure during 2003.

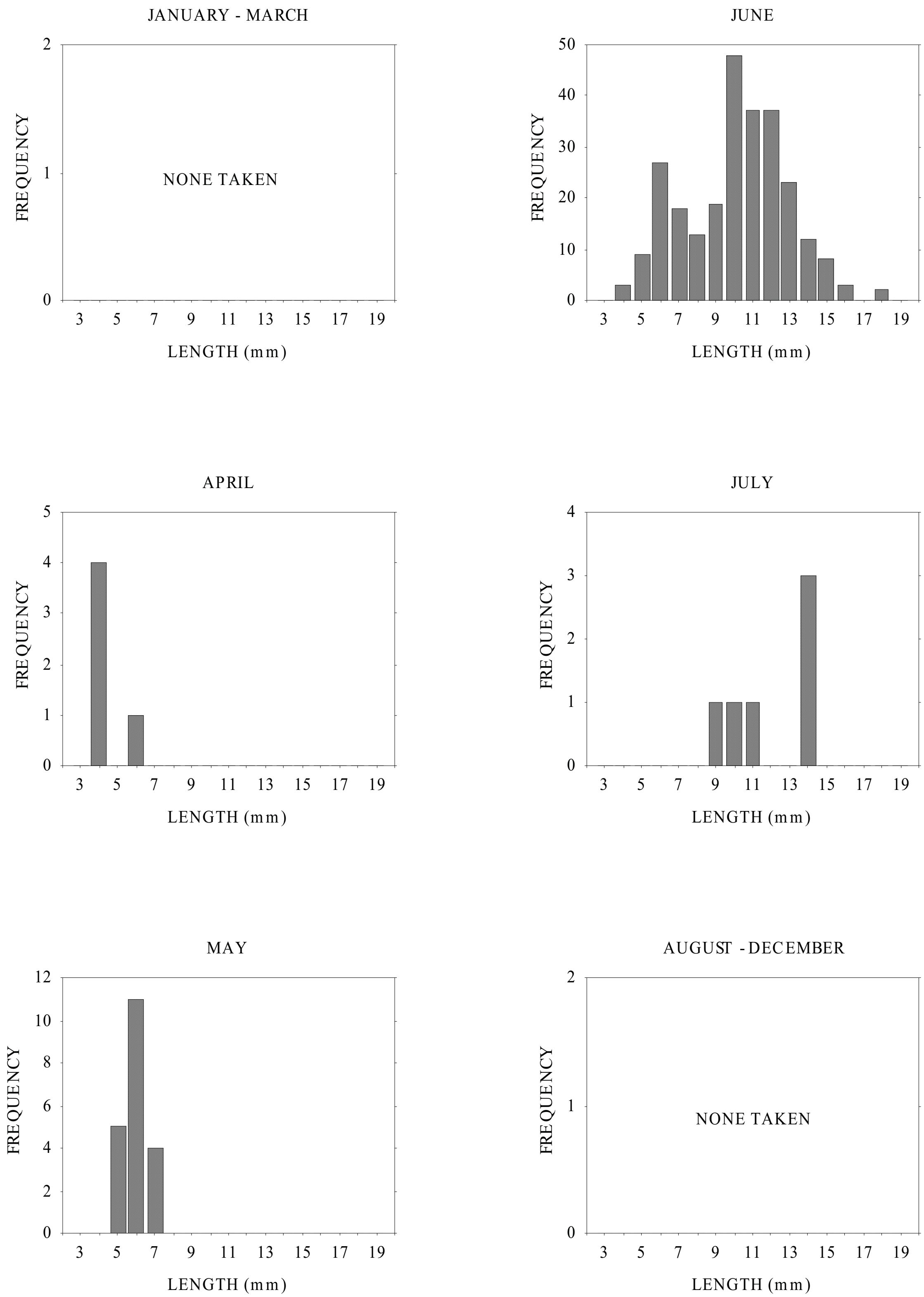



Figure 3-12. Length frequency of *Morone* spp. taken in entrainment sampling at the Salem circulating water intake structure during 2003.

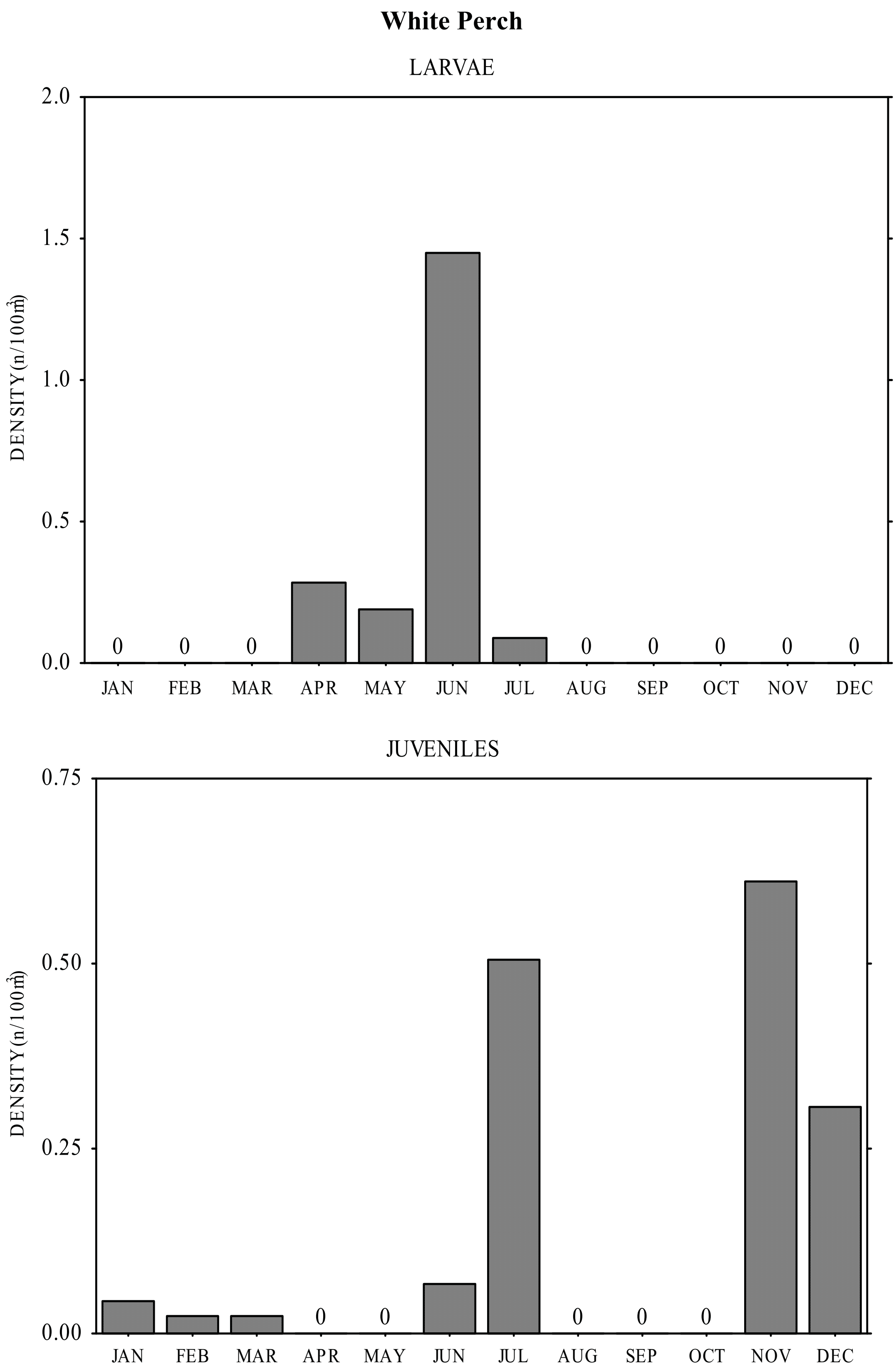



Figure 3-13. Monthly mean density (n/100m$^3$) of white perch larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

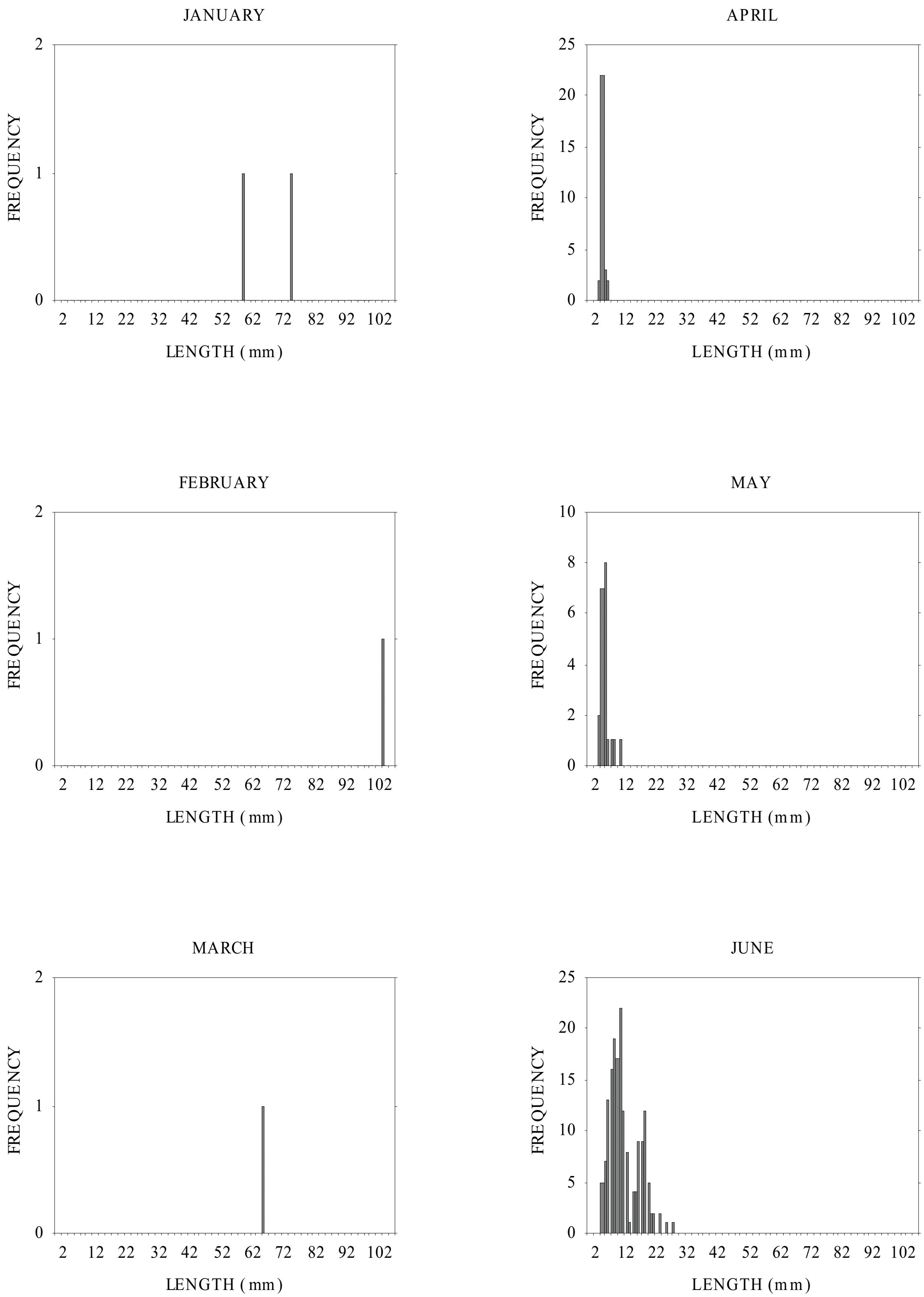
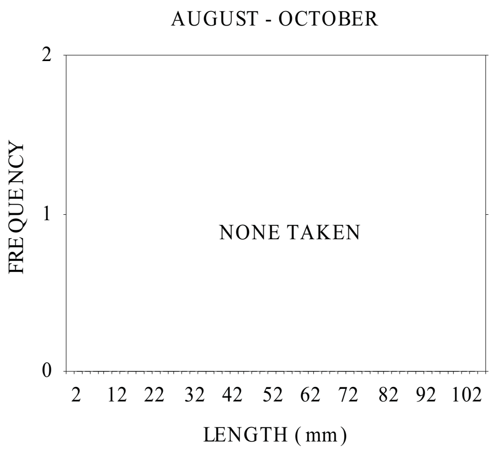
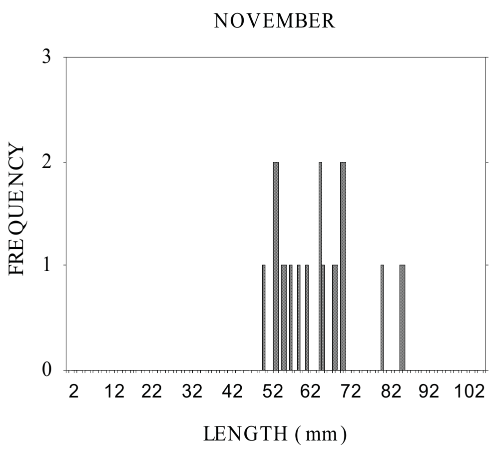



Figure 3-14. Length frequency of white perch taken in entrainment sampling at the Salem circulating water intake structure during 2003.



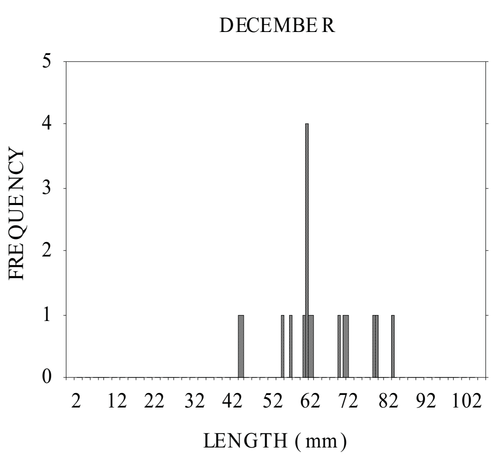




Figure 3-14. Continued.

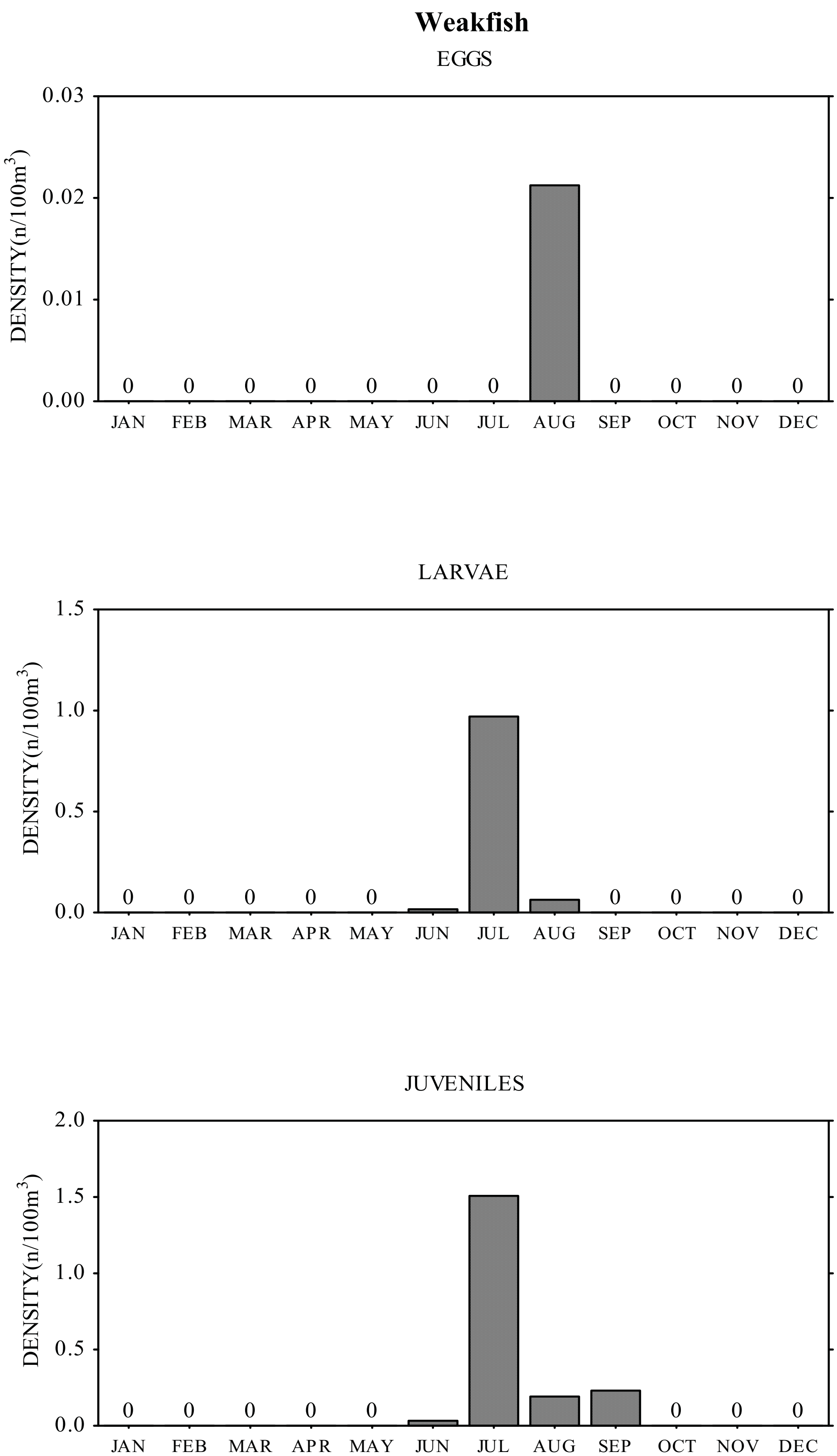



Figure 3-15. Monthly mean density ($n/100m^3$) of weakfish eggs, larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

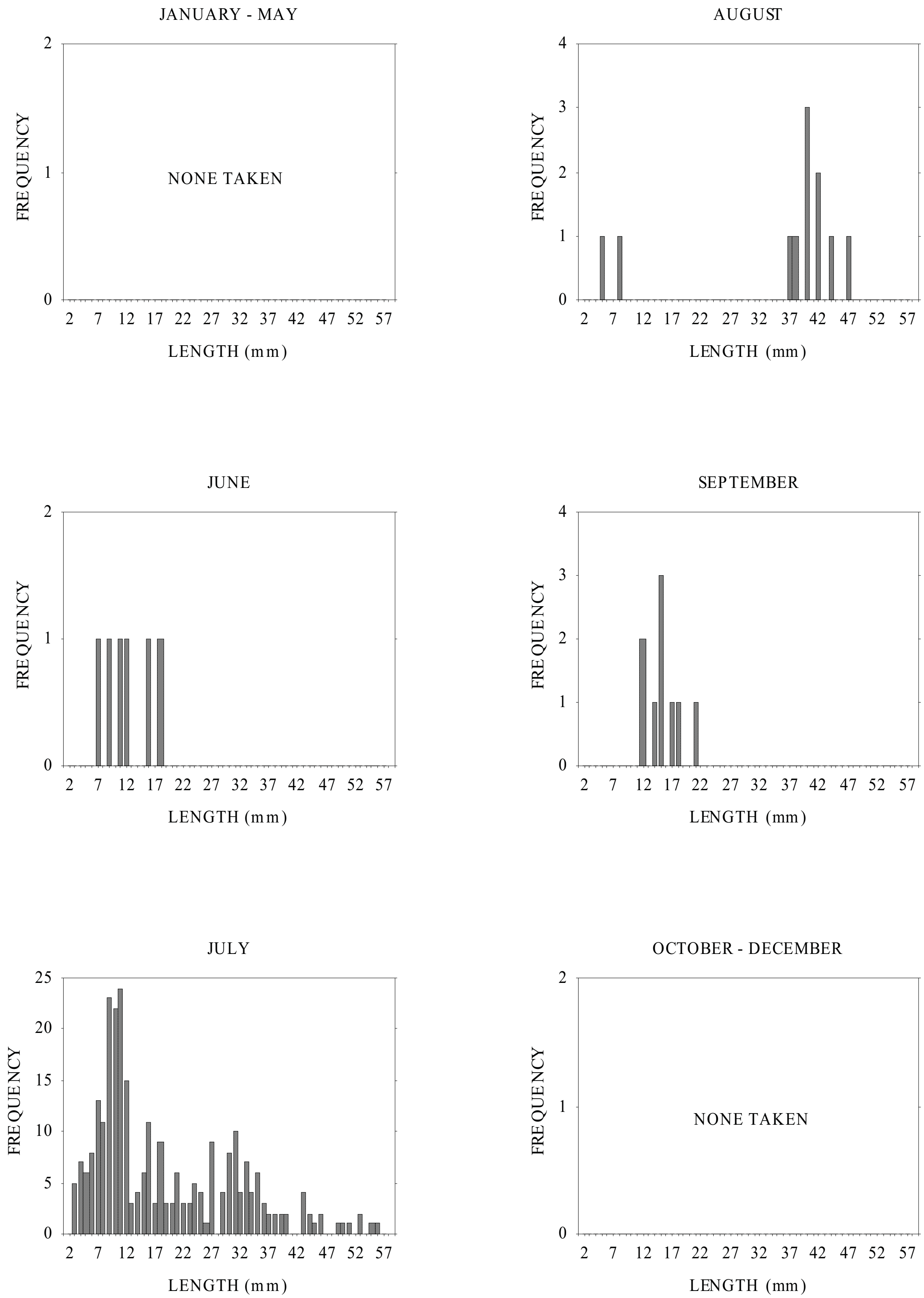
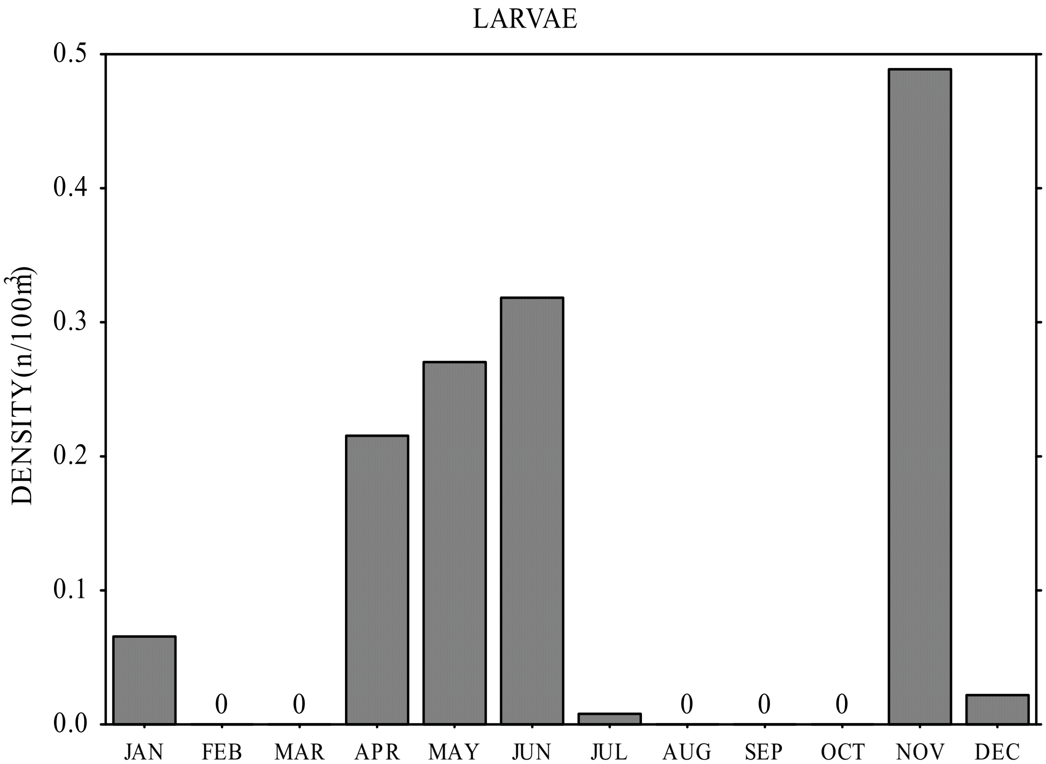



Figure 3-16. Length frequency of weakfish taken in entrainment sampling at the Salem circulating water intake structure during 2003.

## Atlantic Menhaden



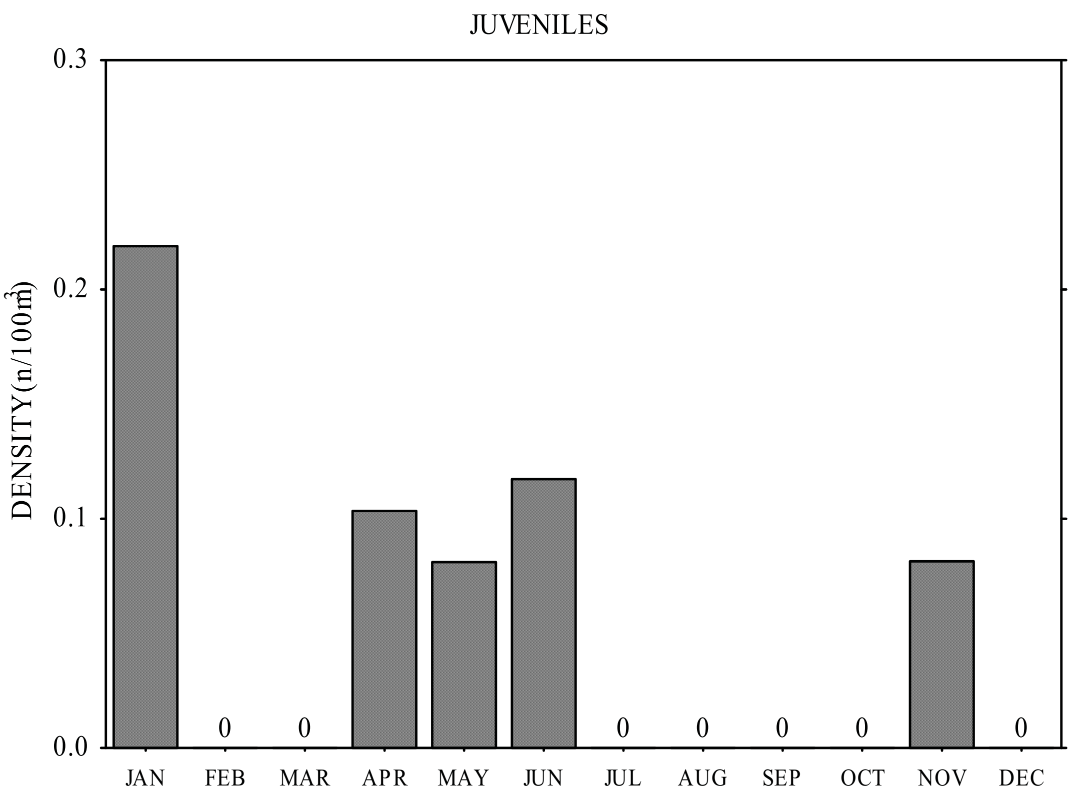




Figure 3-17. Monthly mean density (n/100m$^3$) of Atlantic menhaden larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

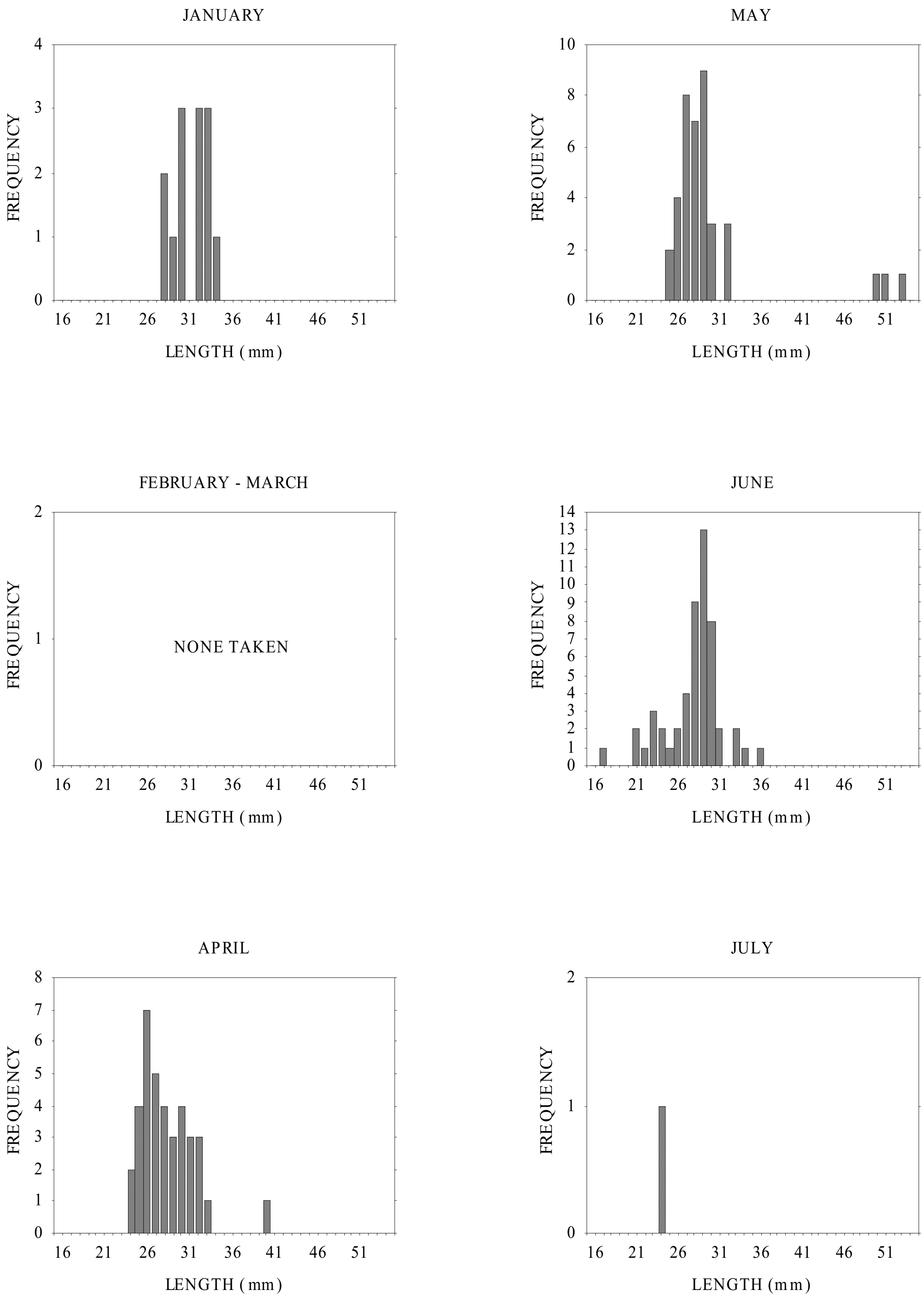



Figure 3-18. Length frequency of Atlantic menhaden taken in entrainment sampling at the Salem circulating water intake structure during 2003.

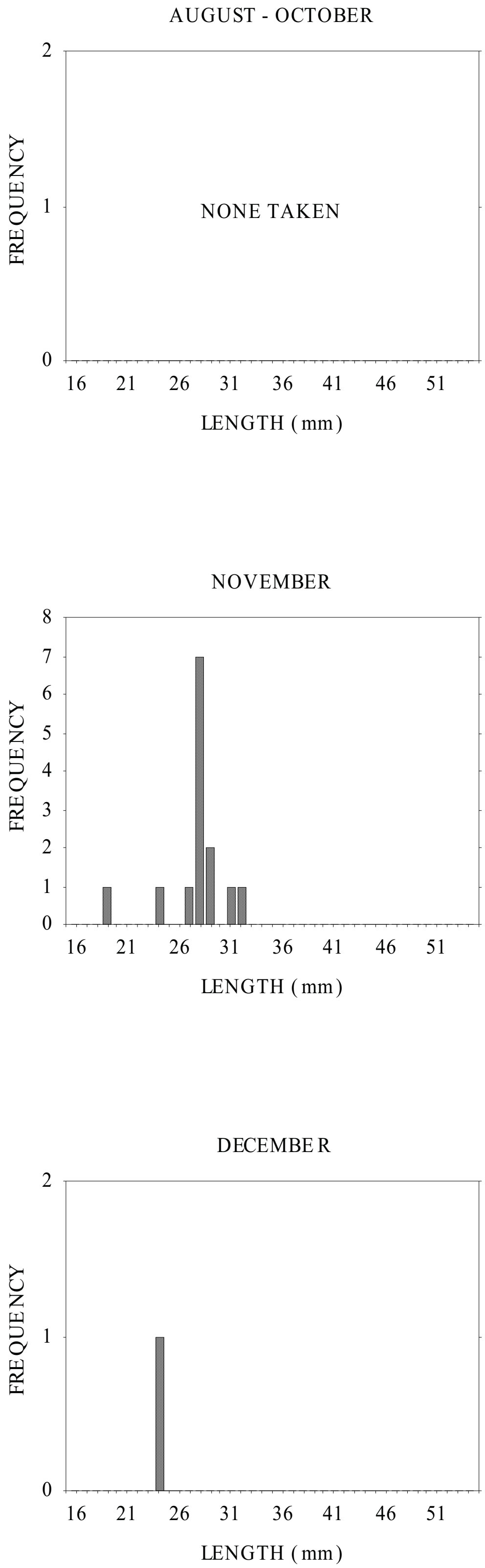



Figure 3-18. Continued.

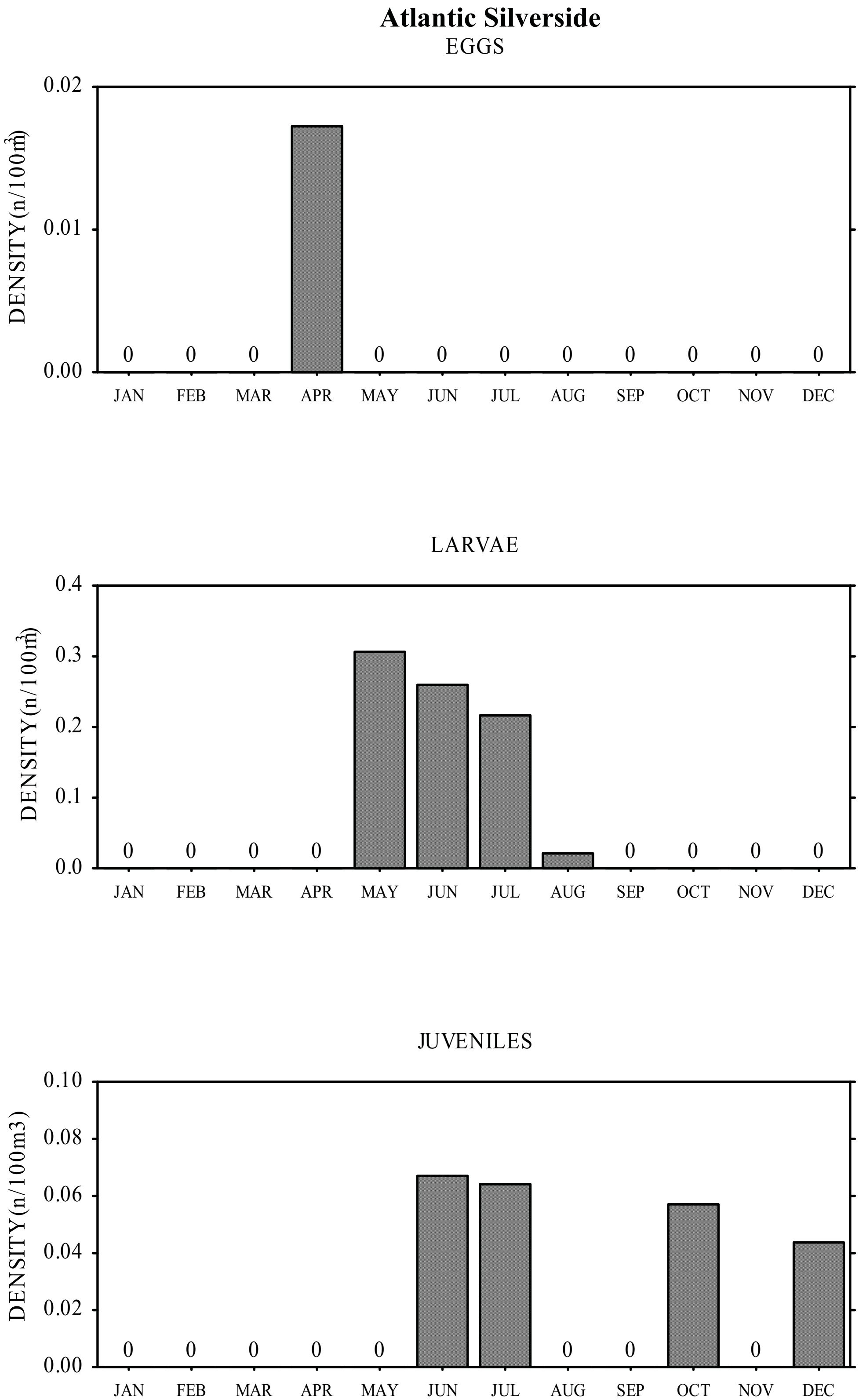



Figure 3-19. Monthly mean density (n/100m$^3$) of Atlantic silverside eggs, larvae, and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

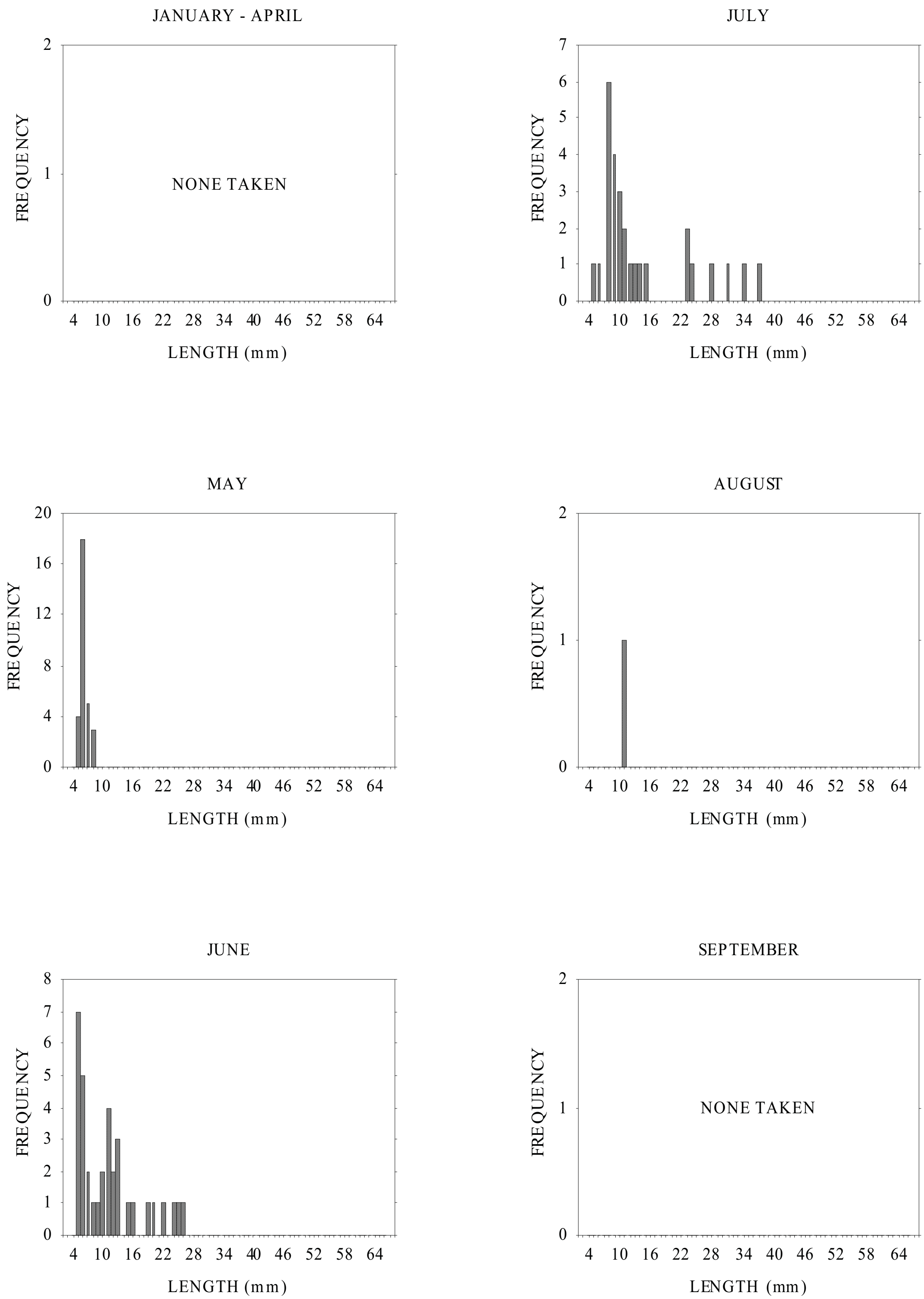



Figure 3-20. Length frequency of Atlantic silverside taken in entrainment sampling at the Salem circulating water intake structure during 2003.

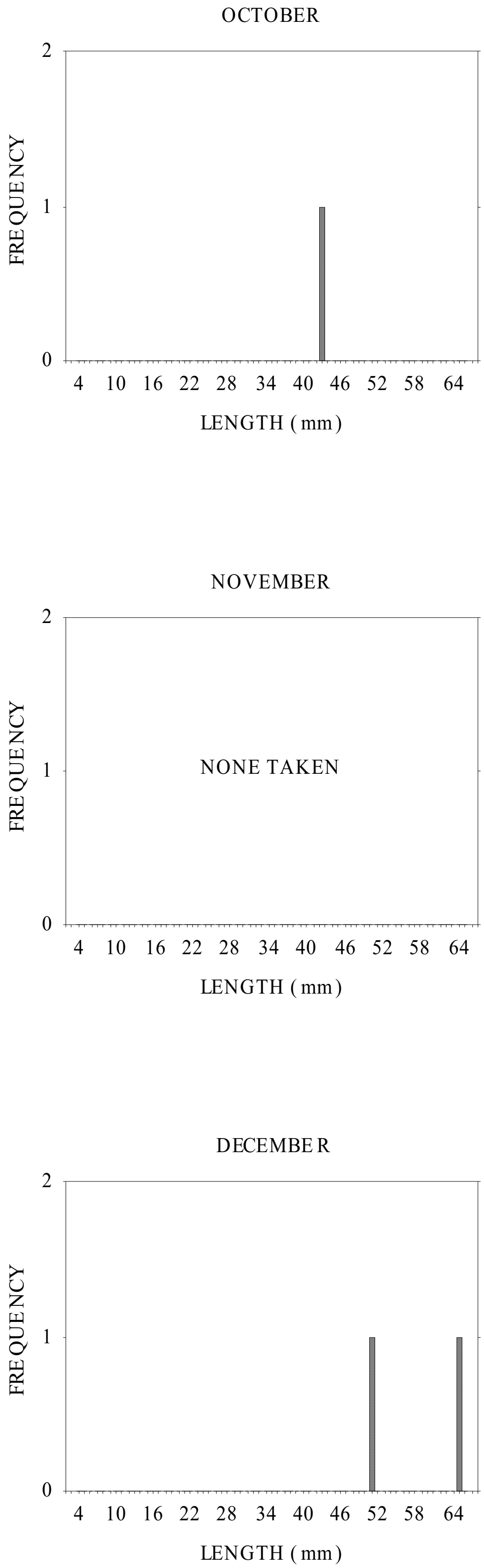
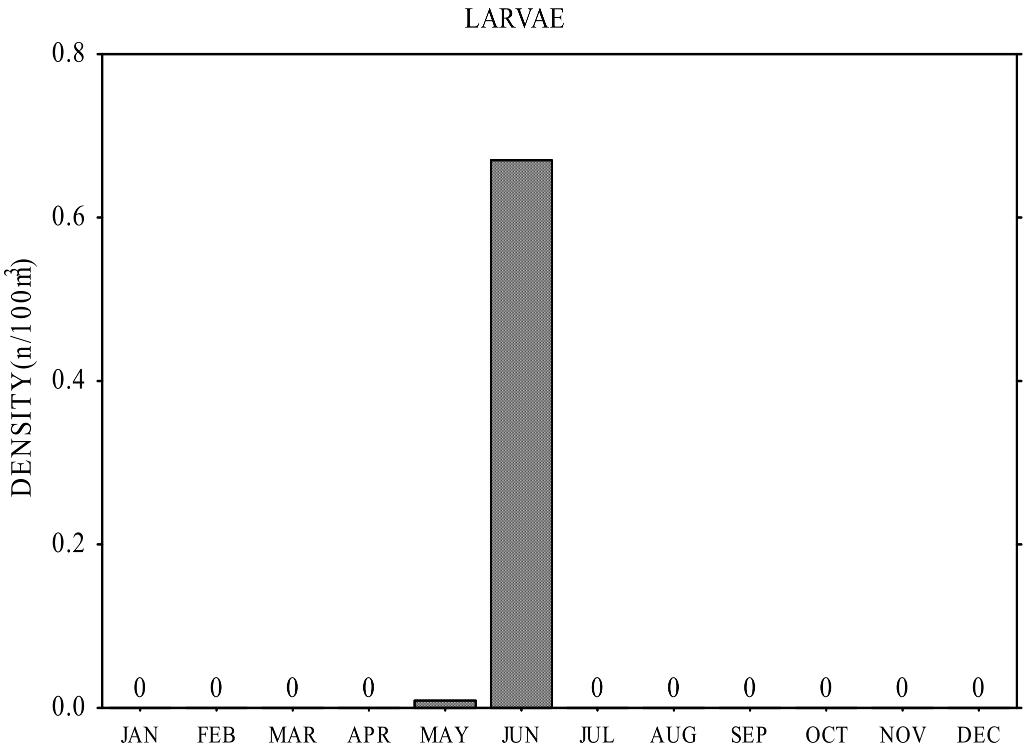



Figure 3-20.  Continued.

# Alewife



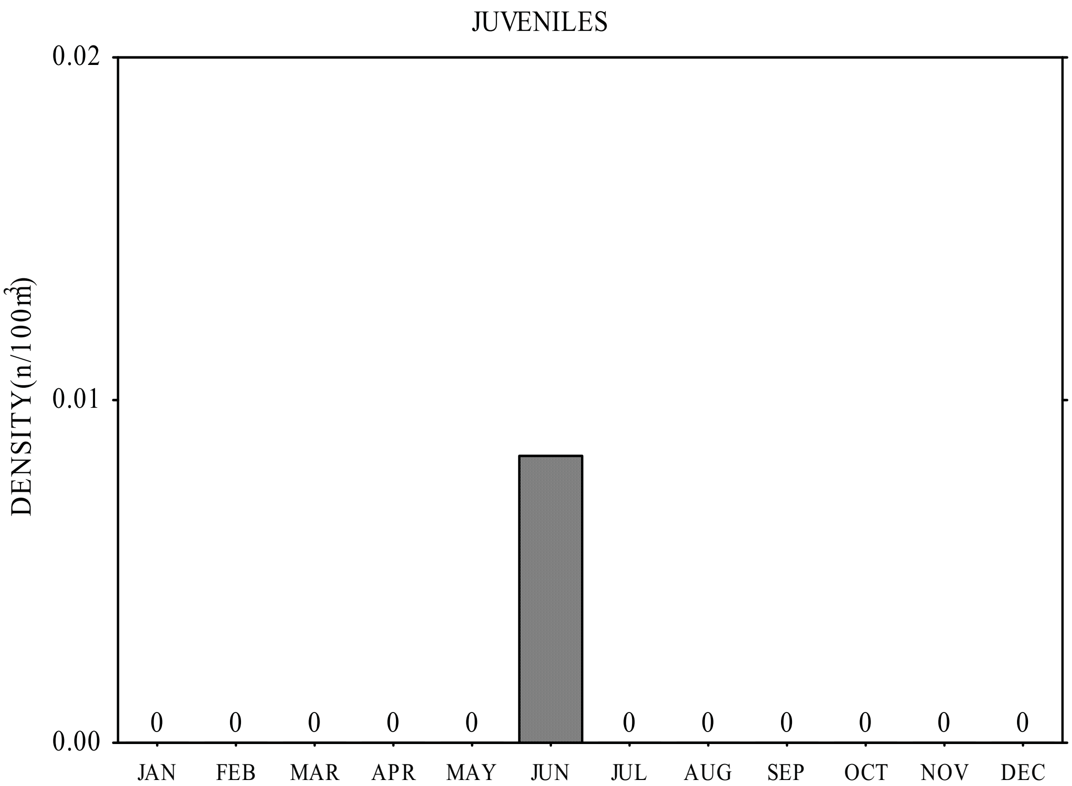




Figure 3-21. Monthly mean density (n/100m$^3$) of alewife larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

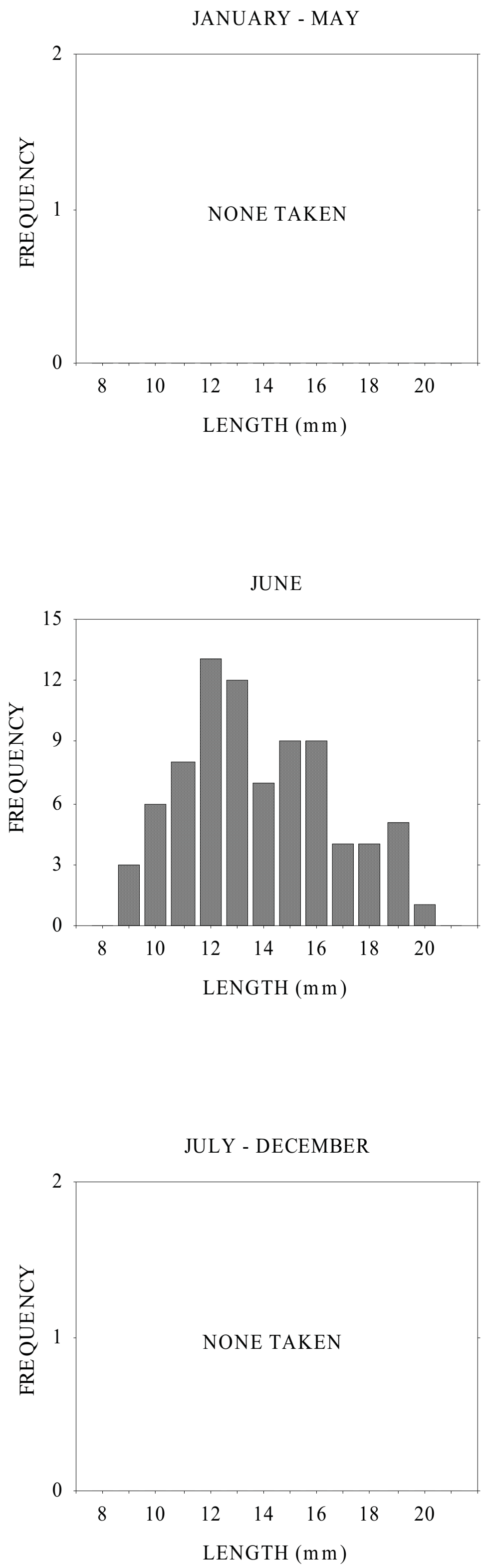



Figure 3-22. Length frequency of alewife taken in entrainment sampling at the Salem circulating water intake structure during 2003.

## *Alosa* spp.

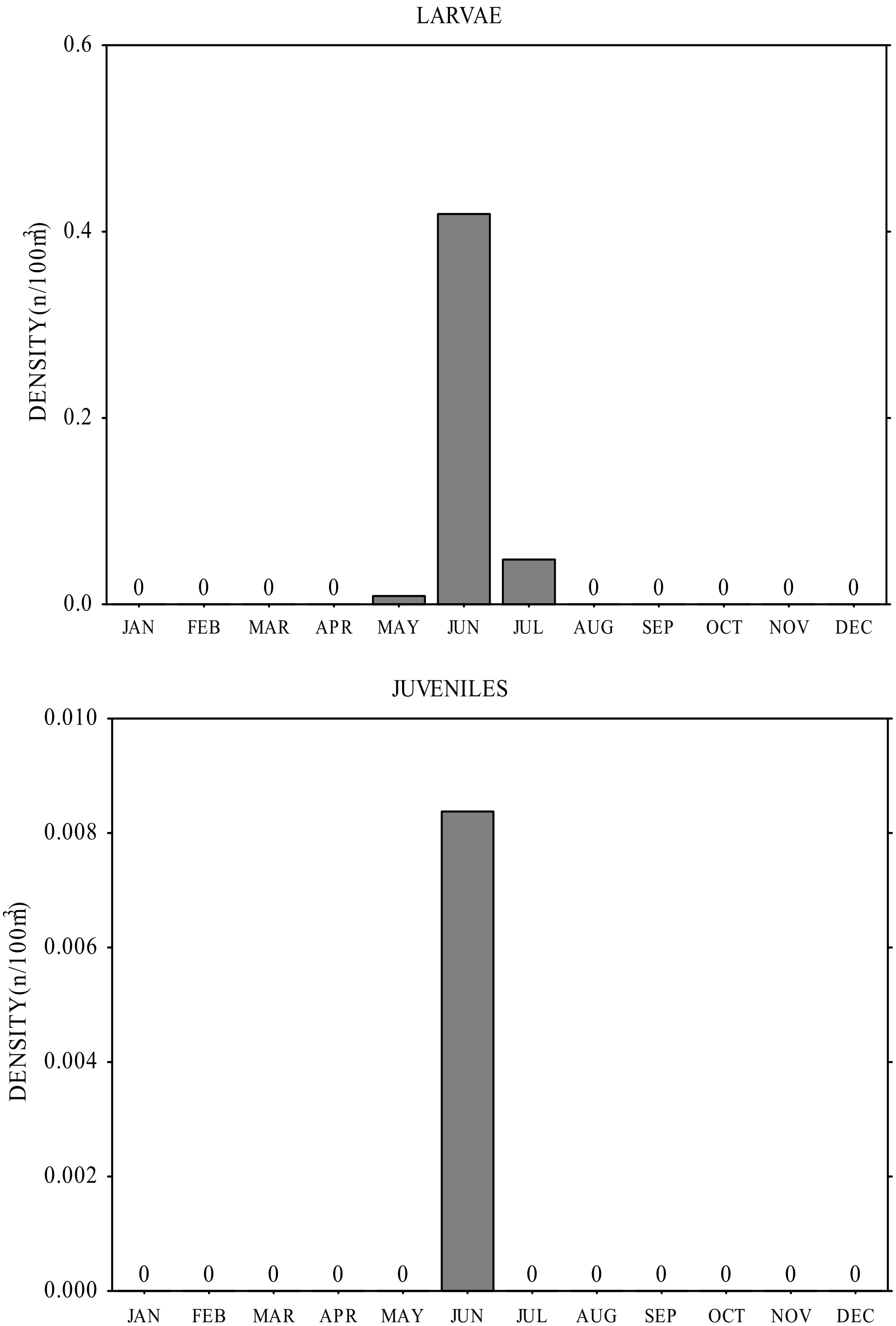



Figure 3-23. Monthly mean density (n/100m$^3$) of *Alosa* spp. larvae and juveniles taken in entrainment sampling at the Salem circulating water intake structure during 2003.

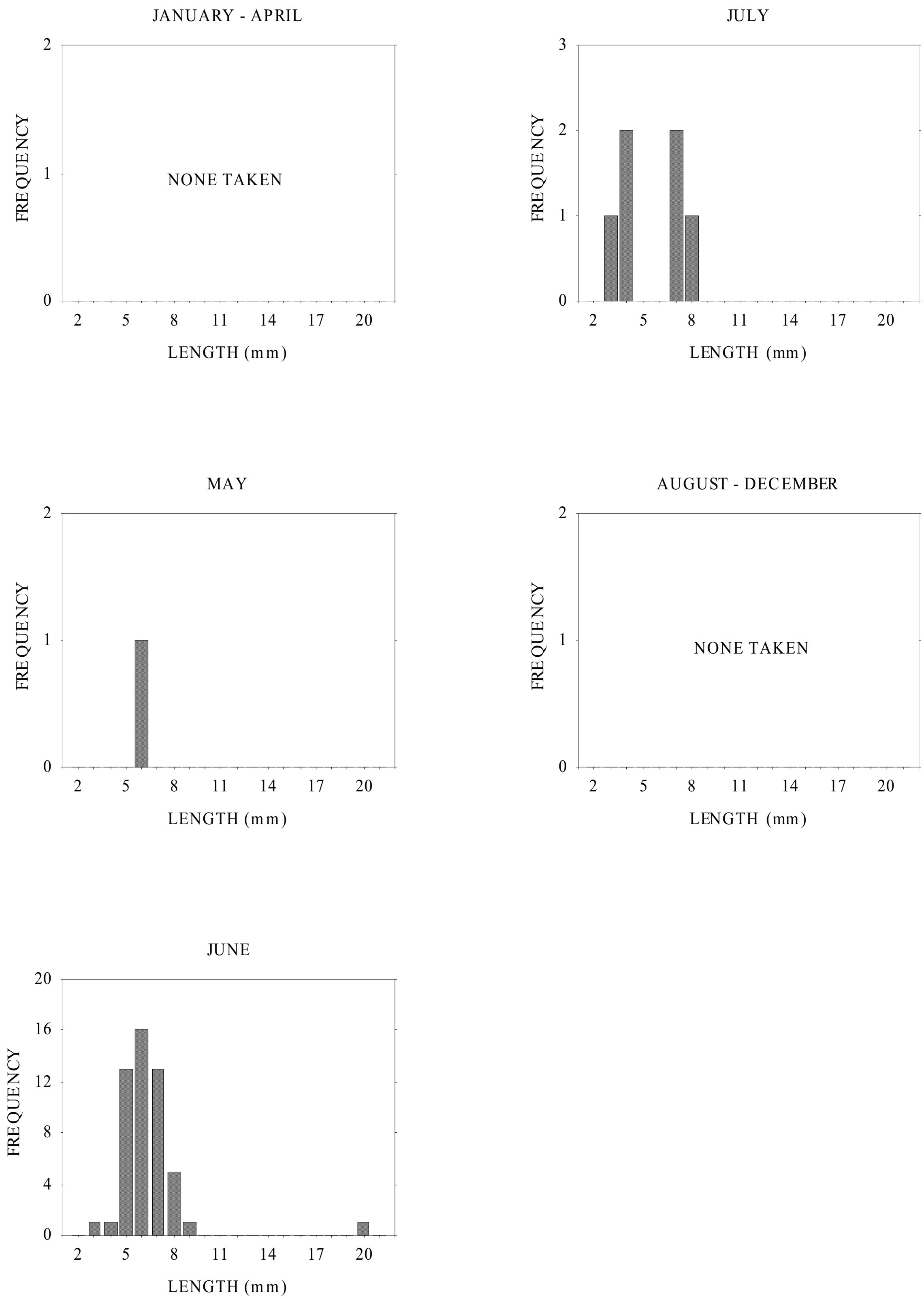



Figure 3-24. Length frequency of *Alosa* spp. taken in entrainment sampling at the Salem circulating water intake structure during 2003.

## CHAPTER 4: FINFISH MONITORING PROGRAM

## TABLE OF CONTENTS

## LIST OF TABLES

**Page**

## LIST OF FIGURES

**Page**

**Page**

# INTRODUCTION

As required by Custom Requirement G.6.a of PSEG Nuclear, LLC's (PSEG) New Jersey Pollutant Discharge Elimination System (NJPDES) Permit, PSEG is to develop and implement an improved biological monitoring program for the Delaware River Estuary.

The bottom trawl effort was conducted within the Delaware Bay and River once per month from April through November at 70 stations using a 4.9-m semi-balloon otter trawl. The pelagic trawl effort was conducted within the same zones once per month from April through November at 80 stations using a 4 x 6-ft (1.8 x 1.2-m) frame trawl. The ichthyoplankton effort was conducted within the same area twice per month from April through July at 180 stations using a 1.0-m diameter, 500-micron (0.5-mm) mesh conical plankton net. The objective of these trawling efforts is to provide representative abundance indices for the species.

This chapter discusses the overall results of all three sampling efforts of the 2003 finfish monitoring program, and the catch information related to the thirteen target species. The focus of this study was to provide abundance data for the fish species, bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), weakfish (*Cynoscion regalis*), white perch (*Morone americana*), striped bass (*M. saxatilis)*, American shad (*Alosa sapidissima*), blueback herring (*A. aestivalis*), alewife (*A. pseudoharengus)*, Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), Atlantic menhaden (*Brevoortia tyrannus*) and Atlantic silverside (*Menidia menidia)*, and the invertebrate species, blue crab (*Callinectes sapidus*), opossum shrimp (*Neomysis americana*) and scud (*Gammarus* spp.) in the project area. Results of the bottom trawl sampling effort for the Baywide trawl programs conducted from 1995 through 2002 have been summarized in previous reports (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999, PSE&G 2000, PSEG 2001, PSEG 2002, PSEG 2003).

## BOTTOM TRAWL EFFORT

### Materials and Methods

The 2003 bottom trawl effort study area extended from the mouth of the Delaware Bay, rkm 0, to near Trenton, rkm 211.

The study area was divided into fourteen zones (Figure 4-1). Zones 1, 2, and 3 (lower bay) are near the mouth of the bay. Zones 4, 5, and 6 are located in the 'middle' bay. Zones 7 and 8 (upper bay) are in the lower Delaware River. Zones 9, 10, 11, 12, 13 and 14 are upriver in the Delaware.

Bottom trawl sampling (daytime only) was conducted once per month from April through November, for a total of eight trawling events. Daylight was defined as the period from one hour after sunrise to one hour before sunset.

Seventy trawls were collected monthly during 2003 from randomly selected stations. These stations were distributed among the fourteen river zones for a total of 560 samples. The number of stations within each zone was allocated using a Neyman allocation program that was based on the proportional area of each zone and on historical fishery data. The allocation of trawls per zone was as follows:

| River Zone | Number of Trawls Per Zone |
|---|---|
| 1 | 4 |
| 2 | 6 |
| 3 | 8 |
| 4 | 6 |
| 5 | 4 |
| 6 | 4 |
| 7 | 4 |
| 8 | 4 |
| 9 | 5 |
| 10 | 5 |
| 11 | 5 |
| 12 | 5 |
| 13 | 5 |
| 14 | 5 |

The primary sampling stations were randomly selected from a list of all available stations in each zone by a computer algorithm program. Alternate stations were also allocated in case a primary station could not be sampled due to navigational hazards, commercial fishing equipment, commercial shipping activity, etc.

Bottom trawls were collected with a 4.9-m (16-ft) semi-balloon otter trawl, manufactured by Trawl and Repair Service LLC in Milton, Louisiana and described as follows:

> "A 16-ft semi-balloon trawl: 17' headrope; 21' footrope; net made of nylon netting of the following size mesh and thread; 1½" stretch (3/4" bar) mesh No. 9 thread body; 1¼" stretch (5/8" bar) mesh No. 15 thread codend, fully rigged with four 2" I.D. net rings at top and bottom for lazy line and purse rope; inner liner of ½" stretch (¼" bar) mesh No. 63 knotless nylon netting inserted and hogtied in codend; head and footropes of 3/8"-diameter poly-Dacron net rope with legs extended 3' and galvanized wire rope thimbles spliced in at each end; six 1½" x 2½" sponge floats spaced evenly on bosom of head rope; net treated in green net dip; trawl doors are 24" in length and 12" in width; doors are made of ¾" marine ply board, 1¼" x 1¼" straps and braces and ½" x 2" bottom shoe runner; 3/16" chain bridle, lap links and 5/16" swivels at the head of each bridle."

Trawl stations were located using an onboard GPS receiver that had been preprogrammed with each station's waypoint (latitude and longitude). The station depths were monitored with an onboard depth sounder.

Trawls were towed for ten minutes at 6 ft/sec. against the direction of the tide. A towline to water depth ratio of 10:1 was used to ensure that the trawl maintained contact with the bottom. Predicted tidal stages were determined using **Tides and Currents for Windows™** (version 2.5b) nautical software program and/or *Eldridge Tide and Pilot Book 2003* (Eldridge Tide and Pilot Book 2003). At each station, predicted tidal currents were visually verified by the crew prior to starting each tow. The tow speed was monitored with an electronic flowmeter with on-deck readout and/or engine rpm.

At the completion of each tow, the net was emptied into a collection container to prepare for sample processing. All finfish and blue crabs were transferred to the sorting table for identification to the lowest practicable taxonomic level (i.e., species). All species were identified, enumerated, and recorded on field data sheets. The subsampling procedure described in the procedures manual (PSEG 2002b) was not used because subsampling was not necessary during the 2003 bottom trawl effort. Any unidentifiable specimens were preserved in 10% formalin and returned to the Nyack Laboratory for species identification.

Length measurements were recorded for all target finfish species and carapace width measurements were recorded for blue crabs. When the count for a target species was less than 100, measurements were recorded for each specimen. When the number of specimens for a species exceeded 100, a representative subsample of 100 specimens was measured. Total length (TL) to the nearest millimeter was measured for fish with square or rounded caudal fins (tip of the snout to the tip of the longest caudal ray). Fork length (FL) to the nearest millimeter was measured for fish with emarginate or forked caudal fins (tip of the snout to the caudal fork). Carapace width to the nearest millimeter (shell point to point) was measured for blue crabs. Live fish and crabs were returned to the water as quickly as possible.

Water quality measurements for water temperature (°C), dissolved oxygen (DO) in milligrams per liter (mg/L), and salinity in parts per thousands (ppt) were recorded at surface, mid-depth and bottom depths at each trawl station. Surface measurements were recorded at stations where the depth was less than 10 ft. The primary meter used to measure these parameters was the YSI-85 DO/Conductivity/Salinity/Temperature Meter. The YSI-55 DO/Temperature Meter and the YSI-30 Conductivity/Salinity/Temperature Meter were used as backups. Field crews also recorded water clarity (by Secchi disk), weather conditions, station depths, and tidal stage (ebb/flood/slack) at each trawl station.

## Results and Discussion

### Physical/Chemical Parameters

Trends in physical and chemical parameters recorded in the Delaware Baywide bottom trawl effort zones during 2003 were not as routinely consistent with those results reported in previous study years (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999 PSE&G 2000, PSEG 2001, PSEG 2002a, PSEG 2003).

Surface, mid-depth and bottom water temperatures varied by season, station depth, and river kilometer at all sampling stations in 2003. A harsh winter with a lot of snow and cold temperatures along with late spring and summer rain caused the temperature range among all 14 zones to be significantly lower in 2003 (4.8-9.3 °C) than in 2002 (12.4-14.4 °C). In fact, the water temperature was colder in all zones during all months in 2003 than it was during 2002

Mean bottom water temperatures increased throughout the spring and summer of 2003, and decreased into the fall. Temperature ranges varied from 4.8-19.6 °C in April through June, 19.9-27.6 °C in July through August, and 12.9-18.7 °C in October-November (Figure 4-2). The lowest water temperature was recorded in April (4.8 °C) and the highest water temperature was recorded in August (27.6 °C).

The temperature gradient pattern in 2003 was more variable than the pattern in 2002. In 2002, bottom water temperatures ranged from 2-7 °C among the fourteen sampling zones within each sampling period (PSEG 2003). In 2003, bottom water temperatures ranged from 4-8 °C among the fourteen sampling zones within each sampling period. The greatest temperature gradient was recorded in August with 7.7 °C between Zones 1 and 7. The least temperature gradient was recorded in November with 3.6 °C between Zones 5 and 11. Zone 1 had the coldest water from May through August. Zone 14 had the coldest in April and September. The coldest water in October was in Zone 10 and in November was in Zone 11. Zone 7 had the warmest water from July through September and Zone 5 had the warmest water in April and November. The warmest water during June was in Zone 8, during October was in Zone 1 and during May was in Zones 10 and 11 (both zones had warmest temperatures of 16.5 °C in May).

In 2003, the mean bottom salinity distribution was relatively consistent with the data from previous years (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999 PSE&G 2000, PSEG 2001, PSEG 2002a, PSEG 2003), as it varied by month and by zone from April through November (Figure 4-3). The upper six zones (9-14) are freshwater zones. The average bottom salinity was <0.1 ppt for all six zones in all eight months in 2003. In 2002, the average bottom salinity for all six zones in all months was<0.1 ppt most of the time. It was >0.1 ppt nine times and exceeded 1.0 ppt only twice.

The seasonal variation within each of the lower eight zones was minor. A lack of the normally expected rain in April brought salinities up in May. The salinity then declined into June in all eight lower zones, except for Zone 3, which stayed about the same (23.6-23.4 ppt). In July, the salinity continued to decrease in Zone 1 and 3, remained the same in Zone 2, but increased in Zones 4-8. For the duration of the program, Zones 2-8 had similar salinity patterns, but Zone 1 showed no real likeness in tendency to the other seven zones. In 2003, the seasonal increase from the spring to the fall, which is characteristic of mid-Atlantic estuaries (Moyle and Cech 1988) and is consistent with previous years' data (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999 PSE&G 2000, PSEG 2001, PSEG 2002a, PSEG 2003), was not as evident in 2003 as it was in previous years.

Zone 1 exhibited the highest mean bottom salinity (29.8 ppt) in May for any zone in any month. The water in the areas closest to the mouth of the bay (Zones 1, 2 and 3) is nearly marine and its salinity was consistently higher than 21 ppt for all eight months. The water in Zones 4, 5 and 6 becomes gradually less saline from south to north. Zone 5 was always the fifth highest (10.3-18.4 ppt) in salinity and Zone 6 was the sixth highest (2.8-11.7 ppt). The water in the river areas (Zones 7 and 8) is nearly fresh and was consistently the least saline of the lower eight zones throughout the program. The salinity in Zone 7 ranged from 0.3 (June) to 4.3 (May). Zone 8 exhibited salinities of 0.1-0.2 ppt for all months except May (1.4 ppt) and September (0.6 ppt). Variation among Zones 1 to 8 was relatively consistent from month to month (Figure 4-3). It was the lowest in November, with a range of 0.1 to 24.3 ppt, and the highest in May with a range of 0.1 to 28.5 ppt.

Monthly zone variations of mean bottom DO readings were higher in 2003 (Figure 4-4) than in 2002 in April, May and August through November, but lower for June and July. During the eight months of sampling in the lower eight zones, the gradient among zones ranged from 1.5 mg/L (May) to 2.9 mg/L (July). Higher DO values in the upper six zones added to the higher gradient among zones in the months of May, and August through November. Mean bottom DO concentrations throughout the fourteen sampling zones ranged from 5.3 to 12.5 mg/L. Overall, the bottom DO concentrations in the lower eight zones were similar to the historical values recorded during previous study years (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999 PSE&G 2000, PSEG 2001, PSEG 2002a), and represent a well-mixed, oxygenated estuary (Moyle and Cech 1988).

**Catch Composition**

During the 2003 Baywide bottom trawl effort, 47,587 fish from 61 species and 659 blue crabs were collected in 560 trawl samples (Table 4-1). Approximately 66.1% (31,453) of the total finfish catch was comprised of target species fish. Bay anchovy (21.7%), Atlantic croaker (20.1%) and white perch (19.8%) dominated the total catch. The remaining ten target finfish species collectively represented 4.5% of the total finfish catch.

A total of 16,134 specimens were collected of 48 non-target finfish species. This represented 33.9% of the total finfish catch. The most abundant non-target finfish species was hogchoker (Table 4-1). Other relatively abundant non-target species included channel catfish and spotted hake. Thirty-nine finfish species were represented by fewer than 50 fish. Seven of these 39 species were target species. Less than ten fish were collected from 23 of these 39 species and three of these were target species.

Total abundance for target species by zone across all months shows dominance of bay anchovy in Zones 1, 2 and 4 (Figure 4-5). Bay anchovy and Atlantic croaker were both dominant in Zone 3. Atlantic croaker was the most abundant species in Zones 5 and 6. Hogchoker and Atlantic croaker were both dominant in Zone 7. White perch were the most abundant in Zones 8, 10 and 14. Hogchoker and white perch were both dominant in Zone 9. Channel catfish and white perch were both dominant in Zones 11-13.

Mean species composition (MSC) and catch per unit effort (CPUE) were calculated by zone and by month for the 2003 sampling season (Figure 4-6). Mean species composition by month is the number of species caught in a month over all zones divided by the number of zones. MSC by zone is the number of species caught in a zone over all months divided by the number of months. Mean CPUE by month is the average CPUE in a month over all zones divided by the number of zones. Mean CPUE by zone is the average CPUE in a zone over all months divided by the number of months.

MSC by month (Figure 4-6) was lowest in April, and highest in October. MSC by zone (Figure 4-6) was the lowest in Zones 11 and 12, and the highest in Zone 5.

Mean CPUE (Figure 4-6) was lowest from April through June, and increased throughout the program with a small peak in August. The CPUE finally peaked in November, when the CPUE was more than 250% higher than the next highest monthly CPUE (August). This finding is related to the high November abundance of Atlantic croaker in Zones 3, 5, and 6, in addition to the high bay anchovy numbers in Zones 2-4, and 7 (Tables 4-2 through 4-15).

Mean CPUE was the lowest in Zones 1, 11 and 13, and the highest in Zones 3 and 9 (Figure 4-6). Target species tended to have the highest species-specific CPUE in all zones; especially in the lower five zones (Tables 4-2 through 4-15). Bay anchovy had the highest CPUE for Zones 1, 2 and 4. Atlantic croaker had the highest CPUE in Zones 3, 5, and 6. White perch had the highest CPUE in Zones 8 and 10-14. Hogchoker had the highest CPUE in Zones 7 and 9. Five zones had more than one species with similarly high CPUE. Zone 3 had Atlantic croaker and bay anchovy. Zone 7 had hogchoker and Atlantic croaker. Zones 11, 12 and 13 had white perch and channel catfish.

The highest CPUE for blue crab was in Zone 5. Only three other zones, out of the fourteen sampled, had a blue crab CPUE greater than one. They were Zones 3, 4, and 6. The blue crab catch varied from month to month rising to a peak during October and November (Tables 4-2 through 4-9).

Figure 4-7 outlines MSC and CPUE by month for each zone. Species composition in 2003 was moderate to high from Zones 1 through 8 and low in the upper zones 9-14.

Length-frequency data are provided for all target fish species in Figures 4-8 through 4-19. Descriptions of the thirteen target species (including blue crab) are presented below. Spatial and temporal distributions are discussed where appropriate. Table 4-1 provides abundance catch by month for each species and Tables 4-2 through 4-15 provide monthly catch by zone for each species. More detailed descriptions of the life histories of the target species, except for Atlantic menhaden and bluefish, are described in Appendix C, Attachments C-1 through C-9, C-12 and C-14 of the Salem 316 (b) Demonstration (PSE&G 1999).

**Alewife**

Eighty-three alewives were collected in the 2003 program, which is more than five times the species catch (15) in 2002 (PSEG 2003). They were caught in every zone except Zone 9. However, most of them (72.3%) were captured in Zones 3, and 6-8. Alewives were taken from July through November ranging in size from 46 to 160 mm FL. The most were found in November and the fewest in September. They and were probably all young-of-the-year (YOY), except for the 160-mm fish in the October catch, which was most likely a yearling (Figure 4-8).

**American shad**

Twenty-three American shad were collected in the 2003 Baywide bottom trawl effort. This result is consistent with the earlier years of this study. For example, thirteen fish were taken in 1999, none in 2000, eight in 2001 and fourteen in 2002 (PSE&G 2000, PSEG 2001, PSEG 2002a, PSEG 2003). The shad caught in 2003 were taken in April, from July through September and in November. They were located in Zones 4, 8, 10, 12 and 13. The American shad captured from July through September ranged in size from 46 to 91 mm FL and were probably all YOY fish. The five caught in April were similar in size, but were most likely yearlings (Figure 4-9).

**Atlantic croaker**

Atlantic croaker was the second most abundant fish species collected in 2003 representing more than 20% of the total finfish catch with 9,549 specimens captured. They were taken in Zones 1-10. More than one-third (37.3%) of the total croaker catch was found in Zone 3, 27.8% in Zone 6 and 21.6% in Zone 5. These three zones accounted for more than 86% of the Atlantic croaker caught. The catch numbers varied throughout the rest of the ten lower zones with the most fish captured in Zone 7 and only one fish found in Zone 10. The largest croaker catch was in November and the second largest catch was in October. These two months accounted for over 98% of the total croaker catch for the year. This seasonal pattern is consistent with the 1996 through 2001 data where most of the Atlantic croaker were taken in the later months of the studies. It is inconsistent with the 2002 study where a large portion (20.6%) of the yearly catch was taken in June (PSE&G 1997, PSE&G 1998, PSE&G 1999, PSE&G 2000, PSEG 2001, PSEG 2002a and PSEG 2003). It should also be noted that the 2003 croaker catch only amounted to about 40% of the 2002 catch (PSEG 2003). Only a small number of adult fish (>200 mm TL) were taken as is shown in the length-frequency distribution graphs presented in Figure 4-10. This is consistent with the data from past years (PSE&G 1997, PSE&G 1998, PSE&G 1999, PSE&G 2000, PSEG 2001, PSEG 2002a and PSEG 2003).

**Atlantic menhaden**

In 2003, only one Atlantic menhaden was taken. This is much closer to the number of fish caught in 2000 (15) and 2001 (10), and much less than the 287 taken in 2002 (PSEG 2001, PSEG 2002a and PSEG 2003). The Atlantic menhaden was found in Zone 3 in November. It measured 106 mm FL and was a YOY (Figure 4-11).

**Atlantic silverside**

Twenty-seven Atlantic silverside were collected during the 2003 Baywide bottom trawl effort. Eleven were caught in 2002, only two were taken in 2000 and none were captured in 2001 (PSEG 2001, PSEG 2002a sand PSEG 2003). Most of the Atlantic silverside were found during August in Zones 4 and 5. One was captured in Zone 3 in November and one in Zone 4 in October. These fish were between 50 and 103 mm FL (Figure 4-12).

**Bay anchovy**

Bay anchovy occur throughout Delaware Bay and are seasonally abundant from the lower Delaware River up to Wilmington, DE (rkm 120), and Philadelphia, PA (rkm 150). O'Herron et al. (1994) reported that bay anchovy was the fourth most abundant species, representing 10.1% of the overall catch, in an extensive survey of the Delaware River Estuary, ranging from the C & D Canal to Trenton, NJ.

Historically, bay anchovy is one of the most abundant species of the mid-Atlantic region estuaries and, in previous years, they represented the largest or second largest number of fish caught in the Baywide bottom trawl effort (PSE&G 1997, PSE&G 1998, PSE&G 1999, PSE&G 2000, PSEG 2001, PSEG 2002a and PSEG 2003). In 2003, they accounted for the largest number of fish caught (10,315; 21.7% of the total finfish). This was approximately half of the 2002 catch (20,423) and almost exactly the same as the 2001 catch (10,351) (PSEG 2002a and PSEG 2003). Anchovy were captured in every sampling month, but more than 38% of them were found in November. Most of them were taken in Zones 1-6 and a few were collected in Zones 7, 8 and 10.

Yearlings and adults (30-90 mm FL) dominated the length-frequency distribution of bay anchovy from April through July (Figure 4-13) In August the YOY fish increased in size and began to become more evident in the catches. The YOY and yearling/adults demonstrated separate frequency cycles (peaks) in August and September, and finally overlapped in October and November. Although separate peaks are presenting these last two months of the program, it is difficult to determine where the YOY frequency cycle ends and the adult frequency cycle begins. This pattern is somewhat consistent with data from previous years' programs, which exhibited similar seasonal length-frequency distributions (PSE&G 1996, PSE&G 1997, PSE&G 1998, PSE&G 1999 PSE&G 2000, PSEG 2001, PSEG 2002a, PSEG 2003).

**Blueback herring**

Five blueback herring were taken in 2003, which was one-quarter of the fish captured in 2002 (20) and about the same as the three specimens that were caught in both 2000 and 2001 (PSEG 2001, PSEG 2002a and PSEG 2003). The blueback herring collected in 2003 were from Zones 2, 3 and 5. One yearling (63 mm FL) was captured in May. The other four were collected during November, were between 49 and 70 mm FL and were likely part of the YOY year class (Figure 4-14).

**Bluefish**

Ten bluefish were taken in the 2003 Baywide bottom trawl effort, which was similar in number to the seventeen collected in 2000, the nineteen taken in 2002 and the fifteen found in 2003 (PSEG 2001, PSEG 2002a and PSEG 2003). The bluefish caught in 2003 were found in Zones 2 and 4. All of the bluefish were captured from July through September and in November. They ranged in size from 125 to 252 mm FL and were probably a mixture of YOY and adults (Figure 4-15).

## Spot

The spawning season of spot along the Atlantic coast varies, extending possibly from mid-October through mid-March (Warlen and Chester 1985, Flores-Coto and Warlen 1993). In 2003, eleven were collected, which is a little more than one-fifth the 52 fish taken in 2002, about the same as the twelve collected in 2001 and a small portion of the fifth ranked catch of 424 in 2000 (PSEG 2001, PSEG 2002a and PSEG 2003). Spot were found in Zones 1-4 in 2003, with the most caught in Zones 3 and 4. They were captured during May, and from August through October. Figure 4-16 demonstrates the likely presence of YOY (123-177 mm TL) in all four months in which spot were caught. The 216-mm TL fish taken in August was probably a yearling.

## Striped bass

In 2003, 312 striped bass were collected, which is more than twice the 143 taken in 2002 and about the same as the 318 found in 2001 (PSEG 2002a and PSEG 2003). However, that is almost seven times the 45 striped bass collected in 2000 and more than thirteen times the 23 taken in 1999 (PSE&G 2000 and PSEG 2001). Weisberg and Burton (1993) deduced that striped bass larvae spawned in the upper Delaware River in the late 1980s and early 1990s were possibly from a recovering native population. However, the species still represented only approximately 0.7% of the total finfish catch in the 2002 Baywide bottom trawl effort, which was about the same as the 0.2% of the total finfish catch that striped bass comprised in 2002, the 1.1% of the catch that they comprised in 2001, the 0.3% of the catch that they comprised in 2000 and the 0.1% of the catch that they comprised in 1999 (PSE&G 2000, PSEG 2001, PSEG 2002a and PSEG 2003).

Striped bass were taken in Zones 5-14. Most of them were caught in Zones 7 and 8, and the rest were split up relatively evenly among the other zones. Although striped bass were captured in every sampling month, approximately 81% of them were collected in July and August. In the 2002 program, most of the striped bass (73%) were found from April through July. The catch numbers varied during the other months of the study in both years (PSEG 2003). The size range of the striped bass yearling and adults caught in 2003 was 80 to 400 mm FL. The YOY fish showed up in abundance during July and August, and were present in much smaller numbers from September through November (Figure 4-17).

**Weakfish**

The total catch for weakfish in the 2003 survey was 1,672, accounting for 3.5% of the total finfish catch. This number is down significantly from the 2001 and 2002 catches when one and one-quarter (2002) to two and one-half (2001) times as many of this species were collected (PSEG 2002a and PSEG 2003). Most (92%) of the weakfish were found in Zones 2-6. The rest were caught in Zones 1, 7 and 8. Weakfish were collected in every month, except April. The most were taken in August. More moderate numbers were found in July, September and October. May, June and November yielded much lower numbers.

The spawning season for weakfish extends from mid May through early August in the lower Delaware Bay and Indian River Bay (Wang and Kernehan 1979). Connaughton and Taylor (1996) reported spawning in Delaware Bay between mid May and early July or August. The appearance of YOY fish was responsible for the great increase in the catch totals from July through October (Figure 4-18). These smaller fish (18-100 mm TL) added significantly to the catch in July, dominated the highest weakfish collection in August, and maintained their presence throughout the rest of the program.

**White perch**

Wang and Kernehan (1979) note that white perch is one of the most abundant resident species of the Delaware River Estuary. O'Herron et al. (1994) reported that white perch was the second most abundant species representing 20.6% of the overall catch. Adult white perch are typically semi-anadromous, making their upriver spawning migration in the spring and returning to the lower reaches of the estuary in the fall where they overwinter (Mansueti 1961).

White perch was the third most abundant fish species collected in 2003 with a total of 9,444 specimens accounting for approximately 19.8% of the total finfish catch. This is more than twice the 5,033 taken in 2002 and almost twenty times the 478 found in 2001 (PSEG 2002a and PSEG 2003). No white perch were taken in marine Zones 1 or 2, and fifteen or less were captured in Zones 3, 4 and 5. Ninety-five percent of the white perch captured were located in Zones 8-14, as most of them were found in the Zones 8-10 and 14.

White perch were collected in every month. The most productive months were August and September. More moderate numbers were found in April, July, October and November. The least productive months were May and June. YOY were recruited in July

(14-52 mm FL) and were apparent throughout the rest of the year as they grew (Figure 4-19).

**Blue crab**

Blue crab migration upstream into the freshwater portion of the Delaware River has been documented. Specimens were taken in impingement collections during 1976 at electric generating stations as far upstream as rkm 167.1 (Ettinger and Blye 1981). In addition to this central Philadelphia location, Ettinger and Blye (1981) reported that, according to the Pennsylvania Fish Commission, fishermen in Neshaminy Creek (just north of Philadelphia) have taken blue crabs. Water quality data reported by these authors suggested that migration by blue crab into the freshwater section of the tidal Delaware River was dependent upon the presence of adequate dissolved oxygen levels. Improvements in Delaware River water quality primarily, as a result of improvements in wastewater treatment, have allowed for the recent blue crab invasion of tidal fresh waters upriver of Philadelphia. Blue crabs are now found throughout the entire estuarine portion of the Delaware River (Epifanio 1995).

The blue crab catch for 2003 (659) was a little more than half the catch in 2002 (1218) and a little more than one-third the catches in 2001 (1,810) and 2000 (1,831) (PSEG 2001, PSEG 2002a and PSEG 2003). In 2003, they were caught in Zones 1-9. Most of the crabs were captured in Zones 5 and 6, and lighter hauls were taken in Zones 1, 3, 4, 7 and 8. Only a few crabs were found in Zones 2 and 9. Blue crabs were collected in all months. The heaviest catches occurred in October and November, with more moderate catches in May and July, and lighter catches in the other months.

## PELAGIC TRAWL EFFORT

### Materials and Methods

The 2003 pelagic trawl effort study area extended from the mouth of the Delaware Bay, river kilometer (rkm) 0, to just near Trenton, rkm 211.

The study area was divided into fourteen zones (Figure 4-1). Zones 1, 2, and 3 (lower bay) are near the mouth of the bay. Zones 4, 5, and 6 are located in the 'middle' bay. Zones 7 and 8 (upper bay) are in the lower Delaware River. Zones 9 through 14 are upriver in the Delaware.

Pelagic trawl sampling (nighttime only) was conducted once per month from April through November, for a total of eight trawling events. Nighttime was defined as the period from one hour after sunset to one hour before sunrise.

Eighty trawls were scheduled to be collected during each monthly collection during 2003 from randomly selected stations. These stations were distributed among the fourteen river zones for a total of 640 samples. The number of stations within each zone was allocated using a Neyman allocation program that was based on the proportional area of each zone and on historical fishery data. The allocation of trawls per zone was as follows**:**

| River Zone | Number of Trawls Per Zone |
|---|---|
| 1 | 8 |
| 2 | 7 |
| 3 | 7 |
| 4 | 8 |
| 5 | 7 |
| 6 | 5 |
| 7 | 5 |
| 8 | 3 |
| 9 | 5 |
| 10 | 5 |
| 11 | 5 |
| 12 | 5 |
| 13 | 5 |
| 14 | 5 |

The primary sampling stations were randomly selected from a list of all available stations in each zone by a computer algorithm program. Alternate stations were also allocated in case a primary station could not be sampled due to navigational hazards, commercial fishing equipment, commercial shipping activity, etc.

Pelagic trawls were collected using a 4 x 6-ft (1.8 x 1.2-m) frame trawl, manufactured by Sea Gear Corporation in Melbourne, Florida and described as follows:

A 4 x 6-ft (1.8 x 1.2-m) frame trawl: 4 ft high by 6 ft wide, and 15 ft long (4.6 m) with a 0.3125-in. (0.7938-cm) bar mesh and 0.25-in. (0.635-cm) cod end liner. It is equipped with a General Oceanics Model (GO) 2030R flowmeter fixed in the center of the frame opening to calculate sample volume. The frame net, when towed at the surface, is rigged with a 20-lb buoyancy float mounted at the corners of the upper frame cross-member. For mid-depth samples, these floats are removed. The lower frame cross member has a 5-kg depressor mounted at each of the corners. The pelagic net is connected by a 20-ft long, 0.5-in. diameter bridle to a swivel shackle at the end of a 500-ft long, 0.5-in. diameter towline marked at 5-ft intervals.

Trawl stations were located using an onboard GPS receiver that had been preprogrammed with each station's waypoint (latitude and longitude). The station depths were monitored with an onboard depth sounder.

Trawls were towed for ten minutes at 4.4 ft/sec with the direction of the prevailing tide. At trawl stations with a depth of 10 ft or less, the sample was collected by towing the pelagic net at the surface. At trawl stations with a depth equal to or greater than 11 ft, 6 ft were subtracted from the actual station depth to calculate the "fishable depth" using the Random Depth Selection Chart for Pelagic Trawl Samples. The sample depth was the first number on the Random Depth Selection Chart that was equal to or less than the "fishable depth". If the random number selected was less than or equal to 10 ft, the sample was collected at the surface. If the random number selected was greater than 11 ft, a mid-water sample was collected at the depth indicated on the table. For consecutive trawls using the Random Depth Selection Chart for Pelagic Trawls, the random number selection process was continued from the previously selected random number.

For surface trawls, 200 ft of towline was employed. For mid-depth samples, a towline to fishing depth ratio of 10:1 was maintained. Predicted tidal stages were determined using **Tides and Currents for Windows™** (version 2.5b) nautical software program and/or *Eldridge Tide and Pilot Book 2003* (Eldridge Tide and Pilot Book 2003).. At each station, prior to starting the tow, the crew visually confirmed the predicted tidal flows. The tow speed was monitored with an electronic flowmeter with on-deck readout and/or engine rpm.

After each tow, the net was emptied into a collection container to prepare for sample processing. All finfish and blue crabs were identified to the lowest practicable taxonomic level (i.e., species). All species were identified, enumerated, and recorded on field data sheets. Any unidentifiable specimens were preserved in 10% formalin and returned to the fisheries laboratory for species identification.

Enumeration of samples containing more than 2000 specimens of a single species was performed using the following subsampling procedure: A container was filled with the species to an identified level and then the specimens of this subsample were counted. This procedure was repeated for three subsamples, and the average number of specimens per subsample was computed. The entire catch of the species was processed by the repeated filling of the container (subsample). The estimated total number of specimens was computed as the product of the average number per subsample times the number of subsamples taken.

Length measurements were recorded to the nearest millimeter for all target species. For target species, when the number for a species exceeded 100, a representative subsample of 100 specimens was measured. When the number for a species was less than 100, measurements were recorded for each specimen. Total length (TL) was measured for fish with square or rounded caudal fins (tip of the snout to the tip of the longest caudal ray). Fork length (FL) was measured for fish with emarginate or forked caudal fins (tip of the snout to the caudal fork). Blue crabs were measured as to carapace width (shell point to point). Live fish and crabs were returned to the water as quickly as possible.

Water quality measurements for surface, mid-depth and bottom water temperature (°C), DO (mg/L), and salinity (ppt) were recorded at each trawl station where the water depth was greater than 10 ft. Surface measurements were recorded at stations where the depth was less than 10 ft. The primary meter used to measure these parameters was a YSI-85 DO/Conductivity/Salinity/Temperature Meter. A YSI-55 DO/Temperature Meter and a YSI-30 Conductivity/Salinity/Temperature Meter were used as backups. Field crews also recorded weather conditions, station depths, and tidal stage (ebb/flood/slack) at each trawl station for each trawl.

## Results and Discussion

### Physical/Chemical Parameters

Surface, mid-depth and bottom water temperatures varied by season, station depth, and river kilometer at all pelagic trawl sampling stations (Figure 4-20). Mean mid-depth water temperatures increased throughout the spring and into the early summer. This trend continued through August in most of the zones decreasing only slightly in Zones 2, 4, 12, 13 and 14, while remaining the same in Zone 11. The mean temperature decreased in all zones into the late summer and fall  Temperature ranges rose from 9.8-14.0 °C in April, 21.9-27.1 °C in August, and back down to 8.3-14.3 °C in November.

The temperature pattern in 2003 was slightly more variable than the pattern in 2002. In 2002, mid-depth water temperatures ranged from 2-8 °C among the fourteen sampling zones within each sampling period (PSEG 2003). In 2003, mid-depth temperatures ranged from 3-6 °C among the fourteen sampling zones within each sampling period. The greatest temperature gradient was recorded in July (6.2 °C between Zones 1 and 7) and the least temperature gradient was recorded in May (2.8 °C between Zones 1 and 9-10, which had the same temperature gradient).

The mean mid-depth salinity distribution for the 2003 pelagic trawl effort varied by month and by zone from April through November (Figure 4-21). The salinity ranges among zones were higher from June through September in the bottom trawl effort, but the bottom trawl salinities were also generally higher than those in the pelagic trawl effort for those months. The upper six zones (9-14) are freshwater zones. The average bottom salinity was <0.1 ppt for all six zones in all eight months in 2003. In 2002, the average bottom salinity for all six zones in all months was <0.1 ppt most of the time. It was >0.1 ppt nine times and exceeded 1.0 ppt only twice.

The seasonal variation of salinity within each of the lower eight zones was minor. A lack of the normally expected rain in April brought salinities up in May in Zones 1-4 and in Zone 7.  The salinity remained the same in Zone 6 and decreased slightly in Zones 5, and 8. The salinity then declined into June in all eight zones. Into July and through October there seemed to be an almost randomness to the fluctuation of salinity from month to month within zones. The salinity then increased into November in all eight zones, except for Zone 4 where it remained the same.

The water in Zones 1-8 became gradually less saline from south to north. Variation among Zones 1 to 8 was relatively consistent from month to month (Figure 4-21). It was the lowest in April and October, which both had a range of 0.1 to 25.9 ppt, and the highest in May, with a range of 1.4 to 29.8 ppt.

Mean mid-depth DO varied by month and by zone from April through November (Figure 4-22). The monthly zone variation of DO readings for all fourteen zones was notably higher (3.8 mg/L higher) in April, 2003 than in April, 2002. The difference between the two years for the other months of the program was lower; ranging from 0.1 to 0.7 mg/L for May, June, August, September and October, and 1.8 to 1.9 mg/L for July and November (PSEG 2003).

During the eight months of sampling in the lower eight zones in 2003, the gradient among zones ranged from 1.0 mg/L (September) to 3.8 mg/L (August). During April, May, September and November, higher DO values in the upper six zones added to higher gradients among all zones versus gradients among the lower eight zones. Mean mid-depth DO concentrations throughout the fourteen sampling zones ranged from 5.4 to 12.6 mg/L.

**Catch Composition**

During the 2003 pelagic trawl effort, 154,391 fish from 42 species and 161 blue crabs were collected in 638 samples (Table 4-16). The highest mean density over all months was collected in Zone 4 (504.3 per 1000 $m^3$) and the lowest was found in Zone 14 (1.7 per 1000 $m^3$) (Tables 4-17 through 4-30).

Approximately 99.2% (153,187) of the total finfish catch was comprised of target species fish. Bay anchovy (100,790; 65.3%) and Atlantic croaker (48,516; 31.4%) dominated the total catch. The remaining eleven target finfish species represented 2.5% of the total finfish catch.

A total of 1,203 specimens, from 28 non-target finfish species representing 0.8% of the total finfish catch, were collected during 2003 (Table 4-16). Only two non-target finfish species represented greater than 0.07% of the total finfish catch. They were striped anchovy (296; 0.19%) and butterfish (256; 0.17%).

Length-frequency data are provided for all target fish species in Figures 4-23 through 4-34. Descriptions of the thirteen target species (including blue crab) are presented below. Mean density (#/1000 $m^3$) is discussed for each species. Spatial and temporal distributions are also discussed where appropriate. Table 4-16 provides total catch by zone for each species and Tables 4-17 through 4-30 provide monthly mean density for each species by zone (one table per zone).

**Alewife**

One hundred forty-two alewives were collected the 2003 pelagic trawl effort in all zones. They were captured from July through November. Most of them (86.6%) were found in Zones 7-12. The 2003 catch was much greater than the 2002 catch of only five fish (PSEG 2003). All of the alewives caught in 2003 were probably YOY, except for one in July, which measured about 100 mm FL and was most likely a yearling (Figure 4-23).

**American shad**

In the 2003 pelagic trawls, 2,067 American shad were collected in all months and seen exclusively in Zones 7-14. It was the third most abundant species collected representing 1.3% of the total finfish catch. They were most abundant in Zone 10 and least abundant in Zone 7. The 2003 American shad catch greatly exceeded the 2002 catch of nine fish (PSEG 2003). A few yearlings were captured in April and May of 2003. The YOY appeared in June and represented 100% of the shad catch from June through November (Figure 4-24)

**Atlantic croaker**

Atlantic croaker was the second most abundant fish species (48,516) collected in pelagic trawls. They represented approximately 31.4% of the total finfish catch. Approximately 57.2% of the total croaker catch was found in Zone 4, 19.0% in Zone 5, 9.7% in Zone 6 and 6.9% in Zone 3. These four zones accounted for almost 93% of the Atlantic croaker caught. The highest monthly mean densities were located in Zones 4, 5 and 6 during November. The numbers varied throughout the other eight lower zones. Only a few fish were captured in Zones 9 and 10, and none were taken in Zones 11-14. The highest monthly mean density was found in Zone 4 during November (1,568.42 per 1000 $m^3$). These numbers, percentages and distributions (by zone and month) are very similar to the ones from the 2002 pelagic effort croaker catch, although the total croaker abundance in 2002 was 21.7% lower than in 2003 (PSEG 2003). No adult fish were taken as is shown in the length-frequency distribution graphs presented in Figure 4-25 where all croaker were >50 mm TL.

## Atlantic menhaden

In the 2003 pelagic trawl effort, 83 Atlantic menhaden were collected in Zones 2-11. Most of them (~65%) were caught in Zones 4, 7 and 8. These 83 fish represented only a tiny fraction of the 2,839 caught in 2002 in pelagic trawls (PSEG 2003). A few yearlings were captured in April of 2003. The YOY appeared in May and represented 100% of the menhaden catch from May through November (Figure 4-26).

## Atlantic silverside

Two hundred eighty-one Atlantic silverside were collected during the 2003 pelagic trawl effort in the lower eight zones from June through November. This was very similar to the 2002 catch of 214 (PSEG 2003). Almost 70% of the silversides captured in 2003 were located in Zones 1-3 and only a few were caught in Zones 7 and 8. The only fish taken in June was a YOY (<30 mm FL). Although the YOY were only represented by four fish, the July data demonstrates a relatively clear upper limit for YOY of 40 mm FL (Figure 4-27). There is either insufficient numbers or too much overlap to see a clear separation between YOY and older fish throughout the rest of the program.

## Bay anchovy

Bay anchovy accounted for the largest number of the fish caught (100,790; 65.2% of the total finfish) in pelagic trawls. These numbers are very similar to the numbers (116,522; 60.1%) from the 2002 pelagic trawl effort (PSEG 2003). In 2003, more than twice as many anchovies were collected as Atlantic croaker, which was second in abundance (48,516). Bay anchovy were collected in every zone, except for Zone 13. More than 94% of them were found in Zones 1-7, including almost half of them in Zone 4 (27,402 fish; 293.83 per 1000 $m^3$) and Zone 5 (22,585 fish; 223.35 per 1000 $m^3$). The numbers were relatively equal in Zones 8 and 9, which contained about three thousand fish each. Upper Zones 10, 11, 12 and 14 contained only a couple of hundred anchovies.

Yearlings and adults (25-90 mm FL) dominated the length-frequency distribution of bay anchovy from April through July (Figure 4-28) A few smaller YOY fish (<30 mm FL) appeared in the July catches along with the older fish, but there was no overlap in frequency cycles (peaks). Although the YOY increased in size and number in August, the YOY and older fish peaks still did not overlap. The YOY began to slightly overlap with the adults in August, but the cycles were easily discernible. The September through November data demonstrates the merger of the two peaks to the point where there is no distinguishable separation between YOY and adults.

**Blueback herring**

One hundred ninety-three blueback herring were captured in pelagic trawls accounting for twice the amount caught in 2002 (PSEG 2003). They were collected in all zones, except for Zone 1. Zones 8, 11 and 12 yielded the greatest catches. Zones 5, 7, 9, 10 and 13 had moderate numbers, and Zones 2-4, 6 and 14 contained only a few fish. Nine herring were captured in April (Figure 4-29). They were probably seven yearlings (70-115 mm FL) and two adults (>200 mm FL). All of the others, which were caught in July and September through November, were most likely YOY.

**Bluefish**

Fourteen bluefish were caught in Zones 1-7 from June though September, 2003. They were evenly distributed throughout the zones. In 2002, ten were collected in a similar distribution (PSEG 2003). The bluefish ranged in size from 48 to 156 mm FL and were probably all YOY (Figure 4-30).

**Spot**

In the pelagic trawl survey, only one spot was collected in Zone 1 during September. It measured 235 mm TL (Figure 4-31). This 2003 catch is similar to the 2002 pelagic trawl catch of three fish (PSEG 2003).

**Striped bass**

In the 2003 pelagic trawl effort, 181 striped bass were collected in Zones 5-14. This is more than seven times the amount that was caught in 2002 (PSEG 2003). Zone 9 yielded about half (90) of the total 2003 bass catch. Striped bass were found from June through October, 2003. The YOY fish (18-112 mm FL) showed up in abundance during June, July and August, and were present in much smaller numbers in September and October (Figure 4-32).

**Weakfish**

The total catch for weakfish in the 2003 pelagic trawl effort was 564 fish, which was about 43% of the 2002 catch. Although it was the fourth most abundant species in 2003, it accounted for only 0.4% of the total finfish catch. Weakfish were found in Zones 1-10. However, most of them (76.8%) were caught in Zone 7. The catches were much lower in the other nine zones. Weakfish were collected from June through September. YOY fish (12-170 mm TL) accounted for 100% of the catch in June and July, and the majority of the catch in August and September (Figure 4-33).

**White perch**

In the 2003 pelagic trawl effort, 355 white perch were captured. This is almost three times more than were caught in the 2002 pelagic trawls (PSEG 2003). All of the 2003 perch were collected in Zones 6-14. Zone 9 contained the most, Zones 8 and 10-12 had lower numbers, and Zones 6, 7, 13 and 14 had the fewest. The most perch were found in September and the least in June, but they were present in every month. Yearling and older adults were clearly evident in the length frequency data for all months sampled, except August and November (Figure 4-34). YOY white perch showed up in significant numbers in June and were considerably evident throughout the rest of the program.

**Blue crab**

The total number of blue crab caught during 2003 pelagic trawls was 161, compared to the 285 found in the 2002 pelagic trawl effort (PSEG 2003). They were caught in Zones 1-7 in 2003. The catches were relatively evenly distributed among the seven zones. The most were taken in Zone 5 and the least in Zone 1. Blue crabs were collected from May through November. The heaviest catches occurred in September and October. There was a moderate catch in November and the lightest hauls were from May through August.

# ICHTHYOPLANKTON EFFORT

## Materials and methods

### Field Procedures

The 2003 ichthyoplankton effort study area extended from the mouth of the Delaware Bay, river kilometer (rkm) 0, to near Trenton, rkm 211.

The study area was divided into fourteen zones (Figure 4-1). Zones 1, 2, and 3 (lower bay) are near the mouth of the bay. Zones 4, 5, and 6 are located in the 'middle' bay. Zones 7 and 8 (upper bay) are in the lower Delaware River. Zones 9, 10, 11, 12, 13 and 14 are upriver in the Delaware.

Ichthyoplankton sampling (nighttime only) was conducted twice per month from April through July, for a total of eight sampling events. Nighttime was defined as the period from one hour after sunset to one hour before sunrise.

Ninety samples were scheduled to be collected during each bimonthly event from randomly selected stations. These stations were distributed among the fourteen river zones for a total of 720 samples. The number of stations within each zone was allocated using a Neyman allocation program that was based on the proportional area of each zone and historical fishery data. The allocation of samples per zone per event was as follows:

| River Zone | Number of Samples per Zone per Event |
|---|---|
| 1 | 14 |
| 2 | 9 |
| 3 | 10 |
| 4 | 10 |
| 5 | 7 |
| 6 | 4 |
| 7 | 4 |
| 8 | 2 |
| 9 | 5 |
| 10 | 5 |
| 11 | 5 |
| 12 | 5 |
| 13 | 5 |
| 14 | 5 |

The primary sampling stations were randomly selected by a computer algorithm program from a list of all available stations in each zone. Alternate stations were also allocated in case a primary station could not be sampled due to navigational hazards, commercial fishing equipment, commercial shipping activity, etc.

The eight events were collected on the following dates:

| Event | Collection Dates |
|---|---|
| 1 | April 1-14 |
| 2 | April 15-24 |
| 3 | May 6-15 |
| 4 | May 19-27 |
| 5 | June 2-10 |
| 6 | June 17-25 |
| 7 | July 1-15 |
| 8 | July 15-25 |

Ichthyoplankton samples were collected using a 1.0-m diameter, 500-µ mesh conical plankton net with a length to diameter ratio of 3:1. The ichthyoplankton net was equipped with a 500-µ screened catch bucket into which the sample was concentrated. A GO Model 2030R mechanical flowmeter was fitted slightly off-center at the mouth of the ichthyoplankton net to measure the volume of water being filtered. A 5-kg depressor was attached to the bridle connection ahead of the ichthyoplankton net with a 5-ft rope to ensure proper fishing attitude. A 0.5-in. diameter towline marked at intervals was attached to the net bridle using a securely tightened shackle. The length of towline and angle (determined with an inclinometer) was used to ensure the net was sampling at the correct depths over the course of the tow. The ichthyoplankton net was deployed and retrieved by hand.

Sampling stations were located using an onboard GPS receiver that had been preprogrammed with each station's waypoint (latitude and longitude). The station depths were monitored with an onboard depth sounder.

The ichthyoplankton net was towed for 4-6 min at a tow speed of 2.2-3.2 ft/sec, in the direction of the tidal flow. Sample tows were conducted from the surface to near bottom in a stepwise oblique manner based on 10-ft intervals. Fishing time was equally divided among the strata for a given depth. No sampling was conducted at stations where the depth was less than 10 ft. For depths of 10-12 ft, one depth stratum was sampled. For sampling station depths of 13-20 ft, two depth strata were sampled. For depths of 21-30 ft, three strata were sampled. For depths greater than 30 ft, a depth stratum was added for each 10-ft interval of increased depth. Based on the measured tow angle (76°), a depth vs.

angle chart was consulted by the field crew to determine the length of the towline required to set the ichthyoplankton net at each desired sampling depth. Predicted tidal stages were determined using **Tides and Currents for Windows™** (version 2.5b) nautical software program and/or *Eldridge Tide and Pilot Book 2003* (Eldridge Tide and Pilot Book 2003). Prior to starting the tow at each station, the predicted tidal flows were visually confirmed by the crew. The tow speed was monitored with an electronic flowmeter with on-deck readout and/or engine rpm.

After retrieval, the net was gently rinsed down with water from the outside of the net. Contents within the net were concentrated into the catch bucket and the net was inspected to ensure that no material was clinging to the sides of the net. The catch bucket was then detached from the ichthyoplankton net and transferred into an appropriate sized pre-labeled sample container. For larger samples, a 500-µ mesh sieve was used to receive the sample for draining. While transferring the sample into the sample container, a catch bucket was used underneath to contain any spilled sample. A pre-numbered metal label was placed inside of the sample container for proper identification. If the sample was split into more than one jar, a waterproof label was placed in the remainder of sample containers designating them as "2 of 4, 3 of 4, etc." A stick-on label was placed on the side of all sample containers that included the unique identifying number for the sample. Samples were preserved on the boat immediately after collection using a 10% Formalin/Rose Bengal solution. When transferring samples from the field to the laboratory, a Chain of Custody Record was completed and given to the senior lab technician, who then checked the samples and signed the record.

Water quality measurements for surface, mid-depth and bottom water temperature (°C), DO (mg/L), and salinity (ppt) were recorded at each ichthyoplankton station where the water depth was greater than 10 ft. Surface measurements were recorded at stations where the depth was less than 10 ft. The primary meter used to measure these parameters was a YSI-85 DO/Conductivity/Salinity/Temperature Meter. A YSI-55 DO/Temperature Meter and a YSI-30 Conductivity/Salinity/Temperature Meter were used as backups. Field crews also recorded weather conditions, station depths, and tidal stage (ebb/flood/slack) at each trawl station.

**Laboratory Procedures**

All of the 2003 ichthyoplankton samples were transported to the laboratory located in Nyack, New York. The samples were checked in when they arrived at the lab using the Chain of Custody procedure. The sample information (location, tag number, number of jars per sample, and date) was recorded in the log book. Each sample was signed out (initials, time and current date) before it was analyzed.

The samples were examined for the presence of fish eggs, larvae, juveniles and adults. Samples were also examined for the presence of the macrozooplankton, *Gammarus spp*. and *Neomysis americana*.

The two phases for sample procedures and analysis are outlined below:

<u>Phase 1 - Sorting Procedure</u>: After a minimum storage time of two days (this allows the formalin to "fix" and the Rose Bengal to stain the biological material), the samples were rinsed with fresh water through a standard 500-μ mesh sieve (#35). A portion of the washed sample was placed in a glass pan on a light box to determine if sub-sampling was needed. If more than 800 fish larvae, 400 fish eggs, 400 *Neomysis americana,* or 100 *Gammarus* spp. were present in the sample, subsampling was initiated. A minimum of 200 eggs, 400 larvae, 200 *Neomysis americana*, and 50 *Gammarus* spp. were removed from the subsample.

The subsampling protocol was based on the "sum quota sampling" technique described in PSEG (2002b). Samples were split using a Motoda plankton splitter to the smallest fraction from which the minimum quota was found. Each time a new sample was split, two fractions, were produced, a left and a right. The fraction, either the left or right that was split further, was randomly chosen by a sorter.

As the samples were sorted, the selected fish larvae, eggs, and macrozooplankton were placed in a vial with 10% formalin, properly labeled and stored until needed for Phase 2. The detritus was then returned to the original sample jar with 10% formalin and stored.

During Phase 1, one sample collected from Zone 3 during Event 6 was dropped as it was in the process of being washed for analysis. A significant portion of this sample was lost, the integrity of the sample was compromised, and it could not be analyzed. For this reason, only 719 samples out of the 720 samples collected were analyzed.

<u>Phase 2 - Identification Procedure</u>: After Phase 1 processing was complete, the sorted organisms were identified, counted and measured. A biologist signed out a sample and removed the 10% formalin from the vial. The sorted organisms were removed from the vial and placed in a Petri dish under a dissecting microscope for analysis. All target species fish in the sample were:

- Identified to the lowest practical taxon (usually species).
- Placed into the appropriate life stage and enumerated.
- Measured to the nearest millimeter (up to fifty individuals per life stage per species). Fork length was recorded for juveniles and adults of species with emarginate or forked caudal fins. Total length was recorded for juveniles and

adults of species with square or rounded caudal fins (e.g. sciaenids), and all yolk-sac and post yolk-sac larvae. The data was recorded on the Ichthyoplankton Monitoring Fish Processing Data Form.

Eggs were identified and enumerated to the lowest practical taxon. For macrozooplankton, both *Gammarus* spp. and *Neomysis americana* were enumerated and up to 50 specimens of each were measured from the anterior most margin of the head (excluding antennae and antennules) to the posterior margin of the telson. The data was recorded on the Ichthyoplankton Monitoring Fish Processing Data Form.

Fish eggs, larvae, and macrozooplankton that were in the subsamples were processed the same way as those in samples that were not subsampled. However, the total number present in the subsamples for each species was estimated by multiplying the number of fish eggs, larvae or macrozooplankton per species found in the subsample by the reciprocal of the split fraction used. For example, the specific number of fish eggs, larvae or macrozooplankton found in samples that were split in half were multiplied by two, the specific number of fish eggs, larvae or macrozooplankton found in samples that were split to a fourth were multiplied by four, and so on.

<u>Quality Control (QC) Procedure</u>: Phase 1 QC inspections were performed to ensure that over 95% of the fish larvae, eggs and macrozooplankton were removed when the sample was sorted. The Continuous Sampling Plan, Type 1 (CSP-1) was the QC procedure used (Banzhaf and Brugger 1970). Initially, a technician had to remove a minimum of 95% of the fish eggs, fish larvae and macrozooplankton from 18 consecutive trays without failure. Then, 14 out of 100 trays were inspected. The 14 trays were randomly selected using a random number table. If one of the 14 trays did not pass QC inspection, the technician reverted to the 100% inspection mode until 18 consecutive trays passed. The processing error per tray was calculated by dividing the total number of organisms found by the inspector by the total number of organisms found by the technician and the inspector, and multiplied by 100. The tray failed inspection if the processing error was greater than 5%.

The split QC procedure ensured the randomness of the splitting process. QC was based on three fractions of the same fraction size that were sorted. The total number of organisms removed from all three split fractions were compared by the Chi Square test ($p<0.05$). All samples were subject to the split QC procedure until the first eight samples passed. Then, 14 out the next 100 samples were randomly chosen for inspection. If a sample failed, the QC procedure reverted to the 100% inspection plan until eight consecutive samples passed.

Split QC was required under the following conditions:

1) The sample was one of the first eight consecutive samples that must pass a split QC inspection.
2) The sample was one of the eight consecutive samples that must pass the inspection following a split QC failure.
3) The sample was one of the randomly chosen 14 out of 100 samples inspected, following a set of eight consecutive samples without a split QC failure.

The randomness of splits was calculated using the Chi Square test. The counts of the three processed fractions were averaged to obtain the expected value for the sample. The Chi Square was calculated as:

$$\Psi^2 = (01 - E)^2/E + (02 - E)^2/E + (03 - E)^2/E$$

Where 01, 02, and 03 are the observed counts for fractions 1, 2, and 3 and E is the expected value (mean average) of fractions 1, 2, and 3.

The sample failed split QC if the calculated chi square value was >5.99. If the sample failed, the unsorted portion of the sample was split and sorted.

Phase 2 QC inspections were performed to ensure that over 95% of the fish and eggs in the sample were accurately identified and counted. Each biologist was inspected individually. The biologist failed the sample if the total number of individual errors made divided by the total number of ichthyoplankton present was greater than 5%. All samples were subject to Phase 2 QC until 18 consecutive samples passed QC. Then 14 random samples were inspected out of 100. If at anytime the biologist failed QC inspection then that biologist reverted to 100% inspection until 18 consecutive samples passed.

Identification errors occurred in three ways:

1. A target fish was misidentified as another target species, with no effect on total count.
2. A target fish was misidentified as a non-target species, or as a piece of detritus, resulting in an under-count.
3. A non-target species, or piece of detritus, is misidentified as a target fish resulting in an over-count.

Each occurrence of these error types was a single technical mistake, and was counted as one error for the calculation of processing error regardless of the net effect on total count.

**Results and Discussion**

**Physical/Chemical Parameters**

Surface, mid-depth and bottom water temperatures in the 2003 ichthyoplankton effort varied by season, station depth, and river kilometer at all sampling stations. Mean mid-depth water temperatures increased throughout the four months sampled. Event 1 water temperature readings (surface and/or bottom temperatures) were not included in the calculation of mean water temperatures in Zones 1-8 for April. The collection of mid-depth water chemistry data was initiated, at PSEG request, during Events 2-8 and were included in the calculation of mean water temperatures in all zones for the remaining surveys. Temperature ranges varied from lows of 7.9-11.3 °C in April, to highs of 21.4-26.1 °C in July (Figure 4-35). Throughout the 2003 sampling program, the water temperature was colder in all zones during all months than it was during 2002.

Mid-depth water temperatures ranged from 3-5 °C among the fourteen sampling zones within each month during ichthyoplankton sampling. The temperature gradient pattern was similar in variability to the water temperature pattern in that it increased throughout the four months sampled. The least temperature gradient was recorded in April (3.4 °C between Zone 1 and Zone 5) and the greatest temperature gradient was recorded in July (4.7 °C between Zone 1 and Zone 5). The coldest water was recorded in April (7.9 °C) and the warmest water was recorded in July (26.1 °C).

In 2003, the mean mid-depth salinity distribution for the ichthyoplankton effort was relatively consistent with the mean bottom salinity data collected during the bottom trawl effort and the mean mid-depth salinity data collected during the pelagic trawl effort for the months common to all three efforts. The salinity varied similarly by month and by zone from April through July (Figure 4-36). The upper six zones (9-14) are freshwater zones. Their mean mid-depth salinity was 0.1 ppt for all months in all zones.

The mean mid-depth salinity seasonal variation within each of the lower eight zones was minor with no variation higher than that in Zone 6, which ranged from 3.1 ppt in June to 8.3 ppt in April. A lack of rain in April significantly increased the salinities in May in Zones 1-5, while lowering the salinities slightly in Zones 6-8.

Zone 1 (30.0 ppt in May) exhibited the highest mean mid-depth salinity for any zone in any month during ichthyoplankton sampling. The water in the areas closest to the mouth of the bay (Zones 1, 2 and 3) is nearly marine and its salinity was consistently as high or higher than 21.9 ppt for all four months. The water in Zones 4, 5 and 6 becomes gradually less saline from south to north. The mean mid-depth salinity recorded in Zone 4 ranged from 17.3 to 19.6 ppt. Zone 5 was always the fifth highest in salinity (7.7-12.2 ppt) and Zone 6 was always the sixth highest (3.1-8.3 ppt). The water in Zones 7 and 8 is nearly fresh and was consistently the least saline of the lower eight zones throughout the program. The salinity in Zone 7 ranged from 0.7 (June) to 2.5 (April). Zone 8 exhibited salinities of 0.2 ppt (June) to 1.3 ppt (April). Variation among Zones 1 to 8 was relatively consistent from month to month (Figure 4-36).

In 2003, the zonal variations of ichthyoplankton mean mid-depth DO readings were relatively consistent with the mean bottom DO data collected during the bottom trawl effort and the mean mid-depth DO data for the pelagic trawl effort for the months common to all three efforts. The DO varied by month and by zone from April through July (Figure 4-37). During the four months of sampling in all 14 zones, the gradient among zones ranged from 2.0 mg/L (June) to 3.8 mg/L (April). Mean mid-depth DO concentrations throughout the fourteen sampling zones ranged from 5.8 to 13.7 mg/L.

**Catch Composition**

During the 2003 ichthyoplankton effort, 2,171,736 fish eggs and larvae from twelve target species and three taxa that contain target species were collected in 719 samples (Table 4-31). Bay anchovy (1,633,701; 75.2%) dominated the total catch, and striped bass was the second most abundant species (238,493; 11.0%). The taxonomic group, *Morone* spp., which includes striped bass and white perch, accounted for 6.4% (139,869) of the total finfish catch. White perch (78,028; 3.4%) and Atlantic menhaden (20,387; 1.0%) were the next most plentiful species.

Total abundance for target finfish species by zone shows dominance of bay anchovy in Zones 1 through 6 (Table 4-31). Striped bass was the most numerous species in Zones 7 and 8 (*Morone* spp. were also abundant in Zone 8). Striped bass and white perch were equally dominant in Zone 9, while white perch was the most abundant species in Zones 10 and 11. Alewife was the most numerous species and the taxonomic groups, *Alosa* spp. and Clupeidae (which include alewife, American shad and blueback herring), were also abundant in Zones 12 through 14. *Alosa* spp. was the most dominant taxon in Zone 14. The 2002 total abundance for target finfish species by zone differed from 2003 as *Alosa* spp. and Clupeidae were less dominant and the white perch were more abundant in upriver Zones 9-14 during 2002.

Descriptions of the twelve target fish species, the two target invertebrate species, and the three taxonomic fish groups that include target fish species are presented below. Mean density (number per 1000 $m^3$) is discussed for each species. Spatial and temporal distributions are also discussed where appropriate. Table 4-31 displays the total abundance of target species collected by zone. Table 4-32 provides mean density by sampling event (all zones combined) for each life stage of each target species. Tables 4-33 through 4-46 provide mean density by sampling event for each life stage of each target species (one table per zone).

**Alewife**

In the 2003 ichthyoplankton effort, alewife was the sixth most dominant species. In Zones 6-14, 18,803 alewife eggs and larvae were collected which is almost exactly twice the alewife catch (9,416) in 2002. The heaviest catches were in Zones 11, 12 and 14. Zones 8-11 and 13 yielded moderate numbers. Zones 5-7 and 14 yielded the lowest numbers.

No yolk-sac larvae were collected. Post yolk-sac larvae were found during all events, except Event 1. The highest mean densities of post yolk-sac larvae were found in Events 3, 4 and 5 with the highest occurring in Event 4. Moderate densities were observed during Events 6 and 7. Events 2 and 8 yielded low post yolk-sac densities. Juvenile alewives were collected only in Event 7.

***Alosa* spp.**

*Alosa* spp. was used as the taxon representing two target species of that genus, alewife and blueback herring. Eggs, yolk-sac and some of the smaller post yolk-sac larvae of these two species cannot be reliably distinguished even when in good condition. Sometimes, damage can limit identification to the family level (see Clupeidae Section below).

In upper freshwater Zones 9-14, 13,536 *Alosa* spp. eggs and larvae were collected in the 2003 ichthyoplankton effort. None were found in the lower eight zones. Most of the *Alosa* spp. ichthyoplankton were taken in Zones 11-14. Zone 10 had a moderate catch and Zone 9 had a light catch.

Eggs and yolk-sac larvae were collected in Events 1-7. Post yolk-sac larvae and juveniles were found only during Event 8. Event 3 had the greatest mean densities for eggs and yolk-sac larvae.

**American shad**

In the 2003 ichthyoplankton samples, 5,412 American shad eggs and larvae were collected in Zones 3 and 9-14, which was 60% more than the catch (3,402) in 2002. Most of the 2003 shad were caught in Zone 13 and the smallest haul was in Zone 9, except for the lone fish captured in Zone 3.

Eggs were collected in Events 2-6 and the highest mean density was in Event 3. Yolk-sac larvae were captured in Events 3-7 with the highest mean density in Event 3. Post yolk-sac larvae were found in Events 3-8 and the highest mean density was observed in Event 4. Juveniles were taken in Events 6-8. Adults were only captured in Event 7.

**Atlantic croaker**

The peak spawning season for Atlantic croaker is from October through February offshore in the Atlantic Ocean (Wang and Kernehan 1979). The 2002 and 2003 ichthyoplankton efforts were conducted from April through July. No croaker larvae were captured in 2003. This is consistent with the 398 juveniles that were collected in 2002, which is also a relatively low number when compared to the numbers of the other target species.

**Atlantic menhaden**

Atlantic menhaden was the fifth most abundant species (20,387 eggs and larvae; 0.9 % of the total ichthyoplankton) collected during the 2003 ichthyoplankton sampling. They were taken in Zones 1-7, 10 and 11. The numbers generally decreased from south to north throughout the lower seven zones. Atlantic menhaden were most abundant in Zone 1 and least abundant in Zones 5-6 and 10-11. The catches were also high in Zones 2-4. The Atlantic menhaden ichthyoplankton catch was much lower in 2003 than in 2002, as 2.7 times more (54,935) were caught in 2002.

Eggs were captured in Events 3-6 with the highest mean density in Event 3 and the lowest in Event 5. Eggs accounted for a very high percentage (>98%) of the total Atlantic menhaden ichthyoplankton caught. Yolk-sac larvae were captured during Events 3, 4 and 6 with low densities in all three events. Post yolk-sac larvae were found in low densities in Events 1-6. A few juveniles and adults were collected during Event 1.

**Atlantic silverside**

Only 182 Atlantic silverside eggs and larvae were collected during the 2003 ichthyoplankton effort. Most of them were found in the Zones 1-6, where Zone 5 yielded the heaviest catch. A few were taken in Zones 7-9 and 11. The Atlantic silverside ichthyoplankton catch was much lower in 2003 than in 2002, as twelve times more (2,178) were caught in 2002.

No eggs were collected in 2003. Yolk-sac larvae were only caught during Event 4. Post yolk-sac larvae were collected in all events, except Event 2. The highest mean density of post yolk-sac larvae was found during Event 7. Juveniles were captured in Events 1 and 6. Adults were present in Events 1 and 6-8 with the highest density occurring in Event 8.

**Bay anchovy**

Bay anchovy accounted for the largest number of the ichthyoplankton caught (1,633,701 eggs and larvae; 75.2% of the total ichthyoplankton) in 2003. There were almost seven times (6.9 times) as many anchovy eggs and larvae caught as striped bass, which was the next most abundant species. The 2003 numbers were consistent with the 2002 catch (1,559,283), when bay anchovy was also the most abundant species (77.0%).

Bay anchovy were captured in every zone. Almost all of them were found in Zones 1-8. They were most plentiful in Zones 1 and 2, while Zones 3 and 4 also yielded high numbers. Moderate numbers were found in Zones 5, 6 and 8. Anchovy abundance was much lower in the rest of the zones.

Eggs were collected in Events 3-8. The highest mean egg densities were found during Events 5-7. More moderate densities were evident in Events 4 and 8, and a lower density was observed in Event 3. Yolk-sac larvae were taken during Events 3 and 8, with Event 8 yielding the higher density. Post yolk-sac larvae were collected in Events 3 and 5-8. The highest mean densities of post yolk-sac larvae were found during Events 7 and 8. There was a more moderate density of post yolk-sac larvae in Event 6 and much lower densities in Events 3 and 5. Juveniles were captured in Events 5-8 with the highest mean density in Event 8. Adults were collected in all eight events. The highest mean density of adults was observed in Event 4. More moderate densities were found during Events 3, 5 and 7, and the lowest adult densities, were seen during Events 1, 2, 6 and 8.

### Blueback herring

In the 2003 ichthyoplankton effort, 143 blueback herring were taken, as compared to the nine juveniles that were collected in 2002. Most of the 2003 fish were found in Zones 9, 11 and 12. The rest were captured in Zones 6, 7, 10, 13 and 14. Post yolk-sac larvae were only caught during Event 8. Juveniles were found during Events 6-8 with the highest mean density observed in Event 8.

### Bluefish

Only one bluefish was collected in the ichthyoplankton sampling, which is similar to the number collected in 2002, which was two. The fish was a juvenile and it was captured during Event 5 in Zone 4.

### Clupeidae

The family, Clupeidae, includes four target species. They are Atlantic menhaden plus three members of the genus *Alosa* (alewife, blueback herring and American shad). Sometimes larvae of these four species cannot be reliably distinguished due to body damage, and quite often life stage cannot be determined either.

During the 2003 ichthyoplankton effort, Clupeidae larvae were found in all fourteen zones, except for Zone 4. Most of them were located in the upper Zones 9-14. Clupeidae larvae were collected in all events, but only a few were seen in Events 1 and 2. Events 3 and 4 yielded the highest mean densities of larvae.

### *Morone* spp.

*Morone* spp. was used as the taxon representing two target species of that genus, striped bass and white perch. Larvae of these two species cannot be reliably distinguished sometimes due to body damage. Quite often life stage cannot be determined either.

In Zones 5-14, 139,869 *Morone* spp. larvae were collected in the 2003 ichthyoplankton effort. The most specimens were caught in Zone 8. Only 2 were captured in Zone 5 and four in Zone 13. *Morone* spp. larvae were found during Events 3 and 5-7. Event 7 had the highest mean density and they were all post yolk-sac larvae.

**Spot**

Spot spawn at sea along the Atlantic coast (Wang and Kernehan 1979). No spot were captured in the 2003 ichthyoplankton sampling. This is consistent with the eight spot collected during the 2002 ichthyoplankton effort.

**Striped bass**

Striped bass was the second most abundant species (238,493 eggs and larvae; 11.0 % of the total ichthyoplankton) collected during the 2003 ichthyoplankton effort. This accounted for 3.8 times as many as were caught in 2002 (62,365). Striped bass were taken in Zones 5-14, and were most abundant in Zone 8. The catches were more moderate in Zones 7 and 9-11. Zones 5, 6 and 12-14 contained the lowest numbers of striped bass eggs and larvae.

Eggs were found in Events 2-6. Event 4 yielded the highest mean density of eggs and the lowest density was in Event 2. Yolk-sac larvae were taken in Events 2-7. The highest mean density of yolk-sac larvae was found during Event 3, and the lowest densities were observed in Event 2. Post yolk-sac larvae were collected in Events 3-8. The highest mean density of post yolk-sac larvae was observed in Event 7. This was the greatest mean density (11,524 larvae per 1000 $m^3$) for any species during any event in the 2003 ichthyoplankton effort. The lowest density of post yolk-sac larvae was found in Event 3. Juveniles were captured during Events 6-8. The highest mean density of juveniles was found in Event 7 and the lowest density was observed in Event 6.

**Weakfish**

In the 2003 ichthyoplankton effort, only 7,886 weakfish eggs and larvae were collected, as compared to the huge number (252,079) that was collected in 2002. This 2003 species catch represented only 3.1% of the 2002 catch, as weakfish dropped from the second most abundant species in 2002 to the sixth most abundant species in 2003. Most of the 2003 weakfish (70.6%) were taken in Zones 1 and 2. They were less abundant in Zones 3-8 and 10. No weakfish were taken in Zones 9 and 11-14.

Eggs were found in all events except the first one. Event 6 yielded the highest mean density of eggs. The lowest egg densities were in Events 3, 5 and 8. Yolk-sac larvae were only captured during Event 7. Post yolk-sac larvae were found in Events 3-8. The highest mean densities of weakfish post yolk-sac larvae were found during Events 7 and 8. Low post yolk-sac densities were evenly distributed throughout Events 3 through 6. Juveniles were found in low densities during Events 7 and 8.

**White perch**

White perch was the fourth most abundant species (78,028 eggs and larvae; 3.6% of the total ichthyoplankton) collected during the ichthyoplankton sampling. This accounted for 1.5 times as many as were caught in 2002 (51,406). White perch were taken in upriver Zones 7-14. They were most abundant in Zone 8. The catches were more moderate in Zones 9-12 and least abundant in Zone 7.

White perch eggs were found in Events 1-6. Event 3, had the greatest mean density for eggs, and Event 1 yielded the lowest egg density. Yolk-sac larvae were captured during Events 2-7. The highest mean density of yolk-sac larvae was found in Event 3 and the lowest density was collected during Event 2. Post yolk-sac larvae were collected in Events 3-8. The highest mean density of post yolk-sac larvae was found in Event 7. More moderate densities were seen during Events 4-6. Lower mean densities occurred in Events 3 and 8. Juveniles were caught in Events 6-8 with the highest density occurring in Event 7 and the lowest in Event 6.

***Neomysis americana***

Opossum shrimp (*Neomysis americana)* are percarideans in the order Mysidacea. They are the most common and abundant mysid inhabiting the estuaries and coastal waters of the northeastern Atlantic coast of the United States. Hargreaves (1995) states that *N. americana* is found throughout the Delaware Bay at salinities >1 ppt. A more detailed description of the life history of *N. americana* is described in Appendix C, Attachment C-11 of the Salem 316 (b) Demonstration (PSE&G 1999).

During the 2003 ichthyoplankton effort, 16,894,133 *N. americana* were collected, which is very similar to the number captured (16,374,338) in 2002. At least one million were taken in each of the lower six zones, throughout which the numbers were relatively evenly distributed. The numbers decreased from south to north through Zones 7-9. River

Zones 10-12 and 14 yielded few mysids. Zone 13 had many more, but not nearly as many as in the lower six zones.

The highest mean density of *N. americana* was during Event 3. There was a more moderate density of mysids in Events 2, 4 and 6-8. The lowest mean densities were found during Events 1 and 5. The highest density of *N. americana* collected in one zone during one event was 3,053,597 per 1000 $m^3$ in Zone 6 during Event 3.

### *Gammarus* spp.

Scuds (*Gammarus* spp.) are percarideans in the order Amphipoda. This *Gammarus* group occurs in the Delaware River Estuary from its headwaters to the lower-river regions (PSEG 1999). They have sickle-shaped bodies and are rapid swimmers, taking occasional rests while settling on their sides (Smith and Johnson 1996). A more detailed description of the life history of *Gammarus* spp. is described in Appendix C, Attachment C-10 of the Salem 316 (b) Demonstration (PSE&G 1999).

The total abundance of *Gammarus* spp. (4,579,228) was approximately 3.3 times the number caught (1,402,330) in the 2002 ichthyoplankton effort. It was also about 27.1% of the total number of *N. americana* (16,894,133) collected during the 2003 program. The number of *Gammarus* spp. taken in Zones 7-12 accounted for over 90% of their total catch. Most of the scuds were collected in Zones 8 and 9. More moderate numbers were found in Zones 3, 6, 7 and 10-12. Zones 1, 2, 4, 5, 13 and 14 yielded the fewest scuds.

Most of the *Gammarus* spp. scuds were caught in Events 4-8. The numbers were the lowest in the beginning of the study during Events 1-3. The highest density of *Gammarus* spp. collected in one zone during one event was 1,032,951 per 1000 $m^3$ in Zone 8 during Event 4.

## LITERATURE CITED

Connaughton, M. A., and M. H. Taylor. 1996. Effects of photoperiod and temperature on sexual recrudence in the male weakfish, *Cynoscion regalis*. Environmental Biology of Fishes 45:273-281.

Banzhaf, R. A. and R. M. Brugger. 1970. MIL-STD-1235(ORD), Single- and Multi-Level Continuos Sampling Procedures and Tables for Inspection by Attributes. *In* W. R. Pabst, Jr. (ed.) Reviews of Standards and Specifications. Journal of Quality Technology 2(1):41-53.

Epifanio, C.E. 1995. Atlantic blue crab. Pages 43-49. In: L.E. Dove and R.M. Nyman [eds.] Living Resources of the Delaware Estuary. July 1995.

*Eldridge Tide and Pilot Book*. 2003. Boston, MA. Published by Marion Jewett White, Robert Eldridge White, Jr. and Linda Foster White.

Ettinger, W.S. and R.W. Blye, Jr. 1981. Occurrence of the blue crab *Callinectes sapidus* in the tidal freshwater reaches of the Delaware and Schuylkill Rivers in 1976. Journal of Crustacean Biology 1(2):177-182.

Flores-Coto, C. and S. M. Warlen. 1993. Spawning time, growth, and recruitment of larval spot *Leiostomus xanthurus* into a North Carolina estuary. Fisheries Bulletin 91:8-22.

Hargreaves, B. R. 1995. Mysid Crustaceans. Pages 59-67 *in* L. E. Dove and R. M. Nyman (ed.) Living resources of the Delaware Estuary. The Delaware Estuary Program.

Mansueti, R. J. 1961. Movements, reproduction, and mortality of the white perch, *Roccus americanus* in the Patuxent Estuary, Maryland. Chesapeake Science 2:142-205.

Moyle, P. B. and J. Cech. 1988. Fishes: an introduction to ichthyology. Second edition. Prentice-Hall, Inc. 559 pp.

O'Herron, J. C., II, T. Lloyd and K. Laidig. 1994. A survey of fish in the Delaware estuary from the area of the Chesapeake and Delaware Canal to Trenton. Prepared for Scientific and Technical Advisory Committee, Delaware Estuary Program, T. Lloyd Associates.

Public Service Electric & Gas Co. (PSE&G) 1996. Biological Monitoring Program, 1995 Annual Report, January 1 through December 31, 1995: Volume I: Finfish Monitoring.

Public Service Electric & Gas Co. 1997. Biological Monitoring Program, 1996 Annual Report, January 1 through December 31, 1996. Chapter 4: Finfish Monitoring.

Public Service Electric & Gas Co. 1998. Biological Monitoring Program, 1997 Annual Report, January 1 through December 31, 1997. Chapter 4: Finfish Monitoring.

Public Service Electric & Gas Co. 1999. Biological Monitoring Program, 1998 Annual Report, January 1 through December 31, 1998. Chapter 4: Finfish Monitoring.

Public Service Electric & Gas Co. 2000. Biological Monitoring Program, 1999 Annual Report, January 1 though December 31, 1999. Chapter 4: Finfish Monitoring.

Public Service Enterprise Group (PSEG). 2001. Biological Monitoring Program, 2000 Annual Report, January 1 though December 31, 2000. Chapter 4: Finfish Monitoring.

Public Service Enterprise Group. 2002a. Biological Monitoring Program, 2001 Annual Report, January 1 though December 31, 2001. Chapter 4: Finfish Monitoring.

Public Service Enterprise Group. 2002b. Baywide Abundance Monitoring Program, PSEG Estuary Enhancement Program, Bottom Trawl, Pelagic Trawl and Ichthyoplankton Survey Procedures Manuals for Field and Laboratory, Revision 0, Effective April 1, 2002.

Public Service Enterprise Group (PSEG). 2003. Biological Monitoring Program, 2002 Annual Report, January 1 though December 31, 2002. Chapter 4: Finfish Monitoring.

Smith, D. L. and K. B. Johnson. 1996. A guide to marine coastal plankton and marine invertebrate larvae. Second edition. Kendall/Hunt Publishing. 221 pp.

Wang, J. C. S. and R. J. Kernehan. 1979. Fishes of the Delaware estuaries-a guide to the early life histories. EA Communications, Towson, MD.

Warlen, S. M., and A. J. Chester. 1985. Age, growth, and distribution of larval spot, (*Leiostomus xanthurus*), off North Carolina. Fisheries Bulletin 83:587-599.

Weisberg, S.B., and W.H. Burton. 1993. Spring distribution and abundance of ichthyoplankton in the tidal Delaware River. Fisheries Bulletin 91:788-797.

Table 4-1 (continued)
PSEG Estuary Enhancement Program
Total catch collected by zone using a bottom trawl,
April through November 2003

| Family | Common Name | Scientific Name | BZ-1 | BZ-2 | BZ-3 | BZ-4 | BZ-5 | BZ-6 | BZ-7 | BZ-8 | BZ-9 | BZ-10 | BZ-11 | BZ-12 | BZ-13 | BZ-14 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LABRIDAE | | | | | | | | | | | | | | | | | |
| | TAUTOG | TAUTOGA ONITIS | | | 1 | | | | | | | | | | | | 1 |
| TRIGLIDAE | | | | | | | | | | | | | | | | | |
| | NORTHERN SEAROBIN | PRIONOTUS CAROLINUS | 9 | 8 | 41 | 13 | 14 | 9 | | | | | | | | | 94 |
| | STRIPED SEAROBIN | PRIONOTUS EVOLANS | 3 | | 7 | 8 | 1 | | | | | | | | | | 19 |
| PERCICHTHYIDAE | | | | | | | | | | | | | | | | | |
| | WHITE PERCH | MORONE AMERICANA | | | 4 | 15 | 11 | 132 | 336 | 2539 | 2205 | 1463 | 433 | 703 | 454 | 1149 | 9444 |
| | STRIPED BASS | MORONE SAXATILIS | | | | | 1 | 3 | 123 | 142 | 14 | 9 | 6 | 1 | 12 | 1 | 312 |
| | UNIDENTIFIED MORONE | MORONE SPP. | | | | | | | | | 1 | | | | | | 1 |
| SERRANIDAE | | | | | | | | | | | | | | | | | |
| | BLACK SEA BASS | CENTROPRISTIS STRIATA | | 2 | 8 | 2 | 4 | 2 | | | | | | | | | 18 |
| POMATOMIDAE | | | | | | | | | | | | | | | | | |
| | BLUEFISH | POMATOMUS SALTATRIX | | 3 | | 7 | | | | | | | | | | | 10 |
| SPARIDAE | | | | | | | | | | | | | | | | | |
| | SCUP | STENOTOMUS CHRYSOPS | 65 | 127 | 46 | 15 | 29 | | | | | | | | | | 282 |
| SCIAENIDAE | | | | | | | | | | | | | | | | | |
| | WEAKFISH | CYNOSCION REGALIS | 85 | 439 | 472 | 268 | 137 | 260 | 7 | 4 | | | | | | | 1672 |
| | SILVER PERCH | BAIRDIELLA CHRYSOURA | | 1 | 3 | | | | | | | | | | | | 4 |
| | SPOT | LEIOSTOMUS XANTHURUS | 2 | 1 | 4 | 4 | | | | | | | | | | | 11 |
| | NORTHERN KINGFISH | MENTICIRRHUS SAXATILIS | 3 | 9 | 7 | 1 | | | 1 | | | | | | | | 21 |
| | ATLANTIC CROAKER | MICROPOGONIAS UNDULATUS | 292 | 45 | 3564 | 172 | 2065 | 2654 | 606 | 103 | 47 | 1 | | | | | 9549 |
| | BLACK DRUM | POGONIAS CROMIS | | | | 1 | | | | | | | | | | | 1 |
| URANOSCOPIDAE | | | | | | | | | | | | | | | | | |
| | NORTHERN STARGAZER | ASTROSCOPUS GUTTATUS | | | | | 2 | | | | | | | | | | 2 |
| GOBIIDAE | | | | | | | | | | | | | | | | | |
| | NAKED GOBY | GOBIOSOMA BOSC | 1 | | 5 | 2 | 4 | 20 | 67 | 3 | 12 | | | | | | 114 |
| STROMATEIDAE | | | | | | | | | | | | | | | | | |
| | BUTTERFISH | PEPRILUS TRIACANTHUS | 8 | 10 | 8 | 6 | 3 | | | | | | | | | | 35 |
| BOTHIDAE | | | | | | | | | | | | | | | | | |
| | SUMMER FLOUNDER | PARALICHTHYS DENTATUS | 8 | 5 | 38 | 18 | 8 | 1 | | | | | | | | | 78 |
| | WINDOWPANE | SCOPHTHALMUS AQUOSUS | 40 | 30 | 81 | 23 | 6 | | | | | | | | | | 180 |
| PLEURONECTIDAE | | | | | | | | | | | | | | | | | |
| | WINTER FLOUNDER | PLEURONECTES AMERICANUS | | 2 | 35 | 1 | 14 | | | | | | | | | | 52 |
| SOLEIDAE | | | | | | | | | | | | | | | | | |
| | HOGCHOKER | TRINECTES MACULATUS | 6 | 73 | 73 | 70 | 253 | 489 | 703 | 1021 | 3254 | 370 | 195 | 202 | 73 | 22 | 6804 |
| ACIPENSERIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC STURGEON | ACIPENSER OXYRHYNCHUS | | | | | | | | | | | | | 1 | 3 | 4 |
| | SHORTNOSE STURGEON | ACIPENSER BREVIROSTRUM | | | | | | | | | | 1 | | | | 1 | 2 |
| CENTRARCHIDAE | | | | | | | | | | | | | | | | | |
| | REDBREAST SUNFISH | LEPOMIS AURITUS | | | | | | | | | | | | | 1 | | 1 |

Table 4-1
PSEG Estuary Enhancement Program
Total catch collected by zone using a bottom trawl,
April through November 2003

| Family | Common Name | Scientific Name | BZ-1 | BZ-2 | BZ-3 | BZ-4 | BZ-5 | BZ-6 | BZ-7 | BZ-8 | BZ-9 | BZ-10 | BZ-11 | BZ-12 | BZ-13 | BZ-14 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORTUNIDAE | | | | | | | | | | | | | | | | | |
| | BLUE CRAB (BLUECLAW) | CALLINECTES SAPIDUS | 15 | 1 | 35 | 76 | 340 | 168 | 13 | 10 | 1 | | | | | | 659 |
| CARCHARHINIDAE | | | | | | | | | | | | | | | | | |
| | SMOOTH DOGFISH | MUSTELUS CANIS | 25 | 11 | 32 | 6 | | | | | | | | | | | 74 |
| RAJIDAE | | | | | | | | | | | | | | | | | |
| | CLEARNOSE SKATE | RAJA EGLANTERIA | 13 | 9 | 6 | | | | | | | | | | | | 28 |
| | LITTLE SKATE | RAJA ERINACEA | 7 | | 15 | 1 | | | | | | | | | | | 23 |
| MYLIOBATIDAE | | | | | | | | | | | | | | | | | |
| | BULLNOSE RAY | MYLIOBATIS FREMINVILLEI | 3 | 2 | | | | | | | | | | | | | 5 |
| ANGUILLIDAE | | | | | | | | | | | | | | | | | |
| | AMERICAN EEL | ANGUILLA ROSTRATA | | | | | | 125 | 42 | 110 | 111 | 31 | 45 | 26 | 42 | 20 | 552 |
| CONGRIDAE | | | | | | | | | | | | | | | | | |
| | CONGER EEL | CONGER OCEANICUS | | | 4 | | 40 | | | | | | | | | | 44 |
| ENGRAULIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED ANCHOVY | ANCHOA HEPSETUS | 20 | 39 | 5 | 1 | 3 | | | | | | | | | | 68 |
| | BAY ANCHOVY | ANCHOA MITCHILLI | 561 | 2171 | 3086 | 3182 | 1218 | 66 | 18 | 12 | | 1 | | | | | 10315 |
| CLUPEIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC MENHADEN | BREVOORTIA TYRANNUS | | | 1 | | | | | | | | | | | | 1 |
| | BLUEBACK HERRING | ALOSA AESTIVALIS | | 1 | 1 | | 3 | | | | | | | | | | 5 |
| | ALEWIFE | ALOSA PSEUDOHARENGUS | 2 | 1 | 16 | 6 | 1 | 13 | 17 | 14 | | 7 | 3 | 1 | 1 | 1 | 83 |
| | AMERICAN SHAD | ALOSA SAPIDISSIMA | | | | 1 | | | | 7 | | 5 | | 8 | 2 | | 23 |
| | ATLANTIC HERRING | CLUPEA HARENGUS HARENGUS | | | | | | | 1 | | | | | | | | 1 |
| ICTALURIDAE | | | | | | | | | | | | | | | | | |
| | CHANNEL CATFISH | ICTALURUS PUNCTATUS | | | | | | | 19 | 571 | 1844 | 548 | 416 | 688 | 380 | 328 | 4794 |
| | BROWN BULLHEAD | AMEIURUS NEBULOUS | | | | | | | 1 | 1 | 1 | 8 | | | | 1 | 12 |
| | WHITE CATFISH | AMEIURUS CATUS | | | | | | | | 1 | 6 | 2 | 1 | 2 | 9 | 12 | 33 |
| BATRACHOIDIDAE | | | | | | | | | | | | | | | | | |
| | OYSTER TOADFISH | OPSANUS TAU | 2 | 1 | 5 | 12 | 32 | 81 | | | | | | | | | 133 |
| GADIDAE | | | | | | | | | | | | | | | | | |
| | SPOTTED HAKE | UROPHYCIS REGIA | 76 | 264 | 336 | 112 | 291 | 1002 | 17 | | | | | | | | 2098 |
| | RED HAKE | UROPHYCIS CHUSS | 2 | | 1 | 1 | | 1 | | | | | | | | | 5 |
| | SILVER HAKE | MERLUCCIUS BILINEARIS | 1 | | | 1 | | | | | | | | | | | 2 |
| OPHIDIIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED CUSK-EEL | OPHIDION MARGINATA | | 1 | 55 | 8 | 21 | 155 | | | | | | | | | 240 |
| ATHERINIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC SILVERSIDE | MENIDIA MENIDIA | | | 1 | 15 | 11 | | | | | | | | | | 27 |
| SYNGNATHIDAE | | | | | | | | | | | | | | | | | |
| | LINED SEAHORSE | HIPPOCAMPUS ERECTUS | | | 1 | 1 | | | | | | | | | | | 2 |
| | NORTHERN PIPEFISH | SYNGNATHUS FUSCUS | 1 | 5 | 23 | 15 | | 1 | | | | | | | | | 45 |

Table 4-1 (continued)
PSEG Estuary Enhancement Program
Total catch collected by zone using a bottom trawl,
April through November 2003

| Family | Common Name | Scientific Name | BZ-1 | BZ-2 | BZ-3 | BZ-4 | BZ-5 | BZ-6 | BZ-7 | BZ-8 | BZ-9 | BZ-10 | BZ-11 | BZ-12 | BZ-13 | BZ-14 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIODONTIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED BURFISH | CHILOMYCTERUS SCHOEPFI | | 1 | 1 | | | | | | | | | | | | 2 |
| CYPRINIDAE | | | | | | | | | | | | | | | | | |
| | CARP | CYPRINUS CARPIO | | | | | | | | | | | | | | 1 | 1 |
| | EASTERN SILVERY MINNOW | HYBOGNATHUS REGIS | | | | | | | | 3 | 17 | 20 | 24 | 25 | 4 | 2 | 95 |
| | GOLDEN SHINER | NOTEMIGONUS CRYSOLEUCAS | | | | | | | | | | 1 | | | | | 1 |
| | SPOTTAIL SHINER | NOTROPIS HUDSONIUS | | | | | | | | | | | | 2 | | 2 | 4 |
| BOTHIDAE | | | | | | | | | | | | | | | | | |
| | SMALLMOUTH FLOUNDER | ETROPUS MICROSTOMUS | | | | 1 | | | | | | | | | | | 1 |
| SCOMBRIDAE | | | | | | | | | | | | | | | | | |
| | SPANISH MACKEREL | SCOMBEROMORUS MACULATUS | 1 | 1 | 6 | 3 | | | | | | | | | | | 11 |
| PERCIDAE | | | | | | | | | | | | | | | | | |
| | YELLOW PERCH | PERCA FLAVESCENS | | | | | | | | | | | | | 1 | 2 | 3 |
| | TESSELLATED DARTER | ETHEOSTOMA OLMSTEDI | | | | | | | | | | 12 | 41 | 21 | 18 | 35 | 127 |
| | WALLEYE | STIZOSTEDION VITREUM | | | | | | | | | | | | | 1 | | 1 |
| DASYATIDAE | | | | | | | | | | | | | | | | | |
| | ROUGHTAIL STINGRAY | DASYATIS CENTROURA | 1 | | 3 | 1 | | | | | | | | | | | 5 |
| CATOSTOMIDAE | | | | | | | | | | | | | | | | | |
| | WHITE SUCKER | CATOSTOMUS COMMERSONI | | | | | | | | | | | 2 | 2 | 1 | 7 | 12 |
| | | TOTAL CATCH | 1252 | 3263 | 8030 | 4069 | 4512 | 5182 | 1971 | 4541 | 7513 | 2479 | 1166 | 1681 | 1000 | 1587 | 48246 |

Table 4-15
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month for Zone 14 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | 1 | | | | | **1** | **0.03** |
| AMERICAN EEL | | 3 | 5 | 1 | 2 | 8 | 1 | | **20** | **0.63** |
| ATLANTIC STURGEON | | | | | 2 | | | 1 | **3** | **0.09** |
| BROWN BULLHEAD | | | | | 1 | | | | **1** | **0.03** |
| CARP | | | | | | | 1 | | **1** | **0.03** |
| CHANNEL CATFISH | 1 | 30 | 65 | 45 | 38 | 111 | 4 | 34 | **328** | **10.25** |
| EASTERN SILVERY MINNOW | 1 | | | | | | 1 | | **2** | **0.06** |
| HOGCHOKER | | | | | 13 | 7 | | 2 | **22** | **0.69** |
| SHORTNOSE STURGEON | | | | 1 | | | | | **1** | **0.03** |
| SPOTFIN SHINER | | | | 3 | | | | | **3** | **0.09** |
| SPOTTAIL SHINER | 1 | 1 | | | | | | | **2** | **0.06** |
| STRIPED BASS | | 1 | | | | | | | **1** | **0.03** |
| TESSELLATED DARTER | | 2 | | 3 | 3 | 15 | 4 | 8 | **35** | **1.09** |
| WHITE CATFISH | 2 | 6 | 1 | | 3 | | | | **12** | **0.38** |
| WHITE PERCH | | 166 | 50 | 403 | 332 | 98 | 28 | 72 | **1149** | **35.91** |
| WHITE SUCKER | | | | | | | 7 | | **7** | **0.22** |
| YELLOW PERCH | | | | 1 | | 1 | | | **2** | **0.06** |
| **Total Finfish Collected** | 5 | 209 | 121 | 458 | 394 | 240 | 46 | 117 | 1590 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 1.3 | 52.3 | 30.3 | 114.5 | 98.5 | 60.0 | 11.5 | 29.3 | **49.7** | |

Table 4-14
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month for Zone 13 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | 1 | | | **1** | **0.03** |
| AMERICAN EEL | 3 | 6 | 4 | 22 | 2 | 3 | | 2 | **42** | **1.31** |
| AMERICAN SHAD | | | | | 1 | 1 | | | **2** | **0.06** |
| ATLANTIC STURGEON | | | | | | 1 | | | **1** | **0.03** |
| CHANNEL CATFISH | | 87 | 7 | 17 | 170 | 36 | 7 | 56 | **380** | **11.88** |
| EASTERN SILVERY MINNOW | 4 | | | | | | | | **4** | **0.13** |
| HOGCHOKER | | 1 | | 3 | 46 | 23 | | | **73** | **2.28** |
| REDBREAST SUNFISH | | | | | | | 1 | | **1** | **0.03** |
| STRIPED BASS | | 1 | | | 9 | 2 | | | **12** | **0.38** |
| TESSELLATED DARTER | | 6 | 1 | 4 | 3 | 1 | | 3 | **18** | **0.56** |
| WALLEYE | | | | | | 1 | | | **1** | **0.03** |
| WHITE CATFISH | 1 | 6 | 1 | | 1 | | | | **9** | **0.28** |
| WHITE PERCH | 14 | 53 | 12 | 127 | 189 | 57 | 1 | 1 | **454** | **14.19** |
| WHITE SUCKER | | | | | 1 | | | | **1** | **0.03** |
| YELLOW PERCH | 1 | | | | | | | | **1** | **0.03** |
| **Total Finfish Collected** | 23 | 160 | 25 | 173 | 422 | 126 | 9 | 62 | 1000 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 5.8 | 40.0 | 6.3 | 43.3 | 105.5 | 31.5 | 2.3 | 15.5 | **31.3** | |

Table 4-13
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month for Zone 12 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | 1 | | | **1** | **0.03** |
| AMERICAN EEL | 1 | | 10 | 11 | 1 | | 3 | | **26** | **0.81** |
| AMERICAN SHAD | | | | | | 8 | | | **8** | **0.25** |
| CHANNEL CATFISH | | 34 | 13 | 57 | 175 | 189 | 52 | 168 | **688** | **21.50** |
| EASTERN SILVERY MINNOW | 10 | 4 | 1 | | 2 | 8 | | | **25** | **0.78** |
| HOGCHOKER | | 1 | 50 | 15 | 90 | 34 | 1 | 11 | **202** | **6.31** |
| SPOTTAIL SHINER | | | | | | 2 | | | **2** | **0.06** |
| STRIPED BASS | | | | | | 1 | | | **1** | **0.03** |
| TESSELLATED DARTER | 6 | | 1 | 5 | 3 | 1 | | 5 | **21** | **0.66** |
| WHITE CATFISH | | 1 | | | | 1 | | | **2** | **0.06** |
| WHITE PERCH | 28 | 47 | 7 | 120 | 155 | 298 | 32 | 16 | **703** | **21.97** |
| WHITE SUCKER | | | | | | | | 2 | **2** | **0.06** |
| **Total Finfish Collected** | 45 | 87 | 82 | 208 | 426 | 543 | 88 | 202 | 1681 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 11.3 | 21.8 | 20.5 | 52.0 | 106.5 | 135.8 | 22.0 | 50.5 | **52.5** | |

Table 4-12
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month for Zone 11 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | 3 | | **3** | **0.09** |
| AMERICAN EEL | 2 | 5 | 6 | 21 | | 5 | 2 | 4 | **45** | **1.41** |
| CHANNEL CATFISH | 5 | 17 | 17 | 12 | 124 | 65 | 120 | 56 | **416** | **13.00** |
| EASTERN SILVERY MINNOW | 19 | 3 | | | | | | 2 | **24** | **0.75** |
| HOGCHOKER | 4 | 10 | 36 | 33 | 56 | 10 | 39 | 7 | **195** | **6.09** |
| STRIPED BASS | | | | | 1 | 1 | 4 | | **6** | **0.19** |
| TESSELLATED DARTER | 6 | 1 | | | | 1 | | 33 | **41** | **1.28** |
| WHITE CATFISH | | 1 | | | | | | | **1** | **0.03** |
| WHITE PERCH | 41 | 8 | 13 | 13 | 214 | 66 | 51 | 27 | **433** | **13.53** |
| WHITE SUCKER | 2 | | | | | | | | **2** | **0.06** |
| **Total Finfish Collected** | 79 | 45 | 72 | 79 | 395 | 148 | 219 | 129 | 1166 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 19.8 | 11.3 | 18.0 | 19.8 | 98.8 | 37.0 | 54.8 | 32.3 | **36.4** | |

Table 4-11
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month for Zone 10 using a bottom trawl
April - November 2003

| **Common Name** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Total** | **CPUE** |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | 7 | | | | | **7** | **0.22** |
| AMERICAN EEL | | 4 | 8 | 4 | 10 | 2 | 2 | 1 | **31** | **0.97** |
| AMERICAN SHAD | 5 | | | | | | | | **5** | **0.16** |
| ATLANTIC CROAKER | | | | | | | | 1 | **1** | **0.03** |
| BAY ANCHOVY | | 1 | | | | | | | **1** | **0.03** |
| BROWN BULLHEAD | | | 8 | | | | | | **8** | **0.25** |
| CHANNEL CATFISH | 11 | 33 | 52 | 7 | 63 | 74 | 94 | 214 | **548** | **17.13** |
| EASTERN SILVERY MINNOW | 8 | 5 | | 4 | | | | 3 | **20** | **0.63** |
| GOLDEN SHINER | | | | | | | 1 | | **1** | **0.03** |
| HOGCHOKER | 10 | 21 | 13 | 3 | 100 | 42 | 33 | 148 | **370** | **11.56** |
| SHORTNOSE STURGEON | | | | | | 1 | | | **1** | **0.03** |
| STRIPED BASS | 1 | 2 | 3 | 1 | | 1 | | 1 | **9** | **0.28** |
| TESSELLATED DARTER | 3 | 1 | | | | 1 | 3 | 4 | **12** | **0.38** |
| WHITE CATFISH | | | 2 | | | | | | **2** | **0.06** |
| WHITE PERCH | 50 | 10 | 32 | 79 | 561 | 351 | 199 | 181 | **1463** | **45.72** |
| **Total Finfish Collected** | 88 | 77 | 118 | 105 | 734 | 472 | 332 | 553 | 2479 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 22.0 | 19.3 | 29.5 | 26.3 | 183.5 | 118.0 | 83.0 | 138.3 | **77.5** | |

Table 4-10
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 9 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| AMERICAN EEL | 1 | 10 | 23 | 36 | 6 | 5 | 13 | 17 | **111** | **3.47** |
| ATLANTIC CROAKER | | | | | | | 28 | 19 | **47** | **1.47** |
| BLUE CRAB (BLUECLAW) | | | | | | 1 | | | **1** | **0.03** |
| BROWN BULLHEAD | | | | | | | 1 | | **1** | **0.03** |
| CHANNEL CATFISH | 28 | 39 | 118 | 61 | 66 | 218 | 387 | 927 | **1844** | **57.63** |
| EASTERN SILVERY MINNOW | 11 | 1 | 5 | | | | | | **17** | **0.53** |
| HOGCHOKER | 253 | 281 | 576 | 434 | 149 | 103 | 566 | 892 | **3254** | **101.69** |
| MORONE SPP. | | | | 1 | | | | | **1** | **0.03** |
| NAKED GOBY | | | | 1 | | 11 | | | **12** | **0.38** |
| STRIPED BASS | 3 | 1 | 2 | 6 | | | 2 | | **14** | **0.44** |
| WHITE CATFISH | | | 6 | | | | | | **6** | **0.19** |
| WHITE PERCH | 455 | 15 | 27 | 110 | 127 | 735 | 353 | 383 | **2205** | **68.91** |
| **Total Finfish Collected** | 751 | 347 | 757 | 649 | 348 | 1073 | 1350 | 2238 | 7513 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 187.8 | 86.8 | 189.3 | 162.3 | 87.0 | 268.3 | 337.5 | 559.5 | **234.8** | |

Table 4-9
PSEG Estuary Enhancement Program
Total catch and catch per unit effor (CPUE) by month in Zone 8 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | 11 | | | 3 | **14** | **0.44** |
| AMERICAN EEL | | 8 | 34 | 21 | 1 | 26 | 11 | 9 | **110** | **3.44** |
| AMERICAN SHAD | | | | 1 | 1 | | | 5 | **7** | **0.22** |
| ATLANTIC CROAKER | | | | | | | 99 | 4 | **103** | **3.22** |
| BAY ANCHOVY | | 1 | | | 1 | 6 | 4 | | **12** | **0.38** |
| BLUE CRAB (BLUECLAW) | | 1 | | | | 8 | 1 | | **10** | **0.31** |
| BROWN BULLHEAD | | | | | | | | 1 | **1** | **0.03** |
| CHANNEL CATFISH | 32 | 40 | 41 | 15 | 39 | 168 | 96 | 140 | **571** | **17.84** |
| EASTERN SILVERY MINNOW | 2 | | | 1 | | | | | **3** | **0.09** |
| HOGCHOKER | 73 | 57 | 142 | 71 | 231 | 94 | 97 | 256 | **1021** | **31.91** |
| NAKED GOBY | | | | | | 3 | | | **3** | **0.09** |
| STRIPED BASS | 22 | | 4 | 10 | 103 | 3 | | | **142** | **4.44** |
| WEAKFISH | | | | | | 4 | | | **4** | **0.13** |
| WHITE CATFISH | | 1 | | | | | | | **1** | **0.03** |
| WHITE PERCH | 335 | 39 | 40 | 349 | 438 | 524 | 544 | 270 | **2539** | **79.34** |
| **Total Finfish Collected** | 464 | 147 | 261 | 468 | 825 | 836 | 852 | 688 | 4541 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 116.0 | 36.8 | 65.3 | 117.0 | 206.3 | 209.0 | 213.0 | 172.0 | **141.9** | |

Table 4-8
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 7 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | 2 | 4 | 11 | **17** | **0.53** |
| AMERICAN EEL | | 5 | 7 | 7 | 5 | 3 | 12 | 3 | **42** | **1.31** |
| ATLANTIC CROAKER | | | | 4 | | | 109 | 493 | **606** | **18.94** |
| ATLANTIC HERRING | | | | | 1 | | | | **1** | **0.03** |
| BAY ANCHOVY | | | | | | 11 | 7 | | **18** | **0.56** |
| BLACK SEA BASS | | | | | | | | | **0** | **0.00** |
| BLUE CRAB (BLUECLAW) | | | | 5 | 3 | 2 | 2 | 1 | **13** | **0.41** |
| BROWN BULLHEAD | 1 | | | | | | | | **1** | **0.03** |
| CHANNEL CATFISH | | | | 3 | 9 | 5 | 1 | 1 | **19** | **0.59** |
| HOGCHOKER | 33 | 27 | 18 | 51 | 184 | 88 | 270 | 32 | **703** | **21.97** |
| NAKED GOBY | | | | | 24 | 9 | 30 | 4 | **67** | **2.09** |
| NORTHERN KINGFISH | | | | | 1 | | | | **1** | **0.03** |
| SPOTTED HAKE | 14 | 3 | | | | | | | **17** | **0.53** |
| STRIPED BASS | | | | 121 | 2 | | | | **123** | **3.84** |
| WEAKFISH | | | | | | 7 | | | **7** | **0.22** |
| WHITE PERCH | 50 | 20 | 10 | 17 | 100 | 41 | 53 | 45 | **336** | **10.50** |
| **Total Finfish Collected** | 98 | 55 | 35 | 208 | 329 | 168 | 488 | 590 | 1971 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 24.5 | 13.8 | 8.8 | 52.0 | 82.3 | 42.0 | 122.0 | 147.5 | **61.6** | |

Table 4-7
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 6 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | | 13 | **13** | **0.41** |
| AMERICAN EEL | 3 | 3 | 7 | 95 | | 5 | 11 | 1 | **125** | **3.91** |
| ATLANTIC CROAKER | | | 5 | 12 | | | 136 | 2501 | **2654** | **82.94** |
| BAY ANCHOVY | | 8 | | | 50 | | 1 | 7 | **66** | **2.06** |
| BLACK SEA BASS | | | 2 | | | | | | **2** | **0.06** |
| BLUE CRAB (BLUECLAW) | 6 | 3 | 9 | 4 | 6 | 11 | 49 | 80 | **168** | **5.25** |
| HOGCHOKER | 85 | 10 | 121 | 18 | 27 | 21 | 107 | 100 | **489** | **15.28** |
| NAKED GOBY | | | | | 4 | | 8 | 8 | **20** | **0.63** |
| NORTHERN PIPEFISH | | | | 1 | | | | | **1** | **0.03** |
| NORTHERN SEAROBIN | 4 | | 5 | | | | | | **9** | **0.28** |
| OYSTER TOADFISH | 10 | 1 | 23 | 6 | | 36 | | 5 | **81** | **2.53** |
| RED HAKE | 1 | | | | | | | | **1** | **0.03** |
| SPOTTED HAKE | 945 | 46 | 9 | | | | | 2 | **1002** | **31.31** |
| STRIPED BASS | 2 | | | | | | | 1 | **3** | **0.09** |
| STRIPED CUSK-EEL | | 6 | | | 71 | 41 | 25 | 12 | **155** | **4.84** |
| SUMMER FLOUNDER | | | 1 | | | | | | **1** | **0.03** |
| WEAKFISH | | | | 4 | 206 | 16 | 30 | 4 | **260** | **8.13** |
| WHITE PERCH | 48 | 1 | 1 | | | | 19 | 63 | **132** | **4.13** |
| **Total Finfish Collected** | 1104 | 78 | 183 | 140 | 364 | 130 | 386 | 2797 | 5182 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 276.0 | 19.5 | 45.8 | 35.0 | 91.0 | 32.5 | 96.5 | 699.3 | **161.9** | |

Table 4-6
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 5 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | 1 | | **1** | **0.03** |
| ATLANTIC CROAKER | | | | 1 | | | 5 | 2059 | **2065** | **64.53** |
| ATLANTIC SILVERSIDE | | | | | 11 | | | | **11** | **0.34** |
| BAY ANCHOVY | 2 | 153 | 2 | 28 | 775 | 168 | 73 | 17 | **1218** | **38.06** |
| BLACK SEA BASS | | | | | | | 4 | | **4** | **0.13** |
| BLACK DRUM | | | | | | | | | **0** | **0.00** |
| BLUE CRAB (BLUECLAW) | 8 | 7 | 2 | 69 | 3 | | 100 | 151 | **340** | **10.63** |
| BLUEBACK HERRING | | | | | | | | 3 | **3** | **0.09** |
| BUTTERFISH | | | | 1 | | | 2 | | **3** | **0.09** |
| CONGER EEL | | | | 40 | | | | | **40** | **1.25** |
| HOGCHOKER | 1 | 8 | 6 | 177 | 1 | | 3 | 57 | **253** | **7.91** |
| NAKED GOBY | 2 | 1 | | | | | | 1 | **4** | **0.13** |
| NORTHERN STARGAZER | | | | | | | 2 | | **2** | **0.06** |
| NORTHERN SEAROBIN | 1 | 4 | 9 | | | | | | **14** | **0.44** |
| OYSTER TOADFISH | 2 | 2 | 6 | 7 | 1 | 5 | 9 | | **32** | **1.00** |
| SCUP | | | 15 | 2 | 9 | 3 | | | **29** | **0.91** |
| SPOTTED HAKE | 95 | 33 | 163 | | | | | | **291** | **9.09** |
| STRIPED ANCHOVY | | | | | | 3 | | | **3** | **0.09** |
| STRIPED BASS | 1 | | | | | | | | **1** | **0.03** |
| STRIPED CUSK-EEL | | 1 | 3 | | | | 7 | 10 | **21** | **0.66** |
| STRIPED SEAROBIN | | | | | | | 1 | | **1** | **0.03** |
| SUMMER FLOUNDER | 1 | | 1 | 5 | | | 1 | | **8** | **0.25** |
| WEAKFISH | | 8 | 5 | 101 | 5 | 4 | 14 | | **137** | **4.28** |
| WHITE PERCH | | 2 | | | | | | 9 | **11** | **0.34** |
| WINDOWPANE | 6 | | | | | | | | **6** | **0.19** |
| WINTER FLOUNDER | | | 7 | 6 | | 1 | | | **14** | **0.44** |
| **Total Finfish Collected** | 119 | 219 | 219 | 437 | 805 | 184 | 222 | 2307 | 4512 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 29.8 | 54.8 | 54.8 | 109.3 | 201.3 | 46.0 | 55.5 | 576.8 | **141.0** | |

Table 4-5
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 4 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | | 6 | **6** | **0.19** |
| AMERICAN SHAD | | | | | | | | 1 | **1** | **0.03** |
| ATLANTIC CROAKER | 2 | | | 12 | 6 | | 17 | 135 | **172** | **5.38** |
| ATLANTIC SILVERSIDE | | | | | 14 | | 1 | | **15** | **0.47** |
| BAY ANCHOVY | 2 | 654 | 16 | 1 | 706 | 163 | 531 | 1109 | **3182** | **99.44** |
| BLACK SEA BASS | | | | 1 | | 1 | | | **2** | **0.06** |
| BLACK DRUM | | | | | | | 1 | | **1** | **0.03** |
| BLUE CRAB (BLUECLAW) | 2 | 54 | | | | | 7 | 13 | **76** | **2.38** |
| BLUEFISH | | | | 1 | 1 | 3 | | 2 | **7** | **0.22** |
| BUTTERFISH | | | 1 | | 2 | 1 | 1 | 1 | **6** | **0.19** |
| HOGCHOKER | 3 | | 2 | 2 | 4 | 5 | 49 | 5 | **70** | **2.19** |
| LINED SEAHORSE | | | 1 | | | | | | **1** | **0.03** |
| LITTLE SKATE | | | | | | | | 1 | **1** | **0.03** |
| NAKED GOBY | | 1 | 1 | | | | | | **2** | **0.06** |
| NORTHERN KINGFISH | | | | | | 1 | | | **1** | **0.03** |
| NORTHERN PIPEFISH | | 8 | | 2 | 1 | 2 | 1 | 1 | **15** | **0.47** |
| NORTHERN SEAROBIN | | 7 | 3 | 1 | 1 | | 1 | | **13** | **0.41** |
| OYSTER TOADFISH | | | | | | | 1 | 11 | **12** | **0.38** |
| RED HAKE | | 1 | | | | | | | **1** | **0.03** |
| ROUGHTAIL STINGRAY | | | | | 1 | | | | **1** | **0.03** |
| SCUP | | | | 7 | 1 | 7 | | | **15** | **0.47** |
| SILVER HAKE | | 1 | | | | | | | **1** | **0.03** |
| SMALLMOUTH FLOUNDER | | | | | | | 1 | | **1** | **0.03** |
| SMOOTH DOGFISH | | | | 2 | 2 | 2 | | | **6** | **0.19** |
| SPANISH MACKEREL | | 1 | | | 2 | | | | **3** | **0.09** |
| SPOT | | | | | | 4 | | | **4** | **0.13** |
| SPOTTED HAKE | 16 | 65 | 25 | | | | 3 | 3 | **112** | **3.50** |
| STRIPED ANCHOVY | | | | | | | 1 | | **1** | **0.03** |
| STRIPED CUSK-EEL | | | | | 4 | | 2 | 2 | **8** | **0.25** |
| STRIPED SEAROBIN | | | | | | | 8 | | **8** | **0.25** |
| SUMMER FLOUNDER | 3 | 3 | 8 | | 1 | | 3 | | **18** | **0.56** |
| WEAKFISH | | 7 | 7 | 4 | 124 | 65 | 57 | 4 | **268** | **8.38** |
| WHITE PERCH | | | | | | | | 15 | **15** | **0.47** |
| WINDOWPANE | 4 | 1 | 5 | | | 2 | 10 | 1 | **23** | **0.72** |
| WINTER FLOUNDER | | | | | | 1 | | | **1** | **0.03** |
| **Total Finfish Collected** | 32 | 803 | 69 | 33 | 870 | 257 | 695 | 1310 | 4069 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 8.0 | 200.8 | 17.3 | 8.3 | 217.5 | 64.3 | 173.8 | 327.5 | **127.2** | |

Table 4-4
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 3 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | | 16 | **16** | **0.50** |
| ATLANTIC CROAKER | | | | 71 | 40 | 2 | 43 | 3408 | **3564** | **111.38** |
| ATLANTIC MENHADEN | | | | | | | | 1 | **1** | **0.03** |
| ATLANTIC SILVERSIDE | | | | | | | | 1 | **1** | **0.03** |
| BAY ANCHOVY | 18 | 190 | 98 | 463 | 243 | 133 | 148 | 1793 | **3086** | **96.44** |
| BLACK SEA BASS | | 1 | | 3 | 3 | 1 | | | **8** | **0.25** |
| BLUEBACK HERRING | | 1 | | | | | | | **1** | **0.03** |
| BLUE CRAB (BLUECLAW) | 4 | 1 | | 8 | 5 | 1 | 9 | 7 | **35** | **1.09** |
| BUTTERFISH | | | 2 | | 1 | 3 | 2 | | **8** | **0.25** |
| CLEARNOSE SKATE | | 3 | 1 | | 1 | | 1 | | **6** | **0.19** |
| CONGER EEL | | 3 | | 1 | | | | | **4** | **0.13** |
| HOGCHOKER | 1 | 25 | | 1 | 9 | 5 | 32 | | **73** | **2.28** |
| LINED SEAHORSE | | | 1 | | | | | | **1** | **0.03** |
| LITTLE SKATE | 6 | | | | | | 2 | 7 | **15** | **0.47** |
| NAKED GOBY | | | | 1 | 1 | 2 | 1 | | **5** | **0.16** |
| NORTHERN KINGFISH | | | | | 5 | | 2 | | **7** | **0.22** |
| NORTHERN PIPEFISH | 3 | 4 | | 13 | | 1 | 1 | 1 | **23** | **0.72** |
| NORTHERN SEAROBIN | 9 | 3 | 6 | 3 | 11 | 6 | 1 | 2 | **41** | **1.28** |
| OYSTER TOADFISH | | 1 | 1 | | | 1 | 2 | | **5** | **0.16** |
| RED HAKE | | 1 | | | | | | | **1** | **0.03** |
| ROUGHTAIL STINGRAY | | | | | 3 | | | | **3** | **0.09** |
| SCUP | | 1 | 2 | 5 | 30 | 7 | 1 | | **46** | **1.44** |
| SILVER PERCH | | | | | | | 3 | 1 | **4** | **0.13** |
| SMOOTH DOGFISH | | 1 | 9 | 7 | 12 | 3 | | | **32** | **1.00** |
| SPANISH MACKEREL | | | | | 6 | | | | **6** | **0.19** |
| SPOT | | 1 | | | 3 | | | | **4** | **0.13** |
| SPOTTED HAKE | 178 | 111 | 40 | | | | 1 | 6 | **336** | **10.50** |
| STRIPED ANCHOVY | | | | | | 3 | 1 | 1 | **5** | **0.16** |
| STRIPED BURRFISH | | | | | 1 | | | | **1** | **0.03** |
| STRIPED CUSK-EEL | 2 | | | | 1 | | 43 | 9 | **55** | **1.72** |
| STRIPED SEAROBIN | | 3 | | | 2 | 1 | 1 | | **7** | **0.22** |
| SUMMER FLOUNDER | 9 | 12 | 6 | 2 | 5 | 1 | 3 | | **38** | **1.19** |
| TAUTOG | | 1 | | | | | | | **1** | **0.03** |
| WEAKFISH | | 29 | 6 | 6 | 296 | 27 | 58 | 50 | **472** | **14.75** |
| WHITE PERCH | | | | | | | | 4 | **4** | **0.13** |
| WINDOWPANE | 48 | 3 | 6 | 4 | 3 | 2 | 12 | 3 | **81** | **2.53** |
| WINTER FLOUNDER | | | 1 | 31 | 2 | 1 | | | **35** | **1.09** |
| **Total Finfish Collected** | 278 | 395 | 179 | 619 | 683 | 200 | 367 | 5310 | 8031 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 69.5 | 98.8 | 44.8 | 154.8 | 170.8 | 50.0 | 91.8 | 1327.5 | **251.0** | |

Table 4-3
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 2 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | | 1 | **1** | **0.03** |
| ATLANTIC CROAKER | | | 1 | 2 | 8 | | 15 | 19 | **45** | **1.41** |
| BAY ANCHOVY | 5 | 96 | 245 | 274 | 128 | 442 | 91 | 890 | **2171** | **67.84** |
| BLACK SEA BASS | 2 | | | | | | | | **2** | **0.06** |
| BLUEBACK HERRING | | | | | | | | 1 | **1** | **0.03** |
| BLUE CRAB (BLUECLAW) | | | 1 | | | | | | **1** | **0.03** |
| BLUEFISH | | | | | | 3 | | | **3** | **0.09** |
| BULLNOSE RAY | | | | | | 2 | | | **2** | **0.06** |
| BUTTERFISH | | | | | 2 | 7 | | 1 | **10** | **0.31** |
| CLEARNOSE SKATE | 1 | 2 | 2 | | | 1 | 2 | 1 | **9** | **0.28** |
| UNIDENTIFIED GOBIIDAE | | | | | | | 1 | | **1** | **0.03** |
| HOGCHOKER | 6 | 19 | | 3 | 4 | 2 | 38 | 1 | **73** | **2.28** |
| NORTHERN KINGFISH | | | 2 | | 1 | 4 | 1 | 1 | **9** | **0.28** |
| NORTHERN PIPEFISH | 4 | 1 | | | | | | | **5** | **0.16** |
| NORTHERN SEAROBIN | | 1 | 7 | | | | | | **8** | **0.25** |
| OYSTER TOADFISH | | | | | | | 1 | | **1** | **0.03** |
| SCUP | | 1 | 2 | 3 | 23 | 95 | 3 | | **127** | **3.97** |
| SILVER PERCH | | 1 | | | | | | | **1** | **0.03** |
| SMOOTH DOGFISH | | 3 | 1 | 1 | 2 | 2 | 2 | | **11** | **0.34** |
| SPANISH MACKEREL | | | 1 | | | | | | **1** | **0.03** |
| SPOT | | 1 | | | | | | | **1** | **0.03** |
| SPOTTED HAKE | 193 | 40 | 7 | 6 | 13 | | 3 | 2 | **264** | **8.25** |
| STRIPED ANCHOVY | | | | | | 39 | | | **39** | **1.22** |
| STRIPED BURRFISH | | | 1 | | | | | | **1** | **0.03** |
| STRIPED CUSK-EEL | | | | | | | 1 | | **1** | **0.03** |
| SUMMER FLOUNDER | 3 | 2 | | | | | | | **5** | **0.16** |
| WEAKFISH | | 30 | 11 | 142 | 57 | 153 | 41 | 5 | **439** | **13.72** |
| WINDOWPANE | 20 | | 2 | 1 | 2 | 2 | 1 | 2 | **30** | **0.94** |
| WINTER FLOUNDER | | | 1 | 1 | | | | | **2** | **0.06** |
| **Total Finfish Collected** | 234 | 197 | 284 | 433 | 240 | 752 | 200 | 924 | 3264 | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 58.5 | 49.3 | 71.0 | 108.3 | 60.0 | 188.0 | 50.0 | 231.0 | **102.0** | |

Table 4-2
PSEG Estuary Enhancement Program
Total catch and catch per unit effort (CPUE) by month in Zone 1 using a bottom trawl
April - November 2003

| Common Name | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Total | CPUE |
|---|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | | | | | | | | 2 | **2** | **0.06** |
| ATLANTIC CROAKER | | | | | | 1 | 6 | 285 | **292** | **9.13** |
| BAY ANCHOVY | 1 | 4 | 6 | 9 | 1 | 371 | 63 | 106 | **561** | **17.53** |
| BLUE CRAB (BLUECLAW) | | | | | | | | 15 | **15** | **0.47** |
| BULLNOSE RAY | | | | 1 | | 2 | | | **3** | **0.09** |
| BUTTERFISH | | | 5 | | | 2 | 1 | | **8** | **0.25** |
| CLEARNOSE SKATE | 1 | 2 | 4 | | 6 | | | | **13** | **0.41** |
| HOGCHOKER | | | | | | | 3 | 3 | **6** | **0.19** |
| LITTLE SKATE | 2 | | | | | | | 5 | **7** | **0.22** |
| NAKED GOBY | | | | | | | 1 | | **1** | **0.03** |
| NORTHERN KINGFISH | | | 1 | | | | 2 | | **3** | **0.09** |
| NORTHERN PIPEFISH | 1 | | | | | | | | **1** | **0.03** |
| NORTHERN SEAROBIN | 1 | | 4 | | 4 | | | | **9** | **0.28** |
| OYSTER TOADFISH | | 2 | | | | | | | **2** | **0.06** |
| RED HAKE | | 2 | | | | | | | **2** | **0.06** |
| ROUGHTAIL STINGRAY | | | | 1 | | | | | **1** | **0.03** |
| SCUP | | 6 | 2 | 1 | 33 | 19 | 4 | | **65** | **2.03** |
| SILVER HAKE | | 1 | | | | | | | **1** | **0.03** |
| SMOOTH DOGFISH | | 11 | | 8 | | 3 | 3 | | **25** | **0.78** |
| SPANISH MACKEREL | | | | | | 1 | | | **1** | **0.03** |
| SPOT | | | | | | | 2 | | **2** | **0.06** |
| SPOTTED HAKE | 16 | 22 | 30 | 1 | 2 | | 3 | 2 | **76** | **2.38** |
| STRIPED ANCHOVY | | | | | | 20 | | | **20** | **0.63** |
| STRIPED SEAROBIN | | | | | | | 3 | | **3** | **0.09** |
| SUMMER FLOUNDER | 2 | 1 | 4 | | | | 1 | | **8** | **0.25** |
| WEAKFISH | | 4 | 1 | 17 | 11 | 1 | 43 | 8 | **85** | **2.66** |
| WINDOWPANE | 15 | | 4 | | 2 | | 1 | 18 | **40** | **1.25** |
| **Total Finfish Collected** | 39 | 55 | 61 | 38 | 59 | 420 | 136 | 444 | **1252** | |
| **Trawls per Month** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | **32** | |
| **Total CPUE** | 9.8 | 13.8 | 15.3 | 9.5 | 14.8 | 105.0 | 34.0 | 111.0 | **39.1** | |

Table 4-16
PSEG Estuary Enhancement Program
Total catch by zone using a pelagic trawl
April - November 2003

| Family | Common Name | Scientific Name | BZ-1 | BZ-2 | BZ-3 | BZ-4 | BZ-5 | BZ-6 | BZ-7 | BZ-8 | BZ-9 | BZ-10 | BZ-11 | BZ-12 | BZ-13 | BZ-14 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORTUNIDAE | | | | | | | | | | | | | | | | | |
| | BLUE CRAB (BLUECLAW) | CALLINECTES SAPIDUS | 5 | 11 | 17 | 39 | 47 | 34 | 8 | | | | | | | | 161 |
| CARCHARHINIDAE | | | | | | | | | | | | | | | | | |
| | SMOOTH DOGFISH | MUSTELUS CANIS | | 2 | | | | | | | | | | | | | 2 |
| ANGUILLIDAE | | | | | | | | | | | | | | | | | |
| | AMERICAN EEL | ANGUILLA ROSTRATA | | | | | | | | 4 | 1 | 1 | 3 | | 1 | 2 | 12 |
| CONGRIDAE | | | | | | | | | | | | | | | | | |
| | CONGER EEL | CONGER OCEANICUS | 7 | | 4 | 1 | 1 | | | | | | | | | | 13 |
| ENGRAULIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED ANCHOVY | ANCHOA HEPSETUS | 40 | 10 | 32 | 75 | 99 | 40 | | | | | | | | | 296 |
| | BAY ANCHOVY | ANCHOA MITCHILLI | 11919 | 7442 | 13862 | 27402 | 22585 | 6078 | 5616 | 2903 | 2778 | 38 | 163 | 3 | | 1 | 100790 |
| CLUPEIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC MENHADEN | BREVOORTIA TYRANNUS | | 4 | 6 | 14 | 5 | 4 | 18 | 22 | 6 | 3 | 1 | | | | 83 |
| | BLUEBACK HERRING | ALOSA AESTIVALIS | | 1 | 3 | 4 | 11 | 3 | 11 | 51 | 14 | 11 | 43 | 31 | 7 | 3 | 193 |
| | ALEWIFE | ALOSA PSEUDOHARENGUS | 1 | 2 | 4 | 8 | 2 | 1 | 21 | 17 | 22 | 13 | 27 | 14 | 9 | 1 | 142 |
| | AMERICAN SHAD | ALOSA SAPIDISSIMA | | | | | | | 5 | 39 | 60 | 941 | 584 | 29 | 333 | 76 | 2067 |
| | GIZZARD SHAD | DOROSOMA CEPEDIANUM | | | | | | | | 2 | | | | | 1 | | 3 |
| | CLUPEA HARENGUS HARENGUS | ATLANTIC HERRING | | 1 | 1 | 15 | 9 | 22 | | | | | | | | | 48 |
| ICTALURIDAE | | | | | | | | | | | | | | | | | |
| | CHANNEL CATFISH | ICTALURUS PUNCTATUS | | | | | | | | 3 | 6 | 5 | 43 | 16 | 25 | 2 | 100 |
| BATRACHOIDIDAE | | | | | | | | | | | | | | | | | |
| | OYSTER TOADFISH | OPSANUS TAU | | | 1 | 1 | 1 | | | | | | | | | | 3 |
| GADIDAE | | | | | | | | | | | | | | | | | |
| | SPOTTED HAKE | UROPHYCIS REGIA | | 8 | 6 | 7 | 1 | 87 | | | | | | | | | 109 |
| OPHIDIIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED CUSK-EEL | OPHIDION MARGINATA | | | | 9 | 4 | 1 | 2 | | | | | | | | 16 |
| ATHERINIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC SILVERSIDE | MENIDIA MENIDIA | 54 | 70 | 70 | 35 | 26 | 21 | 3 | 2 | | | | | | | 281 |
| SYNGNATHIDAE | | | | | | | | | | | | | | | | | |
| | LINED SEAHORSE | HIPPOCAMPUS ERECTUS | 2 | | | 1 | 1 | | | | | | | | | | 4 |
| | NORTHERN PIPEFISH | SYNGNATHUS FUSCUS | 8 | 4 | 20 | 7 | 2 | 5 | 1 | | | | | | | | 47 |
| TRIGLIDAE | | | | | | | | | | | | | | | | | |
| | NORTHERN SEAROBIN | PRIONOTUS CAROLINUS | | | 1 | 2 | | 1 | | | | | | | | | 4 |
| | STRIPED SEAROBIN | PRIONOTUS EVOLANS | | | | | 1 | 1 | | | | | | | | | 2 |
| PERCICHTHYIDAE | | | | | | | | | | | | | | | | | |
| | WHITE PERCH | MORONE AMERICANA | | | | | | 1 | 15 | 38 | 158 | 52 | 50 | 27 | 8 | 6 | 355 |
| | STRIPED BASS | MORONE SAXATILIS | | | | | 8 | 8 | 19 | 19 | 90 | 8 | 18 | 1 | 2 | 8 | 181 |
| | UNIDENTIFIED MORONE SP. | MORONE SPP. | | | | | | | | | 1 | | | | | | 1 |
| POMATOMIDAE | | | | | | | | | | | | | | | | | |
| | BLUEFISH | POMATOMUS SALTATRIX | 2 | 1 | 3 | 1 | 3 | 2 | 2 | | | | | | | | 14 |
| BELONIDAE | | | | | | | | | | | | | | | | | |
| | ATLANTIC NEEDLEFISH | STRONGYLURA MARINA | | | | | | 1 | | | | | | | | | 1 |

Table 4-16
PSEG Estuary Enhancement Program
Total catch by zone using a pelagic trawl
April - November 2003

| Family | Common Name | Scientific Name | BZ-1 | BZ-2 | BZ-3 | BZ-4 | BZ-5 | BZ-6 | BZ-7 | BZ-8 | BZ-9 | BZ-10 | BZ-11 | BZ-12 | BZ-13 | BZ-14 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCIAENIDAE | | | | | | | | | | | | | | | | | |
| | WEAKFISH | CYNOSCION REGALIS | 2 | 14 | 5 | 12 | 17 | 35 | 433 | 20 | 10 | 15 | | | 1 | | 564 |
| | SPOT | LEIOSTOMUS XANTHURUS | 1 | | | | | | | | | | | | | | 1 |
| | ATLANTIC CROAKER | MICROPOGONIAS UNDULATUS | 717 | 299 | 3356 | 27756 | 9231 | 4722 | 1941 | 474 | 19 | 1 | | | | | 48516 |
| GOBIIDAE | | | | | | | | | | | | | | | | | |
| | NAKED GOBY | GOBIOSOMA BOSC | 6 | 3 | 5 | 12 | 47 | 10 | 17 | 2 | 1 | | | | | | 103 |
| STROMATEIDAE | | | | | | | | | | | | | | | | | |
| | BUTTERFISH | PEPRILUS TRIACANTHUS | 76 | 35 | 34 | 80 | 31 | | | | | | | | | | 256 |
| BOTHIDAE | | | | | | | | | | | | | | | | | |
| | SUMMER FLOUNDER | PARALICHTHYS DENTATUS | 1 | | 20 | 2 | | | | | | | | | | | 23 |
| | WINDOWPANE | SCOPHTHALMUS AQUOSUS | 4 | 2 | 1 | 3 | | | | | | | | | | | 10 |
| | SMALLMOUTH FLOUNDER | ETROPUS MICROSTOMUS | 2 | | | 4 | | 1 | | | | | | | | | 7 |
| PLEURONECTIDAE | | | | | | | | | | | | | | | | | |
| | WINTER FLOUNDER | PLEURONECTES AMERICANUS | | 5 | | | 1 | | | | | | | | | | 6 |
| SOLEIDAE | | | | | | | | | | | | | | | | | |
| | HOGCHOKER | TRINECTES MACULATUS | 2 | | 1 | 1 | 3 | | 17 | 5 | 10 | 2 | 53 | 1 | 1 | 1 | 97 |
| SPARIDAE | | | | | | | | | | | | | | | | | |
| | SCUP | STENOTOMUS CHRYSOPS | | | | | 1 | | | | | | | | | | 1 |
| CYPRINIDAE | | | | | | | | | | | | | | | | | |
| | EASTERN SILVERY MINNOW | HYBOGNATHUS REGIS | | | | | | | | | 2 | 1 | | | | | 3 |
| DIODONTIDAE | | | | | | | | | | | | | | | | | |
| | STRIPED BURRFISH | CHILOMYCTERUS SCHOEPFI | | | | 1 | | | | | | | | | | | 1 |
| URANOSCOPIDAE | | | | | | | | | | | | | | | | | |
| | NORTHERN STARGAZER | ASTROSCOPUS GUTTATUS | | | | | 1 | 1 | | | | | | | | | 2 |
| ESOCIDAE | | | | | | | | | | | | | | | | | |
| | ESOX NIGER | CHAIN PICKEREL | | | | | | | | | | | | | | 1 | 1 |
| SERRANIDAE | | | | | | | | | | | | | | | | | |
| | CENTROPRISTIS STRIATA | BLACK SEA BASS | | | 1 | | 32 | | | | | | | | | | 33 |
| | | TOTAL | 12849 | 7914 | 17453 | 55492 | 32170 | 11079 | 8129 | 3601 | 3178 | 1091 | 985 | 122 | 388 | 101 | 154552 |

Table 4-17

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 1)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| AMERICAN EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AMERICAN SHAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC CROAKER | 6.58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.64 | 23.17 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.56 | 0.00 | 0.00 | 0.00 | 1.34 | 1.25 | 0.31 | 0.07 | 1.42 |
| BAY ANCHOVY | 167.34 | 0.86 | 31.28 | 525.65 | 110.00 | 345.01 | 199.03 | 73.04 | 33.05 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 | 0.06 | 0.00 |
| BLUEBACK HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEFISH | 0.02 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.75 | 0.00 | 0.13 | 0.07 | 3.11 | 2.22 | 0.30 | 0.00 | 0.07 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CONGER EEL | 0.07 | 0.00 | 0.49 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GIZZARD SHAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HOGCHOKER | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 |
| LINED SEAHORSE | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.08 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.48 | 0.00 | 0.00 |
| NORTHERN PIPEFISH | 0.07 | 0.00 | 0.00 | 0.07 | 0.08 | 0.00 | 0.00 | 0.34 | 0.08 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.37 | 0.00 | 0.00 | 0.00 | 0.00 | 2.77 | 0.07 | 0.06 | 0.00 |
| STRIPED BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| WEAKFISH | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.00 | 0.00 |
| WHITE PERCH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINDOWPANE | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.22 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 176.0 | 0.9 | 31.9 | 526.0 | 114.5 | 351.3 | 201.0 | 102.3 | 58.3 |

Table 4-18

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 2)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.09 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 2.87 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.24 | 10.16 |
| **ATLANTIC HERRING** | 0.01 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC MENHADEN** | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.20 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.78 | 0.00 | 0.00 | 0.00 | 0.81 | 1.15 | 0.38 | 0.16 | 3.85 |
| **BAY ANCHOVY** | 77.68 | 24.79 | 11.79 | 199.85 | 29.62 | 66.17 | 103.43 | 118.04 | 75.29 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.83 | 0.14 | 0.00 |
| **BLUEBACK HERRING** | 0.01 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUEFISH** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.46 | 0.00 | 0.00 | 0.00 | 3.13 | 0.18 | 0.45 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.04 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.10 |
| **NORTHERN SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.02 | 0.00 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.07 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.46 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 0.15 | 0.00 | 0.00 | 0.00 | 0.63 | 0.44 | 0.18 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| **WINTER FLOUNDER** | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 |
| **Total** | 82.5 | 25.4 | 12.0 | 199.9 | 34.2 | 68.5 | 106.0 | 132.3 | 89.9 |

Table 4-19

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 3)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.32 | 0.00 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 34.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 206.36 | 67.16 |
| **ATLANTIC HERRING** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| **ATLANTIC MENHADEN** | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.15 | 0.18 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.74 | 0.00 | 0.00 | 0.09 | 3.62 | 1.06 | 0.30 | 0.38 | 0.43 |
| **BAY ANCHOVY** | 145.71 | 5.87 | 56.04 | 84.66 | 236.42 | 289.08 | 130.70 | 313.32 | 49.57 |
| **BLACK SEA BASS** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.18 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.83 | 0.54 | 0.00 |
| **BLUEBACK HERRING** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 |
| **BLUEFISH** | 0.03 | 0.00 | 0.00 | 0.08 | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.37 | 0.00 | 0.75 | 0.43 | 0.51 | 0.86 | 0.27 | 0.08 | 0.09 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.04 | 0.00 | 0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.05 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 | 0.26 |
| **NORTHERN SEAROBIN** | 0.01 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.05 | 0.34 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 2.42 | 0.44 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.60 | 0.00 |
| **WEAKFISH** | 0.05 | 0.00 | 0.00 | 0.00 | 0.34 | 0.09 | 0.00 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 182.5 | 6.4 | 57.2 | 85.3 | 241.1 | 293.7 | 133.6 | 524.5 | 117.8 |

Table 4-20

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by month (collected in Zone 4)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.56 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 205.74 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 77.46 | 1,568.42 |
| **ATLANTIC HERRING** | 0.12 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 0.00 |
| **ATLANTIC MENHADEN** | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.97 | 0.00 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.30 | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 0.16 | 0.31 | 1.37 |
| **BAY ANCHOVY** | 293.83 | 3.60 | 50.63 | 68.36 | 537.08 | 1,195.67 | 194.23 | 270.89 | 30.19 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.37 | 0.36 | 1.05 |
| **BLUEBACK HERRING** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.20 |
| **BLUEFISH** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.78 | 0.00 | 0.08 | 0.00 | 1.11 | 3.64 | 1.39 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.01 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.01 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.10 | 0.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.07 |
| **NORTHERN SEAROBIN** | 0.02 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.06 | 0.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.70 | 0.00 | 0.00 | 0.00 | 0.00 | 4.38 | 1.22 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.01 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.09 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 |
| **WEAKFISH** | 1.77 | 0.00 | 0.00 | 0.00 | 13.66 | 0.15 | 0.32 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 504.3 | 5.5 | 50.8 | 68.4 | 552.4 | 1,203.8 | 199.8 | 351.1 | 1,602.1 |

Table 4-21

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 5)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 87.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 196.77 | 578.22 |
| **ATLANTIC HERRING** | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 |
| **ATLANTIC MENHADEN** | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.32 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.25 | 0.00 | 0.00 | 0.00 | 0.64 | 0.28 | 0.09 | 0.40 | 0.84 |
| **BAY ANCHOVY** | 223.35 | 6.78 | 151.33 | 99.61 | 340.26 | 619.57 | 564.27 | 183.85 | 6.77 |
| **BLACK SEA BASS** | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.56 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.44 | 0.00 | 0.07 | 0.00 | 0.21 | 0.23 | 0.27 | 2.86 | 0.23 |
| **BLUEBACK HERRING** | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 |
| **BLUEFISH** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.32 | 0.00 | 0.00 | 0.00 | 0.27 | 2.56 | 0.00 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.01 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.01 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.44 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.83 | 0.00 |
| **NORTHERN PIPEFISH** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.08 |
| **NORTHERN SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.01 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 1.01 | 0.00 | 0.00 | 0.00 | 2.98 | 5.90 | 0.09 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.08 | 0.00 | 0.00 | 0.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.24 | 0.00 |
| **STRIPED SEAROBIN** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 0.20 | 0.00 | 0.00 | 0.00 | 0.18 | 1.40 | 0.18 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINTER FLOUNDER** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 |
| **Total** | 314.3 | 6.9 | 151.4 | 100.5 | 344.5 | 629.9 | 565.8 | 392.5 | 586.5 |

Table 4-22

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 6)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 51.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 25.90 | 438.93 |
| **ATLANTIC HERRING** | 0.25 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.40 | 0.11 |
| **ATLANTIC MENHADEN** | 0.05 | 0.10 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.11 |
| **ATLANTIC NEEDLEFISH** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.24 | 0.00 | 0.00 | 0.00 | 0.34 | 0.50 | 0.00 | 0.60 | 0.75 |
| **BAY ANCHOVY** | 76.93 | 9.85 | 95.35 | 30.05 | 128.43 | 319.13 | 55.53 | 40.34 | 3.82 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.44 | 0.00 | 0.00 | 0.24 | 0.10 | 0.00 | 2.11 | 1.50 | 0.00 |
| **BLUEBACK HERRING** | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 |
| **BLUEFISH** | 0.03 | 0.00 | 0.00 | 0.12 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 0.45 |
| **NORTHERN PIPEFISH** | 0.07 | 0.00 | 0.00 | 0.24 | 0.12 | 0.00 | 0.27 | 0.00 | 0.00 |
| **NORTHERN SEAROBIN** | 0.01 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 1.04 | 4.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.49 | 0.00 | 0.00 | 0.00 | 2.13 | 2.29 | 0.00 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.11 | 0.00 | 0.00 | 0.95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.01 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 0.46 | 0.00 | 0.00 | 0.12 | 3.13 | 0.00 | 0.93 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.01 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 132.0 | 15.1 | 95.3 | 31.7 | 134.4 | 322.3 | 59.1 | 70.5 | 444.6 |

Table 4-23

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 7)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 1.12 | 0.96 | 0.00 |
| **AMERICAN EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 0.07 | 0.00 | 0.00 | 0.11 | 0.11 | 0.00 | 0.26 | 0.12 | 0.00 |
| **ATLANTIC CROAKER** | 32.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.38 | 100.08 | 155.97 |
| **ATLANTIC HERRING** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC MENHADEN** | 0.25 | 0.00 | 0.12 | 1.78 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.05 | 0.00 | 0.00 | 0.00 | 0.23 | 0.00 | 0.13 | 0.00 | 0.00 |
| **BAY ANCHOVY** | 85.77 | 9.88 | 101.02 | 10.13 | 100.85 | 139.00 | 33.65 | 289.59 | 2.06 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 | 0.35 | 0.00 |
| **BLUEBACK HERRING** | 0.18 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 0.57 |
| **BLUEFISH** | 0.03 | 0.00 | 0.00 | 0.10 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CONGER EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.31 | 1.77 | 0.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 1.80 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 |
| **NORTHERN SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.29 | 0.00 | 0.00 | 0.00 | 0.44 | 1.52 | 0.25 | 0.12 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.03 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 5.92 | 0.00 | 0.00 | 36.04 | 10.64 | 0.41 | 0.26 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.28 | 1.77 | 0.23 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 |
| **WINDOWPANE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 126.0 | 13.9 | 102.1 | 48.4 | 112.5 | 142.1 | 38.6 | 391.6 | 158.6 |

Table 4-24

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 8)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 3.35 | 0.00 |
| AMERICAN EEL | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.43 |
| AMERICAN SHAD | 1.02 | 0.00 | 0.00 | 2.65 | 0.40 | 0.00 | 0.00 | 5.13 | 0.00 |
| ATLANTIC CROAKER | 13.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.16 | 24.86 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.58 | 0.00 | 3.28 | 0.38 | 0.00 | 0.20 | 0.57 | 0.23 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.00 |
| BAY ANCHOVY | 72.96 | 0.00 | 22.35 | 0.00 | 67.24 | 65.47 | 370.21 | 56.75 | 1.67 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEBACK HERRING | 1.43 | 0.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.68 | 1.27 |
| BLUEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 |
| CONGER EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GIZZARD SHAD | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.00 |
| HOGCHOKER | 0.14 | 0.25 | 0.00 | 0.00 | 0.23 | 0.00 | 0.00 | 0.68 | 0.00 |
| LINED SEAHORSE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 0.00 |
| NORTHERN PIPEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BASS | 0.48 | 0.00 | 0.00 | 0.19 | 2.22 | 0.87 | 0.57 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEAKFISH | 0.51 | 0.00 | 0.00 | 2.08 | 1.97 | 0.00 | 0.00 | 0.00 | 0.00 |
| WHITE PERCH | 1.07 | 0.47 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 7.64 | 0.21 |
| WINDOWPANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 92.2 | 1.2 | 25.9 | 5.3 | 72.1 | 66.5 | 371.7 | 166.1 | 28.4 |

Table 4-25

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 9)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.33 | 0.00 | 0.00 | 0.00 | 0.84 | 0.75 | 0.90 | 0.13 | 0.00 |
| AMERICAN EEL | 0.02 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AMERICAN SHAD | 0.87 | 0.33 | 0.13 | 1.79 | 0.72 | 0.53 | 2.83 | 0.12 | 0.51 |
| ATLANTIC CROAKER | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.82 | 1.56 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.09 | 0.00 | 0.51 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BAY ANCHOVY | 42.91 | 0.00 | 1.03 | 0.00 | 230.94 | 101.77 | 5.73 | 3.44 | 0.40 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEBACK HERRING | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 0.84 | 0.00 |
| BLUEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.10 | 0.33 | 0.13 | 0.00 | 0.00 | 0.17 | 0.12 | 0.00 | 0.00 |
| CONGER EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.03 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 |
| GIZZARD SHAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HOGCHOKER | 0.15 | 0.86 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.23 | 0.00 |
| LINED SEAHORSE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.01 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| NORTHERN PIPEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BASS | 1.35 | 0.00 | 0.00 | 0.00 | 7.52 | 3.29 | 0.00 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEAKFISH | 0.14 | 0.00 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WHITE PERCH | 2.33 | 0.35 | 0.13 | 0.00 | 2.36 | 3.81 | 8.32 | 0.93 | 2.78 |
| WINDOWPANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 48.9 | 2.1 | 1.9 | 3.1 | 242.6 | 110.3 | 18.8 | 6.5 | 5.4 |

Table 4-26

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 10)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.20 | 0.00 | 0.00 | 0.00 | 0.75 | 0.45 | 0.00 | 0.28 | 0.13 |
| **AMERICAN EEL** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 13.80 | 0.11 | 0.00 | 5.55 | 41.90 | 57.80 | 5.04 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 |
| **ATLANTIC HERRING** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC MENHADEN** | 0.04 | 0.00 | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BAY ANCHOVY** | 0.59 | 0.00 | 0.00 | 0.00 | 3.71 | 0.69 | 0.35 | 0.00 | 0.00 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUEBACK HERRING** | 0.17 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 0.72 | 0.13 |
| **BLUEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.07 | 0.00 | 0.00 | 0.00 | 0.21 | 0.11 | 0.12 | 0.11 | 0.00 |
| **CONGER EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.02 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.11 | 0.00 | 0.00 | 0.43 | 0.13 | 0.36 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 0.20 | 0.00 | 0.00 | 1.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.77 | 0.22 | 0.12 | 0.00 | 2.65 | 2.23 | 0.70 | 0.00 | 0.27 |
| **WINDOWPANE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 16.0 | 0.4 | 0.6 | 7.6 | 49.3 | 62.0 | 6.6 | 1.1 | 0.7 |

Table 4-27

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 11)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.42 | 0.00 | 0.00 | 0.00 | 1.93 | 0.62 | 0.00 | 0.77 | 0.00 |
| AMERICAN EEL | 0.05 | 0.00 | 0.00 | 0.00 | 0.12 | 0.25 | 0.00 | 0.00 | 0.00 |
| AMERICAN SHAD | 8.92 | 0.00 | 0.00 | 1.53 | 50.72 | 17.57 | 1.44 | 0.13 | 0.00 |
| ATLANTIC CROAKER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.01 | 0.00 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BAY ANCHOVY | 2.47 | 0.00 | 0.12 | 0.00 | 0.00 | 19.61 | 0.00 | 0.00 | 0.00 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEBACK HERRING | 0.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.74 | 0.00 |
| BLUEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.65 | 0.00 | 0.00 | 0.00 | 3.85 | 0.62 | 0.59 | 0.13 | 0.00 |
| CONGER EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GIZZARD SHAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HOGCHOKER | 0.79 | 5.70 | 0.00 | 0.00 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 |
| LINED SEAHORSE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN PIPEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BASS | 0.27 | 0.00 | 0.00 | 0.00 | 1.93 | 0.25 | 0.00 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEAKFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WHITE PERCH | 0.77 | 0.00 | 0.00 | 0.00 | 3.52 | 1.62 | 0.49 | 0.54 | 0.00 |
| WINDOWPANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 15.1 | 5.7 | 0.2 | 1.5 | 62.7 | 40.5 | 2.5 | 7.3 | 0.0 |

Table 4-28

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 12)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 1.51 | 0.13 | 0.15 |
| AMERICAN EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AMERICAN SHAD | 0.47 | 0.00 | 0.11 | 0.98 | 1.59 | 0.00 | 0.94 | 0.13 | 0.00 |
| ATLANTIC CROAKER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BAY ANCHOVY | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.26 | 0.00 | 0.00 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEBACK HERRING | 0.51 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 3.08 | 0.90 | 0.00 |
| BLUEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.86 | 0.13 | 0.15 |
| CONGER EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GIZZARD SHAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HOGCHOKER | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| LINED SEAHORSE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN PIPEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BASS | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEAKFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WHITE PERCH | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.55 | 0.13 | 0.00 |
| WINDOWPANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 2.0 | 0.0 | 0.1 | 1.0 | 1.7 | 0.3 | 11.5 | 1.4 | 0.3 |

Table 4-29

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 13)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| ALEWIFE | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.88 | 0.23 | 0.00 | 0.00 |
| AMERICAN EEL | 0.01 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| AMERICAN SHAD | 4.66 | 0.00 | 0.00 | 2.68 | 33.95 | 0.64 | 0.00 | 0.00 | 0.00 |
| ATLANTIC CROAKER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC HERRING | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC MENHADEN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC NEEDLEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ATLANTIC SILVERSIDE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BAY ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLACK SEA BASS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUE CRAB (BLUECLAW) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BLUEBACK HERRING | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.00 | 0.27 |
| BLUEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUTTERFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHAIN PICKEREL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CHANNEL CATFISH | 0.35 | 0.00 | 0.00 | 0.00 | 2.42 | 0.00 | 0.12 | 0.22 | 0.00 |
| CONGER EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| EASTERN SILVERY MINNOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GIZZARD SHAD | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| HOGCHOKER | 0.01 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| LINED SEAHORSE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *MORONE SPP.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NAKED GOBY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN PIPEFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NORTHERN STARGAZER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OYSTER TOADFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SCUP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMALLMOUTH FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SMOOTH DOGFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SPOTTED HAKE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED ANCHOVY | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BASS | 0.03 | 0.00 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED BURRFISH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED CUSK-EEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STRIPED SEAROBIN | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUMMER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEAKFISH | 0.02 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WHITE PERCH | 0.11 | 0.00 | 0.00 | 0.00 | 0.66 | 0.00 | 0.11 | 0.00 | 0.13 |
| WINDOWPANE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WINTER FLOUNDER | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 5.4 | 0.0 | 0.0 | 2.8 | 37.5 | 1.5 | 1.2 | 0.2 | 0.4 |

Table 4-30

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by month (collected in Zone 14)
during the Pelagic Trawl Effort, April-November 2003

| Species (Taxon) | All Months | April | May | June | July | August | September | October | November |
|---|---|---|---|---|---|---|---|---|---|
| **ALEWIFE** | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 |
| **AMERICAN EEL** | 0.03 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **AMERICAN SHAD** | 1.27 | 0.00 | 0.00 | 0.12 | 10.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC CROAKER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC HERRING** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC MENHADEN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC NEEDLEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **ATLANTIC SILVERSIDE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BAY ANCHOVY** | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 |
| **BLACK SEA BASS** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUE CRAB (BLUECLAW)** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BLUEBACK HERRING** | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.00 |
| **BLUEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **BUTTERFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHAIN PICKEREL** | 0.02 | 0.00 | 0.00 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CHANNEL CATFISH** | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.14 | 0.00 | 0.00 |
| **CONGER EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **EASTERN SILVERY MINNOW** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **GIZZARD SHAD** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **HOGCHOKER** | 0.01 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **LINED SEAHORSE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***MORONE SPP.*** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NAKED GOBY** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN PIPEFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **NORTHERN STARGAZER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **OYSTER TOADFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SCUP** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMALLMOUTH FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SMOOTH DOGFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOT** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SPOTTED HAKE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED ANCHOVY** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BASS** | 0.14 | 0.00 | 0.00 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED BURRFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED CUSK-EEL** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **STRIPED SEAROBIN** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **SUMMER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WEAKFISH** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WHITE PERCH** | 0.10 | 0.00 | 0.00 | 0.12 | 0.31 | 0.15 | 0.00 | 0.25 | 0.00 |
| **WINDOWPANE** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **WINTER FLOUNDER** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 1.7 | 0.0 | 0.0 | 0.7 | 11.5 | 0.3 | 0.4 | 0.6 | 0.0 |

Table 4-31
PSEG Estuary Enhancement Program
Total abundance of ichthyoplankton and macrozooplankton target species collected by zone,
April-July 2003

| Species (Taxon) | All | Zone | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zones | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Alewife | 18,803 | 0 | 0 | 1 | 0 | 0 | 1 | 4 | 339 | 1,205 | 2,368 | 4,191 | 4,624 | 4,755 | 1,315 |
| *Alosa* spp. | 13,536 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 566 | 4,157 | 2,138 | 3,284 | 3,316 |
| American Shad | 5,412 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 29 | 58 | 730 | 1,888 | 2,357 | 349 |
| Atlantic Croaker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Atlantic Menhaden | 20,387 | 15,672 | 2,532 | 1,108 | 1,028 | 17 | 10 | 1 | 0 | 0 | 1 | 18 | 0 | 0 | 0 |
| Atlantic Silverside | 182 | 9 | 20 | 10 | 33 | 72 | 31 | 2 | 2 | 2 | 0 | 1 | 0 | 0 | 0 |
| Bay Anchovy | 1,633,701 | 793,044 | 457,387 | 184,678 | 162,628 | 13,390 | 4,519 | 877 | 16,820 | 334 | 13 | 5 | 1 | 2 | 3 |
| Blueback Herring | 143 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 52 | 4 | 56 | 20 | 2 | 7 |
| Bluefish | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clupeidae | 15,295 | 19 | 14 | 19 | 0 | 2 | 4 | 24 | 1,314 | 1,737 | 2,399 | 3,073 | 2,837 | 2,409 | 1,444 |
| *Morone* spp. | 139,869 | 0 | 0 | 0 | 0 | 2 | 33 | 438 | 135,386 | 2,629 | 872 | 377 | 102 | 4 | 26 |
| Spot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Striped Bass | 238,493 | 0 | 0 | 0 | 0 | 30 | 98 | 2,640 | 229,043 | 3,393 | 2,299 | 863 | 106 | 15 | 6 |
| Weakfish | 7,886 | 4,346 | 1,220 | 894 | 409 | 729 | 154 | 101 | 32 | 0 | 1 | 0 | 0 | 0 | 0 |
| White Perch | 78,028 | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 58,624 | 3,425 | 4,586 | 5,482 | 3,651 | 1,025 | 1,142 |
| Total Ichthyoplankton | 2,171,736 | 813,090 | 461,173 | 186,711 | 164,099 | 14,242 | 4,851 | 4,181 | 441,560 | 12,881 | 13,167 | 18,953 | 15,367 | 13,853 | 7,608 |
| *Gammarus* spp. | 4,579,228 | 7,758 | 42,441 | 117,231 | 8,055 | 14,154 | 152,085 | 718,923 | 1,149,274 | 1,124,586 | 455,517 | 331,142 | 345,261 | 72,103 | 40,698 |
| *Neomysis americana* | 16,894,133 | 2,911,771 | 3,302,514 | 2,976,626 | 2,063,021 | 2,208,869 | 3,009,064 | 356,871 | 59,900 | 2,076 | 24 | 32 | 63 | 3,199 | 103 |

Table 4-32 (page 1 of 2)

PSEG Estuary Enhancement Program

Mean density (#/1000 $m^3$) by sampling event (all zones combined) for each life stage of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 116.17 | 0.00 | 0.24 | 198.44 | 491.29 | 159.87 | 36.50 | 34.43 | 3.14 |
| juvenile | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.66 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 12.01 | 0.63 | 11.33 | 59.23 | 16.98 | 4.26 | 2.19 | 1.42 | 0.00 |
| yolk sac larvae | 70.04 | 0.05 | 1.04 | 349.73 | 142.01 | 63.92 | 2.74 | 0.09 | 0.00 |
| post-yolk sac larvae | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.16 |
| juvenile | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.93 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 4.98 | 0.00 | 1.55 | 26.77 | 4.24 | 3.38 | 3.86 | 0.00 | 0.00 |
| yolk sac larvae | 7.11 | 0.00 | 0.00 | 33.02 | 14.21 | 7.95 | 1.50 | 0.10 | 0.00 |
| post-yolk sac larvae | 20.15 | 0.00 | 0.00 | 40.96 | 60.53 | 27.91 | 15.17 | 8.70 | 7.67 |
| juvenile | 0.48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 1.00 | 2.75 |
| adult | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 112.77 | 0.00 | 0.00 | 786.56 | 7.84 | 100.95 | 5.58 | 0.00 | 0.00 |
| yolk sac larvae | 0.39 | 0.00 | 0.00 | 1.82 | 1.28 | 0.00 | 0.05 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.79 | 0.14 | 0.11 | 1.34 | 3.92 | 0.27 | 0.52 | 0.00 | 0.00 |
| juvenile | 0.03 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.01 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.01 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.79 | 0.04 | 0.00 | 0.25 | 1.34 | 1.06 | 0.65 | 1.93 | 1.00 |
| juvenile | 0.06 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 | 0.00 |
| adult | 0.14 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.09 | 0.72 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 8,526.68 | 0.00 | 0.00 | 716.95 | 6,801.06 | 21,260.63 | 19,471.02 | 13,781.41 | 6,087.61 |
| yolk sac larvae | 0.10 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 |
| post-yolk sac larvae | 684.18 | 0.00 | 0.00 | 0.05 | 0.00 | 0.18 | 56.09 | 2,685.08 | 2,724.48 |
| juvenile | 12.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.04 | 29.59 | 68.01 |
| adult | 4.07 | 0.23 | 0.09 | 6.36 | 17.56 | 2.83 | 1.12 | 3.59 | 0.72 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| juvenile | 0.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.09 | 6.20 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-32 (page 2 of 2)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (all zones combined) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.02 | 0.00 | 0.05 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.01 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 12.35 | 0.05 | 0.05 | 43.70 | 30.51 | 7.38 | 6.76 | 6.19 | 3.60 |
| juvenile | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| adult | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.05 | 0.00 | 0.00 | 0.44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 0.05 | 7.38 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 22.55 | 0.00 | 0.84 | 43.90 | 125.45 | 6.74 | 3.20 | 0.00 | 0.00 |
| yolk sac larvae | 17.72 | 0.00 | 0.05 | 106.61 | 17.00 | 10.85 | 6.69 | 0.33 | 0.00 |
| post-yolk sac larvae | 1,496.01 | 0.00 | 0.00 | 0.24 | 336.29 | 70.86 | 18.75 | 11,524.30 | 1.05 |
| juvenile | 70.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 554.92 | 5.28 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 30.82 | 0.00 | 42.82 | 0.05 | 36.38 | 0.16 | 141.69 | 22.64 | 2.96 |
| yolk sac larvae | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 | 0.00 |
| post-yolk sac larvae | 12.07 | 0.00 | 0.00 | 0.05 | 0.04 | 0.10 | 1.73 | 60.63 | 33.87 |
| juvenile | 0.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 2.31 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 14.51 | 0.14 | 28.16 | 44.34 | 29.52 | 7.96 | 6.13 | 0.00 | 0.00 |
| yolk sac larvae | 18.69 | 0.00 | 0.05 | 41.86 | 34.83 | 37.57 | 19.05 | 15.96 | 0.00 |
| post-yolk sac larvae | 328.92 | 0.00 | 0.00 | 80.22 | 154.23 | 165.71 | 232.51 | 1,930.34 | 64.73 |
| juvenile | 152.92 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 1,217.91 | 5.33 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 11,753 | 2 | 86 | 2,583 | 8,327 | 21,942 | 20,035 | 31,890 | 9,026 |
| ***Gammarus* spp.** | 27,845 | 968 | 437 | 2,284 | 32,997 | 45,595 | 47,937 | 20,631 | 71,384 |
| ***Neomysis americana*** | 96,191 | 32,986 | 76,178 | 207,851 | 69,250 | 39,422 | 118,426 | 126,036 | 98,911 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-33 (page 1 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 1) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 553.66 | 0.00 | 0.00 | 3,780.08 | 0.00 | 573.80 | 35.88 | 0.00 | 0.00 |
| yolk sac larvae | 1.19 | 0.00 | 0.00 | 5.26 | 4.51 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.00 | 0.00 | 0.00 | 3.21 | 2.35 | 0.00 | 2.55 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.17 | 0.00 | 0.00 | 0.00 | 0.29 | 0.00 | 1.04 | 0.00 | 0.00 |
| juvenile | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 27,948.25 | 0.00 | 0.00 | 1,132.80 | 30,692.63 | 72,242.18 | 26,748.43 | 63,878.49 | 29,087.50 |
| yolk sac larvae | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.06 |
| post-yolk sac larvae | 695.64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 26.72 | 2,908.75 | 2,579.65 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.68 | 0.32 | 0.00 | 0.00 | 0.30 | 1.98 | 1.37 | 1.47 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-33 (page 2 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 1) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 142.40 | 0.00 | 3.77 | 0.00 | 251.84 | 0.00 | 823.88 | 53.03 | 14.53 |
| yolk sac larvae | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.00 |
| post-yolk sac larvae | 9.09 | 0.00 | 0.00 | 0.00 | 0.30 | 0.00 | 0.99 | 52.78 | 18.04 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 29,353 | 0 | 4 | 4,921 | 30,952 | 72,818 | 27,641 | 66,895 | 31,705 |
| ***Gammarus* spp.** | 279 | 87 | 64 | 322 | 376 | 175 | 265 | 732 | 220 |
| ***Neomysis americana*** | 98,573 | 3,624 | 1,324 | 20,092 | 124,409 | 58,956 | 323,311 | 118,727 | 123,929 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 2) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 149.45 | 0.00 | 0.00 | 1,098.37 | 0.37 | 113.40 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.89 | 0.00 | 0.00 | 6.25 | 0.86 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.36 | 0.97 | 0.00 | 1.04 | 6.94 | 1.29 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.03 | 0.44 | 0.00 | 0.00 | 0.38 | 6.66 | 0.86 | 0.00 | 0.00 |
| juvenile | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 23,517.46 | 0.00 | 0.00 | 0.00 | 9,375.70 | 35,432.24 | 124,206.37 | 11,344.44 | 9,352.28 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1,363.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 134.46 | 941.48 | 9,979.11 |
| juvenile | 0.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.42 | 0.00 | 3.05 |
| adult | 5.72 | 0.51 | 0.00 | 2.20 | 22.56 | 8.87 | 0.92 | 8.45 | 0.38 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-34 (page 4 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 2) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 50.06 | 0.00 | 406.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 12.43 | 0.00 | 0.00 | 0.52 | 0.00 | 0.00 | 0.94 | 3.63 | 95.76 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 25,102 | 2 | 406 | 1,108 | 9,407 | 35,563 | 124,345 | 12,298 | 19,431 |
| ***Gammarus* spp.** | 2,237 | 186 | 187 | 86 | 13,991 | 225 | 397 | 699 | 821 |
| ***Neomysis americana*** | 176,371 | 80,958 | 7,175 | 47,709 | 218,177 | 127,289 | 242,297 | 386,249 | 296,468 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 3) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.05 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.05 | 0.00 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 59.61 | 0.00 | 0.00 | 467.97 | 5.79 | 3.13 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 1.02 | 0.00 | 0.00 | 3.38 | 4.34 | 0.00 | 0.47 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.40 | 0.00 | 0.45 | 5.48 | 5.30 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.56 | 0.00 | 0.00 | 2.29 | 2.15 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 8,613.25 | 0.00 | 0.00 | 4,834.16 | 4,425.96 | 36,525.37 | 18,734.65 | 1,672.38 | 2,713.47 |
| yolk sac larvae | 0.05 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1,219.15 | 0.00 | 0.00 | 0.48 | 0.00 | 0.43 | 3.31 | 4,635.29 | 5,113.70 |
| juvenile | 41.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 266.28 | 63.58 |
| adult | 3.60 | 0.00 | 0.00 | 23.40 | 4.19 | 0.81 | 0.43 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-35 (page 6 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 3) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.16 | 0.43 | 0.00 | 0.87 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 16.65 | 0.00 | 5.13 | 0.00 | 0.00 | 0.00 | 121.79 | 0.00 | 6.30 |
| yolk sac larvae | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.13 | 0.00 |
| post-yolk sac larvae | 28.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 191.13 | 40.53 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 9,986 | 0 | 6 | 5,339 | 4,448 | 36,530 | 18,861 | 6,768 | 7,938 |
| ***Gammarus* spp.** | 5,903 | 268 | 393 | 121 | 404 | 65 | 23,395 | 2,851 | 17,981 |
| ***Neomysis americana*** | 154,467 | 78,277 | 111,753 | 101,046 | 106,151 | 26,991 | 173,338 | 353,283 | 284,894 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-36 (page 7 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 4) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| **Species (Taxon) by** | **All** | **April** | | **May** | | **June** | | **July** | |
|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Events*** | **Event 1** | **Event 2** | **Event 3** | **Event 4** | **Event 5** | **Event 6** | **Event 7** | **Event 8** |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 48.10 | 0.00 | 0.00 | 320.42 | 64.38 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 2.09 | 0.38 | 0.00 | 0.00 | 15.11 | 0.89 | 0.34 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.91 | 0.00 | 0.00 | 0.00 | 2.06 | 1.21 | 0.69 | 3.33 | 0.00 |
| juvenile | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 |
| adult | 0.55 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.43 | 3.25 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 7,589.86 | 0.00 | 0.00 | 32.45 | 7,486.21 | 21,788.54 | 7,199.77 | 21,870.90 | 2,341.02 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 952.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 157.84 | 3,687.95 | 3,771.33 |
| juvenile | 27.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 220.83 |
| adult | 7.08 | 0.00 | 0.44 | 6.95 | 35.29 | 2.59 | 1.81 | 5.63 | 3.90 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 4) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 16.90 | 0.00 | 5.21 | 0.42 | 0.00 | 0.00 | 0.00 | 129.54 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 3.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.17 | 18.63 | 7.90 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 8,649 | 1 | 6 | 360 | 7,603 | 21,794 | 7,367 | 25,716 | 6,348 |
| ***Gammarus* spp.** | 406 | 125 | 117 | 155 | 765 | 148 | 793 | 1,018 | 129 |
| ***Neomysis americana*** | 97,138 | 23,908 | 15,443 | 251,430 | 79,626 | 63,736 | 91,817 | 194,767 | 56,381 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-37 (page 9 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 5) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.08 | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.63 | 0.00 | 0.00 | 1.03 | 2.34 | 0.53 | 1.16 | 0.00 | 0.00 |
| juvenile | 0.40 | 3.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.07 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 3.79 | 0.00 | 0.00 | 0.00 | 8.26 | 0.66 | 3.60 | 11.10 | 6.69 |
| juvenile | 0.35 | 0.54 | 0.00 | 0.00 | 0.00 | 0.00 | 2.26 | 0.00 | 0.00 |
| adult | 0.92 | 1.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 | 0.56 | 4.66 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 203.95 | 0.00 | 0.00 | 0.00 | 26.41 | 2.00 | 100.11 | 1,212.24 | 290.84 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 734.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 264.56 | 3,561.41 | 2,049.45 |
| juvenile | 44.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 356.46 |
| adult | 23.46 | 1.62 | 0.52 | 22.42 | 120.39 | 11.45 | 7.28 | 22.76 | 1.22 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-37 (page 10 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 5) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.00 | 0.00 | 0.00 |
| juvenile | 1.53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.27 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 2.10 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 55.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.66 | 11.71 | 334.40 | 95.56 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,070 | 8 | 1 | 24 | 157 | 17 | 397 | 5,155 | 2,805 |
| ***Gammarus* spp.** | 1,028 | 47 | 60 | 14 | 3,364 | 324 | 3,220 | 536 | 659 |
| ***Neomysis americana*** | 168,755 | 162,507 | 700,082 | 234,705 | 44,737 | 56,186 | 110,717 | 25,946 | 15,164 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-38 (page 11 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 6) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 1.23 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.24 | 0.00 | 0.00 | 1.93 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.14 | 0.00 | 0.00 | 0.00 | 1.16 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.03 | 0.00 | 1.23 | 0.00 | 7.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 3.77 | 0.00 | 0.00 | 0.00 | 3.15 | 3.69 | 0.00 | 14.67 | 8.63 |
| juvenile | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.11 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 123.18 | 0.00 | 0.00 | 0.00 | 6.99 | 1.23 | 0.00 | 0.00 | 977.20 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 460.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 941.39 | 2,745.26 |
| juvenile | 0.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.45 |
| adult | 6.98 | 0.00 | 0.00 | 20.91 | 22.60 | 7.30 | 0.00 | 2.79 | 2.28 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.94 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-38 (page 12 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 6) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.58 | 0.00 | 0.00 | 1.14 | 3.47 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 1.24 | 0.00 | 0.00 | 2.94 | 7.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 9.82 | 0.00 | 0.00 | 0.00 | 26.80 | 3.67 | 32.56 | 15.57 | 0.00 |
| juvenile | 1.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.11 | 7.33 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 17.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 61.74 | 81.07 |
| juvenile | 2.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.77 | 15.91 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 630 | 0 | 1 | 27 | 78 | 17 | 36 | 1,047 | 3,833 |
| ***Gammarus* spp.** | 19,495 | 14,681 | 1,474 | 1,025 | 1,650 | 3,065 | 122,670 | 4,967 | 6,424 |
| ***Neomysis americana*** | 436,387 | 7,472 | 130,343 | 3,053,597 | 56,741 | 41,804 | 77,677 | 86,081 | 37,383 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-39 (page 13 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 7) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.58 | 0.00 | 0.00 | 0.00 | 4.62 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.13 | 0.00 | 0.00 | 0.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.02 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.07 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 113.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 221.16 | 683.86 |
| juvenile | 0.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 | 0.00 | 4.23 |
| adult | 1.23 | 0.00 | 0.00 | 2.16 | 5.62 | 0.98 | 0.00 | 0.00 | 1.07 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-39 (page 14 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 7) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 | 2.21 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.48 | 0.00 | 0.00 | 3.82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 11.30 | 0.00 | 0.00 | 0.00 | 0.00 | 17.67 | 0.00 | 72.74 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 65.03 | 0.00 | 0.00 | 517.90 | 0.00 | 2.33 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 156.75 | 0.00 | 0.00 | 1,216.26 | 36.85 | 0.00 | 0.93 | 0.00 | 0.00 |
| post-yolk sac larvae | 110.79 | 0.00 | 0.00 | 0.00 | 404.35 | 163.13 | 69.19 | 247.33 | 2.31 |
| juvenile | 1.95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.07 | 7.56 | 6.94 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 11.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 94.15 |
| juvenile | 2.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.65 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 2.77 | 0.00 | 0.00 | 22.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 9.24 | 0.00 | 0.00 | 17.57 | 2.38 | 44.71 | 4.01 | 5.28 | 0.00 |
| juvenile | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.96 | 1.09 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 489 | 0 | 0 | 1,780 | 455 | 233 | 80 | 555 | 810 |
| ***Gammarus* spp.** | 92,262 | 4,943 | 1,400 | 33,023 | 15,424 | 123,673 | 441,296 | 70,765 | 47,570 |
| ***Neomysis americana*** | 46,393 | 23 | 622 | 152,879 | 8,860 | 27,273 | 241 | 49,527 | 131,715 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-40 (page 15 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 8) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 99.45 | 0.00 | 0.00 | 67.55 | 561.83 | 85.58 | 37.57 | 43.10 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.18 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.86 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 5,050.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 39,824.23 | 579.47 |
| juvenile | 29.93 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 239.47 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-40 (page 16 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 8) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 16.92 | 0.00 | 0.00 | 0.00 | 57.93 | 9.51 | 37.57 | 25.86 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.62 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 109.12 | 0.00 | 0.00 | 858.56 | 9.65 | 4.75 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 286.34 | 0.00 | 0.00 | 1,949.17 | 196.84 | 9.51 | 135.24 | 0.00 | 0.00 |
| post-yolk sac larvae | 66,035.43 | 0.00 | 0.00 | 0.00 | 8,522.94 | 1,779.38 | 393.41 | 517,579.36 | 8.35 |
| juvenile | 3,117.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24,892.30 | 43.89 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 5.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 40.10 |
| juvenile | 4.58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 36.63 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 1.65 | 0.00 | 8.54 | 4.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 11.94 | 0.00 | 0.00 | 95.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 10,859.30 | 0.00 | 0.00 | 180.86 | 1,847.08 | 2,813.33 | 2,137.51 | 79,874.76 | 20.88 |
| juvenile | 6,845.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 54,758.32 | 2.44 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 92,474 | 0 | 9 | 3,156 | 11,196 | 4,702 | 2,741 | 717,011 | 975 |
| ***Gammarus* spp.** | 340,119 | 379 | 8,804 | 21,183 | 1,032,951 | 666,243 | 534,997 | 329,003 | 127,394 |
| ***Neomysis americana*** | 18,206 | 0 | 152 | 660 | 0 | 14 | 18 | 131 | 144,671 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-41 (page 17 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 9) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 138.98 | 0.00 | 1.22 | 35.22 | 141.46 | 512.20 | 0.00 | 394.19 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 3.82 | 0.00 | 30.41 | 2.48 | 0.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 3.10 | 0.00 | 8.39 | 16.61 | 0.00 | 0.87 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 1.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.22 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 2.20 | 0.00 | 0.00 | 0.98 | 0.00 | 9.54 | 1.62 | 5.05 | 0.00 |
| juvenile | 0.97 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 | 2.58 | 4.14 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 | 0.00 | 0.83 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 2.37 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 28.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 222.22 |
| juvenile | 6.37 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 49.71 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 |
| juvenile | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 0.00 | 38.13 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-41 (page 18 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 9) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.12 | 0.00 | 1.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 19.09 | 0.00 | 0.00 | 5.47 | 62.65 | 30.38 | 0.00 | 50.39 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 9.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 71.28 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 203.68 | 0.00 | 15.49 | 17.64 | 1,546.21 | 10.75 | 1.73 | 0.00 | 0.00 |
| yolk sac larvae | 35.81 | 0.00 | 0.00 | 39.40 | 47.52 | 188.37 | 3.17 | 0.83 | 0.00 |
| post-yolk sac larvae | 156.43 | 0.00 | 0.00 | 0.00 | 629.54 | 400.41 | 1.59 | 181.05 | 7.54 |
| juvenile | 8.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 | 2.51 | 65.96 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 66.07 | 0.00 | 489.00 | 121.63 | 0.99 | 1.50 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 12.19 | 0.00 | 1.22 | 49.96 | 1.93 | 42.23 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 305.69 | 0.00 | 0.00 | 153.79 | 502.50 | 526.59 | 2.47 | 1,141.23 | 57.79 |
| juvenile | 12.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.09 | 78.35 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,021 | 0 | 547 | 443 | 2,933 | 1,728 | 16 | 1,868 | 541 |
| ***Gammarus* spp.** | 125,130 | 51 | 170 | 1,296 | 84,806 | 323,908 | 31,622 | 124,799 | 409,394 |
| ***Neomysis americana*** | 211 | 0 | 8 | 12 | 0 | 1 | 1,621 | 1 | 6 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-42 (page 19 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 10) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 266.61 | 0.00 | 0.85 | 226.13 | 1,172.29 | 279.81 | 391.76 | 60.43 | 1.63 |
| juvenile | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.83 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 6.66 | 8.13 | 9.48 | 19.28 | 12.32 | 4.04 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 56.03 | 0.00 | 3.51 | 432.14 | 9.12 | 1.78 | 0.00 | 1.68 | 0.00 |
| post-yolk sac larvae | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.61 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.11 | 0.00 | 0.00 | 0.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.86 | 0.00 | 0.00 | 1.84 | 0.00 | 5.04 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 5.24 | 0.00 | 0.00 | 5.55 | 6.77 | 21.18 | 3.48 | 4.96 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.11 | 0.00 | 0.00 | 0.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.67 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.84 | 2.41 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-42 (page 20 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 10) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 33.57 | 0.00 | 0.00 | 60.38 | 100.03 | 17.44 | 57.21 | 21.65 | 6.50 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.98 | 0.00 | 0.00 | 7.86 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 61.80 | 0.00 | 0.00 | 7.36 | 472.22 | 14.81 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 30.51 | 0.00 | 0.00 | 67.15 | 112.17 | 3.16 | 59.18 | 2.45 | 0.00 |
| post-yolk sac larvae | 169.76 | 0.00 | 0.00 | 0.00 | 1,253.39 | 9.49 | 87.03 | 8.20 | 0.00 |
| juvenile | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 39.25 | 2.44 | 78.70 | 182.98 | 46.67 | 3.23 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 27.02 | 0.00 | 0.00 | 104.84 | 48.50 | 27.49 | 15.66 | 19.62 | 0.00 |
| post-yolk sac larvae | 435.81 | 0.00 | 0.00 | 375.76 | 497.04 | 174.95 | 2,245.69 | 166.14 | 26.89 |
| juvenile | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.71 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,137 | 11 | 93 | 1,493 | 3,731 | 563 | 2,860 | 287 | 52 |
| ***Gammarus* spp.** | 47,626 | 17 | 49 | 1,437 | 29,494 | 55,213 | 54,786 | 16,458 | 223,553 |
| ***Neomysis americana*** | 3 | 0 | 1 | 6 | 4 | 6 | 1 | 0 | 3 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-43 (page 21 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 11) for each life stage of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 489.53 | 0.00 | 2.53 | 1,190.32 | 652.02 | 1,773.00 | 195.43 | 98.70 | 4.24 |
| juvenile | 0.84 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.72 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 38.23 | 0.00 | 67.47 | 220.53 | 14.46 | 3.41 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 451.06 | 0.86 | 5.69 | 3,564.95 | 17.62 | 19.38 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 2.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16.85 |
| juvenile | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 0.46 | 0.00 | 0.86 | 0.94 | 1.89 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 24.79 | 0.00 | 0.00 | 85.65 | 10.35 | 102.29 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 53.40 | 0.00 | 0.00 | 47.96 | 12.62 | 302.40 | 34.09 | 29.21 | 0.90 |
| juvenile | 1.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.82 | 6.72 | 5.83 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 2.19 | 0.00 | 0.00 | 17.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.12 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 1.87 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.43 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 5.86 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 | 46.08 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-43 (page 22 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 11) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 93.78 | 0.00 | 0.00 | 490.12 | 78.59 | 67.45 | 19.02 | 16.59 | 14.92 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 37.01 | 0.00 | 0.00 | 5.72 | 212.39 | 75.17 | 2.76 | 0.00 | 0.00 |
| yolk sac larvae | 11.85 | 0.00 | 0.00 | 57.36 | 32.43 | 0.00 | 3.29 | 1.68 | 0.00 |
| post-yolk sac larvae | 54.83 | 0.00 | 0.00 | 4.23 | 410.40 | 17.30 | 0.00 | 5.15 | 1.57 |
| juvenile | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.59 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 35.91 | 0.00 | 14.15 | 199.47 | 63.83 | 6.96 | 2.87 | 0.00 | 0.00 |
| yolk sac larvae | 107.42 | 0.00 | 0.00 | 212.88 | 27.22 | 549.69 | 53.67 | 15.94 | 0.00 |
| post-yolk sac larvae | 481.82 | 0.00 | 0.00 | 737.81 | 415.33 | 874.48 | 1,073.22 | 686.82 | 66.89 |
| juvenile | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.58 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,894 | 1 | 91 | 6,835 | 1,950 | 3,793 | 1,385 | 868 | 166 |
| ***Gammarus* spp.** | 36,059 | 17 | 57 | 284 | 7,707 | 51,249 | 45,484 | 6,034 | 177,643 |
| ***Neomysis americana*** | 4 | 0 | 0 | 11 | 3 | 4 | 1 | 0 | 10 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-44 (page 23 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 12) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 551.20 | 0.00 | 0.00 | 1,175.42 | 2,924.89 | 269.47 | 13.55 | 20.81 | 5.43 |
| juvenile | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.72 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 132.57 | 0.00 | 72.85 | 714.61 | 269.34 | 3.75 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 105.92 | 0.00 | 0.80 | 422.71 | 102.72 | 312.89 | 8.25 | 0.00 | 0.00 |
| post-yolk sac larvae | 2.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 20.48 |
| juvenile | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.63 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 57.00 | 0.00 | 2.60 | 393.43 | 32.18 | 23.65 | 4.13 | 0.00 | 0.00 |
| yolk sac larvae | 35.36 | 0.00 | 0.00 | 148.89 | 102.27 | 29.06 | 2.64 | 0.00 | 0.00 |
| post-yolk sac larvae | 121.75 | 0.00 | 0.00 | 326.52 | 287.40 | 163.26 | 88.77 | 36.49 | 71.52 |
| juvenile | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.42 | 10.77 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.90 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 |
| juvenile | 2.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.02 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-44 (page 24 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 12) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 42.58 | 0.00 | 0.80 | 127.93 | 179.19 | 11.71 | 17.05 | 0.00 | 9.06 |
| juvenile | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.83 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 9.88 | 0.00 | 2.60 | 0.81 | 20.66 | 8.61 | 46.32 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 1.79 | 0.00 | 0.00 | 0.00 | 5.86 | 3.12 | 0.83 | 0.92 | 3.58 |
| juvenile | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.88 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 37.91 | 0.00 | 13.86 | 102.56 | 166.41 | 16.85 | 3.58 | 0.00 | 0.00 |
| yolk sac larvae | 70.26 | 0.00 | 0.00 | 170.82 | 284.08 | 46.69 | 47.72 | 12.81 | 0.00 |
| post-yolk sac larvae | 303.47 | 0.00 | 0.00 | 89.32 | 570.07 | 243.91 | 3.65 | 756.08 | 764.76 |
| juvenile | 1.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.85 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,478 | 0 | 94 | 3,673 | 4,945 | 1,133 | 236 | 834 | 917 |
| ***Gammarus* spp.** | 38,349 | 11 | 27 | 197 | 1,958 | 18,549 | 11,924 | 9,393 | 264,730 |
| ***Neomysis americana*** | 7 | 0 | 1 | 50 | 1 | 3 | 0 | 1 | 0 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-45 (page 25 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 13) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 473.65 | 0.00 | 0.00 | 899.97 | 2,795.45 | 6.06 | 35.08 | 26.57 | 26.08 |
| juvenile | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.67 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 11.84 | 3.28 | 0.00 | 8.49 | 8.57 | 38.49 | 35.91 | 0.00 | 0.00 |
| yolk sac larvae | 316.59 | 0.00 | 1.85 | 1,490.09 | 828.03 | 178.40 | 34.36 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 30.01 | 0.00 | 24.17 | 83.14 | 39.78 | 29.65 | 63.34 | 0.00 | 0.00 |
| yolk sac larvae | 65.40 | 0.00 | 0.00 | 355.28 | 136.02 | 6.66 | 24.41 | 0.81 | 0.00 |
| post-yolk sac larvae | 144.85 | 0.00 | 0.00 | 356.29 | 550.95 | 5.03 | 144.27 | 71.59 | 30.71 |
| juvenile | 1.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.38 | 8.99 |
| adult | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.82 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.72 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 4-45 (page 26 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 m$^3$) by sampling event (collected in Zone 13) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.21 | 0.00 | 0.00 | 1.71 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 17.91 | 0.00 | 0.00 | 4.36 | 88.18 | 2.05 | 10.56 | 7.47 | 32.10 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.16 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 1.39 | 0.00 | 0.00 | 0.00 | 0.00 | 8.22 | 2.89 | 0.00 | 0.00 |
| yolk sac larvae | 0.11 | 0.00 | 0.87 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.00 | 0.97 |
| juvenile | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 19.70 | 0.00 | 0.00 | 26.84 | 48.13 | 77.04 | 5.57 | 0.00 | 0.00 |
| yolk sac larvae | 52.69 | 0.00 | 0.00 | 149.69 | 133.34 | 3.00 | 85.97 | 49.53 | 0.00 |
| post-yolk sac larvae | 37.71 | 0.00 | 0.00 | 0.00 | 20.40 | 0.00 | 1.97 | 40.75 | 238.59 |
| juvenile | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.53 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 1,176 | 3 | 27 | 3,376 | 4,649 | 355 | 445 | 209 | 343 |
| ***Gammarus* spp.** | 8,056 | 18 | 23 | 273 | 2,691 | 1,055 | 3,548 | 6,166 | 50,676 |
| ***Neomysis americana*** | 357 | 3 | 0 | 33 | 0 | 9 | 10 | 1 | 2,804 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.

Table 4-46 (page 27 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 14) for each life stage of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by | All | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Events* | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Alewife** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 130.83 | 0.00 | 0.00 | 16.93 | 855.79 | 1.88 | 6.09 | 1.89 | 19.07 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Alosa* spp.** | | | | | | | | | |
| egg | 22.79 | 0.00 | 27.63 | 100.71 | 0.98 | 24.04 | 3.48 | 25.48 | 0.00 |
| yolk sac larvae | 326.41 | 0.00 | 0.00 | 368.68 | 1,598.65 | 637.25 | 6.71 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **American shad** | | | | | | | | | |
| egg | 1.93 | 0.00 | 0.00 | 3.48 | 2.45 | 7.53 | 1.95 | 0.00 | 0.00 |
| yolk sac larvae | 1.26 | 0.00 | 0.00 | 1.98 | 7.15 | 0.00 | 0.00 | 0.94 | 0.00 |
| post-yolk sac larvae | 34.74 | 0.00 | 0.00 | 0.00 | 231.82 | 1.02 | 0.87 | 9.29 | 34.95 |
| juvenile | 2.58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.90 | 19.70 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic Croaker** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic menhaden** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Atlantic silverside** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bay anchovy** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.74 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Blueback herring** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.25 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Bluefish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

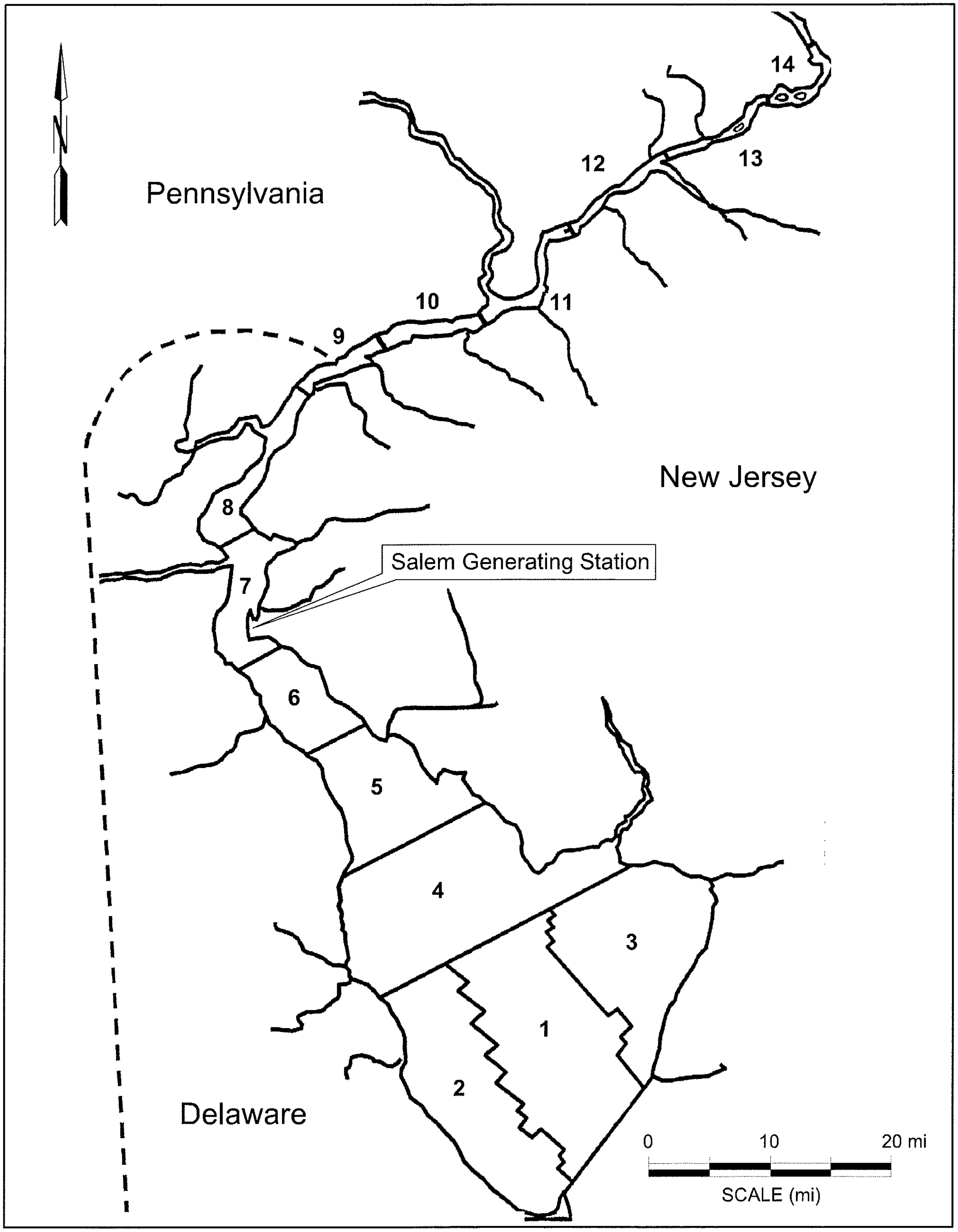
Table 4-46 (page 28 of 28)

PSEG Estuary Enhancement Program
Mean density (#/1000 $m^3$) by sampling event (collected in Zone 14) for each life stage
of each target species caught during the Ichthyoplankton Effort, April-July 2003

| Species (Taxon) by Life Stage | All Events* | April | | May | | June | | July | |
|---|---|---|---|---|---|---|---|---|---|
| | | Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | Event 6 | Event 7 | Event 8 |
| **Clupeidae** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 2.40 | 0.00 | 0.00 | 0.87 | 17.37 | 0.00 | 0.00 | 0.94 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Morone* spp.** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Spot** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Striped bass** | | | | | | | | | |
| egg | 0.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.90 | 0.00 | 0.00 |
| yolk sac larvae | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.97 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.92 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Weakfish** | | | | | | | | | |
| egg | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| post-yolk sac larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| juvenile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **White perch** | | | | | | | | | |
| egg | 63.03 | 0.00 | 0.00 | 162.80 | 205.40 | 37.71 | 98.32 | 0.00 | 0.00 |
| yolk sac larvae | 59.72 | 0.00 | 0.00 | 9.43 | 131.84 | 7.19 | 139.88 | 189.45 | 0.00 |
| post-yolk sac larvae | 4.43 | 0.00 | 0.00 | 0.87 | 30.08 | 1.79 | 0.00 | 0.90 | 1.79 |
| juvenile | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.67 |
| adult | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| undetermined larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total IP** | 652 | 0 | 28 | 666 | 3,082 | 718 | 261 | 231 | 88 |
| ***Gammarus* spp.** | 4,603 | 27 | 41 | 281 | 4,445 | 1,071 | 894 | 4,531 | 25,530 |
| ***Neomysis americana*** | 12 | 0 | 1 | 87 | 1 | 3 | 0 | 0 | 3 |

Note: Event 1 occurred April 1-14.
Event 2 occurred April 15-24.
Event 3 occurred May 6-15.
Event 4 occurred May 19-27.
Event 5 occurred June 2-10.
Event 6 occurred June 17-25.
Event 7 occurred July 1-15.
Event 8 occurred July 15-25.

*The "All Events" column contains the mean density for all events combined. It is not the total across each row.




| Public Service Enterprise Group | Figure 4-1.<br>Delaware Bay and River Sampling Zones |
| --- | --- |

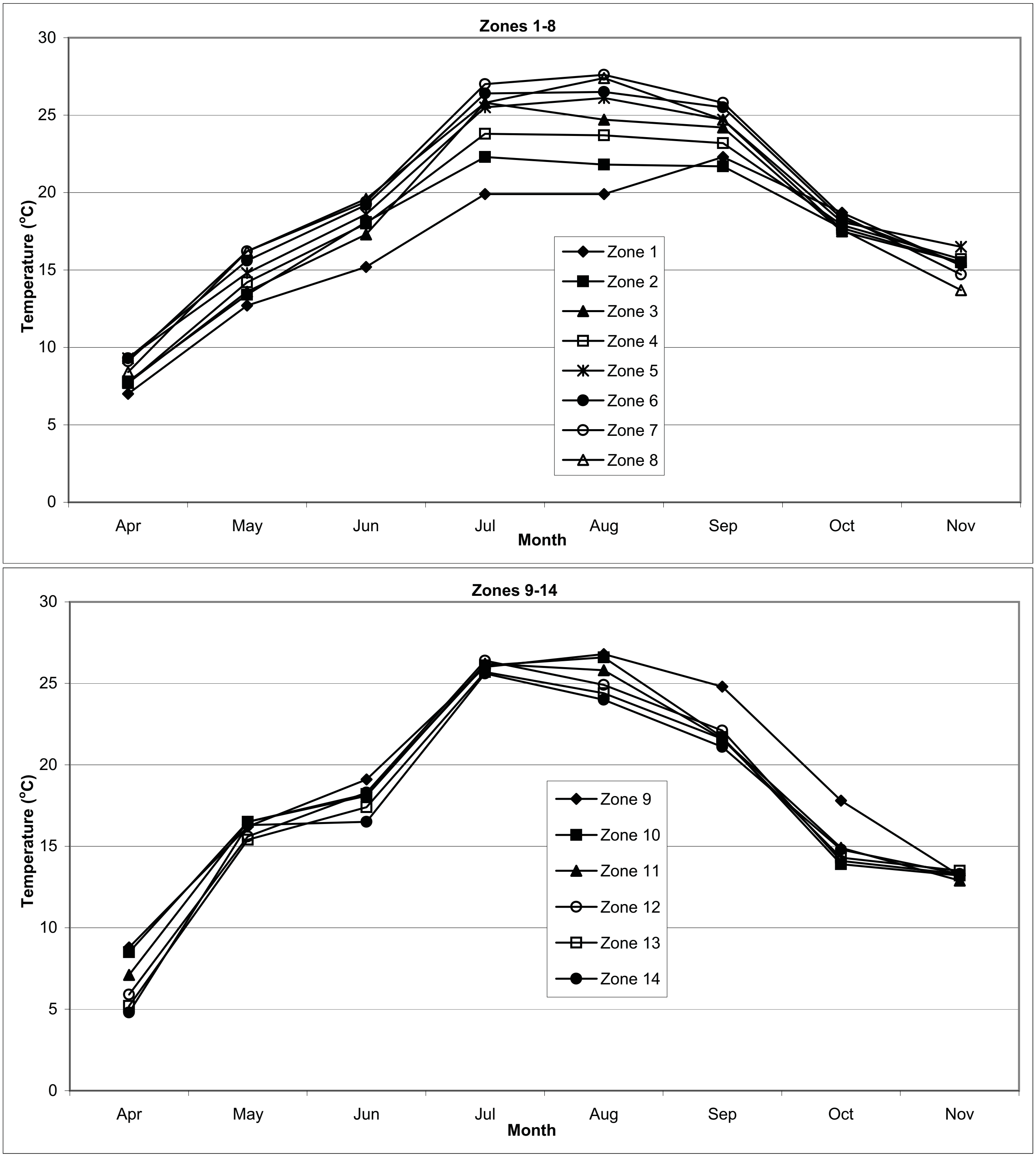
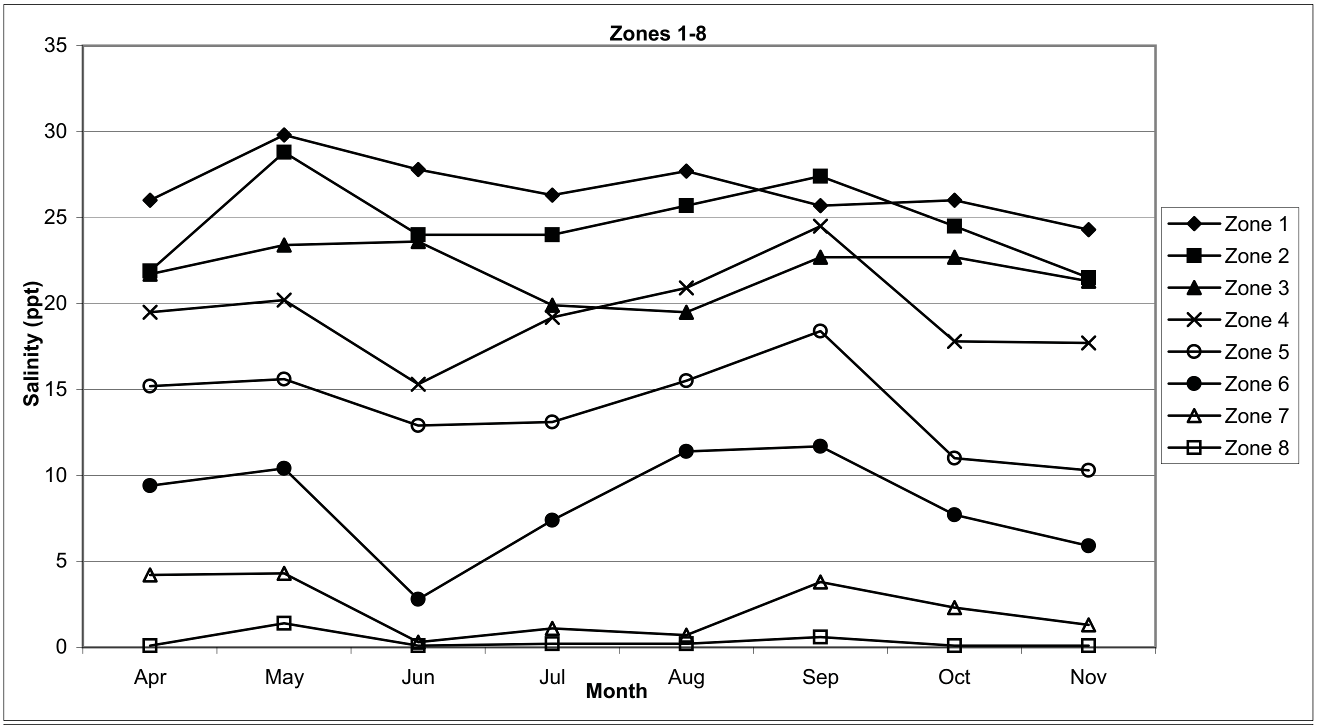



Figure 4-2 Spatial and temporal distribution of mean bottom water temperature observed during the Bottom Trawl Effort, April - November 2003



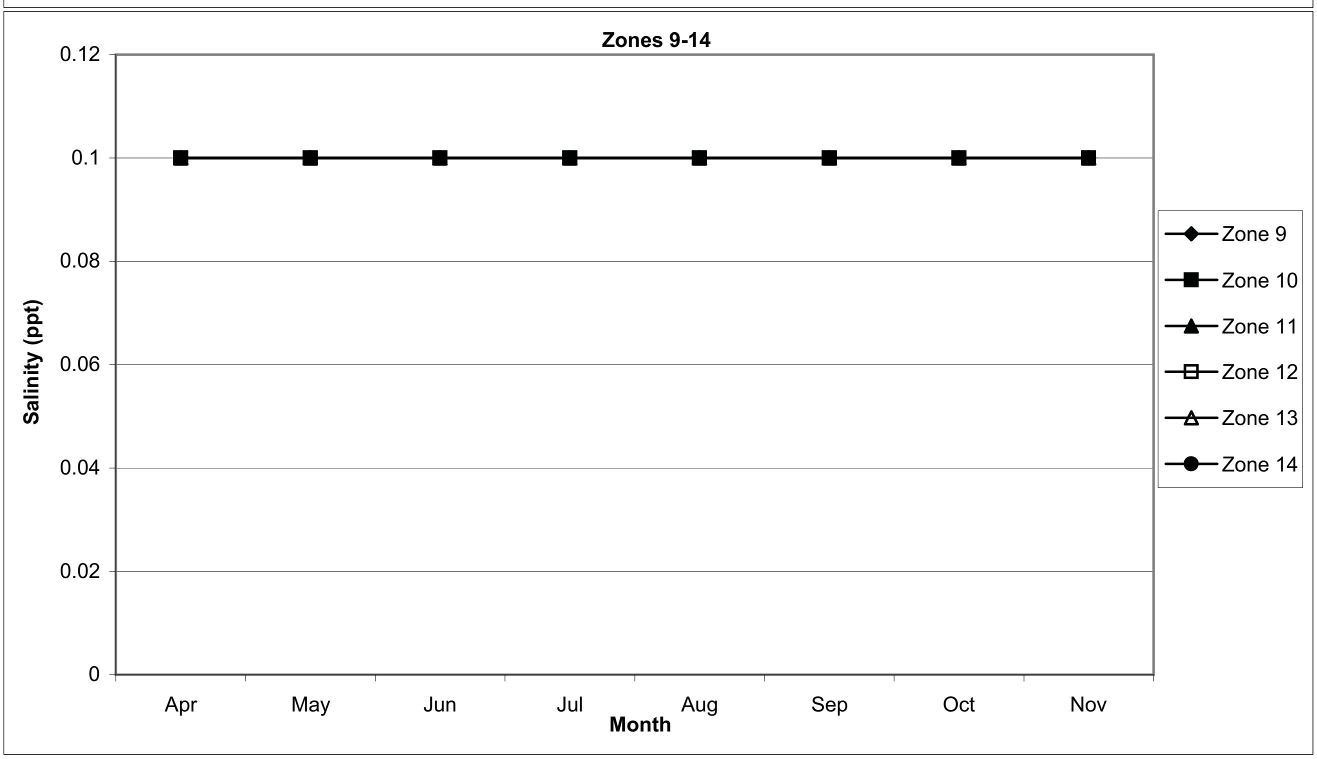
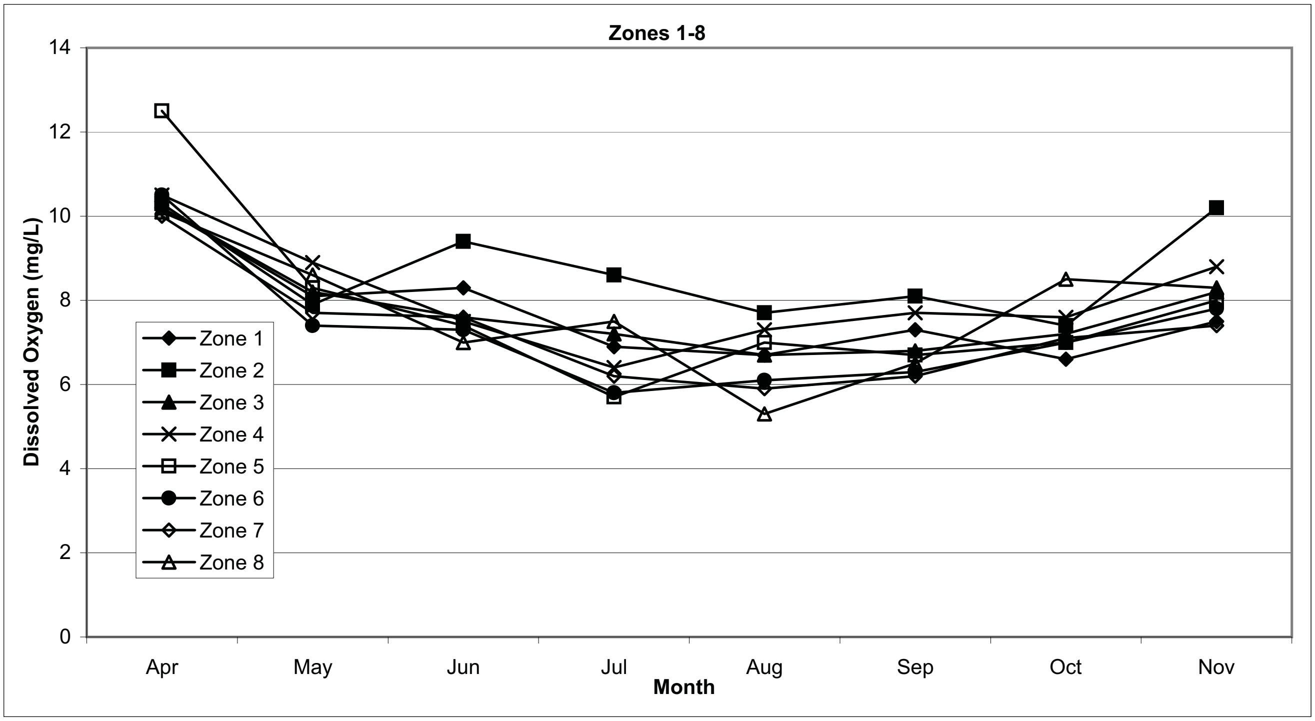




Figure 4-3 Spatial and temporal distribution of mean bottom salinity observed during the Bottom Trawl Effort, April - November 2003



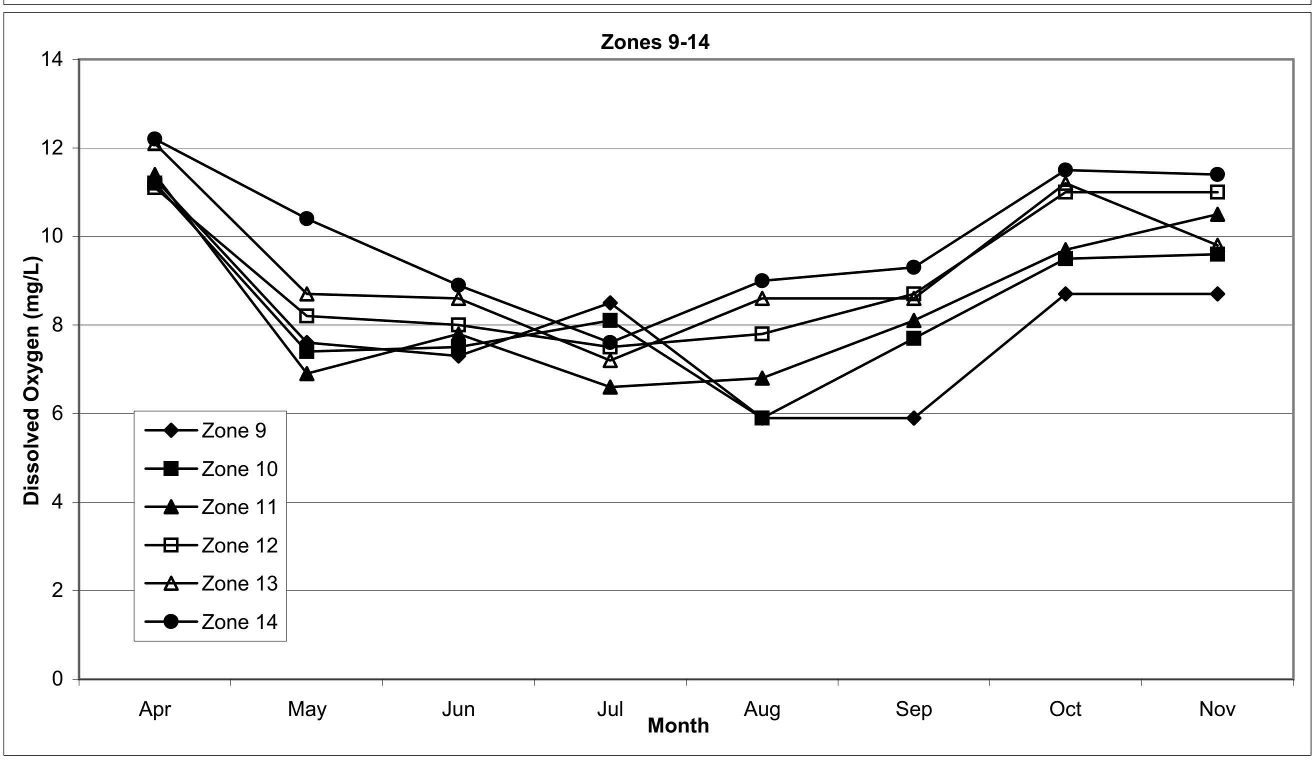




Figure 4-4 Spatial and temporal distribution of mean bottom dissolved oxygen observed during the Bottom Trawl Effort, April - November 2003

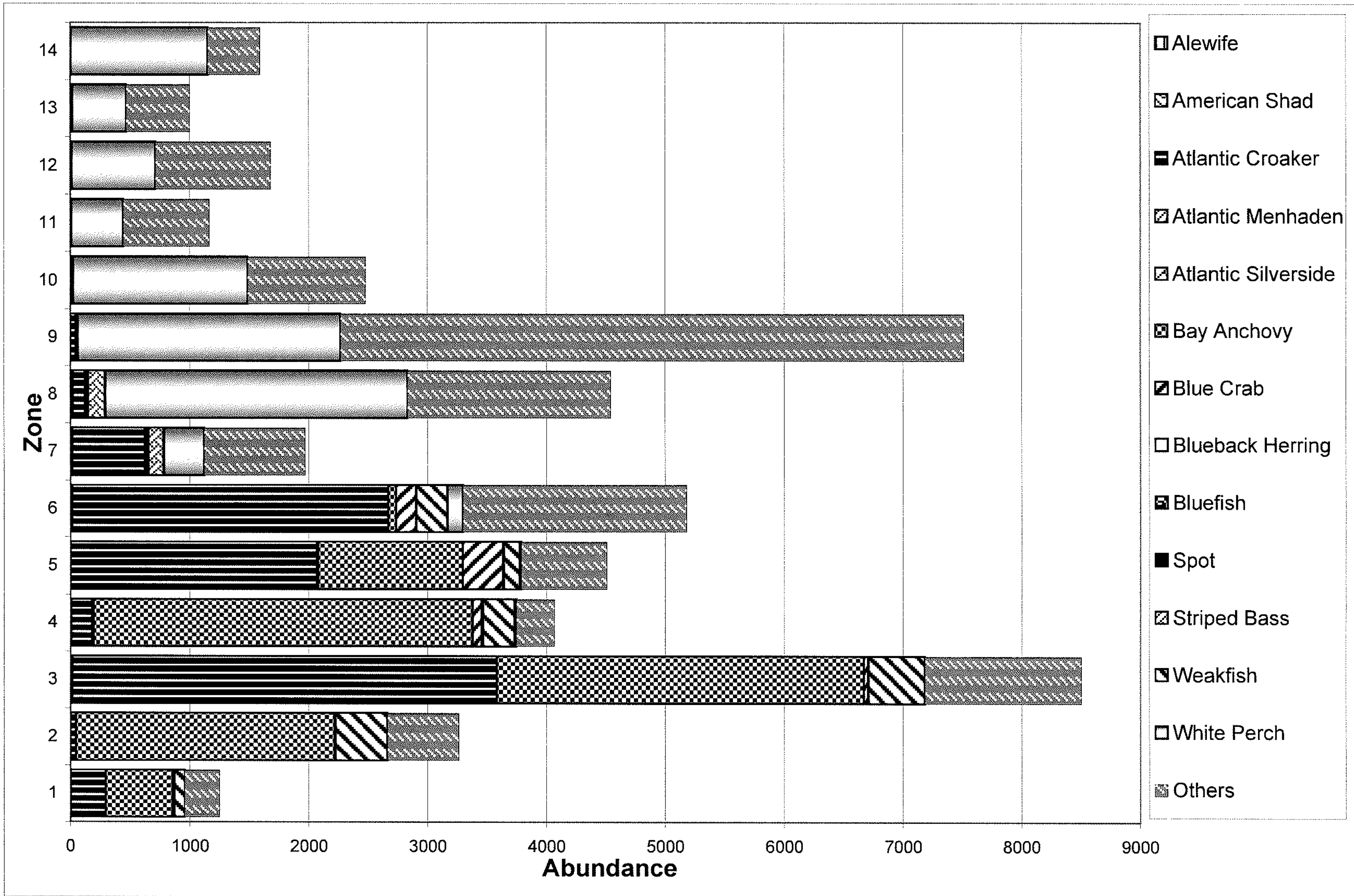
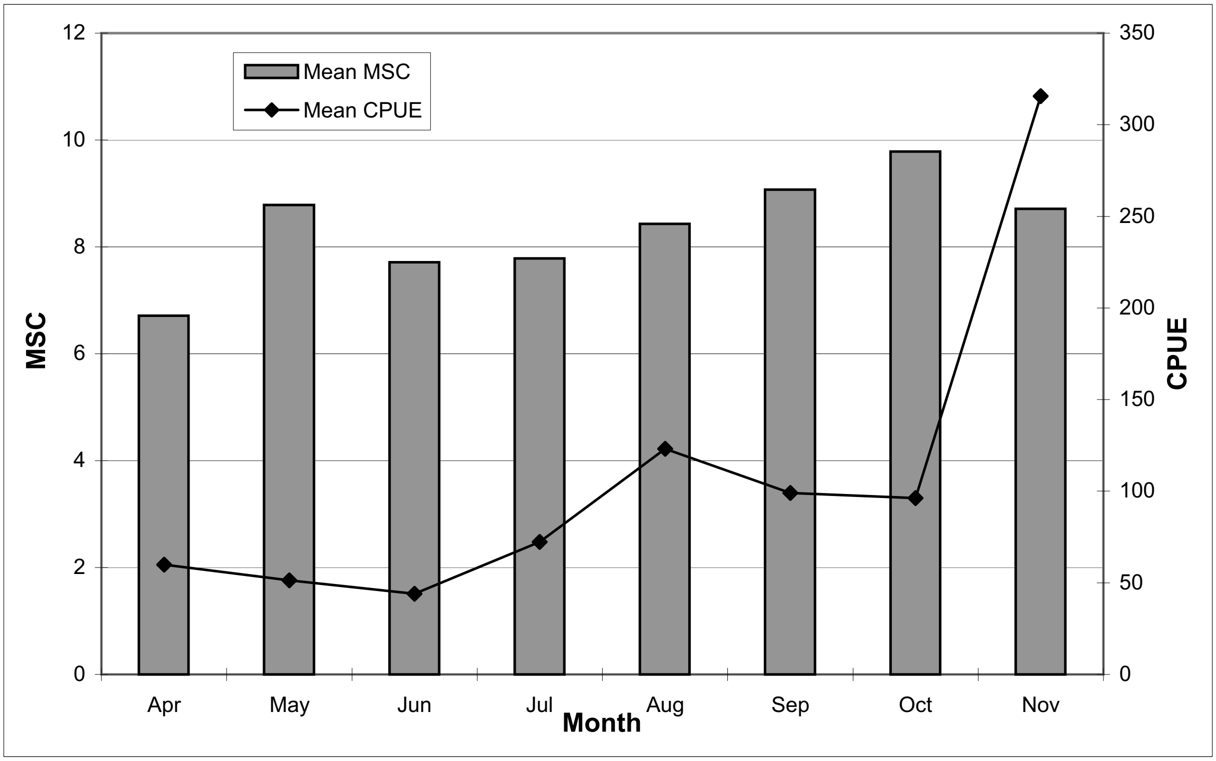
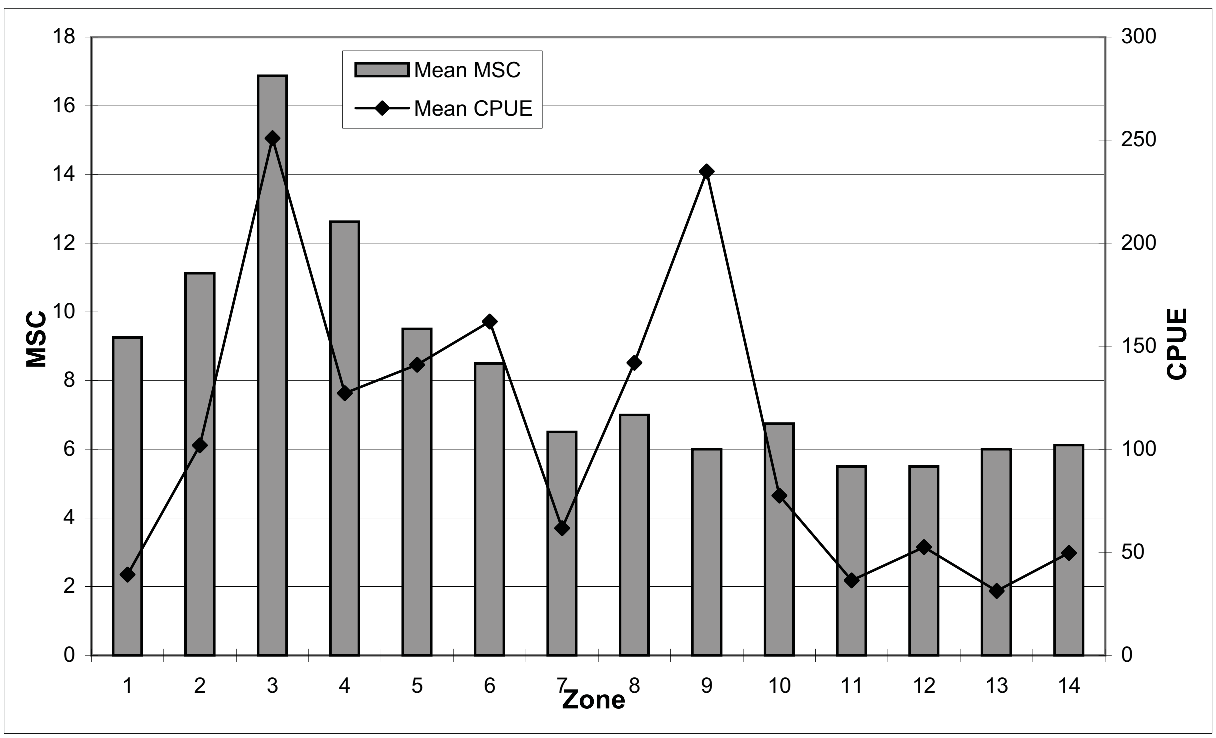



Figure 4-5 Total abundance by zone for target species and others caught during the Bottom Trawl Effort, April - November 2003




Mean species composition (MSC) and CPUE by month




Mean species composition (MSC) and CPUE by zone

Figure 4-6 Mean species composition (MSC) and catch per unit effort (CPUE) by zone and by month for all species caught during the Bottom Trawl Effort, April - November 2003

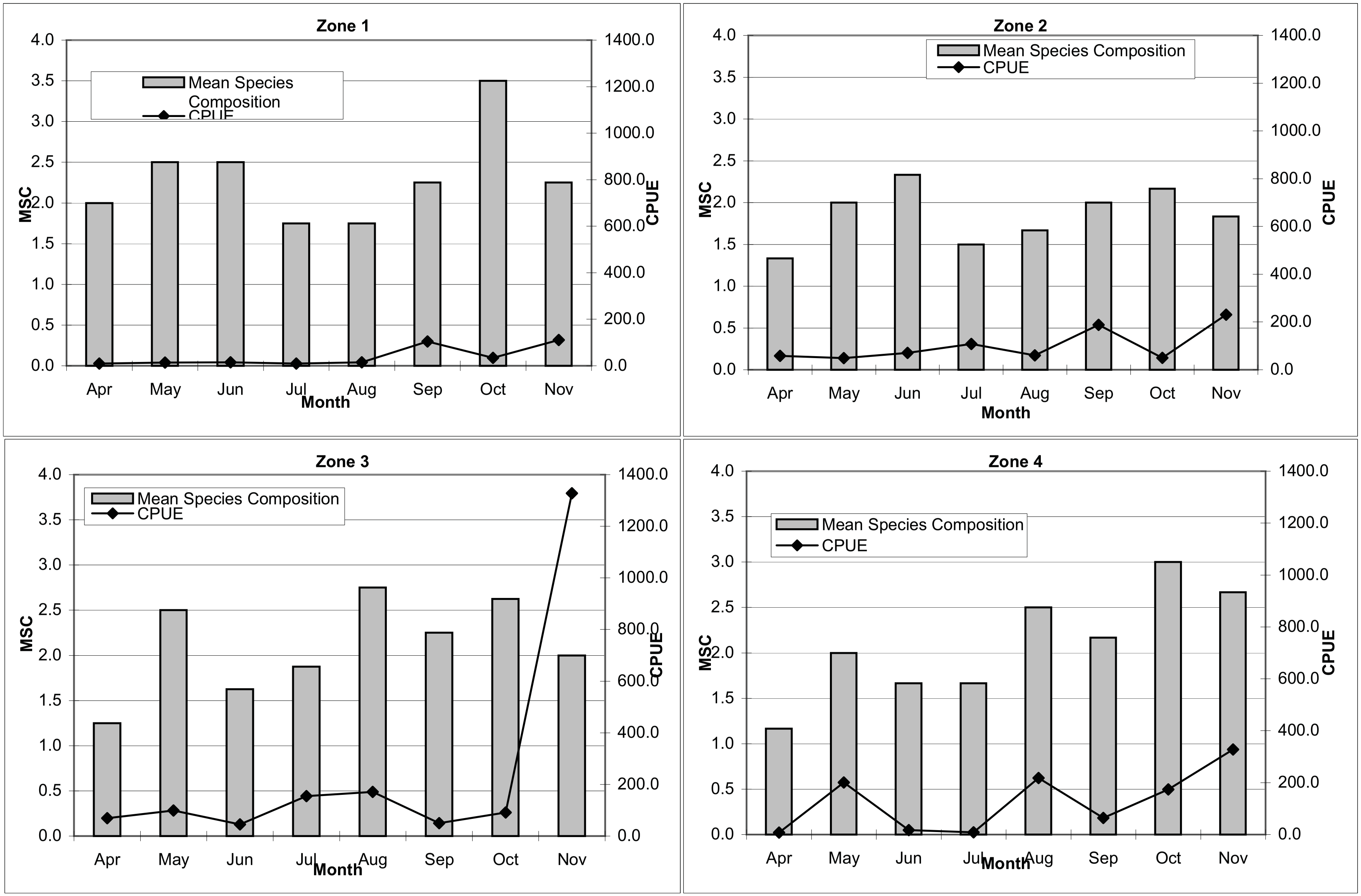



Figure 4-7 Mean species composition (MSC) and catch per unit effort (CPUE) by month for each zone during the Bottom Trawl Effort, April - November 2003

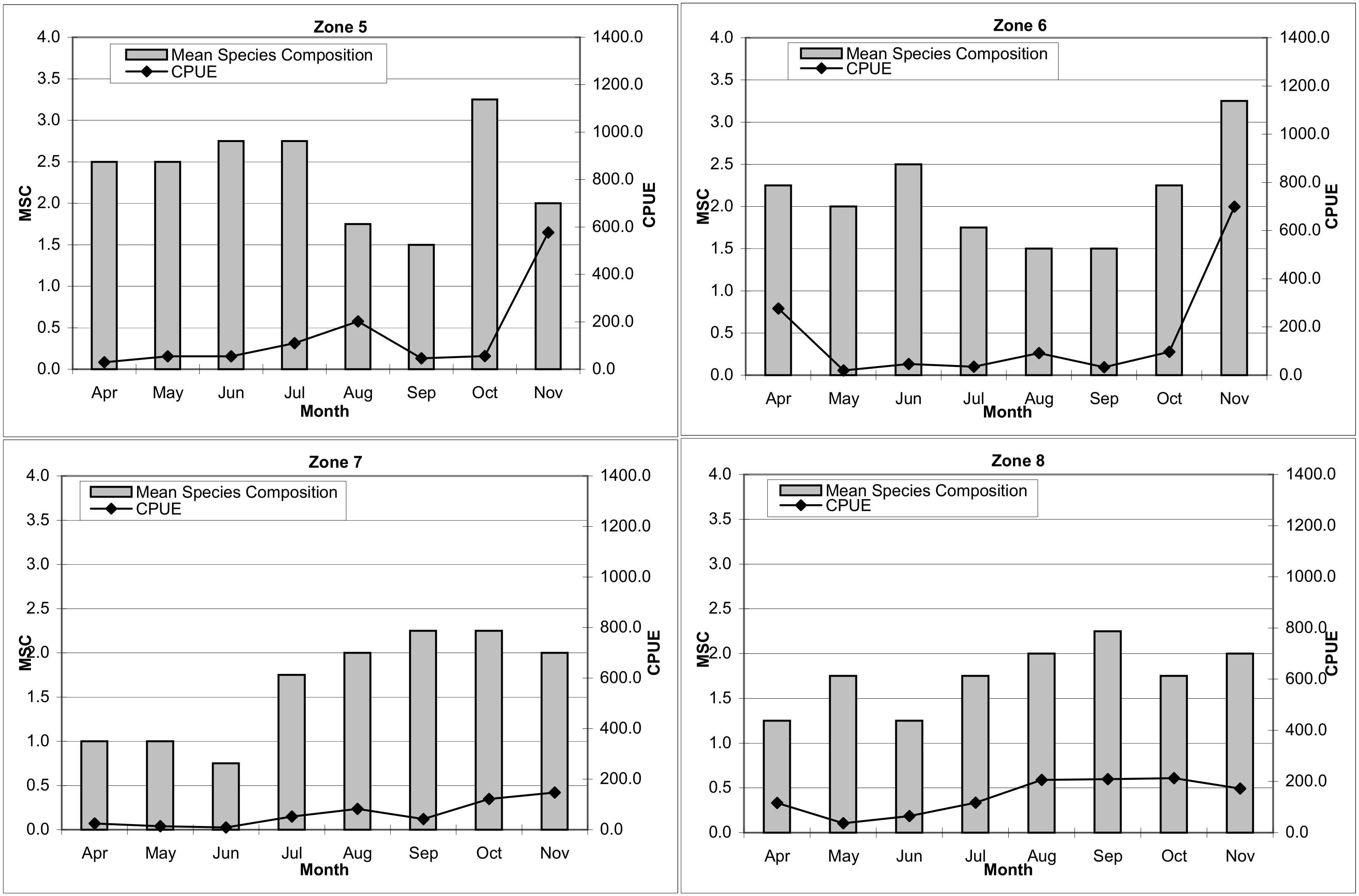



Figure 4-7 (continued) Mean species composition (MSC) and catch per unit effort (CPUE) by month for each zone during the Bottom Trawl Effort, April - November 2003

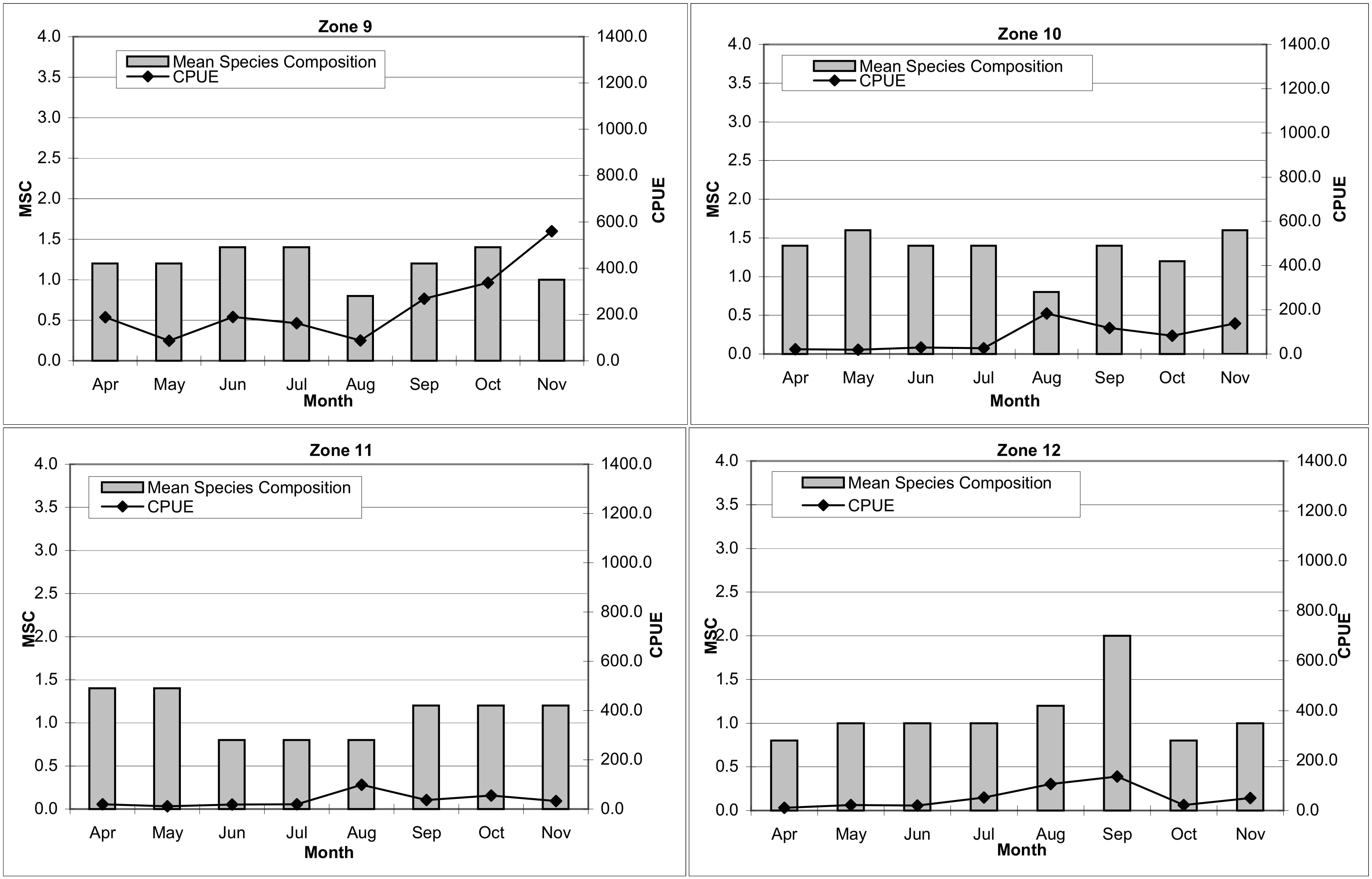
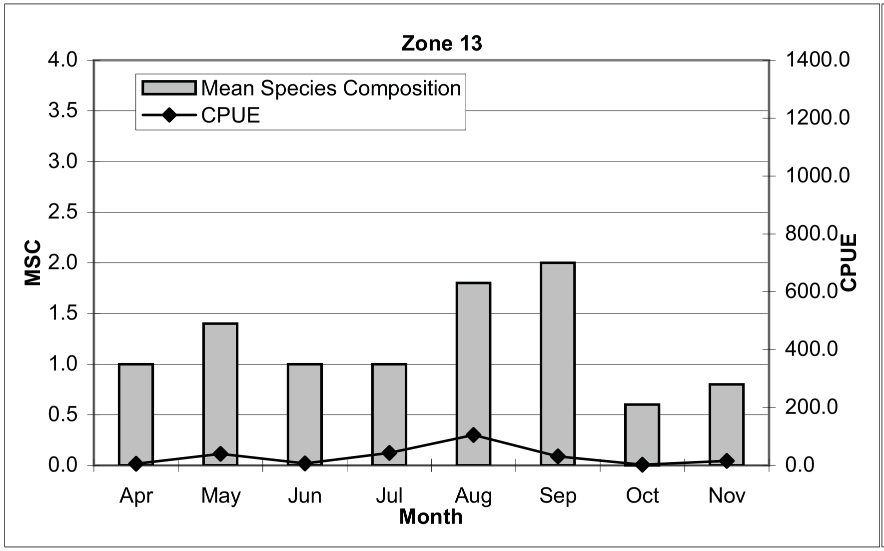



Figure 4-7 (continued) Mean species composition (MSC) and catch per unit effort (CPUE) by month for each zone during the Bottom Trawl Effort, April - November 2003



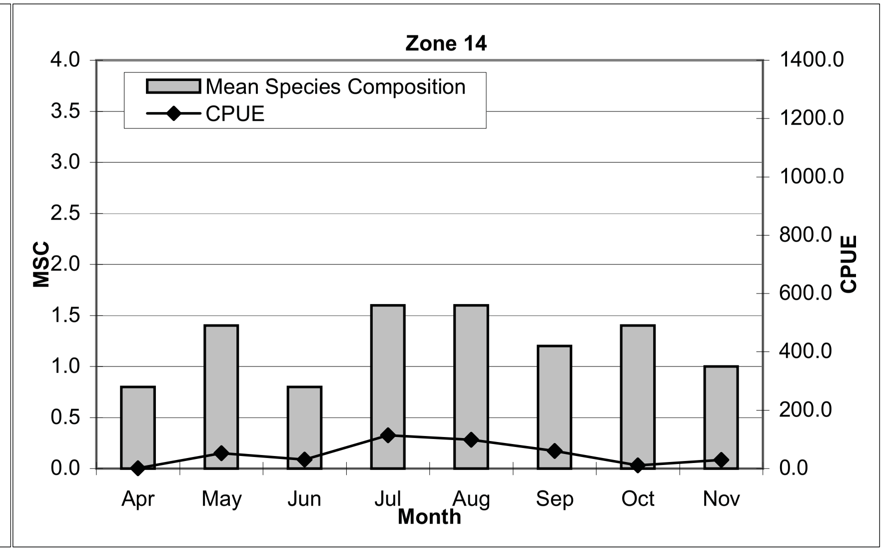




Figure 4-7 (continued) Mean species composition (MSC) and catch per unit effort (CPUE) by month for each zone during the Bottom Trawl Effort, April - November 2003

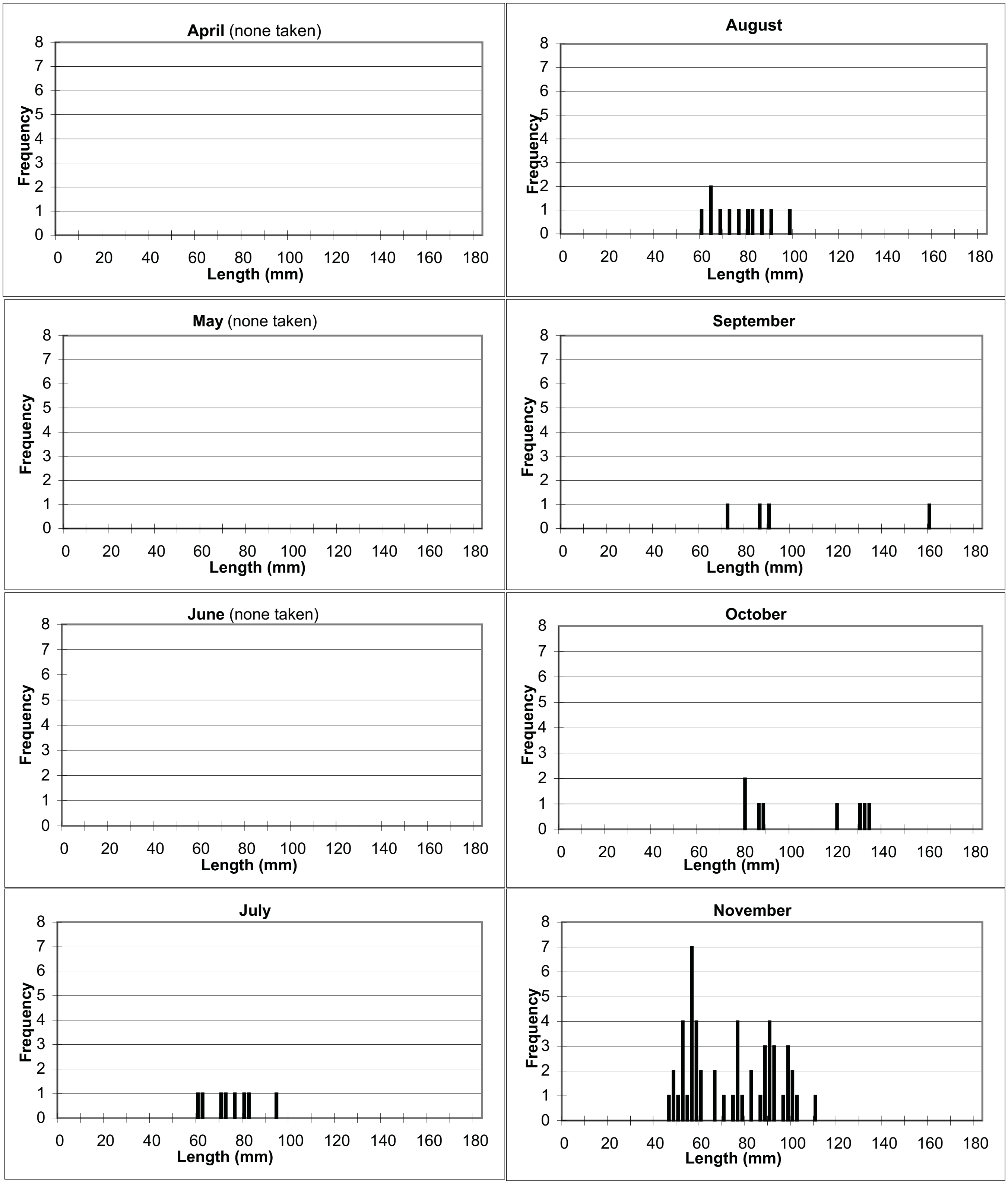



Figure 4-8 Length-frequency distribution of alewife by month during the Bottom Trawl Effort, April - November 2003

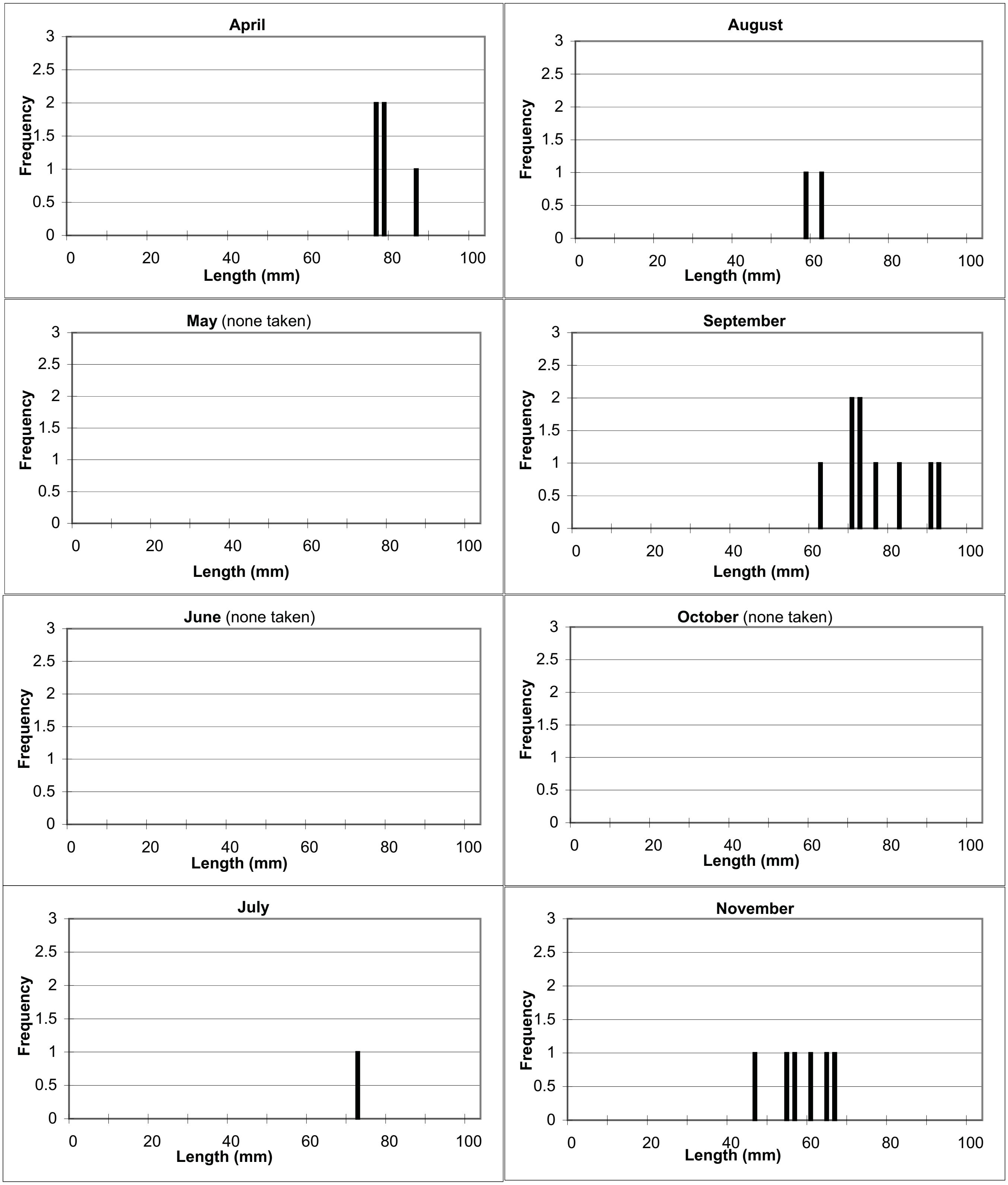



Figure 4-9 Length-frequency distribution of American shad by month during the Bottom Trawl Effort, April - November 2003

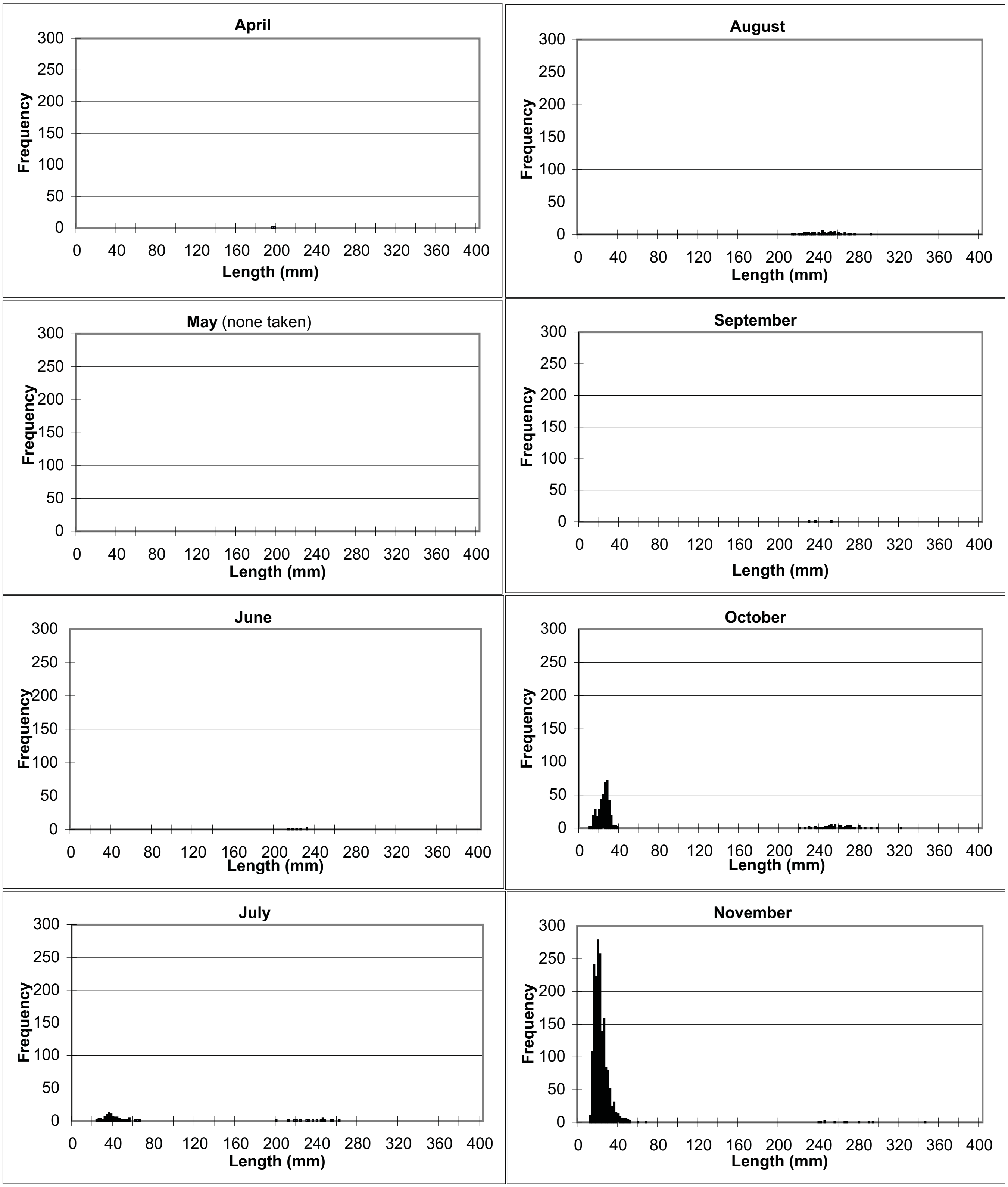



Figure 4-10 Length-frequency distribution of Atlantic croaker by month during the Bottom Trawl Effort, April - November 2003

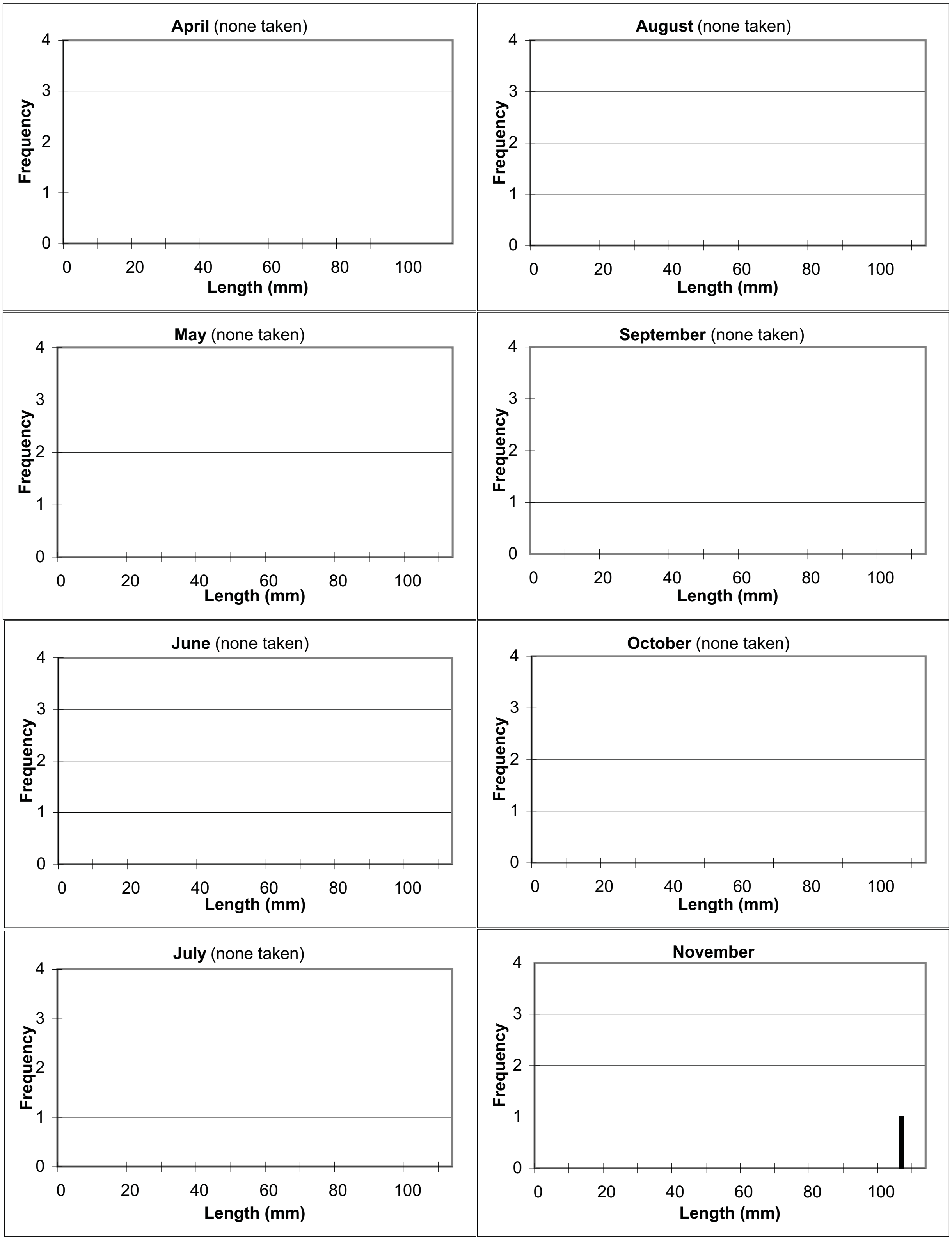



Figure 4-11 Length-frequency distribution of Atlantic menhaden by month during the Bottom Trawl Effort, April - November 2003

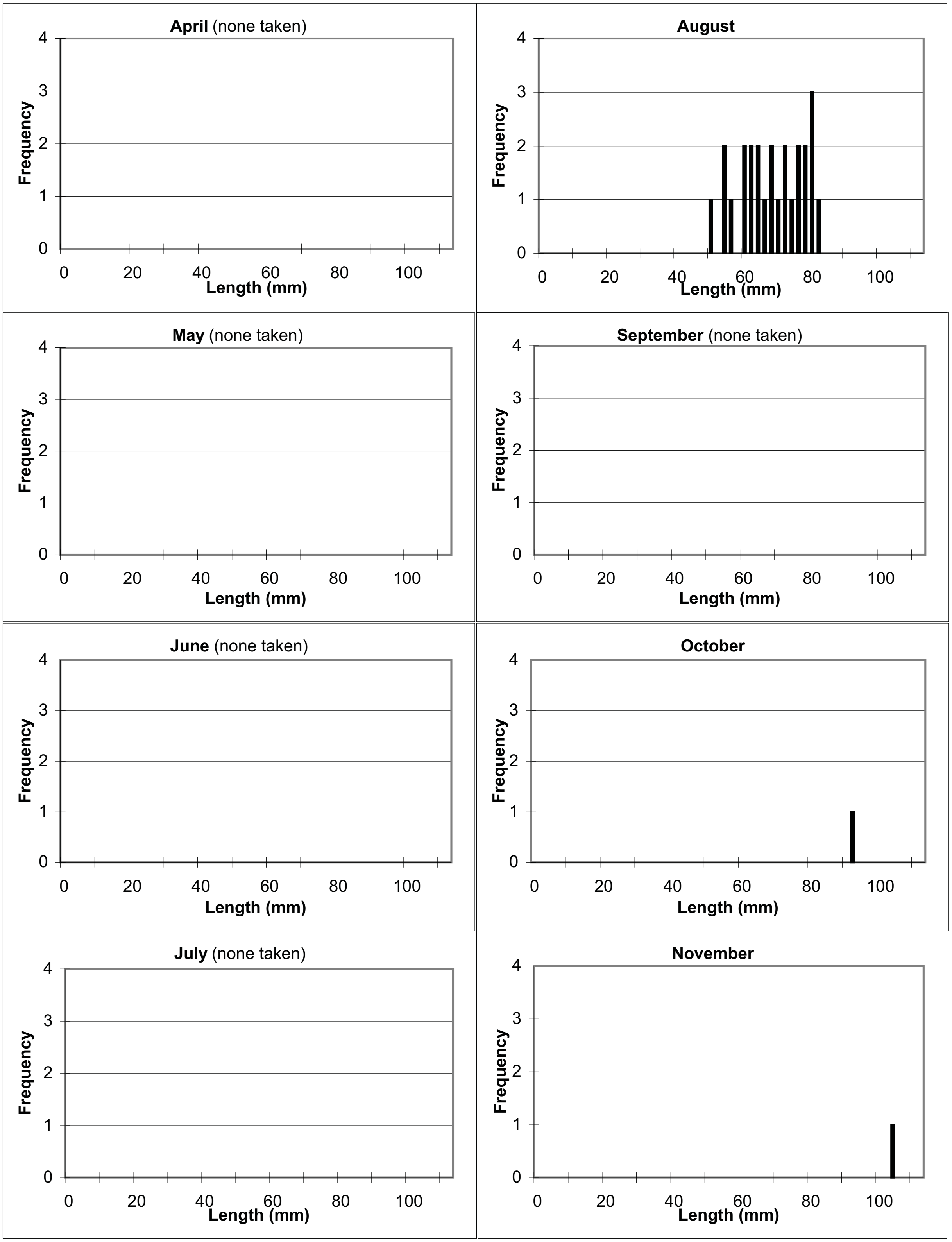



Figure 4-12 Length-frequency distribution of Atlantic silverside by month during the Bottom Trawl Effort, April - November 2003

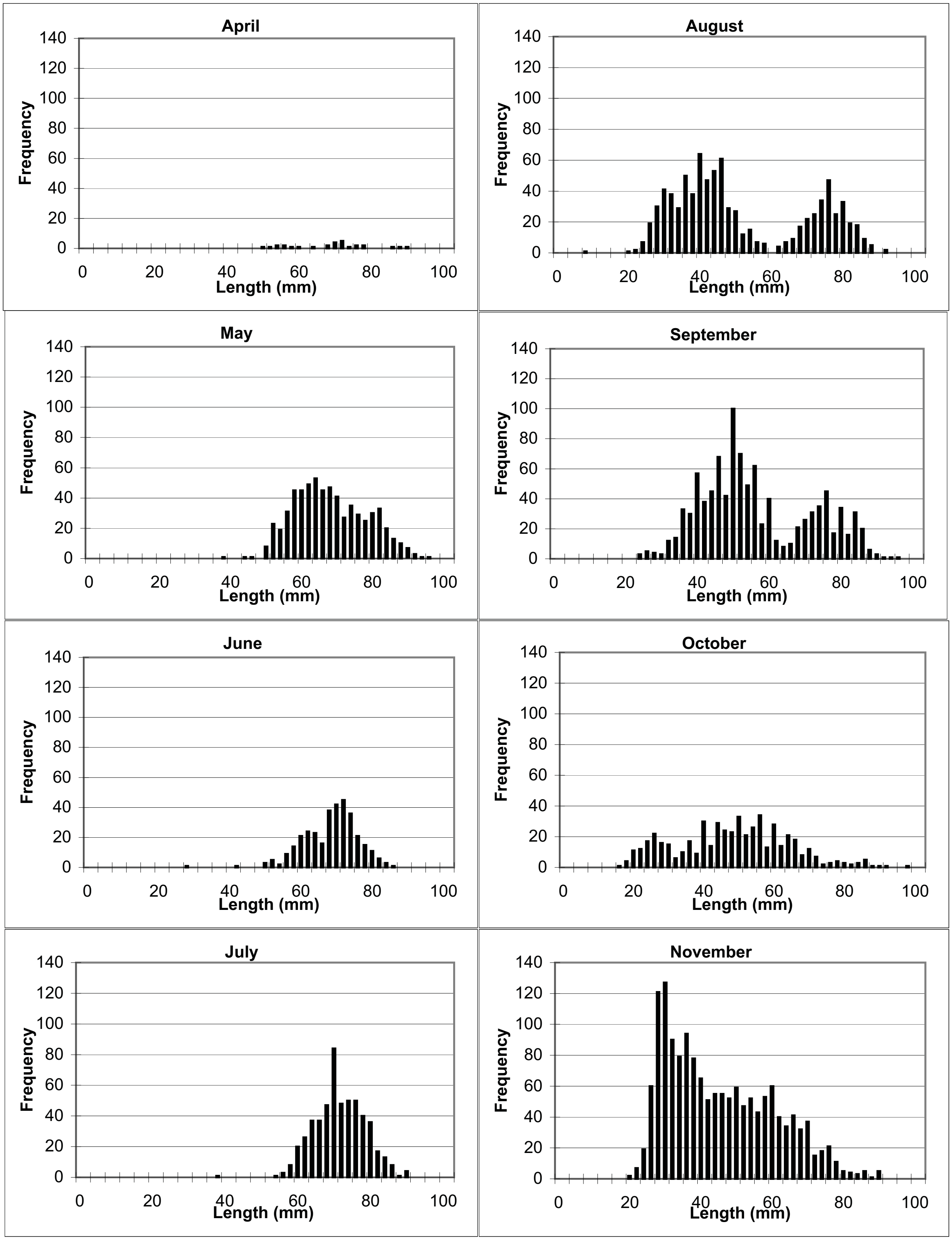



Figure 4-13 Length-frequency distribution of bay anchovy by month during the Bottom Trawl Effort, April - November 2003

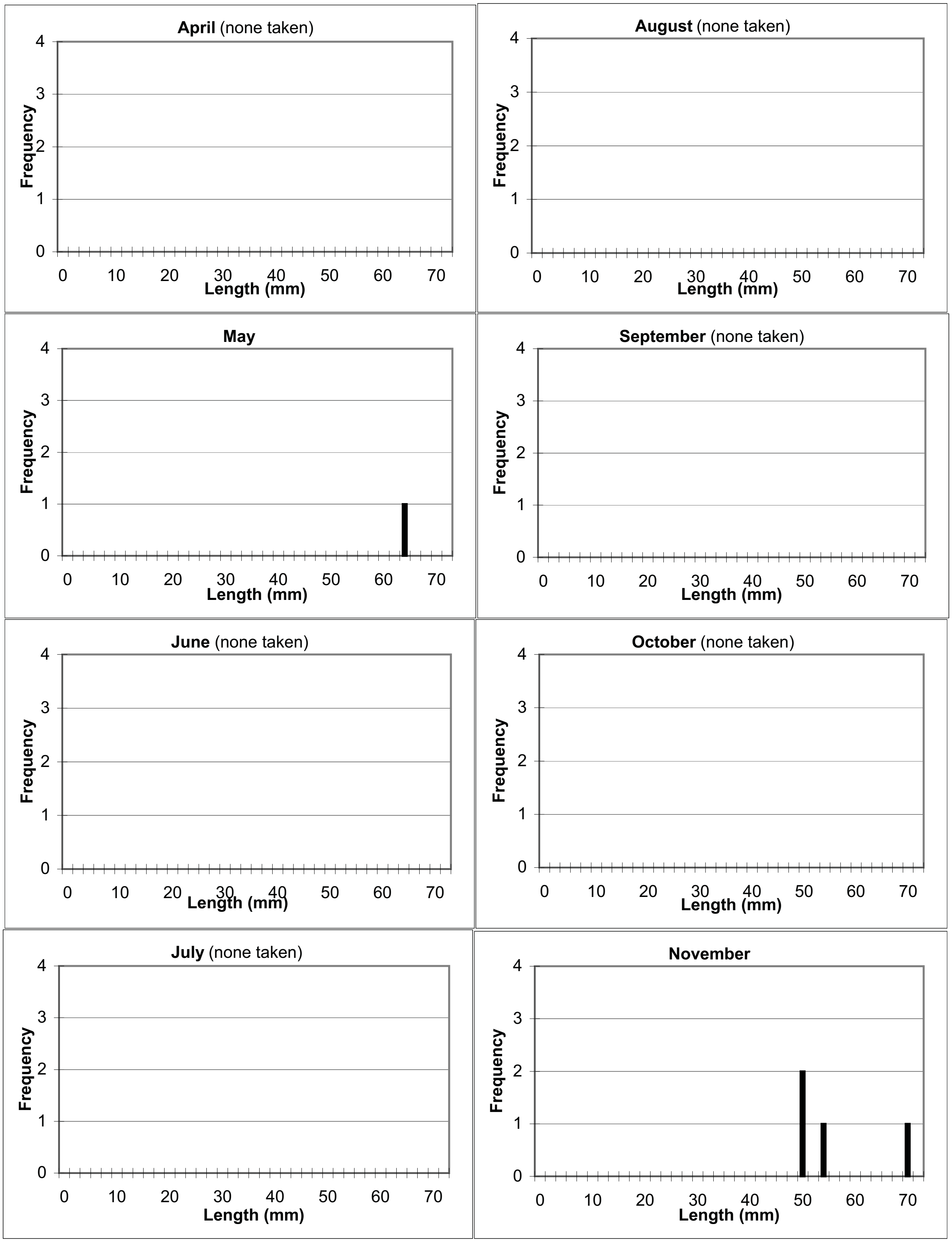



Figure 4-14 Length-frequency distribution of blueback herring by month during the Bottom Trawl Effort, April - November 2003

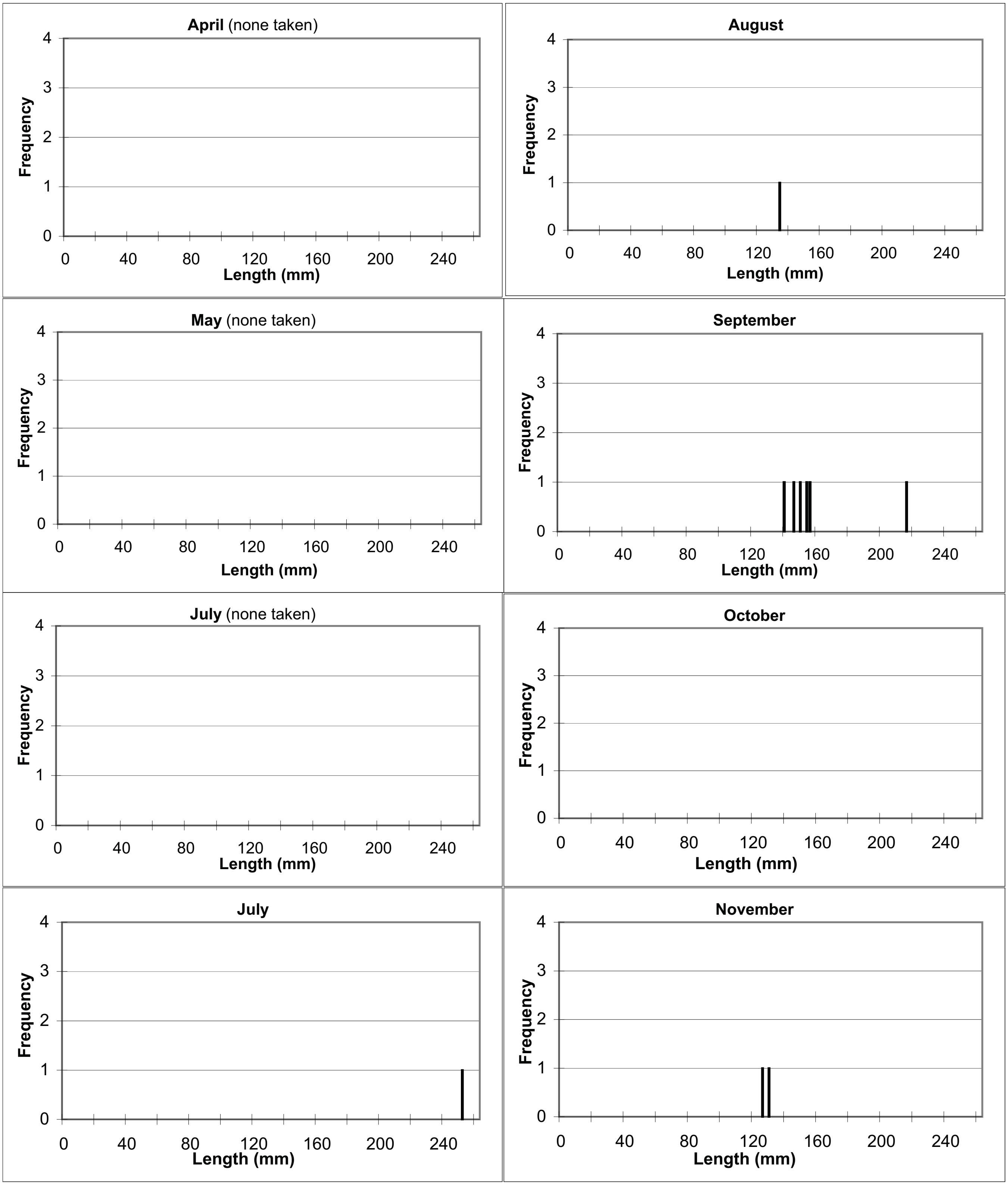



Figure 4-15 Length-frequency distribution of bluefish by month during the Bottom Trawl Effort, April - November 2003

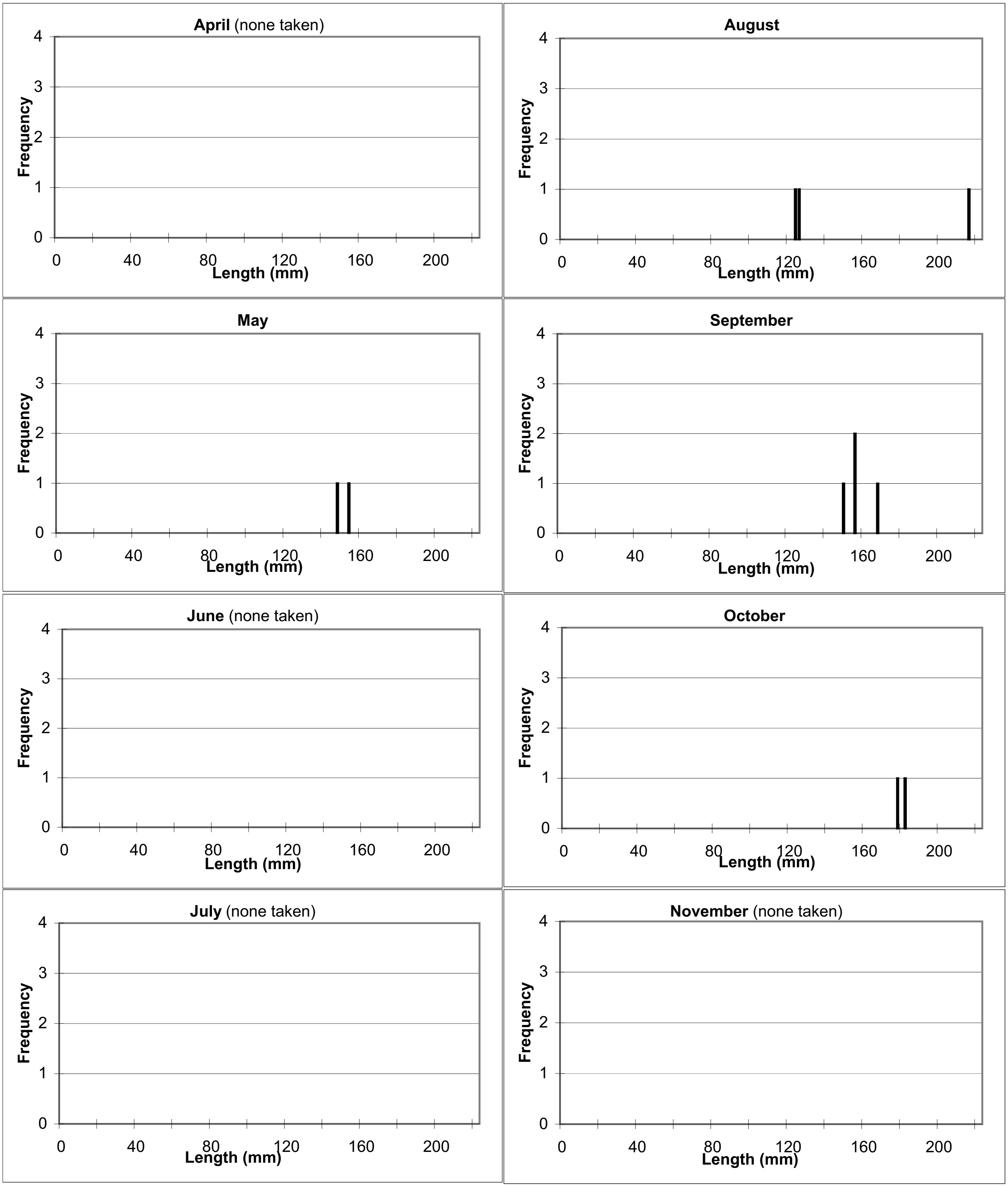



Figure 4-16 Length-frequency distribution of spot by month during the Bottom Trawl Effort, April - November 2003

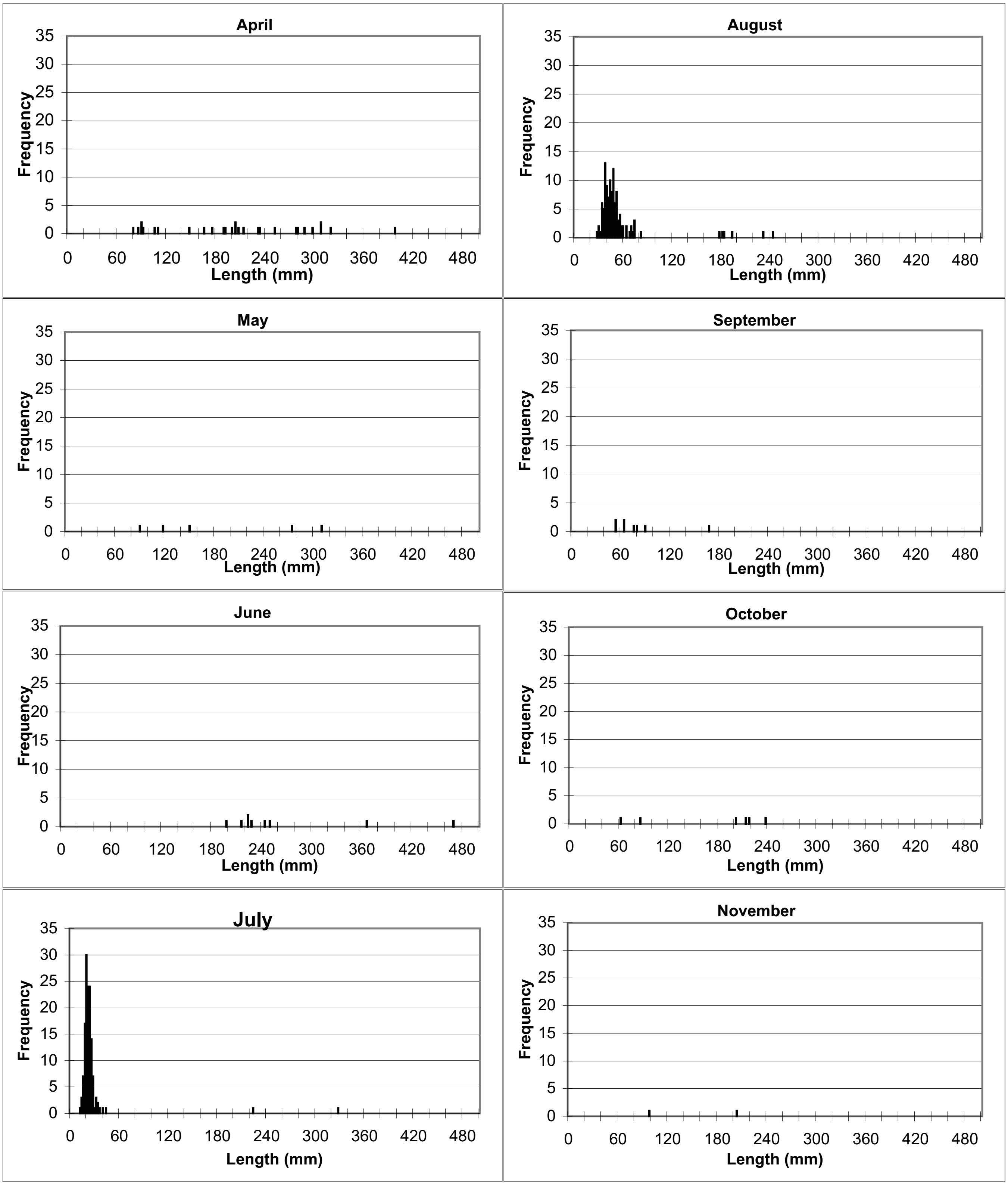



Figure 4-17 Length-frequency distribution of striped bass by month during the Bottom Trawl Effort, April - November 2003

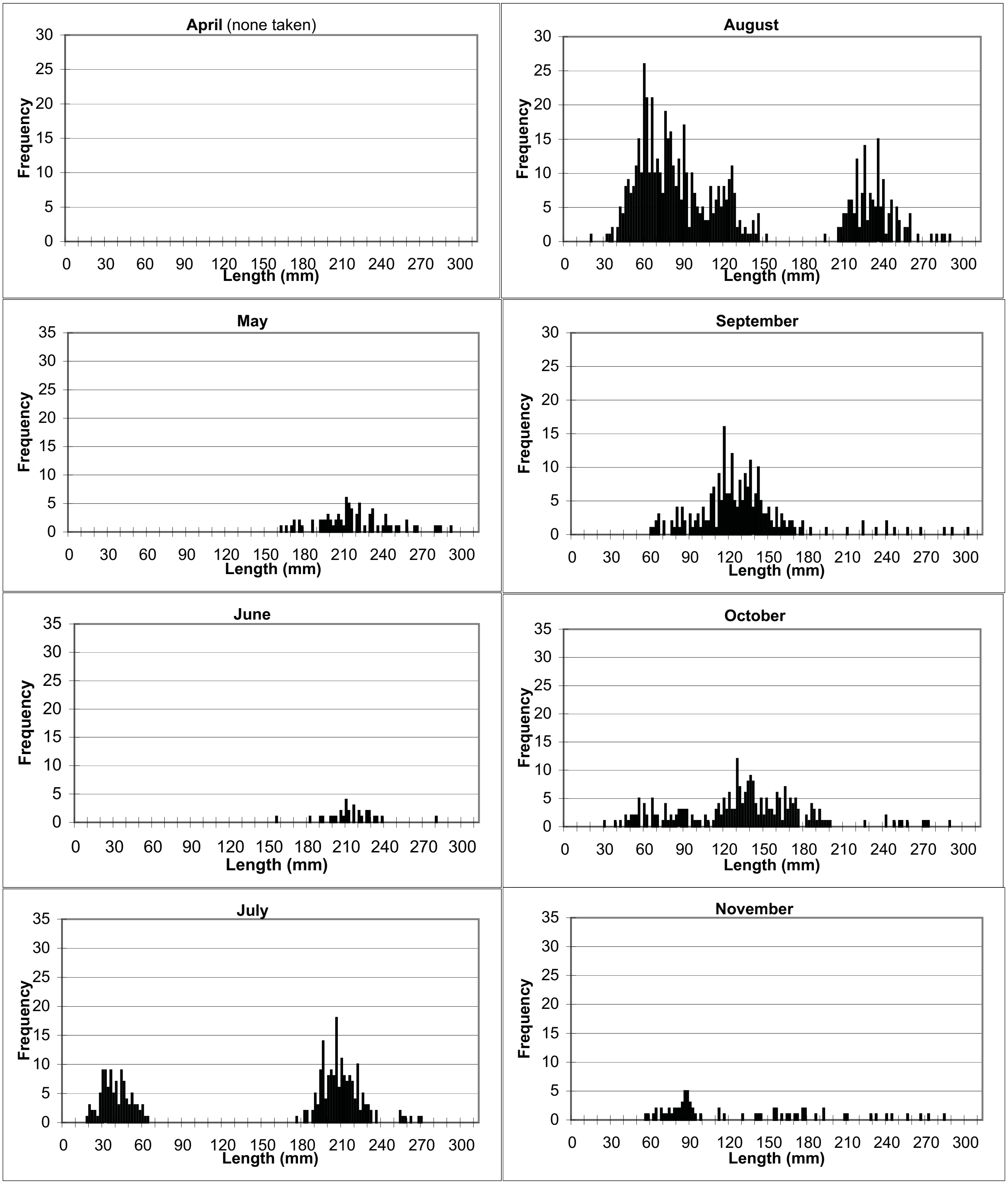



Figure 4-18 Length-frequency distribution of weakfish by month during the Bottom Trawl Effort, April - November 2003

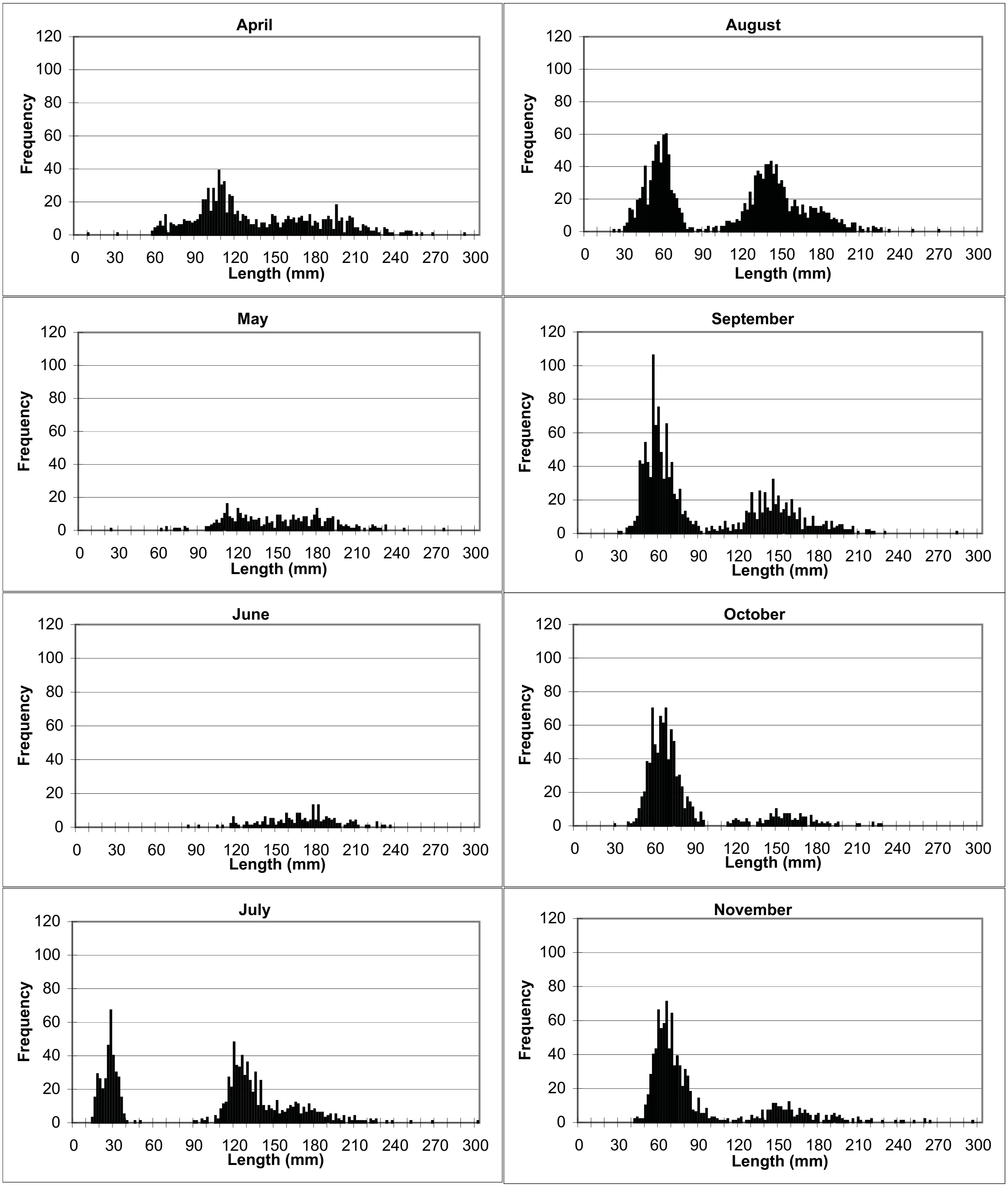



Figure 4-19 Length-frequency distribution of white perch by month during the Bottom Trawl Effort, April - November 2003

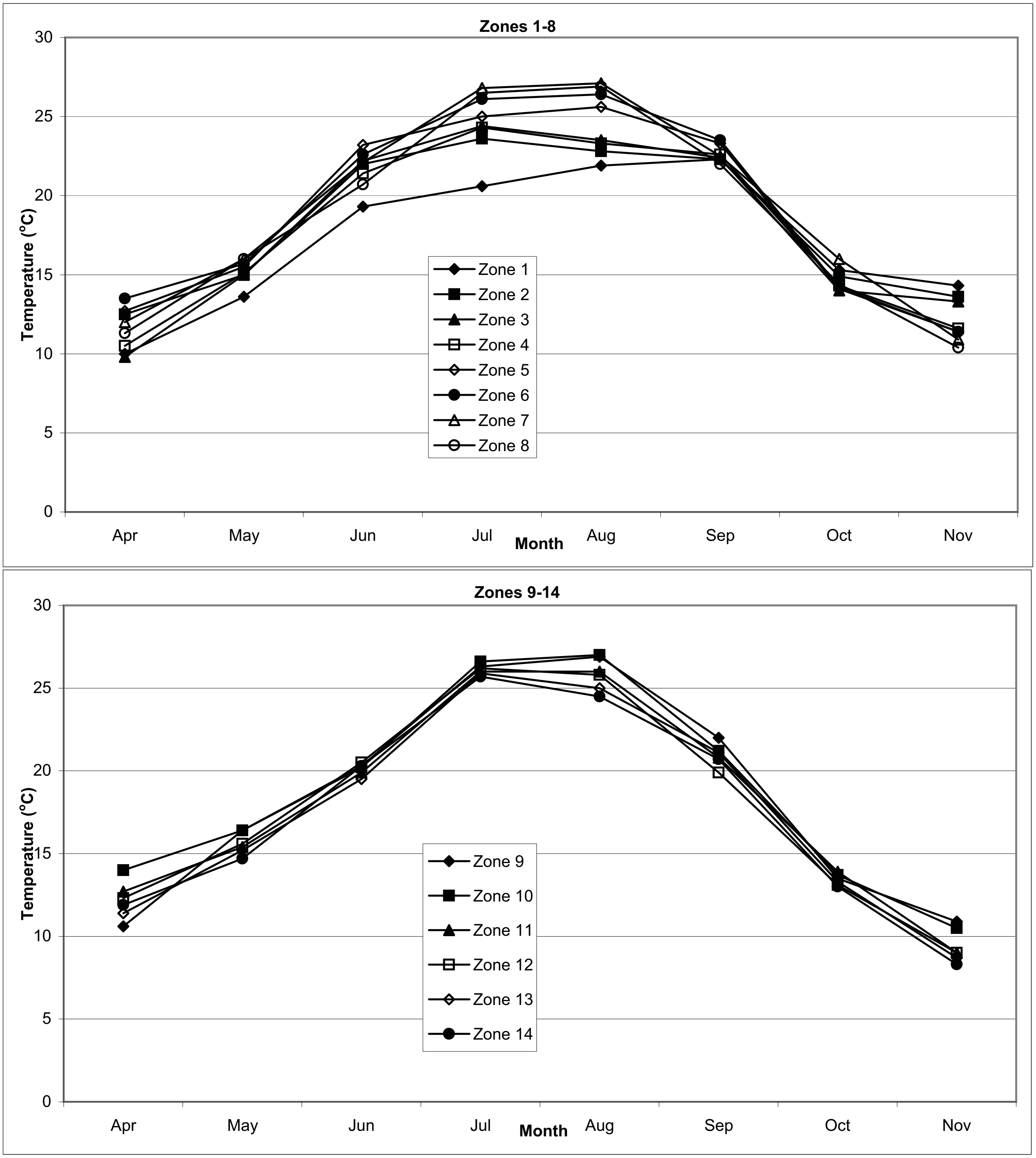



Figure 4-20 Spatial and temporal distribution of mean mid-depth water temperature observed during the Pelagic Trawl Effort, April - November 2003

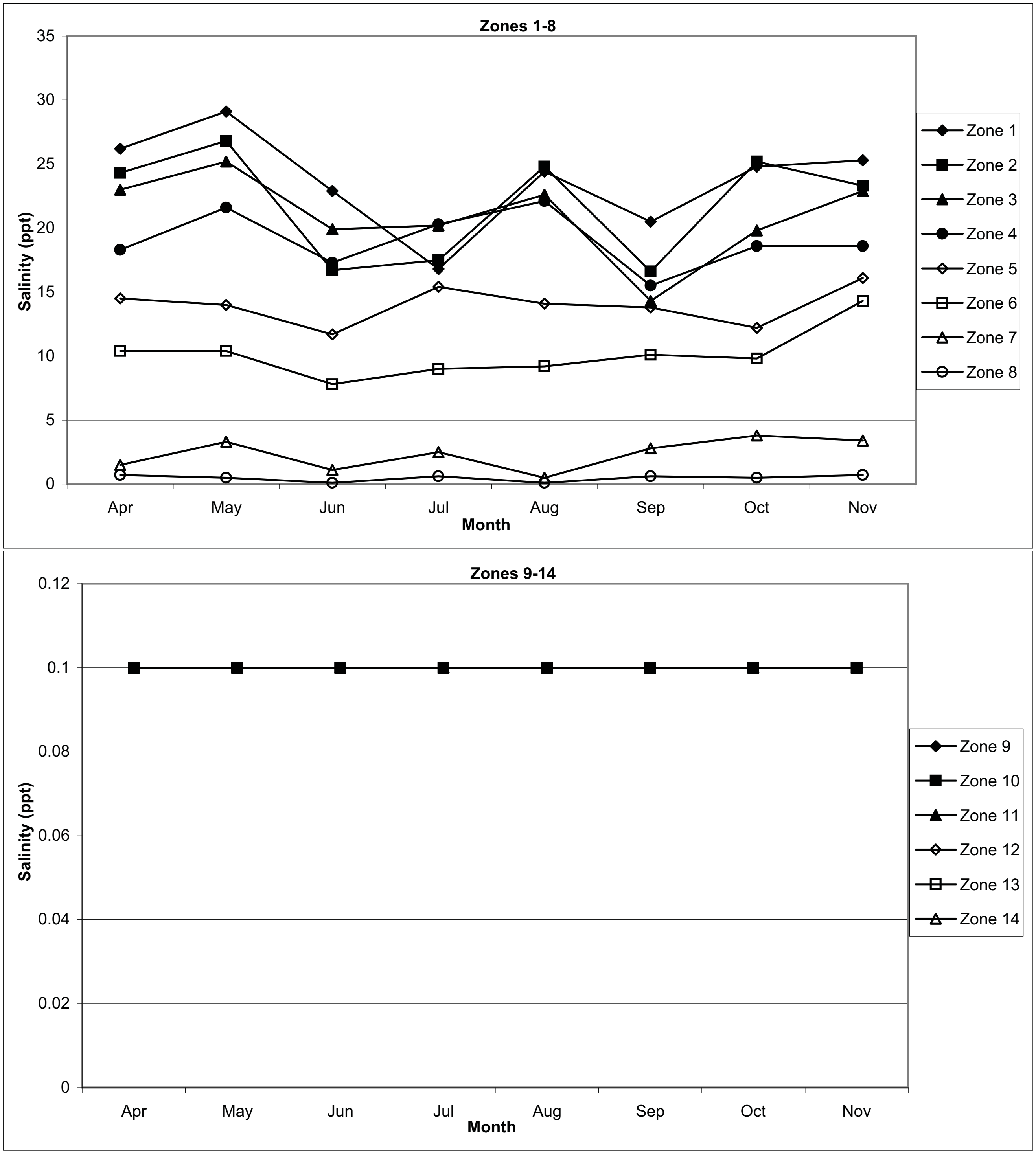
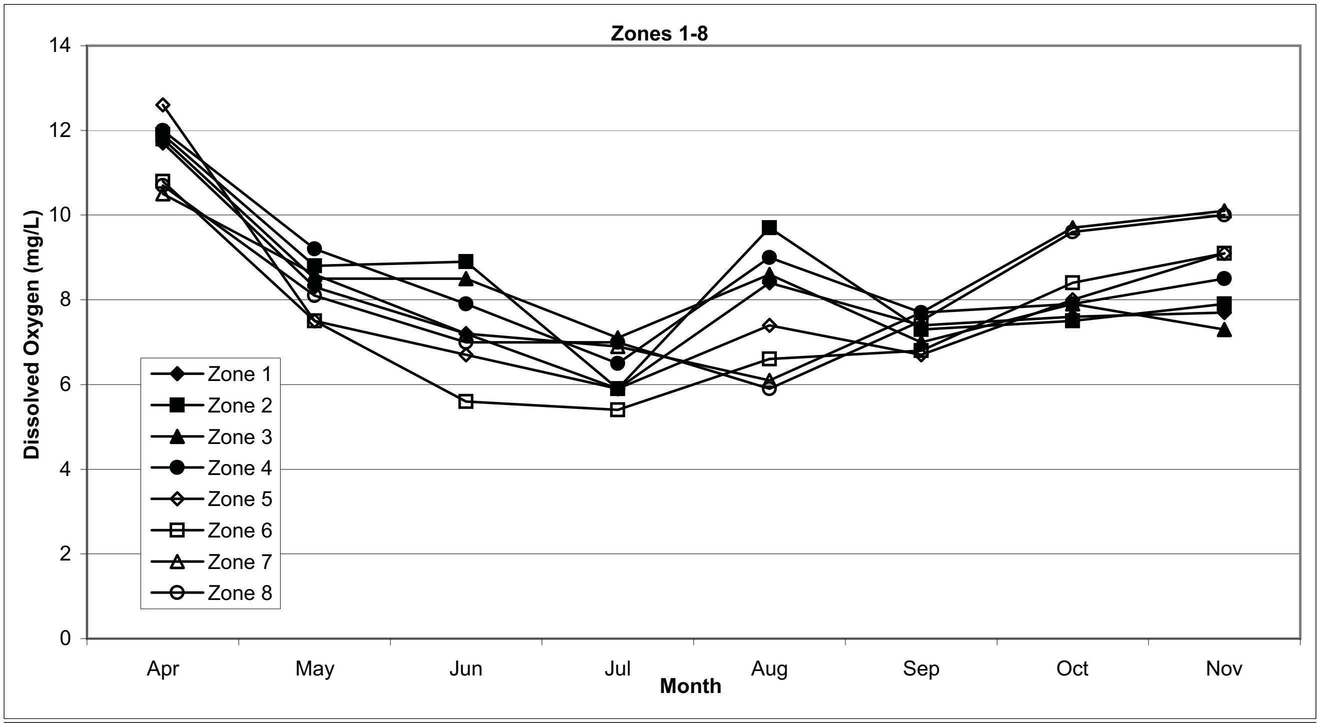



Figure 4-21 Spatial and temporal distribution of mean mid-depth salinity observed during the Pelagic Trawl Effort, April - November 2003



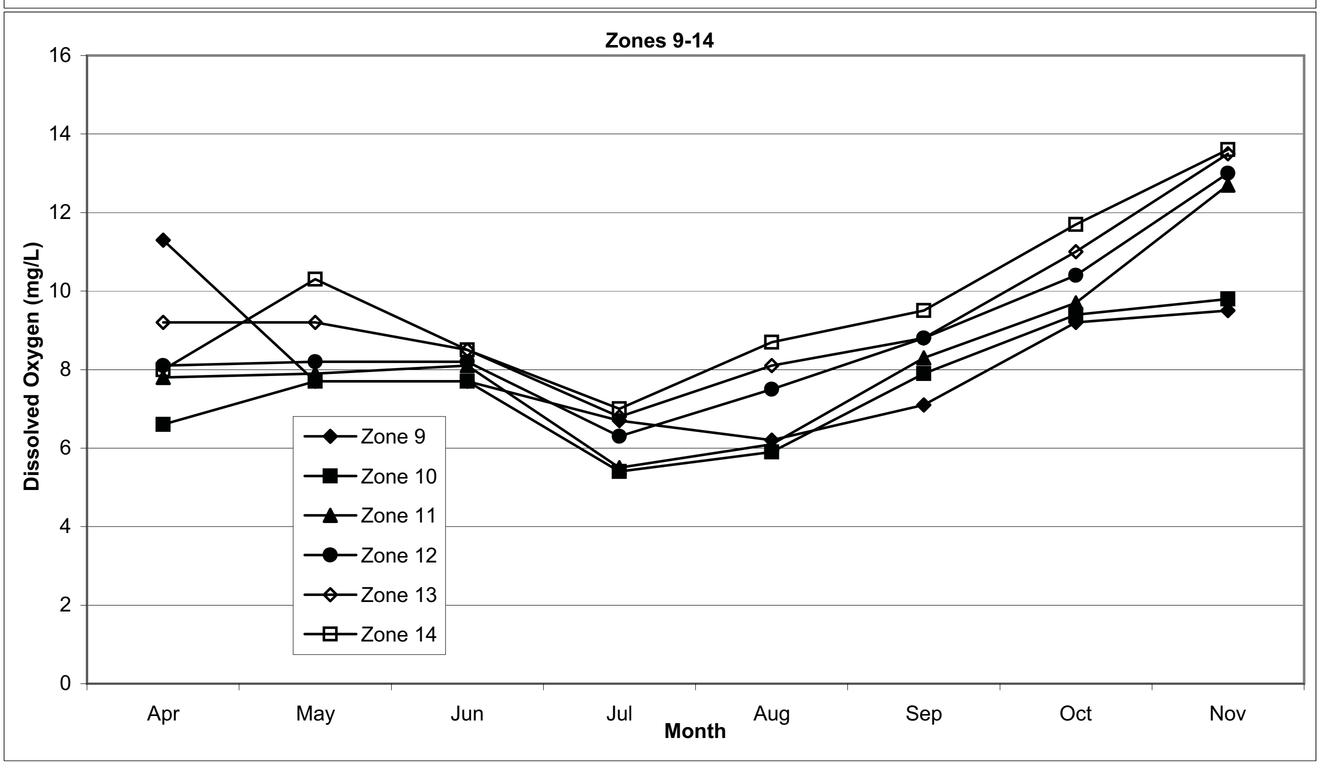




Figure 4-22 Spatial and temporal distribution of mean mid-depth dissolved oxygen observed during the Pelagic Trawl Effort, April - November 2003

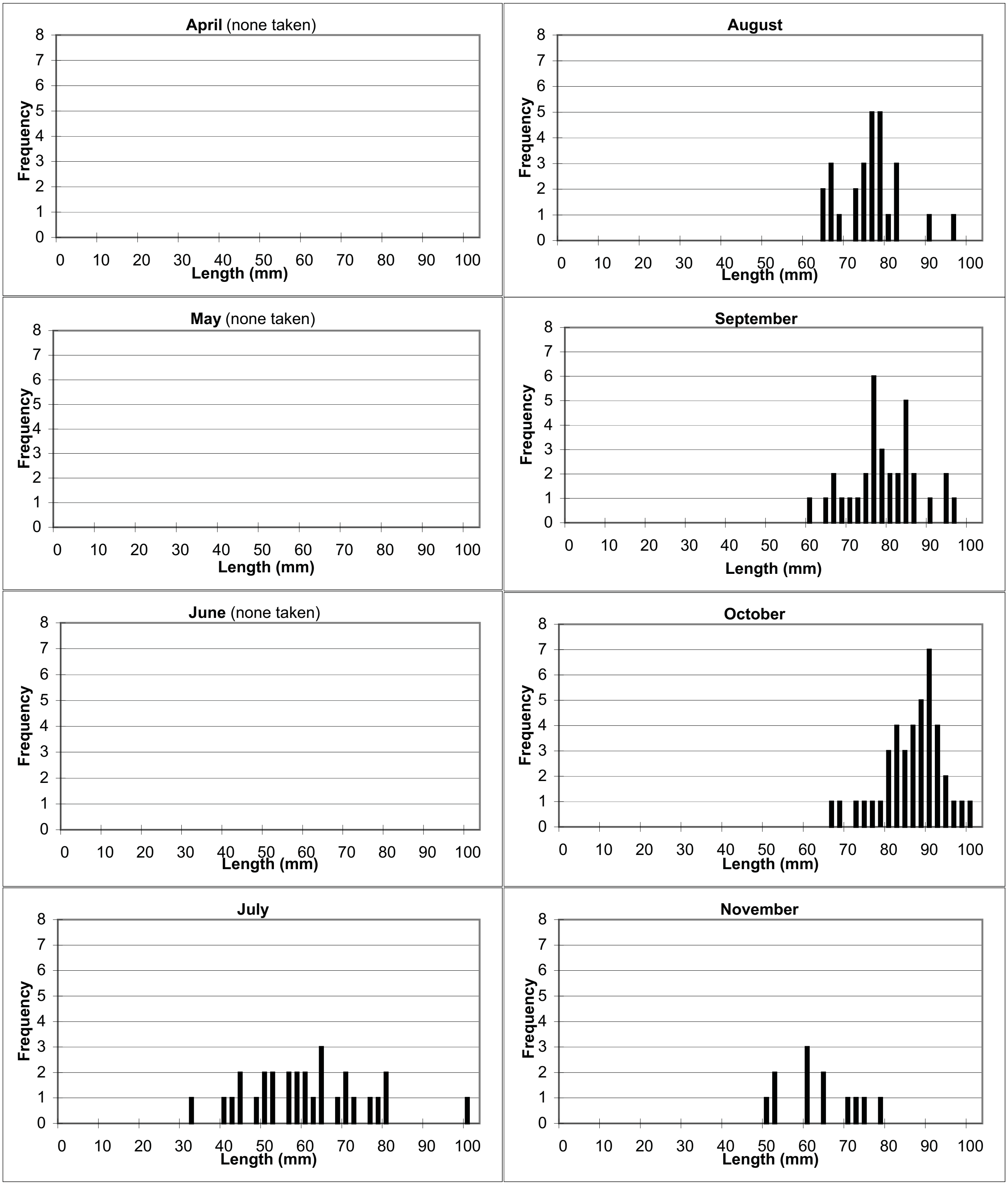



Figure 4-23 Length-frequency distribution of alewife by month during the Pelagic Trawl Effort, April - November 2003

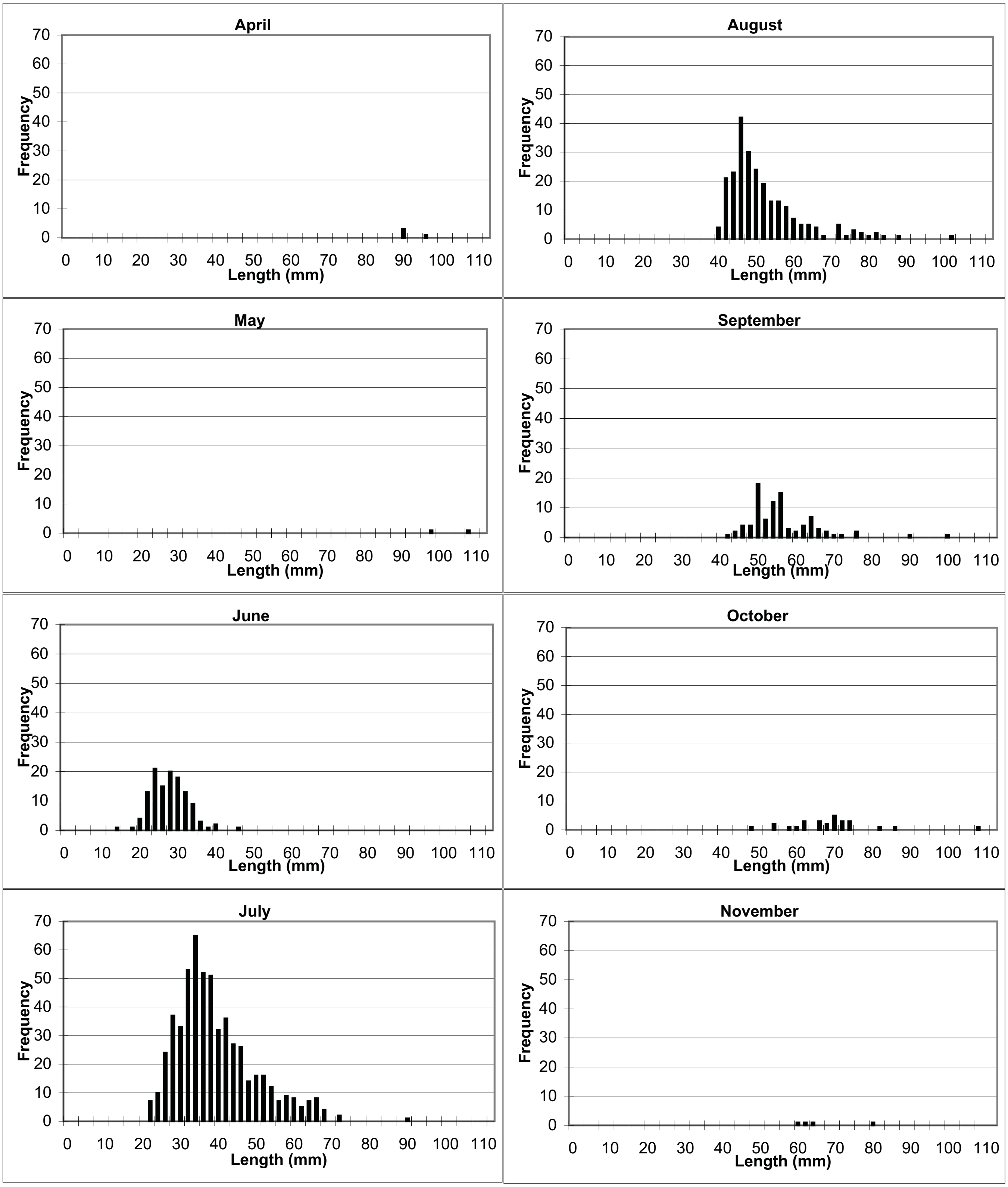



Figure 4-24 Length-frequency distribution of American shad by month during the Pelagic Trawl Effort, April - November 2003

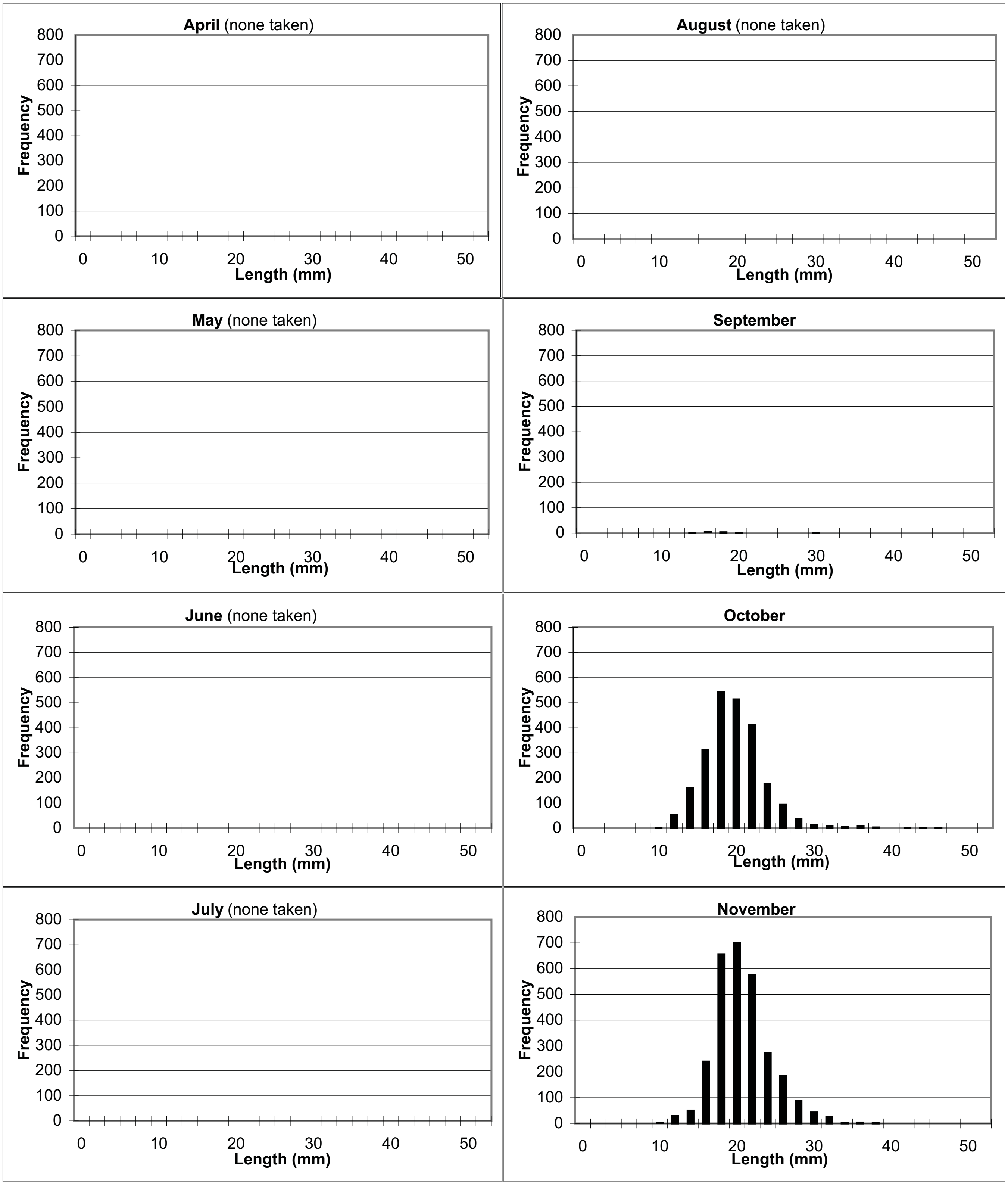



Figure 4-25 Length-frequency distribution of Atlantic croaker during the Pelagic Trawl Effort, April - November 2002

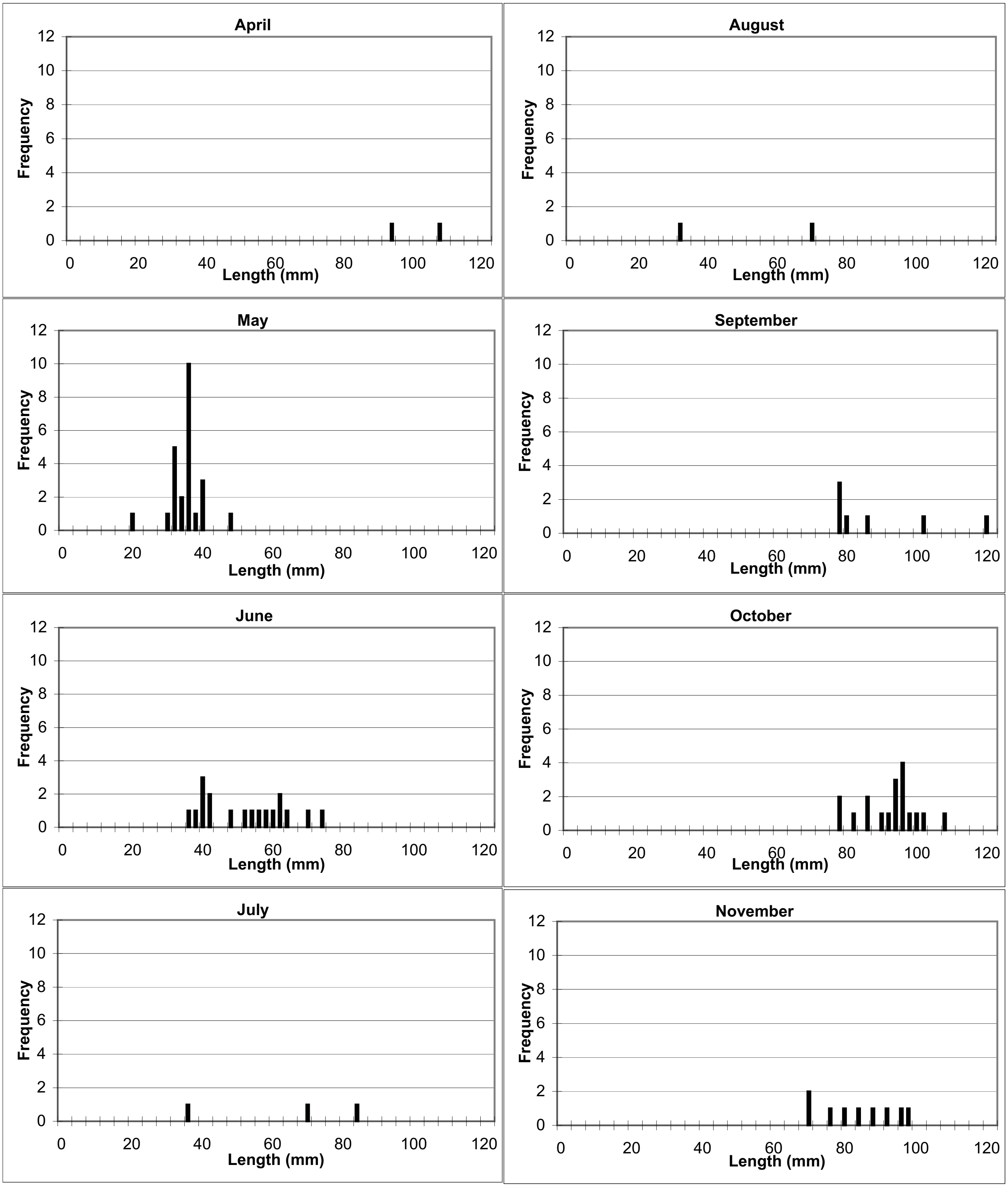



Figure 4-26 Length-frequency distribution of Atlantic menhaden by month during the Pelagic Trawl Effort April - November 2003

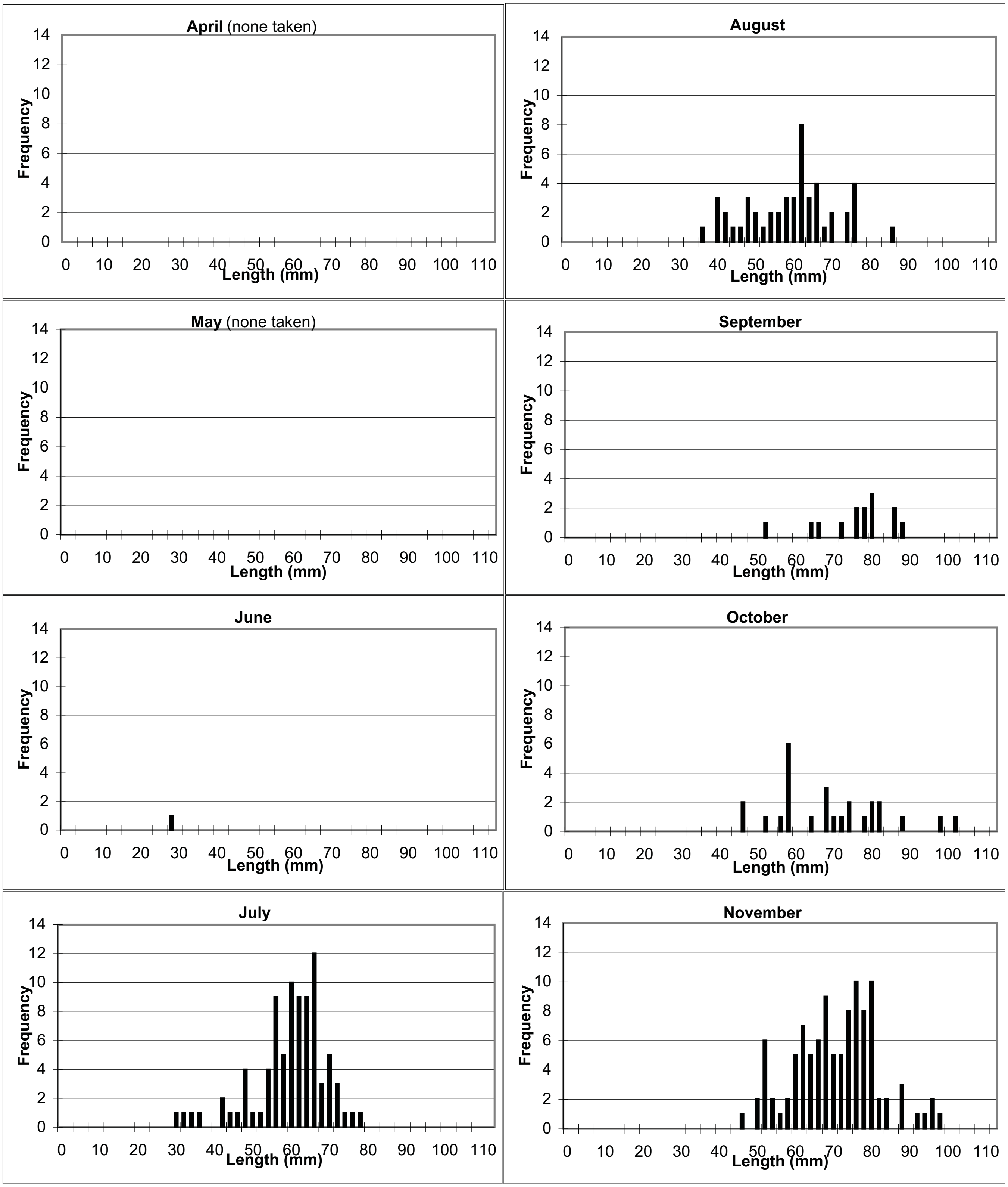



Figure 4-27 Length-frequency distribution of Atlantic silverside by month during the Pelagic Trawl Effort, April - November 2003

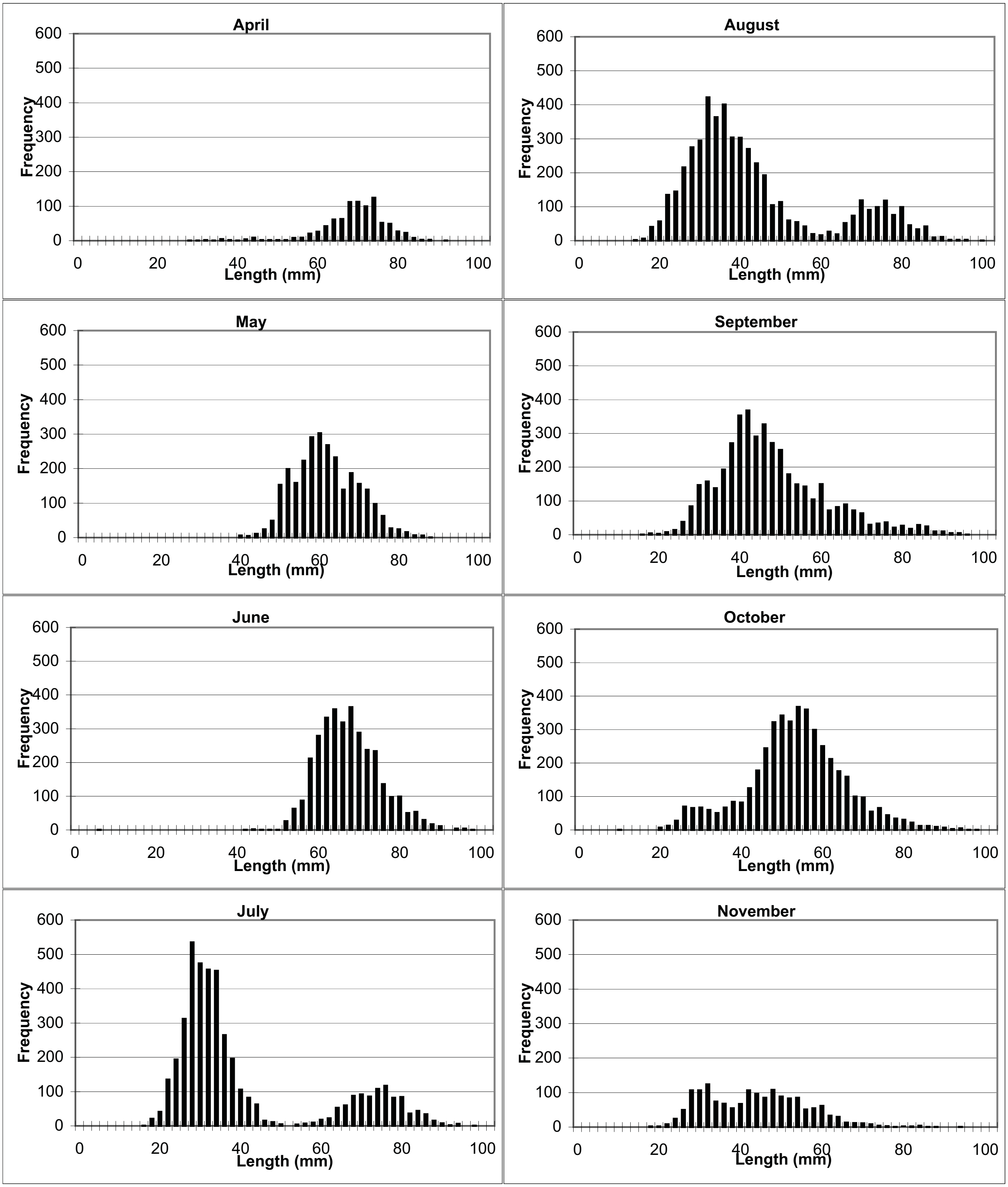



Figure 4-28  Length-frequency distribution of bay anchovy by month during the Pelagic Trawl Effort, April - November 2003

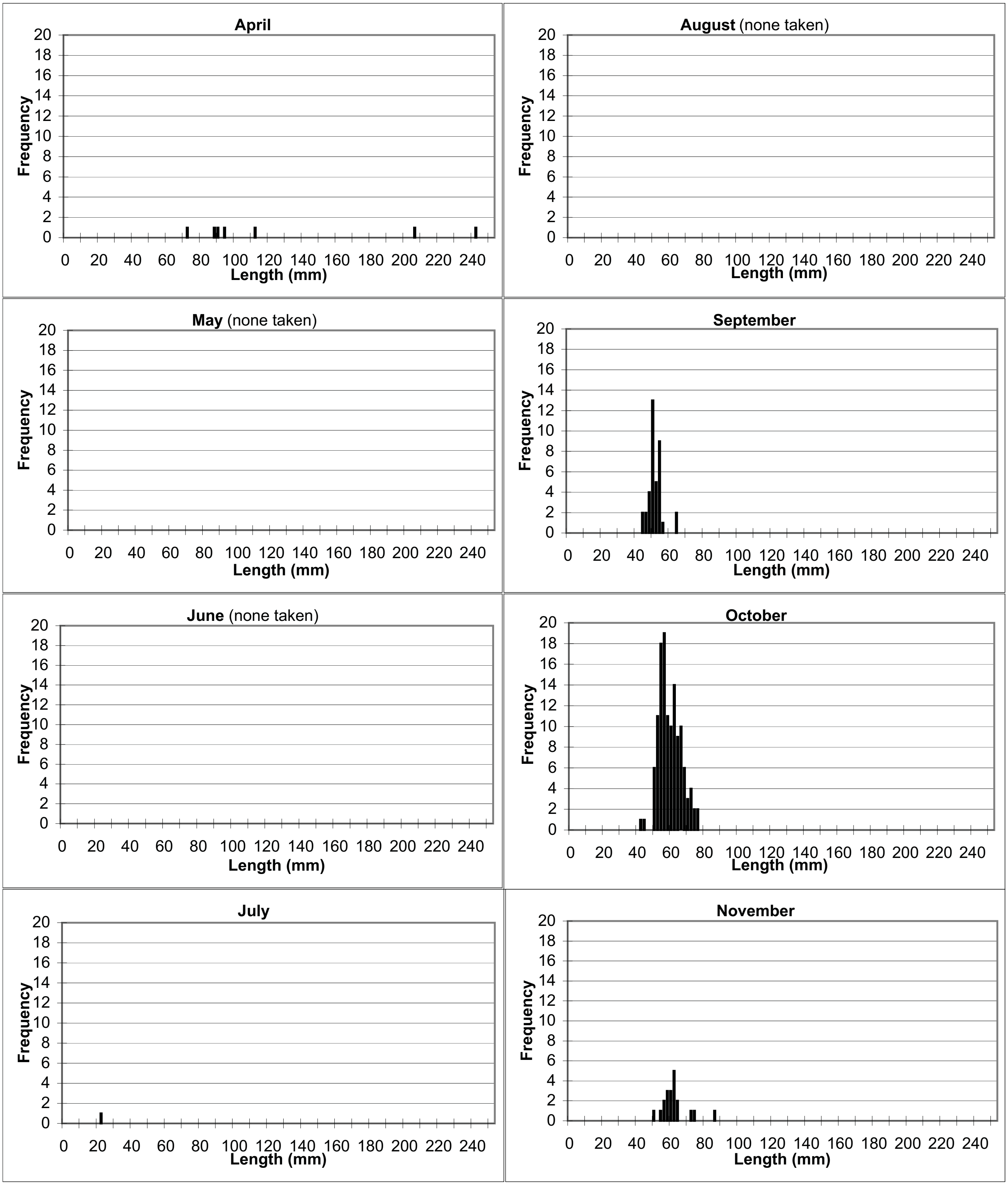



Figure 4-29 Length-frequency distribution of blueback herring by month during the Pelagic Trawl Effort, April - November 2003

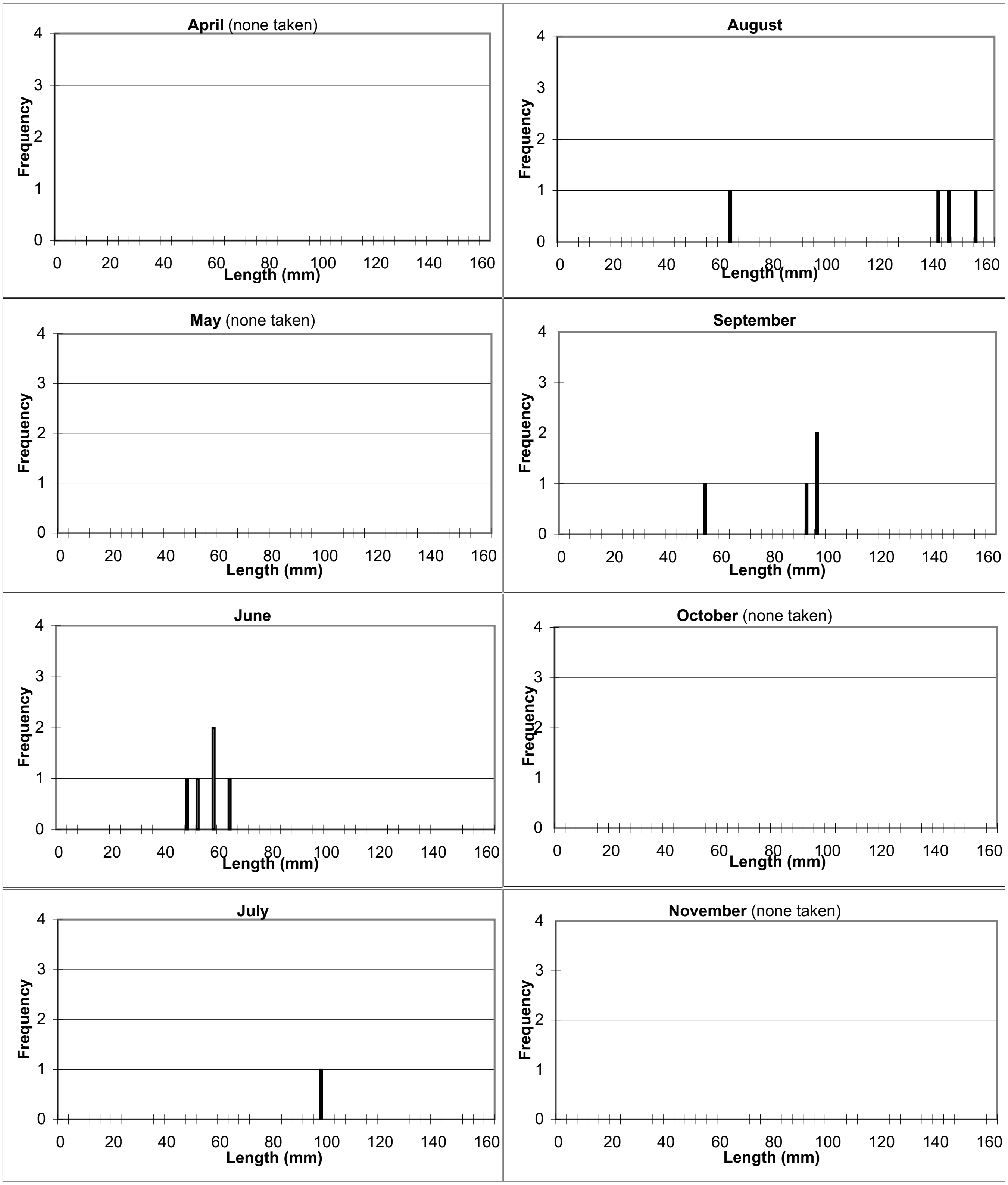



Figure 4-30 Length-frequency distribution of bluefish by month during the Pelagic Trawl Effort, April - November 2003

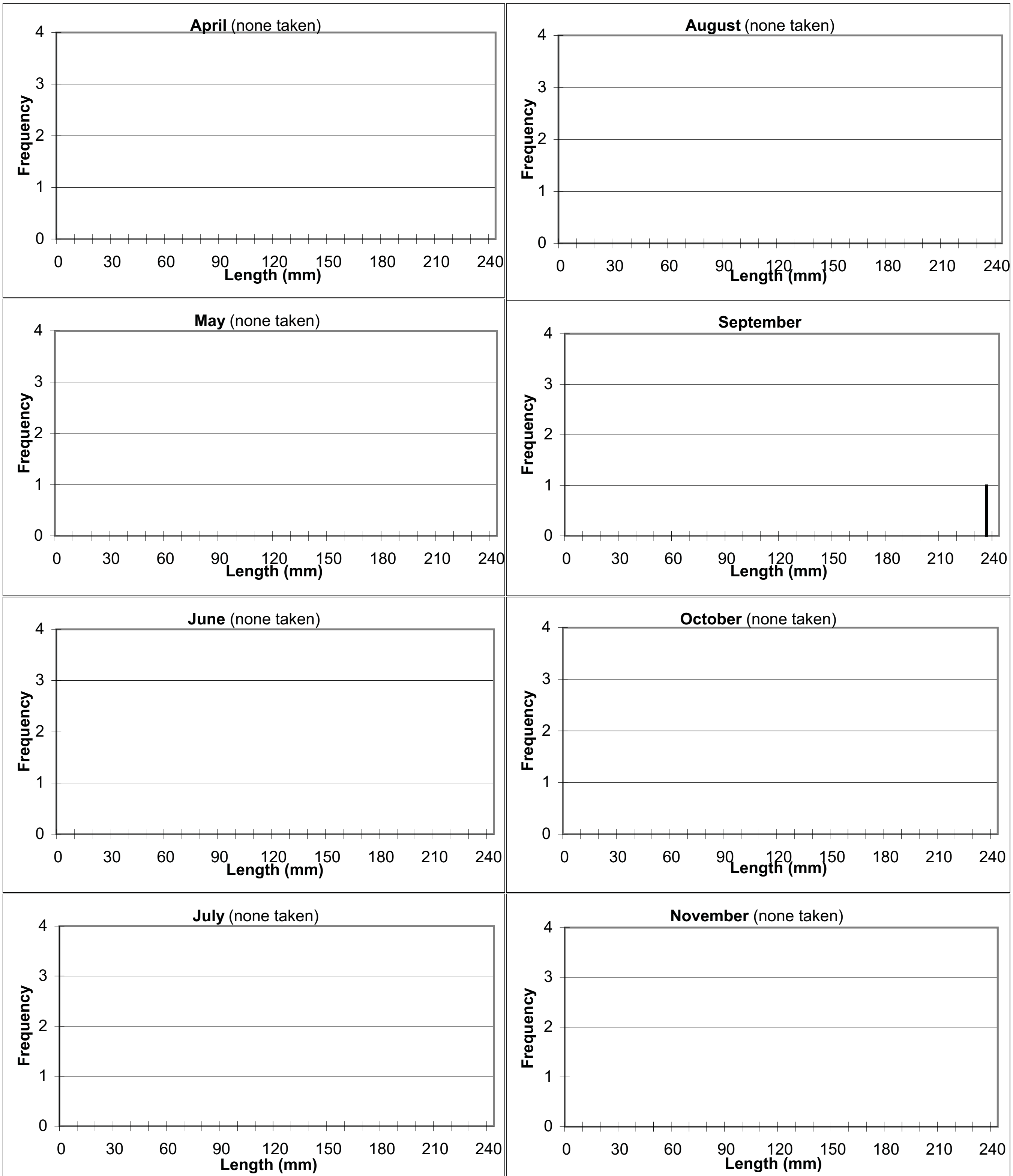



Figure 4-31 Length-frequency distribution of spot by month during the Pelagic Trawl Effort, April - November 2003

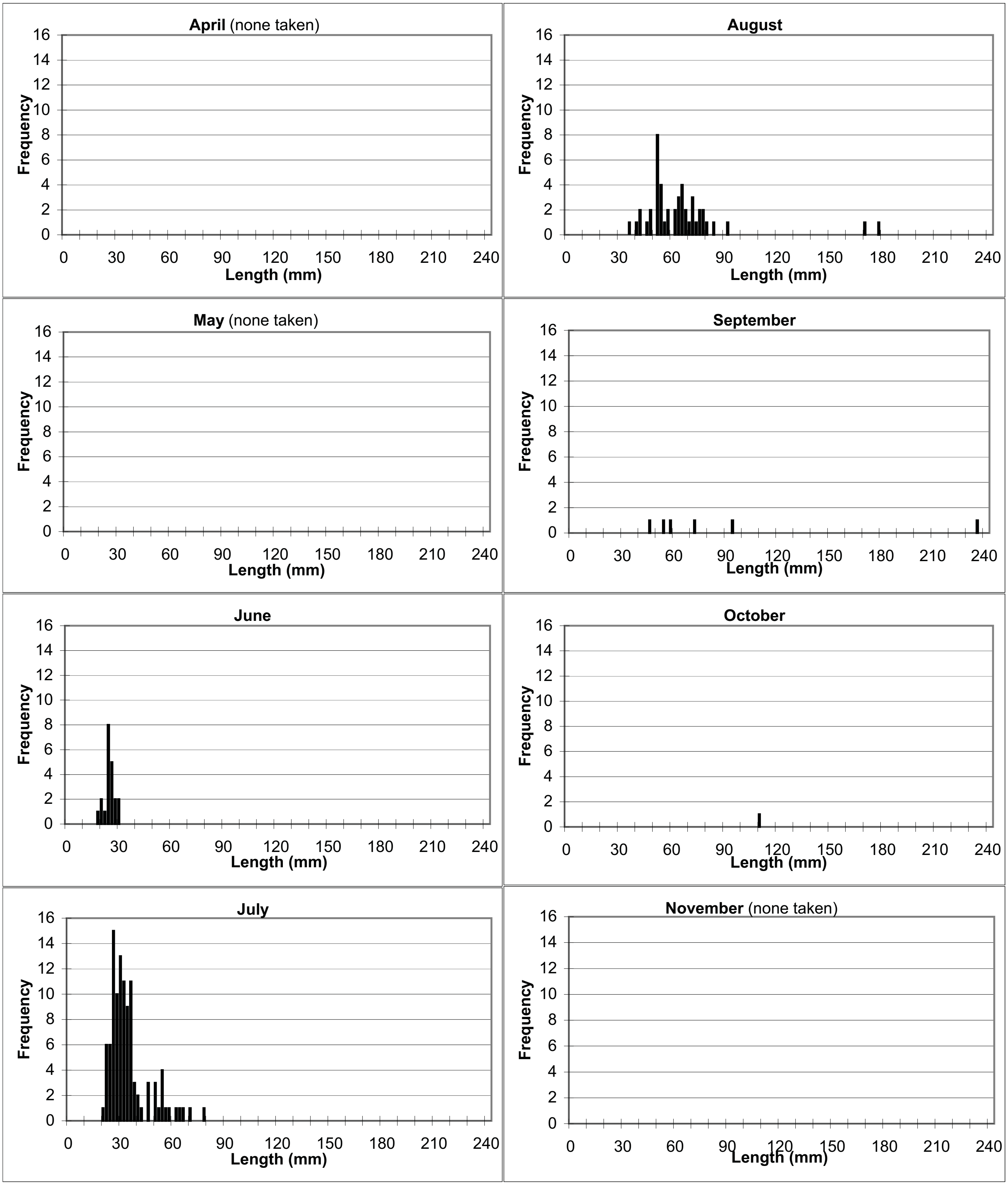



Figure 4-32 Length-frequency distribution of striped bass by month during the Pelagic Trawl Effort, April - November 2003

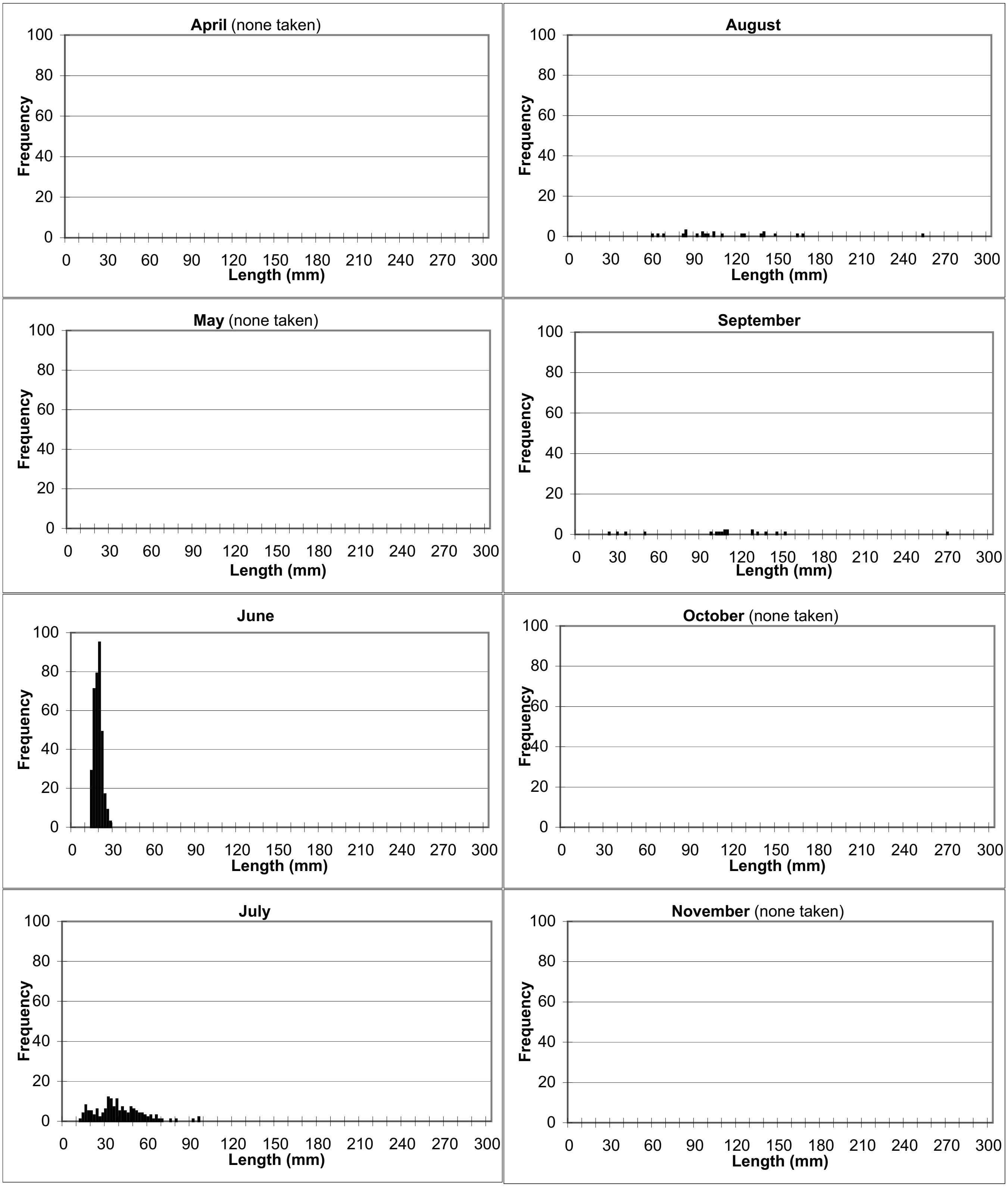



Figure 4-33 Length-frequency distribution of weakfish by month during the Pelagic Trawl Effort, April - November 2003

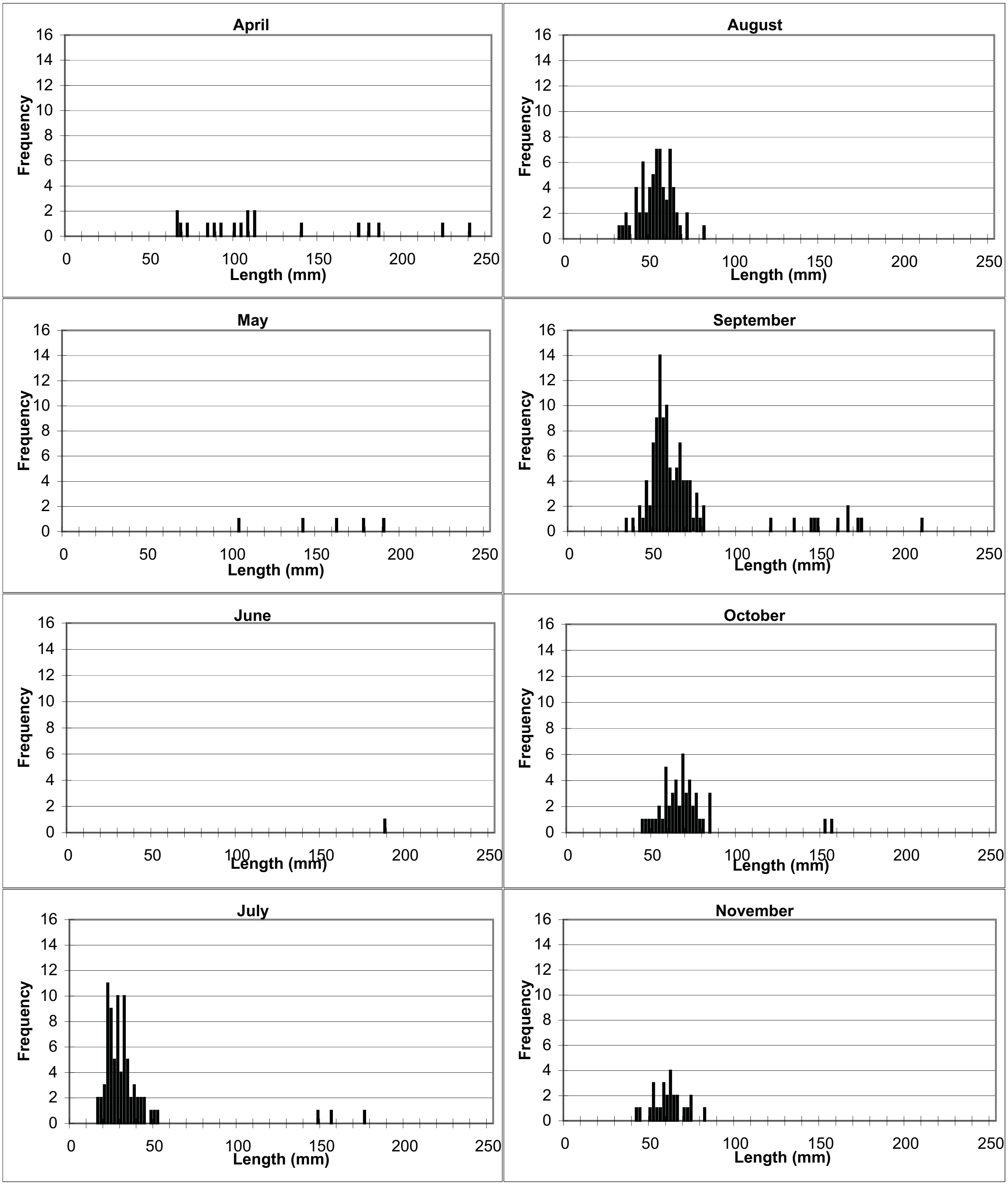
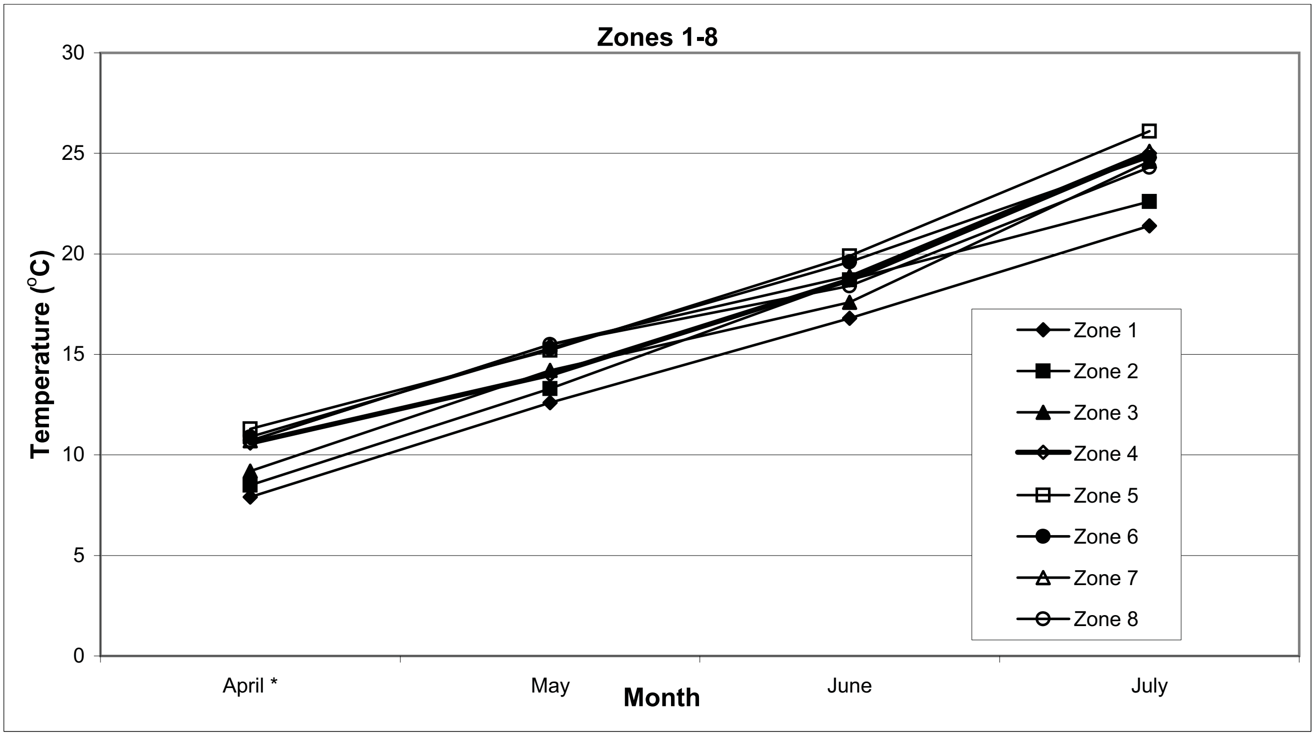



Figure 4-34  Length-frequency distribution of white perch by month during the Pelagic Trawl Effort, April - November 2003



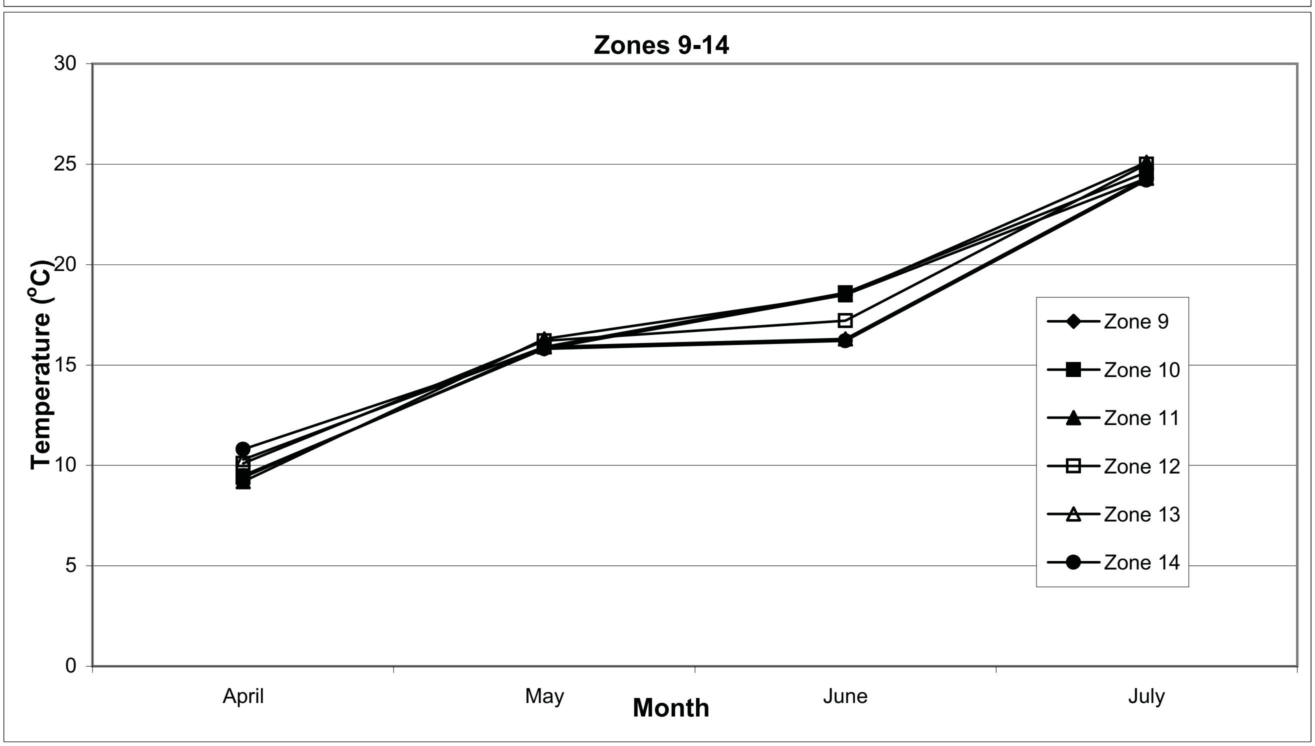
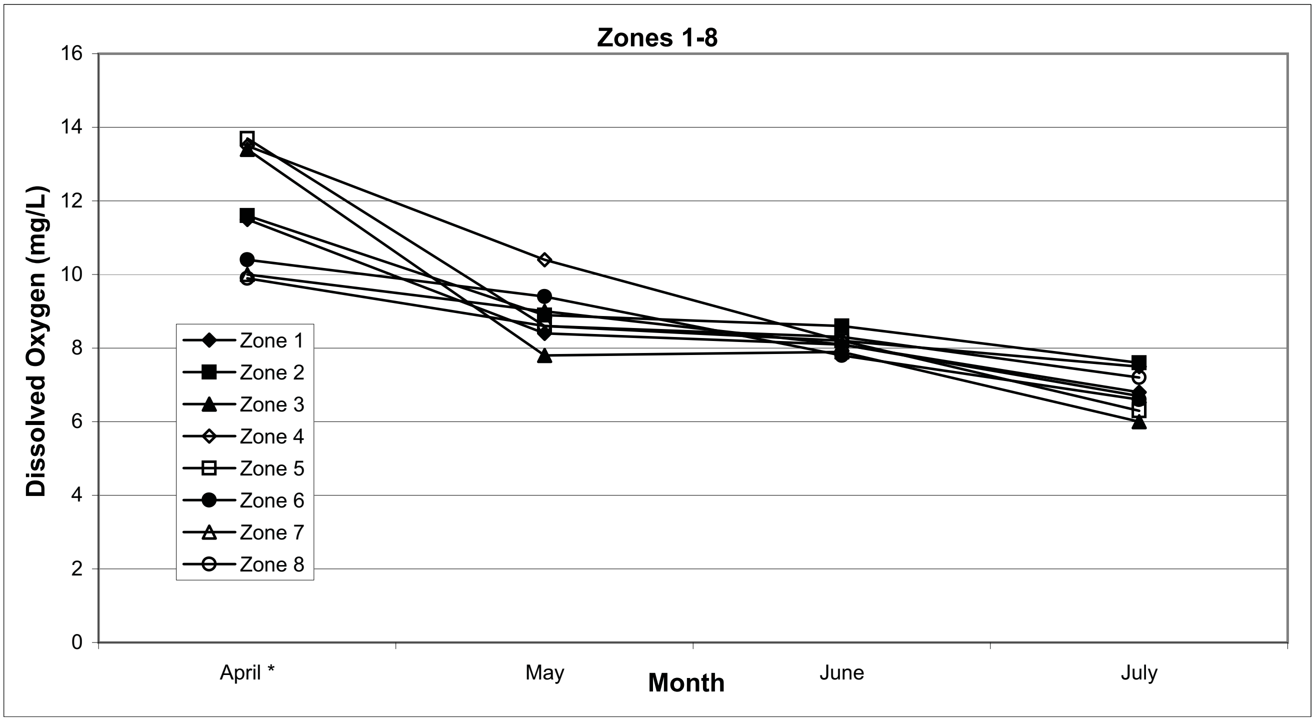




Figure 4-35 Spatial and temporal distribution of mean mid-depth water temperatures observed during the Ichthyoplankton Trawl Effort, April - July 2003

* Event 1 not represented in Zones 1-8 for April 2003



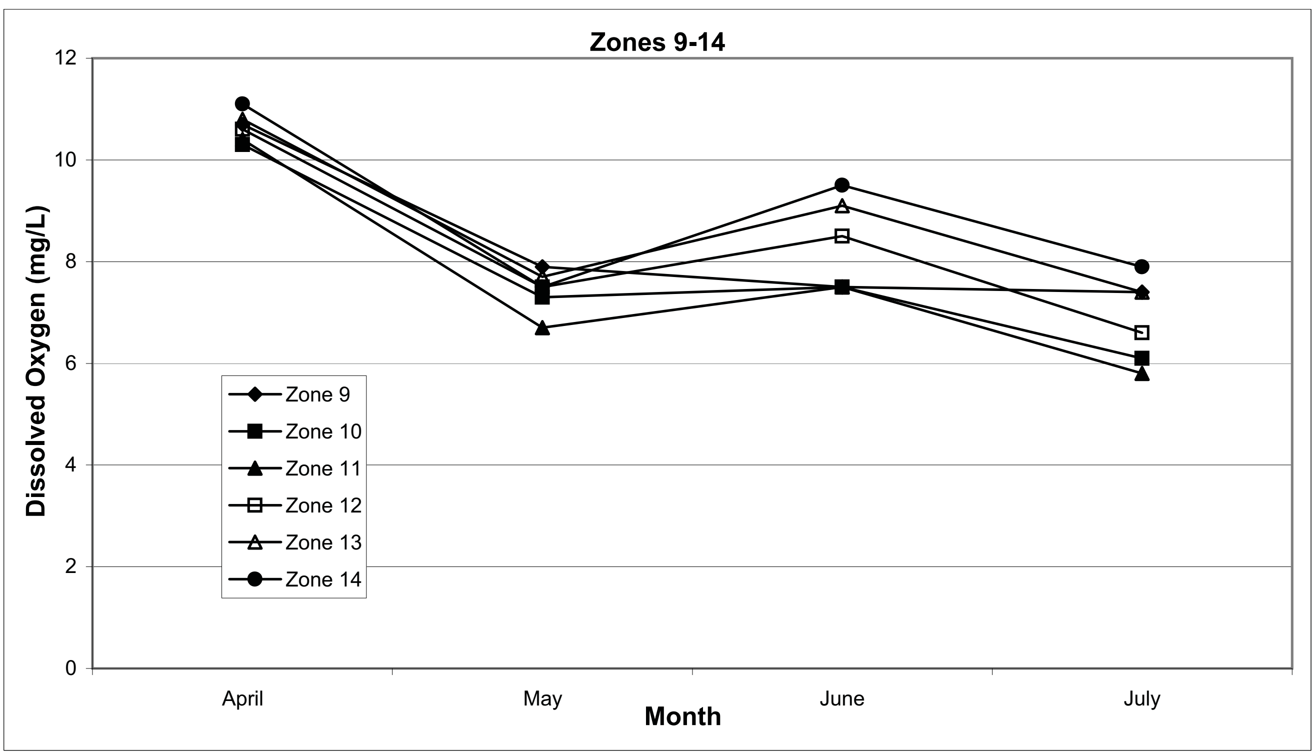




Figure 4-37 Spatial and temporal distribution of mean mid-depth dissolved oxygen observed during the Ichthyoplankton Trawl Effort, April - July 2003

* Event 1 not represented in Zones 1-8 for April 2003

## CHAPTER 5: BAYWIDE BEACH SEINE

### TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# BAYWIDE BEACH SEINE

## INTRODUCTION

A number of annual survey programs collect empirical data on the relative abundance of finfish of the Delaware River estuary. Among various finfish studies that have been conducted over the past several decades is the Delaware River Striped Bass Recruitment Study conducted by the New Jersey Department of Environmental Protection (NJDEP). This annual survey, initiated in 1980, entails beach seine sampling throughout the tidal Delaware River from the Chesapeake and Delaware Canal to the fall line at Trenton, New Jersey. While the number of sampling stations has varied over the years, presently 32 stations are sampled with a 100-ft (30.5-m) beach seine on a monthly frequency in June and November, and semimonthly during July through October. Whereas the focus of this survey is to monitor the year-class strength of striped bass (*Morone saxatilis*), relevant abundance data is obtained for other species such as white perch (*Morone americana*), blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*), which similarly utilize the shallows within this portion of the River as part of their principal nursery grounds during this temporal period.

PSEG's Baywide Beach Seine Survey was initiated in 1995 to complement the NJDEP seine survey, providing sampling beyond the geographical boundaries of the respective study area to more fully characterize target species abundance and distribution patterns within the estuary. To enhance compatibility with the results being generated from the existing agency sampling program, the sampling gear and deployment procedures for the Baywide Beach Seine Survey were developed following the methods described in Baum (1994), and through personal communications with the principal investigator Mr. Thomas Baum of NJDEP.

This report constitutes the ninth-year progress report for the Baywide Beach Seine Survey. It presents the overall results of sampling and provides discussion regarding the occurrence of the SGS finfish target species: blueback herring, alewife, American shad (*Alosa sapidissima*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), white perch, striped bass, bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), and Atlantic croaker (*Micropogonias undulatus).*

## MATERIALS AND METHODS

Beach seine sampling was conducted during daylight once per month in June and November, and twice per month during July through October. Daylight is defined as the period one hour after sunrise to one hour before sunset. Samples were taken at 40 fixed stations in the Delaware Bay and lower River (Figure 5-1). Sampling at all stations was conducted within the period of two hours before to two hours after high slack water specific to that particular location. Sampling at high water increases the probability that individuals collected are more likely to be bayfront, shore zone residents rather than marsh tributary transients.

Station spatial distribution was based on a partitioning of the overall study area shoreline into 32 equal-length regions. During the design phase of the study in 1995, the perimeter of the Delaware Bay from Cape May, NJ (rkm 0) to the lower Delaware River at the Chesapeake and Delaware Canal (rkm 100) was divided into 32 equal-length regions. Each region was further partitioned into 0.1-nautical mile segments. One fixed station was established within each of the 32 regions. Eight additional stations were established at bayfront locations adjacent to PSEG marsh restoration sites. These 40 fixed stations (identifiable by latitude/longitude coordinates and flagged, labeled markers) have been sampled annually since 1995.

Seine hauls were taken with a 100- x 6-ft (30.5- x 1.8-m) bagged haul seine with a 1/4-inch (6.25 mm) nylon mesh, identical to the gear employed by New Jersey Department of Environmental Protection (NJDEP) in their beach seine program conducted upstream of the present study. The seine is set perpendicularly from shore, by boat, until the bag is reached, at which time the remainder of the net is set in an arc-like fashion back to shore. The direction of the set was chosen relative to prevailing tidal current, wind and surf conditions to produce the most effective net deployment. The standard sampling effort was a single haul at each station.

With each collection, finfish were identified to the lowest practical taxonomic level (usually species), counted, and measured. A subsample of 100 specimens of each target species was measured to the nearest mm. For all non-target species, minimum and maximum lengths were recorded. Fork length (FL) was measured for all species with emarginate or forked caudal fins; for other species, total length (TL) was measured.

Surface measurements of water temperature (ºC), salinity (ppt) and dissolved oxygen (mg/ℓ) were recorded with each collection, as were water clarity (secchi depth), tidal stage, wave height, and weather conditions. Water quality parameters were measured with an YSI Model 85 OCST meter.

Catch results are summarized by sampling period, river kilometer (rkm) region and "beach type". The data are expressed in terms of total number taken, percent of total catch and mean number of specimens per seine haul. Sampling periods were each of the monthly or twice-monthly collection events; regions were defined as 20-rkm sections measured up the centerline of the estuary; and "beach types" were determined after qualitative assessments of the bottom type within the intertidal zone at the deployment location at each station. For graphic presentation purposes, species' length data was partitioned into 5-mm intervals.

# RESULTS AND DISCUSSION

## PHYSICAL AND CHEMICAL PARAMETERS

### Temperature

The pattern in water temperature observed in 2003 exhibited the typical seasonal pattern found in a temperate climate (Figure 5-2a). Over the period of sampling, mean shore zone water temperature increased from the initial value of 23.4ºC during the second half of June to the seasonal maximum level of 26.9°C during first half of July. Mean temperature remained stable through August, varying <1ºC. During the remainder of the sampling period, it decreased to 12.1°C during the first half of November.

The longitudinal differences across this lower 100 rkm of the estuary ranged from 1.0 to 5.6°C during the biweekly sampling periods (Figure 5-2b). The largest and smallest differences within sampling periods occurred during the first halves of November and October, respectively. Among regions, the highest mean temperatures were not recorded consistently in any particular region during the ten sampling periods. However, the lowest mean temperature occurred in region rkm 0-20 during five of ten sampling periods.

### Salinity

The overall range and mean values of salinity, as observed in the shore zone during the 2003 beach seine sampling, are presented in Figure 5-3a. It is important to note that the freshwater discharge in Delaware River was relatively high for the duration of the 2003 beach seine sampling season. The minimum flow during the sampling period, as measured at the Trenton, NJ gauging station was 149.7 percent of normal in July and the maximum was 449.1 percent of normal in September (www.state.nj.us/drbc/data). Within that context and considering the relatively restricted temporal window provided by the five-month sampling season, salinity levels exhibited in 2003 were most likely seasonally "typical" for a high flow or "wet" year, but comparison to other year's data are confounded by the recent two-month expansion of the sampling period in 2002. Mean values by sampling period ranging from 8.9 to 15.8 ppt, minimum values were 0.2 to 1.9 ppt, and maximum levels were 24.0 to 33.5 ppt.

The longitudinal gradient in salinity during the sampling periods also reflects the high flow profile with the greatest difference between minimum and maximum regional means of 32.1 ppt recorded in the first half of August (Figure 5-3b). During August the river flow at Trenton, NJ was 262.9 percent of normal (www.state.nj.us/drbc/data). The smallest difference between minimum and maximum regional means of 19.5 ppt was recorded in the first half of October, when river flow was 408.9 percent of normal.

### Dissolved Oxygen

The Delaware Bay is generally considered to be well oxygenated throughout the year, and the high degree of tidal-driven mixing results in nearly homogeneous vertical distributions of dissolved oxygen in the water column (PSE&G 1984). Smith (1987) and Michels (1995) concluded that dissolved oxygen levels in the Delaware Bay are not limiting to normal finfish species distributions. The minimum dissolved oxygen value measured during the study period of 3.0 mg/ℓ was recorded at Station 24 during the first half of July. Mean dissolved oxygen by sampling period ranged from 6.0 to 8.7 mg/ℓ, and demonstrated the generally increasing seasonal trend as water temperature decreased (Figure 5-4a).

Regional mean dissolved oxygen concentrations are depicted in Figure 5-4b. During a given sampling period, the greatest regional difference of 3.6 mg/ℓ was recorded during the second half of June. The greatest difference in mean dissolved oxygen within a region by sampling period was recorded in region rkm 0-20 with a range of 2.8 mg/ℓ. The smallest difference in mean dissolved oxygen within a region by sampling period was recorded in region rkm 61-80 with a range of 0.9 mg/ℓ.

## CATCH COMPOSITION

Totals of 22,956 specimens of 49 finfish species and 79 blue crab (*Callinectes sapidus*) were collected in the 400 seine samples during 2003 (Table 5-1). Atlantic silverside was the most abundant species taken in the seine catch (n=11,671), comprising 50.9 percent of the annual sample (Table 5-2). Bay anchovy, with a catch of 5,438 specimens, ranked second and comprised 23.7 percent of the catch. Historically, Atlantic silverside and bay anchovy have been dominant in the shore zone of the lower Delaware Estuary (Daiber 1954; DeSylva *et al.* 1962; PSEG 1996-2003). Striped killifish (*Fundulus majalis*), weakfish, striped bass, Atlantic menhaden, and Atlantic croaker were the only other species to individually represent at least one percent of the total catch. Nearly half (20 of 49) of the species taken were represented by 10 or fewer specimens. A total of six species was taken during all 10 sampling events; nine species were taken in all regions; and 11 species were taken at all beach types. Only five species were collected during all sampling periods, in all regions and at all beach types: Atlantic menhaden, bay anchovy, Atlantic silverside, white perch and striped bass. These species may be characterized as the ubiquitous core of this seasonal baywide, shore zone community in 2003.

The component of the seine catch composition represented by the target species is provided in Tables 5-2, 5-3 and 5-4. Temporally, Atlantic silverside comprised from 10.4 to 64.6 percent of the catch within the 10 sampling periods, and was the predominant target species during the eight periods from July through October (Table 5-2). Bay anchovy comprised from 6.1 to 32.8 percent of the catch during these ten periods, and ranked second in abundance during seven of ten periods. Weakfish represented 12.5, 15.4 and 7.4 percent of the catches, respectively, during the three sampling periods in July and the first half of August. Striped bass, Atlantic menhaden and blueback herring were the only other target species to comprise more than five percent of the total catch in any given sampling period. Striped bass comprised from 6.4 to 19.9 percent of the catch during the first three sampling periods. Atlantic menhaden represented 36.9 percent of the catch during the first sampling period, and blueback herring comprised 7.9 percent in the second half of October. Spatially, Atlantic silverside comprised from 7.7 to 60.4 percent of the catch within the five 20-rkm regions, and was the predominant target species in the four regions rkm 0-80 (Table 5-3). Bay anchovy represented from 15.7 to 53.8 percent in the five regions. They ranked second to Atlantic silverside in regions 0-80, but were the predominant target species in region rkm 81-100. Weakfish, striped bass, Atlantic mendaden, Atlantic croaker and blueback herring were the only other target species that comprised more than five percent of the total catch in any of the five regions. Weakfish represented 5.2 percent of the catch in region rkm 0-20 and 6.0 percent in rkm 41-60. Striped bass comprised 11.5 percent in region rkm 61-80 and 10.8 percent in rkm 81-100. Atlantic menhaden represented 11.8 percent of the catch in region rkm 81-100. Atlantic croaker comprised 7.2 percent of the catch in region rkm 0-20, and blueback herring comprised 5.9 percent of the catch in region rkm 81-100. At the five beach types, Atlantic silverside comprised from 20.4 to 60.5 percent of the total catch, and was the predominant target species at the sand, sand/peat and peat/mud beaches. Bay anchovy comprised from 9.9 to 43.6 percent of the catch at the five beach types, and was the predominant target species at the peat and mud beaches. Weakfish and Atlantic menhaden were the only other target species to comprise more than five percent of the total catch in any of the five beach types. Weakfish comprised 5.0 and 5.7 percent at the peat and peat/mud beaches, respectively, and Atlantic menhaden represented 5.1 percent of the total catch at sand/peat beaches.

## SPECIES RICHNESS AND NUMERIC ABUNDANCE

As a result of the dominance of the Atlantic silverside and bay anchovy (75 percent of the catch), the measure of numeric abundance relative to time, region and beach type largely reflects the pattern of occurrence of these species across these gradients. Overall finfish abundance in the shore zone, as measured by mean catch per haul, was initially low at 22.6 in the first half of June then increased to the first of two seasonal peaks in abundance during the second half of August with a mean catch per haul of 94.7 (Figure 5-5a). The second peak occurred during the first half of October with a catch of 107.0 per haul. These peaks were supported by the predominance of Atlantic silversides and bay anchovy (Table 5-2). Thereafter, catches were ≤ 57.4. Regionally, finfish abundance was similarly high in the regions rkm 0-20 and 21-40 with mean catches per haul of 75.3 and 72.9, respectively (Figure 5-5b). Abundance was intermediately high in regions rkm 41-60 and 61-80 with mean catches of 44.5 and 41.9, respectively. Relative to beach type, abundance was highest at mud beaches with a mean catch of 99.4 (Figure 5-5c). Abundance at the other beach types ranged from 38.9 at peat beaches to 67.8 at sand beaches.

Over the sampling season, species richness (N) ranged from 16 in the second half of June to 33 in the first half of August; richness was ≥21 in all but three sampling periods. Regionally, species richness was highest in rkm 0-20 with 37 species taken (Figure 5-5b). Species richness was progressively lower in regions rkm 21-40, 41-60 and 61-80 with 31, 25 and 25 species, respectively. Richness was lowest (N=15) in rkm 81-100; the lower salinity (<5 ppt) of this reach of the study area is not generally tolerated by most marine species, but was too high for the occurrence of most freshwater species. Relative to beach type, species richness was highest at the sand beaches with 45 species taken; intermediate at the sand/peat and peat beaches with 31 and 26 species, respectively; and low at peat/mud and mud beaches with 14 and 17 species, respectively (Figure 5-5c).

## SPECIES ACCOUNTS

The following species accounts present the sampling results specific to each of the SGS target finfish species. These data summaries describe periods of occurrence, temporal and spatial abundance patterns, size distribution and inferred age composition. Graphic presentations of abundance and length-frequency data were prepared for those target species represented by at least ten specimens collected.

### American shad, blueback herring, and alewife

Totals of 117 American shad, 214 blueback herring, and 52 alewife were taken in this study during 2003 (Table 5-1). American shad was collected during all but two sampling periods, i.e., second halves of July and September; abundance was highest in the first half of November with a catch of 1.2 per haul (Figure 5-6a). Blueback herring was collected only during the last two sampling periods; the catch per haul was 3.9 in the second half of October when over 70 percent of the individuals were taken (Table 5-1; Figure 5-9a). Alewife was taken during the first half of September (<0.1 per haul), second half of October (0.9), and in the first half of November (0.4; Figure 5-10a). All individuals taken were members of the 2003 year class (PSE&G 1999a), with American shad ranging in length from 27 to 78 mm FL (Figure 5-7), blueback herring ranging from 40 to 69 mm FL (Figure 5-9), alewife ranging from 51 to 105 mm FL (Figure 5-11). American shad was taken in all regions except rkm 21-40, and were similarly abundant in regions rkm 61-80 and 81-100 with a mean catches of 0.9 and 1.0 per haul, respectively (Figure 5-6b). Blueback herring was taken in all regions except rkm 0-20, and were similarly abundant in regions rkm 41-60 and 81-100 with a mean catches of 1.8 and 1.7 per haul, respectively (Figure 5-8b). Alewife was taken in all regions, but most abundant in rkm 81-100 with a mean catch of 0.3 (Figure 5-10 b). Relative to beach type, none of the three species was taken at stations characterized by peat/mud or mud, but all three were collected the other three beach types (Table 5-4). American shad was most abundant at peat beach type with a mean catch of 0.9 per haul (Figure 5-6c). Blueback herring and alewife were most abundant at the sand beach type with catches of 0.9 and 0.2 per haul (Figures 5-8c and 5-10c).

As has been observed in all prior years except 2001 (PSE&G 1996-2000 and PSEG 2001-2003), the relatively small annual catch of alosids observed in the present study were at least an order of magnitude lower (given an essentially similar level of effort) than taken upriver in the NJDEP beach seine monitoring program (Baum, pers. comm., preliminary 2003 catch data). The annual results of the present study, considered in conjunction with the agency survey, continues to provide evidential support to the general concensus that the summer nursery grounds for these three species within the main-stem Delaware Estuary is restricted to freshwater and brackish portions of the River.

**Atlantic menhaden**

During 2003, a total of 603 Atlantic menhaden was taken (Table 5-1). As one of the ubiquitous core species group, Atlantic menhaden was taken during all sampling periods, in all regions, and at all beach types (Figure 5-12). They were most abundant during the second half of June, with a catch of 8.3 specimens per haul; abundance through the remaining sampling periods was low with catches ≤ 1.8 per haul (Figure 5-12a). Atlantic menhaden ranged in length from 20 to 139 mm FL (Figure 5-13), and all were age 0+ (Able and Fahay 1998). During the period from the second half June through the second half of August when over 83 percent of total catch was collected, their modal length ranged from 33 to 48 mm FL. Although taken in all regions, Atlantic menhaden was most abundant in region rkm 81-100 with a mean catch of 3.4 per haul (Figure 5-12b). Mean catches in the other regions ranged from 0.2 to 2.1. Atlantic menhaden was most abundant at the sand/peat beach type with a mean catch of 2.7 (Figure 5-12c). The catch at the other beach types was ≤1.4.

**Bay anchovy**

A total of 5,438 bay anchovy was taken, comprising 23.7 percent of the 2003 seine catch (Tables 5-1 and 5-2). As a characteristically ubiquitous species within the study area, bay anchovy was taken during all sampling periods, in all regions, and at all beach types (Figure 5-14). Initially in the sampling season, i.e., second half of June through July, the catch of bay anchovy was low with mean catches ≤ 7.4 per haul, then it increased to the first of two similar seasonal peaks in abundance during the second half of August with a mean catch per haul of 27.2 (Figure 5-14a). The second peak occurred during the first half of October with a catch of 32.2 per haul. Thereafter, catches declined to 6.7 per haul in the first half of November. Bay anchovy ranged in length from 16 to 98 mm FL (Figure 5-15), including individuals age 1+ and older (PSE&G 1999a). Based on the subsample measured, all individuals taken in the second half of June were age 1+ and older. Age 1+ and older continued to dominate the catch in July comprising from 79 to 92 percent of the catch. Modal lengths in June and July samples were 63 and 73 mm FL. Thereafter, age 0+ of the 2003 year-class dominated the catch of bay anchovy during each collection period comprising from 69 to 99 percent, and modal lengths were 43 to 48 mm. Overall, age 0+ individuals comprised about 72 percent of the species' catch. Bay anchovy was most abundant in the region rkm 21-40 with a mean catch of 17.7 per haul, and least abundant in rkm 41-60 with a catch of 8.2. In the other regions, the mean catches ranged from 11.8 to 15.4 (Figure 5-14b). Bay anchovy was most abundant at the mud beach type with a mean catch of 33.3 specimens per haul (Figure 5-14c). The catch at the other beach types was ≤ 17.0.

**Atlantic silverside**

Atlantic silverside was the most abundant species collected during 2003, with a total of 11,671 specimens taken (Table 5-1). As one of the ubiquitous core species group, Atlantic silverside was taken during all sampling periods, in all regions, and at all beach types (Figure 5-16). Their abundance was bi-modal with the first protracted peak occurring during the three sampling periods from second half of July through the second half of August with mean catches of 39.5, 45.2 and 42.8 specimens per haul, respectively (Figure 5-16a). The second larger but temporally compressed peak in abundance was in the first half of October with a catch of 69.1 per haul. Thereafter, catches declined to 9.4 per haul in the first half of November. Atlantic silverside ranged in length from 13 to 122 mm FL (Figure 5-17), including individuals age 0+ to potentially age 2 (Conover and Ross 1982). Although age composition for this species is difficult to infer from length data alone, it appears that age 0+ (2003 year class) and 1+ (2002 year class) were evenly represented during the first collection period comprising 47.9 and 52.1 percent of the catch, respectively (Able and Fahay 1998). Thereafter, age 0+ were predominant in each collection period comprising from 95.8 to 100.0 percent. Modal lengths increased from 28 to 68 mm FL in sampling through August. In September through November modal lengths ranged from 58 to 68 mm FL. Atlantic silverside exhibited a general pattern of declining abundance in a progression up estuary (Figure 5-16b). Their abundance was similarly high in regions rkm 0-20 and 21-40 with mean catches of 41.8 and 38.0 per haul, respectively (Figure 5-16b). They were secondarily abundant in region rkm 41-60 with a mean catch of 26.9; the lowest catch per haul (2.2) occurred in region rkm 81-100. Atlantic silverside abundance was similarly high at the sand and sand/peat beach types with a mean catches of 37.3 and 32.5, respectively, and similarly low at peat and mud beaches with mean catches of 15.5 and 20.3 per haul, respectively (Figure 5-16c).

**White perch**

A total of 195 white perch was taken in the 2003 seine program (Table 5-1). Though taken in relatively low numbers, white perch appeared in all sampling periods, in all regions, and at all beach types (Figure 5-18). The relatively low catch was not totally unexpected since the principal summer nursery and feeding grounds occur in the tributaries to the Estuary and in the Delaware River above the upstream limits of the study area. By contrast, the NJDEP seine effort in the river upstream has yielded, with essentially the same level of effort, annual catches of 1,808 -13,791 white perch over the past 11 years 1993-2003 (Baum 1993-1996; Baum et al. 1997-2003; Baum, pers. comm., preliminary 2003 catch data). The sampling results of the present study, considered in conjunction with the agency survey, continues to provide evidential support to the general concensus that the summer nursery grounds for this species within the mainstem Delaware Estuary is restricted to the freshwater and brackish portions of the River.

White perch abundance was similarly high in the first halves of July and November with mean catches of 1.1 and 1.6 specimens per haul, respectively (Figure 5-18a). They were least abundant during the sampling periods from the second half of August through the second half of September with a catches of 0.1 per haul during each period. Their increasing abundance during the remaining collection periods through the first half of November reflects the typical onset of their seasonal downriver migration to overwintering areas within the lower River and Bay. White perch ranged in length from 21 to 328 mm FL (Figure 5-19), including individuals age 0+ to potentially age 10+ or older (Clark 1998). Age 0+ specimens comprised 70 percent of the catch. White perch exhibited a general pattern of increasing abundance in a progression up estuary (Figure 5-18b). Their abundance was similarly high in regions rkm 81-100 and 61-80 with mean catches of 1.1 and 1.0 per haul, respectively. They were intermediately abundant in regions rkm 41-60 and 21-40 with a mean catches of 0.3 in each region, and the lowest catch per haul (< 0.1) occurred in region rkm 0-20. White perch was most abundant at mud beaches with a mean catch of 0.7, and least abundant at peat/mud beaches with a mean catch of 0.1 (Figure 5-18c).

**Striped bass**

During 2003, a total of 852 striped bass was taken (Table 5-1). Striped bass was taken during all sampling periods, in all regions, and at all beach types (Figure 5-20). During the sampling season, the catch of striped bass increased from 1.5 specimens per haul in the second half of June to 6.1 per haul in the first half of July, and then generally decreased to catches of approximately one per haul during October and November (Figure 5-20a). Striped bass ranged in length from 20 to 556 mm FL (Figure 5-21), including individuals age 0+ to potentially age 4+ (Baum et al. 2002). Age 0+ was predominant during all sampling periods after the first one in the second half of June comprising 81 percent of the total catch. Striped bass was most abundant in region rkm 61-80 with a mean catch of 4.8 per haul, and secondarily abundant in region rkm 81-100 with a catch of 3.1 (Figure 5-20b). Mean catches in the other regions were ≤1.5. Striped bass was most abundant at the sand beach type with a mean catch of 3.4; secondarily abundant at sand/peat, mud and peat/mud beaches with mean catches of 2.1, 1.8 and 1.6 per haul, respectively; and least abundant at the peat beaches with mean catch of <0.1 (Figure 5-20c).

**Bluefish**

During 2003, a total of 100 bluefish was taken (Table 5-1). Bluefish was taken during all sampling periods except the second half of October, in all regions, and at all beach types except peat/mud (Figure 5-22). Their abundance was similarly high during the second half of June, the first half of July and the second half of August with mean catches of 0.5, 0.5 and 0.6, respectively (Figure 5-22a); during the other sampling periods their catches were ≤0.4. Bluefish ranged in length from 52 to 195 mm FL (Figure 5-23), all but one were age 0+ (Able and Fahay 1998). Bluefish was most abundant in region rkm 0-20 with a mean catch of 0.5 per haul (Figure 5-22b). Mean catches in the other regions ranged from 0.1 to 0.3. Bluefish was most abundant at the sand beach type with a mean catch of 0.4 (Figure 5-22c). The catch at the other beach types was ≤0.2.

**Weakfish**

During 2003, a total of 975 weakfish was taken (Table 5-1). Weakfish was taken during all sampling periods except the first halves of October and November, in all regions, and at all beach types (Figure 5-24). The catch was the highest during the second half of July with a mean catch of 10.1 per haul, declined to 1.4 during the first half of September, and thereafter the catch was ≤0.1 (Figure 5-24a). This trend is reflective of their seasonal movement offshore during the fall and exodus from the Estuary by late October/early November. Weakfish ranged in length from 19 to 775 mm TL (Figure 5-25). All but 11 individuals were age 0+ (2003 year class; Michels 1997); 10 of the older specimens were likely age 1+ and one was age 9+ (PSE&G 1999a). Modal lengths of age 0+ taken during July and August collection periods, when 93 percent of total catch was collected, ranged from 23 mm to 88 mm TL. Weakfish was most abundant in the region rkm 0-20 with a mean catch of 7.8 per haul (Figure 5-24b). Mean catches in the other regions were ≤2.3. Weakfish was most abundant at the sand beach type with a mean catch of 4.2 (Figure 5-24c). Their abundance was intermediate at the peat, peat/mud and mud beach types with mean catches of 1.6, 2.7 and 1.9, respectively, and lowest (0.8) at the sand/peat beach type.

**Spot**

A total of 11 spot was taken in 2003 (Table 5-1). Spot was taken only during the four sampling periods in July and August, in the two regions rkm 0-40 and region rkm 61-80, and at the sand, sand/peat and peat beach types (Figure 5-26). The mean catch by period, region or beach type was ≤0.1. They ranged in length from 62 to 158 mm FL, and all were age 0+ (Figure 5-27).

**Atlantic croaker**

During 2003, a total of 469 Atlantic croaker was taken (Table 5-1). It was taken during six of 10 sampling periods, and the mean catch per haul was highest in the second half of November at 10.2 (Figure 5-28a). Mean catch during the other sampling periods was ≤1.45 per haul. They ranged in length from 14 to 270 mm TL (Figure 5-29); including individuals age 0+ and 1+ (PSEG 1984). Based on the subsample measured, all but three individuals taken were members of the 2003 year class. Modal lengths during sampling periods in October and November ranged from 18 to 28 mm TL. Atlantic croaker was most abundant in the region rkm 0-20 with a mean catch of 5.4 per haul (Figure 5-28b). Mean catch in the other regions was ≤0.6 per haul. Atlantic croaker was most abundant at the sand beach type with a mean catch of 2.76 per haul (Figure 5-28c). Their abundance was similarly low at the other beach types with mean catches ranging to 0.4 per haul.

## LITERATURE CITED


Able, K. W. and M. P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers University Press, New Brunswick, NJ.

Baum, T. A. 1993. Delaware River striped bass recruitment study. Federal Aid in Fisheries Restoration Project F-15-R-32. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 1994. Delaware River striped bass recruitment study. Federal Aid in Fisheries Restoration Project F-15-R-35. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 1995. Delaware River striped bass recruitment study. Federal Aid in Fisheries Restoration Project F-15-R-36. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 1996. Delaware River striped bass recruitment survey. In: New Jersey Striped Bass Fisheries, 1995. Federal Aid in Fisheries Restoration Project F-15-R-37. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. Personal communication. Preliminary 2003 catch data.

Baum, T. A., R. L. Allen, and H. E. Corbett. 1997. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 1996. Federal Aid in Fisheries Restoration Project F-15-R-38. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 1998. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 1997. Federal Aid in Fisheries Restoration Project F-15-R-39. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 1999. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 1998. Federal Aid in Fisheries Restoration Project F-15-R-40. New Jersey Division of Fish, Game and Wildlife, Trenton, NJ.

____. 2000. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 1999. Federal Aid in Fisheries Restoration Project F-15-R-41. New Jersey Division of Fish and Wildlife, Trenton, NJ.

____. 2001. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 2000. Federal Aid in Fisheries Restoration Project F-15-R-42. New Jersey Division of Fish and Wildlife, Trenton, NJ.

____. 2002. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 2001. Federal Aid in Fisheries Restoration Project F-15-R-42. New Jersey Division of Fish and Wildlife, Trenton, NJ.

____. 2003. Delaware River young of year recruitment survey. In: New Jersey Striped Bass Fisheries: 2002. Federal Aid in Fisheries Restoration Project F-15-R-42. New Jersey Division of Fish and Wildlife, Trenton, NJ.

Clark, J. 1998. Anadromous species investigations: White perch management plan for the Delaware River basin. Federal Aid in Fisheries Restoration Project F-47-R-5, Job 1-VI. Delaware Division of Fish and Wildlife, Dover, DE.

Conover, D.O., and M.R. Ross. 1982. Patterns in seasonal abundance, growth and biomass of the Atlantic silverside, *Menidia menidia*, in a New England Estuary. Estuaries 5:275-286.

Daiber, F.C. 1954. Fisheries research program. Univ. Delaware Marine Labs. Biennial Report, 1953-1954, 2: 50-64.

DeSylva, D.P., F.A. Kalber, Jr., and C.N. Shuster, Jr. 1962. Fishes and ecological conditions in the shore zone of the Delaware River estuary, with notes on other species collected in deeper waters. Unvi. Del. Mar. Lab. Info Ser. Pub. 5:1-164.

Michels, S.F. 1995. Bottom trawl survey of adult groundfish in Delaware Bay. In: Coastal finfish assessment survey. Federal Aid in Fisheries Restoration Project F-42-R-6, Job 1-2. Delaware Division of Fish and Wildlife, Dover, DE.

___. 1997. Bottom trawl survey of juvenile fishes in the Delaware Estuaries. In: Coastal finfish assessment survey. Federal Aid in Fisheries Restoration Project F-42-R-8, Job 1-3. Delaware Division of Fish and Wildlife, Dover, DE.

Public Service Electric & Gas Co. (PSE&G). 1996. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 1995 Annual Report. Public Service Electric & Gas Co., Newark, NJ.

___. 1997. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 1996 Annual Report.

___. 1998. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 1997 Annual Report.

___. 1999a. Salem Generating Station NJPDES Permit Renewal Application. Appendix C, Attachments C-1 through C-9.

___. 1999b. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 1998 Annual Report.

___. 2000. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 1999 Annual Report.

Public Service Enterprise Group (PSEG). 2001. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 2000 Annual Report. Public Service Enterprise Group, Newark, NJ.

Public Service Enterprise Group (PSEG). 2002. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 2001 Annual Report. Public Service Enterprise Group, Newark, NJ.

Public Service Enterprise Group (PSEG). 2003. Chapter 5: Baywide Beach Seine In: Biological Monitoring Program, 2002 Annual Report. Public Service Enterprise Group, Newark, NJ.

Smith, R. 1987. Marine fish populations in Delaware Bay. Trawl Surveys. Federal Aid in Fisheries

Table 5-1. Number of finfish and blue crab, by sampling period, taken by seine in the Delaware Bay and River during 2003.

| Species | | Jun 16-30 | Jul 1-15 | Jul 16-31 | Aug 1-15 | Aug 16-31 | Sept 1-15 | Sept 16-30 | Oct 1-15 | Oct 16-31 | Nov 1-15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Smooth dogfish** | *Mustelus canis* | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **Clearnose skate** | *Raja eglanteria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| **Southern stingray** | *Dasyatis americana* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Smooth butterfly ray** | *Gymnura micrura* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cownose ray** | *Rhinoptera bonasus* | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| **Atlantic sturgeon** | *Acipenser oxyrhynchus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| **American eel** | *Anguilla rostrata* | 4 | 8 | 0 | 8 | 4 | 6 | 4 | 0 | 0 | 0 | 34 |
| **American shad** | *Alosa sapidissima* | 13 | 1 | 0 | 2 | 4 | 1 | 0 | 29 | 20 | 47 | 117 |
| **Blueback herring** | *Alosa aestivalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 156 | 55 | 214 |
| **Alewife** | *Alosa pseudoharengus* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 37 | 14 | 52 |
| **Atlantic menhaden** | *Brevoortia tyrannus* | 334 | 30 | 30 | 33 | 73 | 1 | 28 | 53 | 2 | 19 | 603 |
| **Gizzard shad** | *Dorosoma cepedianum* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 2 | 6 |
| **Striped anchovy** | *Anchoa hepsetus* | 0 | 0 | 4 | 43 | 65 | 63 | 12 | 1 | 0 | 0 | 188 |
| **Bay anchovy** | *Anchoa mitchilli* | 296 | 211 | 159 | 729 | 1086 | 694 | 272 | 1289 | 433 | 269 | 5438 |
| **Common carp** | *Cyprinus carpio* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Eastern silvery minnow** | *Hybognathus regis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 3 |
| **Satinfin shiner** | *Cyprinella analostana* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Channel catfish** | *Ictalurus punctatus* | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 12 |
| **Spotted hake** | *Urophycis regia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 |
| **Striped cusk-eel** | *Ophidion marginata* | 2 | 0 | 36 | 3 | 291 | 1 | 0 | 1 | 0 | 0 | 334 |
| **Halfbeak** | *Hyporhamphus unifasciatus* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Atlantic needlefish** | *Strongylura marina* | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| **Sheepshead minnow** | *Cyprinodon variegatus* | 6 | 0 | 3 | 5 | 0 | 1 | 0 | 0 | 2 | 0 | 17 |
| **Mummichog** | *Fundulus heteroclitus* | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 0 | 8 | 3 | 24 |

Table 5-1. Continued.

| Species | | Jun 16-30 | Jul 1-15 | Jul 16-31 | Aug 1-15 | Aug 16-31 | Sept 1-15 | Sept 16-30 | Oct 1-15 | Oct 16-31 | Nov 1-15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Striped killifish** | *Fundulus majalis* | 12 | 23 | 153 | 117 | 273 | 289 | 48 | 36 | 55 | 21 | 1027 |
| **Atlantic silverside** | *Menidia menidia* | 94 | 433 | 1580 | 1806 | 1712 | 993 | 804 | 2763 | 1112 | 374 | 11671 |
| **Northern pipefish** | *Syngnathus fuscus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Northern searobin** | *Prionotus carolinus* | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 3 |
| **White perch** | *Morone americana* | 19 | 44 | 7 | 9 | 5 | 5 | 4 | 16 | 24 | 62 | 195 |
| **Striped bass** | *Morone saxatilis* | 58 | 242 | 195 | 99 | 34 | 65 | 28 | 46 | 43 | 42 | 852 |
| **Bluegill** | *Lepomis macrochirus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Bluefish** | *Pomatomus saltatrix* | 18 | 20 | 10 | 5 | 22 | 1 | 15 | 7 | 0 | 2 | 100 |
| **Crevalle jack** | *Caranx hippos* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| **Florida pompano** | *Trachinotus carolinus* | 0 | 0 | 0 | 5 | 10 | 6 | 6 | 4 | 2 | 0 | 33 |
| **Permit** | *Trachinotus falcatus* | 0 | 0 | 0 | 2 | 5 | 7 | 14 | 1 | 0 | 0 | 29 |
| **Spotted sea trout** | *Cynoscion nebulosus* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Weakfish** | *Cynoscion regalis* | 8 | 152 | 404 | 234 | 115 | 56 | 3 | 0 | 3 | 0 | 975 |
| **Silver perch** | *Bairdiella chrysoura* | 0 | 0 | 5 | 4 | 10 | 4 | 3 | 0 | 1 | 1 | 28 |
| **Spot** | *Leiostomus xanthurus* | 0 | 1 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 11 |
| **Northern kingfish** | *Menticirrhus saxatilis* | 0 | 0 | 2 | 4 | 20 | 14 | 3 | 21 | 3 | 0 | 67 |
| **Atlantic croaker** | *Micropogonias undulatus* | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 58 | 407 | 469 |
| **Black drum** | *Pogonias cromis* | 0 | 9 | 2 | 3 | 15 | 9 | 6 | 1 | 2 | 2 | 49 |
| **Striped mullet** | *Mugil cephalus* | 0 | 4 | 0 | 0 | 3 | 0 | 4 | 0 | 3 | 10 | 24 |
| **White mullet** | *Mugil curema* | 0 | 0 | 0 | 1 | 1 | 11 | 0 | 8 | 0 | 0 | 21 |
| **Butterfish** | *Peprilus triacanthus* | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| **Summer flounder** | *Paralichthys dentatus* | 12 | 13 | 1 | 1 | 0 | 5 | 1 | 0 | 0 | 0 | 33 |
| **Winter flounder** | *Pleuronectes americanus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Hogchoker** | *Trinectes maculatus* | 25 | 15 | 12 | 18 | 34 | 173 | 0 | 0 | 0 | 0 | 277 |
| **Northern puffer** | *Sphoeroides maculatus* | 0 | 1 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 8 |
| **Total** | | **903** | **1220** | **2616** | **3153** | **3789** | **2410** | **1264** | **4280** | **1968** | **1350** | **22956** |
| | | | | | | | | | | | | |
| **Blue crab** | *Callinectes sapidus* | 4 | 5 | 13 | 10 | 7 | 16 | 15 | 4 | 3 | 2 | 79 |

Table 5-2. Percent composition, by sampling period, for finfish taken in the 2002 baywide seine survey, **target species in bold.**

| Species | Jun 16-30 | Jul 1-15 | Jul 16-31 | Aug 1-15 | Aug 16-31 | Sept 1-15 | Sept 16-30 | Oct 1-15 | Oct 16-31 | Nov 1-15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Atlantic silverside** | **10.4** | **35.6** | **60.4** | **57.3** | **45.2** | **41.2** | **63.6** | **64.6** | **56.5** | **27.7** | **50.9** |
| **Bay anchovy** | **32.8** | **17.3** | **6.1** | **23.1** | **28.7** | **28.8** | **21.5** | **30.1** | **22.0** | **19.9** | **23.7** |
| Striped killifish | 1.3 | 1.9 | 5.8 | 3.7 | 7.2 | 12.0 | 3.8 | 0.8 | 2.8 | 1.6 | 4.5 |
| **Weakfish** | **0.9** | **12.5** | **15.4** | **7.4** | **3.0** | **2.3** | **0.2** | | **0.2** | | **4.2** |
| **Striped bass** | **6.4** | **19.9** | **7.5** | **3.1** | **0.9** | **2.7** | **2.2** | **1.1** | **2.2** | **3.1** | **3.7** |
| **Atlantic menhaden** | **36.9** | **2.2** | **1.1** | **1.0** | **1.9** | **<0.1** | **2.2** | **1.2** | **0.1** | **1.4** | **2.6** |
| **Atlantic croaker** | | | **<0.1** | **<0.1** | **<0.1** | | | **0.0** | **2.9** | **30.1** | **2.1** |
| Striped cusk-eel | 0.2 | | 1.4 | 0.1 | 7.7 | <0.1 | | <0.1 | | | 1.5 |
| Hogchoker | 2.8 | 1.2 | 0.5 | 0.6 | 0.9 | 7.2 | | | | | 1.2 |
| **Blueback herring** | | | | | | | | | **7.9** | **4.1** | **0.9** |
| **White perch** | **2.1** | **3.6** | **0.3** | **0.3** | **0.1** | **0.2** | **0.3** | **0.4** | **1.2** | **4.6** | **0.8** |
| Striped anchovy | | | 0.2 | 1.4 | 1.7 | 2.6 | 0.9 | <0.1 | | | 0.8 |
| **American shad** | **1.4** | **0.1** | | **0.1** | **0.1** | **<0.1** | | **0.7** | **1.0** | **3.5** | **0.5** |
| **Bluefish** | **2.0** | **1.6** | **0.4** | **0.2** | **0.6** | **<0.1** | **1.2** | **0.2** | | **0.1** | **0.4** |
| Northern kingfish | | | 0.1 | 0.1 | 0.5 | 0.6 | 0.2 | 0.5 | 0.2 | | 0.3 |
| **Alewife** | | | | | | | **0.1** | | **1.9** | **1.0** | **0.2** |
| Black drum | | 0.7 | 0.1 | 0.1 | 0.4 | 0.4 | 0.5 | <0.1 | 0.1 | 0.1 | 0.2 |
| American eel | 0.4 | 0.7 | | 0.3 | 0.1 | 0.2 | 0.3 | | | | 0.1 |
| Florida pompano | | | | 0.2 | 0.3 | 0.2 | 0.5 | 0.1 | 0.1 | | 0.1 |
| Summer flounder | 1.3 | 1.1 | <0.1 | <0.1 | | 0.2 | 0.1 | | | | 0.1 |
| Permit | | | | 0.1 | 0.1 | 0.3 | 1.1 | <0.1 | | | 0.1 |
| Silver perch | | | 0.2 | 0.1 | 0.3 | 0.2 | 0.2 | | 0.1 | 0.1 | 0.1 |
| Mummichog | 0.1 | 0.2 | 0.1 | 0.1 | <0.1 | 0.1 | 0.2 | | 0.4 | 0.2 | 0.1 |
| Striped mullet | | 0.3 | | | 0.1 | | 0.3 | | 0.2 | 0.7 | 0.1 |
| White mullet | | | | <0.1 | <0.1 | 0.5 | | 0.2 | | | 0.1 |

Table 5-2 Continued.

| **Species** | **Jun 16-30** | **Jul 1-15** | **Jul 16-31** | **Aug 1-15** | **Aug 16-31** | **Sept 1-15** | **Sept 16-30** | **Oct 1-15** | **Oct 16-31** | **Nov 1-15** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheepshead minnow | 0.7 | | 0.1 | 0.2 | | <0.1 | | | 0.1 | | 0.1 |
| Spotted hake | | | | | | | | | | 1.0 | 0.1 |
| Channel catfish | | 0.9 | | | | | | | | 0.1 | 0.1 |
| **Spot** | | **0.1** | **0.1** | **0.1** | **0.1** | | | | | | **<0.1** |
| Northern puffer | | 0.1 | 0.1 | 0.1 | | | 0.1 | | | | <0.1 |
| Gizzard shad | | | | 0.0 | | | | <0.1 | 0.1 | 0.1 | <0.1 |
| Atlantic needlefish | | | | 0.2 | | | | | | | <0.1 |
| Smooth dogfish | | | 0.1 | <0.1 | | | | | | | <0.1 |
| Eastern silvery minnow | | | | | | | | | 0.1 | 0.1 | <0.1 |
| Northern searobin | | | | <0.1 | | | 0.2 | | | | <0.1 |
| Butterfish | | | 0.1 | <0.1 | | | | | | | <0.1 |
| Clearnose skate | | | | | | | | | | 0.1 | <0.1 |
| Cownose ray | | | | <0.1 | | <0.1 | | | | | <0.1 |
| Crevalle jack | | | | | | | 0.2 | | | | <0.1 |
| Southern stingray | | | | | <0.1 | | | | | | <0.1 |
| Smooth butterfly ray | | | | | | <0.1 | | | | | <0.1 |
| Atlantic sturgeon | | | | | | | | | 0.1 | | <0.1 |
| Common carp | 0.1 | | | | | | | | | | <0.1 |
| Satinfin shiner | | | | <0.1 | | | | | | | <0.1 |
| Halfbeak | | | | | | <0.1 | | | | | <0.1 |
| Northern pipefish | | | | | | | | <0.1 | | | <0.1 |
| Bluegill | | | | | | | | | | 0.1 | <0.1 |
| Spotted sea trout | | | | <0.1 | | | | | | | <0.1 |
| Winter flounder | | | | | | | | | | 0.1 | <0.1 |

Table 5-3. Percent composition by river kilometer region, for finfish taken in the 2003 baywide seine survey, **target species in bold.**

| Species | 0-20 | 21-40 | 41-60 | 61-80 | 81-100 | Total |
|---|---|---|---|---|---|---|
| **Atlantic silverside** | **55.5** | **52.1** | **60.4** | **42.1** | **7.7** | **50.9** |
| **Bay anchovy** | **15.7** | **24.2** | **18.3** | **31.9** | **53.8** | **23.7** |
| Striped killifish | 2.1 | 8.6 | 1.5 | 1.2 | | 4.5 |
| **Weakfish** | **5.2** | **4.3** | **6.0** | **2.0** | **0.1** | **4.2** |
| **Striped bass** | **1.4** | **2.0** | **1.7** | **11.5** | **10.8** | **3.7** |
| **Atlantic menhaden** | **0.2** | **2.9** | **2.5** | **3.3** | **11.8** | **2.6** |
| **Atlantic croaker** | **7.2** | **0.8** | **0.5** | | | **2.0** |
| Striped cusk-eel | 6.3 | <0.1 | | | | 1.5 |
| Hogchoker | | 2.4 | 1.4 | | 0.1 | 1.2 |
| **Blueback herring** | | **<0.1** | **4.0** | **0.5** | **5.9** | **0.9** |
| **White perch** | **0.1** | **0.4** | **0.8** | **2.5** | **3.9** | **0.8** |
| Striped anchovy | 2.0 | 0.3 | 0.6 | 0.8 | 0.1 | 0.8 |
| American shad | <0.1 | | 0.1 | 2.2 | 3.4 | 0.5 |
| **Bluefish** | **0.6** | **0.2** | **0.2** | **0.8** | **0.7** | **0.4** |
| Northern kingfish | 0.5 | 0.5 | | | | 0.3 |
| **Alewife** | **0.2** | **<0.1** | **0.5** | **0.3** | **0.9** | **0.2** |
| Black drum | | 0.3 | 0.5 | 0.1 | | 0.2 |
| American eel | 0.1 | 0.2 | 0.3 | <0.1 | | 0.1 |
| Pompano | 0.4 | 0.1 | 0.1 | | | 0.1 |
| Summer flounder | 0.5 | <0.1 | 0.1 | | | 0.1 |
| Permit | 0.4 | 0.1 | <0.1 | | | 0.1 |
| Silver perch | 0.3 | 0.1 | <0.1 | | | 0.1 |
| Mummichog | 0.1 | 0.1 | 0.2 | <0.1 | | 0.1 |
| Striped mullet | 0.2 | 0.1 | 0.1 | | | 0.1 |
| White mullet | 0.1 | 0.1 | | <0.1 | | 0.1 |
| Sheepshead minnow | 0.1 | 0.1 | 0.1 | <0.1 | | 0.1 |
| Spotted hake | 0.2 | <0.1 | | | | 0.1 |
| Channel catfish | | | | 0.3 | | 0.1 |
| **Spot** | **0.1** | **0.1** | | **<0.1** | | **<0.1** |
| Northern puffer | 0.1 | <0.1 | 0.1 | | | <0.1 |
| Atlantic needlefish | | | | 0.2 | | <0.1 |
| Gizzard shad | <0.1 | | | 0.1 | 0.2 | <0.1 |
| Butterfish | <0.1 | <0.1 | | | | <0.1 |
| Eastern silvery minnow | | | | | 0.3 | <0.1 |
| Northern searobin | 0.1 | | | | | <0.1 |
| Smooth dogfish | 0.1 | | | | | <0.1 |

Table 5-3. Continued.

| Species | 0-20 | 21-40 | 41-60 | 61-80 | 81-100 | Total |
|---|---|---|---|---|---|---|
| Clearnose skate | <0.1 | | | | | <0.1 |
| Cownose ray | <0.1 | <0.1 | | | | <0.1 |
| Crevalle jack | <0.1 | <0.1 | | | | <0.1 |
| Atlantic sturgeon | | | | <0.1 | | <0.1 |
| Bluegill | | | | <0.1 | | <0.1 |
| Common carp | | | | <0.1 | | <0.1 |
| Halfbeak | <0.1 | | | | | <0.1 |
| Northern pipefish | | | | <0.1 | | <0.1 |
| Satinfin shiner | | | | | 0.1 | <0.1 |
| Smooth butterfly ray | <0.1 | | | | | <0.1 |
| Southern stingray | <0.1 | | | | | <0.1 |
| Spotted sea trout | <0.1 | | | | | <0.1 |
| Winter flounder | | | <0.1 | | | <0.1 |

Table 5-4. Percent composition, by beach type, for finfish taken in the 2003 baywide seine survey, **target species in bold.**

| Species | Sand | Sand/Peat | Peat | Peat/Mud | Mud | Total |
|---|---|---|---|---|---|---|
| **Atlantic silverside** | **55.0** | **60.5** | **39.8** | **59.2** | **20.4** | **50.9** |
| **Bay anchovy** | **17.3** | **22.1** | **43.6** | **9.9** | **33.5** | **23.7** |
| Striped killifish | 2.1 | 1.8 | 0.5 | 16.8 | 23.0 | 4.5 |
| **Weakfish** | **4.8** | **1.6** | **5.0** | **5.7** | **5.0** | **4.2** |
| **Striped bass** | **4.9** | **3.8** | **1.2** | **3.5** | **1.8** | **3.7** |
| **Atlantic menhaden** | **1.6** | **5.1** | **3.4** | **1.3** | **1.4** | **2.6** |
| **Atlantic croaker** | **4.1** | **0.1** | **0.4** | | **0.4** | **2.0** |
| Striped cusk-eel | 3.1 | <0.1 | | | | 1.5 |
| Hogchoker | <0.1 | | 1.3 | 0.8 | 10.6 | 1.2 |
| **Blueback herring** | **1.3** | **0.2** | **1.6** | | | **0.9** |
| **White perch** | **0.9** | **0.6** | **1.2** | **0.3** | **0.8** | **0.8** |
| Striped anchovy | 1.1 | 0.7 | 0.4 | 0.1 | 0.8 | 0.8 |
| **American shad** | **0.3** | **1.6** | **0.3** | | | **0.5** |
| **Bluefish** | **0.6** | **0.4** | **0.4** | | **0.2** | **0.4** |
| Northern kingfish | 0.2 | 0.1 | | 0.9 | 1.2 | 0.3 |
| **Alewife** | **0.3** | **0.2** | **0.2** | | | **0.2** |
| Black drum | 0.1 | 0.1 | 0.1 | 1.0 | 0.7 | 0.2 |
| American eel | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 |
| Pompano | 0.3 | 0.1 | <0.1 | | | 0.1 |
| Summer flounder | 0.3 | 0.1 | 0.1 | | | 0.1 |
| Permit | 0.3 | <0.1 | | | | 0.1 |
| Silver perch | 0.2 | | 0.1 | 0.1 | | 0.1 |
| Mummichog | 0.1 | <0.1 | 0.1 | 0.3 | 0.1 | 0.1 |
| Striped mullet | 0.2 | 0.1 | <0.1 | | | 0.1 |
| White mullet | 0.1 | 0.1 | <0.1 | | | 0.1 |
| Sheepshead minnow | 0.1 | <0.1 | 0.1 | | 0.2 | 0.1 |
| Spotted hake | 0.1 | | | | | 0.1 |
| Channel catfish | | 0.2 | | | | 0.1 |
| **Spot** | **<0.1** | **0.1** | **<0.1** | | | **<0.1** |
| Northern puffer | <0.1 | 0.1 | | | | <0.1 |
| Atlantic needlefish | | | 0.2 | | | <0.1 |
| Gizzard shad | <0.1 | <0.1 | 0.1 | | | <0.1 |
| Butterfish | <0.1 | | | | 0.1 | <0.1 |
| Eastern silvery minnow | <0.1 | | | | | <0.1 |
| Northern searobin | <0.1 | | | | | <0.1 |
| Smooth dogfish | <0.1 | | | | | <0.1 |
| Clearnose skate | <0.1 | | | | | <0.1 |
| Cownose ray | <0.1 | <0.1 | | | | <0.1 |
| Crevalle jack | <0.1 | | | | | <0.1 |
| Atlantic sturgeon | <0.1 | | | | | <0.1 |
| Bluegill | <0.1 | | | | | <0.1 |

Table 5-4 Continued.

| Species | Sand | Sand/Peat | Peat | Peat/Mud | Mud | Total |
|---|---|---|---|---|---|---|
| Commom carp | | <0.1 | | | | <0.1 |
| Halfbeak | <0.1 | | | | | <0.1 |
| Northern pipefish | <0.1 | | | | | <0.1 |
| Satinfin shiner | <0.1 | | | | | <0.1 |
| Smooth butterfly ray | <0.1 | | | | | <0.1 |
| Southern stingray | <0.1 | | | | | <0.1 |
| Spotted sea trout | <0.1 | | | | | <0.1 |
| Winter flounder | | <0.1 | | | | <0.1 |

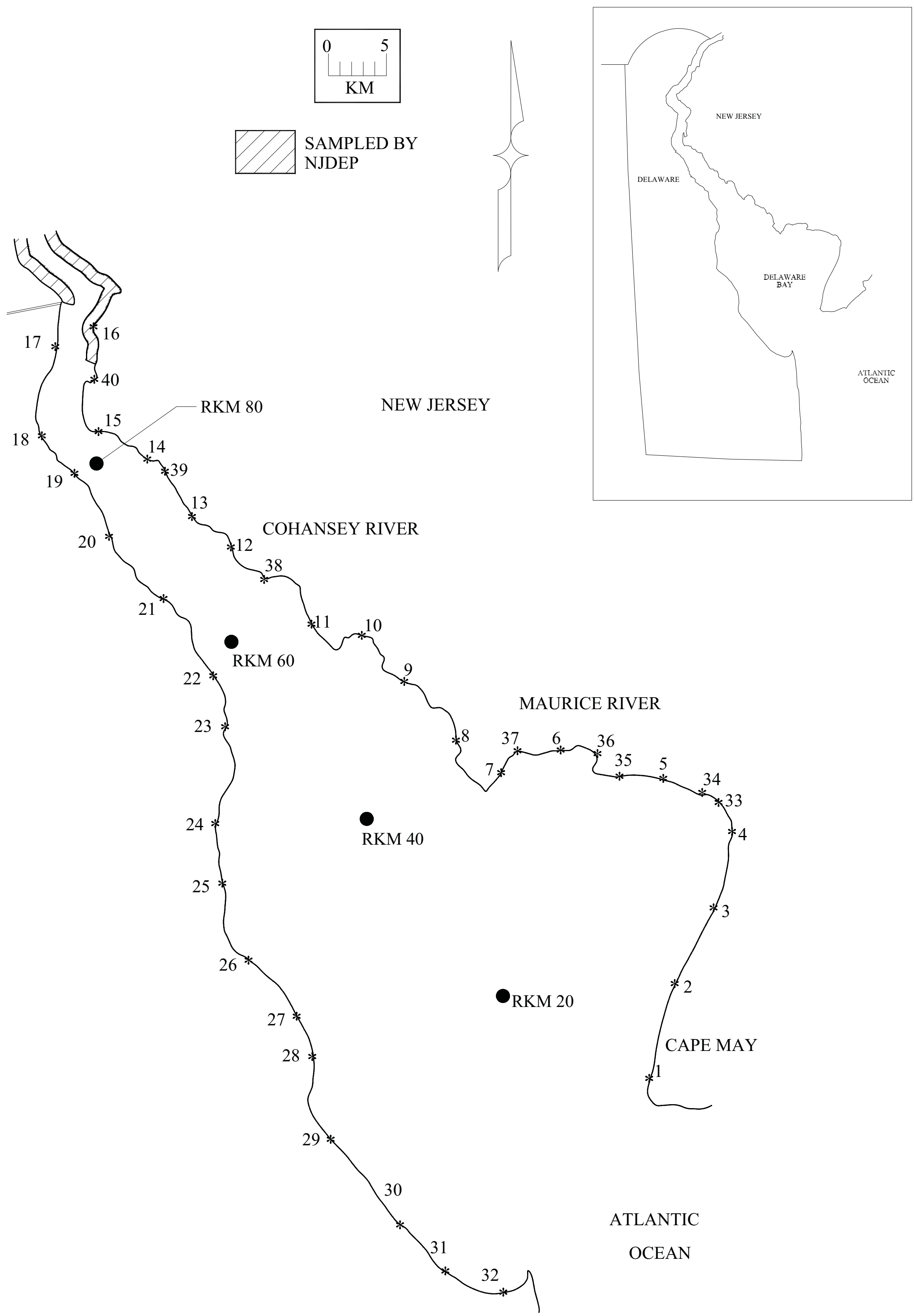
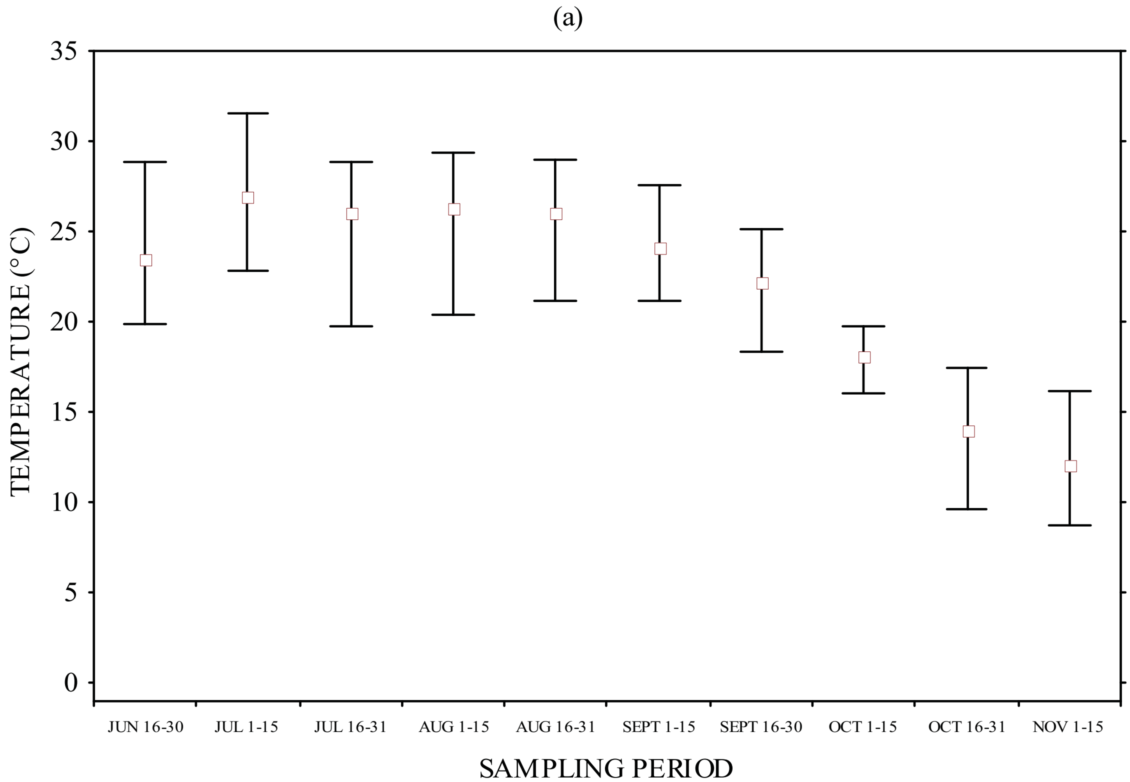



Figure 5-1. Baywide beach seine station locations.



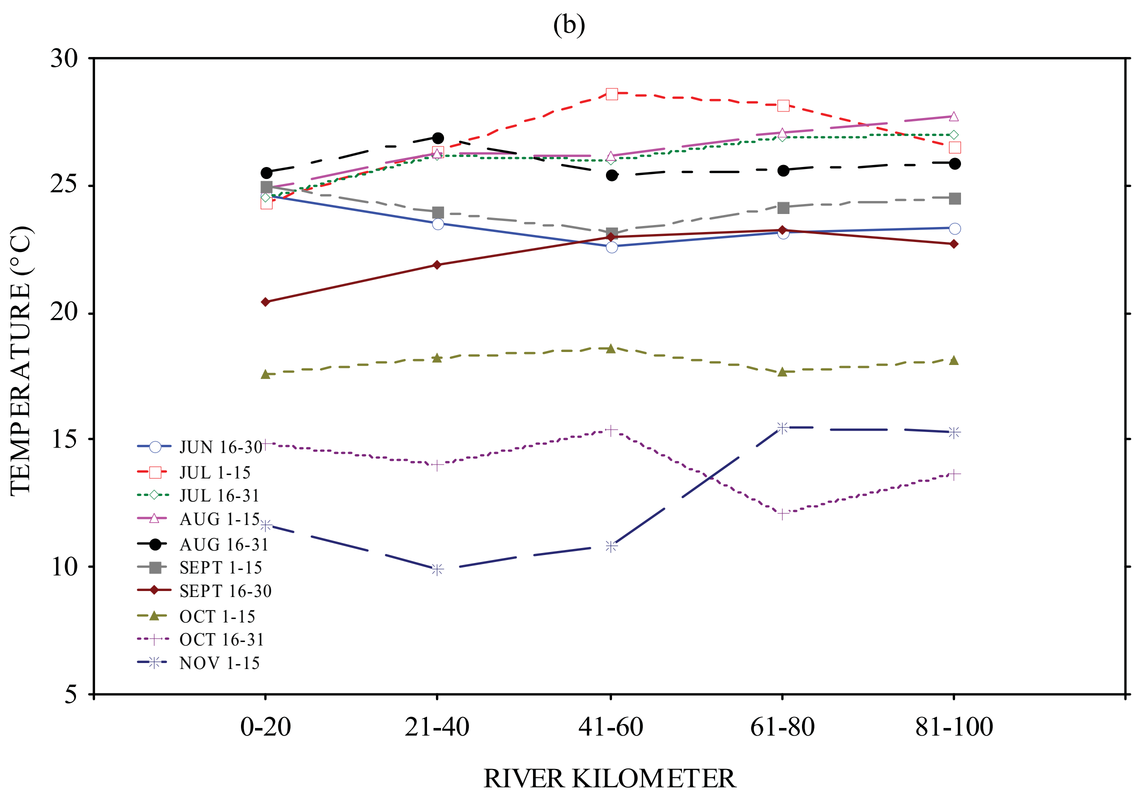
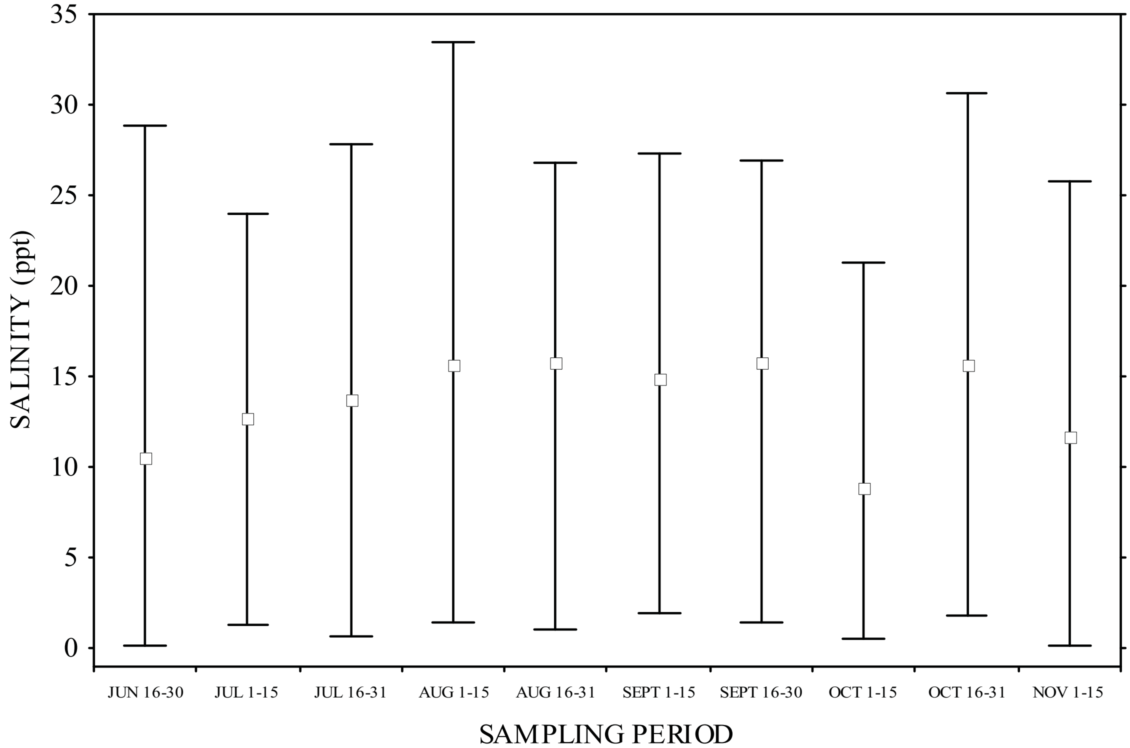




Figure 5-2. Mean temperature by sampling period (a) showing minimum and maximum values, and by river kilometer (b) as observed during the 2003 baywide seine survey

(a)




(b)

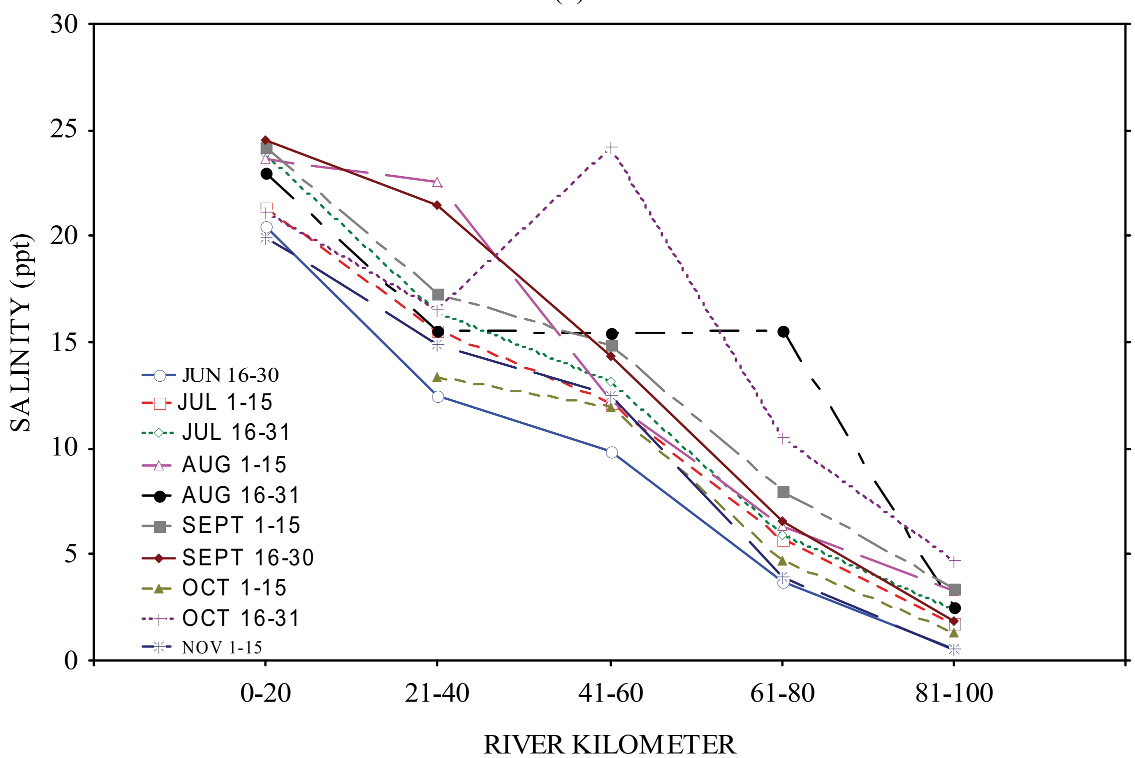
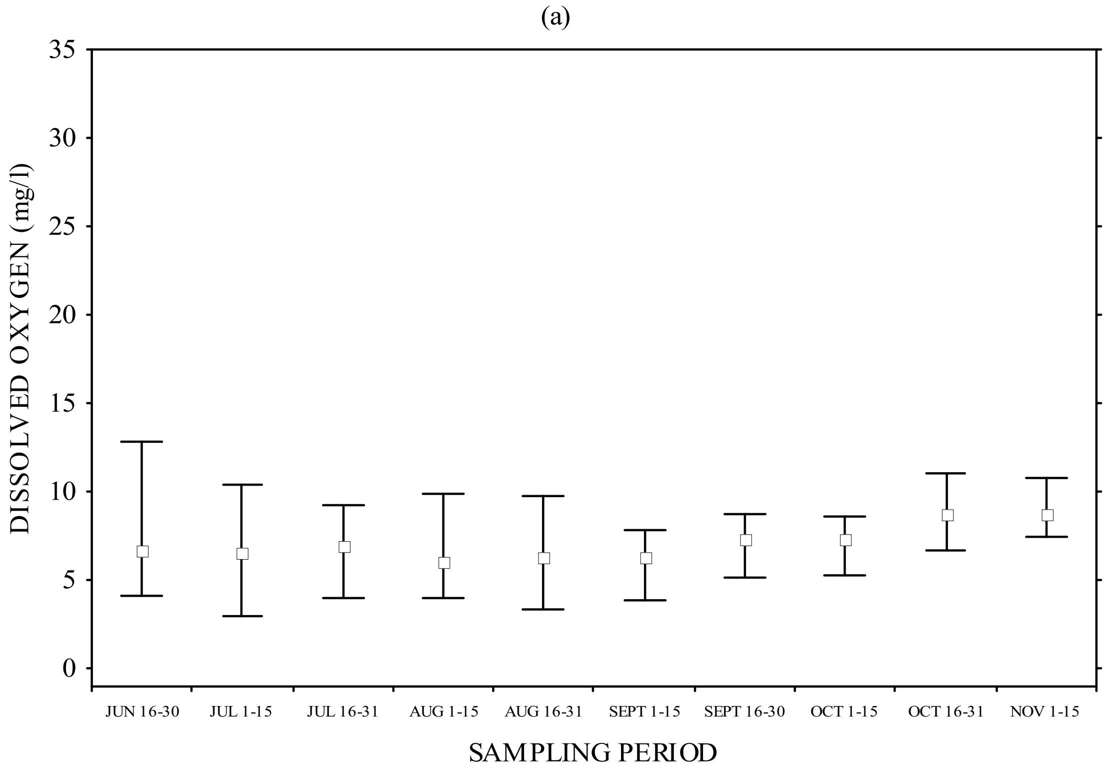



Figure 5-3. Mean salinity by sampling period (a) showing minimum and maximum values, and by river kilometer (b) as observed during the 2003 baywide seine survey.



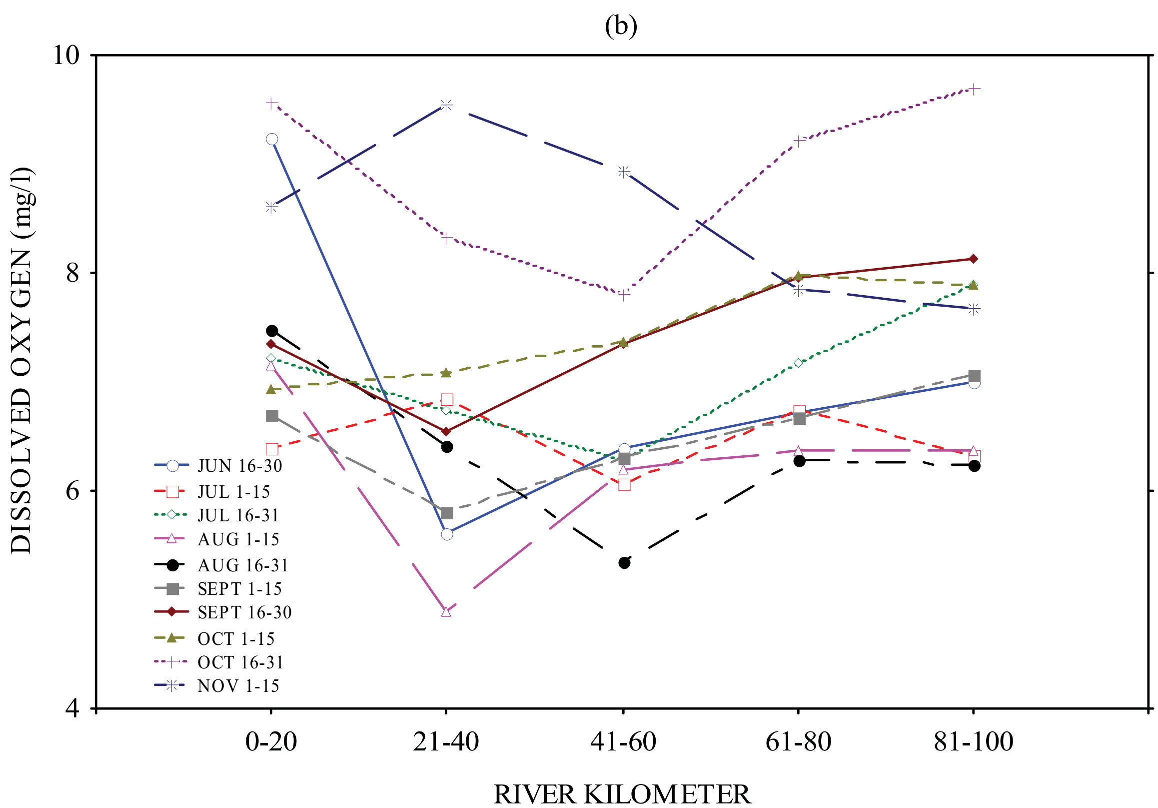




Figure 5-4. Mean dissolved oxygen by sampling period (a) showing minimum and maximum values, by river kilometer (b) as observed during the 2003 baywide seine survey.

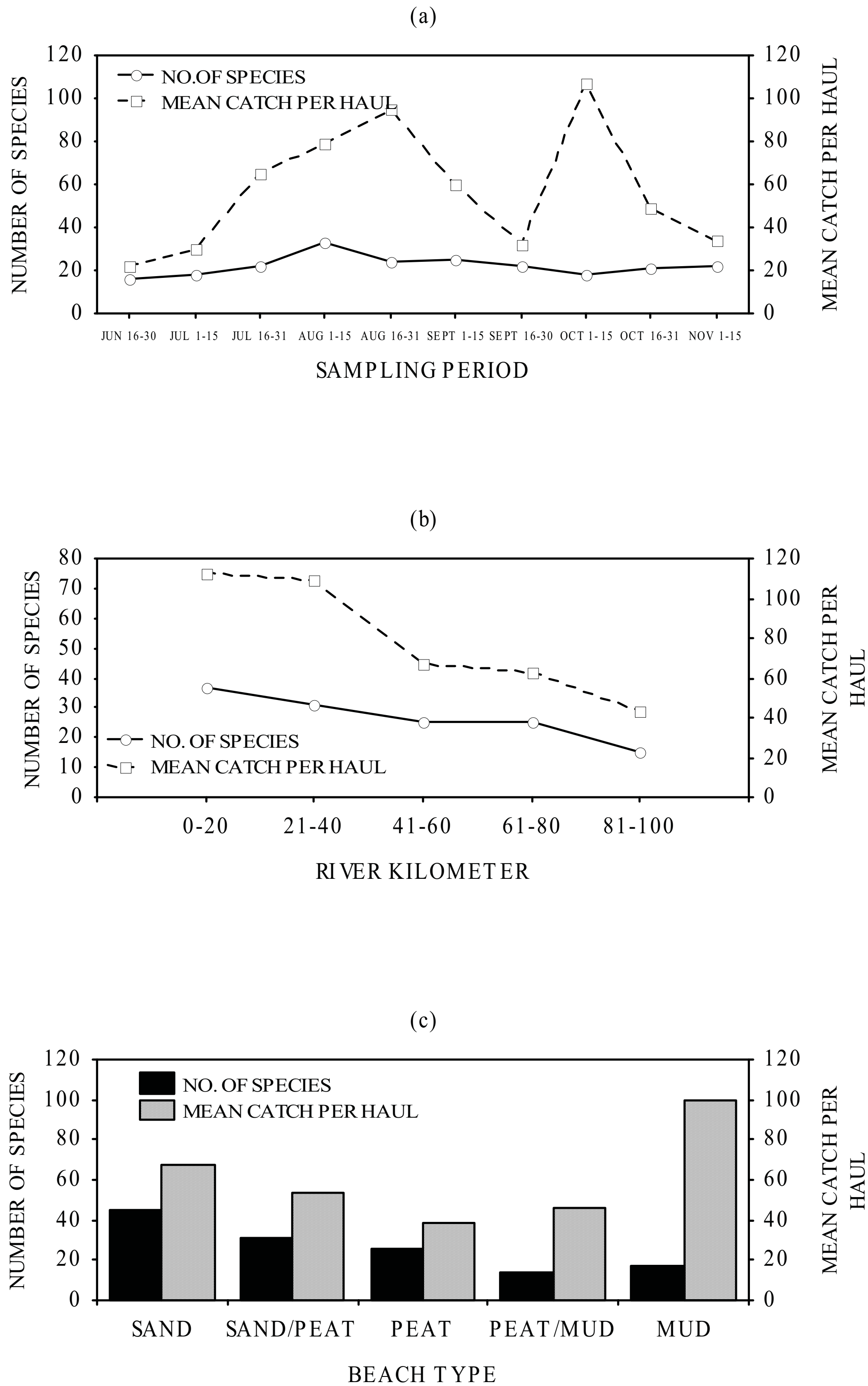



Figure 5-5. Mean abundance and species richness by sampling period (a), river kilometer (b), and beach type (c) as observed during the 2003 baywide seine survey.

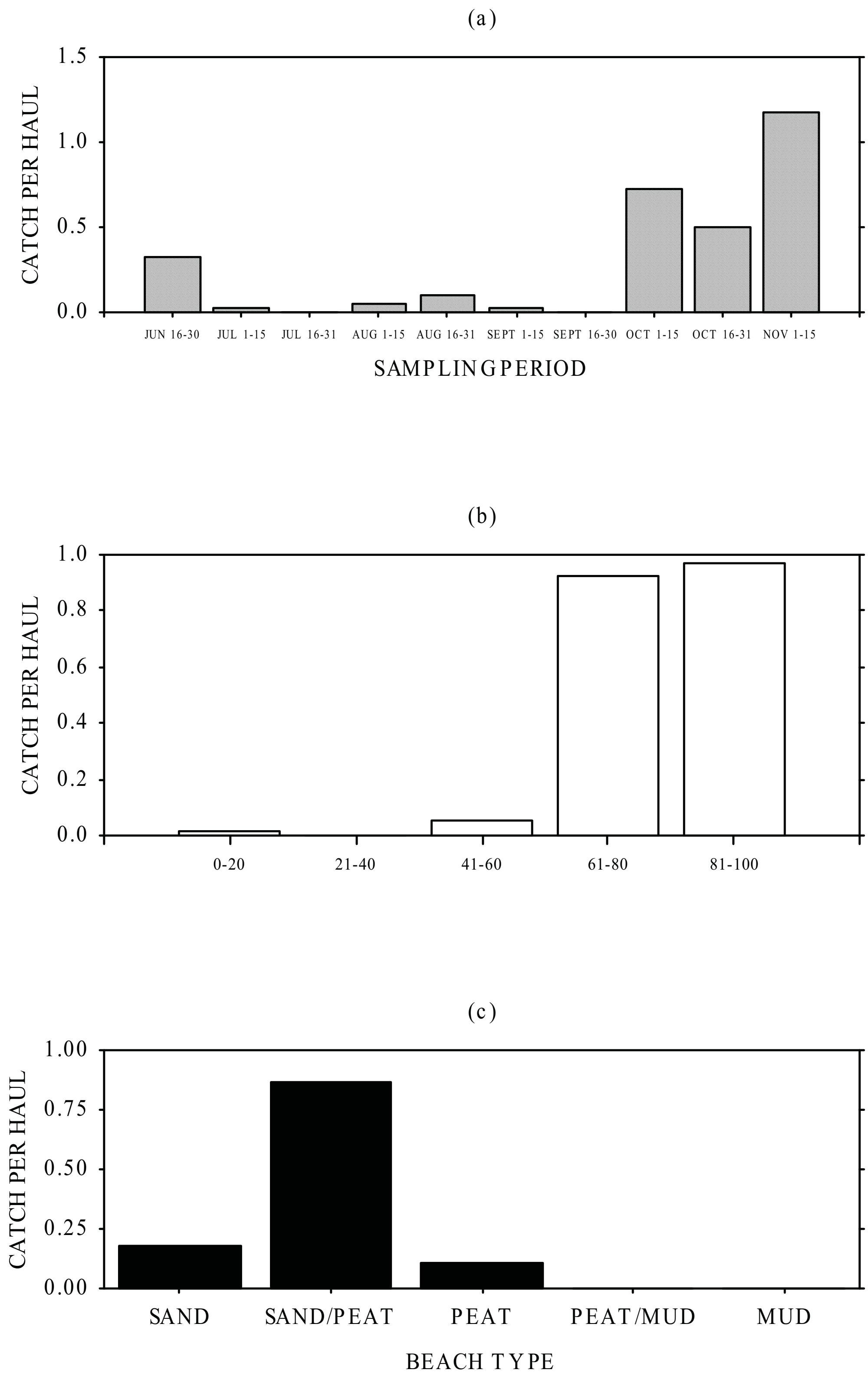



Figure 5-6. Mean catch per haul of American shad by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

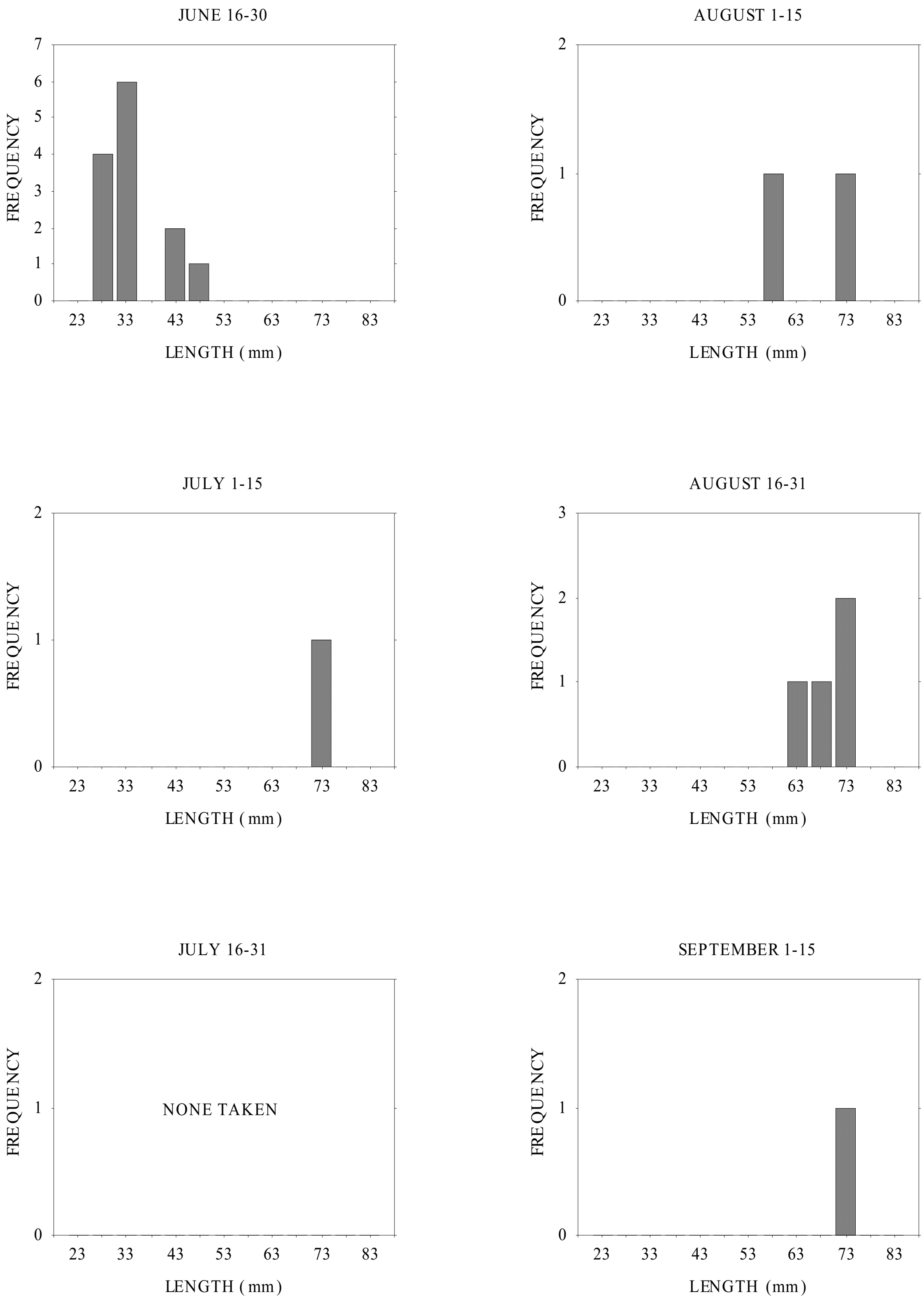
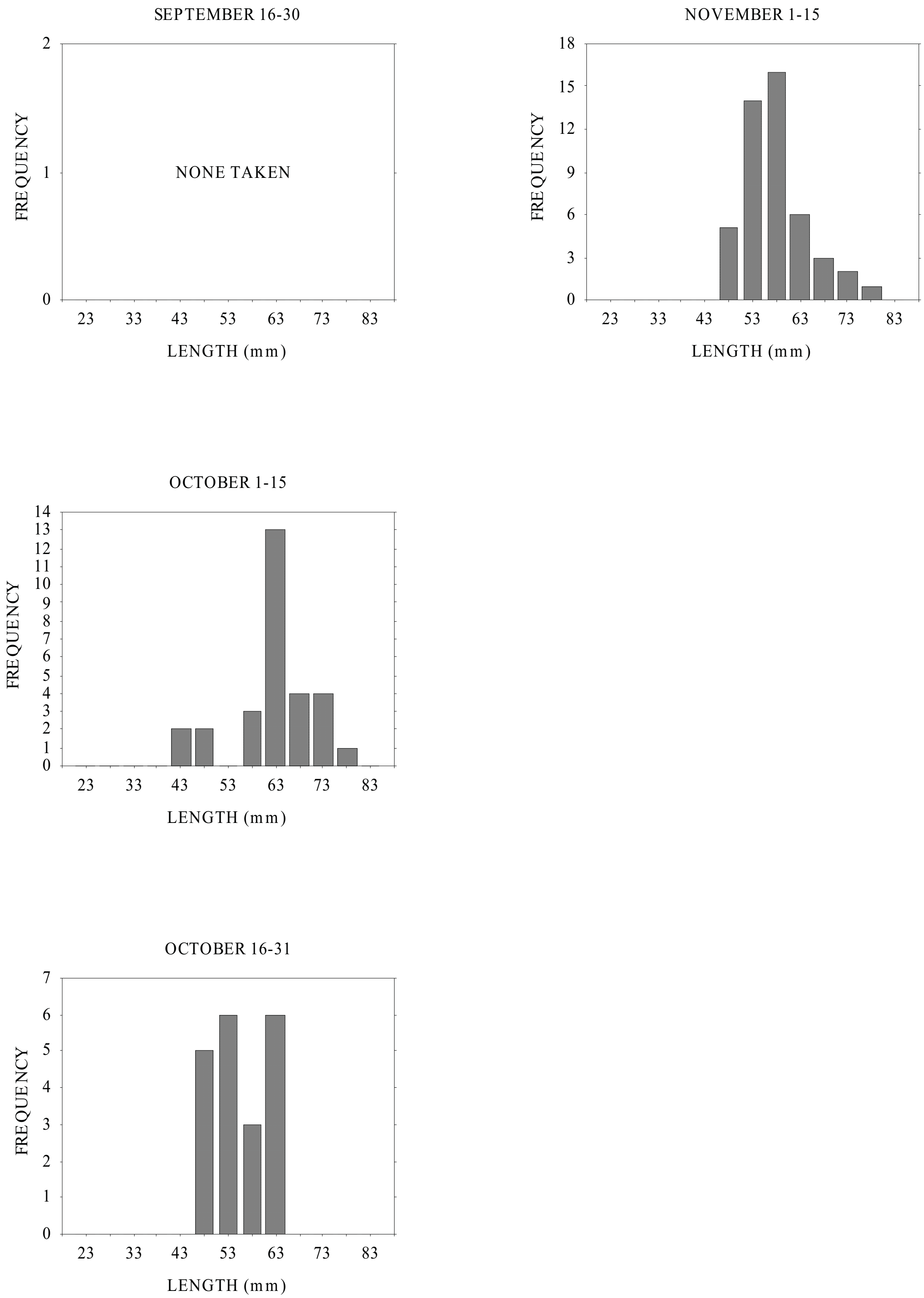



Figure 5-7. Length-frequency distribution by sampling period for American shad taken during the 2003 baywide seine survey.

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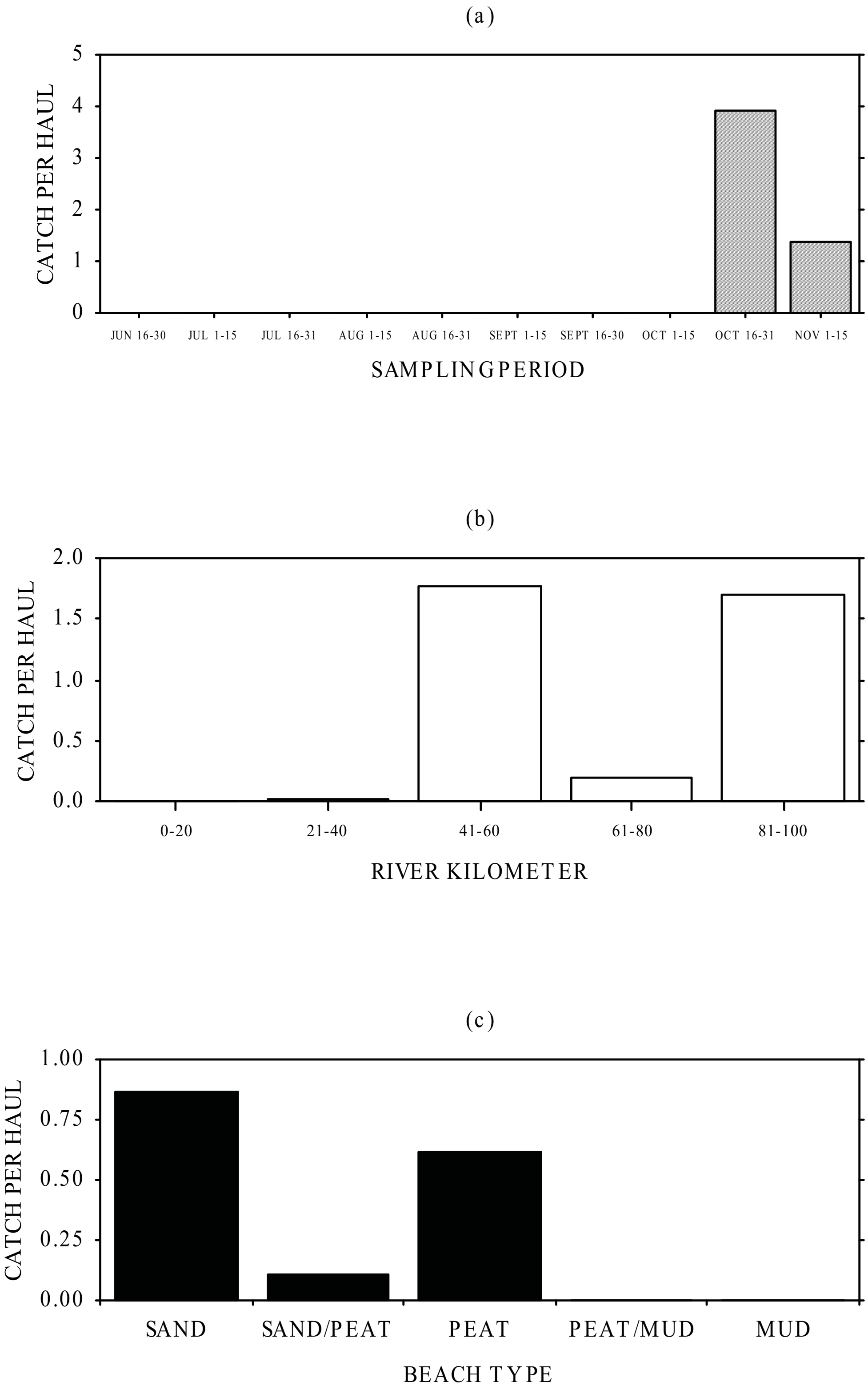
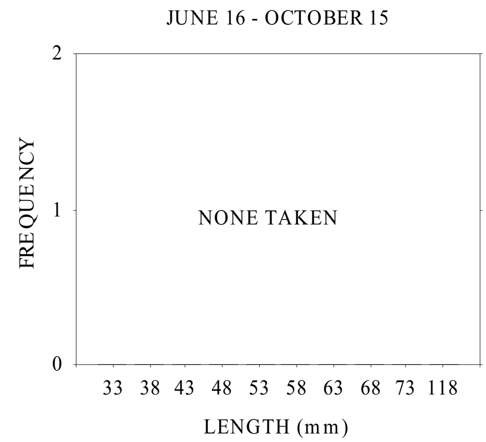
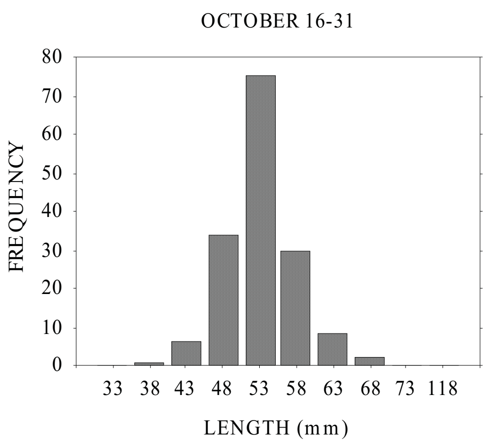



Figure 5-8. Mean catch per haul of blueback herring by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.



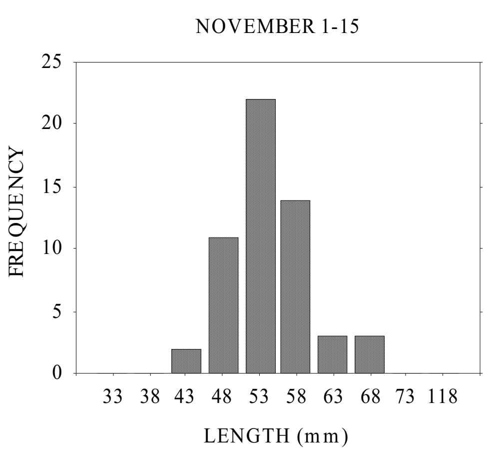




Figure 5-9. Length-frequency distribution by sampling period for blueback herring taken during the 2003 baywide seine survey.

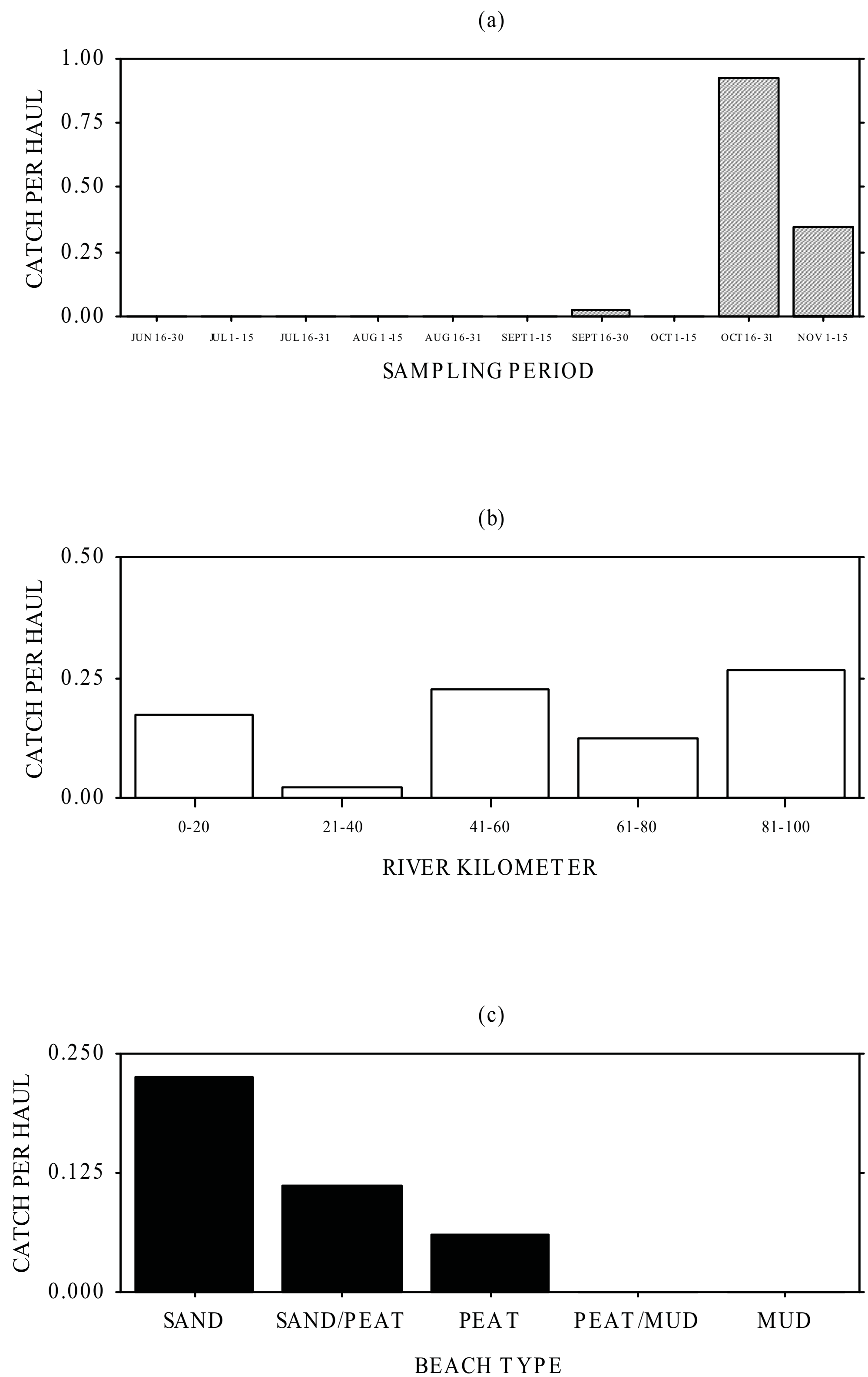



Figure 5-10. Mean catch per haul of alewife by sampling period (a), river kilometer (b), and beach type (c) as observed during the 2003 baywide beach seine survey.

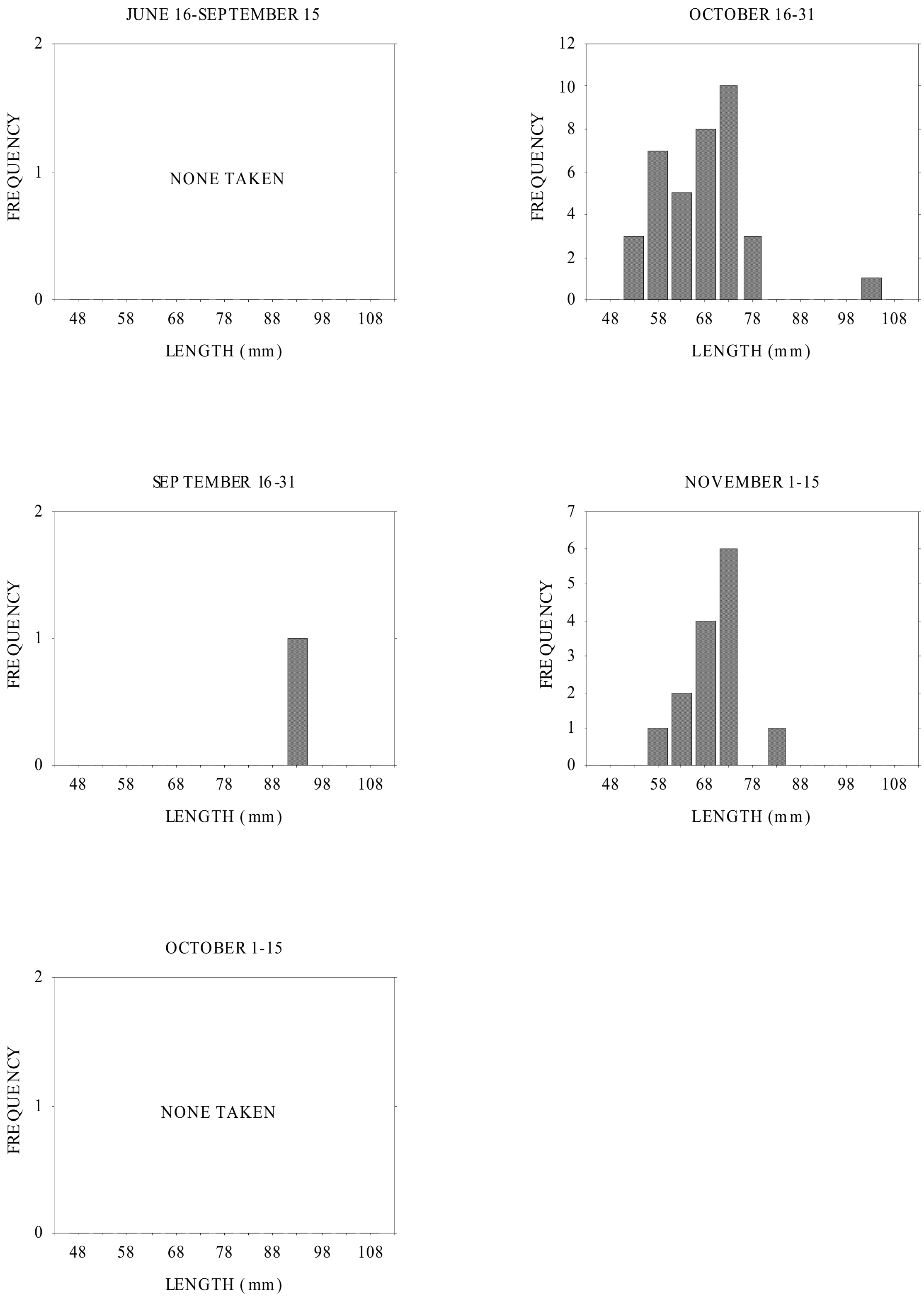



Figure 5-11. Length-frequency distribution by sampling period for alewife taken during the 2003 baywide seine survey.

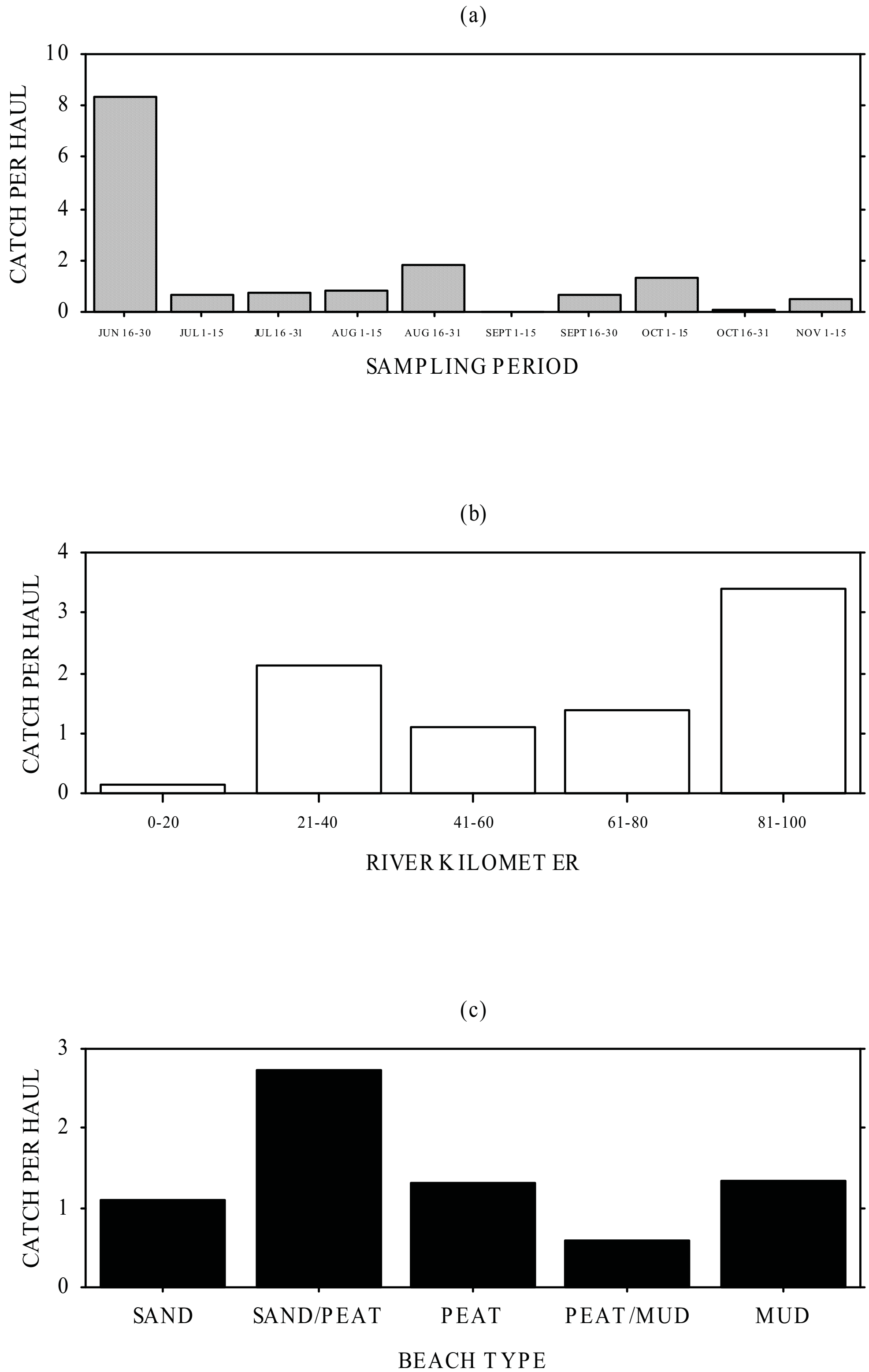



Figure 5-12. Mean catch per haul of Atlantic menhaden by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

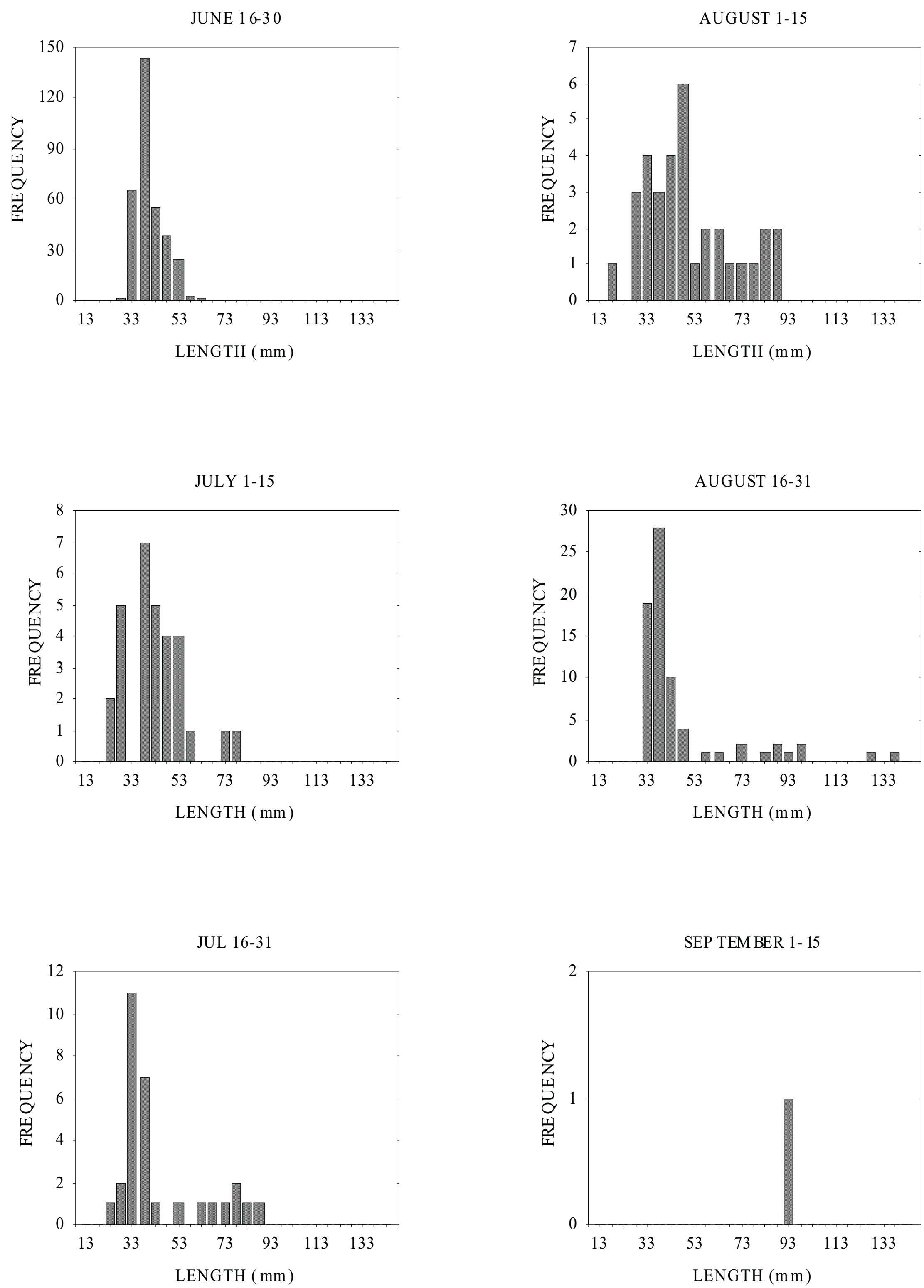
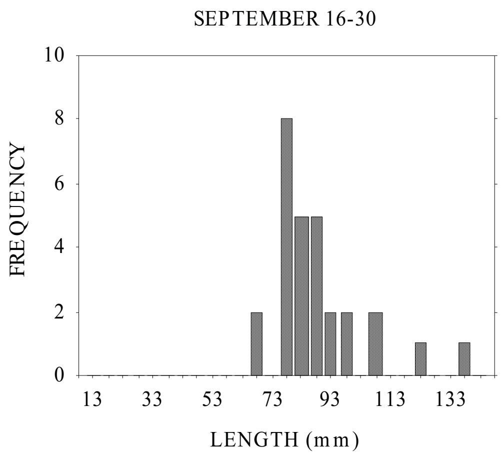
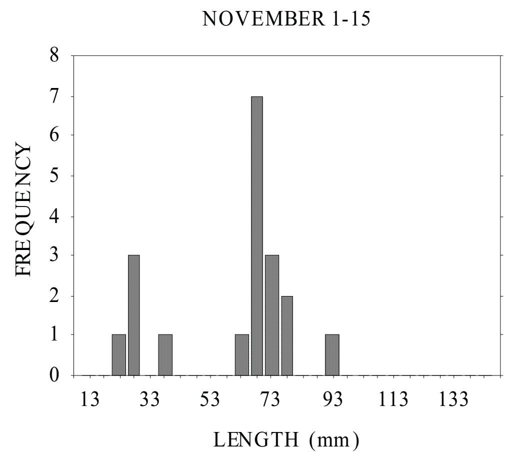
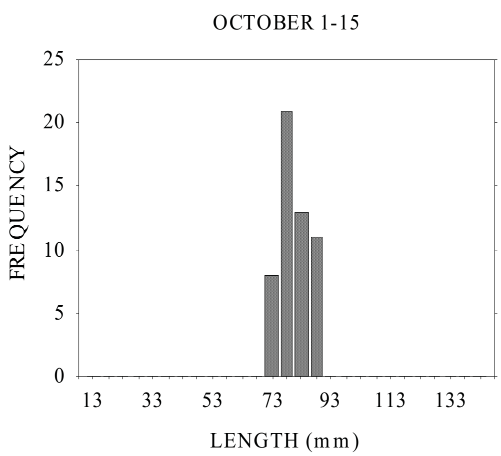
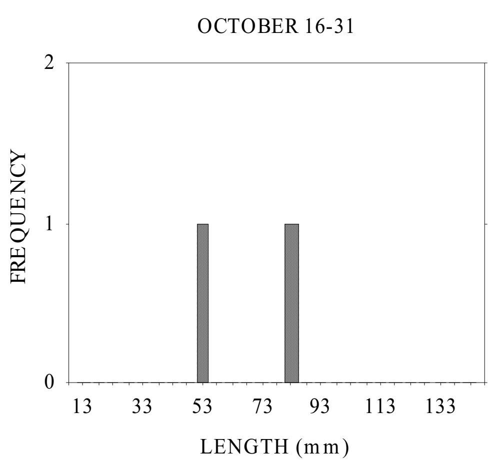



Figure 5-13. Length-frequency distribution by sampling period for Atlantic menhaden taken during the 2003 baywide seine survey.

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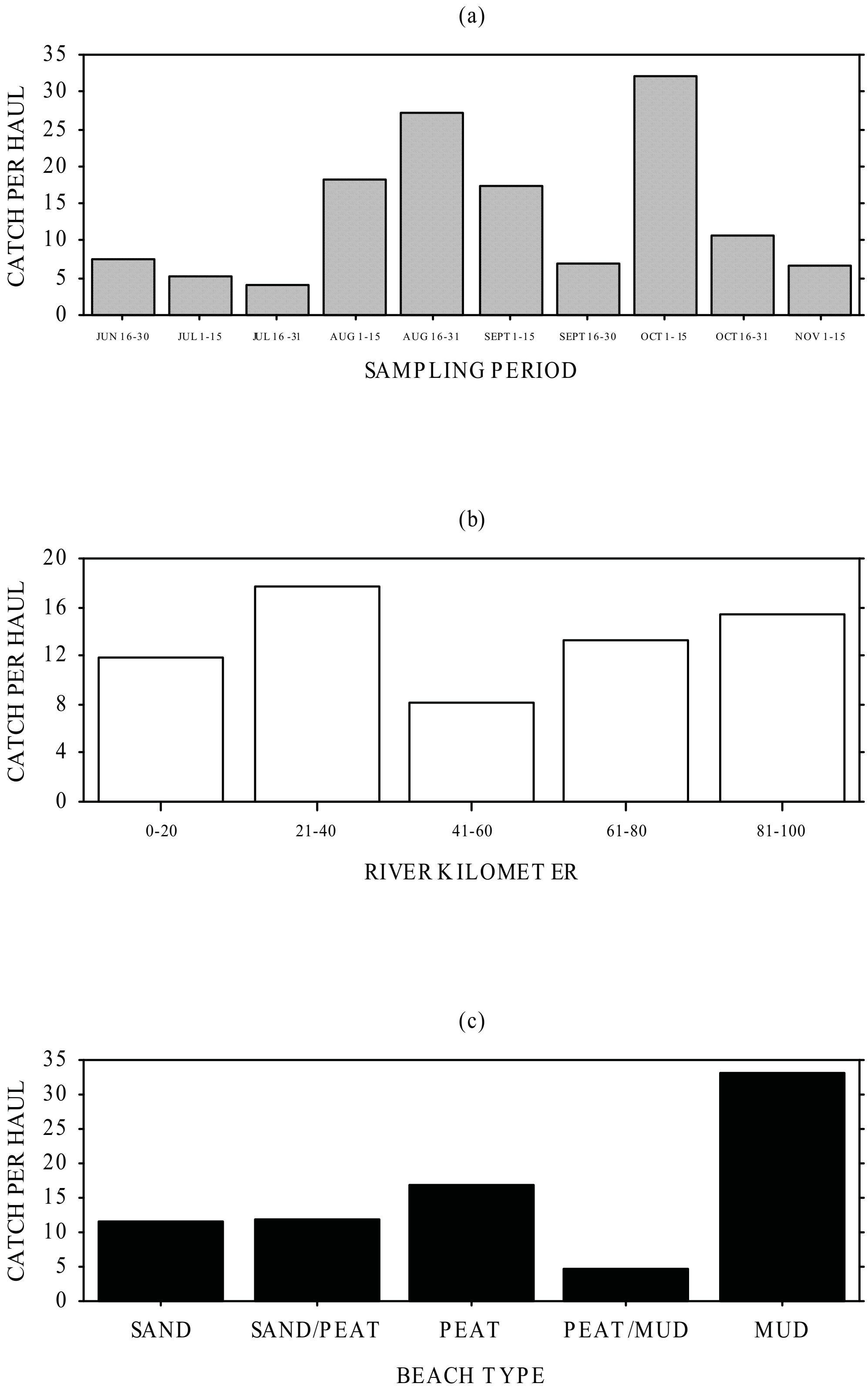



Figure 5-14. Mean catch per haul of bay anchovy by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

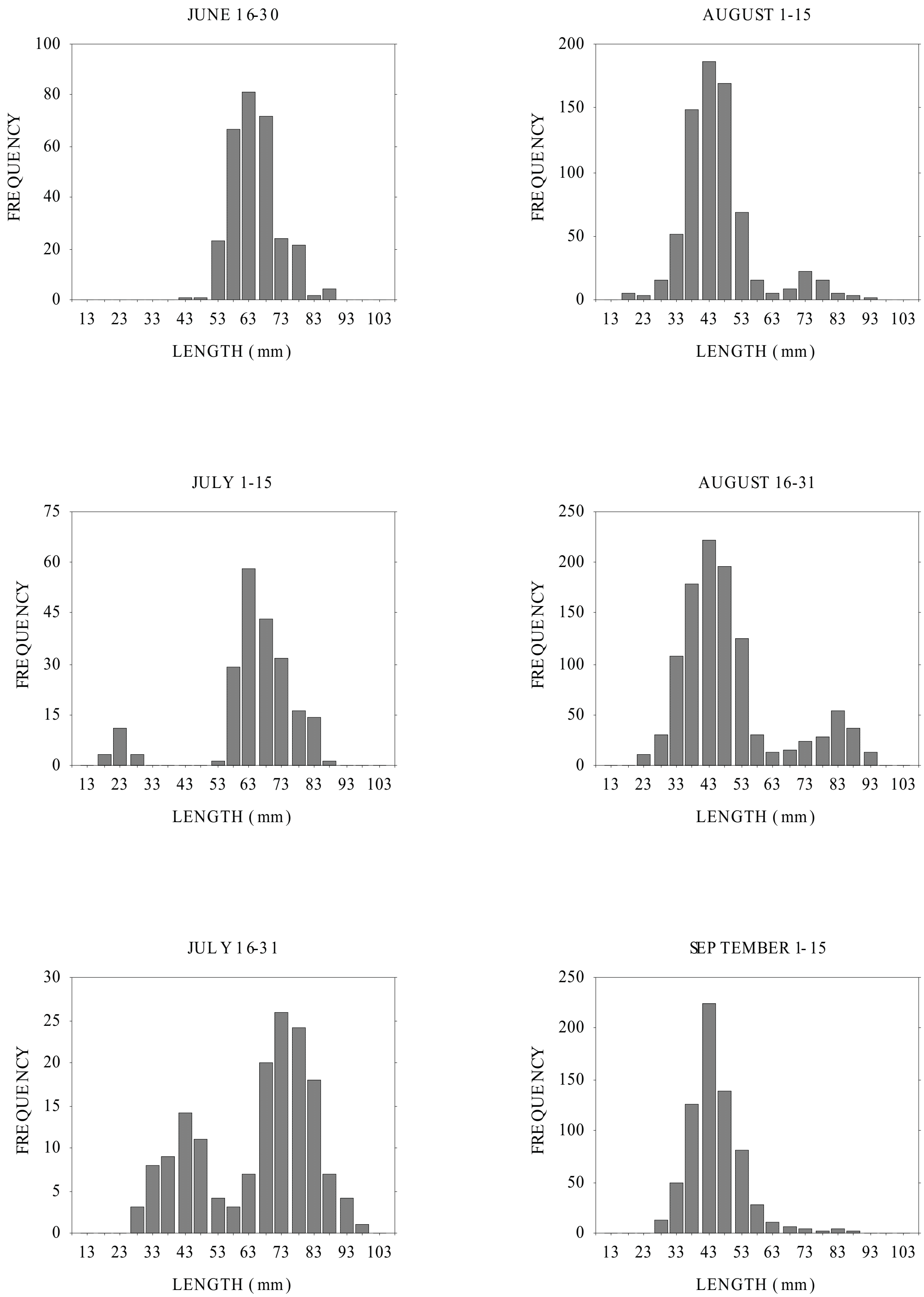
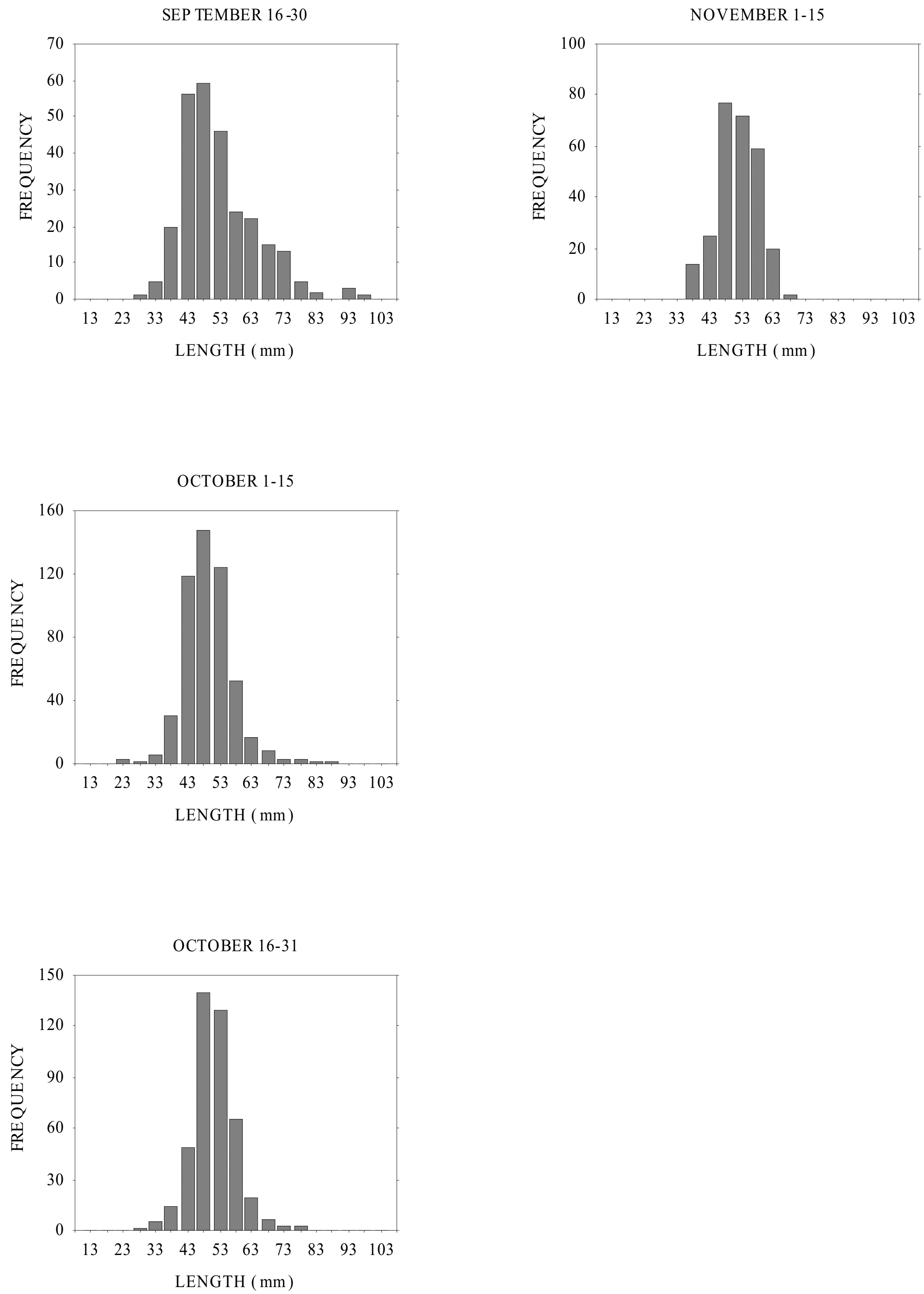



Figure 5-15. Length-frequency distribution by sampling period for bay anchovy taken during the 2003 baywide seine survey.

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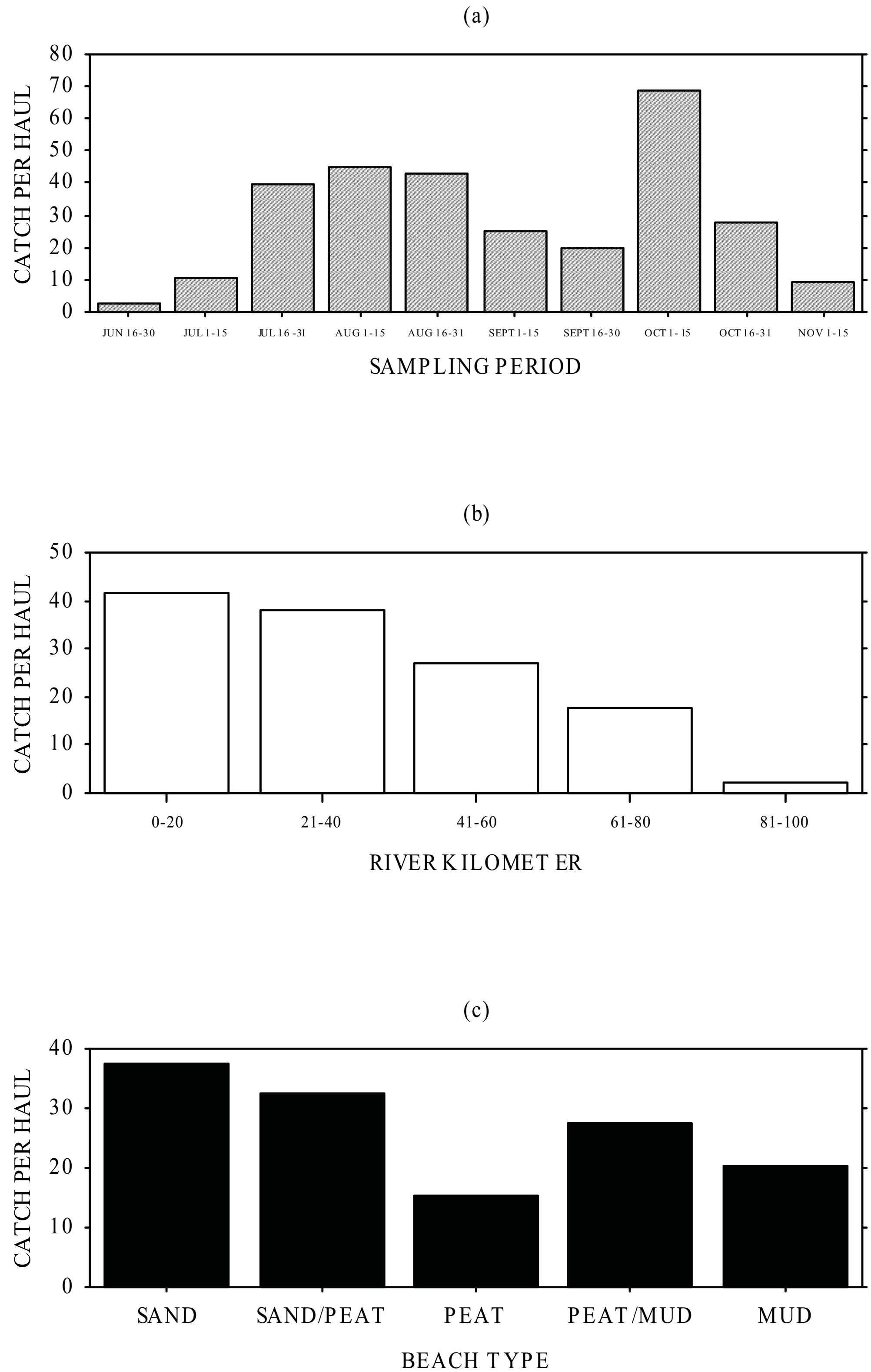



Figure 5-16. Mean catch per haul of Atlantic silverside by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

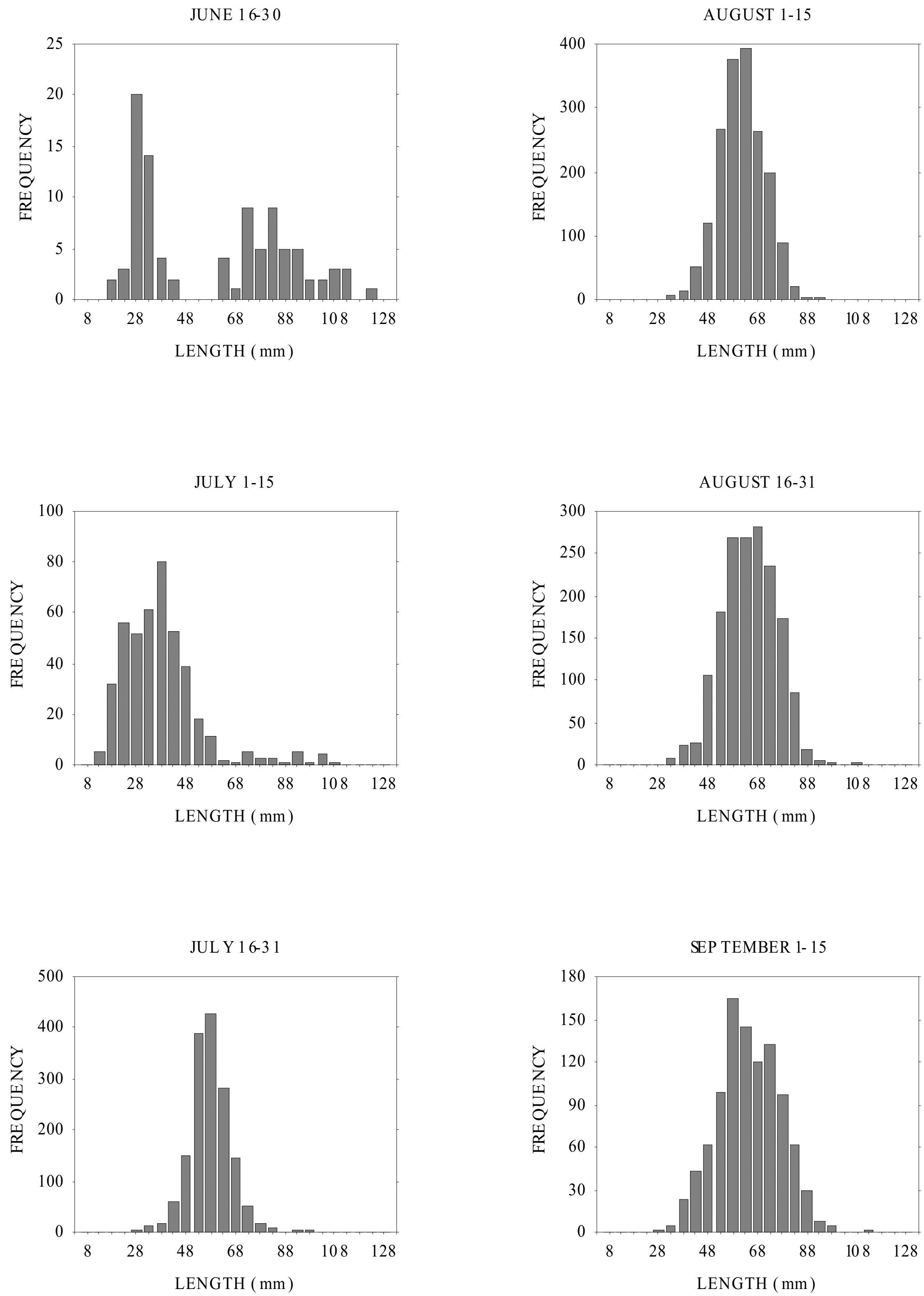
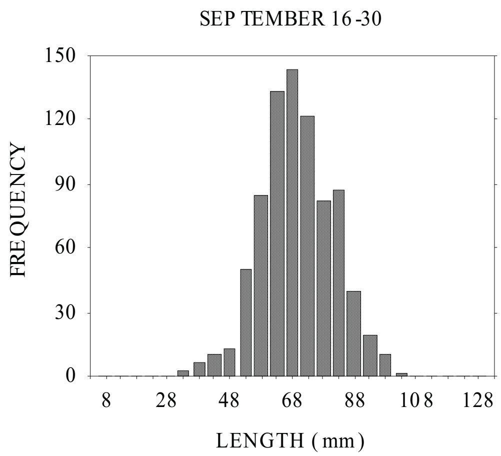
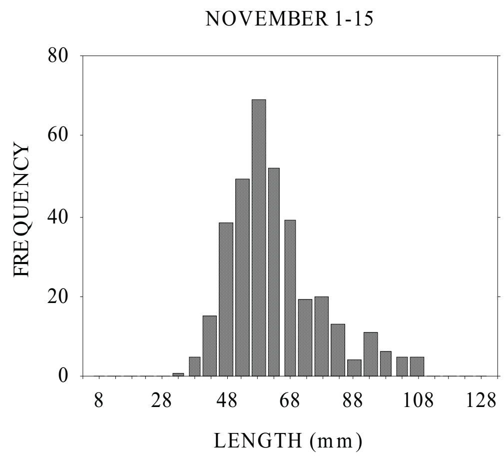
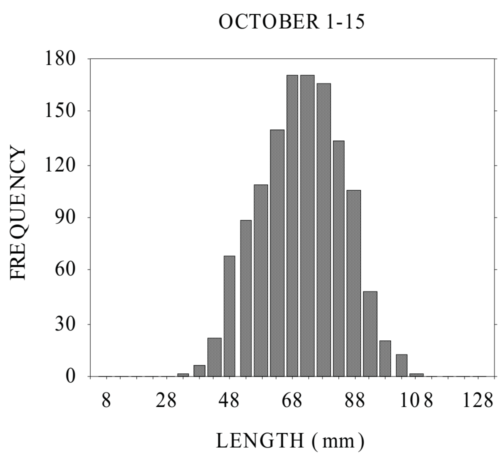
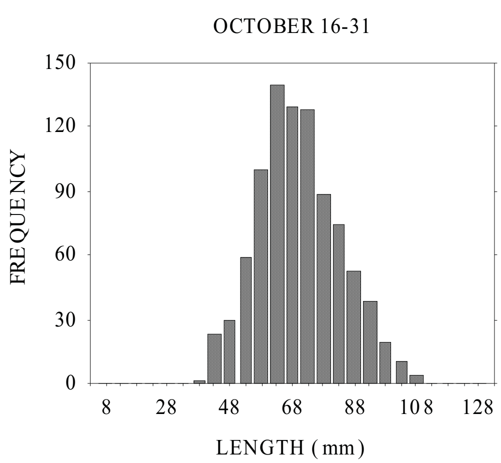



Figure 5-17. Length-frequency distribution by sampling period for Atlantic silverside taken during the 2003 baywide seine survey.

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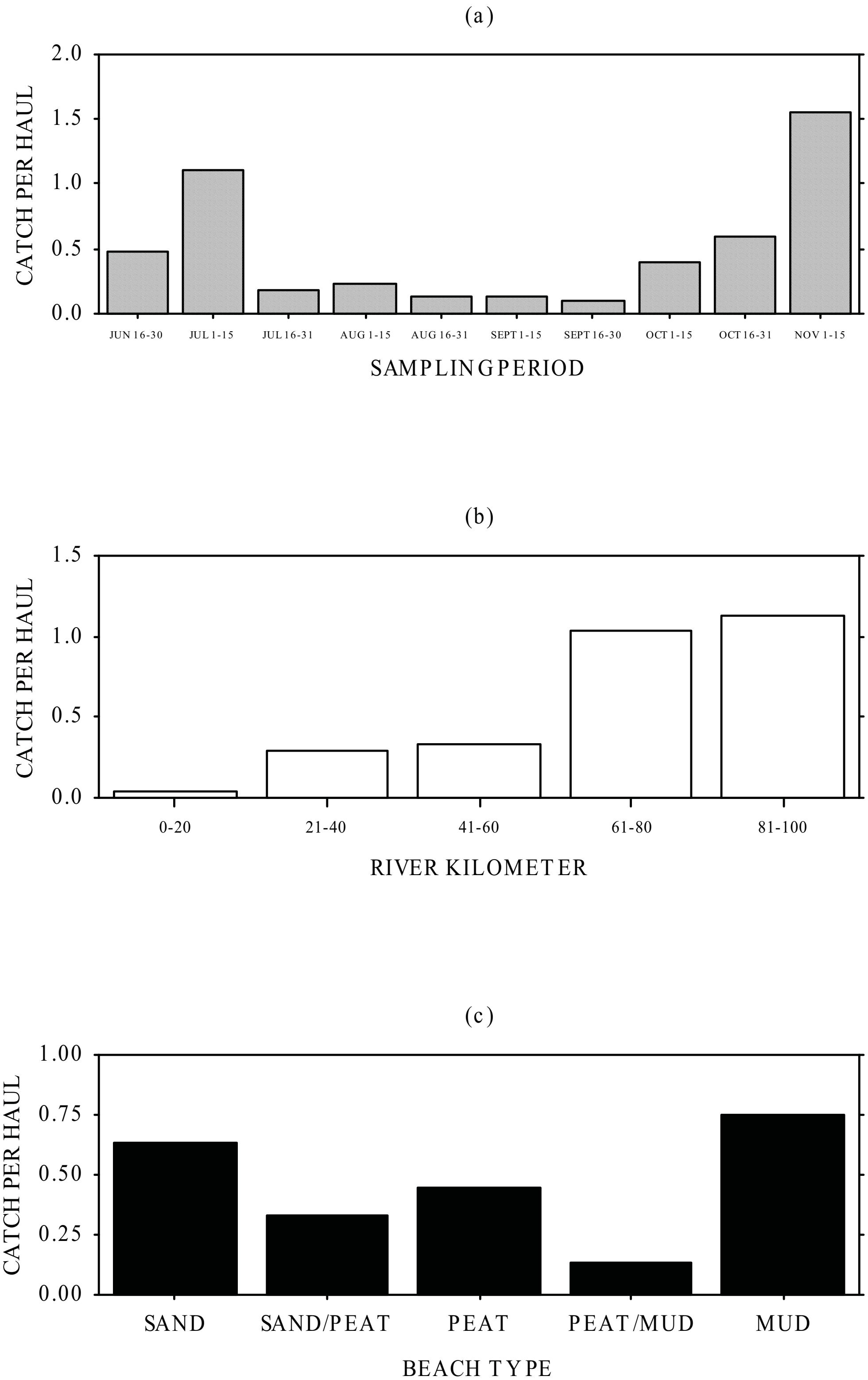



Figure 5-18. Mean catch per haul of white perch by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

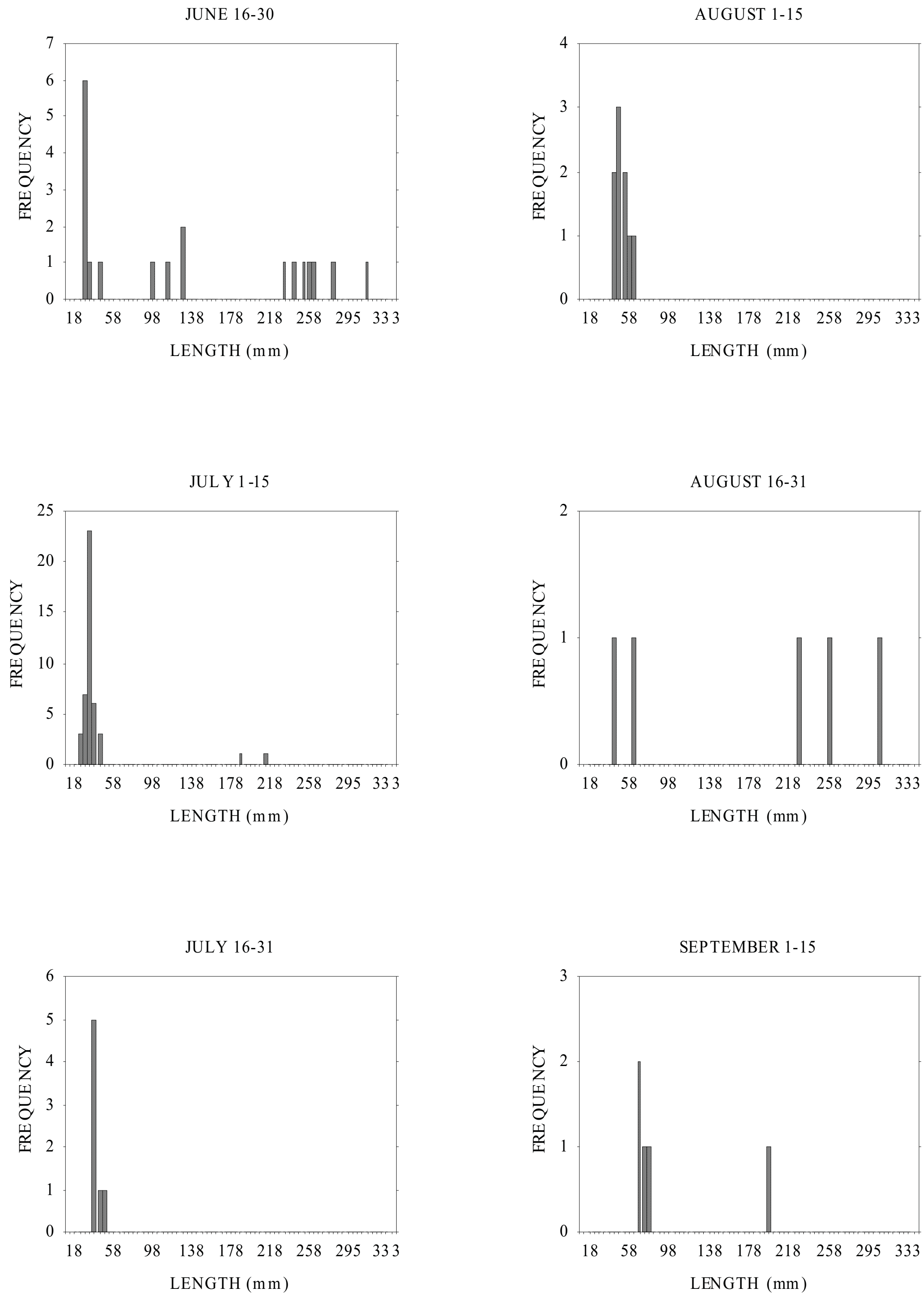
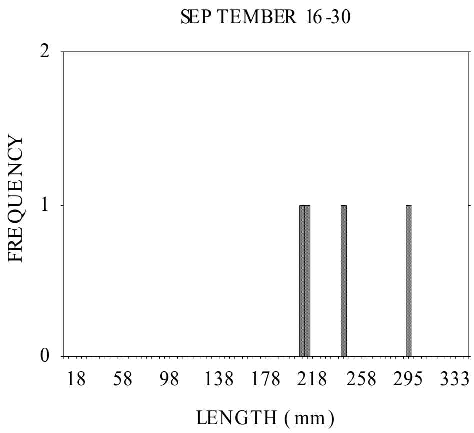
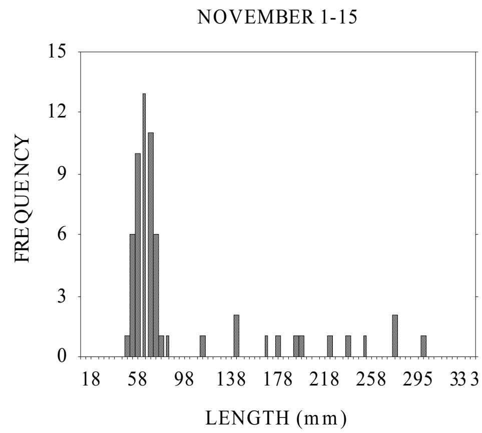
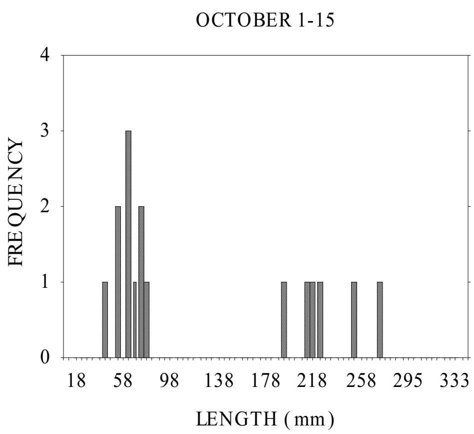
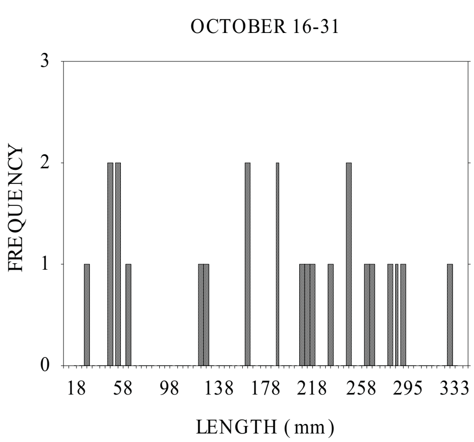



Figure 5-19. Length-frequency distribution by sampling period for white perch taken during the 2003 baywide seine survey.

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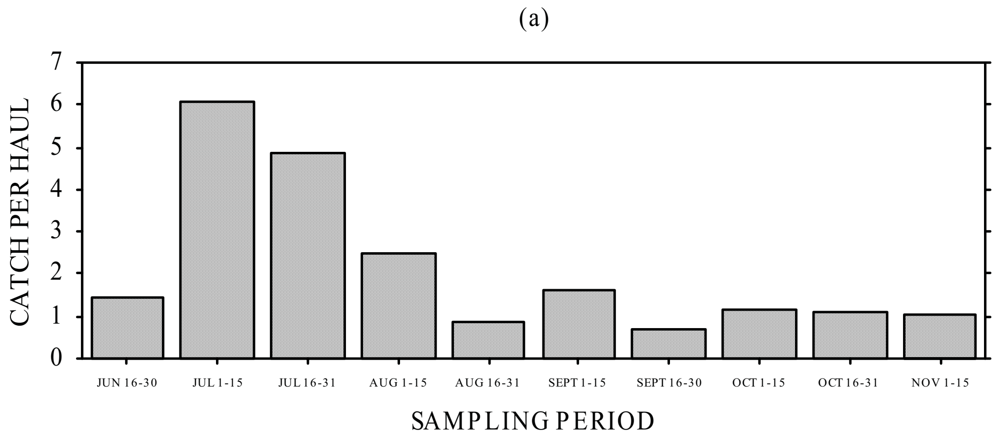
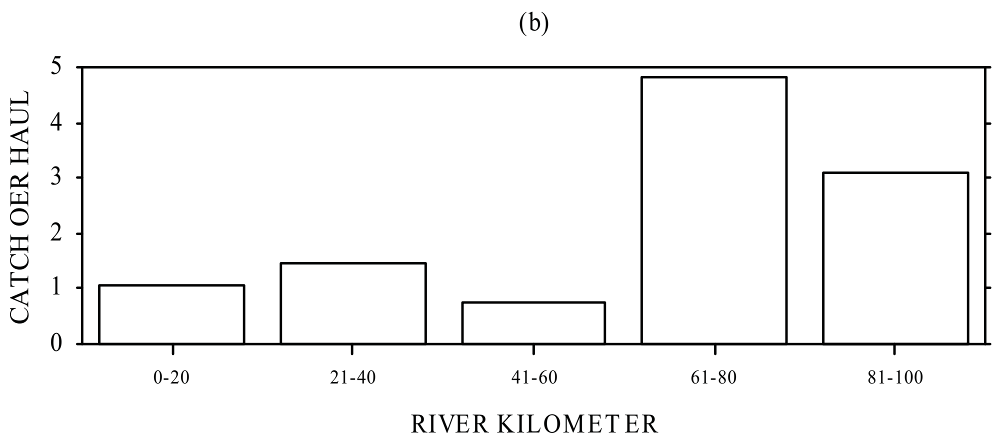


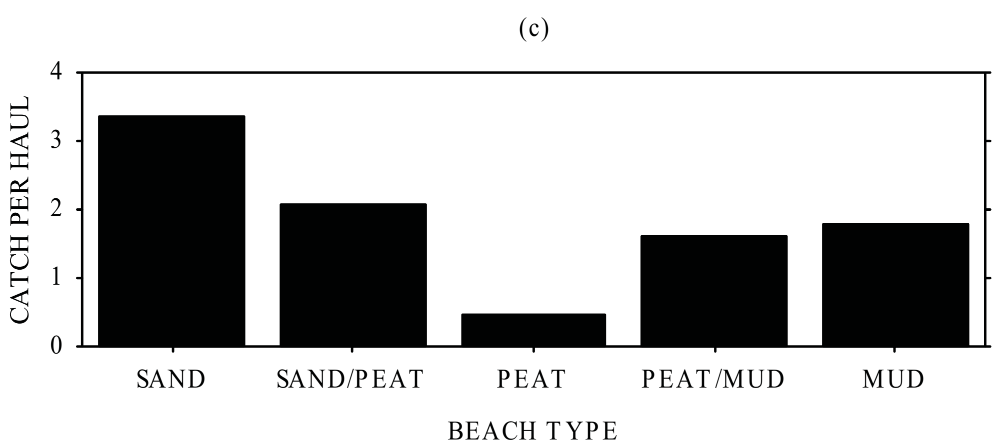




Figure 5-20. Mean catch per haul of striped bass by sampling period (a), river kilometer (b) and beach type (c), as observed during the 2003 baywide seine survey.

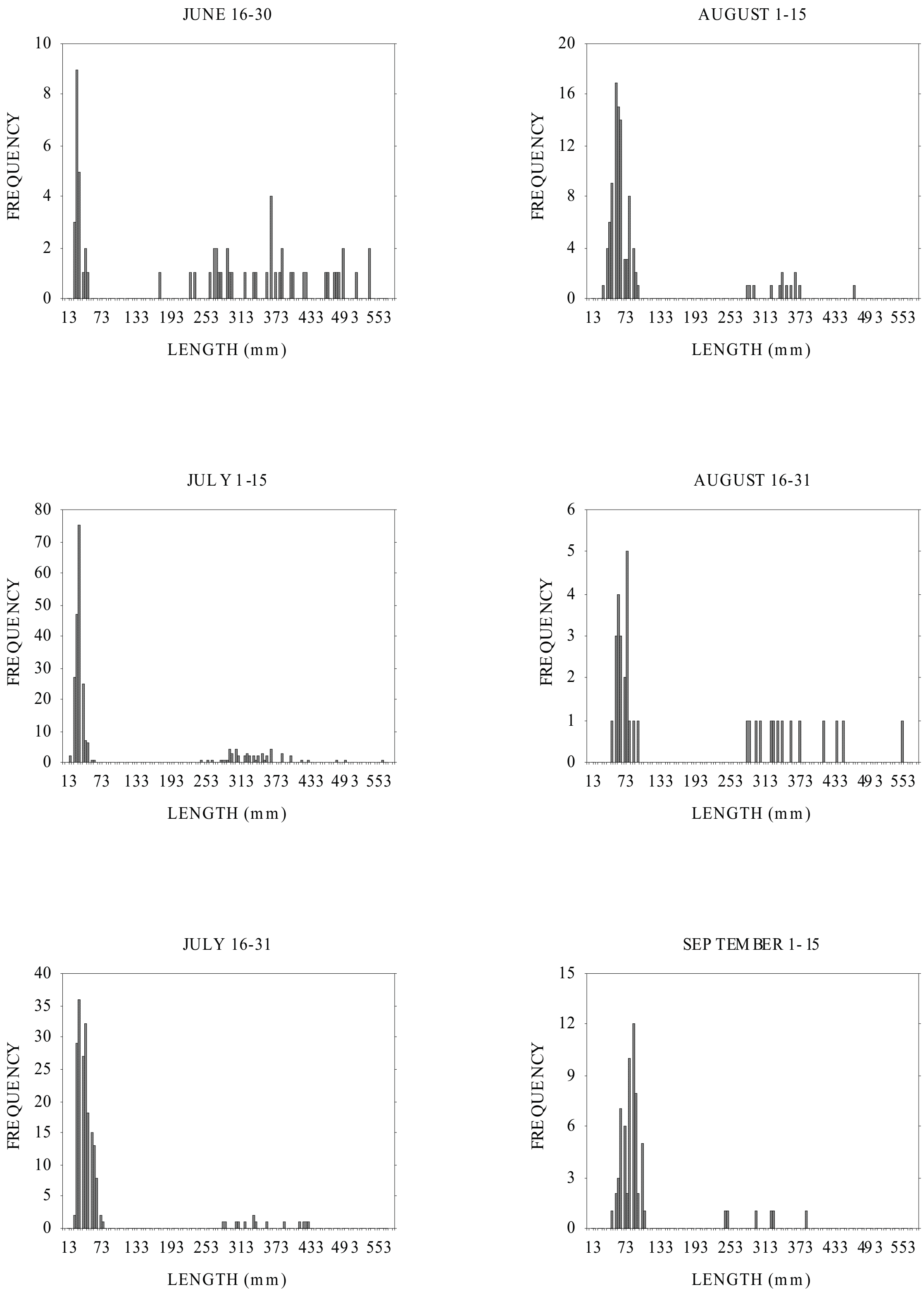
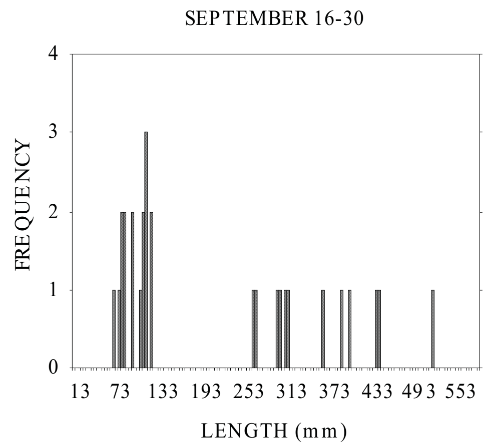
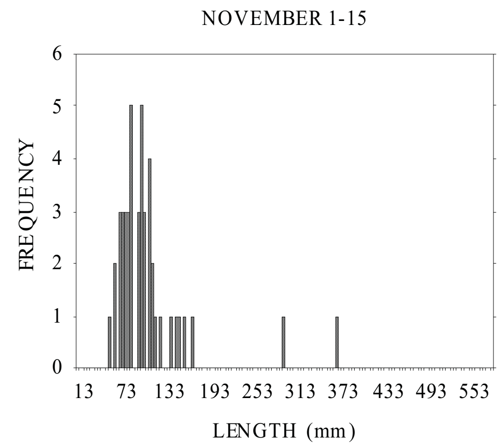
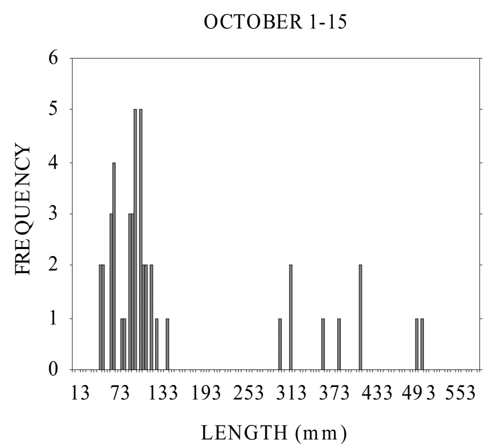
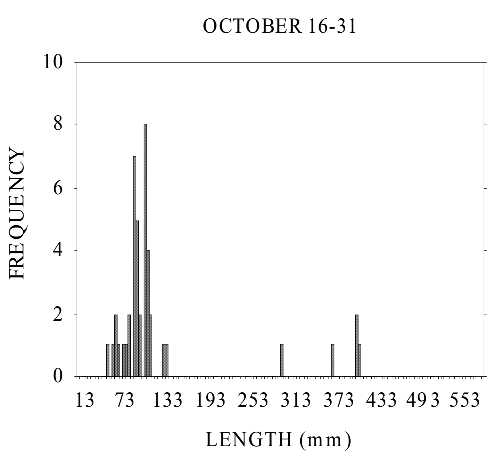



Figure 5-21. Length-frequency distribution by sampling period for striped bass taken during the 2003 baywide seine survey.

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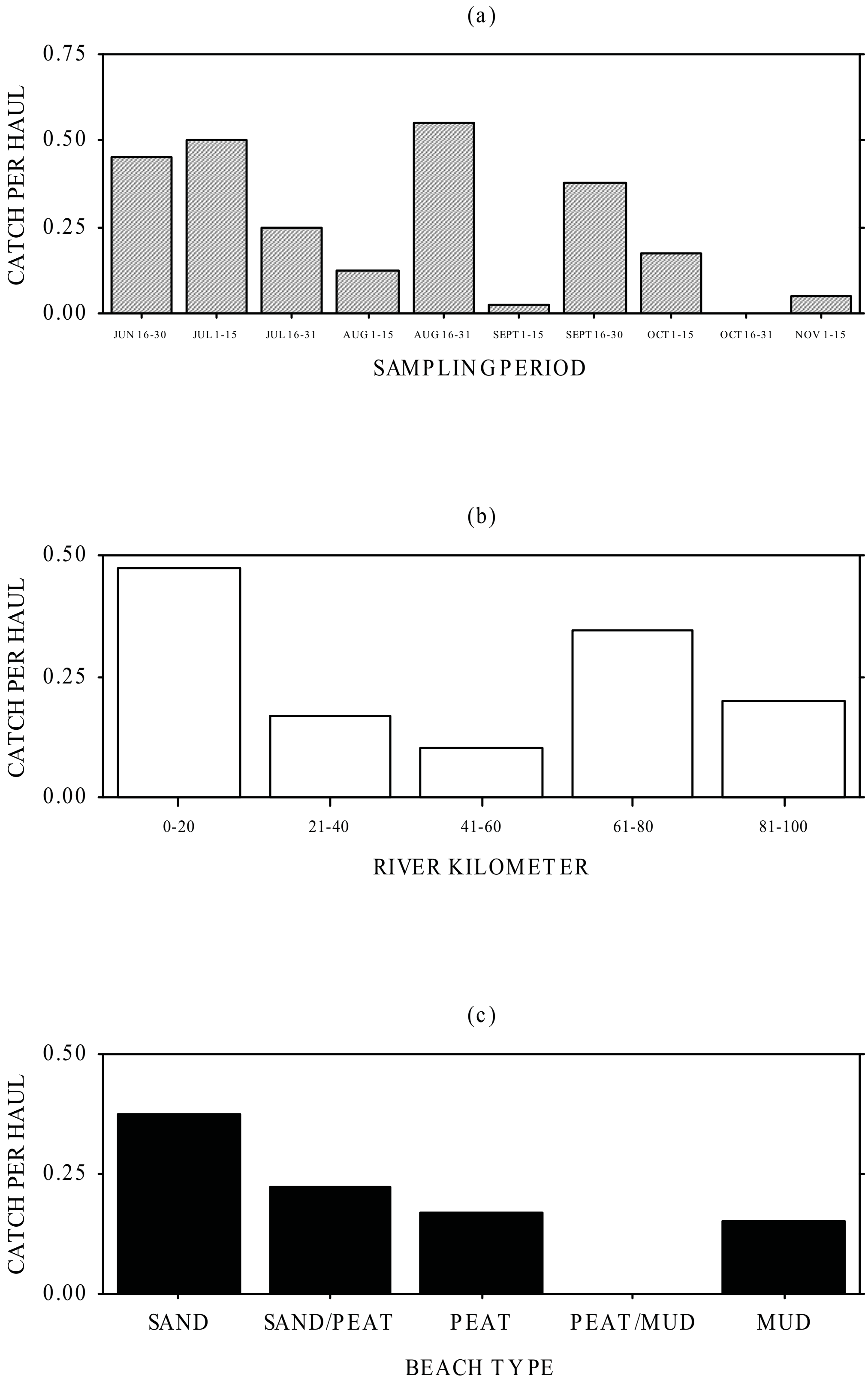



Figure 5-22. Mean catch per haul of bluefish by sampling period (a), river kilometer (b) and beach type (c) as observed during the 2003 baywide seine survey.

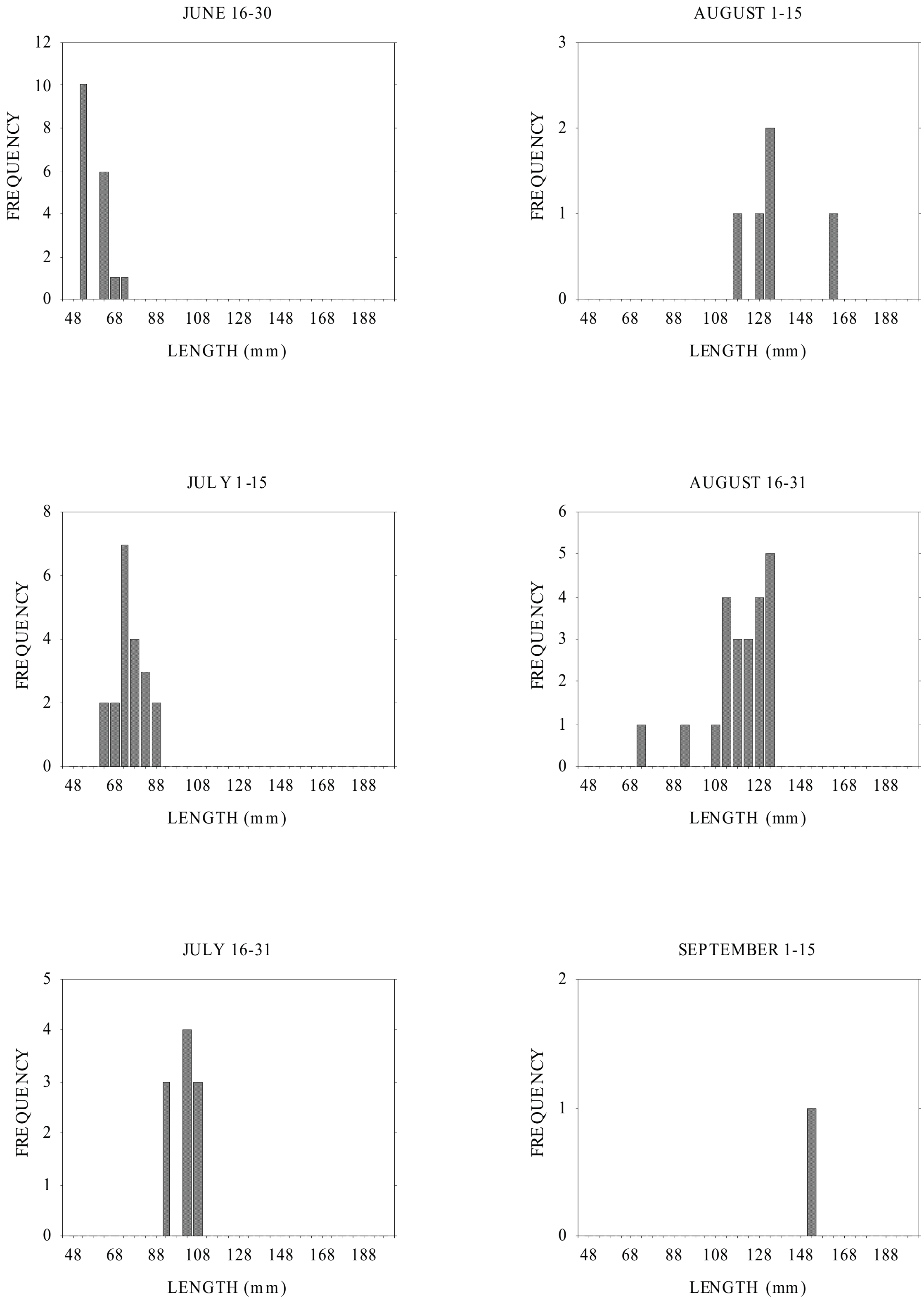
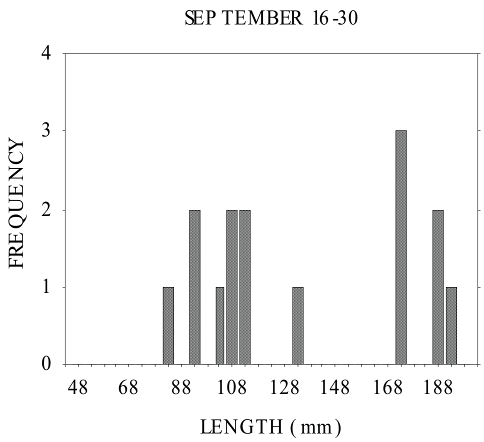
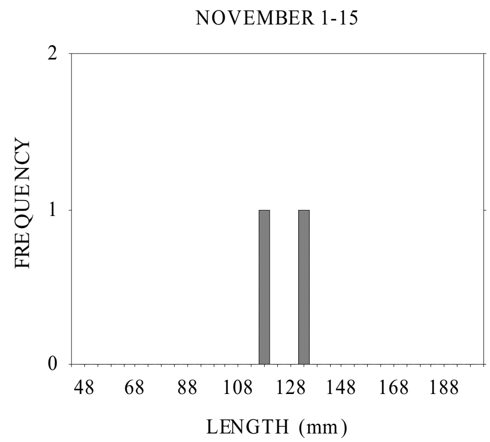
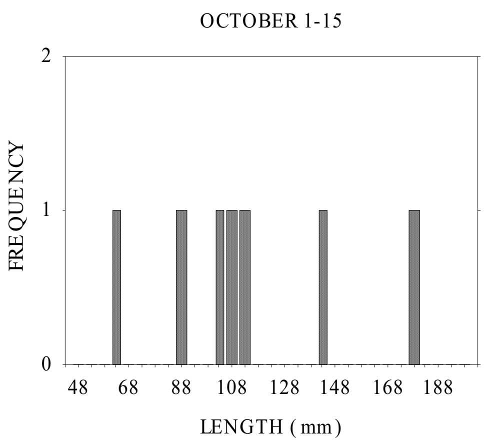
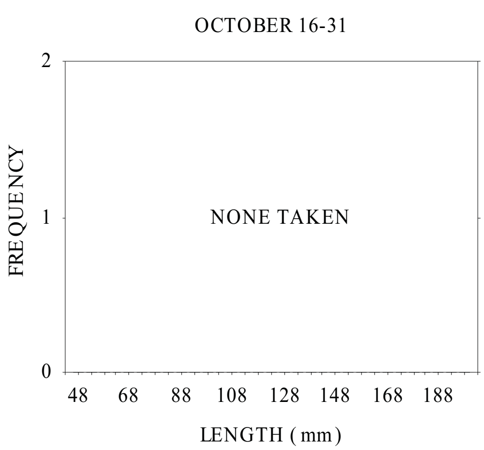



Figure 5-23. Length-frequency distribution by sampling period for bluefish taken during the 2003 baywide seine survey.

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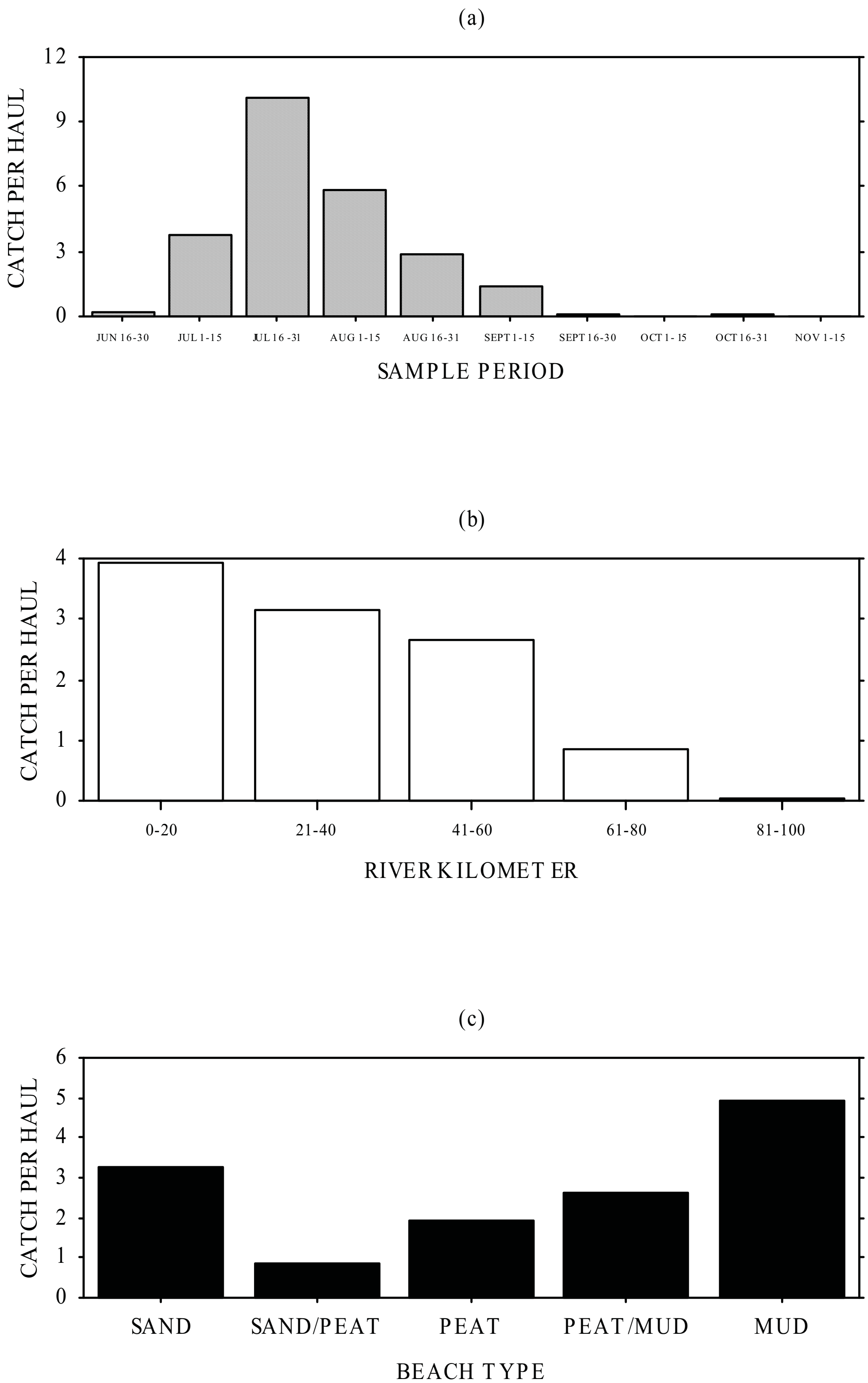



Figure 5-24. Mean catch per haul of weakfish by sampling period (a), river kilometer (b) and beach type (c), as observed during the 2003 baywide seine survey.

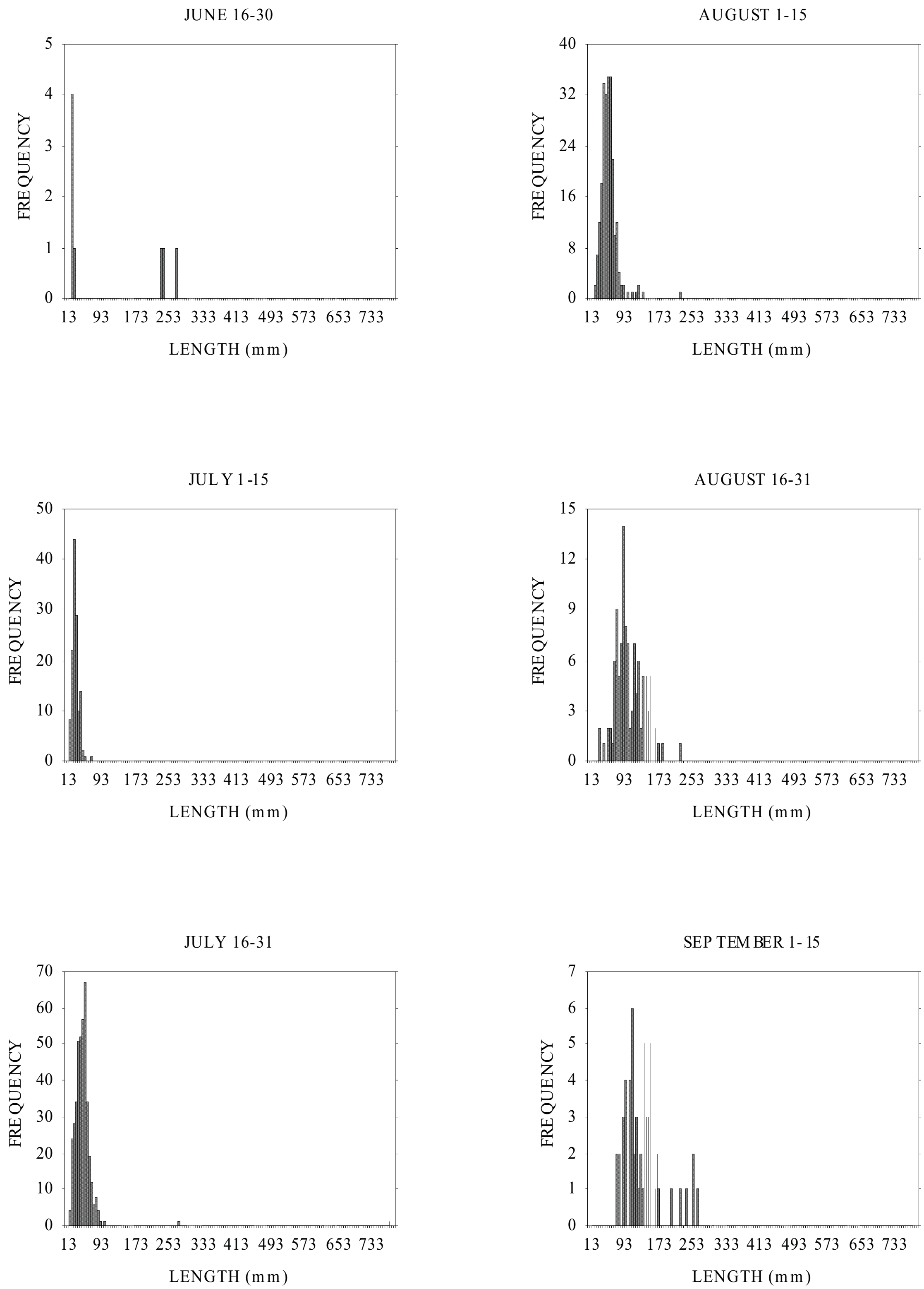
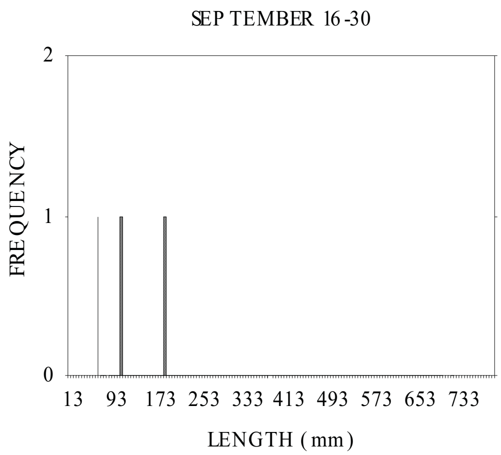
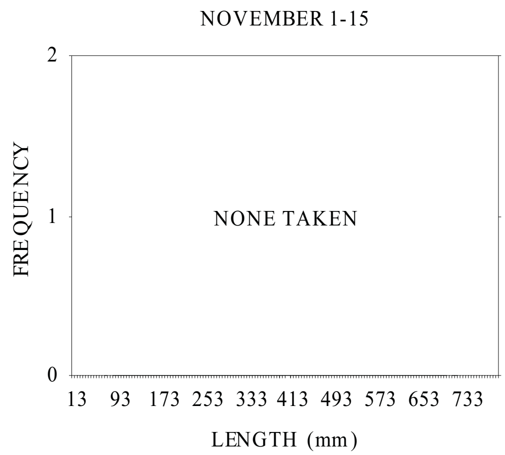
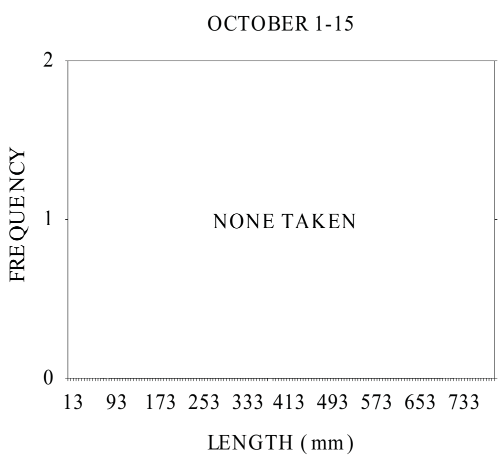
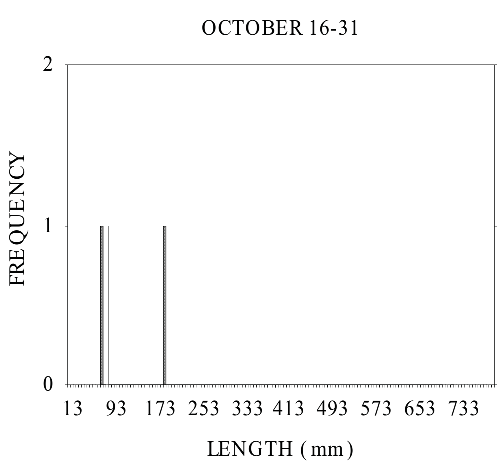



Figure 5-25. Length-frequency distribution by sampling period for weakfish taken during the 2003 baywide seine survey.

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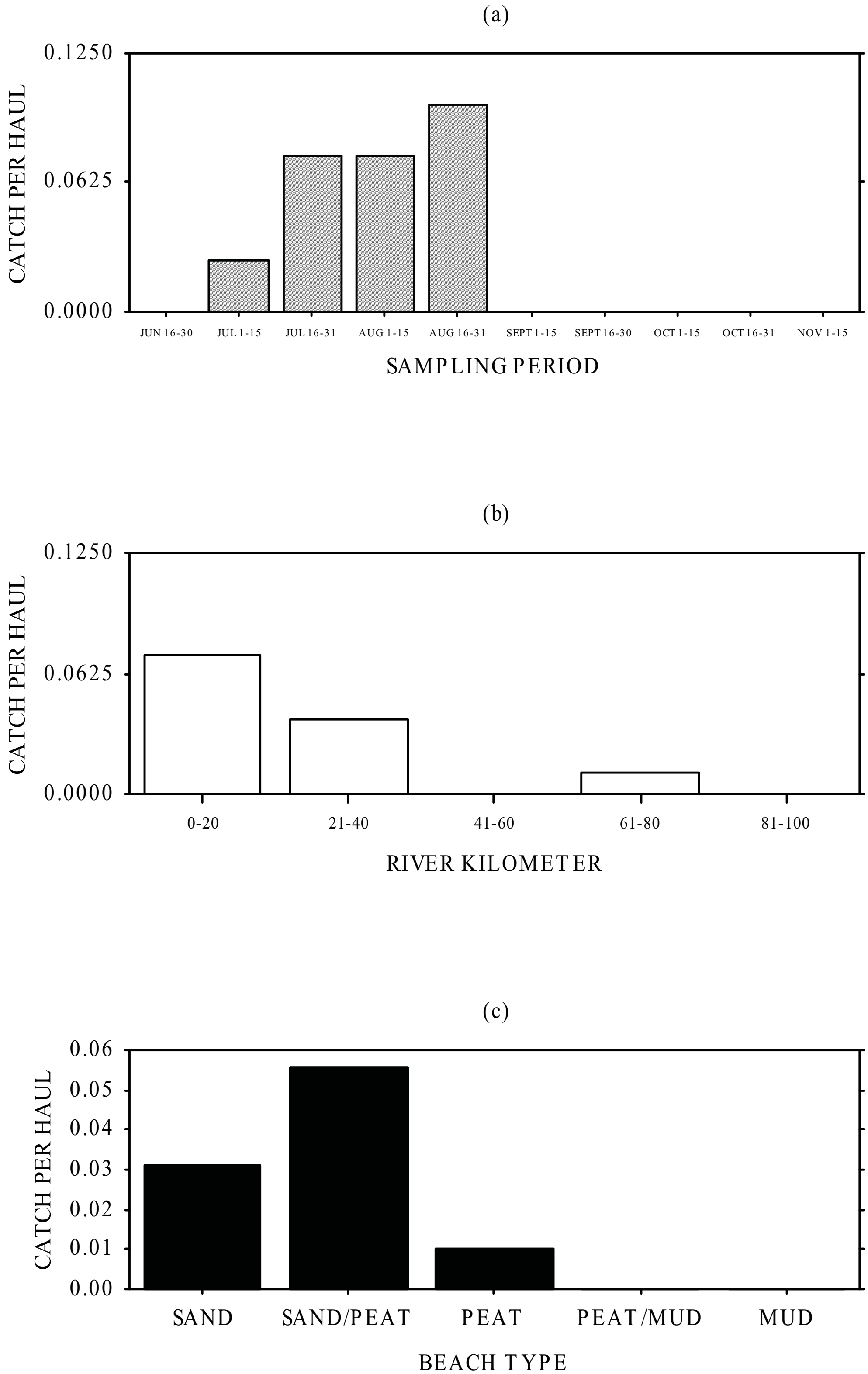



Figure 5-26. Mean catch per haul of spot by sampling period (a), river kilometer (b) and beach type (c), as observed during the 2003 baywide seine survey.

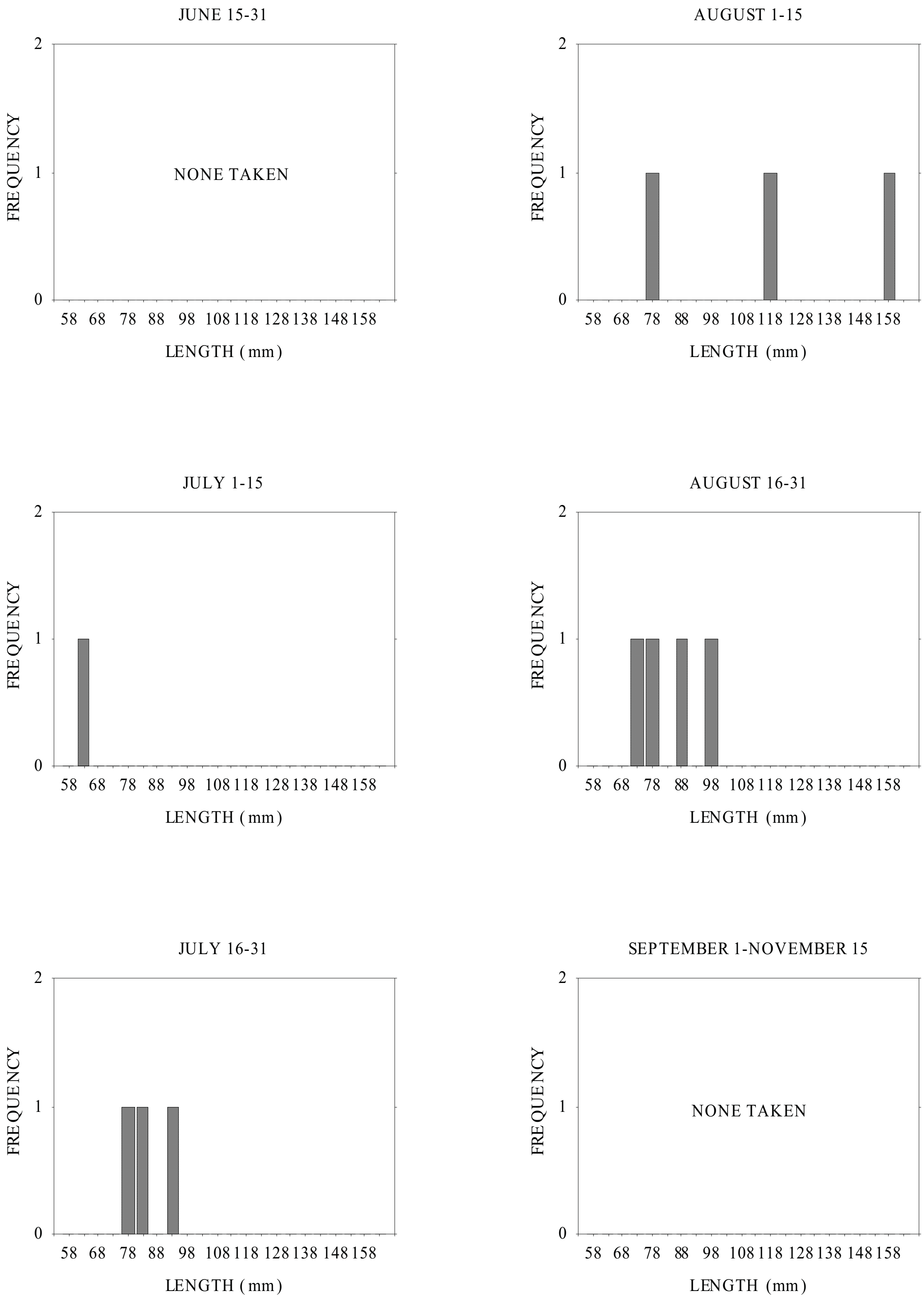



Figure 5-27. Length-frequency distribution by sampling period for spot taken during the 2003 baywide seine survey.

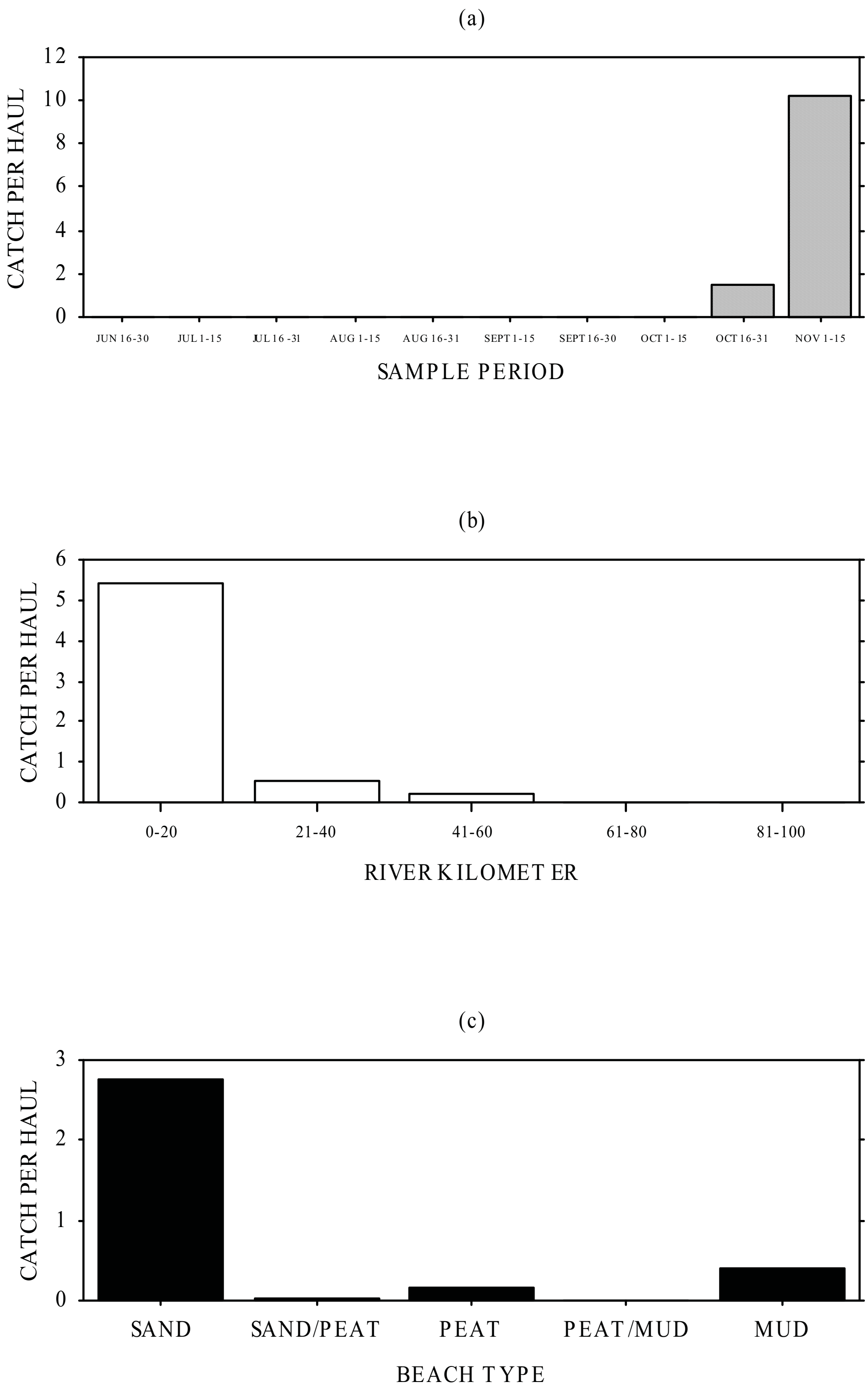



Figure 5-28. Mean catch per haul of Atlantic croaker by sampling period (a), river kilometer (b) and beach type (c), as observed during the 2003 baywide seine survey.

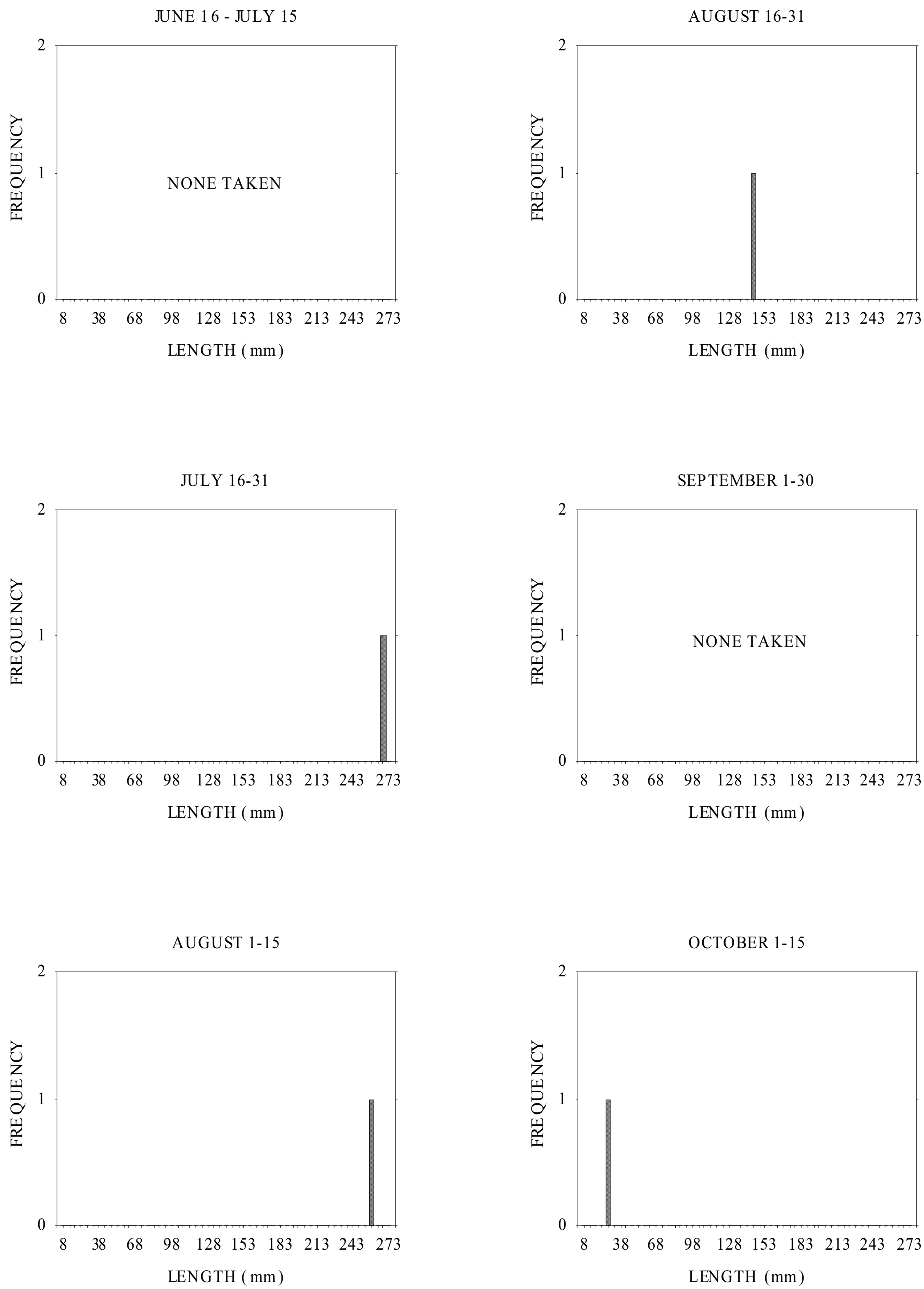
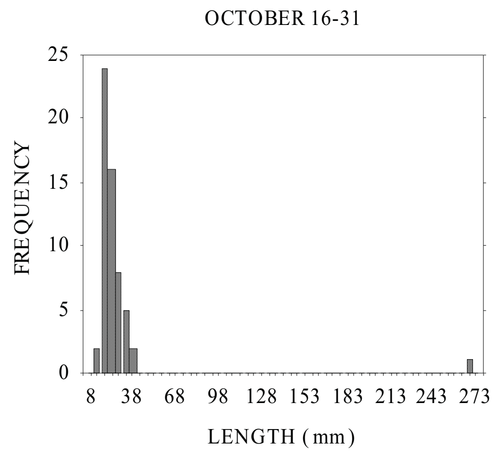



Figure 5-29. Length-frequency distribution by sampling period for Atlantic croaker taken during the 2003 baywide seine survey.



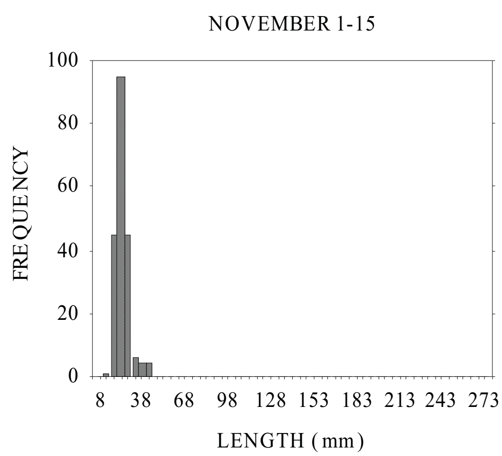




Figure 5-29. Continued.

Appendix 5-1. Region (rkm) and beach-type designations for the 40 beach seine stations.

| Station # | Region (rkm) | Beach Type |
|---|---|---|
| 1 | 0 - 20 | Sand |
| 2 | 0 – 20 | Sand |
| 3 | 0 - 20 | Sand |
| 4 | 21 - 40 | Sand/Peat |
| 5 | 21 – 40 | Sand/Peat |
| 6 | 21 – 40 | Mud |
| 7 | 21 – 40 | Peat |
| 8 | 41 – 60 | Sand |
| 9 | 41 – 60 | Sand |
| 10 | 41 – 60 | Peat |
| 11 | 41 – 60 | Sand |
| 12 | 61 – 80 | Sand/Peat |
| 13 | 61 – 80 | Sand/Peat |
| 14 | 61 – 80 | Peat |
| 15 | 61 – 80 | Sand |
| 16 | 81 - 100 | Sand |
| 17 | 81 - 100 | Peat |
| 18 | 61 – 80 | Sand/Peat |
| 19 | 61 – 80 | Sand |
| 20 | 61 – 80 | Sand/Peat |

| Station # | Region (rkm) | Beach Type |
|---|---|---|
| 21 | 61 – 80 | Sand |
| 22 | 41 – 60 | Sand/Peat |
| 23 | 41 – 60 | Peat |
| 24 | 41 – 60 | Peat |
| 25 | 21 - 40 | Mud |
| 26 | 21 – 40 | Sand |
| 27 | 21 – 40 | Sand |
| 28 | 21 - 40 | Peat/Mud |
| 29 | 0 – 20 | Sand |
| 30 | 0 – 20 | Sand |
| 31 | 0 – 20 | Sand |
| 32 | 0 - 20 | Sand |
| 33 | 21 - 40 | Peat |
| 34 | 21 – 40 | Peat/Mud |
| 35 | 21 – 40 | Sand/Peat |
| 36 | 21 – 40 | Peat/Mud |
| 37 | 21 - 40 | Peat |
| 38 | 41 – 60 | Sand/Peat |
| 39 | 61 – 80 | Peat |
| 40 | 81 - 100 | Peat |

## CHAPTER 6: FISH LADDER MONITORING

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# FISH LADDER MONITORING

## 6.1 INTRODUCTION

PSEG Nuclear LLC (PSEG), as a Special Condition of its NJPDES Permit (1995) (No. NJ0005622, Part IV-B/C Special Conditions, H.4), was required to construct and maintain five fish ladders on Delaware River estuary tributaries for spawning run restoration of the alewife (*Alosa pseudoharengus*) and the blueback herring (*Alosa aestivalis*), collectively known as river herring. Site evaluation studies conducted in 1994 and 1995 resulted in the initial selection of five impoundments for construction of fish ladders: Silver Lake, McGinnis Pond, McColley Pond, in Delaware and Cooper River Lake, and Sunset Lake in New Jersey. Silver Lake in Dover, McGinnis Pond near Frederica, and McColley Pond near Milford drain to the Delaware Bay (Figures 6-1, 6-2, 6-3, 6-4; Table 6-1). Construction of Alaska Steeppass fish ladders at these three locations was completed in 1996. Sunset Lake in Bridgeton, New Jersey (Figures 6-1, 6-6; Table 6-1); drains to the Delaware Bay. Construction of Alaska Steeppass fish ladder at Sunset Lake was completed in 1997. Cooper River Lake in Camden, New Jersey, drains into the Delaware River (Figures 6-1, 6-7; Table 6-1). Construction of an Alaska Steeppass fish ladder at this site was completed in 1998.

Even though these five initial sites satisfied the 1994 permit requirements, PSEG, using PSEG funds escrowed to DNREC as a result of a settlement agreement, has since installed fish ladders at three additional sites in Delaware. These sites are Coursey Pond, Garrisons Lake, and Moores Lake. Coursey Pond is near Frederica, Delaware and drains into Delaware Bay (Figures 6-1, 6-5; Table 6-1). Construction of the Alaska Steeppass fish ladder at Coursey Pond was completed in 1997. In early 1999, the final two Alaska Steeppass fish ladders were installed at Moores and Garrisons lakes near Dover and Cheswold, Delaware, respectively (Figures 6-1, 6-8, 6-9; Table 6-1); both of these impoundments drain to the Delaware Bay.

Components of PSEG's 2001 Improved Biological Monitoring Work Plan (IBMWP) require that monitoring for adult and juvenile river herring use of each of these sites be performed annually. Study objectives are to: 1) quantify the adult river herring use of the fish ladders and 2) to document year-class development by sampling for juveniles in the impoundments. In 2001, a modification to the Biological Monitoring Work Plan was approved by the NJDEP that allowed the discontinuation of larval monitoring.

In 1999, an additional objective, to stock targeted impoundments with adult herring during the spawning run, was formally added to this program; some limited stocking (lifting) took place in prior years, particularly in 1998. This stocking element was initiated to augment the remnant herring runs at selected sites by promoting optimal adult spawning activity within these targeted impoundments, which should accelerate the rate of increase in spawning run size in subsequent years. The stocking program should yield additional juvenile production, which after a four-year maturation period at sea, would result in a greater number of adult herring returning to that fish ladder site in subsequent years.

## 6.2 MATERIALS AND METHODS

### SPILLPOOL MONITORING

Spillpool temperatures were monitored three days per week starting February 6 in advance of opening the fish ladders. This monitoring was conducted to ensure that when the temperature reached 7.0 °C that the fish ladders were opened and that at 8.0 °C the monitoring of the fish ladder passage commenced.

### COMMERCIAL CATCH MONITORING

Commercial catch of river herring at Bowers Beach, DE, was monitored to provide an indication of pre-run herring aggregation in the Delaware Bay near the mouths of the Murderkill and St. Jones rivers. Catch log forms were provided to commercial fishermen to document their herring catch from gillnets set in the near shore waters of the Delaware Bay. When possible the speciation of the catch was confirmed as the commercial fishermen do not always differentiate between alewife and blueback herring but often referring to them collectively as "branch herring".

### ADULT PASSAGE SAMPLING

Spawning of river herring in the tributaries to Delaware Bay and lower River is reported to occur at water temperature ranges of 12.0-22.5°C for alewife and 15.0-24.0°C for blueback herring, (Smith, 1971; Wang and Kernehan, 1979). Jones (1999) reported alewives arriving at Wagamons at 9-11°C and blueback herring arriving at 13-20°C. Adult passage sampling is scheduled to begin when water temperature in the spill pool reaches 8°C. In 2001, monitoring at the Delaware fish ladder sites commenced on March 11$^{th}$, Sunset Lake monitoring began on March 13 and Cooper River Lake sampling commenced on April 7th, when water temperatures reached and remained at or above 8ºC. Table 6-2 describes the fish ladder operation and maintenance activities for each of the eight sites.

Although the study design required sampling at each site for a minimum of five days per week with a minimum of four hours of sampling per pond per day, sampling during 2002 was continuous (24 hour) at several sites. This was achieved by leaving the exit trap in place and visiting each site one or more times each day to enumerate catch and release the herring into the impoundment. The six Delaware traps were modified in 2001 to minimize holding mortality by limiting confining areas within each trap and incorporating K-less® knotless netting (Figures 6-11 and 6-12). The fish ladder at Cooper River Lake continues to be inaccessible for downstream monitoring purposes at high tide. A modified commercial trap net was employed at the upper end of the fish ladder extending into the lake (Figure 6-13). Sampling at all sites was discontinued on June 14th, at which time water temperatures exceeded 26ºC (Figure 6-16) and no herring had been observed for a period of one week.

Adult herring use of the fish ladders was monitored with a fish trap placed at the exit (upper end) of the fish ladder (Figures 6-10, 6-11, 6-12, and 6-13). The fish trap was secured to the trash bars at the exit of the fish ladder and positioned so that it extended into the pond. At Coursey

Pond and McColley Pond, a reducer was placed at the outlet of the fish ladder to standardize the exit opening and the fish trap was attached to the reducer. At Silver Lake, a fish diversion curtain constructed of weighted, clear vinyl strips, was suspended across the lower end of the spill pool at the start of the spawning run to guide adult herring to the entrance of the fish ladder (Figure 6-14). At Moores Lake a temporary aluminum fish diversion flume was employed to direct fish to the entrance of the fish ladder (Figure 6-15).

The adult passage sampling sequence commenced when the fish trap was secured to the face of the fish ladder. Upon subsequent arrival at the site, the fish trap was checked for fish. Any catch was identified to species, enumerated, and the herring released into the pond; other species taken (e.g., gizzard shad, white perch) were released back to the spill pool. Next, the spill pool and tail water areas below the dam were observed for the presence of adult herring and any indication of spawning activity; polarized glasses were used to facilitate these observations. Cast netting and/or dip netting was occasionally employed to confirm observations and species identification; this activity was limited to minimize disturbance to the adult herring.

Additionally, impoundment and spill pool water quality parameters were measured at a minimum of once per day. Water temperature, conductivity, and dissolved oxygen were measured using a Yellow Springs Instruments (YSI) Model 85; an Oaklon® Model pHTestr 2 was used to measure pH; both instruments were calibrated daily to ensure accuracy. Water clarity was measured with a standard 20 cm (8-in) secchi disk. Meteorological conditions (e.g., sky conditions, weather) were also noted.

Hourly temperature monitoring was initiated at all sites using "TidbiT" temperature loggers. Loggers were used in each of the spillpools and placed to minimize disturbance by the public.

## STOCKING

A goal of establishing at lease five adult river herring per surface acre of impoundment, through the adult passage or by the stocking program, was based on recommendations from researchers in New England and Canada. Target stocking numbers were as follows:

| Impoundment | Acreage | @5/acre | Target number of herring |
|---|---|---|---|
| Garrisons Lake | 86.0 | 430 | 430 |
| Silver Lake | 157.8 | 789 | 1,000 |
| Moores Lake | 27.0 | 135 | 135 |
| McGinnis Pond | 31.3 | 157 | 157 |
| Coursey Pond | 58.1 | 291 | 291 |
| McColley Pond | 49.0 | 245 | 245 |
| Silver Lake (Milford) | 28.5 | 143 | 143 |
| Cooper River Lake | 179.4 | 897 | 1,000 |
| Stewart Lake | 37.0 | 185 | 185 |
| Sunset Lake | 77.6 | 388 | 1,000 |

Adult herring were taken from local tributaries and spillpools using cast nets, electroshocking, and a specially designed pound net. The Union Lake fish ladder (Millville, NJ) was utilized to procure adult herring for stocking the two New Jersey impoundments (Figure 6-1). Fish were transferred from the point of capture to the release site in a specially outfitted transport tank. Only vigorous adults were counted as stocked; the few fish that had lost equilibrium were stocked but not counted. For the seven Delaware sites, an effort was made to utilize adults from the site-specific spill pool; however, due to the paucity of herring at Garrisons and Silver Lake spillpools, most adults stocked into these impoundments were obtained from the substantial existing runs at Moores, McGinnis, Coursey, and McColley ponds.

Adult blueback herring were also stocked into Union and Evans Pond in New Jersey as agreed to with the NJDEP.

### JUVENILE SAMPLING

Monthly electroshocker sampling during September through November was used to assess juvenile river herring occurrence at each of the eight impoundments. The primary goal of this sampling was to provide evidence of successful post-larval herring development. A Smith-Root Model 2.5-GPP portable electro-fisher unit with two UAA-4 umbrella anode arrays was used for electroshocking efforts. The electroshocker unit was operated in pulsed DC at 120 pulses per second and typically at 6-8 amps. The standard sampling duration was 1200 sec (20 min) of electroshocker operation at each impoundment. Effort was directed to the open water of the impoundments where experience has shown the highest probability of encountering juvenile herring. Sampling was restricted to the late afternoon and evening hours (twilight) since this is when juveniles are more apt to congregate near the surface and near shore (Lindenburg, 1976). Fish are counted each time the foot switch is pressed. The count of small numbers of fish is exact. Estimates of larger numbers of fish are made in 10, 25, 50, 100, 150, and 200 fish increments. When herring were encountered in considerable numbers, electroshocking was briefly interrupted to limit the stress on the fish.

With each collection, a subsample of specimens of each herring species was measured for fork length, to the nearest millimeter. Several specimens of each species from each impoundment were retained for QA/QC of the speciation and inclusion into the annual voucher collection.

## 6.3 RESULTS

### SPILLPOOL MONITORING

Spillpools were observed and spillpool temperatures were monitored manually from January 7 through March 18, 2003. Spillpool temperatures were also collected using a “TidbiT” temperature logger. Representative water temperature data is presented in Figure 6-16.

## COMMERCIAL CATCH MONITORING

Commercial catches at Bowers Beach, DE were monitored from February 1 through April 5. Due to ice flows and heavy debris concentration off of Bowers Beach, commercial nets were not set and temperature data were collected only occasionally (Table 6-3).

## ADULT PASSAGE MONITORING AND STOCKING

Adult passage monitoring during 2003 spanned the period March 18th to June 16th, during which time a total of 17,088.66 hours of fish ladder trap net sampling was conducted. The following table lists the sampling hours specific to each site:

| Fish Ladder Site | Hours Sampled |
|---|---|
| **Garrisons Lake** | 2,153.72 |
| **Silver Lake** | 2,139.32 |
| **Moores Lake** | 2,162.58 |
| **McGinnis Pond** | 2,158.75 |
| **Coursey Pond** | 2,161.17 |
| **McColley Pond** | 2,160.17 |
| **Cooper River Lake** | 2,142.03 |
| **Sunset Lake** | 2,010.92 |
| **Total** | 17,088.66 |

The daily catches of adult herring at each of the eight fish ladder sites during 2003 are listed in Table 6-4. The range and peak periods of occurrence of each herring species, along with corresponding spill pool water temperatures at each site are described in Table 6-5. The number of pre-spawn herring stocked in each of the impoundments is presented in Table 6-6. The following briefly summarizes the trap net catch and stocking effort at each site:

- Trap net sampling at Garrisons Lake yielded 13 alewife and 21 blueback herring. The Alewife were taken from April 4 though May 1, 2003. The blueback herring were taken from April 28 through May 31. Due to the frequent rains and higher than average flows in the creeks, no blueback herring were stocked into Garrisons Lake from the spillpools of other Delaware impoundments draining into the Delaware Bay.

- Trap net sampling at Silver Lake yielded no alewife and 15 blueback herring; the blueback herring were taken April 30 through May 30. An additional 201 blueback herring were stocked between May 19 and June 1 from the spillpools of other Delaware impoundments draining into the Delaware Bay.

- Sampling at Moores Lake yielded 72 alewife and 438 blueback herring; the alewife were taken March 20 through May 5 and the blueback herring were taken April 24 through June 14. No fish were stocked into this impoundment since the number of herring passed through the fish ladder exceeded the target number of 135 adult herring.

- Trap net sampling at McGinnis Pond yielded 2 alewife and 27 blueback herring; the alewife were taken April 16 through April 19 and the blueback herring were taken April 29 through June 6. Twenty two blueback herring were stocked into this impoundment.

- Sampling at Coursey Pond yielded 127 alewife and 215 blueback herring; the alewife were taken March 24 through May 5 and the blueback herring were taken April 25 through June 3. No fish were stocked into this impoundment since the number of herring passed through the fish ladder exceeded the target number of 291 adult herring.

- Sampling at McColley Pond yielded 62 alewife and 109 blueback herring; the alewife were taken March 23 through May 12 and the blueback herring were taken April 24 through May 31. No fish were stocked into this impoundment.

- Trap net sampling at Cooper River Lake yielded 3 alewife and 9 blueback herring; the alewife were taken on April 17 and April 29, the blueback herring were taken on May 14 and May 15. On June 3, 197 blueback herring were stocked into Cooper River Lake from the Union Lake fish ladder.

- Sampling at Sunset Lake yielded 15 alewife and 49 blueback herring; the alewife were taken April 16 through May 1 and the blueback herring were taken April 29 through June 2. Over the period May 5 through June 1, 969 blueback herring were stocked into Sunset Lake from the Union Lake fish ladder.

## JUVENILE SAMPLING

Results of the juvenile sampling in the eight impoundments during 2003 are presented in Tables 6-7 and 6-11. A total of 6,631 juvenile blueback herring, 4 adult blueback herring, and 158 juvenile alewife were observed and/or counted in the approximately 496 minutes of electroshocking. Length ranges of subsampled juvenile herring are presented in Table 6-8. The following summarizes the catch at each site:

- At Garrisons Lake, no juvenile herring were observed or captured.

- At Silver Lake, no alewife and 2 blueback herring were counted. A length of 96 mm FL was measured for the sampled blueback herring.

- At Moores Lake, no alewife and no blueback herring were counted. Twenty six juvenile blueback herring were removed over the summer from fish growing ponds which receive water from the Moores Lake raceway.

- At McGinnis Pond, no alewife or blueback herring were counted.

- At Coursey Pond, no alewife and a total of 7 blueback herring were counted with lengths of 122 and 136 mm FL.

- At McColley Pond, no alewife and one juvenile blueback herring was counted on September 25.

- At Cooper River Lake 6,448 blueback herring and 158 alewife were counted (Table 6-7); blueback herring and alewife were taken in each monthly sample. Alewife length range was 86-163 mm FL and blueback length range was 70-93 mm FL (Table 6-8).

- At Sunset Lake, no alewife and 173 juvenile blueback herring were observed and counted during September through November sampling. Juvenile lengths ranged from 107-111 mm FL.

## 6.4 DISCUSSION

### ADULT USE OF THE FISH LADDERS

In 2003, adult river herring migrated into freshwater to spawn in the creeks, spillpools, and ponds beginning in early March continuing through early June. As expected, the adult herring movement appeared to be associated with rising creek water temperature and sunny days. As evidenced in Table 6-4, the occurrence of adult herring at the fish ladder sites generally coincides with reported spawning temperatures of between 15.0 and 24.0°C for blueback herring (Smith, 1971) and 12.0-22.5°C for alewife (Wang and Kernehan, 1979). However, in this study pre-spawning blueback herring were observed at temperatures up to 26.7°C. Most herring movement was observed during the middle part of the day, on sunny days, with warming temperatures, which is consistent with observations by Leim and Scott (1966). Very little herring movement was observed on overcast days or at night. A summary of monitoring results at each of the fish ladder sites over the period of study (1996-2003) is presented in Table 6-9. A summary of all of the species utilizing the fish ladders is presented in Table 6-10.

Short duration sampling was conducted in 2001, 2002, and 2003 to determine the temporal distribution of herring passage through the fish ladders. Results from sampling, on days when few or no herring moved through the ladder, were removed. A lack of 2002 and 2003 data is due to very few herring utilizing the ladder during the days when short duration sampling was conducted. The resulting distribution shown in Figure 6-18 is similar to the results found by Jones (1999) at Wagamons Pond. Herring generally began to move up the fish ladder about 0900 hours and continued to use the ladder through approximately 2100 hours.

### Garrisons Lake

The Garrisons Lake fish ladder, installed early in 1999 appears to be functioning properly. The ladder and trap are easily accessible and are subject to occasional vandalism. The trap at Garrisons Lake also suffers from a high debris loading of vegetation and trash which requires daily cleaning to ensure that the flow through the ladder is sufficient to pass herring. The 34 herring which passed yields 34 spawners or 7.9% of the target goal of 430. Heavy persistent rain over the period and the resulting higher flows over the dam and through the ladder may have affected the herrings' ability to use the fish ladder. The higher than average precipitation and numerous cloudy days also limited the availability of spawning run adult herring available in other areas for stocking into Garrisons Lake.

**Silver Lake**

Entrance modifications initiated in 1996 appear to have directed the flow from the ladder into the stream channel. The fish diversion curtain also appears to be effective, as the number of herring passed through the ladder has increased since its use began in 1998 (Table 6-9). The 15 adult herring counted passing the fish ladder coupled with the 201 stocked yields 216 spawners or 21.6% of the target goal of 1,000. In the 2001, 2002, and 2003, seasons stocked fish were released in mid-pond, west of the causeway, in an effort to provide immediate access to spawning habitat (Figure 6-2). Seasonally high precipitation and flows may have limited the use of the ladder and certainly limited the availability of spawning run adult fish to stock.

**Moores Lake**

The fish ladder at Moores Lake, also installed in 1999, appears to be functioning properly. A wooden weir at the exit of the spill pool apron renders the fish ladder inaccessible at the lower portions of the tide. Substantial spawning was observed in 1999 and 2000 throughout the spill pool area. In 2001 a temporary concrete diversion flume was installed by PSEG on the dam apron to guide the spawning run fish from the gap in the wooden weir to the entrance of the fish ladder. In 2002 the concrete diversion flume was replaced by a temporary aluminum flume. The 652 spawning run herring counted passing through the fish ladder and 438 passed into the pond yielding 377.8% of the target goal of 135. The flumes appear to have been successful passing 690, 682, 652 herring in 2001, 2002, and 2003 as compared to 95 and 78 in 1999 and 2000 (Table 6-9).

**McGinnis Pond**

Velocities within the structure and the entrance configuration allowed some fish to pass in 1996 and 1997. In early 1998, modifications were made to the fish ladder to lower velocities. While no herring passed earlier in that season, after the modifications to the ladder, 25 adult blueback herring were observed exiting the fish ladder. Permanent modifications to this fish ladder were completed in early 1999. In 2003, 29 adult herring were counted passing through the ladder and 22 were stocked, yielding 51 spawners or 32.5% of the target goal of 157. The situation of herring not being able to reach the McGinnis spillpool has been addressed by stream cleaning which was conducted again in 2003 to remove woody debris that routinely blocks and diverts the stream. Seasonally high precipitation and flows may have limited the use of the ladder and certainly limited the availability of spawning run adult fish to stock. In 2003, spawning run herring were seldom observed in the spillpool and the stream below McGinnis Pond which is a marked contrast to many of the previous years.

## Coursey Pond

River herring approaching the Coursey Pond fish ladder appeared to follow the bridge abutment to the entrance of the fish ladder. If they did not encounter the fish ladder or chose not to use it they moved in a counter clockwise direction around the spillpool. Herring appeared to have the opportunity to pass the fish ladder entrance each time they circled. Some herring were observed spawning among the rocks (rip rap) in the spillpool. In 2003, 348 adult herring were counted using the fishladder with 342 allowed to pass into the pond which represents 117.5% of the target goal of 291 spawners. Some pilferage from the trap was reported.

## McColley Pond

Appropriate velocities continue within the structure and the entrance was accessible to fish throughout the tidal cycle. River herring approaching the McColley Pond fish ladder appeared to follow the bridge abutment to the entrance of the fish ladder. If they did not encounter the fish ladder or chose not to use it they moved in a counter clockwise direction around the spillpool. Herring appeared to have the opportunity to pass the fish ladder entrance each time they circled. Some herring were observed spawning among the rocks (rip rap) in the spillpool. In 2003, 226 herring counted using the fishladder and 171 passed into the pond representing 69.8% of the target goal of 245 spawning adults. Some pilferage from the trap was reported. Mortalities of spawning run fish in this trap appear to be due to inappropriate netting of fish by the public. Seasonally high precipitation and flows may have limited the use of the ladder and certainly limited the availability of spawning run adult fish to stock.

## Cooper River Lake

In 2,142 hours of trap sampling only 12 adult herring were taken at the Cooper River Lake fish ladder in 2003. At higher tidal elevations, spawning run herring are able and known to pass through the water control structure tide gates. Three alewife and nine blueback herring passing through the fish ladder combined with the 197 stocked yields 209 spawning run adults or 20.9% of the target goal of 1,000. Seasonally high precipitation and flows may have limited the use of the ladder and certainly limited the availability of spawning run adult fish to stock.

## Sunset Lake

Engineering changes were initiated in 1998 to reduce fish ladder velocities and, subsequent to the changes, one alewife and one blueback herring were taken at the exit of the Sunset Lake fish ladder. The occurrence of other fish in the ladder indicated that the ladder was operating with appropriate water velocities. Permanent engineering changes were completed for the 1999 spawning season. The run of adult herring to the base of the ladder in 2001 appeared to have been moderate as, unlike the previous three years, large numbers of herring were observed in the spill pool at the base of the ladder. A small run was observed in 2003. Few herring were observed in the second spillpool. Stream cleaning in the reach below the fishladder was initiated in 2000 and continued in 2001, 2002, and 2003 to remove the impediments. The larger and deeper of the two tributaries leaving Sunset Lake flows from the second spillpool, which does not have a fish ladder. Fishermen have claimed that the majority of the run follows this deeper tributary, however, visual monitoring and conversations with fishermen has not provided evidence for a strong run up this channel in 2003 or previous years.

The 64 adult herring that were counted passing through the fish ladder coupled with the 969 stocked during 2003 yields 1,033 spawning run adult herring or 103.3% of the target goal of 1,000. Seasonally high precipitation and flows may have limited the use of the ladder and certainly limited the availability of spawning run adult fish to stock. Some pilferage from the trap was observed and reported. The trap was removed on several occasions by juveniles intent on using it in the spillpools.

## JUVENILE HERRING

In all of the impoundments where they are found, juvenile herring appear to prefer open water of a depth of 1.2-1.8 m (4 to 6 feet). Richkus (1974) observed that juvenile alewives avoided the shaded portions of tanks and heavily shaded water below a bridge in Bellville Reservoir. Juvenile herring appeared to occasionally school with similarly-sized juvenile gizzard shad through October. All of the juvenile herring and gizzard shad appeared to segregate by species as the water temperatures in the ponds dropped and the herring normally began to emigrate from the ponds in mid to late November.

The Sunset Lake juvenile bypass has been open since the fish ladder was closed in mid-July. When the juvenile bypass and the spillways in Sunset Lake are unavailable, juvenile herring could potentially follow the canal towards the Cohansey River and escape if water was being discharged at that point.

Juvenile blueback herring taken in the ponds were full bodied and appeared to be well fed and in good condition. During 2003, these pond-reared herring attained a greater length (1½ times) than observed for herring juveniles taken in beach seine sampling in the mainstem Delaware River (PSEG, 2004 Chapter 5). Shirey (1996, 1997, and 2000) and Jones (1999) similarly found that river herring juveniles in the Delaware Ponds attained significantly greater lengths than their counterparts which had resided in the tidal waters within the same tributary system. Richkus (1974) noted varied growth rates in juvenile alewife from different ponds and an inverse relationship between growth and juvenile alewife density. Jones (1999) suggests that growth of juvenile herring in Wagamons Pond (Milton, DE) may be density-dependent, perhaps due to greater interspecific competition for food. As evidenced in Table 6-8, the lengths of juveniles were generally the smallest in Cooper River Lake where their abundance was greatest.

No growth anomalies or external parasites were noted on the collected herring.

A lack of success in the production of juvenile herring in Moores Lake in view of the numbers of adult passed is surprising. Higher than average rainfall and lower than average temperatures may have effected spawning or survival, or flushed larvae out of the pond. Twenty six juvenile blueback herring were removed over the summer from fish growing ponds which receive water from the Moores Lake raceway.

The 2003 fish ladder monitoring study provides continuing evidence of adult river herring use of the fish ladders at all of the ponds, as well as successful spawning and juvenile development in some of the ponds. The 2003 spawning run was effected by the high rainfall which caused higher than normal flows and higher velocities. The cooler temperatures and lack of warm sunny days appears to have produced a smaller than average run. Commercial fishermen in New Jersey and Delaware that collect herring for bait all commented on the small run. A lack of herring in the spillpools also may result in a higher than average rate of pilfering from the traps. A summary of monitoring results at each of the fish ladder sites over the period of study (1996-2003) is presented in Table 6-9. A summary of all of the species utilizing the fish ladders is presented in Table 6-10.

## 6.5 LITERATURE CITED

Environmental Consulting Services, Inc. (ECSI). 1990. A report on fishes, with special reference to anadromous fishes, and water quality during hydraulic dredging in the upper Cohansey River during April 1990. Prepared for U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA.

Environmental Consulting Services, Inc. (ECSI). 1996. Procedures Manual for Biological Monitoring Program for the Delaware Estuary. Prepared for Public Service Electric and Gas Co., Newark, NJ.

Jones, W.J. 1999. Establishment of River Herrings in a southern Delaware Impoundment: evaluation of fish passage and predation. Masters Thesis, University of Maryland Eastern Shore. 181p.

Leim, A.H. and W.B. Scott. 1966. Fishes of the Atlantic coast of Canada. Fish. Res. Bd. Canada Bull. 155:88-90.

Lindenburg, J.G. 1976. The seasonal depth distribution of landlocked alewife (*Alosa pseudoharengus*) in a shallow eutrophic lake. Trans. Am. Fish. Soc.105: 395-399.

Richkus, W.A. 1974. The influence of environmental variables on the migratory behavior of adult and juvenile alewives, *Alosa pseudoharengus* (Wilson). Doctoral thesis. University of Rhode Island. 225p.

Shirey, C.A. 1991. An inventory of fishes and invertebrates in Delaware's streams. Report for period February 1, 1986 through April 30, 1991. Project No. F-37-R. Delaware Div. of Fish and Wildlife, Dover, DE.

Shirey, C.A. 1996. Job I-2 River herrings project. Anadromous species investigations. Federal Aid Fish. Restor. F-47-R-4 annual report. DNREC Div. Fish and Wildlife, Dover, DE.

Shirey, C.A. 1997. Job I-3 River herrings research. Anadromous species investigations. Federal Aid Fish. Restor. F-47-R-4 annual report. DNREC Div. Fish and Wildlife, Dover, DE.

Shirey, C.A. 2000. River herring reproduction in seven Delaware impoundments with fish ladders. Federal Aid Fish. Restor. F-47-R-4. DNREC Div. Fish and Wildlife, Dover, DE.

Shirey, C.A. Personal communication. Preliminary herring data for sampling year 2000.

Shirey, C.A. Personal communication. Preliminary herring data for sampling year 2001.

Shirey, C.A. Personal communication. Preliminary herring data for sampling year 2002.

Smith, B.A. 1971. The fishes of four low-salinity tidal tributaries of the Delaware River estuary. Master's thesis. Cornell University, Ithaca, NY.

Wang, J.C.S. and R.J. Kernehan. 1979. Fishes of the Delaware estuaries: a guide to early life histories. Ecological Analysts. Towson, MD.

Table 6-1. Characterization of the eight fish ladders sites.

| | Garrisons Lake | Silver Lake | Moores Lake |
|---|---|---|---|
| | | | |
| Size (acres) | 85.9 | 157.8 | 27.1 |
| Length (miles) | 0.76 | 1.71 | 0.76 |
| Perimeter (miles) | 2.19 | 4.52 | 1.87 |
| Maximum Depth (feet) | 4.0 | 9.0 | 5.0 |
| Mean Depth (feet) | 1.3 | 4.0 | 2.6 |
| Receiving Waters | Leipsic River, drains into the Delaware Bay | Saint Jones River, drains into Delaware Bay | Isaac Branch drains into Saint Jones River, drains into Delaware Bay |
| Distance from Delaware Bay (miles) | 12.57 | 13.33 | 11.30 |
| Impoundment Watershed Size (acres) | 10,752 | 20,480 | 11,776 |
| Tributaries of the Impoundment | Willis Branch, Leipsic River from Massey's Mill Pond, and two small unnamed branches | Forked Branch McKee Run and an unnamed branch | Drainage from Wyoming Lake |
| Combined Tributary Length (miles) | 8.03 | 29.25 | 1.52 |
| Shoreline | Natural, wooded | Natural, bulkhead, small beach | Natural, bulkhead, small beach |
| Bottom Types | Mud | Sand and mud | Sand and mud |
| Surrounding Land Use | Residential, forested and farm lands | Urban and agricultural | Urban and agricultural |
| Predominant Vegetation | Spatterdock | Swamp Loosestrife, Water Willow, and Spatterdock | Spatterdock |
| Water Quality | Eutrophic, tannins | Eutrophic, tannins | Eutrophic, tannins |
| Notes | DNREC dredging planned for 2004 | | |

Table 6-1.  Continued.

| | McGinnis Pond | Coursey Pond | McColley Pond |
|---|---|---|---|
| | | | |
| Size (acres) | 31.3 | 58.1 | 49.0 |
| Length (miles) | 0.76 | 0.72 | 1.14 |
| Perimeter (miles) | 2.16 | 2.48 | 3.34 |
| Maximum Depth (feet) | 9.0 | 4.0 | 6.0 |
| Mean Depth (feet) | 4.4 | 2.0 | 2.9 |
| Receiving waters | Hudson Branch, drains into Spring Creek, drains into the Murderkill River, drains into the Delaware Bay | Murderkill River, drains into the Delaware Bay | Brown's Branch, drains into the Murderkill River, drains into the Delaware Bay |
| Distance from Delaware Bay (miles) | 11.66 | 12.06 | 11.68 |
| Impoundment Watershed Size (acres) | 7,040 | 14,579 | 6,080 |
| Tributaries of the Impoundment | Hudson Branch and two unnamed branches | Murderkill River from Killen Pond and Spring Branch | Browns Branch and an unnamed branch |
| Combined Tributary Length (miles) | 2.75 | 11.81 | 21.15 |
| Shoreline | Natural, heavily wooded | Natural, heavily wooded | Natural, heavily wooded |
| Bottom Types | Sand and Mud | Sand and Mud | Sand and Mud |
| Surrounding Land Use | Rural, forested and farm lands | Rural, forested and farm lands | Rural, forested and farm lands |
| Predominant Vegetation | Swamp Loosestrife and Spatterdock Elodea, and Lyngbya (algae) | Swamp Loosestrife, Spatterdock, | Swamp Loosestrife and Spatterdock |
| Water Quality | Eutrophic, tannins | Eutrophic, tannins | Eutrophic, tannins |
| Notes | | | |

Table 6-1. Continued.

| | Cooper River Lake | Sunset Lake |
|---|---|---|
| | | |
| Size (acres) | 179.35 | 77.60 |
| Length (miles) | 4.53 | 0.67 |
| Perimeter (miles) | 9.57 | 2.10 |
| Maximum Depth (feet) | 10.0 | 9.0 |
| Mean Depth (feet) | | |
| Receiving waters | Cooper River, drains into the Delaware River | Cohansey River, drains into the Delaware Bay |
| Distance from Delaware Bay (miles) | 2.95 | 20.38 |
| Impoundment Watershed Size (acres) | 23,680 | 29,248 |
| Tributaries of the Impoundment | No tributaries within the lake, Wallworth Lake and Evans Pond drain into Cooper River Lake | A spring fed tributary from Mary Elmer Lake and the Cohansey River |
| Combined Tributary Length (miles) | 8.94 | 34.15 |
| Shoreline | Urban and parkland | Natural, wooded, some bulkhead and hard shore, small beaches |
| Bottom Types | Mud, sand, and rubble | Sand and mud stumps in upper reaches |
| Surrounding Land Use | Urban and parkland | Parkland and residential |
| Predominant Vegetation | Spatterdock | Spatterdock |
| Water Quality | Eutrophic | Eutrophic, tannins |
| Notes | | |

Table 6-2. Operations and Maintenance Log for the eight fish ladder sites during 2003.

| Date | | Action |
|---|---|---|
| 1/9/2003 | | Delaware bypasses closed. Ladders inspected. Trash removed. |
| Note | | The Delaware and New Jersey fish ladders and bypass facilities (closed for the season) are checked occasionally over the winter. |
| 1/24/2003 | | Delaware Ladders inspected for ice damage |
| 2/25/2003 | | Delaware Ladders inspected |
| 3/7/2003 | | Delaware Ladders inspected |
| 3/14/2003 | | Delaware Ladders inspected and opened |
| 3/21/2003 | | Sunset Lake inspected and opened |
| 3/23/2003 | | Sunset Lake inspection Ladder structure is in good condition and free of internal debris. No Ice damage was noted. Loose debris inside fenced area was removed. Considerable debris in the canal above the ladder was removed. Signage is fading. Chain link fence is undamaged. Individuals have been swinging on the panels at the lower end. Individuals have also climbed the fence to gain access to the interior. |
| 3/24/2003 | | Cooper River Lake inspection, ladder structure is in good condition. Internal debris was removed. Loose debris inside fenced area was removed. Signage is fading. Chain link fence is undamaged. No ice damage was noted. |
| 3/26/2003 | | Garrisons Lake Ladder structure is in good condition. Internal debris was removed. Signage is fading. No ice damage was noted. |
| 3/26/2003 | | Silver Lake Ladder structure is in good condition. One safety grating panel has been removed. Internal debris was removed. Signage is fading. No ice damage was noted. |
| 3/26/2003 | | Moores Lake Ladder structure is in good condition. Internal debris was removed. Signage is fading. No ice damage was noted. |
| 3/26/2003 | | McGinnis Pond Ladder structure is in good condition. Internal debris was removed. Signage is fading. No ice damage was noted. |
| 3/26/2003 | | Courseys Pond Ladder structure is in good condition. Internal debris was removed. Signage on dam is fading. Explanatory sign in south parking lot has been vandalized and all but the posts is missing. No ice damage was noted. |
| 3/26/2003 | | McColley Pond Ladder structure is in good condition. One of the safety grating has been damaged and needs replacement. Internal debris was removed. Signage is fading. No ice damage was noted. |
| 4/4/2003 | | Courseys Pond inspected |
| 4/4/2003 | | Silver Lake diversion curtain installed. Installation was delayed due to high flows. |
| 4/17/2003 | | Sunset Lake Ladder inspected |
| 4/23/2003 | | Sunset Lake Ladder inspected |
| 6/28/2003 | | Damaged grating panel at Silver Lake Ladder replaced. |

Table 6-2. Continued.

| | | |
|---|---|---|
| 6/28/2003 | | Damaged grating panel at Coursey Pond Ladder replaced. |
| 7/4/2003 | | Ladders closed |
| 7/4/2003 | | Silver Lake diversion curtain removed |
| 7/21/2003 | | Delaware Ladders inspected |
| 7/22/2003 | | New Jersey Ladders inspected |
| 9/15/2003 | | Delaware Juvenile bypass's opened |
| 12/15/2003 | | Juvenile bypass's closed |
| Note | | Cooper River Lake fish ladder will be inspected weekly throughout the year as part of the Camden County Parks inspection of the water control structure. |
| | | |

Table 6-3. Commercial Catch Data from Delaware Bay near Bowers Beach, 2003.

| Date | Bay Temp. (°C) | Catch/effort | Confirmed Species | Notes |
|---|---|---|---|---|
| 1/15/2003 | 2.1 | | | Bowers Beach, ice, no netting |
| 1/17/2003 | 1.9 | | | Bowers Beach, ice, no netting |
| 2/2/2003 | 2.3 | | | Bowers Beach, debris, no netting |
| 2/16/2003 | 3.2 | | | Bowers Beach, debris, no netting |
| 2/28/2003 | 4.5 | | | Bowers Beach, debris, no netting |
| 3/10/2003 | 4.4 | | | Bowers Beach, no netting |
| 3/23/2003 | 5.8 | | | Bowers Beach, no netting |
| 3/31/2003 | 7.2 | | | Bowers Beach, no netting |
| 4/8/2003 | 8.2 | | | Bowers Beach, no netting |

Unit of effort 50-yd gillnet/24 hr set
Commercial fishermen do not differentiate between alewife and blueback herring referring to them collectively as “branch herring”.

Table 6-4. Number of adult herring collected in fish ladder trap sampling at the eight fish ladder sites in 2003 with number alive and number dead.

| | Garrisons Lake | | Silver Lake | | Moore's Lake | | McGinnis Pond | | Coursey Pond | | McColley Pond | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 3/18/03 | | | | | | | | | | | | |
| 3/19/03 | | | | | | | | | | | | |
| 3/20/03 | | | | | 3 | | | | | | | |
| 3/21/03 | | | | | | | | | | | | |
| 3/22/03 | | | | | | | | | | | | |
| 3/23/03 | | | | | 4 | | | | | | 3 | |
| 3/24/03 | | | | | | | | | 1 | | | |
| 3/25/03 | | | | | 1 | | | | | | | |
| 3/26/03 | | | | | 9 | | | | | | | |
| 3/27/03 | | | | | 1 | | | | 2 | | (1) | |
| 3/28/03 | | | | | | | | | 3 | | | |
| 3/29/03 | | | | | | | | | | | | |
| 3/30/03 | | | | | | | | | | | | |
| 3/31/03 | | | | | | | | | | | | |
| 4/1/03 | | | | | | | | | | | | |
| 4/2/03 | | | | | | | | | | | | |
| 4/3/03 | | | | | | | | | 3 | | | |
| 4/4/03 | 6 | | | | | | | | 2 | | | |
| 4/5/03 | | | | | | | | | | | | |
| 4/6/03 | | | | | | | | | 1 | | | |
| 4/7/03 | | | | | | | | | | | | |
| 4/8/03 | | | | | | | | | 3 | | | |
| 4/9/03 | | | | | | | | | | | | |
| 4/10/03 | | | | | | | | | | | | |
| 4/11/03 | | | | | | | | | | | | |
| 4/12/03 | | | | | | | | | | | | |
| 4/13/03 | | | | | | | | | | | | |
| 4/14/03 | | | | | | | | | 1 | | | |
| 4/15/03 | | | | | | | | | 16 | | 16 | |
| 4/16/03 | 2 | | | | | | 1 | | 13(1) | | 15(1) | |
| 4/17/03 | | | | | 22 | | | | | | 4(2) | |
| 4/18/03 | | | | | | | | | | | | |
| 4/19/03 | | | | | | | 1 | | | | | |
| 4/20/03 | | | | | | | | | | | | |
| 4/21/03 | | | | | | | | | 4 | | | |
| 4/22/03 | | | | | | | | | | | | |

Table 6-4.  Continued.

| Date | Garrisons Lake | | Silver Lake | | Moore's Lake | | McGinnis Pond | | Coursey Pond | | McColley Pond | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 4/23/03 | | | | | 3 | | | | 2 | | | |
| 4/24/03 | | | | | 1 | 3 | | | 2 | | 3 | 2 |
| 4/25/03 | | | | | 4 | 3 | | | 21 | 6 | 16 | 11 |
| 4/26/03 | | | | | | | | | | | | |
| 4/27/03 | 1 | | | | | | | | 32 | 7 | | |
| 4/28/03 | 1 | 6 | | | 7 | 13 | | | 2 | 1 | | |
| 4/29/03 | 1 | 2 | | | 7 | 39 | | 2 | 7 | 14 | 1 | |
| 4/30/03 | 1 | | | 1 | 7 | 58 | | | 2 | 32 | 4(5) | 2(2) |
| 5/1/03 | 1 | | | | 1 | 3 | | | 4 | 36(2) | | 6(8) |
| 5/2/03 | | | | | | 32 | | | | | | |
| 5/3/03 | | 3(1) | | | 1 | 3 | | 3 | 2 | 21(1) | | 8(8) |
| 5/4/03 | | | | | | | | | | | | |
| 5/5/03 | | | | | 1 | 15(1) | | 1 | 2 | 32(1) | (1) | 13(6) |
| 5/6/03 | | | | | | 6 | | | | 3 | | |
| 5/7/03 | | | | | | | | | | | | |
| 5/8/03 | | | | | | 2 | | | | | | |
| 5/9/03 | | | | | | | | | | | | |
| 5/10/03 | | 1(1) | | 3(1) | | 172 (1) | | 2 | | 33 | | 23 (10) |
| 5/11/03 | | | | | | [3] | | | | | | |
| 5/12/03 | | | | | | 33(1) | | 2 | | 6(1) | (2) | (10) |
| 5/13/03 | | | | | | | | | | | | |
| 5/14/03 | | | | | | 6 | | 1 | | | | |
| 5/15/03 | | | | | | 4 | | | | 2 | | 2(1) |
| 5/16/03 | | 1 | | 1 | | 7 | | | | 11 | | 26 |
| 5/17/03 | | | | | | | | | | | | |
| 5/18/03 | | | | | | | | | | | | |
| 5/19/03 | | | | | | 1 | | | | | | |
| 5/20/03 | | | | | | 2 | | | | | | |
| 5/21/03 | | | | | | 3 | | | | 1 | | |
| 5/22/03 | | | | | | | | | | | | |
| 5/23/03 | | | | | | 29 | | 4 | | 1 | | |
| 5/24/03 | | 3 | | 4 | | [41] | | 4 | | | | |
| 5/25/03 | | | | | | | | | | | | 1 |
| 5/26/03 | | | | | | | | | 2 | | | |
| 5/27/03 | | | | | | 1 | | | | | | |
| 5/28/03 | | | | | | [1] | | | | | | |

Table 6-4. Continued.

| | Garrisons Lake | | Silver Lake | | Moore's Lake | | McGinnis Pond | | Coursey Pond | | McColley Pond | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 5/29/03 | | | | | | 1 | | | | | | |
| 5/30/03 | | | | 6 | | | | | | | | |
| 5/31/03 | | 5 | | | | [128] (2) | | 6 | | 6 | | 15 |
| 6/1/03 | | | | | | [16] | | | | 1 | | |
| 6/2/03 | | | | | | (5)[3] | | | | | | |
| 6/3/03 | | | | | | (2)[2] | | 1 | | 2 | | |
| 6/4/03 | | | | | | | | | | | | |
| 6/5/03 | | | | | | | | | | | | |
| 6/6/03 | | | | | | | | 1 | | | | |
| 6/7/03 | | | | | | | | | | | | |
| 6/8/03 | | | | | | 1 | | | | | | |
| 6/9/03 | | | | | | [4] | | | | | | |
| 6/10/03 | | | | | | [3](1) | | | | | | |
| 6/11/03 | | | | | | | | | | | | |
| 6/12/03 | | | | | | | | | | | | |
| 6/13/03 | | | | | | | | | | | | |
| 6/14/03 | | | | | | 1 | | | | | | |
| 6/15/03 | | | | | | | | | | | | |
| 6/16/03 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Alive | 13 | 21 | 0 | 15 | 72 | 438 | 2 | 27 | 127 | 215 | 62 | 109 |
| Removed | 0 | 0 | 0 | 0 | 0 | 201 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dead | 0 | 2 | 0 | 1 | 0 | 13 | 0 | 0 | 1 | 5 | 12 | 43 |
| Total | 13 | 23 | 0 | 16 | 72 | 652 | 2 | 27 | 128 | 220 | 74 | 152 |
| | | | | | | | | | | | | |

number dead = ( )
number removed for stocking = [ ]

Table 6-4. Continued.

| Date | Cooper River Lake | | Sunset Lake | |
|---|---|---|---|---|
| | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 3/24/2003 | | | | |
| 3/25/2003 | | | | |
| 3/26/2003 | | | | |
| 3/27/2003 | | | | |
| 3/28/2003 | | | | |
| 3/29/2003 | | | | |
| 3/30/2003 | | | | |
| 3/31/2003 | | | | |
| 4/1/2003 | | | | |
| 4/2/2003 | | | | |
| 4/3/2003 | | | | |
| 4/4/2003 | | | | |
| 4/5/2003 | | | | |
| 4/6/2003 | | | | |
| 4/7/2003 | | | | |
| 4/8/2003 | | | | |
| 4/9/2003 | | | | |
| 4/10/2003 | | | | |
| 4/11/2003 | | | | |
| 4/12/2003 | | | | |
| 4/13/2003 | | | | |
| 4/14/2003 | | | | |
| 4/15/2003 | | | | |
| 4/16/2003 | | | 1 | |
| 4/17/2003 | 2 | | | |
| 4/18/2003 | | | | |
| 4/19/2003 | (1) | | 2 | |
| 4/20/2003 | | | | |
| 4/21/2003 | | | 5 | |
| 4/22/2003 | | | 1 | |
| 4/23/2003 | | | | |
| 4/24/2003 | | | 2 | |
| 4/25/2003 | | | | |
| 4/26/2003 | | | 1 | |
| 4/27/2003 | | | | |
| 4/28/2003 | | | | |
| 4/29/2003 | 1 | | 1 | 1 |

Table 6-4. Continued.

| Date | Cooper River Lake | | Sunset Lake | |
|---|---|---|---|---|
| | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 4/30/2003 | | | | |
| 5/1/2003 | | | 2 | 13 |
| 5/2/2003 | | | | 5 |
| 5/3/2003 | | | | 2 |
| 5/4/2003 | | | | |
| 5/5/2003 | | | | |
| 5/6/2003 | | | | |
| 5/7/2003 | | | | |
| 5/8/2003 | | | | |
| 5/9/2003 | | | | 12 |
| 5/10/2003 | | | | |
| 5/11/2003 | | | | |
| 5/12/2003 | | | | 1 |
| 5/13/2003 | | | | 3 |
| 5/14/2003 | | 1 | | 2 |
| 5/15/2003 | | 8 | | |
| 5/16/2003 | | | | |
| 5/17/2003 | | | | 1 |
| 5/18/2003 | | | | |
| 5/19/2003 | | | | 1 |
| 5/20/2003 | | | | |
| 5/21/2003 | | | | |
| 5/22/2003 | | | | 3 |
| 5/23/2003 | | | | |
| 5/24/2003 | | | | |
| 5/25/2003 | | | | |
| 5/26/2003 | | | | |
| 5/27/2003 | | | | |
| 5/28/2003 | | | | |
| 5/29/2003 | | | | |
| 5/30/2003 | | | | |
| 5/31/2003 | | | | |
| 6/1/2003 | | | | 2 |
| 6/2/2003 | | | | 3 |
| 6/3/2003 | | | | |
| 6/4/2003 | | | | |

Table 6-4.  Continued.

| | Cooper River Lake | | Sunset Lake | |
|---|---|---|---|---|
| Date | Alewife | Blueback Herring | Alewife | Blueback Herring |
| 6/5/2003 | | | | |
| 6/6/2003 | | | | |
| 6/7/2003 | | | | |
| 6/8/2003 | | | | |
| 6/9/2003 | | | | |
| 6/10/2003 | | | | |
| 6/11/2003 | | | | |
| 6/12/2003 | | | | |
| 6/13/2003 | | | | |
| 6/14/2003 | | | | |
| | | | | |
| Alive | 3 | 9 | 15 | 49 |
| Removed | 0 | 0 | 0 | 0 |
| Dead | 1 | 0 | 0 | 0 |
| Total | 4 | 9 | 15 | 49 |
| | | | | |

Table 6-5. Range and peak periods of occurrence for alewife and blueback herring as observed in trap net sampling, with corresponding spill pool water temperatures (°C), at the eight fish ladder sites in 2003.

| Species | Garrisons Lake | Silver Lake | Moores Lake | McGinnis Pond | Coursey Pond | McColley Pond | Cooper River Lake | Sunset Lake |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Alewife** | | | | | | | | |
| Period of occurrence | April 4 – May 1 | | March 20 – April 5 | April 16 – April 19 | March 24 – April 26 | March 23 – May 12 | April 17 – April 29 | April 16 – May 1 |
| Temperature range (°C) | 12.8 – 21.7 | | 10.1 – 19.9 | 12.6 – 18.1 | 9.2 – 20.0 | 13.3 – 18.4 | 11.2 – 17.9 | 12.1 – 19.2 |
| Peak occurrence | April 4 | | April 17 | April 16 – April 19 | April 25 - April 27 | April 15 – April 17 | | |
| Temperature (°C) | 12.8 | | 17.1 | 12.6 – 18.1 | 15.9 – 17.0 | 15.4 – 18.4 | | |
| | | | | | | | | |
| **Blueback Herring** | | | | | | | | |
| Period of occurrence | April 28 – May 31 | April 30 – May 30 | April 24 – June 14 | April 29 – June 6 | April 25 – June 3 | April 24 – May 31 | May 14 – May 15 | April 29 – June 2 |
| Temperature range (°C) | 16.1 – 21.3 | 16.2 – 18.7 | 15.4 – 27.3 | 15.4 – 22.0 | 15.1 – 21.0 | 15.0 – 19.6 | 16.8 – 17.2 | 15.6 – 20.1 |
| Peak occurrence | April 28 – April 29 | May 30 | May 10 | May 31 | April 30 – May 5 | May 16 | | May 1 – May 9 |
| Temperature (°C) | 21.0 – 21.3 | 16.7 | 17.6 | 19.1 | 17.3 – 19.1 | 16.3 | | 17.5 – 20.1 |

Table 6-6. Number of spawning run adult herring counted passing and stocked in the eight impoundments in 2003.

| | Garrisons Lake | | Silver Lake | | Moores Lake | | McGinnis Pond | | Coursey Pond | | McColley Pond | | Cooper River Lake | | Sunset Lake | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** | **Alewife** | **Blueback** |
| March 17-23 | | | | | 7 | | | | | | 3 | | | | | |
| March 24-30 | | | | | 11 | | | | 6 | | | | | | | |
| March 31-April 6 | 6 | | | | | | | | 6 | | | | | | | |
| April 7-13 | | | | | | | | | 3 | | | | | | | |
| April 14-20 | 2 | | | | 22 | | 2 | | 30 | | 35 | | 2 | | 3 | |
| April 21-27 | 1 | | | | 8 | 6 | | | 61 | 13 | 19 | 13 | | | 9 | |
| April 28-May 4 | 4 | 11 | | 1 | 23 | 148 | | 5 | 17 | 104 | 5 | 16 | 1 | | 3 | 21 |
| May 5-11 | | 1 | | 3 | 1 | 195 | | 3 | 2 | 68 | | 36 | | | | 12<br>**136** |
| May 12-18 | | 1 | | 1<br>**3** | | 50 | | 3<br>**1** | | 19 | | 28 | | 9 | | 7<br>**15** |
| May 19-25 | | 3 | | 4<br>**41** | | 35 | | 8 | | 2 | | 1 | | | | 4<br>**734** |
| May 26-June 1 | | 5 | | 6<br>**145** | | 2 | | 6<br>**19** | 2 | 7 | | 15 | | | | 2<br>**84** |
| June 2-8 | | | | **5** | | 1 | | 2<br>**2** | | 2 | | | | **197** | | 3 |
| June 9-15 | | | | **7** | | 1 | | | | | | | | | | |
| June 16-22 | | | | | | | | | | | | | | | | |
| Total Passed | 13 | 21 | 0 | 15 | 72 | 438 | 2 | 27 | 127 | 215 | 62 | 109 | 3 | 9 | 15 | 49 |
| Total Stocked | **0** | **0** | **0** | **201** | **0** | **0** | **0** | **22** | **0** | **0** | **0** | **0** | **0** | **197** | **0** | **969** |
| **Transport mortality** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **Total Spawners** | 13 | 21 | 0 | 216 | 72 | 438 | 2 | 49 | 127 | 215 | 62 | 109 | 3 | 206 | 15 | 1,018 |
| | | | | | | | | | | | | | | | | |
| **Total Herring** | 34 | | 216 | | 510 | | 51 | | 342 | | 171 | | 209 | | 1,033 | |
| **Target Number** | 430 | | 1,000 | | 135 | | 157 | | 291 | | 245 | | 1,000 | | 1,000 | |
| **Percent** | 7.9 | | 21.6 | | 377.8 | | 32.5 | | 117.5 | | 69.8 | | 20.9 | | 103.3 | |

Stocked fish are shown in **bold.**

Table 6-7. Number of juvenile and adult observed in electroshocker sampling in the eight impoundments in 2003.

| | Garrisons Lake | | Silver Lake | | Moores Lake | | McGinnis Pond | | Coursey Pond | | McColley Pond | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Alewife | Blueback | Alewife | Blueback | Alewife | Blueback | Alewife | Blueback | Alewife | Blueback | Alewife | Blueback |
| 9/22/2003 | | | | | 0 | 0 | 0 | 0 | | | | |
| 9/23/2003 | 0 | 0 | 0 | 2 | | | | | | | | |
| 9/25/2003 | | | | | | | | | 0 | 7 | 0 | (1) |
| 10/16/2003 | | | | | | | | | 0 | 0 | 0 | 0 |
| 10/20/2003 | 0 | 0 | 0 | 0 | | | | | | | | |
| 10/24/2003 | | | | | 0 | 0 | 0 | 0 | | | | |
| 11/17/2003 | | | | | | | | | 0 | 0 | 0 | 0 |
| 11/18/2003 | | | | | 0 | 0 | 0 | 0 | | | | |
| 11/19/2003 | | | 0 | 0 | | | | | | | | |
| 11/20/2003 | 0 | 0 | | | | | | | | | | |
| Juvenile Total | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 |
| Adult Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Table 6-7. Continued.

| | Sunset Lake | | Cooper River Lake | |
|---|---|---|---|---|
| Date | Alewife | Blueback | Alewife | Blueback |
| 9/24/2003 | 0 | 136 | | |
| 9/29/2003 | | | 35 | 1,059 |
| 10/23/2003 | | | 120 | 4,365(3) |
| 10/30/2003 | 0 | 36 | | |
| 11/9/2003 | | | 3 | 1,024 |
| 11/16/2003 | 0 | 1 | | |
| | | | | |
| Juvenile Total | 0 | 173 | 158 | 6,448 |
| Adult Total | 0 | 0 | 0 | 3 |

Table 6-8. Length range (mm FL) of juvenile herring taken in the eight impoundments during 1999-2003 with Delaware DNREC samples added.

| | Garrisons Lake | Silver Lake | Moores Lake | McGinnis Pond | Coursey Pond | McColley Pond | Sunset Lake | Cooper R. Lake |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **1999** | | | | | | | | |
| **Alewife** | | | | | | | | |
| Sept | | | 101,112 | | **104-108** | | | |
| Oct | | | | | 112-132 | | 132 | 93-104 |
| Nov | | | | | 131-136 | | | |
| **Blueback** | | | | | | | | |
| Sept | | | **85-104** | **89-92** | | **80-95** | 86-106 | 62-115 |
| Oct | | | 98-114 | | | 86-95 | 85-108 | 68-76 |
| Nov | | | 123 | 99 | 123-130 | 83-95 | | 65-84 |
| ***Alosa* spp.** | | | | | | | | |
| Sept | | | 86-117 | 91-105 | 109,114 | 85-89 | | |
| Oct | | | | | | | | |
| Nov | | | | | | | | |
| | | | | | | | | |
| **2000** | | | | | | | | |
| **Alewife** | | | | | | | | |
| Sept | | | | | | | | |
| Oct | | | | | **134** | | | 105 |
| Nov | | | | | | | | |
| **Blueback** | | | | | | | | |
| Sept | | | | 89-100 | 106-114 | 85-95 | 90-105 | 57-65 |
| Oct | | | 102,104 | 90-110<br>**90-111** | | 91-103<br>**92-108** | 93-130 | |
| Nov | | | | 101-110 | 150 | 93-126 | 101-122 | 72-82 |
| ***Alosa* spp.** | | | | | | | | |
| Sept | | | | | | 85-89 | | |
| Oct | | | | | 143 | | | 63-144 |
| Nov | | | | | | | | |
| | | | | | | | | |
| **2001** | | | | | | | | |
| **Alewife** | | | | | | | | |
| Sept | | | | | 138 | | | |
| Oct | | | | | | | | |
| Nov | | | | | | | | |
| Dec | | | 128 | | | | | |
| **Blueback** | | | | | | | | |
| Sept | | 93 | | 86-98 | 126 | 103-122<br>**93-132** | | 62-68 |
| Oct | | **122-139** | | 83-97 | 163 | | | 71-170 |
| Nov | | 123-132 | | | | | 203-214 | 74-174 |
| Dec | | | | | | 113-149 | | |

Table 6-8. Continued.

| | **Garrisons Lake** | **Silver Lake** | **Moores Lake** | Ginnis **Pond** | **Coursey Pond** | **McColley Pond** | **Sunset Lake** | **Cooper R. Lake** |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **2002** | | | | | | | | |
| **Alewife** | | | | | | | | |
| Sept | | | | | 132-140 | | | |
| Oct | | | | | | | | |
| Nov | | | | | | | | |
| **Blueback** | | | | | | | | |
| Sept | | | | 94-108 | 108 | 70-79 | 69-82 | 86-154 |
| Oct | | | | | | | 80-94 | 88-165 |
| Nov | | | | | | | 83-115 | |
| | | | | | | | | |
| **2003** | | | | | | | | |
| **Alewife** | | | | | | | | |
| Sept | | | | | | | | 86-163 |
| Oct | | | | | | | | 100-162 |
| Nov | | | | | | | | 122-136 |
| **Blueback** | | | | | | | | |
| Sept | | 96 | | | 122-136 | | 107-111 | 70-84 |
| Oct | | | | | | | | 83-91 |
| Nov | | | | | | | | 82-93 |
| | | | | | | | | |
| Delaware DNREC sampling in **bold** (Shirey, 2000 and pers. comm.) | | | | | | | | |

Table 6-9. Summary of annual herring monitoring results at the eight fish ladder sites during 1996-2003.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **Garrisons Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1999** | 1,320 | | | | 20 | | 94.5 | | No Sampling | | No Sampling | |
| Alewife | | 5 | | | | | | | | | | |
| Blueback | | 34 | | 318 | | | | | | | | |
| *Alosa spp***.** | | | | | | 5 | | 67 | | | | |
| | | | | | | | | | | | | |
| **2000** | 1,312 | | | | 20 | | 60.4 | | No Sampling | | No Sampling | |
| Alewife | | 12 | | | | | | | | | | |
| Blueback | | 58 | | 48 | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,254 | | | | No Sampling | | 60.3 | | No Sampling | | No Sampling | |
| Alewife | | 0 | | | | | | | | | | |
| Blueback | | 4 | | 473 | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,183 | | | | No Sampling | | 60.0 | | No Sampling | | No Sampling | |
| Alewife | | 0 | | | | | | | | | | |
| Blueback | | 3 | | 432 | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,154 | | | | No Sampling | | 61.1 | | No Sampling | | No Sampling | |
| Alewife | | 13 | | | | | | | | | | |
| Blueback | | 18 | | | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |

Table 6-9.  Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | **Units** | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **Silver Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1996** | 78 | | | | 20 | | 268.0 | | 5 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 4 | | 84 | | | | | | | | |
| *Alosa* spp. | | | | | | 6 | | | | | | |
| | | | | | | | | | | | | |
| **1997** | 112 | | | | 20 | | 137.3 | | 4 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | **7** | | | | | | | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1998** | 1,082 | | | | 20 | | 147.4 | | 3 | | No Sampling | |
| Alewife | | **2** | | | | | | | | | | |
| Blueback | | 111 | | 713 | | | | 5 | | | | |
| *Alosa* spp. | | | | | | 1 | | | | | | |
| | | | | | | | | | | | | |
| **1999** | 1,368 | | | | 20 | | 66.5 | | No Sampling | | No Sampling | |
| Alewife | | 11 | | | | | | | | | | |
| Blueback | | 152 | | 687 | | | | | | | | |
| *Alosa* spp. | | | | | | 3 | | | | | | |
| | | | | | | | | | | | | |
| **2000** | 2,079 | | | | 20 | | 64.7 | | No Sampling | | No Sampling | |
| Alewife | | 2 | | | | | | | | | | |
| Blueback | | 63 | | 419 | | | | | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,234 | | | | No Sampling | | 60.0 | | No Sampling | | No Sampling | |
| Alewife | | 14 | | | | | | | | | | |
| Blueback | | 137 | | 993 | | | | 25 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,151 | | | | No Sampling | | 63.1 | | No Sampling | | No Sampling | |
| Alewife | | 18 | | | | | | | | | | |
| Blueback | | 121 | | 865 | | | | 3 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Table 6-9.  Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | **Units** | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **Silver Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,139 | | | | No Sampling | | 62.6 | | No Sampling | | No Sampling | |
| Alewife | | 13 | | | | | | | | | | |
| Blueback | | 18 | | | | | | 2 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Adult | | Adult | | Larvae | | Juveniles | | Juveniles | | Juveniles | |
| Effort | Hrs. | No. | | No. | Units | No. | Min. | No. | Units | No. | Days | No. |
| | | | | | | | | | | | | |
| **Moores Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1999** | 1,104 | | | | 20 | | 73.4 | | | | | |
| Alewife | | 9 | | | | | | 2 | No Sampling | | No Sampling | |
| Blueback | | 86 | | 271 | | | | 76 | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2000** | 2,080 | | | | 20 | | 60.1 | | | | | |
| Alewife | | 5 | | | | | | | No Sampling | | No Sampling | |
| Blueback | | 73 | | 70 | | | | 71 | | | | |
| *Alosa spp.* | | | | | | 30 | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,229 | | | | | | 81.5 | | | | | |
| Alewife | | 21 | | | No Sampling | | | 1 | No Sampling | | No Sampling | |
| Blueback | | 669 | | | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,112 | | | | | | 62.3 | | | | | |
| Alewife | | 28 | | | No Sampling | | | | No Sampling | | No Sampling | |
| Blueback | | 654 | | | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,163 | | | | | | 61.9 | | | | | |
| Alewife | | 72 | | | No Sampling | | | | No Sampling | | No Sampling | |
| Blueback | | 606 | | | | | | | | | | |
| *Alosa spp.* | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | **Units** | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **McGinnis Pond** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1996** | 79 | | | | 20 | | 225.0 | | 3 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 1 | | 32 | | | | 20 | | | | |
| *Alosa* spp. | | | | | | 6 | | | | | | |
| | | | | | | | | | | | | |
| **1997** | 110 | | | | 20 | | 87.3 | | 3 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 2 | | | | | | 114 | | | | |
| *Alosa* spp. | | | | | | 5 | | | | | | |
| | | | | | | | | | | | | |
| **1998** | 1,032 | | | | 20 | | 139.6 | | 3 | | 76 | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 25 | | 211 | | | | 398 | | | | |
| *Alosa* spp. | | | | | | 2 | | | | | | 44 |
| | | | | | | | | | | | | |
| **1999** | 1,368 | | | | 20 | | 74.8 | | No Sampling | | No Sampling | |
| Alewife | | 13 | | 5 | | | | | | | | |
| Blueback | | 35 | | 166 | | | | 1 | | | | |
| *Alosa* spp. | | | | | | 5 | | 8 | | | | |
| | | | | | | | | | | | | |
| **2000** | 2,083 | | | | 20 | | 64.0 | | No Sampling | | No Sampling | |
| Alewife | | 6 | | | | | | | | | | |
| Blueback | | 27 | | 200 | | | | 718 | | | | |
| *Alosa* spp. | | | | | | 1 | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,229 | | | | No Sampling | | 60.7 | | No Sampling | | No Sampling | |
| Alewife | | 4 | | | | | | | | | | |
| Blueback | | 95 | | 241 | | | | 244 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,162 | | | | No Sampling | | 65.0 | | No Sampling | | No Sampling | |
| Alewife | | 18 | | | | | | | | | | |
| Blueback | | 756 | | | | | | 899 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Adult | | Adult | | Larvae | | Juveniles | | Juveniles | | Juveniles | |
| Effort | Hrs. | No. | | No. | Units | No. | Min. | No. | Units | No. | Days | No. |
| | | | | | | | | | | | | |
| **McGinnis Pond** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,159 | | | | No Sampling | | 64.6 | | No Sampling | | No Sampling | |
| Alewife | | 2 | | | | | | | | | | |
| Blueback | | 23 | | | | | | | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | **Units** | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **Coursey Pond** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1997** | 105 | | | | 20 | | 128.8 | | 3 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 30 | | | | | | 12 | | | | |
| *Alosa* spp. | | | | | | 1 | | 1 | | | | |
| | | | | | | | | | | | | |
| **1998** | 1,097 | | | | 20 | | 124.1 | | 3 | | No Sampling | |
| Alewife | | 11 | | | | | | | | | | |
| Blueback | | 477 | | 156 | | | | 144 | | | | |
| *Alosa* spp. | | | | | | 1 | | | | | | |
| | | | | | | | | | | | | |
| **1999** | 729 | | | | 20 | | 60.1 | | No Sampling | | No Sampling | |
| Alewife | | 257 | | | | | | 56 | | | | |
| Blueback | | 845 | | | | | | 26 | | | | |
| *Alosa* spp. | | | | | | 13 | | 7 | | | | |
| | | | | | | | | | | | | |
| **2000** | 2,084 | | | | 20 | | 63.0 | | No Sampling | | No Sampling | |
| Alewife | | 48 | | | | | | 7 | | | | |
| Blueback | | 736 | | | | | | 28 | | | | |
| *Alosa* spp. | | | | | | 14 | | 4 | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,277 | | | | No Sampling | | 61.0 | | No Sampling | | No Sampling | |
| Alewife | | 63 | | | | | | 10 | | | | |
| Blueback | | 1,336 | | | | | | 62 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,160 | | | | No Sampling | | 60.0 | | No Sampling | | No Sampling | |
| Alewife | | 309 | | | | | | 5 | | | | |
| Blueback | | 1,222 | | | | | | 124 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,161 | | | | No Sampling | | 61.8 | | No Sampling | | No Sampling | |
| Alewife | | 128 | | | | | | | | | | |
| Blueback | | 218 | | | | | | **7** | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Adult | | Adult | | Larvae | | Juveniles | | Juveniles | | Juveniles | |
| Effort | Hrs. | No. | | No. | Units | No. | Min. | No. | Units | No. | Days | No. |
| | | | | | | | | | | | | |
| **McColley Pond** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1996** | 82 | | | | 20 | | 214.4 | | 3 | | No Sampling | |
| Alewife | | 3 | | | | | | | | | | |
| Blueback | | 112 | | 8 | | | | 24 | | 1 | | |
| *Alosa* spp. | | | | | | 8 | | | | | | |
| | | | | | | | | | | | | |
| **1997** | 102 | | | | 20 | | 164.2 | | 3 | | No Sampling | |
| Alewife | | 1 | | | | | | 1 | | | | |
| Blueback | | 176 | | | | | | 131 | | | | |
| *Alosa* spp. | | | | | | 4 | | 1 | | | | |
| | | | | | | | | | | | | |
| **1998** | 1,074 | | | | 20 | | 88.1 | | 3 | | 76 | |
| Alewife | | 16 | | | | | | | | | | |
| Blueback | | 543 | | 7 | | | | 1,061 | | | | |
| *Alosa* spp. | | | | | | 6 | | | | | | 48 |
| | | | | | | | | | | | | |
| **1999** | 728 | | | | 20 | | 61.8 | | No Sampling | | No Sampling | |
| Alewife | | 147 | | | | | | | | | | |
| Blueback | | 975 | | 11 | | | | 300 | | | | |
| *Alosa* spp. | | | | | | 28 | | 189 | | | | |
| | | | | | | | | | | | | |
| **2000** | 2,112 | | | | 20 | | 62.2 | | No Sampling | | No Sampling | |
| Alewife | | 42 | | | | | | | | | | |
| Blueback | | 1,208 | | | | | | 715 | | | | |
| *Alosa* spp. | | | | | | 17 | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,260 | | | | No Sampling | | 72.5 | | No Sampling | | No Sampling | |
| Alewife | | 32 | | | | | | | | | | |
| Blueback | | 886 | | | | | | 92 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,185 | | | | No Sampling | | 62.4 | | No Sampling | | No Sampling | |
| Alewife | | 119 | | | | | | | | | | |
| Blueback | | 813 | | | | | | 688 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9.  Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Life Stage** | **Adult** | | **Adult** | | **Larvae** | | **Juveniles** | | **Juveniles** | | **Juveniles** | |
| **Effort** | **Hrs.** | **No.** | | **No.** | **Units** | **No.** | **Min.** | **No.** | **Units** | **No.** | **Days** | **No.** |
| | | | | | | | | | | | | |
| **McColley Pond** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,160 | | | | No Sampling | | 62.8 | | No Sampling | | No Sampling | |
| Alewife | | 74 | | | | | | | | | | |
| Blueback | | 154 | | | | | | 1 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Adult | | Adult | | Larvae | | Juveniles | | Juveniles | | Juveniles | |
| Effort | Hrs. | No. | | No. | Units | No. | Min. | No. | Units | No. | Days | No. |
| | | | | | | | | | | | | |
| **Cooper River Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1998** | 47 | | | | 20 | | 110.9 | | 4 | | No Sampling | |
| Alewife | | 3 | | | | | | | | | | |
| Blueback | | | | 766 | | | | | | | | |
| *Alosa* spp. | | | | | | 41 | | 15,000 | | | | |
| | | | | | | | | | | | | |
| **1999** | 114 | | | | 20 | | 62.0 | | No Sampling | | No Sampling | |
| Alewife | | | | | | | | 19 | | | | |
| Blueback | | 1 | | 1,069 | | 62 | | 12,375 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2000** | 656 | | | | 20 | | 60.4 | | No Sampling | | No Sampling | |
| Alewife | | 1 | | 23 | | | | 12 | | | | |
| Blueback | | 3 | | 941 | | | | 3,417 | | | | |
| *Alosa* spp. | | | | | | 70 | | 4,419 | | | | |
| | | | | | | | | | | | | |
| **2001** | 1,058 | | | | No Sampling | | 60.6 | | No Sampling | | No Sampling | |
| Alewife | | 2 | | | | | | 105 | | | | |
| Blueback | | | | 1,071 | | | | 24,222 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 1,499 | | | | No Sampling | | 60.8 | | No Sampling | | No Sampling | |
| Alewife | | 10 | | | | | | | | | | |
| Blueback | | 1 | | 840 | | | | 438 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,142 | | | | No Sampling | | 61.2 | | No Sampling | | No Sampling | |
| Alewife | | 4 | | | | | | 158 | | | | |
| Blueback | | 9 | | | | | | 6,448 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-9. Continued.

| Sampling Element | Fish Ladder Sampling | | Herring Stocking | | Bongo Net | | Electro-shocking | | Surface/ Push Trawl | | Spill pool Sampling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Stage | Adult | | Adult | | Larvae | | Juveniles | | Juveniles | | Juveniles | |
| Effort | Hrs. | No. | | No. | Units | No. | Min. | No. | Units | No. | Days | No. |
| | | | | | | | | | | | | |
| **Sunset Lake** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1997** | 269 | | | | 20 | | 82.0 | | 3 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | | | 50 | | | | | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **1998** | 266 | | | | 20 | | 132.6 | | 3 | | No Sampling | |
| Alewife | | | | | | | | | | | | |
| Blueback | | 6 | | 1,045 | | | | 1,301 | | | | |
| *Alosa* spp. | | 1 | | | | 3 | | | | | | |
| | | | | | | | | | | | | |
| **1999** | 1,382 | | | | 20 | | 60.8 | | No Sampling | | No Sampling | |
| Alewife | | 44 | | 3 | | | | 10 | | | | |
| Blueback | | 16 | | 892 | | | | 202 | | | | |
| *Alosa* spp. | | | | | | 1 | | | | | | |
| | | | | | | | | | | | | |
| **2000** | 1,920 | | | | 20 | | 61.3 | | No Sampling | | No Sampling | |
| Alewife | | 17 | | 71 | | | | | | | | |
| Blueback | | 15 | | 430 | | | | 335 | | | | |
| *Alosa* spp. | | | | | | 6 | | | | | | |
| | | | | | | | | | | | | |
| **2001** | 2,420 | | | | No Sampling | | 103.9 | | No Sampling | | No Sampling | |
| Alewife | | 16 | | | | | | | | | | |
| Blueback | | 179 | | 1,370 | | | | | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2002** | 2,260 | | | | No Sampling | | 61.3 | | No Sampling | | No Sampling | |
| Alewife | | 87 | | 254 | | | | | | | | |
| Blueback | | 279 | | 756 | | | | 1683 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **2003** | 2,011 | | | | No Sampling | | 60.3 | | No Sampling | | No Sampling | |
| Alewife | | 15 | | | | | | | | | | |
| Blueback | | 49 | | | | | | 173 | | | | |
| *Alosa* spp. | | | | | | | | | | | | |

Table 6-10. Summary of species and numbers collected in adult passage monitoring at eight fish ladder sites during 2003.

| Species | Garrisons Lake | Silver Lake | Moores Lake | McGinnis Pond | Coursey Pond | McColley Pond | Sunset Lake | Cooper River Lake |
|---|---|---|---|---|---|---|---|---|
| Alewife | 13 | | 72 | 2 | 128 | 74 | 15 | 4 |
| Black Crappie | 9 | | 3 | | 5 | 2 | 1 | 4 |
| Blueback Herring | 21 | 16 | 667 | 27 | 218 | 154 | 49 | 9 |
| Bluegill | 34 | 28 | 5 | 2 | 15 | 2 | 2 | |
| Brown Bullhead | 114 | 1 | 1 | | | | | 1 |
| Brown Trout | | | | | | | 3 | |
| Carp | 1 | | | | 14 | 4 | 1 | 1 |
| Chain Pickeral | | | | | | 2 | 4 | |
| Channel Catfish | 5 | | | | | 1 | | |
| Gizzard Shad | 197 | 429 | | 11 | 570 | 629 | 885 | 63 |
| Golden Shiner | 85 | 1 | | 1 | 1 | 8 | | |
| Largemouth Bass | 4 | 1 | 2 | 1 | | | 1 | 2 |
| Pumpkinseed | | | | | | | 30 | 6 |
| White Catfish | 1,353 | 1 | 1 | | 2 | | 16 | 2 |
| White Perch | 1,579 | 44 | 1 | | 14 | 9 | 1 | 72 |
| Yellow Perch | | | | | | | 2 | 5 |
| | | | | | | | | |
| **Total** | 3,415 | 521 | 752 | 44 | 967 | 885 | 1,010 | 169 |

Table 6-11. Summary of species and numbers collected in electrofishing sampling at eight fish ladder sites during 2003.

| Species | Garrisons Lake | Silver Lake | Moores Lake | McGinnis Pond | Coursey Pond | McColleys Pond | Cooper River Lake | Sunset Lake |
|---|---|---|---|---|---|---|---|---|
| Alewife | | | | | | | 158 | |
| American Eel | 41 | 5 | 5 | 1 | 3 | 18 | | 31 |
| Asian Grass Carp | | | | | | | 1 | |
| Black Crappie | 48 | | 111 | | 1 | 5 | | 7 |
| Blueback Herring | | 2 | | | 7 | 1 | 6,448 | 173 |
| Bluegill | 694 | 42 | 559 | 207 | 24 | 77 | 50 | 1,210 |
| Brown Bullhead | 5 | | | | 1 | 2 | | 2 |
| Carp | 32 | 163 | 88 | | 23 | 102 | 29 | 117 |
| Chain Pickeral | | | 22 | 32 | | 14 | | 6 |
| Common Sucker | | | | 1 | | | | 2 |
| Creek Chub | 1 | | | | | | | |
| Eastern Silvery Minnow | | | | 1 | | | | 1 |
| Gizzard Shad | 438 | 2,114 | 281 | 472 | 988 | 153 | 603 | 1,002 |
| Golden Shiner | | | 5 | 1 | | 50 | | |
| Largemouth Bass | 87 | 61 | 145 | 51 | 19 | 129 | 2 | 153 |
| Pumpkinseed | 96 | | 347 | 12 | 40 | 261 | | 387 |
| Striped Bass | | | | 1 | | | | 10 |
| White Catfish | | | | | | | | 2 |
| White Perch | 39 | 102 | 105 | 5 | 58 | 74 | 3 | 13 |
| Yellow Perch | 3 | 3 | 23 | 120 | 1 | 7 | | 982 |
| | | | | | | | | |
| **Total** | 1,484 | 2,492 | 1,691 | 904 | 1,165 | 893 | 7,294 | 4,098 |

Table 6-12. Temporal sampling of spawning run herring at three fishladders, during 2001.

| | Moores Lake | | | Coursey Pond | | | McColley Pond | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 4/24/01 | 4/25/01 | 5/7/01 | 4/23/01 | 4/24/01 | 4/25/01 | 4/23/01 | 4/24/01 | 4/25/01 | 5/7/01 | Average |
| | | | | | | | | | | | |
| 7:30 | | | | | | | | | | | |
| 8:00 | | | | | | | | | | | |
| 8:30 | | | | | | | | | | | |
| 9:00 | | | | | | | | | | | |
| 9:30 | | | | | | | | | | | |
| 10:00 | | | | | | | | 0.33 | | | 0.33 |
| 10:30 | 10.33 | 4.75 | | | 19.00 | 1.50 | | 0.33 | | | 7.18 |
| 11:00 | 10.33 | 4.75 | | | 19.00 | 1.50 | | 0.33 | | | 7.18 |
| 11:30 | 10.33 | 4.75 | | | 19.00 | 1.50 | | 21.45 | | 2.04 | 9.51 |
| 12:00 | 10.33 | 4.75 | | | 6.40 | 1.50 | | 21.45 | | 2.04 | 7.41 |
| 12:30 | 10.33 | 2.09 | 3.40 | | 6.40 | 13.00 | | 21.45 | 3.47 | 2.04 | 7.52 |
| 13:00 | 10.33 | 2.09 | 3.40 | | 6.40 | 13.00 | | 21.45 | 3.47 | 2.04 | 7.52 |
| 13:30 | 11.00 | 2.09 | 3.40 | | 6.40 | 13.00 | | 21.45 | 3.47 | 2.04 | 7.60 |
| 14:00 | 11.00 | 2.09 | 3.40 | | 6.40 | 13.00 | | 21.45 | 3.47 | 2.04 | 7.60 |
| 14:30 | 11.00 | 2.09 | 3.40 | | 6.40 | 13.00 | 3.63 | 21.45 | 3.47 | 2.04 | 7.16 |
| 15:00 | 11.00 | 2.09 | 3.40 | | 6.40 | 13.00 | 3.63 | 21.45 | 3.47 | 2.04 | 7.16 |
| 15:30 | 11.00 | 2.09 | 3.40 | 3.57 | 6.40 | 13.00 | 3.63 | 21.45 | 3.47 | 2.04 | 6.80 |
| 16:00 | 11.00 | 2.09 | 3.40 | 3.57 | 6.40 | 13.00 | 3.63 | 21.45 | 3.47 | | 7.56 |
| 16:30 | 11.00 | 2.09 | 3.40 | 3.57 | | | 3.63 | 21.45 | 3.47 | | 6.94 |
| 17:00 | | 2.09 | | 3.57 | | | 3.63 | | | | 3.10 |
| 17:30 | | 2.09 | | 3.57 | | | 3.63 | | | | 3.10 |
| 18:00 | | | | 3.57 | | | 3.63 | | | | 3.60 |
| 18:30 | | | | 3.57 | | | 3.50 | | | | 3.54 |
| 19:00 | | | | 16.50 | | | 3.50 | | | | 10.00 |
| 19:30 | | | | 16.50 | | | 5.50 | | | | 11.00 |
| 20:00 | | | | 1.50 | | | 5.50 | | | | 3.50 |
| 20:30 | | | | 1.50 | | | 3.00 | | | | 2.25 |
| 21:00 | | | | | | | 3.00 | | | | 3.00 |
| 22:00 | | | | | | | | | | | |
| 22:30 | | | | | | | | | | | |
| 23:00 | | | | | | | | | | | |
| 23:30 | | | | | | | | | | | |
| 0:00 | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

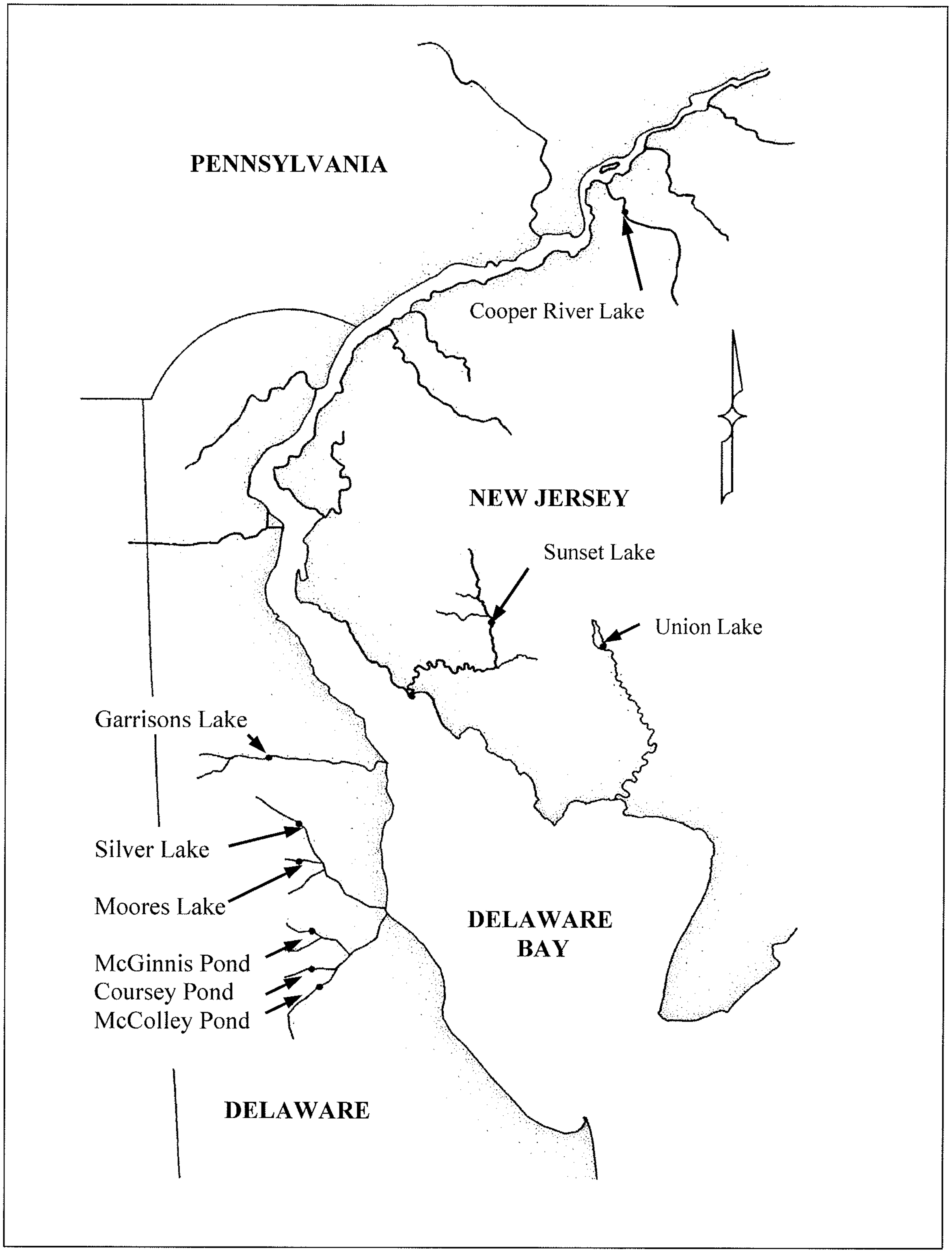



Figure 6-2. Map depicting the locations of the eight PSEG fish ladders and Union Lake within the Delaware River estuary.

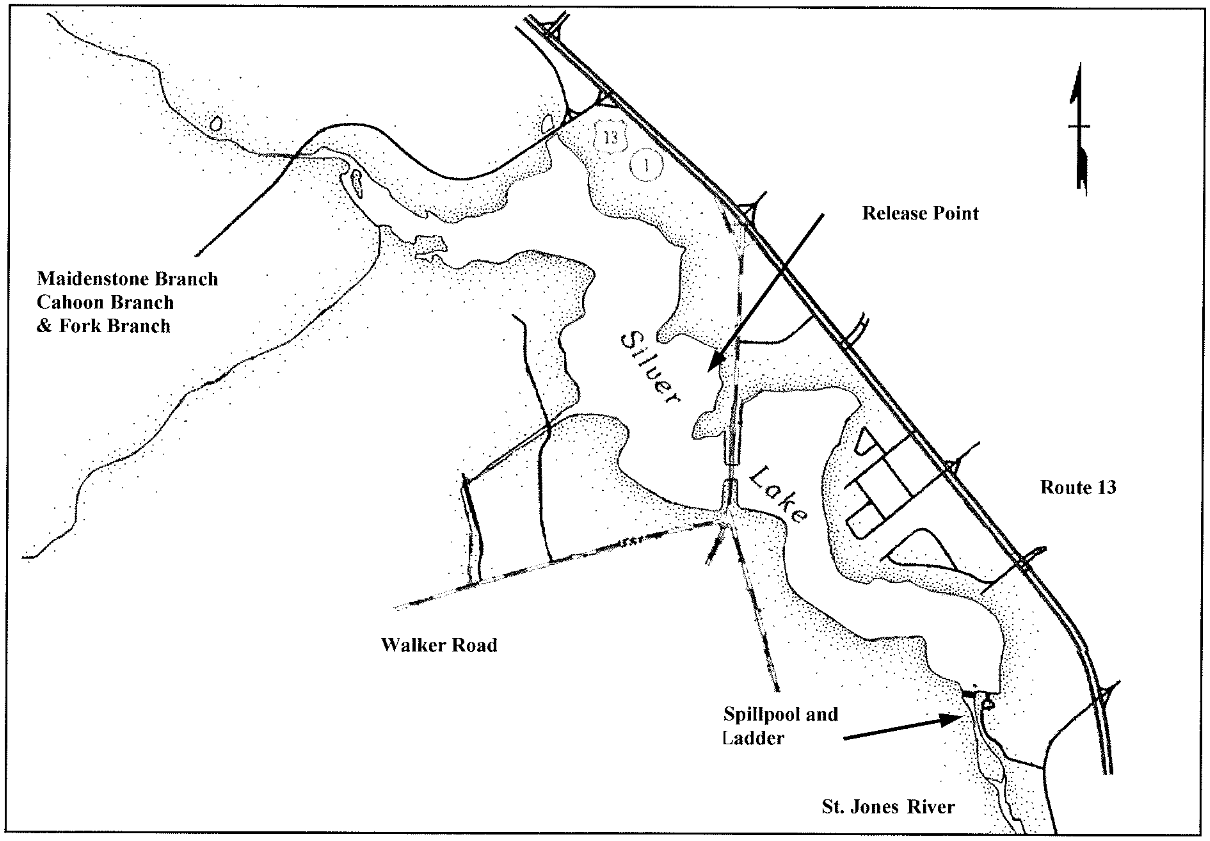



Figure 6-2. Silver Lake on the St Jones River, in Dover, DE.

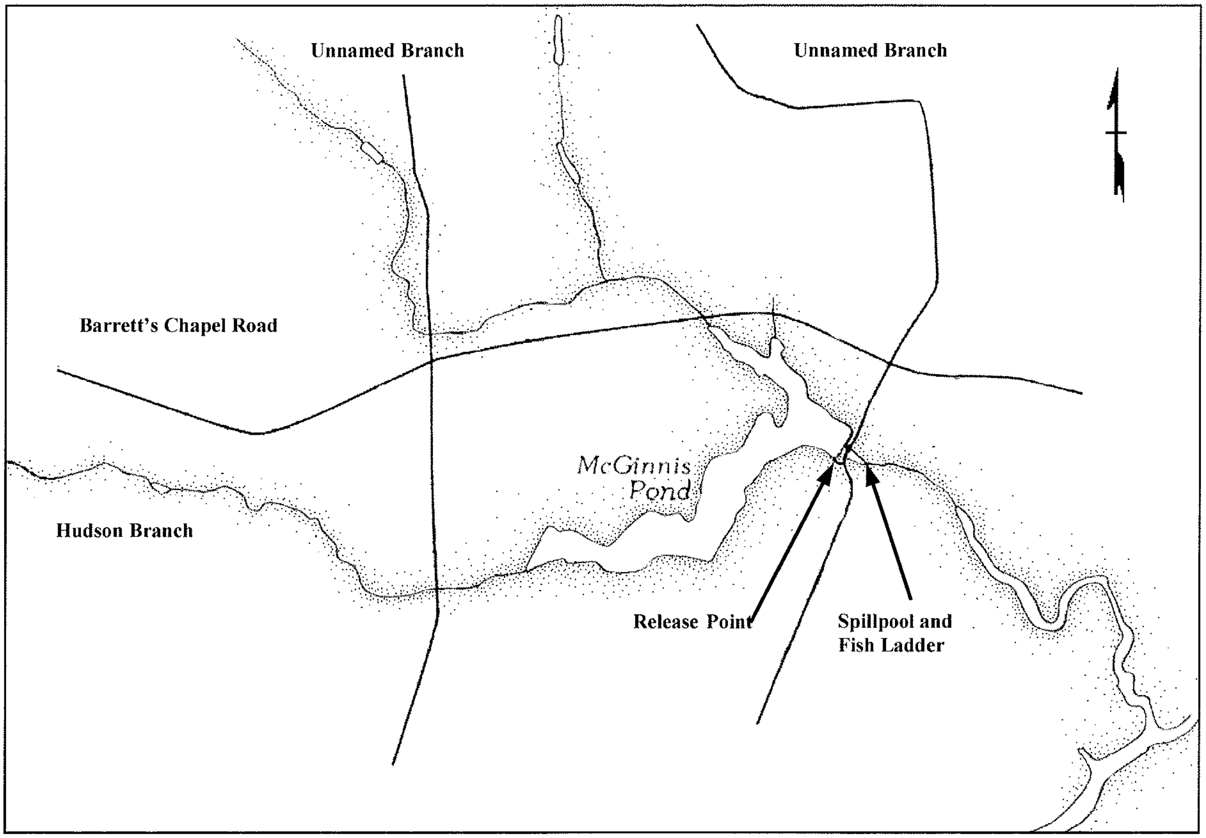



Figure 6-3. McGinnis Pond on Hudson Branch, a tributary of the Murderkill River, near Frederica, DE.

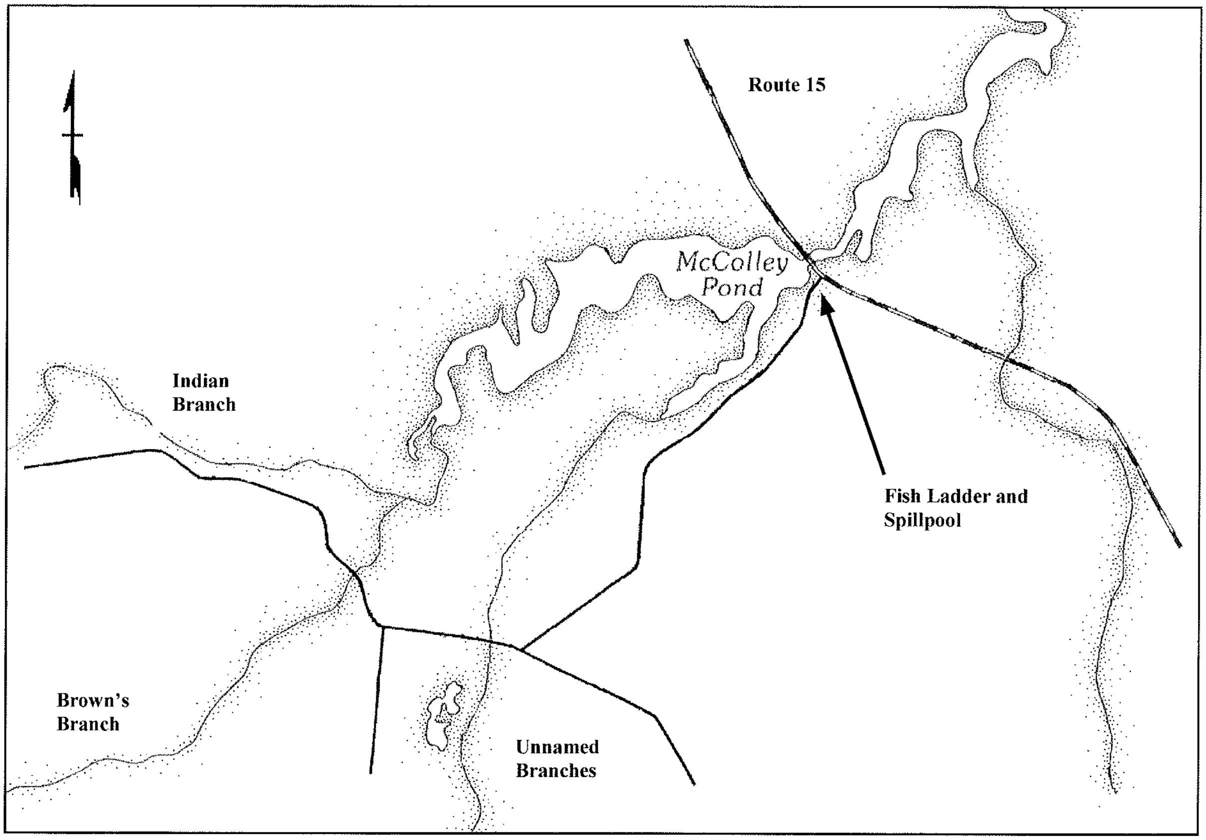



Figure 6-4. McColley Pond on Brown's Branch, a tributary to the Murderkill River, near Milford, DE.

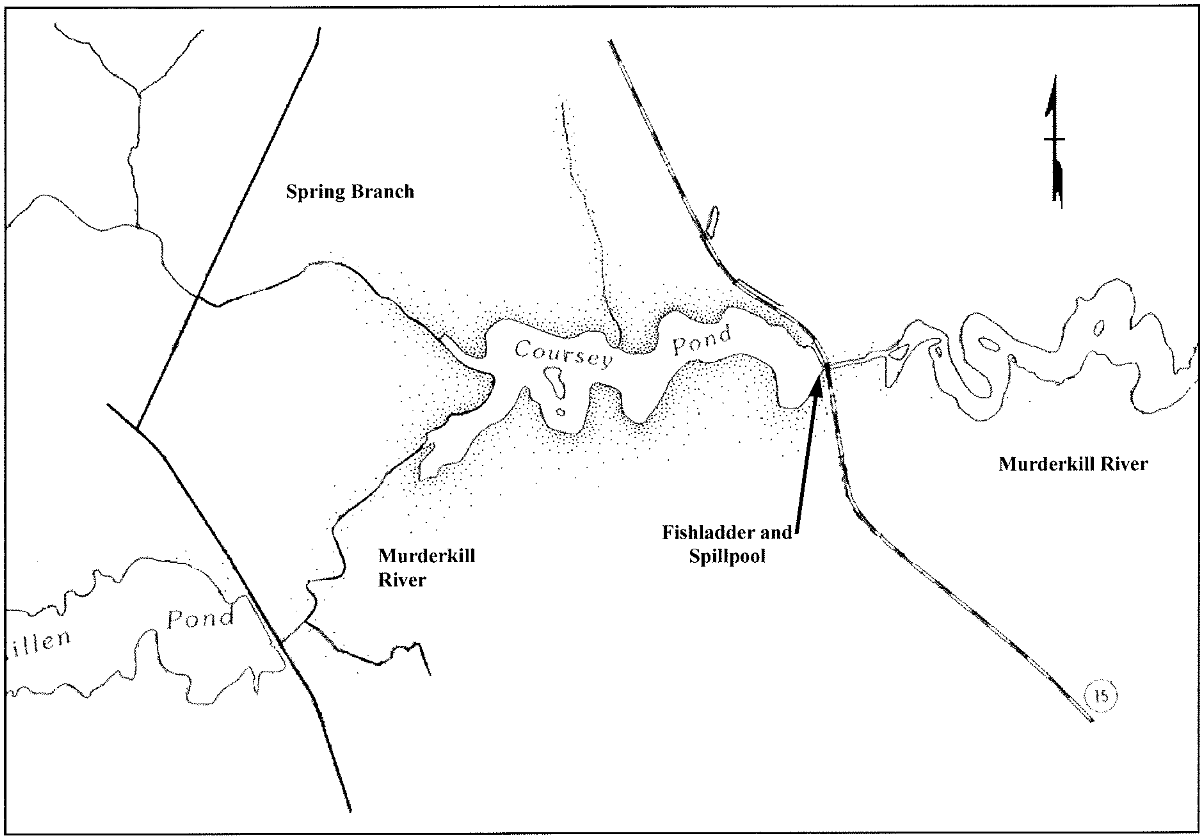



Figure 6-5. Coursey Pond on the Murderkill River, near Frederica, DE.

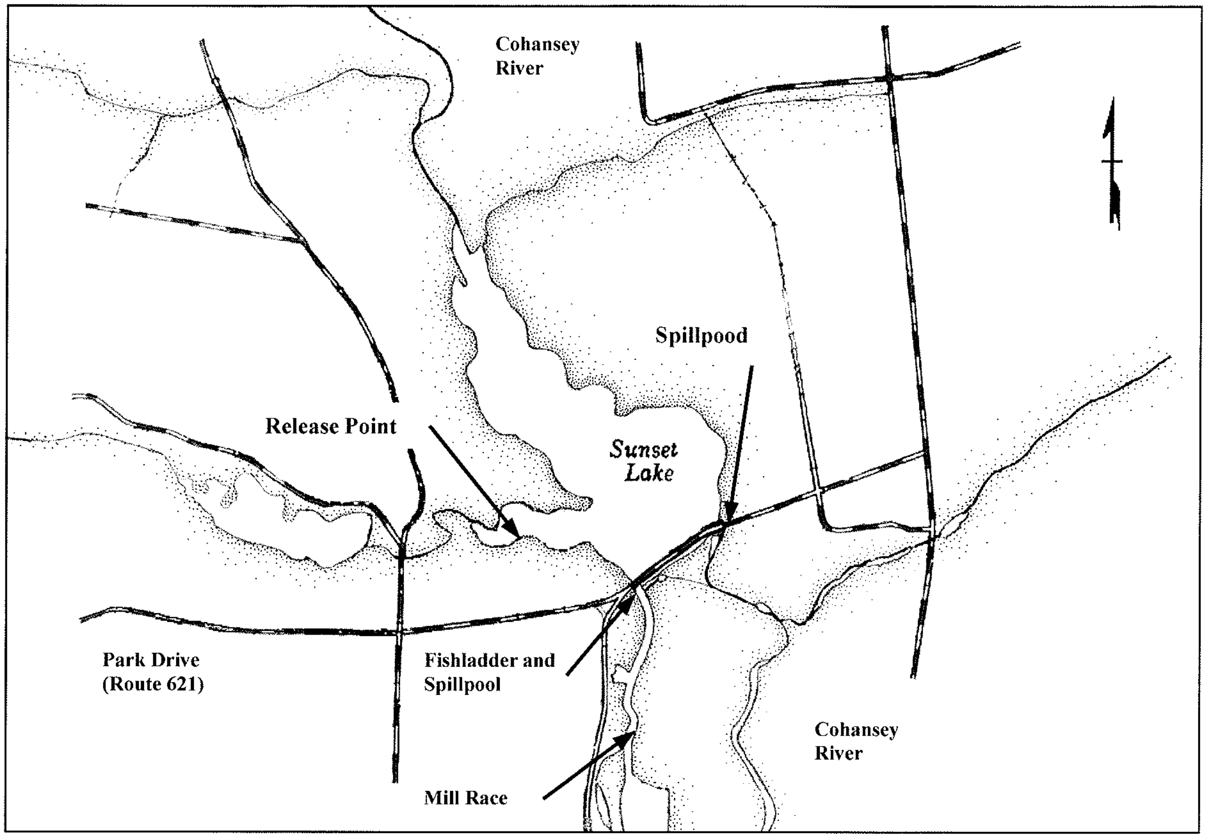


Figure 6-6. Sunset Lake on the Cohansey River, in Bridgeton, NJ.

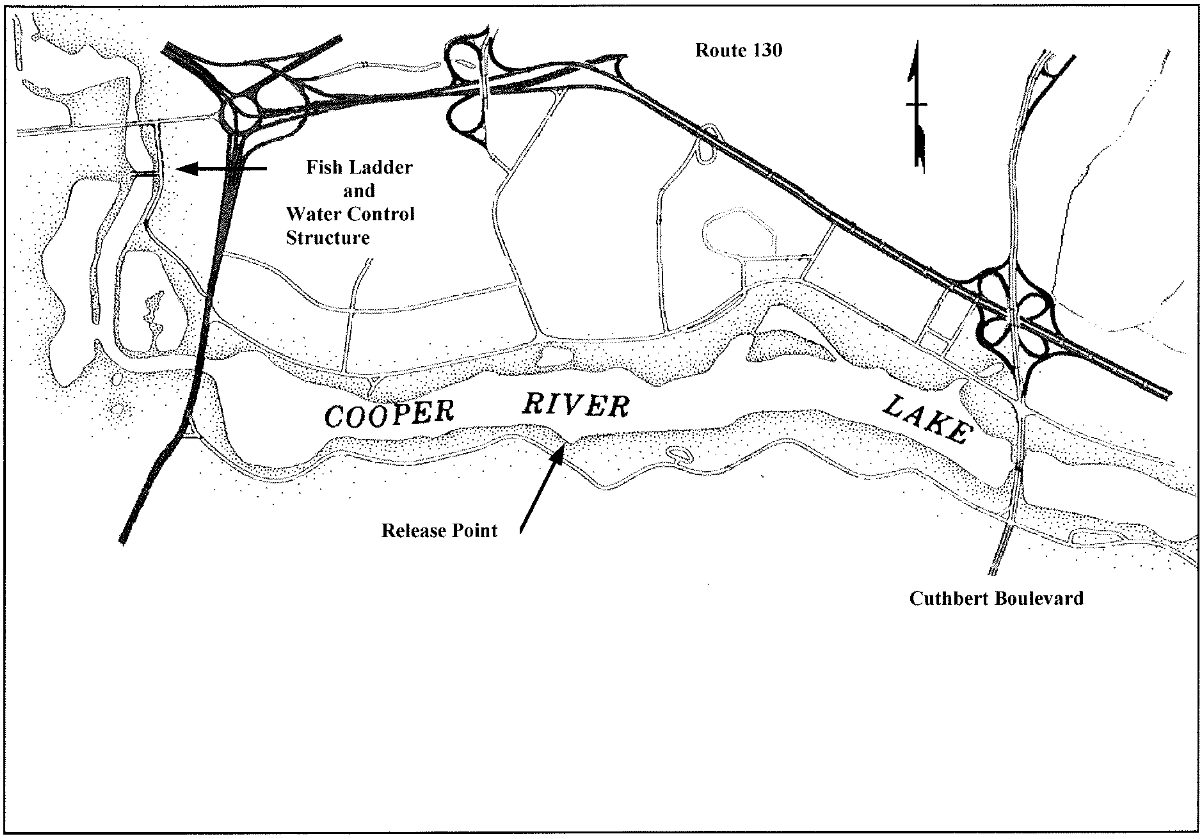



Figure 6-7. Cooper River Lake, an impoundment of the Cooper River, in Camden, NJ.

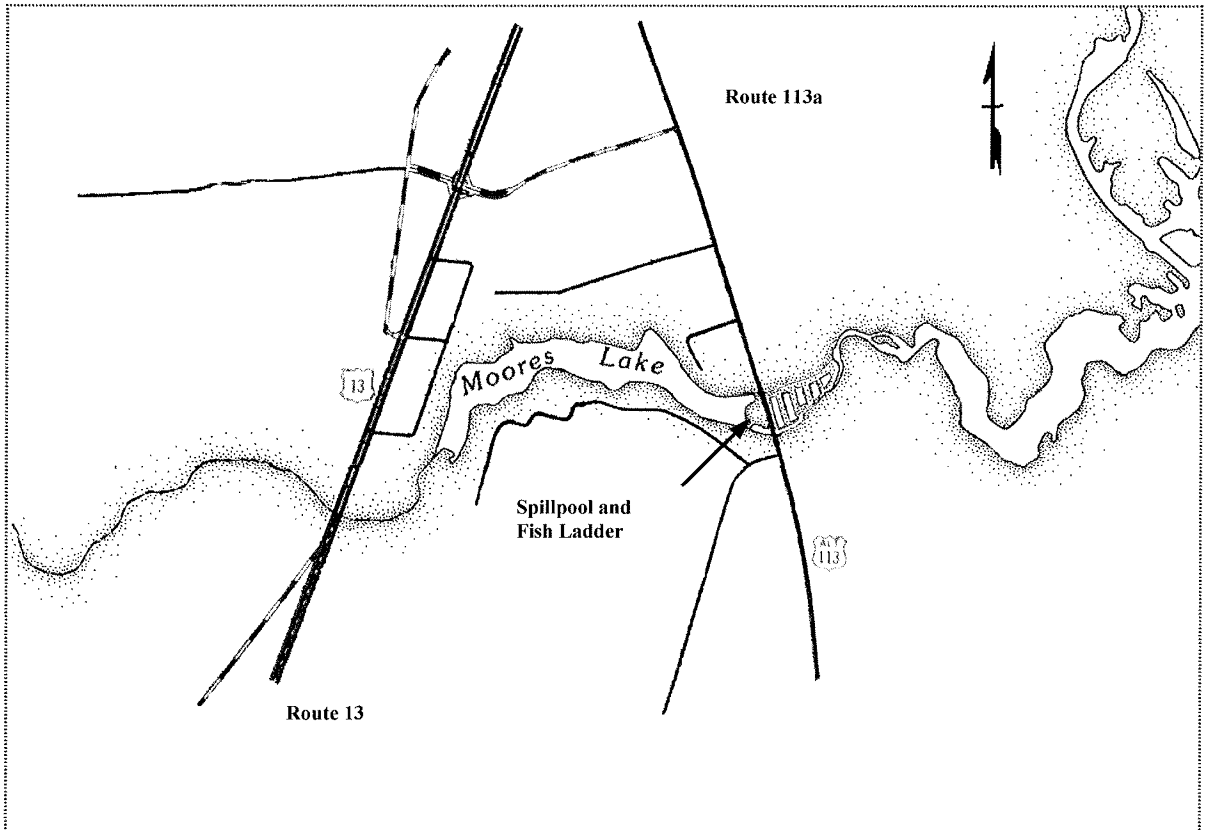



Figure 6-8. Moores Lake on Isaacs Branch, a tributary to the St. Jones River, near Dover, DE.

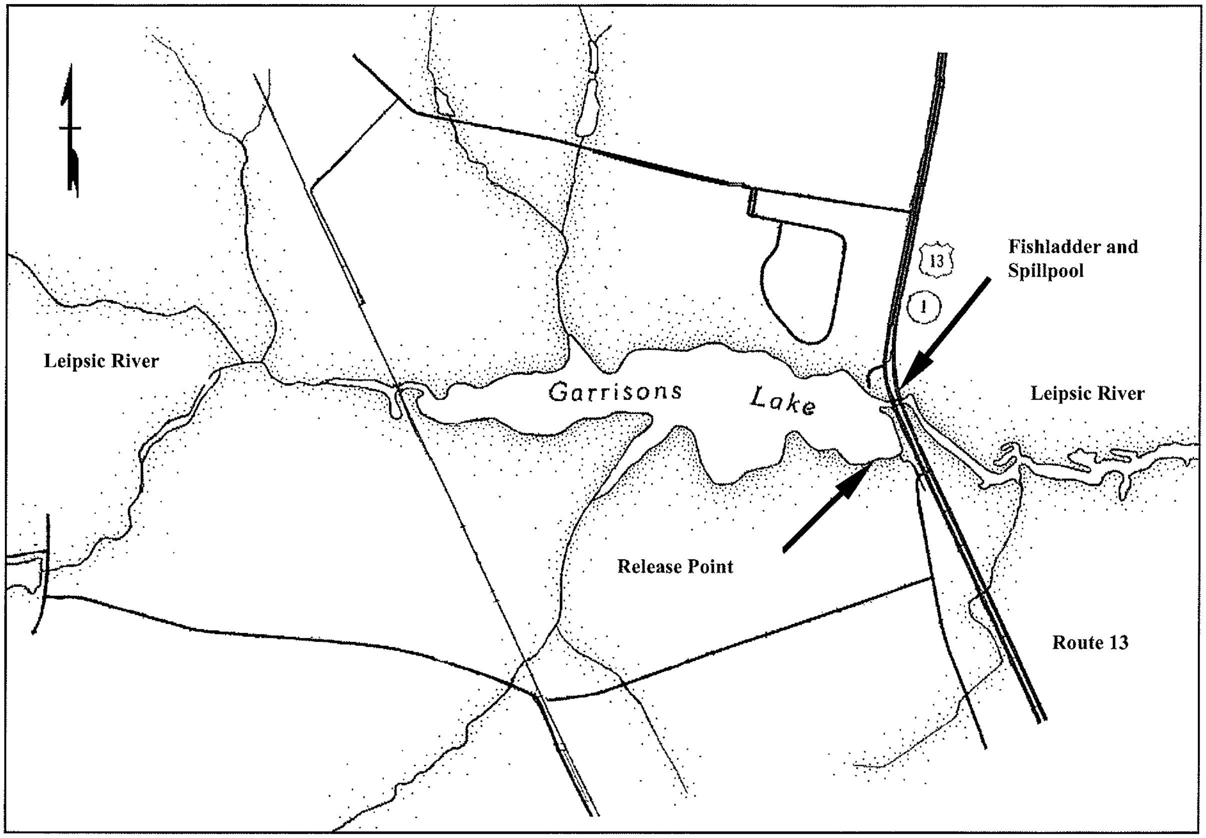



Figure 6-9. Garrisons Lake on the Leipsic River, near Cheswold, DE showing fish ladder and stocking release point locations.

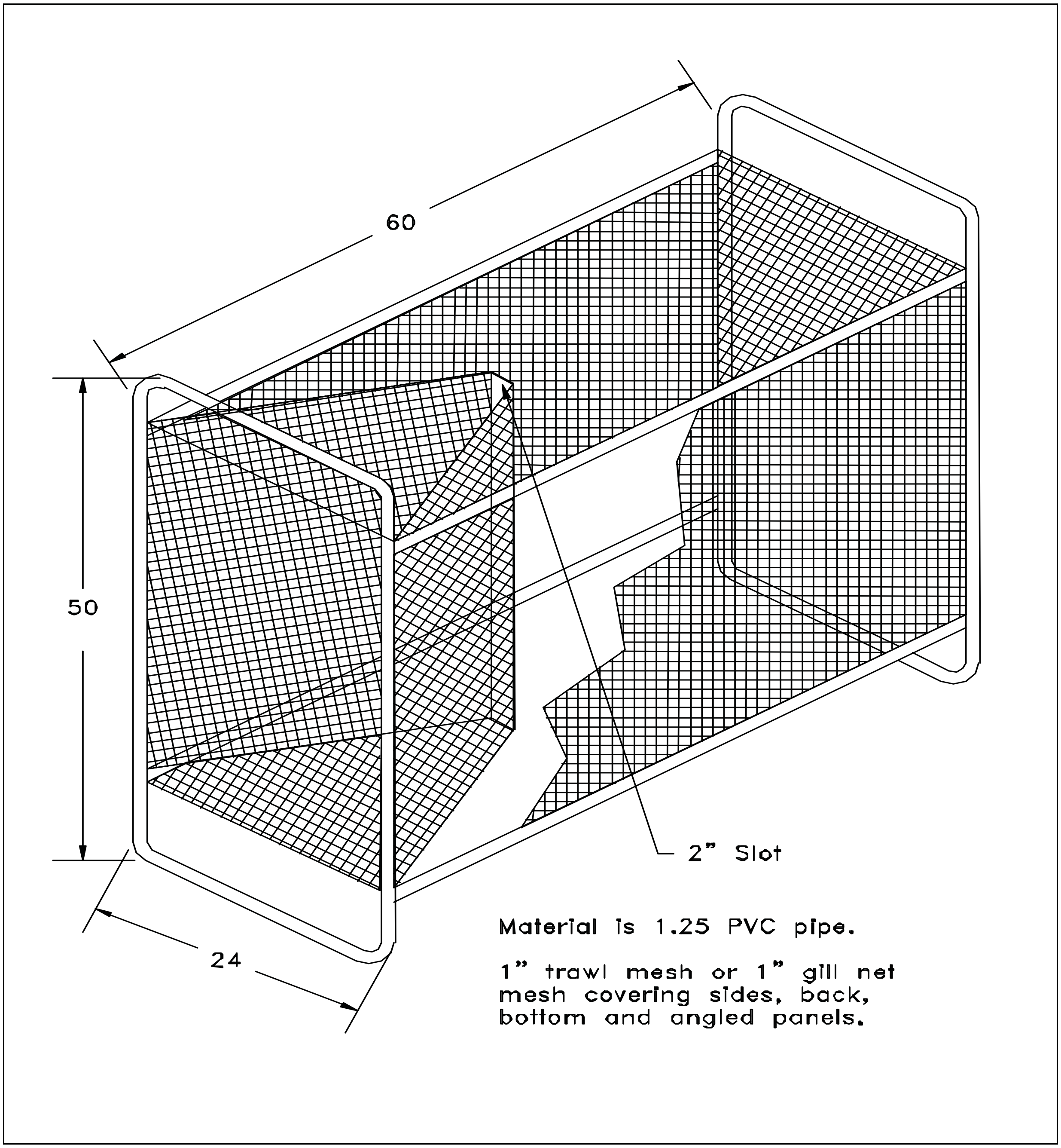



Figure 6-10. Generalized fish trap used to collect fish at the exit (upper end) of the fish ladders.

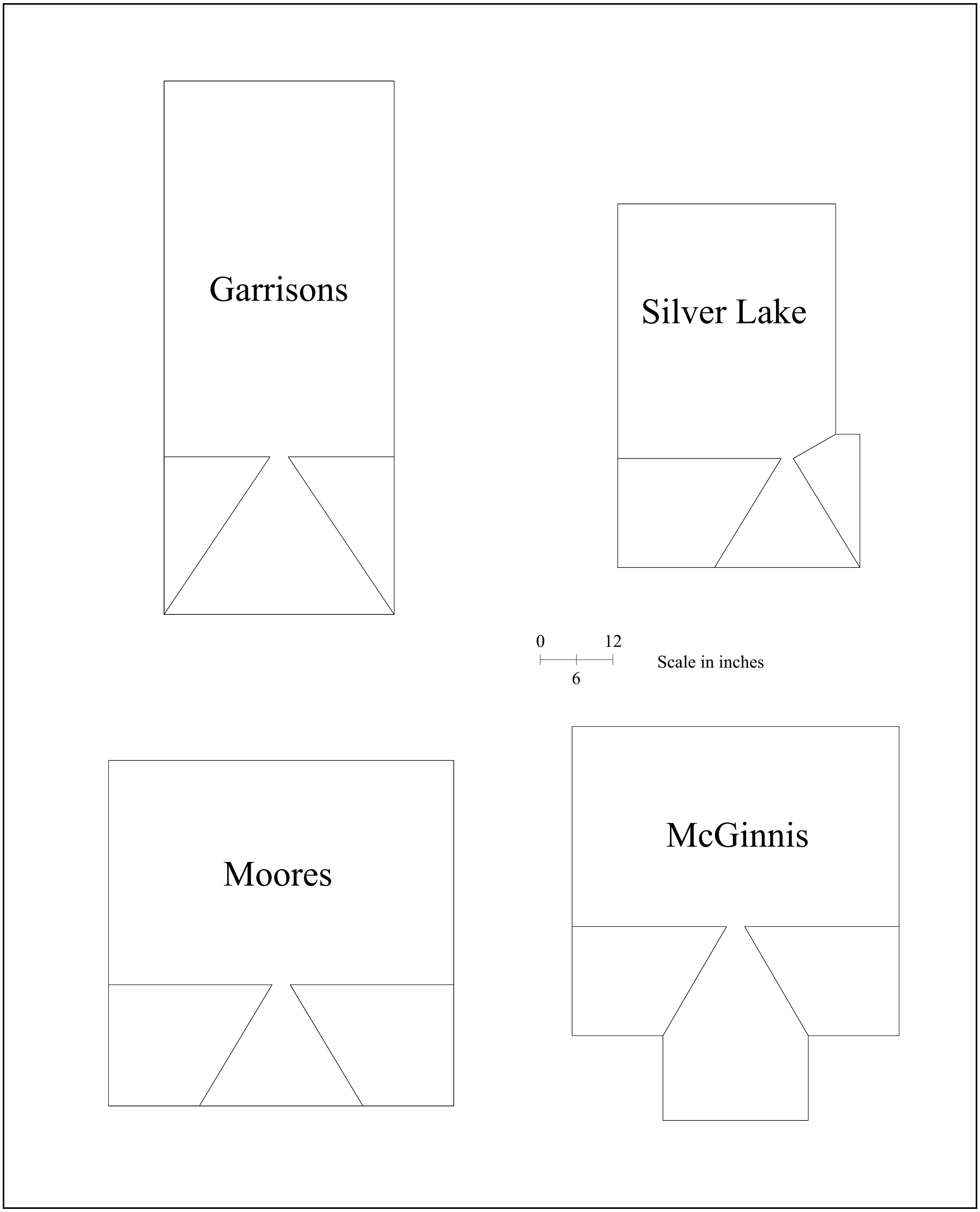



Figure 6-11. Plan views of four fish traps used to collect fish at the exit (upper end) of the fish ladders.

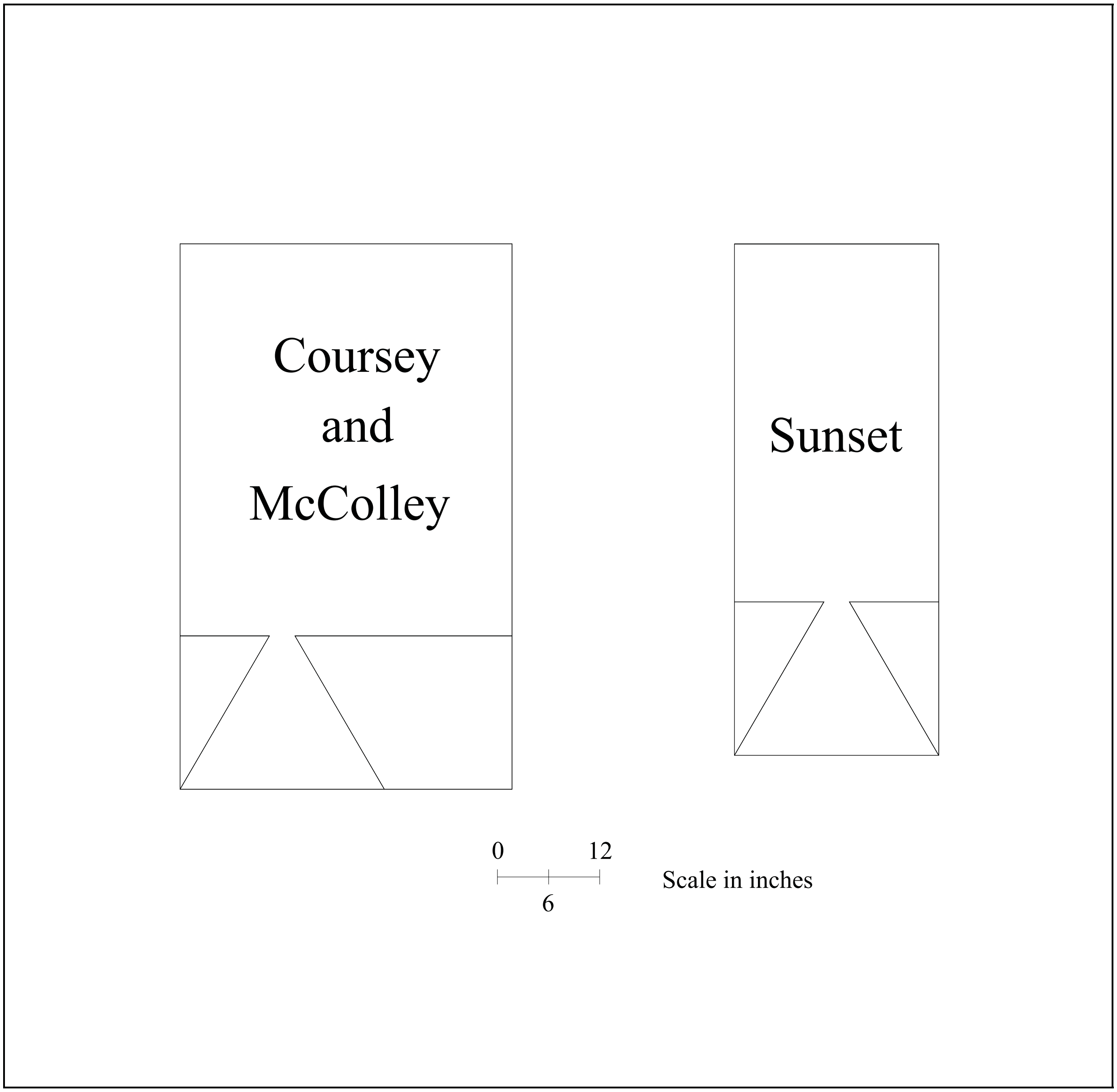



Figure 6-12. Plan views of two fish traps used to collect fish at the exit (upper end) of the fish ladders.

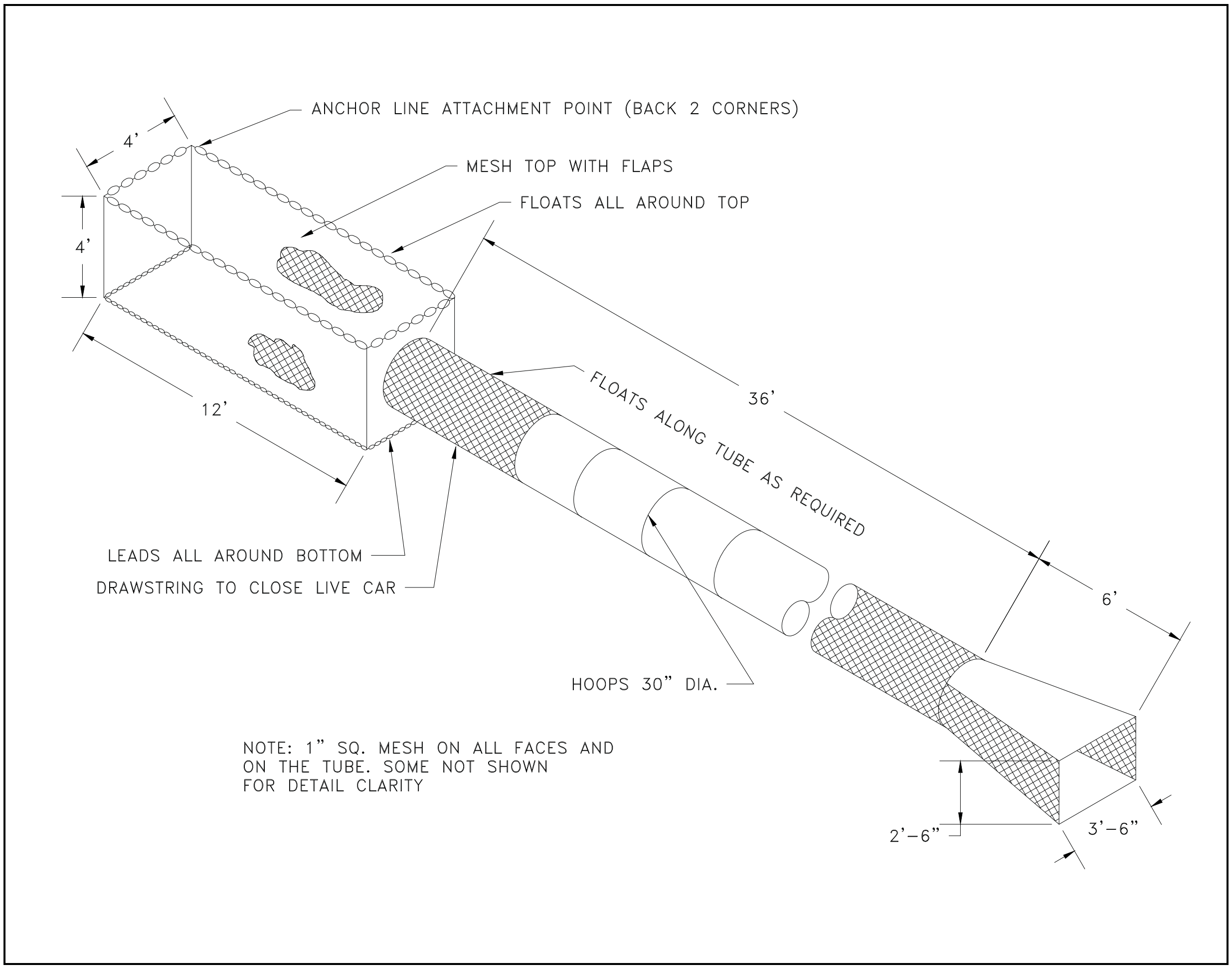



Figure 6-13. Modified commercial fish trap used to collect fish at the exit (upper end) of the Cooper River Lake fish ladder.

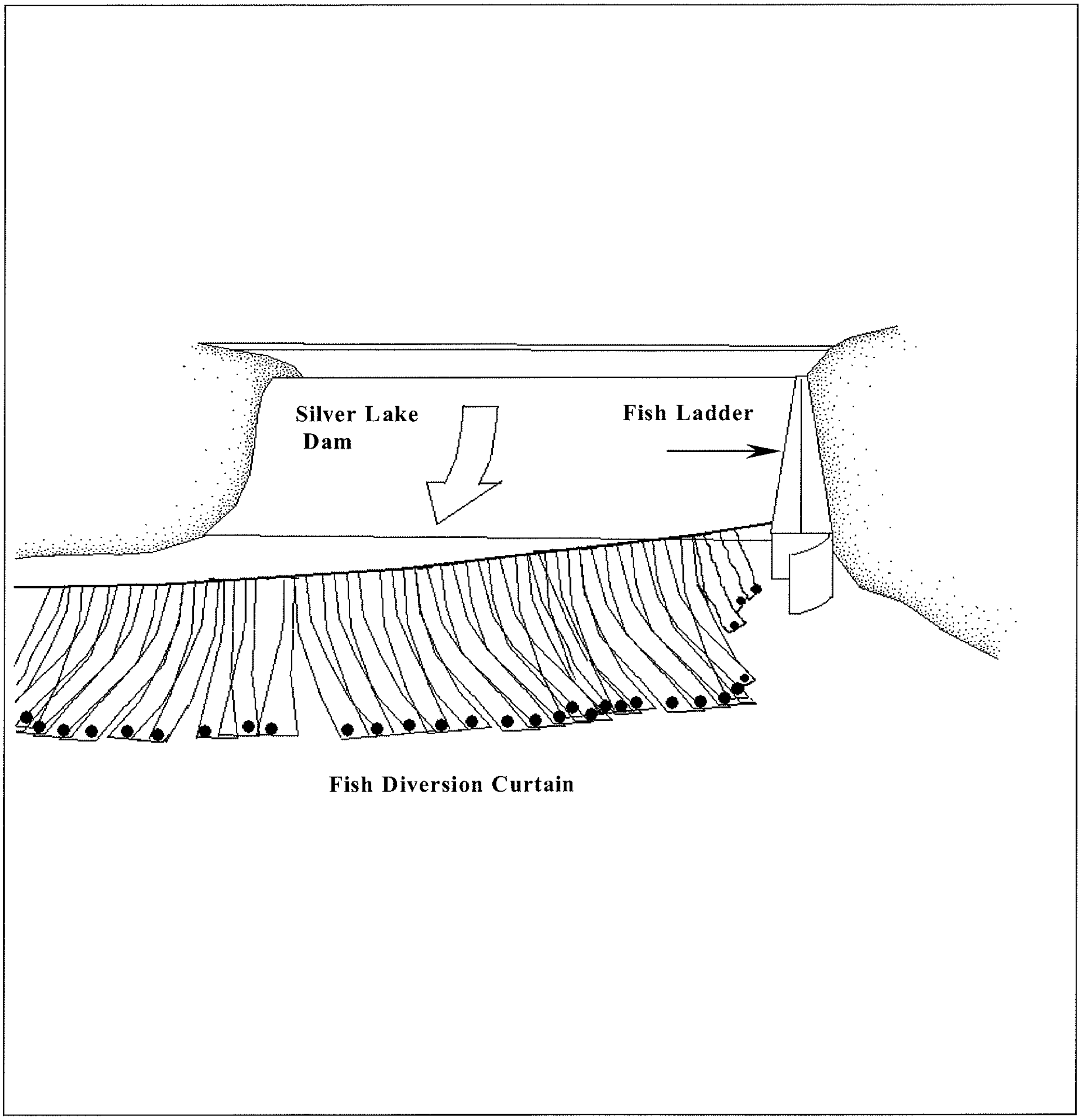



Figure 6-14. Fish diversion curtain at the Silver Lake fish ladder.

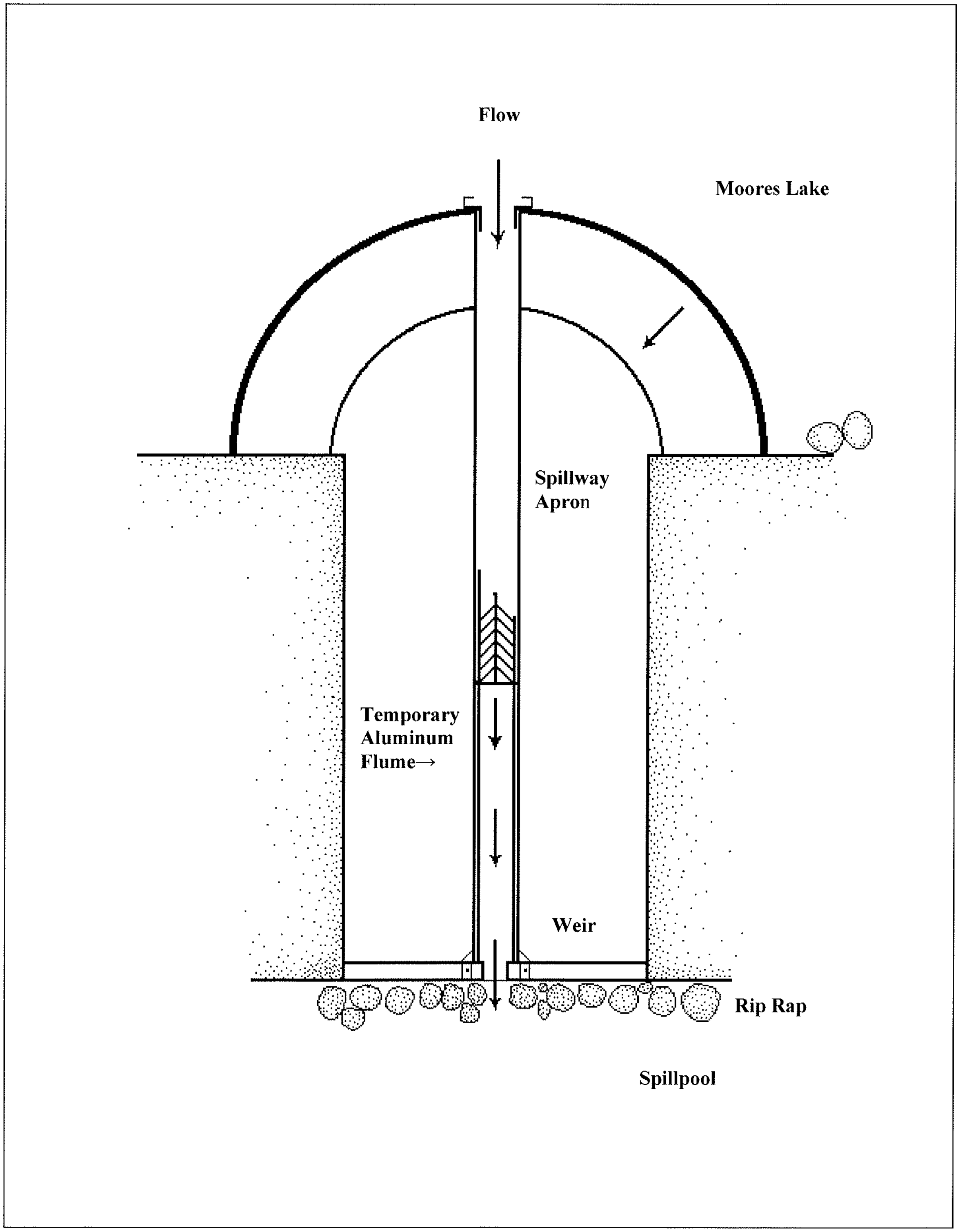



Figure 6-15. Fish diversion flume at Moores Lake fish ladder

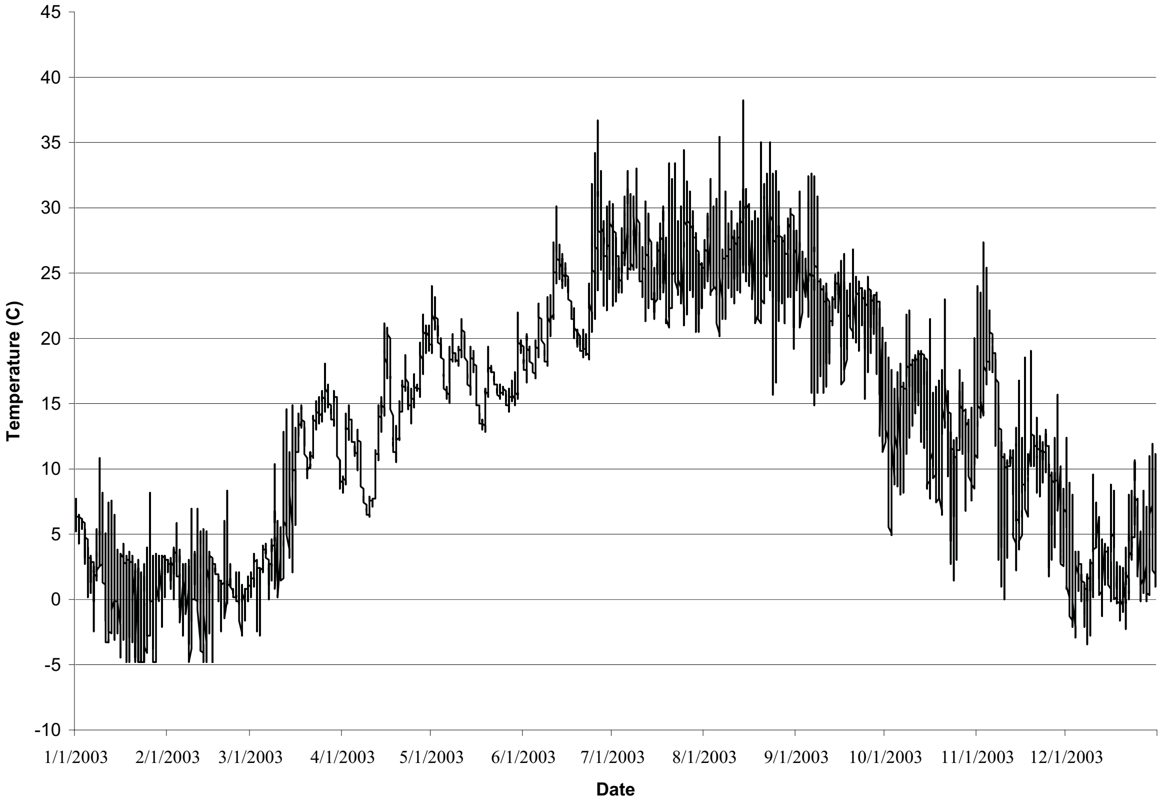



Figure 6-16. Water temperatures (°C ) at Garrisons Lake Spillpool during January 1, 2003 through December 31, 2003. Measurements collected hourly with a "TidbiT" temperature logger.

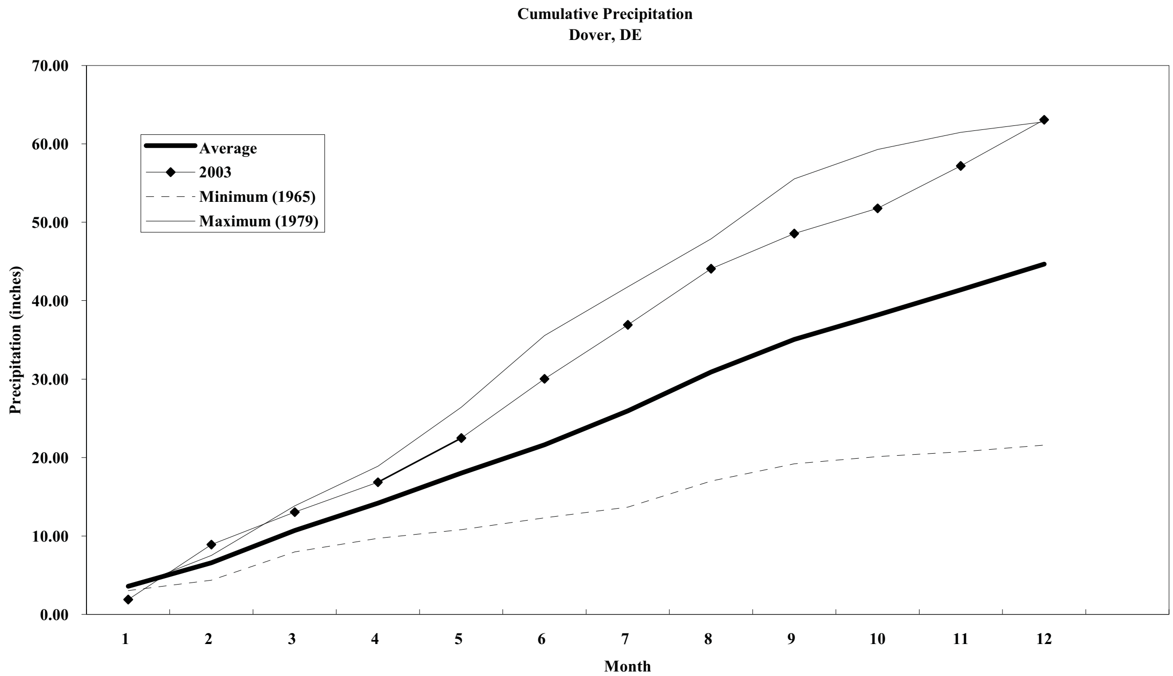



Figure 6-17. Cumulative precipitation for 2003 with 1922-2003 average from data collected by Del DOT in Dover, DE.

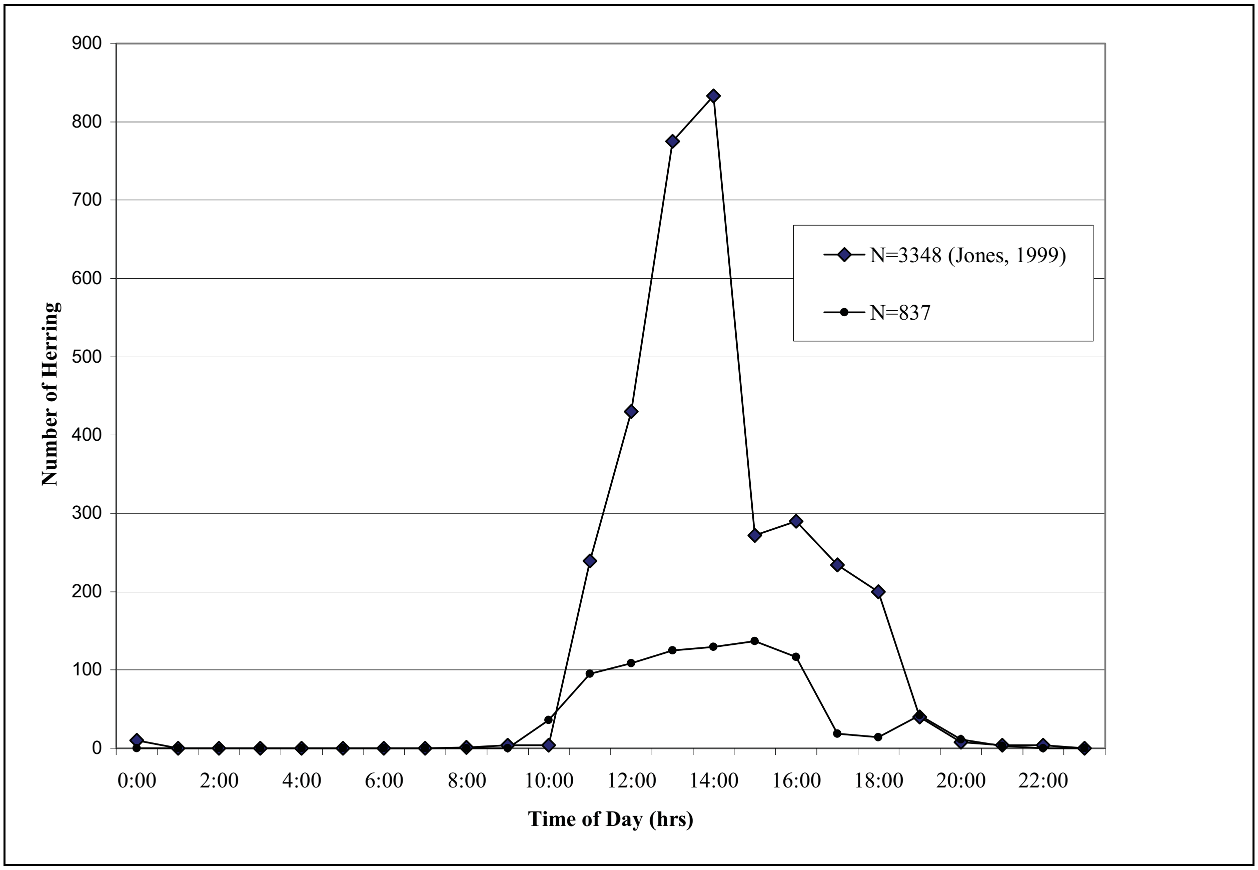



Figure 6-18. Hourly herring passage at Coursey and McColley Ponds, and Moores Lake, April 23-May 7, 2001 with hourly data from Wagamons Pond, 1997-1998 (Jones,1999).

# CHAPTER 7

# MARSH RESTORATION PROJECT: FISH ASSEMBLAGE STRUCTURE

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# CHAPTER 7: MARSH RESTORATION PROJECT: FISH ASSEMBLAGE STRUCTURE

## Table of Contents

## LIST OF TABLES

## LIST OF FIGURES

## 1.0 INTRODUCTION

Among the primary goals of salt marsh restoration is an increase in fish production through the provision of quality nursery habitat. Both an increase in habitat quantity and quality contribute to this goal. Many marine fish species utilize estuarine marsh as nursery habitat, and to some, this habitat is critical (Gunter 1956; Nixon and Oviatt 1973; Daiber 1977; Weinstein 1979; Kneib 1997; Beck et al. 2001). However, fish are highly mobile even in their juvenile stages, and occasional documentation of species' presence is not sufficient to demonstrate utilization or on-site production. Instead, rigorous evaluation of restoration success requires knowledge of the temporal and spatial distribution, movement, and growth patterns of fishes in the marsh and adjacent habitat (Able 1999). This report details results from a rigorous survey of fishes, blue crabs, and turtles undertaken in Delaware Bay salt marshes restored by the Estuary Enhancement Program of Public Service Enterprise Group (PSEG), and in nearby reference sites during 2003. This survey continues monitoring begun in 1996 with the initiation of physical marsh restoration efforts and, thus, provides the eighth annual report in a long term monitoring project. Results are presented in a manner consistent with that for the studies in 1996, 1997, 1998, 1999, 2000, 2001, and 2002 (PSE&G 1999) in order to facilitate future comparisons between years.

Human activity has impacted Delaware Bay fish populations for the last 200 years (Sebold 1992). Invasion by the common reed, *Phragmites australis*, as well as unnatural cycles of tidal inundation from salt hay farming-related tidal control (via bulkheading and diking), continues to affect Delaware Bay marshes and their fish communities. Both processes are believed to be detrimental to the natural nursery functions (see Beck et al. in 2001) of salt marshes (Weinstein et al. 1997, Weinstein and Balletto 1999, Able and Hagan 2000, 2003). Invasion by *Phragmites* is common in oligohaline upper bay marshes such as Alloway Creek; salt hay farms historically utilize intertidal land fringing the lower mesohaline bay (e.g. Commercial Township). Pursuant to the requirements of the NJPDES permit for the Salem Generating Station, the Public Service Enterprise Group (PSEG) began restoration of affected salt marshes in 1996 in Delaware Bay via the Estuary Enhancement Program (EEP). Methods used in this restoration program are tailored to the sites (i.e. *Phragmites* or former salt hay farm sites) as reviewed in Weinstein et al. (1997). Construction of a network of channels opens sites previously used as salt hay farms to tidal circulation. Treatment with Rodeo® and a surfactant followed by prescribed burning eradicates stands of *Phragmites* in oligohaline sites dominated by this species. The goal of both activities is the re-establishment of *Spartina* or other desirable types of vegetation with a corresponding increase in marsh fish utilization and production.

Several studies in recent years examined the functional significance of marshes and the role that fishes play in it (Rountree and Able 1992b; Szedlmayer and Able 1996; Smith 1995, and see Kneib 1997, Deegan et al. 2000, Weinstein and Kreeger 2001). These have suggested that marsh fish are important conduits of organic material and energy from the area of high primary production in the marsh to the nearby estuaries and the ocean. Although many of these studies provide a sound basis for understanding marsh ecosystems, observations from elsewhere should not be extrapolated to Delaware Bay, where salinity and tidal range are more variable. Salt marsh habitat encompasses a wide salinity range in the Delaware Bay, and includes sub-habitats of infrequently flooded marsh surface, regularly flooded intertidal marsh surface, intertidal marsh creek, subtidal marsh creek, and bay-marsh fringe. Of these, intertidal and subtidal marsh creeks are already known as important habitats for many fish species (Cain and Dean 1976; Shenker and Dean 1979; Weinstein 1979; Weinstein et al. 1980; Hodson et al. 1981; Rozas and Odum 1987; Kneib 1997) and are the focus of further study in the current work.

The few prior studies that examined the structure of juvenile fish assemblages in Delaware Bay marshes generally concluded that these habitats serve as important habitat to a number of commercially important species. Smith (1971) used daytime seine and trawl collections to characterize juvenile fish assemblages in low-salinity salt marsh creeks, and recorded 55 species representing 43 genera. Wang and Kernehan (1979) compiled data concerning early life stages of 112 species for all of Delaware Bay. Able and Fahay (1998) synthesized the information available for the first year in the life of estuarine species in the Middle Atlantic Bight, including several dominant forms in Delaware Bay. More recently, PSE&G (1997), Able et al. (1998), Able et al. (2000), Grothues and Able (2003a, b), and Able et al. (in press) compared fish assemblage and growth among habitats within reference and restored marshes in Delaware Bay as an early indicator of the success of the large scale marsh restoration activities conducted by PSEG (Weinstein et al. 1997). Within the restricted salinity zone of the lower Delaware Bay, fish growth, abundance, and diversity in restored salt hay farm sites were all greater than or similar to reference sites (Able et al. in press). A study of large marsh creeks in the upper bay showed that subtidal marsh fish assemblages differed among restored and reference marshes, but that restoration sites were abundantly utilized by fish and that the differences could more easily be ascribed to external factors (such as larval transport) than to vegetation status (Grothues and Able 2003 a). Additional studies show that assemblages in these habitats vary between low and high tide and between day and night as a function of both the movement and catch-ability of fish with tidal or diel habits (Talbot and Able 1984; Talbot et al. 1986; Sogard and Able 1991; Rountree and Able 1992a, 1993; Able et al. 1996; Able and Fahay, 1998). In 1998, work on this project also addressed diel/diurnal assemblage differences in the Delaware Bay (PSE&G 1999). In 1999, the addition of several sites dominated by either *P. australis*, *S. alterniflora*, or under treatment for *P. australis* eradication, but all at Alloway Creek in the upper Delaware Bay (Fig. 1), allowed for comparison of the co-variation of plant community treatment history and fish assemblage within a single location. A study at Alloway Creek found that differences in utilization of restored, unrestored, and naturally vegetated creeks were generally small, but that these differences held for the majority of species. Most species, but especially white perch, were more abundantly collected in untreated, *Phragmites*-dominated creeks than in either restored or naturally *Spartina*-vegetated creeks (Grothues and Able 2003 b). This pattern of increased fish abundance in subtidal large marsh creek assemblages is in contrast to that for intertidal small marsh creeks and raises important questions regarding the trophic transfer between fishes of the marsh surface and subtidal creek assemblages. Sampling at Alloway Creek continued in 2003.

The overall long-term objective of this research is to evaluate the effectiveness of restoration activities on faunal response with emphasis on the patterns and processes that control fish utilization and production for restored wetlands in Delaware Bay. More specifically, fish species composition, life history stage, and size are compared across habitat types (large and small marsh creeks) in restored and reference marshes. The target species, as before, are weakfish (*Cynoscion regalis*), white perch (*Morone americana*), spot (*Leiostomus xanthurus*), and bay anchovy (*Anchoa mitchilli*), although all fish species, as well as blue crabs (*Callinectes sapidus*), horseshoe crabs (*Limulus polyphemus*), and diamondback terrapin turtles (*Malaclemys terrapin*) were included in sampling for a more complete understanding of restoration effects.

## 2.0 MATERIALS AND METHODS

### 2.1 Study sites and sampling frequency

Study sites in 2003 were the same as those in 2002 (PSEG 2003). Both weir sites at Mill Creek were changed in 2002 from previous years to accommodate changes in the restoration site boundaries; these new sites were continued in 2003. Also one weir site at Browns Run has a past history of change (1999), but no changes were made in 2003. Other locations remained unchanged from those sampled in 1996, 1997, 1998, 1999, 2000, and 2001 (PSEG 1997, 1998, 1999, 2000, 2001, 2002) in order to provide the basis for long-term comparative evaluation of the success of marsh restoration activities.

The monitoring area encompasses five restoration and two reference tidal marsh sites arrayed along both the New Jersey and Delaware shores of Delaware Bay. An additional location, Alloway Creek, contains both untreated and restored (*Spartina*) sites and untreated (*Phragmites* dominated) sites (Table 7-1). Seven sites located in New Jersey were sampled intensively once a month, from May to November (Table 7-1, Fig. 7-1). The intensively sampled sites included Dennis Township (Fig. 7-2), Commercial Township (Fig. 7-3), Browns Run (Fig. 7-4), Moores Beach (Fig. 7-5), Alloway Creek (Fig. 7-6), Mill Creek (Fig. 7-7), and Mad Horse Creek (Fig. 7-8). The seven regularly sampled sites may be broadly grouped into Lower Bay (Dennis Township, Commercial Township, Moores Beach) or Upper Bay (Browns Run, Mad Horse Creek, Alloway Creek, and Mill Creek) sites, based on their proximity to the mouth of Delaware Bay. Additionally, a State of Delaware site, The Rocks (Fig. 7-9), was sampled twice during the fall (October and November). The eight sites encompass a range of marsh salinity environments along the bay from saline to fresh water (Table 7-2). The more intensively studied restoration sites can also be divided broadly into two groups based on the nature of alteration: former salt hay farms adjacent to the lower to middle bay and *Phragmites*-dominated sites adjacent to the middle to upper bay and along the Cohansey River.

The salt hay farm restoration sites that were sampled intensively during 2003 are Dennis Township and Commercial Township (Fig. 7-1). Restoration at the salt hay farms entailed the creation of higher order marsh creeks and the breaching of earthen dikes to allow a natural tidal inundation cycle to re-establish tidal exchange within the formerly diked salt hay farms.

Moores Beach, located between the Dennis and Commercial Township sites, was designated as a reference site for the salt hay restoration sites. Reference sites act as a standard against which the progress of restoration at the salt hay farm sites can be measured. Restoration at the Dennis Township site began in January of 1996 and was completed in August of 1996, while restoration at the Commercial Township site began in September of 1996 and was completed in December of 1997.

The *Phragmites*-dominated restoration sites that were intensively sampled on the New Jersey shore of the bay are Browns Run and Mill Creek (Fig. 7-1). At these sites, restoration efforts are ongoing and include a range of measures to remove *Phragmites* and encourage the natural re-vegetation of *S. alterniflora* and other types of vegetation. Initial efforts to control *Phragmites* involved aerial, ground, and boat-based application of Rodeo® and surfactant in late 1996 and 1997, with controlled burning in the spring of 1998. These activities occurred from August 27, 1996 to March 6, 1998 at Mill Creek, and from September 9, 1996 to September 24, 1997 at Browns Run. Mad Horse Creek, located between the Browns Run and Mill Creek sites, is the designated reference site for the *Phragmites*-dominated restoration sites. Ongoing activities include remnant dike and spoil pile removal, mowing, marsh plain modifications and follow-up Rodeo® with surfactant application to provide for long term control of *Phragmites* and to create marsh plain conditions more favorable for *Spartina* and other desirable vegetation. Mad Horse Creek has a minimal disturbance history, and probably represents the most natural marsh condition among the reference sites.

Monitoring at the Alloway Creek site began in 1999 and continued in 2003 in order to provide reference and treated sites that were similar in salinity and distance from the bay mouth. The co-variation of salinity and distance from the bay mouth was recognized as a potential confounding factor in evaluating the faunal response at the Browns Run and Mill Creek restoration sites (Grothues and Able 2003 a, b). Sampling in Alloway Creek encompassed (within a single salinity/temperature and distance regime) *Phragmites* dominated sites, sites naturally dominated by *Spartina*, and Treated sites, and therefore allowed more readily interpretable analysis.

## 2.2 Sampling techniques

Physical and chemical parameters were measured at the beginning of each sample, for both otter trawl and weir samples. From May to November 2003, temperature, dissolved oxygen concentration, and salinity were measured with a hand-held salinity, temperature, oxygen meter (YSI Models 85), by lowering the probe into the water and recording near-surface values. Water transparency was measured by lowering a Secchi disc in the water column until it was no longer visible and recording the corresponding depth in 0.1 m increments.

Large marsh creeks were sampled using a 4.9 m (16 ft) headrope otter trawl with 6 mm (0.25 in) cod end mesh. At each site, two marsh creeks were sampled at three locations: upper, lower, and mouth (e. g. Fig. 7-6). The mouth of a creek was defined as its intersection with the next higher order creek. In general, the creek mouth trawling stations are subtidal and the upper and lower stations are intertidal to shallow subtidal. In cases where three appropriate locations could not be found within the same creek system (e. g. Fig. 7-4), another location was selected in a nearby creek that approximated the desired creek parameters (width, depth, vegetation type). In addition to marsh creeks, bay locations situated immediately outside the intersection of the creek with the bay were sampled at several sites as in previous years. Bay sites were sampled off Mad Horse Creek, off Dennis Township and off Moores Beach from May to November whenever marsh creeks were sampled (Table 7-1). Start and end points for each trawl were recorded using Global

Positioning System (GPS) co-ordinates, to ensure that identical areas were sampled each month. Sampling took place around high tide, with four two-minute tows per station. All tows were against the current at a constant engine RPM of 1800 (90 hp Honda outboard on 18 ft Maritime skiff). Depth was measured at each site using a Humminbird® Wideye depth recorder. The ratio of towline to water depth was maintained at 5:1 with minor adjustments to compensate for current speed and tidal flow. Tows terminated early owing to obstructions were eliminated from analyses if less than 1.5 minutes. A total of 1459 otter trawls were made.

The first 20 of each fish species, blue crabs (*Callinectes sapidus*), terrapin turtles (*Malaclemys terrapin*), and horseshoe crabs (*Limulus polyphemus*) in each replicate tow were identified, enumerated, and measured separately to the nearest millimeter. Fork length (FL) was recorded for fish species with forked tails; total lengths (TL) were recorded for all other fish. Carapace width (CW) was measured for blue crabs and horseshoe crabs, and carapace length (CL) was recorded for terrapin and snapping turtles. Individual fishes not identifiable to species were preserved in 95% ethanol or 10% formalin and processed in the laboratory. All fish not preserved for laboratory identification and all and turtles were returned to the water at the end of all sampling within a creek reach.

Small intertidal marsh creeks were sampled using weirs (2.0 m x 1.5 m x 1.5 m, with 5.0 m x 1.5 m wings, 6.0 mm mesh) set at high tide and hauled at low tide approximately six hours later. At each intertidal creek sampled, a net was stretched across the channel with support poles embedded vertically in the sediment. Wings were extended back onto the marsh surface from each end of the net, forming a funnel-shaped weir. Wing support poles were lashed to net support poles, and the net line was buried in the bottom sediment to eliminate gaps in the weir. Local topography occasionally prevented the complete draining of creeks. Therefore, any fish remaining in standing pools of water were seined into the block net, although this did not always ensure that all fish were retrieved because they often buried themselves in the mud. In addition, the potentially taxa-selective predation by wading birds frequently occurred before the net was retrieved, and this appeared to occur at all sites. Thus, the weir catches represent minimum numbers observed and may not accurately reflect species ratios. Nets were deployed at two intertidal creeks emptying into one of the marsh creeks adjacent to an otter trawling site (e. g. Fig. 7-6). Fish and blue crabs were identified and enumerated, and up to 50 individuals per species per sample were measured, using the same techniques as for the trawl collections.

A total of seven sites were sampled monthly using weirs deployed during the day; in addition to infrequent sampling at The Rocks, these totaled 125 sets.

## 2.3 Data analysis

Species composition and abundances were calculated as catch-per-unit-effort (CPUE), percent frequency of occurrence, and relative abundance (the proportion of the species in the total sample of individuals). Length frequency distributions were used to interpret size distributions for target species.

# 3.0 RESULTS AND DISCUSSION

## 3.1 Physical and chemical parameters

Salinity, dissolved oxygen, and temperature were within the range of values expected for Middle Atlantic Bight salt marshes (Fig. 7-10; Table 7-2). Salinity at lower bay sites tended from low values in June to a sharp peak in October. This pattern owes to generally higher inputs of fresh water to the sites during spring. Salinity at upper bay sites fluctuated only slightly. A salinity gradient was evident across the sites, with higher values at sites closer to the mouth of the bay (Dennis and Commercial Townships, Moores Beach) and lower values up the bay (Browns Run, Mad Horse Creek, Mill Creek). All sites at Alloway Creek and Mill Creek were among the lowest salinity observed and these sites were similar in salinity. Individually, sites peaked in temperature anywhere from July to September, but all sites reached similarly high temperatures in July.

Dissolved oxygen declined gradually from highs near or above saturation in May to lows in July (Moores Beach), through October, and increased to highs again in November (Fig. 7-10). The pattern in dissolved oxygen concentration is opposite to that of temperature and likely owes to a functional inverse relationship between temperature and gas solubility, as well as increased biological oxygen demand during summer. Moores Beach typically experienced the lowest dissolved oxygen level of all sites, but Browns Run and Commercial Township also experienced similar lows.

## 3.2 Sampling gear differences

The fauna sampled by weirs and otter trawls differed both in size frequency and species composition. Size frequencies for all fish sampled by otter trawls indicated that this gear collected larger fish as indicated by a significantly greater mean size of 82.2 mm, (S.E [Standard error] = 0.6) compared to weirs at 46.4 mm (S. E. = 0.4 Wilcoxon $Z = -38.32$, $p < 0.0001$, Fig. 7-11). The smaller average size of individuals collected by weirs is a consequence of different assemblages from different habitats sampled by each gear. Small creeks draining the marsh surface are dominated by killifishes (Fundulidae) and silversides (Atherinidae), small species that spend much of their life on the marsh surface or in shallow subtidal water (Talbot and Able 1984, Talbot et al. 1986, Kneib 1997). On the other hand, larger creeks sampled by otter trawls are utilized by a greater size range of individuals. Consequently, species composition also varied according to gear type. In trawl samples, the following species were most abundant: white perch (38%), bay anchovy (10%), blue crab (9%), striped bass (8%), Atlantic croaker and Atlantic silverside (*Menidia menidia*) (both 7%), hogchoker (*Trinectes maculatus*) (5%), mummichog

(*Fundulus heteroclitus*) (4%), and weakfish (2%) (Table 7-3). In contrast, mummichog (91%) was the dominant species collected from weirs, followed by Atlantic silverside (5%), and bay anchovy (2%) (Table 7-3).

### 3.3 Fish utilization of restoration and reference sites

A total of 54 species of fish, representing 31 families were collected from May to November 2003 in Delaware Bay marshes and adjacent bay sites (Table 7-4). This number comprises 49% of the species reported from New Jersey estuaries (Able and Fahay 1998). The species collected were composed primarily of transients (68%), i.e. those that spend a portion of their life history outside the bay, and residents (32%), i.e. those that spend their entire life history in the bay. In addition, three invertebrates, blue crab, lady crab (*Ovolipes ocellatus*) and horseshoe crab, and a reptile, diamondback terrapin were included in the catches.

#### 3.3.1 Large marsh creeks

Fish abundance in the large marsh creeks, as expressed by monthly catch-per-unit-effort (CPUE) for all fish collected by otter trawls at regularly sampled sites, varied seasonally (Fig. 7-12). Abundance trends in the lower bay were similar among all three sites, with increases of an order of magnitude in July or August over previous months, an early fall decrease, and a November increase (to an annual high for Moores Beach and Commercial Township). Abundance at upper bay sites was similar in pattern and magnitude at Mill Creek and Mad Horse Creek, with low catches until August, after which abundance gradually declined again. Catches at Browns Run large marsh creeks stayed consistently low, although also increasing in August and rising gradually thereafter until a high in November. Within Alloway Creek, seasonal patterns of abundance were similar at the Treated and *Spartina* sites with late summer/early fall peaks, but fish were overall more abundant at the *Spartina* site. Cumulative fish abundance at Alloway Creek *Phragmites* large marsh creeks was higher than at both Treated and *Spartina* sites, and rose to peaks in both September and November. However, the *Spartina* site saw the highest peak (episodic) abundance among the three sites.

Mean abundance (across site) of the four target species each peaked in a different month (Fig. 7-13). Bay anchovy numbers peaked in September. White perch catch peaked in October following a generally increasing trend. Spot were very rare in 2003, being present only in a few July, August and September samples. Weakfish were also not well represented in large marsh creek collections, appearing mostly in August collections, and were absent in May, June, and November.

Total CPUE of all fish and of blue crabs differed among sites (Fig. 7-14). Abundance at all three Alloway Creek sites individually was higher than any other site, and within Alloway Creek, fish were most abundant at *Phragmites* creeks, followed by *Spartina*, and then Treated creeks. Fish abundance at Mill Creek, Mad Horse Creek, and Dennis Township were similarly high, followed by Moores Beach, Commercial Township, and Browns Run. Thus there was a general overall pattern of fish abundance decreasing with river mile and covarying salinity gradient until the middle site (Browns Run) and then increasing again. This pattern is also similar to richness and may be related to the stress experienced by either marine or fresh water species at the limits of their salinity tolerances (see Bulger et al. 1993). Crab abundance increased with salinity with highest CPUE at the lower bay Dennis Township restored site and lowest at the upper bay Mill Creek restored site (Fig. 7-14). Therefore, river mile and/or salinity were strong linear determinants of overall blue crab abundance.

There was no readily apparent trend to fish or crab abundance as a response to site type (i.e. restoration or reference). In the upper bay, the Mad Horse Creek reference site had fewer fish than one of the restored sites Mill Creek, but more than the other, Browns Run, but within Alloway Creek, the *Phragmites* site had the highest abundance and Treated the lowest. In the lower bay, fish abundance at the Moores Beach reference site was intermediate to the two restored sites.

The four target species together comprised 57% of the total fish CPUE in large marsh creeks (Table 7-3). Of these, white perch (CPUE = 4.84 ±0.44) was by far the most abundant target species (and the most abundant species overall) followed by bay anchovy (CPUE = 1.29 ±0.15) and weakfish (CPUE = 0.31 ±0.04). Spot were rare in 2003 (CPUE = 0.05 ±0.01). Other abundant species in the marsh creeks included striped bass (CPUE = 1.03 ±0.10), Atlantic croaker (CPUE = 0.91 ±0.17), Atlantic silverside (CPUE =0.83 ±0.22), hogchoker (*Trinectes maculatus*) (CPUE =0.62 ±0.07), mummichog (*Fundulus heteroclitus*) (CPUE =0.50 ±0.13), and blue crab (CPUE =1.16 ±0.11) (Table 7-3).

A total of 48 identified fish species were collected by otter trawls from the large marsh creek sites (Table 7-3). There was considerable variation in species composition between sites. Richness was greatest at Dennis Township with 29 fish species collected; 25 were collected at the Alloway *Phragmites* site, 22 each at Commercial Township and Alloway Creek Treated sites, 21 each at the Alloway *Spartina* site, Mad Horse Creek, and Mill Creek, 20 at Moores Beach, and 18 at Browns Run, (Tables 7-5 to 7-13).

The contribution of the target species varied between marsh study sites (Fig. 7-15). In the upper bay, white perch and bay anchovy contributed substantially to relative abundance, ranking always within the top four species and together contributing more than 50% of the total at Browns Run and Mill Creek. Bay anchovy made up 22% and white perch 7% of individual fishes and invertebrates collected at Mad Horse Creek. At Alloway Creek, White perch constituted more than half of the catch at all sites and represented 75% of the total catch at the *Phragmites* site, followed by Alloway Spartina (61%) and Treated sites (51%). Bay anchovy were, by far, most abundant at the Treated site within Alloway (19%), and represented similar proportions of the total at *Spartina* (4%) and *Phragmites* (2%) sites. Weakfish were uncommon in upper bay sites, and important as a percentage only at Mill Creek (3%). Weakfish made up 1% or less of the total catch at all other upper bay large marsh creek sites. Only three spot were collected in the upper bay large marsh creeks, one each at Mad Horse Creek, Alloway *Phragmites*, and Alloway Treated, and they always made up less than 1% of the total catch.

As a group, target species contributed less to the total fish catch at lower bay sites than at upper bay sites (Fig. 7-15). Atlantic croaker and mummichog were abundant in lower bay large marsh creeks, and both white perch and bay anchovy were much reduced in their absolute abundance (CPUE), so both factors contributed to a lower relative abundance for the target species. However, both weakfish and spot were more abundant in the lower bay, more so even than white perch. White perch contributed 2%, 3%, and 3% to the catches at Dennis Township, Moores Beach, and Commercial Township respectively. Bay anchovy, contributed 45% at Dennis Township and 5% at Moores Beach but 21% at Commercial Township. The difference in relative abundance among sites reflected a difference in the absolute abundance (CPUE). Weakfish were common at Dennis Township where they constituted 16% of the total catch. Weakfish made up 3% of the catch at Commercial Township and 1% of the catch at Moores Beach. Although more common than in the upper bay large marsh creeks, spot contributed relatively little to lower bay trawl catches in 2003, making up 5% of the catch at Commercial Township, and 1% or less at Moores Beach and Dennis Township.

At The Rocks, sampled only in fall, the CPUE for all species collected in large marsh creeks was 16.72 ±2.00 (Table 7-14). The target white perch was the most abundant species (42%) and bay anchovy were present at 1% of the total. Weakfish and spot were absent as expected for late fall. Atlantic croaker made up a substantial part of the catch and were the second most abundant species at 33% of the total. Because fall is the time at which Atlantic croaker recruit to marsh creeks and The Rocks was sampled only in fall, a high proportion of this species is to be expected in the catch relative to sites sampled throughout the year.

### 3.3.2 Small marsh creeks

Monthly CPUE totals for all fish collected from small marsh creeks with weirs varied by five orders of magnitude with highest modes in August at Browns Run; fish were also abundant in small marsh creeks in July and August at Commercial Township and in September at Dennis Township and Mill Creek (Fig. 7-16). At Alloway Creek, CPUE reached a seasonal peak in July at the *Phragmites* and Treated sites, and in August at the *Spartina* site. Differences in seasonal abundance among sites owed to the dominance of different species across the salinity gradient, with mummichog, Atlantic silverside, and Atlantic croaker primarily responsible for the trends. At Dennis Township, the September maximum was set by Atlantic croaker; at Commercial Township the protracted summer maximum was set by both mummichog and Atlantic silverside, and at Moores Beach a later protracted peak owed to mummichog and Atlantic silverside. In the upper bay, the highest abundance overall was set primarily by mummichog with a mean monthly CPUE in August near 22,000 at Browns Run; but an episodic catch of bay anchovy in a single weir set the trend at Mill Creek. In comparison to all other sites, fish occurred in low abundance in small marsh creeks at Mad Horse Creek, where seasonal modes owed to mummichog and naked goby (*Gobiosoma bosc*). Mummichog also dominated the overall seasonal abundance trend at Alloway Creek sites, although catch varied among sites with highest abundance at the treated site.

None of the target species were regularly abundant in small marsh creeks (Fig. 7-17). Only bay anchovy reached notably high abundance anywhere, although this owed primarily to a single weir set in September at Mill Creek. Several spot were collected in August and September at Browns Run, and one weakfish each was taken in August at Mill Creek and Mad Horse Creek. White perch were the most broadly distributed with season, being represented by few fish in June, July, August, October, and November at Browns Run, Mad Horse Creek, Mill Creek and Alloway Creek. The four target species together comprised 2% of the total weir-caught fish collection from the small marsh creeks, but this was essentially all bay anchovy from one set in Mill Creek (Table 7-3). Of the other target species, only white perch were relatively abundant in small marsh creeks, although those catches were spread over season and site with a peak in abundance at Browns Run (Table 7-5 to 7-13). Spot and weakfish together contributing less than 1% of the total abundance in small marsh creeks.

The dominant non-target species showed strong seasonal patterns of abundance (Fig. 7-18). Mummichog became abundant in May and peaked in August, then declined sharply for the remainder of the sample season. However, the seasonal abundance at different sites was hidden by the hyper-abundace of this species at Browns Run. Atlantic silverside, though less abundant, showed a similar seasonal pattern. Sheepshead minnow *(Cyprinodon variegatus)*, were relatively abundant in October and November, although appearing only at Moores Beach. Naked goby (*Gobiosoma bosc*) were abundant at Mad Horse Creek in two months, September and October. Striped bass also occurred in small marsh creeks in August, September and October and mostly at Browns Run, although 1 to 3 specimens were taken in small marsh creeks from Commercial Township, Mad Horse Creek, Mill Creek, Alloway Creek *Phragmites* and Alloway Creek *Spartina* (Tables 7-5 to 7-13).

Mummichog was the most abundant species collected in weirs overall contributing 91% of the total catch. Atlantic silverside was the second most abundant fish at 5% of the total followed by bay anchovy at 2%. No other species contributed as much as 1% to the total catch, despite episodically high abundance at individual sites (e.g. naked goby at Mad Horse Creek and sheepshead minnow at Moores Beach) (Table 7-3).

A total of 25 fish, reptile, and crab species were collected in the small marsh creeks at the monthly sampled weir sites (Table 7-3). Restored marshes in both the lower and upper bay supported richer assemblages than did reference sites. Browns Run weir collections contained the most species with 16; Mill Creek weirs collected 15 species and Mad Horse Creek weirs collected 10. In the lower bay, weirs at Dennis Township collected 9 species; Commercial Township weirs collected 7 identifiable species (and *Morone spp.*), and Moores Beach weirs collected 6 species. In Alloway Creek, Treated site collections had the richest composition with 9 species; followed by the *Phragmites* site with 8 species and the *Spartina* site with 7 species. However, many species from small marsh creek collections were represented by three or less individuals per site over the whole season. Further, species from weir collections that were unique to any site were often well represented in the large marsh creeks (such as brown bullhead and common carp); therefore they generally represented species of predominantly large marsh creek assemblages that were utilizing small marsh creeks rather than unique marsh surface assemblage members. An exception was sheepshead minnow (*Cyprinodon variegatus*), which was well represented at Moores Beach but otherwise absent.

The dominant species of small marsh creek assemblages varied by site. At Dennis Township, Atlantic silverside dominated catches with 68% relative abundance (CPUE = 12.63 ±6.97) (Table 7-6). Mummichog were also relatively abundant at 21% of the catch (CPUE = 3.88 ±1.27) and bay anchovy followed at 7% (CPUE = 1.38 ±0.95). Mummichog dominated weir catches at Commercial Township at 92% (CPUE = 418.69 ±269.78) and only Atlantic silverside were also abundant relative to other species at 8% (CPUE = 36.81 ±15.29) (Table 7-7). Atlantic silverside and mummichog together dominated Moores Beach weir collections, contributing a similar 46% (CPUE = 113.71 ±78.6) and 44% (CPUE = 110.50 ±38.41) of the total catch (Table 7-5). Sheepshead minnow were also abundant there at 10 % of the catch (CPUE = 23.93 ±14.29). Mad Horse Creek weir collections were dominated by mummichog (52%, CPUE = 12.64 ±6.20); naked goby (27%, CPUE = 6.57 ±5.97) and Atlantic silverside (14%, CPUE = 3.43 ±1.60) (Table 7-8). Mill Creek weir samples collected mostly bay anchovy in a single anomalous set catching 63% of the total small marsh creek fishes collected there (CPUE = 105.07 ±101.63); mummichog were also abundantly and more evenly distributed over the season to make up 35% of the catch (CPUE = 58.71 ±25.96) (Table 7-9). Mummichog were most abundant at, and dominated, Browns Run weir collections at 97% (CPUE =4284.50 ±2796.37); a total of 59,983 mummichog were taken there (Table 7-10). Relative to other sites, Atlantic silverside were also abundant at Browns Run (CPUE =123.14 ±33.42) although, because of the overwhelming number of mummichog, they only contributed 3% of the total catch. Weirs at Alloway Creek were dominated by mummichog at all sites, mostly so at the Treated site 96%, followed by the *Phragmites* site with at 90%, and the Spartina site at 79%; however, the total number of mummichog varied even more than the relative contribution with an order of magnitude more collected at the Treated site (CPUE = 120.31 ±76.03) than at the *Phragmites* (CPUE = 16.31 ±9.37) and two orders of magnitude more than at the *Spartina* site (CPUE = 5.21 ±3.16) (Tables 7-11 to 7-13). White perch were also abundant in Alloway Creek small marsh creeks relative to other sites, and were most abundant at the Treated site making up 2% of the catch there (CPUE = 3.0 ±2.20), followed by the *Phragmites* site at 5% contribution but with lower abundance (CPUE = 0.85 ±0.60) and the *Spartina* site with highest contribution at 10% (owing to a low number of dominant mummichog) but lowest abundance over the three sites (CPUE = 0.64 ±0.36).

The marsh surface did not flood during sampling events at The Rocks, but there was water in one small marsh creeks during one of the two sampling that had outflow. A single weir set at The Rocks collected seven mummichog (Table 7-14).

### 3.4 Accounts for target species

The following is a summary of the distribution, abundance and habitat use patterns for the target species at the regular study sites based on sampling in large marsh creeks with otter trawls and in small marsh creeks with weirs during 2003.

### 3.4.1 Bay anchovy

This species was periodically common throughout all of the sampled large marsh creeks and was episodically abundant in a few small marsh creeks (Fig. 7-19, 7-20). In large marsh creeks, abundance was initially modest in May at Dennis Township and Commercial Township in the lower bay and Alloway Creek and in June in the other upper bay sites, followed in all cases by a decline in the next month and then a rise again in summer or fall. This pattern was due to the spring population in large marsh creeks of age 1 adults, followed by their probable emigration and mortality, and then the recruitment of YOY. Among large marsh creeks, bay anchovy were most abundant at Mill Creek (CPUE = 3.53 ±0.80), followed by Mad Horse Creek (CPUE = 1.90 ±0.36), Commercial Township (CPUE = 0.92 ±0.24), Browns Run (CPUE = 0.86 ±0.16), Dennis Township (CPUE = 0.47 ±0.09), and Moores Beach (CPUE = 0.25 ±0.07). Bay anchovy abundance at Alloway Creek also followed a pattern of decline from a spring high in May to a second similar or even higher abundance in August-November. Among Alloway Creek sites, CPUE of bay anchovy was highest at the Treated site (CPUE = 3.32 ±1.16) followed distantly by the *Spartina* site (CPUE = 0.80 ±0.16) and *Phragmites* site (CPUE = 0.48 ±0.16) (Table 7-11 to 7-13, Fig. 7-19).

Bay anchovy were absent from all small marsh creeks in the spring, but became episodically abundant in summer or fall, suggesting a difference in the frequency of use of small marsh creeks by age 1 and YOY fish. Bay anchovy were highly abundant in a single September weir set in a small marsh creek at Mill Creek with 1426 individuals collected there, bringing the yearly mean CPUE for that site to 105.07 ±101.63. Bay anchovy were also periodically abundant in small marsh creeks at Browns Run (CPUE = 8.79 ±4.54) and Dennis Township (CPUE = 1.38 ±0.95), but few were collected even episodically at Mad Horse Creek (CPUE = 0.71 ±0.49) or Commercial Township (CPUE = 0.38 ±0.18) and none were collected from Moores Beach weirs. Bay anchovy were absent from small marsh creeks at the Alloway Creek *Spartina* site, but five were collected from weirs at the Alloway Creek Treated site (all in September) and three from those at the Alloway Creek *Phragmites* site (two in August and one in September).

The size frequency distribution of bay anchovy differed little among sites beginning in August, when a clear modal progression indicates the recruitment of YOY ranging in size from about 15 to 40 mm with a change in the mean size of about 5 mm per month until November (Figs. 7-22 to 7-29). The size of bay anchovy collected early in the year, however, varies noticeably with site. Larger bay anchovy (modal size between 65 and 75 mm) populated Commercial Township, Moores Beach, and Browns Run in spring, and individuals to 95 mm were collected from Mad Horse Creek in May, but individuals as small as 25 mm were collected at Dennis Township in May and the mean and mode were also small there, allowing the possibility that these were YOY. There were no bay anchovy collected in June at Dennis Township, and the three taken in July are clearly all age 1. At Alloway Creek, YOY appeared in July but were scare at all habitat types until September, when a wide size range of YOY (20-70 mm) were collected. (Sexual maturity is at approximately 40 mm FL or greater and within the first year of life, Zastrow et al. 1991). The sizes of young-of-the-year are within the range observed in earlier collections in Delaware Bay (Able and Fahay 1998).

### 3.4.2 Spot

Spot were uncommon in 2003 (Figure 7-30 to 7-32), and rare outside of Commercial Township large marsh creeks. At Commercial Township, 35 were collected between June and August (CPUE = 0.23 ±0.09) contributing to 5% of the total catch there (Table 7-7). Eighteen spot were collected from large marsh creeks at Moores Beach (CPUE = 0.11 ±0.03) (Table 7-5), but spread out with one or more in every month except May and November. Eight were collected at Dennis Township (CPUE = 0.05 ±0.02) between July and September (Table 7-6). Four spot were collected from among all upper bay large marsh creeks, with one taken at Mad Horse Creek and one each at the three Alloway Creek sites, Alloway Creek *Phragmites*, and Alloway Creek *Spartina*. As in the lower bay, the catch of spot in the upper bay was spread over the sample season with one collected in July, two in August, and one in September. Spot were absent from all small marsh creeks weir collections with one site exception, Browns Run, where they were abundantly collected in both August and September (Figure7-31). Despite a relatively high CPUE of 2.21 ±1.26, they contributed less than 1% to the catch because of the high abundance of the dominant mummichog there. Spot were represented by two year classes. Two age 1 spot were collected in June, one at Commercial Township and one at Moores Beach. Both were within the size range that could be expected for fast growing spot at the end of the year, or slow growing spot from the previous year, but appeared a month previous to any small fish. YOY spot first appeared in July at lower bay sites and at the Alloway *Phragmites* site. By September, the year class mode approached 150 mm TL (Fig. 7-32 through 7-40) and the last collected spot in October was 145 mm. Spot were taken in too few weirs to allow for a conclusion regarding a size difference in the use of small and large marsh creeks.

This demersal species is near the northern limit of its range and its abundance can be quite variable from year to year in the study area (Able and Fahay 1998). Spawning does not occur in the bay and is limited to areas south of Cape Hatteras or in the southern part of the Middle Atlantic Bight (Able and Fahay 1998).

### 3.4.3 Weakfish

Weakfish were distributed bi-modally with regard to river distance and salinity in 2003 (Figure 7-41, 7-42). Weakfish were seasonally abundant at Dennis Township and moderately so at Alloway Creek and Mill Creek, but were uncommon elsewhere and lowest at Browns Run although they were collected on at least one occasion from large marsh creeks of each sampled site. The earliest appearance of this species was in July at the Alloway Creek Treated and Alloway Creek *Spartina* site. At Dennis Township, Moores Beach, Commercial Township, Mad Horse Creek, Mill Creek, and Alloway Creek *Phragmites,* weakfish first appeared in August, and abundance also peaked that moth at Dennis Township, Commercial Township and Alloway Creek Treated. Only three weakfish were collected in Browns Run large marsh creeks, one in September and two in October. Weakfish abundance peaked at Mill Creek in October. Weakfish were absent or rare at other sites by October and in November were colleted only at Commercial Township (n=2). Weakfish contributed to 16% of the total catch at Dennis Township with 257 individuals collected in large marsh creeks (CPUE = 1.45 ±0.28) (Table 7-6). Weakfish were second most abundant at Alloway Creek *Spartina* (CPUE = 0.33 ±0.10) followed by Mill Creek (CPUE = 0.29 ±0.08), Alloway Creek Treated (CPUE = 0.19 ±0.06), Commercial Township (CPUE = 0.13 ±0.04), Alloway Creek Phragmites (CPUE = 0.10 ±0.03), Moores Beach (CPUE = 0.09 ±0.03), Mad Horse Creek (CPUE = 0.08 ±0.02), and Browns Run (CPUE = 0.02 ±0.01) (Tables 7-6 to 7-13).

In small marsh creeks, weakfish were also most abundant at Dennis Township, although only three were taken (CPUE = 0.19 ±0.19). One was collected by weir at Moores Beach and one at Mill Creek. There is some suggestion of bimodality in the size class distribution of weakfish from Dennis Township, where they were abundant (Figure7-43) or from the all other sites in aggregate (Figures 7-44 to 7-51), but, as in past years, this appears to be two YOY cohorts. The smallest weakfish collected were in the 20 mm class in August (at Mad Horse Creek and September (at Dennis Township), although YOY with a modal size of about 65 mm were already present in August at Dennis Township. These sizes are within the range of young-of-the-year from the bay based on earlier collections by PSEG (Able and Fahay 1998).

### 3.4.4 White perch

This resident species occurred at all sites in large marsh creeks (Fig. 7-52) but was uncommon in the lower bay. At all three lower bay sites, white perch abundance was bi-modal with regard to season, and was null in August and at Dennis Township and in July, August, and September at Moores Beach and Commercial Township. Seasonal distribution was also bimodal at Browns Run and Mad Horse Creek, but white perch abundance reached seasonal highs in August at Mill Creek and was also very high that month at Alloway Creek *Phragmites*. However, the relative low spring (April/May) abundance of white perch at Mill Creek and all Alloway sites still exceeded the relative high (within site) abundance at lower bay sites. Peak abundance among all sites was in October at Alloway Creek *Spartina.* Averaged over the sample season, white perch were most abundant at the Alloway Creek *Phragmites* site (CPUE = 19.62 ±2.92), followed by Alloway Creek *Spartina* (CPUE = 13.62 ±3.02), Alloway Creek Treated (CPUE = 9.06 ±1.19), Mill Creek (CPUE = 5.04 ±0.60), Browns Run (CPUE = 1.14 ±0.18), Mad Horse Creek (CPUE = 0.65 ±0.09), Dennis Township (CPUE = 0.27 ±0.07), Commercial Township (CPUE = 0.14 ±0.04), and Moores Beach (CPUE = 0.10 ±0.04) (Tables 7-5 through 7-13). White perch were present in small marsh creeks only in the upper bay, and occasionally in abundance (Fig. 7-53). There did not seem to be a seasonal trend to the abundance of white perch in small marsh creeks, as CPUE peaked in June at Mill Creek, in July at Mad Horse Creek and Alloway Creek Treated, in August at Alloway Creek *Phragmites*, in October at Alloway Creek *Spartina* (and a second high then at Alloway Creek Treated) and in November at Browns Run. White perch were most abundant in small marsh creeks of Alloway Creek Treated (CPUE = 3.00 ±2.20), followed by Browns Run (CPUE = 2.00 ±1.43), Mill Creek (CPUE = 1.07 ±0.68), Alloway Creek (CPUE = 0.85 ±0.0.60), Alloway Creek *Spartina* (CPUE = 0.64 ±0.36), and Mad Horse Creek (CPUE = 0.36 ±0.20). Based on the occurrence of individuals > 90 mm TL, these presumed age 1 and older individuals were collected in the spring and fall at every site (Fig. 7-54 to 7-63). Young-of-the-year fish were absent in the lower bay sites over the entire sampling season (Fig. 7-54; 7-55; 7-56). Abundant YOY white perch ranging from 15 to 90 mm appeared in most upper bay sites beginning in July and as late as November, except at Browns Run where a single YOY of 35 mm appeared first in August and uncommonly thereafter (Fig. 7-54 to 7-62). Age-class structure of white perch did not appear to differ among sites within Alloway Creek (Fig. 7-60; 7-61; 7-62).

### 3.5 Effects of restoration on faunal composition, abundance and size

Comparisons in faunal composition, abundance, and size of fish, between restored and reference sites are made in the following sections, but restricted to within, rather than among upper and lower bay zones. Previous work has shown that the greatest source of variation within the Delaware Bay estuary is along the salinity gradient (Able et al. 2001). Substantially different fish assemblages populate the marsh at either end of this gradient and generalizations are not easily made across them. Furthermore, restoration efforts in the lower bay are of a different type than in the upper bay (salt hay farm reclamation versus *Phragmites* eradication).

### 3.5.1 Effects of restoration at lower bay former salt hay farms

#### 3.5.1.1 Large marsh creeks

Abundance of all species collected in large marsh creeks of the lower bay was greatest at one of the restored sites, Dennis Township (CPUE = 13.27 ±1.41) and lowest at the other restored site Commercial Township (CPUE = 5.67 ±0.82) with the Moores Beach reference site (CPUE = 8.51 ±1.56) more similar to Commercial Township than to Dennis Township. Including the documented invertebrates and reptiles, Dennis Township had the richest assemblage with 33 species, followed by Commercial Township with 25 species and Moores Beach with 23 species (Tables 7-5 to 7-7). The assemblage rank order varied greatly among the top ten species, and did so based on substantial differences for relative abundance. While blue crab were first or second most abundant, the relative abundance of Atlantic silverside changed greatly, being ranked second at Commercial Township and third at Moores Beach, but sixth at Dennis Township, while weakfish and hogchocker were relatively more abundant there. Dennis Township and Moores Beach were more similar to each other than to Commercial Township in the relative abundance of other species, notably mummichog, which ranked second at Dennis Township and fourth at Moores Beach, but 22nd at Commercial Township. Thus, similarity based on assemblage is difficult to ascertain without advanced statistical analysis, but evaluated on richness alone, the Commercial Township restored site and the Moores Beach reference site were more similar to each other than to Dennis Township during 2003.

Similarities and differences in the assemblages of large marsh creeks at lower bay sites were reflected in the size structure of fishes when comparing only constructed creeks at Dennis Township and Commercial Township with creeks of similar order at Moores Beach (Fig. 7-63). Measured fish were larger at the restored sites, Dennis Township (mean length = 64.56 mm) and Commercial Township (mean length = 62.95 mm) than at the Moores Beach reference site (mean length =38.20 mm) due to both a dearth of small fishes and also an abundance of very long fish (primarily American eels) in comparison to Moores Beach. There was no strong evidence for two modes corresponding to different year classes. The skewed distribution is typical of one caused by the high mortality of young-of-the-year but may also partly reflect an ability of larger fish to evade capture and infrequent use of large marsh creeks by larger fish.

### 3.5.1.2 Small marsh creeks

The overall abundance of fishes in lower bay weirs was greatest at the Commercial Township restoration site (CPUE = 456.94 ±281.10) followed by the Moores Beach reference site (CPUE =280.42 ±116.27). Total abundance was an order of magnitude less in small marsh creeks of the Dennis Township restoration site (CPUE =19.19 ±7.31) where both mummichog and Atlantic silverside were far less abundant (Tables 7-5; 7-6; 7-7). These two species were the dominant marsh surface fish at all three sites, but Atlantic silverside ranked above mummichog only at Dennis Township. Other assemblage differences were in the ranking of sheepshead minnow (third at Moores Beach) and bay anchovy (third at Dennis Township) and blue crab (third at Commercial Township). All third and fourth ranked species were relatively high in abundance at one site only. Richness was higher at both restoration sites than at the reference site, with nine species (two invertebrates) taken at Dennis Township, eight at Commercial Township, and six at Moores Beach. Thus, in 2003, marsh surface assemblages at each of the lower bay sites was unique, and the two restored salt hay farms differed as much among each other as among restored and reference site.

Fishes from lower order large marsh creeks at Moores Beach (mean size = 36.05 mm) were smaller than those at Commercial Township (mean size = 39.70 mm) and Dennis Township (mean size = 43.02 mm. The shape of the distribution differed among all sites in reflection of their differing assemblages, with the dearth of small mummichog allowing for the relative prominence of a second mode at Dennis Township, while Commercial Township had a broader first mode than either of the other two sites (Fig. 7-64).

### 3.5.2 Effects of restoration at Upper Bay *Phragmites*-dominated marshes

#### 3.5.2.1 Large marsh creeks

The overall abundance at the treated and reference sites in the upper bay varied by one order of magnitude. The reference Mad Horse Creek and the restored Mill Creek site supported a similar abundance of fish as measured by otter trawls (CPUE = 10.6 ±1.92 at Mad Horse Creek and CPUE =10.4 ±1.24) at Mill Creek. The other restored site, Browns Run supported the lowest abundance (CPUE = 3.10 ±0.33) of all upper bay sites. Within Alloway Creek, abundance was highest at the *Phragmites* site (CPUE = 26.18 ±3.25) site, followed by the *Spartin*a site (CPUE =22.44 ±3.56) and lowest at the Treated site (CPUE =17.74 ±2.14). Assemblages were similar in that white perch was the dominant species at all three sites, and bay anchovy, striped bass, and hogchoker always ranked among the four next most abundant species. Differences in species richness among the Alloway Creek site large marsh creeks (27 at *Phragmites*, 24 at Treated, 23 at *Spartina*) owed to rare species; no species were abundant at one site and absent at another. Among the Alloway Creek sites, mean size was smallest at the *Phragmites* site (mean size = 87.86 mm) and highest at the *Spartina* site (mean size = 104.52 mm) with an intermediate size at the Treated site (mean size = 98.18) (Fig. 7-65). The shapes of the size distributions at all Alloway Creek sites was similar in that the three modes could be discerned, but the *Spartina* and Treated sites were the most similar in the relative prominence of each mode.

The Alloway Creek *Spartina* site was similar in higher fish abundance to the restored Mill Creek site (CPUE = 10.95 ±0.74) and Mad Horse Creek reference site (CPUE = 9.43 ±0.89) and higher than the Browns Run restoration site (CPUE = 6.21 ±0.55). Assemblages were similar among the two treated and reference sites, with rank order changes owing to relatively small differences in the number of dominant species. Total species richness at the treated sites at Browns Run and Mill Creek, and the reference site at Mad Horse Creek was 26, 22, and 25, respectively. The top ranked species at the reference Mad Horse Creek was Atlantic silverside, while only a single individual of this species was taken at Mill Creek and 15 at Browns Run. Instead, white perch dominated at both of the restored sites but was ranked third at Mad Horse Creek. Bay anchovy ranked second at all three sites. Fish were biggest at Browns Run (mean size = 101.81 mm), which had fewer of the relatively small Atlantic silverside and bay anchovies than did Mad Horse Creek (mean size = 68.58 mm) and Mill Creek (mean size = 67.59) (Fig. 7-66).

#### 3.5.2.2 Small marsh creeks

There were great differences in abundance of fishes collected in small marsh creeks among reference and restoration sites at upper bay sites. Fish abundance was one to two orders of magnitude greater at the restored sites (CPUE = 4444.93 ±2806.91 at Browns Run and 1205.71 ±433.18 at Mill Creek, Table 7-9; 7-10) than at the reference site (Mad Horse Creek CPUE = 29.79 ±10.92). Among sites at Alloway Creek also, fish abundance was highest at the treated site

(CPUE =124.92 ±77.84, Table 7-12) followed by that at the *Phragmites* (CPUE =18.23 ±10.04, Table 7-13) and *Spartina* sites (CPUE =7.14 ±3.35, Table 7-11).

The mean size of fish from small marsh creeks was greatest at the Browns Run restoration site (mean size = 54.32 mm), but the other restoration site Mill Creek (mean size = 46.89 mm) and the reference site Mad Horse Creek (mean size = 45.88 mm), were similar (Fig 7-67; 7-68). However, all weir collections were composed of primarily small fish, i. e. YOY of various species in addition to adult mummichog and Atlantic silverside. Several large eels, catfish and carp extended the tail of the distribution at all sites but were not abundant enough to greatly influence the mean size of measured fish. Within- species among-site similarities in size may be hidden by differences in assemblage composition among sites. Despite the general abundance of mummichog, assemblages differed greatly in the number of other species among the restored and reference sites. Bay anchovy dominated weir collections from Mill Creek overall; although these came from mostly from a single set the relative low abundance of mummichog allowed them to dominate. Naked goby were abundant at Mad Horse Creek, ranking second there, and were also abundant at Mill Creek, although overshadowed there by abundant mummichog and Atlantic silverside. In addition to higher abundance, the two restored sites supported richer assemblages than the reference site, with 16 species collected at Browns Run, 15 at Mill Creek, and 10 at Mad Horse Creek.

At Alloway Creek, the Treated site collections contained 9 species, while the untreated *Phragmites* site weir collections contained 8 species and the *Spartina* site collections contained 7. In all cases, one of the species represented was blue crab. Most species were rare, but similarly so at all sites so that rare species at the Spartina site, with few mummichog, were better represented in relative abundance (Tables 7-11 to 7-13). Fishes collected from the *Phragmites* site were smaller (mean size = 41.41 mm) than those collected from Treated (mean size =49.99 mm) and *Spartina* sites (mean size = 47.72), a reflection of the difference in their assemblages.

### 3.5.3 Fish assemblages at bay stations

In general, fish assemblages from large marsh creeks shared many species with the bay stations immediately adjacent to these sites (Tables 7-15 to 7-18). Eight species were taken exclusively at bay stations in 2003; these were striped anchovy (*Anchoa hepsetus*), striped searobin (*Prionotus evolans*), smallmouth flounder (*Etropus microstomus*), northern puffer (*Sphoeroides maculatus*), fourspine stickleback (*Apeltes quadracus*), clearnose skate (*Raja eglantaria*), cownose ray (*Rhinopterus bonasus*) and spotted hake (*Urophycis regia*). Among species common to marsh creeks, 5 of the top six were more abundant in bay trawl catches than creek trawl catches at Commercial Township, including Atlantic croaker, blue crab, striped bass, black drum, and Atlantic herring. Of the top six species in bay samples also occurring in creeks at Moores Beach, five (Atlantic croaker, bay anchovy, summer flounder, Atlantic silverside, black drum) were more abundant in the bay samples. At Dennis Township, three of the top six were more abundant in the bay samples (bay anchovy, Atlantic croaker, and striped cusk eel (*Ophidion marginatum*)). At Mad Horse Creek, four of the top six species were more abundant in bay samples; these were weakfish, striped bass, white perch, and summer flounder (*Paralichthys dentatus*). Comparisons between the three lower bay site stations indicated that overall abundance was greatest off Moores Beach (CPUE =46.13 ±13.43) followed by Commercial Township (CPUE =41.50 ±15.00) and Dennis Township (CPUE =15.16 ±3.44). Bay samples from the three lower bay sites had similarly rich similarly rich assemblages with 19 species collected (ten singletons) at Dennis Township, 18 at Moores Beach (five singletons) and 17 (six singletons) at Commercial Township. Atlantic croaker and secondarily bay anchovy dominated the overall catch at Commercial Township and Moores Beach; the order was switched off Dennis Township. Bay anchovy were also common off Mad Horse Creek where they secondarily dominated in abundance behind weakfish. Fourteen species (three singletons) were collected off Mad Horse Creek.

### 3.6 Comparison Summary

Summary comparisons of fish habitat use among sites within the lower or upper bay, as based on the three indicators discussed in this report (fish CPUE, mean fish length, and fish species richness) are given in Fig. 7-69 and 7-71. These comparisons are based on collections from all sampled creeks within sites; in restored lower bay sites these include both created and larger order creeks. There is no seasonal trend in total fish abundance evident for large marsh creeks throughout the bay within the sample season despite trends in the abundance of individual species. Species richness was somewhat higher in reference than created large marsh creeks at lower bay restored sites (former salt hay farms) and was considerably higher at restored sites in small marsh creeks than in those of the reference site. Mean length was also similar among the two restored lower bay small marsh creeks, but length was considerably greater at restored large marsh creeks than reference large marsh creeks. It is important to note that this size difference may owe to assemblage differences and does not necessarily constitute increased growth at the restored sites. Abundance in large marsh creeks was greatest at the Dennis Township restored site and lowest at the Commercial Township site. Abundance in small marsh creeks of restored site was greater in one case (Commercial Township) and less in the other (Dennis Township) than at the reference site. Abundance in lower bay site large marsh creeks was second highest at Dennis Township, and lowest at Commercial Township, due mostly to the unusual abundance of mummichogs in trawl collections. Thus, in 2003 fish utilization of restored marshes at the former salt hay farms in the lower bay was similar or greater to that in reference marsh by two measures for both large marsh creeks and small marsh creeks.

In the upper bay, abundance, mean length, and richness of fishes in one of the restoration sites (Mill Creek) was similar to the reference site (Mad Horse Creek). Abundance of these was higher than the other restoration site (Browns Run) as was species richness. The least valuable measure, composite mean length was higher at Browns Run than for the other two sites. However, similarities or differences in both evaluators may owe to differences in assemblage, as reflected in species richness (also lower at Browns Run). In small marsh creeks, abundance was greater at both restoration sites than at the reference site, as was richness. Mean length was similar at the reference site and one restoration site, and higher at the other restoration site. Thus, by two measures, large marsh creeks in the upper bay restoration sites compare similarly or poorly with the reference site, while restored small marsh creeks compare very favorably with reference sites. It should be noted that the Mad Horse Creek may not always be appropriate as a reference site to either Browns Run or Mill Creek large marsh creeks because salinity fluctuations within this range appear to limit subtidal populations more than do changes in surface vegetation (Grothues and Able 2003b).

In Alloway Creek, reference (*Phragmites, Spartina*) and restored (Treated *Phragmites*) sites were sampled within a single estuarine system. Abundance at Alloway Creek large marsh creeks was highest in the untreated reference site and lowest in the *Spartina* reference site although similar to that in the treated site. Mean length was lowest at the treated site. Richness was highest at the *Phragmites* site and similar at the Spartina and Treated sites. In small marsh creeks, the Treated site had the highest abundance, mean length, and richness. Thus, restoration at small marsh creeks appears to be going very well for fish. Among large marsh creeks, restored creeks do not support as abundant or rich a population as the *Phragmites*-dominated creeks, but do compare favorably with the *Spartina* reference.

## 4.0 LITERATURE CITED

Able K. W. 1999. Measures of juvenile fish habitat quality: Examples from a National Estuarine Research Reserve. pp 134-147 In L. R. Benaka (ed.) Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Symposium 22, Bethesda, Maryland.

Able, K. W. Hagan S. M. 2000. Effects of Common Reed (*Phragmites australis*) Invasion on Marsh Surface Macrofauna: Response of Fishes and Decapod Crustaceans. Estuaries 23(5):633-646.

Able, K. W. and S. M. Hagan 2003. The impact of common reed, *Phragmites australis*, on Essential Fish Habitat: influence on reproduction, embryological development and larval abundance of mummichog (*Fundulus heteroclitus*). Estuaries 26(1):40-50.

Able, K. W., D. Nemerson, R. Bush, P. Light. 2001. Spatial variation in Delaware Bay (U. S. A.) marsh creek fish assemblages. Estuaries 24(3): 441-452.

Able, K.W., D. M. Nemerson, P.R. Light and R.O. Bush. 2000. Initial response of fishes to marsh restoration at a former salt hay farm bordering Delaware Bay. pp. 749-773 In M. P. Weinstein and D. A. Kreeger (eds.), Concepts and Controversies in Tidal Marsh Ecology. Kluwer Academic Publishers, The Netherlands.

Able, K.W., D.M. Nemerson and T.M. Grothues. (In press) Evaluating salt marsh restoration in Delaware Bay:continued analysis of fish response at former salt hay farms. Estuaries.

Able, K. W., D. A. Witting, R. S. McBride, R. A. Rountree and K. J. Smith. 1996. Fishes of polyhaline estuarine shores in Great Bay - Little Egg Harbor, New Jersey: A case study of seasonal and habitat influences, In: Nordstrom, K. F. and C. T. Roman (eds.) Estuarine Shores: Evolution, Environments and Human Alterations. John Wiley and Sons.

Able, K. W. and M. P. Fahay. 1998. The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight. Rutgers University Press.

Beck, M.W., K.L. Heck Jr., K.W. Able, D.L Childers, D.B Eggleston, B.M.Gillanders, B. Halpern, C.G. Hays, K. Hoshino, T.J. Minello, R.J. Orth, P.F. Sheridan, M.P. Weinstein. 2001. The Identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates. BioScience. 51(8): 633-641

Bulger, A. B., B. C. Haden, M. E. Monaco, D. M. Nelson, and M. G. McCormick-Ray. 1993. Biologically-based estuarine salinity zones derived from a multivariate analysis. Estuaries. 16:311-322

Cain, R. L. and J. M. Dean. 1976. Annual occurrence abundance and diversity of fish in a South Carolina intertidal creek. Marine Biology. 36:369-379.

Daiber, F. C. 1977. Salt marsh animals: Distributions related to tidal flooding, salinity, and vegetation. Chapter 5, p.79-108 In: V. J. Chapman (ed.), Wet Coastal Ecosystems. Elsevier Scientific Publishing Co., Amsterdam, The Netherlands.

Deegan, L.A., J.E. Hughes, R.A. Rountree. 2000. Salt marsh ecosystem support of marine transient species. Pp335-365.In M. P. Weinstein and D. A. Kreeger (eds.), Concepts and Controversies in Tidal Marsh Ecology. Kluwer Academic Publishers, The Netherlands.

Grothues, T. M. and K. W. Able. 2003 A. Discerning vegetation and environmental correlates with subtidal marsh fish assemblage dynamics during *Phragmites* eradication efforts: interannual trend measures. Estuaries. 26(2B):574-586

Grothues, T. M. and K. W. Able. 2003 B. Response of juvenile fish assemblages in tidal marsh creeks during treatment for *Phragmites* removal. Estuaries. 26(2B):563-573

Gunter, G. 1956. Some relations of faunal distribution to salinity in estuarine waters. Ecology 37:616-619.

Hodson, R. G., J. O. Hackman and C. R. Bennett. 1981. Food habits of young spot in nursery areas of the Cape Fear Estuary, North Carolina. Transactions American Fish Society 110(4):495-501.1981.

Kneib, R. T. 1997. The role of tidal marshes in the ecology of estuarine nekton. p. 163-220 In : A. D. Ansell, R. N. Gibson, and Margaret Barnes, (eds.) Oceanography and Marine Biology: an Annual Review 1997, 35, UCL Press.

Nixon, S. W. and C. Oviatt. 1973. Ecology of a New England salt marsh. Ecological Monographs. 43: 463-498.

PSE&G. 1997. Biological Monitoring Program Annual Report-1996, Chapter 7, Newark, NJ.

PSE&G. 1998. Biological Monitoring Program Annual Report-1997, Chapter 7, Newark, NJ.

PSE&G. 1999. Biological Monitoring Program Annual Report-1998, Chapter 7, Newark, NJ.

PSE&G. 2000. Biological Monitoring Program Annual Report-1999, Chapter 7, Newark, NJ.

PSE&G. 2001. Biological Monitoring Program Annual Report-2000, Chapter 7, Newark, NJ.

PSE&G. 2002. Biological Monitoring Program Annual Report-2001, Chapter 7, Newark, NJ.

PSE&G. 2003. Biological Monitoring Program Annual Report-2002, Chapter 7, Newark, NJ.

Rountree, R. A. and K. W. Able. 1992a. Fauna of subtidal polyhaline marsh creeks in southern New Jersey: Composition, abundance, and biomass. Estuaries 15(21): 171-185.

Rountree, R. A. and K. W. Able. 1992b. Foraging habits, growth, and temporal patterns of salt-marsh creek habitat use by young-of-the-year summer flounder in New Jersey. Transactions American Fish Society 12: 765-776.

Rountree, R. A. and K. W. Able. 1993. Diel variation in decapod crustacean and fish assemblages in New Jersey polyhaline marsh creeks. Estuarine Coastal Shelf Science. 37, 181-201.

Rozas, L. P. and W. E. Odum. 1987. Fish and microcrustacean use of submerged plant beds in tidal freshwater and marsh creeks. Marine Ecology Progress Series. 38:213-224.

Sebold, K. R. 1992. From Marsh to Farm: The Transformation of Coastal New Jersey. New Jersey Coastal Heritage Trail. National Park Service, U. S. Department of the Interior, Washington D. C.

Shenker, J. M. and J. M. Dean. 1979. The utilization of a salt marsh creek by larval and juvenile fishes: abundance, diversity and temporal variation. Estuaries 2(3): 154-163.

Smith, B. A. 1971. The fishes of four low-salinity tidal tributaries of the Delaware Bay estuary. M. S. Thesis, Cornell University. 304 pp.

Smith, K. J. 1995. Processes regulating habitat use by salt marsh nekton in a southern New Jersey estuary. Ph.D dissertation, Rutgers University, New Brunswick, N.J

Sogard, S. M. and K. W. Able. 1991. A comparison of eelgrass, sea lettuce macroalgae, and marsh creeks as habitat for epibenthic fishes and decapods. Estuarine Coastal and Shelf Science. 33:501-519.

Szedlmayer, S. T. and K. W. Able. 1996. Patterns of seasonal availability and habitat use by fishes and decapod crustaceans in a southern New Jersey estuary. Estuaries 19(3), 697-709.

Talbot, C. W. and K. W. Able.1984. Composition and distribution of larval fish in New Jersey high marshes. Estuaries 7 (4A): 434-443.

Talbot C. W., K. W. Able and J. K. Shisler. 1986. Fish species composition in New Jersey salt marshes: Effects of marsh alterations for mosquito control. Transactions American Fish Society. 115: 269-278.

Wang, J. C. S. and R. J. Kernehan. 1979. Fishes of the Delaware Estuaries: A Guide to the Early Life Histories. Ecological Analysis Communications, Towson, Maryland.

Weinstein, M. P., Balletto, J. H. 1999. Does the common reed *Phragmites australis* affect essential fish habitat? Estuaries 22: 63-72

Weinstein, M. P. 1979. Shallow marsh habitats as primary nurseries for fish and shellfish, Cape Fear River, North Carolina. Fishery Bulletin 77:339-357.

Weinstein, M. P., Balletto, J. H., Teal, J. M., and Ludwig, D. F. 1997. Success criteria and adaptive management for a large-scale wetland restoration project. Wetlands Ecology and Management vol. 4 no. 2 pp. 111-127. SPB Academic Publishing bv, Amsterdam.

Weinstein, M. P. and D. A. Kreeger, (eds.), 2001. Concepts and Controversies in Tidal Marsh Ecology. Kluwer Academic Publishers, The Netherlands.

Weinstein, M. P., S. L. Weiss, and M. F. Waters. 1980. Multiple determinants of community structure in shallow marsh habitats, Cape Fear River estuary, North Carolina, USA. Marine Biology 5:227-243.

Table 7-1. Summary of sampling effort during 2003 at all study sites in Delaware Bay. Large marsh creeks and bay sites were sampled with otter trawls and small marsh creeks were sampled with weirs. See Figure 7-1 through 7-10 for sampling locations.

| SITE | MAY | JUN | JUL | AUG | SEP | OCT | NOV | Site Totals |
|---|---|---|---|---|---|---|---|---|
| **Alloway Creek** | | | | | | | | |
| *Phragmites* Site Trawls | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 126 |
| *Phragmites* Site Weirs | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 13 |
| *Spartina* Site Trawls | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 126 |
| *Spartina* Site Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| Treated Site Trawls | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 126 |
| Treated Site Weirs | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 13 |
| **Browns Run** | | | | | | | | |
| Trawls | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 168 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| **Commercial Township** | | | | | | | | |
| Trawls | 20 | 24 | 24 | 24 | 24 | 24 | 24 | 184 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| **Dennis Township** | | | | | | | | |
| Trawls | 20 | 25 | 28 | 28 | 28 | 28 | 28 | 140 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| **Mad Horse Creek** | | | | | | | | |
| Trawls | 28 | 27 | 28 | 28 | 28 | 28 | 28 | 195 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| **Mill Creek** | | | | | | | | |
| Trawls | 20 | 20 | 20 | 12 | 16 | 24 | 24 | 136 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| **Moores Beach** | | | | | | | | |
| Trawls | 24 | 28 | 26 | 28 | 24 | 28 | 28 | 186 |
| Weirs | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |

continued

Table 7-1 continued

| SITE | MAY | JUN | JUL | AUG | SEP | OCT | NOV | Site Totals |
|---|---|---|---|---|---|---|---|---|
| **The Rocks** | | | | | | | | |
| Trawls | 0 | 0 | 0 | 0 | 0 | 24 | 23 | 47 |
| Weirs | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Monthly Total Trawls | 190 | 202 | 204 | 198 | 198 | 234 | 233 | 1459 |
| Monthly Total Weirs | 16 | 18 | 18 | 18 | 18 | 19 | 18 | 125 |
| Monthly Total (Combined) | 206 | 220 | 222 | 216 | 216 | 253 | 251 | 1632 |

Table 7-2: Physical parameters and sampling characteristics of Delaware Bay marsh study sites during 2003. See Fig. 7-1 through 7-10 for the location of individual sites. "Treated" sites in Alloway Township are those on PSEG property where *Phragmites* was or is currently being eradicated.

| Site | Type | Sampling frequency | Area (Ha) | Mean surface salinity[1] (ppt) | Mean surface D.O.[1] (mg/l) | Mean surface temp.[1] (EC) | Mean secchi depth[1] (m) | Mean distance of trawling stations from bay (km) | Mean depth range at trawling stations[2] (m) |
|---|---|---|---|---|---|---|---|---|---|
| Alloway Creek | *Phragmites* dominated | Monthly | -- | 1.51 | 6.82 | 20.75 | 0.19 | 4.75 | 1.97 |
| Alloway Creek | *Spartina* dominated | Monthly | -- | 1.34 | 6.71 | 20.79 | 0.18 | 3.7 | 1.96 |
| Alloway Creek | Treated *Phragmites* | Monthly | -- | 1.59 | 6.80 | 21.14 | 0.19 | 3.1 | 1.93 |
| Browns Run | Treated *Phragmites* | Monthly | 162 | 5.04 | 5.27 | 21.50 | 0.24 | 15.9 | 1.44 |
| Commercial Township | Salt Hay Farm Restoration | Monthly | 1619 | 16.19 | 5.74 | 20.28 | 0.29 | Upper sites 4.5<br>Lower sites 2.7 | 2.18 |
| Dennis Township | Salt Hay Farm Restoration | Monthly | 227 | 16.78 | 6.21 | 19.59 | 0.19 | 0.97 | 1.71 |
| Mad Horse Creek | Reference | Monthly | 1564 | 7.14 | 6.22 | 20.54 | 0.26 | East sites 2.1<br>West sites 5.0 | 2.02 |
| Mill Creek | Treated *Phragmites* | Monthly | 518 | 1.49 | 7.18 | 19.29 | 0.16 | 3.6 | 1.24 |
| Moores Beach | Reference | Monthly | 521 | 17.39 | 4.98 | 20.37 | 0.35 | 1.35 | 1.79 |
| The Rocks | Reference | November-December | -- | 1.06 | 7.16 | 16.30 | 0.17 | 1.50 | 2.37 |

[1] The salinity, D.O., temperature and Secchi values are the mean of the monthly average (May to November) for the six primary sites.
[2] Values are the mean of the minimum and maximum depths at each trawling station at each site.

Table 7.3. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for all sites May to November 2003. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | 1 | <0.01 | 0.01 | 0.00 | 17 | 1 | <0.01 | 0.03 | 0.03 | 4 |
| *Alosa mediocris* | <1 | <0.01 | 0.00 | 0.00 | 2 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 5 | 0.01 | 0.07 | 0.01 | 100 | 1 | <0.01 | 0.02 | 0.02 | 2 |
| *Alosa sapidissima* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 1 | <0.01 | 0.01 | 0.00 | 19 | 1 | <0.01 | 0.01 | 0.01 | 1 |
| *Ameiurus nebulosus* | 7 | 0.01 | 0.16 | 0.03 | 221 | 2 | <0.01 | 0.07 | 0.6 | 9 |
| ***Anchoa mitchilli*** | **29** | **0.10** | **1.29** | **0.15** | **1791** | **19** | **0.02** | **12.71** | **11.06** | **1640** |
| *Anguilla rostrata* | 7 | 0.01 | 0.09 | 0.01 | 126 | 14 | <0.01 | 0.29 | 0.11 | 37 |
| *Bairdiella chrysoura* | <1 | <0.01 | 0.00 | 0.00 | 4 | -- | -- | -- | -- | -- |
| *Brevoortia tyrannus* | 4 | 0.01 | 0.10 | 0.03 | 140 | 8 | <0.01 | 0.16 | 0.06 | 20 |
| *Carnax hippos* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Centropristis striata* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Clupea harengus* | 1 | <0.01 | 0.01 | 0.00 | 13 | -- | -- | -- | -- | -- |
| *Clupea spp* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Conger oceanicus* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **10** | **0.02** | **0.31** | **0.04** | **424** | **2** | **<0.01** | **0.04** | **0.03** | **5** |
| *Cyprinus carpio* | 1 | <0.01 | 0.01 | 0.00 | 17 | 1 | <0.01 | 0.01 | 0.01 | 1 |
| *Cyprinodon variegatus* | <1 | <0.01 | 0.00 | 0.00 | 1 | 8 | <0.01 | 2.61 | 1.64 | 337 |
| *Dorosoma cepedianum* | 2 | <0.01 | 0.03 | 0.01 | 40 | -- | -- | -- | -- | -- |
| *Enneacanthus spp* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | 4 | 0.04 | 0.50 | 0.13 | 699 | 76 | 0.91 | 551.52 | 317.35 | 71146 |
| *Fundulus majalis* | <1 | <0.01 | 0.00 | 0.00 | 2 | 1 | <0.01 | 0.01 | 0.01 | 1 |
| *Gobiosoma bosc* | 3 | <0.01 | 0.03 | 0.01 | 44 | 12 | <0.01 | 1.39 | 0.75 | 179 |
| *Hybognathus regius* | 1 | <0.01 | 0.01 | 0.01 | 16 | 2 | <0.01 | 0.02 | 0.01 | 2 |
| *Ictalurus punctatus* | 6 | 0.01 | 0.18 | 0.03 | 249 | -- | -- | -- | -- | -- |
| *Lagodon rhomboides* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **3** | **<0.01** | **0.05** | **0.01** | **65** | **3** | **<0.01** | **0.24** | **0.15** | **31** |
| *Lepomis macrochirus* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |

Table 7-3 continued

| Species | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Menidia beryllina* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Menidia menidia* | 6 | 0.07 | 0.83 | 0.22 | 1146 | 39 | 0.05 | 32.47 | 10.09 | 4189 |
| *Micropogonias undulatus* | 10 | 0.07 | 0.91 | 0.17 | 1269 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **44** | **0.38** | **4.84** | **0.44** | **6719** | **14** | <0.01 | **0.83** | **0.29** | **107** |
| *Morone saxatilis* | 27 | 0.08 | 1.03 | 0.10 | 1427 | 12 | <0.01 | 0.29 | 0.13 | 38 |
| *Morone spp* | 1 | <0.01 | 0.01 | 0.00 | 14 | 1 | <0.01 | 0.01 | 0.01 | 1 |
| *Mugil curema* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Mustelus canis* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Notropis hudsonius* | <1 | <0.01 | 0.00 | 0.00 | 3 | -- | -- | -- | -- | -- |
| *Ophidion marginatum* | 1 | <0.01 | 0.01 | 0.00 | 14 | -- | -- | -- | -- | -- |
| *Opsanus tau* | <1 | <0.01 | 0.00 | 0.00 | 5 | -- | -- | -- | -- | -- |
| *Paralichthys dentatus* | 1 | <0.01 | 0.01 | 0.00 | 18 | 2 | <0.01 | 0.02 | 0.01 | 2 |
| *Perca flavescens* | <1 | <0.01 | 0.00 | 0.00 | 3 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 7 | 0.01 | 0.17 | 0.03 | 240 | 3 | <0.01 | 0.12 | 0.08 | 16 |
| *Pomotamus saltatrix* | 2 | <0.01 | 0.02 | 0.00 | 30 | 1 | <0.01 | 0.01 | 0.01 | 1 |
| *Psuedopleuronectes americanus* | <1 | <0.01 | 0.00 | 0.00 | 5 | -- | -- | -- | -- | -- |
| *Scophthalmus aquosus* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Stenotomus chrysops* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| *Syngnathus fuscus* | 1 | <0.01 | 0.01 | 0.00 | 14 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 16 | 0.05 | 0.62 | 0.07 | 857 | -- | -- | -- | -- | -- |
| *Unidentified fish* | <1 | <0.01 | 0.00 | 0.00 | 2 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **11.37** | **0.63** | **15769** | -- | -- | **602.86** | **320.13** | **77769** |
| *Callinectes sapidus* | 29 | 0.09 | 1.16 | 0.11 | 1603 | 25 | <0.01 | 2.39 | 0.79 | 308 |
| *Limulus polyphemus* | 2 | 0.01 | 0.07 | 0.02 | 104 | 1 | <0.01 | 0.02 | 0.02 | 3 |
| *Malaclemys terrapin* | 5 | <0.01 | 0.05 | 0.01 | 76 | 2 | <0.01 | 0.02 | 0.01 | 2 |
| *Ovalipes ocellatus* | <1 | <0.01 | 0.00 | 0.00 | 1 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **12.66** | **0.64** | **17553** | -- | -- | **605.29** | **320.15** | **78082** |

Table 7-4. Checklist of Delaware Bay fauna collected in this study, May to November 2003. T = transient species, R = resident species.

| | Species | Common Name | Pattern of Utilization |
|---|---|---|---|
| **Invertebrates** | | | |
| | *Callinectes sapidus* | blue claw crab | R |
| | *Limulus polyphemus* | horseshoe crab | T |
| | *Ovalipes ocellatus* | lady crab | R |
| **Anguillidae** | | | |
| | *Anguilla rostrata* | American eel | T |
| | *Conger oceanicus* | conger eel | T |
| **Atherinidae** | | | |
| | *Menidia beryllina* | inland silverside | R |
| | *Menidia menidia* | Atlantic silverside | T |
| **Batrachoididae** | | | |
| | *Opsanus tau* | oyster toadfish | R |
| **Bothidae** | | | |
| | *Etropus microstomus* | smallmouth flounder | T |
| | *Paralichthys dentatus* | summer flounder | T |
| | *Scophthalmus aquosus* | windowpane | T |
| **Carangidae** | | | |
| | *Caranx hippos* | crevalle jack | T |
| | *Selene vomer* | lookdown | T |
| **Carcharhinidae** | | | |
| | *Mustelus canis* | smooth dogfish | T |
| **Centrarchidae** | | | |
| | *Lepomis macrochirus* | bluegill sunfish | R |
| **Clupeidae** | | | |
| | *Alosa aestivalis* | blueback herring | T |
| | *Alosa mediocris* | hickory shad | T |
| | *Alosa pseudoharengus* | alewife | T |
| | *Alosa sapidissima* | American shad | T |
| | *Brevoortia tyrannus* | menhaden | T |
| | *Clupea harengus* | Atlantic herring | T |
| | *Dorosoma cepedianum* | gizzard shad | R |

**Table 7-4 continued**

| | Species | Common Name | Pattern of Utilization |
|---|---|---|---|
| **Cyprinidae** | | | |
| | *Cyprinus carpio* | common carp | R |
| | *Hybognathus regius* | eastern silvery minnow | R |
| | *Notropis hudsonius* | spottail shiner | R |
| **Cyprinodontidae** | | | |
| | *Cyprinodon variegatus* | sheepshead minnow | R |
| **Engraulidae** | | | |
| | *Anchoa hepsetus* | striped anchovy | T |
| | *Anchoa mitchilli* | bay anchovy | T |
| **Fundulidae** | | | |
| | *Fundulus heteroclitus* | mummichog | R |
| | *Fundulus majalis* | striped killifish | R |
| **Gasterosteidae** | | | |
| | *Apeltes quadracus* | fourspine stickelback | R |
| **Gobiidae** | | | |
| | *Gobiosoma bosc* | naked goby | R |
| **Ictaluridae** | | | |
| | *Ameiurus catus* | white catfish | R |
| | *Ameiurus nebulosus* | brown bullhead | R |
| | *Ictalurus punctatus* | channel catfish | R |
| **Mugilidae** | | | |
| | *Mugil curema* | white mullet | T |
| **Myliobatidae** | | | |
| | *Rhinoptera bonasus* | cownose ray | T |
| **Ophidiidae** | | | |
| | *Ophidion marginatum* | striped cusk eel | T |

**Table 7-4 continued**

| | Species | Common Name | Pattern of Utilization |
|---|---|---|---|
| **Percichthyidae** | | | |
| | *Morone americana* | white perch | R |
| | *Morone saxatilis* | striped bass | T |
| **Percidae** | | | |
| | *Perca flavescens* | yellow perch | R |
| **Physcidae** | | | |
| | *Urophycis regia* | spotted hake | T |
| **Plueronectidae** | | | |
| | *Psuedopleuronectes americanus* | winter flounder | T |
| **Pomatomidae** | | | |
| | *Pomatomus saltatrix* | bluefish | T |
| **Rajidae** | | | |
| | *Raja eglanteria* | clearnose skate | T |
| **Sciaenidae** | | | |
| | *Bairdiella chrysoura* | silver perch | T |
| | *Cynoscion regalis* | weakfish | T |
| | *Leiostomus xanthurus* | spot | T |
| | *Micropogonias undulatus* | Atlantic croaker | T |
| | *Pogonias cromis* | black drum | T |
| **Serranidae** | | | |
| | *Centropristis striata* | black sea bass | T |
| **Soleidae** | | | |
| | *Trinectes maculatus* | hogchoker | R |
| **Sparidae** | | | |
| | *Lagodon rhomboides* | pinfish | T |
| | *Stenotomus chrysops* | scup | T |
| **Syngnathidae** | | | |
| | *Syngnathus fuscus* | northern pipefish | T |

**Table 7-4 continued**

| | Species | Common Name | Pattern of Utilization |
|---|---|---|---|
| **Tetraodontidae** | | | |
| | *Sphoeroides maculatus* | northern puffer | T |
| **Triglidae** | | | |
| | *Prionotus evolans* | striped searobin | T |
| **Reptilia** | | | |
| | *Malaclemys terrapin* | diamondback terrapin | R |

Table 7-5. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Moores Beach, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa psuedoharengus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **12** | **0.04** | **0.25** | **0.07** | **41** | -- | -- | -- | -- | -- |
| *Anguilla rostrata* | 1 | <0.01 | 0.01 | 0.01 | 2 | 36 | 0.01 | 1.43 | 0.87 | 20 |
| *Brevoortia tyrannus* | 2 | <0.01 | 0.03 | 0.02 | 5 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **5** | **0.01** | **0.09** | **0.03** | **14** | **7** | **<0.01** | **0.07** | **0.07** | **1** |
| *Cyprinodon variegatus* | -- | -- | -- | -- | -- | 57 | 0.10 | 23.93 | 14.29 | 335 |
| *Fundulus heteroclitus* | 10 | 0.10 | 0.66 | 0.30 | 107 | 71 | 0.44 | 110.50 | 38.41 | 1547 |
| *Gobiosoma bosc* | 4 | 0.01 | 0.04 | 0.01 | 6 | -- | -- | -- | -- | -- |
| *Lagodon rhomboides* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **8** | **0.02** | **0.11** | **0.03** | **18** | -- | -- | -- | -- | -- |
| *Menidia menidia* | 14 | 0.17 | 1.10 | 0.43 | 178 | 43 | 0.46 | 113.71 | 78.76 | 1592 |
| *Micropogonias undulatus* | 14 | 0.57 | 3.70 | 1.31 | 599 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **5** | **0.02** | **0.10** | **0.04** | **17** | -- | -- | -- | -- | -- |
| *Morone saxatilis* | 11 | 0.02 | 0.14 | 0.03 | 23 | -- | -- | -- | -- | -- |
| *Ophidion marginatum* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Paralichthys dentatus* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 4 | 0.01 | 0.04 | 0.01 | 6 | -- | -- | -- | -- | -- |
| *Psuedopleuronectes americanus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 9 | 0.02 | 0.13 | 0.04 | 21 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **6.47** | **1.48** | **1048** | -- | -- | **249.64** | **109.17** | **3495** |

Table 7-5 continued

| Species | Large Marsh Creeks: Percent frequency of occurrence | Large Marsh Creeks: Relative abundance | Large Marsh Creeks: Catch per unit effort | Large Marsh Creeks: Standard error | Large Marsh Creeks: Total collected | Small Marsh Creeks: Percent frequency of occurrence | Small Marsh Creeks: Relative abundance | Small Marsh Creeks: Catch per unit effort | Small Marsh Creeks: Standard error | Small Marsh Creeks: Total collected |
|---|---|---|---|---|---|---|---|---|---|---|
| *Callinectes sapidus* | 40 | 0.23 | 1.96 | 0.37 | 317 | 7 | <0.01 | 0.29 | 0.29 | 4 |
| *Limulus polyphemus* | 2 | <0.01 | 0.02 | 0.01 | 4 | -- | -- | -- | -- | -- |
| *Malaclemys terrapin* | 6 | 0.01 | 0.06 | 0.02 | 10 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **8.51** | **1.56** | **1379** | -- | -- | **249.93** | **109.23** | **3499** |

Table 7-6. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Dennis Township, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa psuedoharengus* | 2 | <0.01 | 0.03 | 0.02 | 5 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **24** | **0.05** | **0.47** | **0.09** | **83** | **19** | **0.07** | **1.38** | **0.95** | **22** |
| *Anguilla rostrata* | 16 | 0.02 | 0.21 | 0.04 | 37 | -- | -- | -- | -- | -- |
| *Brevoortia tyrannus* | 5 | 0.02 | 0.15 | 0.08 | 27 | 19 | 0.01 | 0.19 | 0.10 | 3 |
| *Centropristis striata* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Clupea harengus* | 2 | <0.01 | 0.04 | 0.03 | 7 | -- | -- | -- | -- | -- |
| *Conger oceanicus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **24** | **0.16** | **1.45** | **0.28** | **257** | **6** | **0.01** | **0.19** | **0.19** | **3** |
| *Cyprinodon variegatus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Enneacanthus spp* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | 17 | 0.32 | 2.90 | 0.96 | 514 | 75 | 0.21 | 3.88 | 1.27 | 62 |
| *Fundulus majalis* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Gobiosoma bosc* | 1 | <0.01 | 0.01 | 0.01 | 2 | 6 | 0.01 | 0.13 | 0.13 | 2 |
| ***Leiostomus xanthurus*** | **3** | **<0.01** | **0.05** | **0.02** | **8** | -- | -- | -- | -- | -- |
| *Menidia beryllina* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Menidia menidia* | 12 | 0.07 | 0.60 | 0.20 | 107 | 44 | 0.68 | 12.63 | 6.97 | 202 |
| *Micropogonias undulatus* | 18 | 0.10 | 0.92 | 0.28 | 162 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **16** | **0.03** | **0.27** | **0.07** | **47** | -- | -- | -- | -- | -- |
| *Morone saxatilis* | 8 | 0.01 | 0.10 | 0.03 | 18 | -- | -- | -- | -- | -- |
| *Mugil curema* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Mustelus canis* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Ophidion marginatum* | 3 | 0.01 | 0.06 | 0.02 | 10 | -- | -- | -- | -- | -- |
| *Paralichthys dentatus* | 3 | <0.01 | 0.05 | 0.03 | 8 | -- | -- | -- | -- | -- |

Table 7-6 continued

| Species | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Pogonias cromis* | 18 | 0.07 | 0.60 | 0.18 | 107 | 6 | 0.01 | 0.19 | 0.19 | 3 |
| *Pomotamus saltatrix* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Psuedopleuronectes americanus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Scophthalmus aquosus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Syngnathus fuscus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 19 | 0.12 | 1.10 | 0.33 | 195 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **9.11** | **1.16** | **1611** | -- | -- | **18.56** | **7.26** | **297** |
| *Callinectes sapidus* | 42 | 0.26 | 3.51 | 0.71 | 622 | 19 | 0.02 | 0.44 | 0.27 | 7 |
| *Limulus polyphemus* | 14 | 0.04 | 0.54 | 0.18 | 96 | 6 | 0.01 | 0.19 | 0.19 | 3 |
| *Malaclemys terrapin* | 7 | 0.01 | 0.10 | 0.03 | 18 | -- | -- | -- | -- | -- |
| *Ovalipes ocellatus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **13.27** | **1.41** | **2348** | -- | -- | **19.19** | **7.31** | **307** |

Table 7-7. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Commercial Township, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | **Large Marsh Creeks** | | | | | **Small Marsh Creeks** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa psuedoharengus* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **25** | **0.21** | **0.92** | **0.24** | **140** | **25** | **<0.01** | **0.38** | **0.18** | **6** |
| *Anguilla rostrata* | 8 | 0.02 | 0.10 | 0.03 | 15 | 6 | <0.01 | 0.06 | 0.06 | 1 |
| *Bairdiella chrysoura* | 3 | 0.01 | 0.03 | 0.01 | 4 | -- | -- | -- | -- | -- |
| *Brevoortia tyrannus* | 5 | 0.09 | 0.38 | 0.21 | 58 | -- | -- | -- | -- | -- |
| *Clupea harengus* | 1 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Clupea spp* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **8** | **0.03** | **0.13** | **0.04** | **19** | -- | -- | -- | -- | -- |
| *Cyprinodon variegatus* | -- | -- | -- | -- | -- | 13 | <0.01 | 0.13 | 0.09 | 2 |
| *Fundulus heteroclitus* | 1 | <0.01 | 0.01 | 0.01 | 1 | 69 | 0.92 | 418.69 | 269.78 | 6699 |
| *Gobiosoma bosc* | 8 | 0.03 | 0.11 | 0.03 | 17 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **11** | **0.05** | **0.23** | **0.09** | **35** | -- | -- | -- | -- | -- |
| *Menidia menidia* | 9 | 0.21 | 0.95 | 0.50 | 144 | 63 | 0.08 | 36.81 | 15.29 | 589 |
| *Micropogonias undulatus* | 10 | 0.21 | 0.95 | 0.33 | 144 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **9** | **0.03** | **0.14** | **0.04** | **22** | -- | -- | -- | -- | -- |
| *Morone saxatilis* | 11 | 0.03 | 0.13 | 0.03 | 20 | -- | -- | -- | -- | -- |
| *Morone spp* | -- | -- | -- | -- | -- | 6 | <0.01 | 0.06 | 0.06 | 1 |
| *Ophidion marginatum* | 1 | <0.01 | 0.01 | 0.01 | 1 | 6 | <0.01 | 0.06 | 0.06 | 1 |
| *Opsanus tau* | 3 | 0.01 | 0.03 | 0.02 | 5 | -- | -- | -- | -- | -- |
| *Paralichthys dentatus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 5 | 0.03 | 0.11 | 0.04 | 17 | -- | -- | -- | -- | -- |
| *Psuedopleuronectes americanus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |

Table 7-7 continued

| Species | Large Marsh Creeks: Percent frequency of occurrence | Large Marsh Creeks: Relative abundance | Large Marsh Creeks: Catch per unit effort | Large Marsh Creeks: Standard error | Large Marsh Creeks: Total collected | Small Marsh Creeks: Percent frequency of occurrence | Small Marsh Creeks: Relative abundance | Small Marsh Creeks: Catch per unit effort | Small Marsh Creeks: Standard error | Small Marsh Creeks: Total collected |
|---|---|---|---|---|---|---|---|---|---|---|
| *Syngnathus fuscus* | 3 | 0.01 | 0.03 | 0.01 | 5 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 7 | 0.02 | 0.09 | 0.03 | 13 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **4.41** | **0.79** | **670** | -- | -- | **456.19** | **280.82** | **7299** |
| *Callinectes sapidus* | 55 | 0.21 | 1.20 | 0.16 | 183 | 31 | <0.01 | 0.75 | 0.39 | 12 |
| *Limulus polyphemus* | 2 | <0.01 | 0.03 | 0.02 | 4 | -- | -- | -- | -- | -- |
| *Malaclemys terrapin* | 3 | 0.01 | 0.03 | 0.01 | 5 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **5.67** | **0.82** | **862** | -- | -- | **456.94** | **281.10** | **7311** |

Table 7-8. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Mad Horse Creek, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | 1 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 4 | <0.01 | 0.04 | 0.02 | 7 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **46** | **0.22** | **1.90** | **0.36** | **317** | **14** | **0.03** | **0.71** | **0.49** | **10** |
| *Anguilla rostrata* | 1 | <0.01 | 0.01 | 0.01 | 1 | 14 | 0.01 | 0.14 | 0.10 | 2 |
| *Brevoortia tyrannus* | 7 | 0.01 | 0.12 | 0.04 | 20 | 7 | 0.01 | 0.21 | 0.21 | 3 |
| *Clupea harengus* | 1 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **7** | **0.01** | **0.08** | **0.02** | **13** | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | 7 | 0.05 | 0.46 | 0.17 | 76 | 71 | 0.52 | 12.64 | 6.20 | 177 |
| *Gobiosoma bosc* | 1 | <0.01 | 0.01 | 0.01 | 2 | 21 | 0.27 | 6.57 | 5.97 | 92 |
| *Ictalurus punctatus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **1** | **<0.01** | **0.01** | **0.01** | **1** | -- | -- | -- | -- | -- |
| *Menidia menidia* | 11 | 0.48 | 4.20 | 1.64 | 701 | 57 | 0.14 | 3.43 | 1.60 | 48 |
| *Micropogonias undulatus* | 6 | 0.01 | 0.12 | 0.04 | 20 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **37** | **0.07** | **0.65** | **0.09** | **109** | **21** | **0.01** | **0.36** | **0.20** | **5** |
| *Morone saxatilis* | 29 | 0.04 | 0.39 | 0.06 | 65 | 21 | 0.01 | 0.21 | 0.11 | 3 |
| *Paralichthys dentatus* | 1 | 0.00 | 0.02 | 0.01 | 3 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Pogonias cromis* | 17 | 0.05 | 0.47 | 0.11 | 78 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Syngnathus fuscus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 9 | 0.03 | 0.29 | 0.11 | 49 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **8.83** | **1.90** | **1474** | -- | -- | **24.36** | **9.34** | **341** |
| *Callinectes sapidus* | 37 | 0.16 | 1.68 | 0.33 | 280 | 43 | 0.18 | 5.43 | 3.31 | 76 |
| *Malaclemys terrapin* | 9 | 0.01 | 0.10 | 0.02 | 16 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **10.60** | **1.96** | **1770** | -- | -- | **29.79** | **10.29** | **417** |

Table 7-9. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Mill Creek, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa mediocris* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 4 | 0.01 | 0.05 | 0.02 | 7 | 7 | <0.01 | 0.14 | 0.14 | 2 |
| *Ameiurus catus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 15 | 0.02 | 0.21 | 0.06 | 29 | 14 | <0.01 | 0.64 | 0.51 | 9 |
| ***Anchoa mitchilli*** | **48** | **0.34** | **3.53** | **0.80** | **480** | **50** | **0.63** | **105.07** | **101.63** | **1471** |
| *Anguilla rostrata* | 7 | 0.01 | 0.08 | 0.03 | 11 | 14 | 0.00 | 0.21 | 0.15 | 3 |
| *Brevoortia tyrannus* | 7 | 0.01 | 0.09 | 0.03 | 12 | 14 | <0.01 | 0.14 | 0.10 | 2 |
| ***Cynoscion regalis*** | **15** | **0.03** | **0.29** | **0.08** | **40** | **7** | **<0.01** | **0.07** | **0.07** | **1** |
| *Cyprinus carpio* | 1 | <0.01 | 0.01 | 0.01 | 1 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Dorosoma cepedianum* | 10 | 0.01 | 0.11 | 0.03 | 15 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | -- | -- | -- | -- | -- | 86 | 0.35 | 58.71 | 25.96 | 822 |
| *Fundulus majalis* | -- | -- | -- | -- | -- | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Gobiosoma bosc* | -- | -- | -- | -- | -- | 29 | <0.01 | 0.36 | 0.17 | 5 |
| *Hybognathus regius* | 4 | 0.01 | 0.09 | 0.05 | 12 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Ictalurus punctatus* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Menidia menidia* | 1 | <0.01 | 0.01 | 0.01 | 1 | 36 | 0.01 | 1.07 | 0.46 | 15 |
| *Micropogonias undulatus* | 4 | 0.01 | 0.05 | 0.02 | 7 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **76** | **0.49** | **5.04** | **0.60** | **686** | **21** | **0.01** | **1.07** | **0.68** | **15** |
| *Morone saxatilis* | 7 | 0.01 | 0.13 | 0.05 | 18 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Morone spp* | 6 | 0.01 | 0.10 | 0.03 | 13 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 7 | 0.04 | 0.40 | 0.17 | 55 | -- | -- | -- | -- | -- |
| *Unidentified fish* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |

Table 7-9 continued

| Species | Large Marsh Creeks: Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Small Marsh Creeks: Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Fish** | -- | -- | **10.28** | **1.23** | **1398** | -- | -- | **167.79** | **109.07** | **2349** |
| *Callinectes sapidus* | 7 | 0.01 | 0.11 | 0.04 | 15 | 7 | <0.01 | 0.14 | 0.14 | 2 |
| *Malaclemys terrapin* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **10.40** | **1.24** | **1415** | -- | -- | **167.93** | **109.06** | **2351** |

Table 7-10. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Browns Run, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | **Large Marsh Creeks** | | | | | **Small Marsh Creeks** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | -- | -- | -- | -- | -- | 7 | <0.01 | 0.29 | 0.29 | 4 |
| *Alosa psuedoharengus* | 1 | <0.01 | 0.01 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 1 | <0.01 | 0.01 | 0.01 | 1 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| ***Anchoa mitchilli*** | **36** | **0.28** | **0.86** | **0.16** | **145** | **36** | <0.01 | **8.79** | **4.54** | **123** |
| *Anguilla rostrata* | 2 | 0.01 | 0.02 | 0.01 | 3 | 21 | <0.01 | 0.43 | 0.25 | 6 |
| *Brevoortia tyrannus* | 4 | 0.02 | 0.07 | 0.03 | 12 | 21 | <0.01 | 0.79 | 0.45 | 11 |
| *Carnax hippos* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **1** | **0.01** | **0.02** | **0.01** | **3** | -- | -- | -- | -- | -- |
| *Cyprinus carpio* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | -- | -- | -- | -- | -- | 100 | 0.97 | 4284.50 | 2796.37 | 59983 |
| *Gobiosoma bosc* | 1 | <0.01 | 0.01 | 0.01 | 1 | 36 | <0.01 | 5.36 | 3.38 | 75 |
| ***Leiostomus xanthurus*** | -- | -- | -- | -- | -- | **29** | <0.01 | **2.21** | **1.26** | **31** |
| *Menidia menidia* | 7 | 0.03 | 0.09 | 0.03 | 15 | 57 | 0.03 | 123.14 | 33.42 | 1724 |
| *Micropogonias undulatus* | 1 | 0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **36** | **0.37** | **1.14** | **0.18** | **192** | **21** | <0.01 | **2.00** | **1.43** | **28** |
| *Morone saxatilis* | 24 | 0.19 | 0.58 | 0.13 | 98 | 50 | <0.01 | 2.07 | 1.06 | 29 |
| *Paralichthys dentatus* | 1 | <0.01 | 0.01 | 0.01 | 1 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Pogonias cromis* | 8 | 0.04 | 0.12 | 0.04 | 20 | 21 | <0.01 | 0.93 | 0.65 | 13 |
| *Pomotamus saltatrix* | 6 | 0.03 | 0.08 | 0.03 | 13 | 7 | <0.01 | 0.07 | 0.07 | 1 |
| *Syngnathus fuscus* | 2 | 0.01 | 0.02 | 0.01 | 4 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 2 | 0.01 | 0.03 | 0.02 | 5 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **3.10** | **0.33** | **520** | -- | -- | **4430.71** | **2808.15** | **62030** |

Table 7-10 continued

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Callinectes sapidus* | 33 | 0.16 | 0.59 | 0.10 | 99 | 86 | <0.01 | 14.07 | 5.57 | 197 |
| *Malaclemys terrapin* | 7 | 0.03 | 0.08 | 0.02 | 13 | 14 | <0.01 | 0.14 | 0.10 | 2 |
| **Total All Species** | -- | -- | **3.76** | **0.34** | **632** | -- | -- | **4444.93** | **2806.91** | **62229** |

Table 7-11. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Alloway Creek *Phragmites* sites, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | **Large Marsh Creeks** | | | | | **Small Marsh Creeks** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | 2 | <0.01 | 0.05 | 0.04 | 6 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 6 | <0.01 | 0.09 | 0.04 | 11 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 38 | 0.05 | 1.19 | 0.25 | 150 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **16** | **0.02** | **0.48** | **0.16** | **60** | **15** | **0.01** | **0.23** | **0.17** | **3** |
| *Anguilla rostrata* | 13 | 0.01 | 0.17 | 0.04 | 21 | 15 | 0.01 | 0.15 | 0.10 | 2 |
| *Brevoortia tyrannus* | 3 | <0.01 | 0.03 | 0.02 | 4 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **8** | **0.11** | **0.10** | **0.03** | **13** | -- | -- | -- | -- | -- |
| *Cyprinus carpio* | 6 | <0.01 | 0.10 | 0.03 | 12 | -- | -- | -- | -- | -- |
| *Dorosoma cepedianum* | 6 | <0.01 | 0.13 | 0.05 | 16 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | -- | -- | -- | -- | -- | 62 | 0.90 | 16.31 | 9.37 | 212 |
| *Gobiosoma bosc* | 3 | <0.01 | 0.03 | 0.02 | 4 | -- | -- | -- | -- | -- |
| *Hybognathus regius* | 2 | <0.01 | 0.02 | 0.02 | 3 | 8 | <0.01 | 0.08 | 0.08 | 1 |
| *Ictalurus punctatus* | 15 | 0.02 | 0.44 | 0.12 | 56 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **1** | **<0.01** | **0.01** | **0.01** | **1** | -- | -- | -- | -- | -- |
| *Menidia menidia* | -- | -- | -- | -- | -- | 23 | 0.02 | 0.38 | 0.24 | 5 |
| *Micropogonias undulatus* | 3 | <0.01 | 0.07 | 0.05 | 9 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **83** | **0.75** | **19.62** | **2.92** | **2472** | **15** | **0.05** | **0.85** | **0.60** | **11** |
| *Morone saxatilis* | 48 | 0.06 | 1.60 | 0.23 | 202 | 15 | 0.01 | 0.15 | 0.10 | 2 |
| *Morone spp* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Notropis hudsonius* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Paralichthys dentatus* | 1 | <0.01 | 0.02 | 0.02 | 2 | -- | -- | -- | -- | -- |
| *Perca flavescens* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |

Table 7-11 continued

| Species | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Pogonias cromis* | 5 | <0.01 | 0.05 | 0.02 | 6 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 2 | <0.01 | 0.02 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Stenotomus chrysops* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 40 | 0.07 | 1.75 | 0.37 | 221 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **26.00** | **3.25** | **3276** | -- | -- | **18.15** | **10.04** | **236** |
| *Callinectes sapidus* | 10 | 0.01 | 0.13 | 0.04 | 17 | 8 | <0.01 | 0.08 | 0.08 | 1 |
| *Malaclemys terrapin* | 5 | <0.01 | 0.05 | 0.02 | 6 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **26.18** | **3.25** | **3299** | -- | -- | **18.23** | **10.04** | **237** |

Table 7-12. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Alloway Creek treated sites, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | 4 | <0.01 | 0.06 | 0.03 | 7 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 13 | 0.01 | 0.20 | 0.06 | 25 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 2 | <0.01 | 0.02 | 0.01 | 3 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 7 | <0.01 | 0.09 | 0.03 | 11 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **28** | **0.19** | **3.32** | **1.16** | **418** | **15.00** | **<0.01** | **0.38** | **0.31** | **5** |
| *Anguilla rostrata* | 10 | 0.01 | 0.15 | 0.05 | 19 | 8.00 | <0.01 | 0.08 | 0.08 | 1 |
| *Brevoortia tyrannus* | -- | -- | -- | -- | -- | 8.00 | <0.01 | 0.08 | 0.08 | 1 |
| ***Cynoscion regalis*** | **11** | **0.01** | **0.19** | **0.06** | **24** | -- | -- | -- | -- | -- |
| *Cyprinus carpio* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Dorosoma cepedianum* | 4 | <0.01 | 0.06 | 0.03 | 7 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | 1 | <0.01 | 0.01 | 0.01 | 1 | 92.00 | 0.96 | 120.31 | 76.03 | 1564 |
| *Gobiosoma bosc* | 3 | <0.01 | 0.04 | 0.02 | 5 | 8.00 | <0.01 | 0.08 | 0.08 | 1 |
| *Ictalurus punctatus* | 16 | 0.04 | 0.65 | 0.20 | 82 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **1** | **<0.01** | **0.01** | **0.01** | **1** | -- | -- | -- | -- | -- |
| *Menidia menidia* | -- | -- | -- | -- | -- | 15.00 | 0.01 | 0.77 | 0.69 | 10 |
| *Micropogonias undulatus* | 11 | 0.02 | 0.29 | 0.09 | 37 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **75** | **0.51** | **9.06** | **1.19** | **1141** | **15.00** | **0.02** | **3.00** | **2.20** | **39** |
| *Morone saxatilis* | 52 | 0.15 | 2.68 | 0.55 | 338 | 8.00 | <0.01 | 0.15 | 0.15 | 2 |
| *Perca flavescens* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 2 | <0.01 | 0.02 | 0.02 | 3 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 2 | <0.01 | 0.02 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Syngnathus fuscus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 17 | 0.04 | 0.71 | 0.22 | 90 | -- | -- | -- | -- | -- |
| *Unidentified fish* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |

Table 7-12 continued

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| **Total Fish** | -- | -- | **17.60** | **2.14** | **2218** | -- | -- | **124.85** | **77.85** | **1623** |
| *Callinectes sapidus* | 10 | 0.01 | 0.12 | 0.04 | 15 | 8.00 | <0.01 | 0.08 | 0.08 | 1 |
| *Malaclemys terrapin* | 2 | <0.01 | 0.02 | 0.01 | 2 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **17.74** | **2.14** | **2235** | -- | -- | **124.92** | **77.84** | **1624** |

Table 7-13. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for Alloway Creek *Spartina* sites, May to November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa aestivalis* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Alosa psuedoharengus* | 17 | 0.01 | 0.29 | 0.08 | 37 | -- | -- | -- | -- | -- |
| *Alosa sapidissima* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 15 | 0.01 | 0.23 | 0.06 | 29 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **26** | **0.04** | **0.80** | **0.16** | **101** | **--** | **--** | **--** | **--** | **--** |
| *Anguilla rostrata* | 9 | <0.01 | 0.09 | 0.03 | 11 | 14.00 | 0.02 | 0.14 | 0.10 | 2 |
| *Brevoortia tyrannus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| ***Cynoscion regalis*** | **13** | **0.01** | **0.33** | **0.10** | **41** | **--** | **--** | **--** | **--** | **--** |
| *Cyprinus carpio* | 2 | <0.01 | 0.02 | 0.01 | 2 | -- | -- | -- | -- | -- |
| *Dorosoma cepedianum* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | -- | -- | -- | -- | -- | 57.00 | 0.79 | 5.21 | 3.16 | 73 |
| *Gobiosoma bosc* | 4 | <0.01 | 0.04 | 0.02 | 5 | 7.00 | 0.04 | 0.29 | 0.29 | 4 |
| *Hybognathus regius* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Ictalurus punctatus* | 13 | 0.02 | 0.38 | 0.17 | 48 | -- | -- | -- | -- | -- |
| ***Leiostomus xanthurus*** | **1** | **<0.01** | **0.01** | **0.01** | **1** | **--** | **--** | **--** | **--** | **--** |
| *Lepomis macrochirus* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Menidia menidia* | -- | -- | -- | -- | -- | 7.00 | 0.04 | 0.29 | 0.29 | 4 |
| *Micropogonias undulatus* | 10 | 0.01 | 0.33 | 0.15 | 41 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **78** | **0.61** | **13.62** | **3.02** | **1716** | **36.00** | **0.10** | **0.64** | **0.36** | **9** |
| *Morone saxatilis* | 57 | 0.21 | 4.62 | 0.73 | 582 | -- | -- | -- | -- | -- |
| *Perca flavescens* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |
| *Pomotamus saltatrix* | 1 | <0.01 | 0.01 | 0.01 | 1 | -- | -- | -- | -- | -- |

Table 7-13 continued

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Trinectes maculatus* | 39 | 0.07 | 1.48 | 0.28 | 186 | -- | -- | -- | -- | -- |
| **Total Fish** | **--** | **--** | **22.29** | **3.55** | **2808** | **--** | **--** | **6.57** | **3.28** | **92** |
| *Callinectes sapidus* | 11 | 0.01 | 0.13 | 0.04 | 17 | 14.00 | 0.08 | 0.57 | 0.50 | 8 |
| *Malaclemys terrapin* | 2 | <0.01 | 0.02 | 0.01 | 2 | -- | -- | -- | -- | -- |
| **Total All Species** | **--** | **--** | **22.44** | **3.56** | **2827** | **--** | **--** | **7.14** | **3.35** | **100** |

Table 7-14. Composite species composition for large marsh creek (otter trawl) and small marsh creek (weir) collections for The Rocks, Delaware, in October and November 2003. See Table 7-2 for site characteristics. Percent frequency of occurrence = percent of samples containing each species, relative abundance for fish = total number collected of the individual species/total number of fish collected; relative abundance for non-fish species = total number collected of the individual species/total number of fish and non-fish collected; catch per unit effort (CPUE) = mean number of individuals collected per sample. Target species are in bold type. Dashes indicate zero catches.

| | Large Marsh Creeks | | | | | Small Marsh Creeks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Alosa psuedoharengus* | 15 | 0.02 | 0.26 | 0.10 | 12 | -- | -- | -- | -- | -- |
| *Ameiurus catus* | 2 | <0.01 | 0.02 | 0.02 | 1 | -- | -- | -- | -- | -- |
| *Ameiurus nebulosus* | 2 | <0.01 | 0.02 | 0.02 | 1 | -- | -- | -- | -- | -- |
| ***Anchoa mitchilli*** | **13** | **0.01** | **0.13** | **0.05** | **6** | -- | -- | -- | -- | -- |
| *Anguilla rostrata* | 13 | 0.01 | 0.13 | 0.05 | 6 | -- | -- | -- | -- | -- |
| *Brevoortia tyrannus* | 2 | <0.01 | 0.02 | 0.02 | 1 | -- | -- | -- | -- | -- |
| *Dorosoma cepedianum* | 2 | <0.01 | 0.02 | 0.02 | 1 | -- | -- | -- | -- | -- |
| *Fundulus heteroclitus* | -- | -- | -- | -- | -- | 100 | 1.00 | 7.00 | | 7 |
| *Gobiosoma bosc* | 4 | <0.01 | 0.04 | 0.03 | 2 | -- | -- | -- | -- | -- |
| *Ictalurus punctatus* | 57 | 0.08 | 1.26 | 0.20 | 59 | -- | -- | -- | -- | -- |
| *Micropogonias undulatus* | 51 | 0.33 | 5.26 | 1.03 | 247 | -- | -- | -- | -- | -- |
| ***Morone americana*** | **87** | **0.42** | **6.74** | **1.60** | **317** | -- | -- | -- | -- | -- |
| *Morone saxatilis* | 49 | 0.08 | 1.34 | 0.41 | 63 | -- | -- | -- | -- | -- |
| *Notropis hudsonius* | 4 | <0.01 | 0.04 | 0.03 | 2 | -- | -- | -- | -- | -- |
| *Pogonias cromis* | 6 | 0.01 | 0.13 | 0.09 | 6 | -- | -- | -- | -- | -- |
| *Trinectes maculatus* | 26 | 0.03 | 0.47 | 0.14 | 22 | -- | -- | -- | -- | -- |
| **Total Fish** | -- | -- | **15.87** | **2.01** | **746** | -- | -- | **7.00** | | **7** |
| | | | | | | -- | -- | -- | -- | -- |
| *Callinectes sapidus* | 43 | 0.05 | 0.81 | 0.18 | 38 | -- | -- | -- | -- | -- |
| *Malaclemys terrapin* | 4 | <0.01 | 0.04 | 0.03 | 2 | -- | -- | -- | -- | -- |
| **Total All Species** | -- | -- | **16.72** | **2.00** | **786** | -- | -- | **7.00** | | **7** |

Table 7-15. Ranked species composition for bay otter trawl collections near Moores Beach during May to November 2003. Target species in bold. See Figure 7-5 for location of sampling site.

| | **Bay** | | | | |
|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Micropogonias undulatus* | 17 | 0.52 | 23.42 | 12.71 | 562 |
| ***Anchoa mitchilli*** | **100** | **0.45** | **20.08** | **4.95** | **482** |
| *Callinectes sapidus* | 38 | 0.02 | 1.08 | 0.39 | 26 |
| *Anchoa hepsetus* | 13 | 0.01 | 0.25 | 0.17 | 6 |
| *Paralichthys dentatus* | 17 | <0.01 | 0.21 | 0.10 | 5 |
| *Menidia menidia* | 8 | <0.01 | 0.21 | 0.15 | 5 |
| *Clupea harengus* | 8 | <0.01 | 0.13 | 0.09 | 3 |
| *Pogonias cromis* | 8 | <0.01 | 0.13 | 0.09 | 3 |
| ***Leiostomus xanthurus*** | **8** | **<0.01** | **0.08** | **0.06** | **2** |
| *Morone spp* | 8 | <0.01 | 0.08 | 0.06 | 2 |
| *Syngnathus fuscus* | 8 | <0.01 | 0.08 | 0.06 | 2 |
| *Limulus polyphemus* | 4 | <0.01 | 0.08 | 0.08 | 2 |
| *Morone saxatilis* | 4 | <0.01 | 0.08 | 0.08 | 2 |
| ***Cynoscion regalis*** | **4** | **<0.01** | **0.04** | **0.04** | **1** |
| *Etropus microstomus* | 4 | <0.01 | 0.04 | 0.04 | 1 |
| ***Morone americana*** | **4** | **<0.01** | **0.04** | **0.04** | **1** |
| *Scophthalmus aquosus* | 4 | <0.01 | 0.04 | 0.04 | 1 |
| *Selene vomer* | 4 | <0.01 | 0.04 | 0.04 | 1 |
| **TOTAL** | | | **46.13** | **13.43** | **1107** |

Table 7-16. Ranked species composition for bay otter trawl collections near Commercial Township during May to November 2003. Target species in bold. See Figure 7-3 for location of sampling site.

| | Bay | | | | |
|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| *Micropogonias undulatus* | 13 | 0.74 | 29.34 | 14.02 | 939 |
| ***Anchoa mitchilli*** | **81** | **0.23** | **9.13** | **3.09** | **292** |
| *Callinectes sapidus* | 31 | 0.04 | 1.59 | 0.69 | 51 |
| *Morone saxatilis* | 16 | 0.01 | 0.34 | 0.17 | 11 |
| *Pogonias cromis* | 13 | 0.01 | 0.28 | 0.19 | 9 |
| *Clupea harengus* | 9 | <0.01 | 0.19 | 0.11 | 6 |
| ***Morone americana*** | **9** | <0.01 | **0.13** | **0.07** | **4** |
| *Syngnathus fuscus* | 9 | <0.01 | 0.13 | 0.07 | 4 |
| *Gobiosoma bosc* | 6 | <0.01 | 0.06 | 0.04 | 2 |
| *Limulus polyphemus* | 6 | <0.01 | 0.06 | 0.04 | 2 |
| *Prionotus evolans* | 6 | <0.01 | 0.06 | 0.04 | 2 |
| *Brevoortia tyrannus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| ***Cynoscion regalis*** | **3** | <0.01 | **0.03** | **0.03** | **1** |
| *Etropus microstomus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| ***Leiostomus xanthurus*** | **3** | <0.01 | **0.03** | **0.03** | **1** |
| *Sphoeroides maculatus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Urophycis regia* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| **TOTAL** | | | **41.50** | **15.00** | **1328** |

Table 7-17. Ranked species composition for bay otter trawl collections near Dennis Township during May to November 2003. Target species in bold. See Figure 7-2 for location of sampling site.

| | Bay | | | | |
|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| ***Anchoa mitchilli*** | **72** | **0.58** | **7.44** | **1.86** | **238** |
| *Micropogonias undulatus* | 22 | 0.23 | 2.94 | 1.80 | 94 |
| *Callinectes sapidus* | 31 | 0.13 | 1.97 | 0.71 | 63 |
| ***Cynoscion regalis*** | **28** | **0.08** | **1.00** | **0.38** | **32** |
| *Ophidion marginatum* | 9 | 0.06 | 0.75 | 0.54 | 24 |
| *Limulus polyphemus* | 16 | 0.03 | 0.41 | 0.19 | 13 |
| *Trinectes maculatus* | 9 | 0.01 | 0.19 | 0.11 | 6 |
| *Syngnathus fuscus* | 9 | 0.01 | 0.09 | 0.05 | 3 |
| ***Morone americana*** | **3** | <0.01 | **0.06** | **0.06** | **2** |
| *Anguilla rostrata* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Apeltes quadracus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Centropristis striata* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| ***Leiostomus xanthurus*** | **3** | <0.01 | **0.03** | **0.03** | **1** |
| *Morone saxatilis* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Pomotamus saltatrix* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Psuedopleuronectes americanus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Raja eglanteria* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Rhinoptera bonasus* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| *Urophycis regia* | 3 | <0.01 | 0.03 | 0.03 | 1 |
| **TOTAL** | | | **15.16** | **3.44** | **485** |

Table 7-18. Ranked species composition for bay otter trawl collections near Mad Horse Creek during May to November 2003. Target species in bold. See Figure 7-8 for location of sampling site.

| | Bay | | | | |
|---|---|---|---|---|---|
| **Species** | Percent frequency of occurrence | Relative abundance | Catch per unit effort | Standard error | Total collected |
| ***Cynoscion regalis*** | **29** | **0.37** | **2.36** | **0.81** | **66** |
| ***Anchoa mitchilli*** | **46** | **0.19** | **1.25** | **0.32** | **35** |
| *Morone saxatilis* | 57 | 0.17 | 1.07 | 0.24 | 30 |
| ***Morone americana*** | **39** | **0.12** | **0.75** | **0.21** | **21** |
| *Paralichthys dentatus* | 14 | 0.03 | 0.21 | 0.12 | 6 |
| *Callinectes sapidus* | 18 | 0.03 | 0.18 | 0.07 | 5 |
| *Micropogonias undulatus* | 7 | 0.02 | 0.14 | 0.11 | 4 |
| *Morone spp* | 11 | 0.02 | 0.14 | 0.08 | 4 |
| *Pogonias cromis* | 11 | 0.02 | 0.14 | 0.08 | 4 |
| *Trinectes maculatus* | 14 | 0.02 | 0.14 | 0.07 | 4 |
| *Ophidion marginatum* | 11 | 0.02 | 0.11 | 0.06 | 3 |
| *Alosa psuedoharengus* | 4 | 0.01 | 0.04 | 0.04 | 1 |
| *Brevoortia tyrannus* | 4 | 0.01 | 0.04 | 0.04 | 1 |
| *Clupea harengus* | 4 | 0.01 | 0.04 | 0.04 | 1 |
| **TOTAL** | | | **6.61** | **1.16** | **185** |

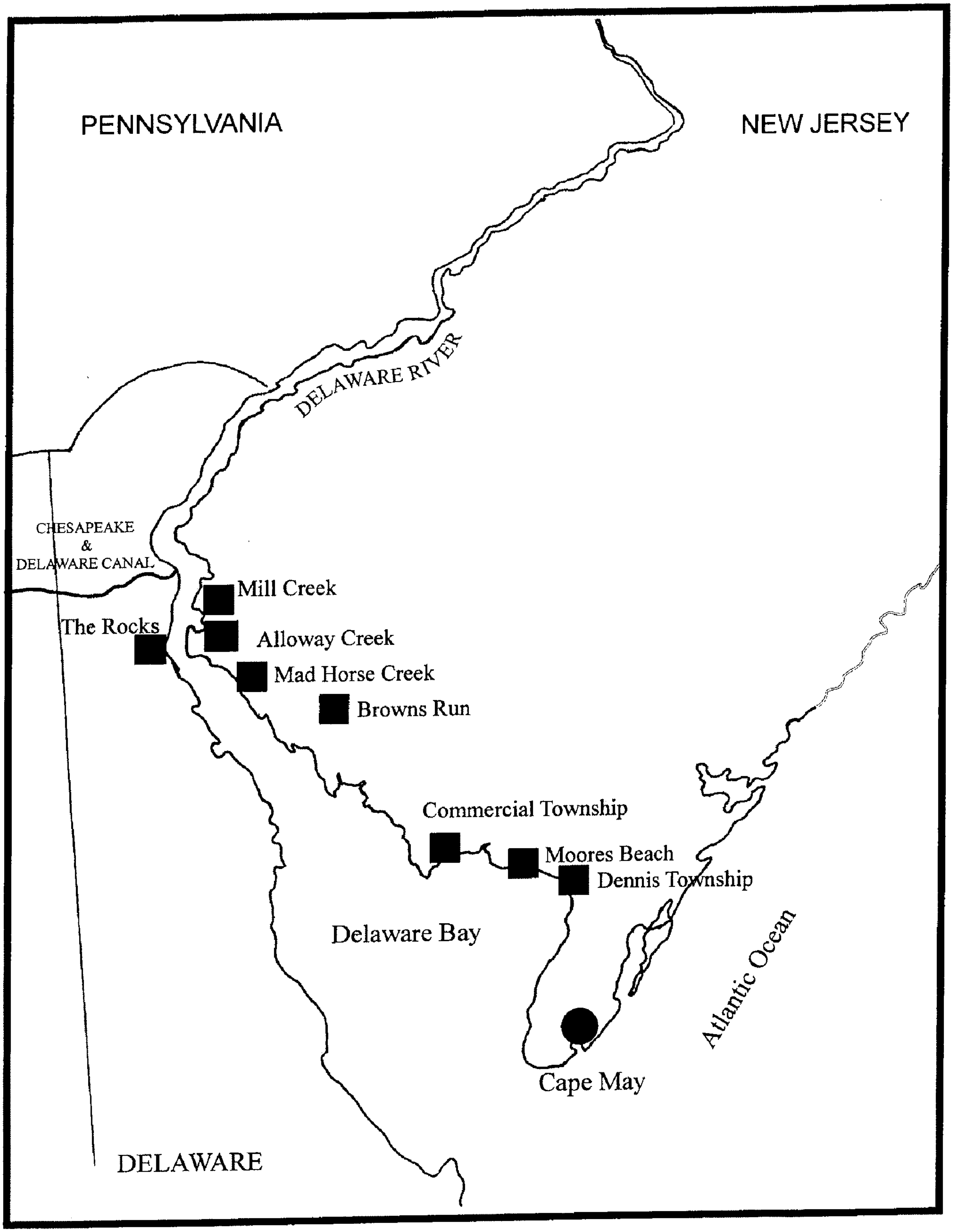



Figure 7-1 Restored and reference marsh study sites in Delaware Bay.

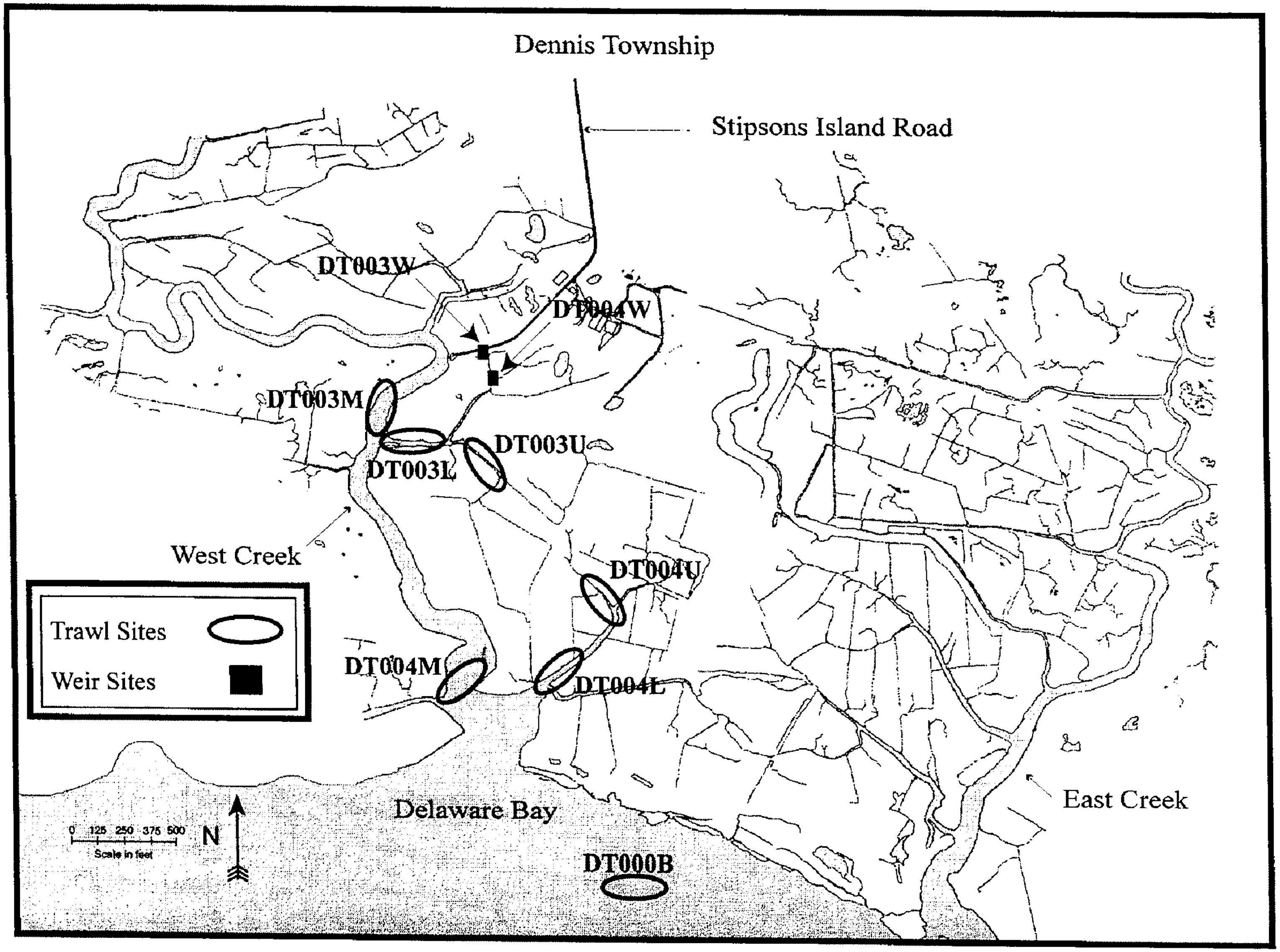



Figure 7-2 Dennis Township sampling sites (restoration) in Delaware Bay during 2003.

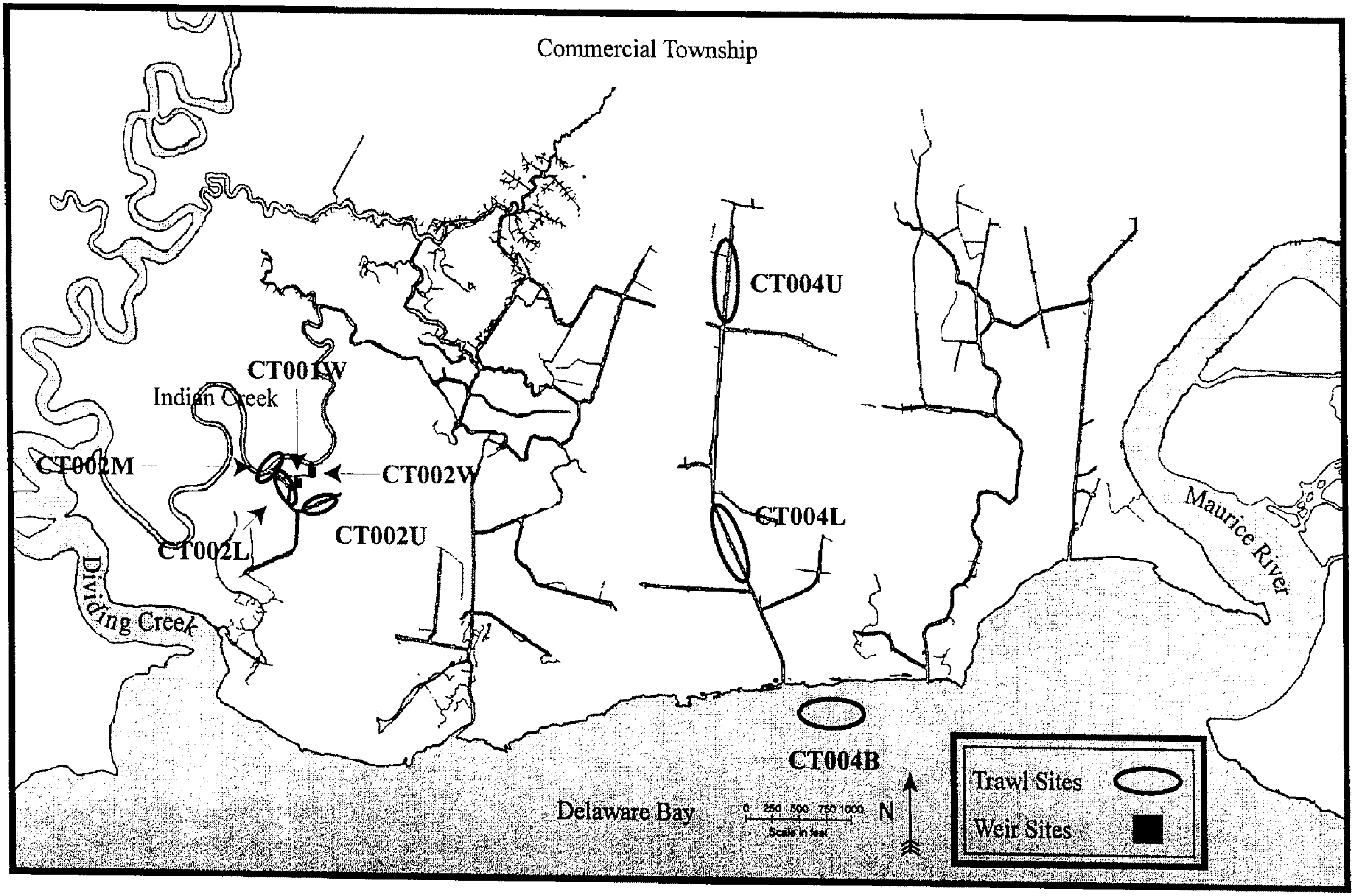



Figure 7-3 Commercial Township sampling sites (restoration) in Delaware Bay during 2003.

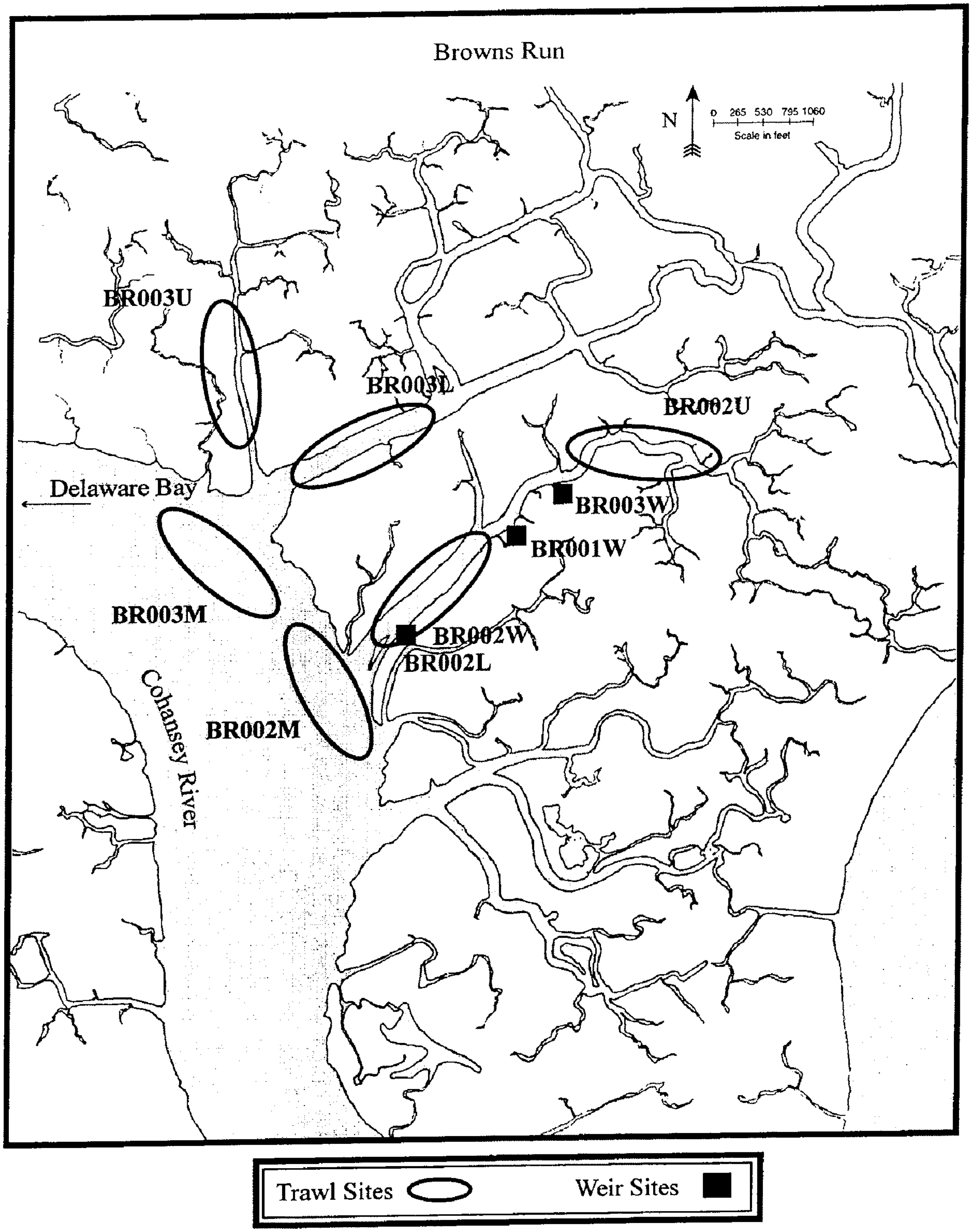



Figure 7-4 Browns Run sampling sites (restoration) in Delaware Bay during 2003.

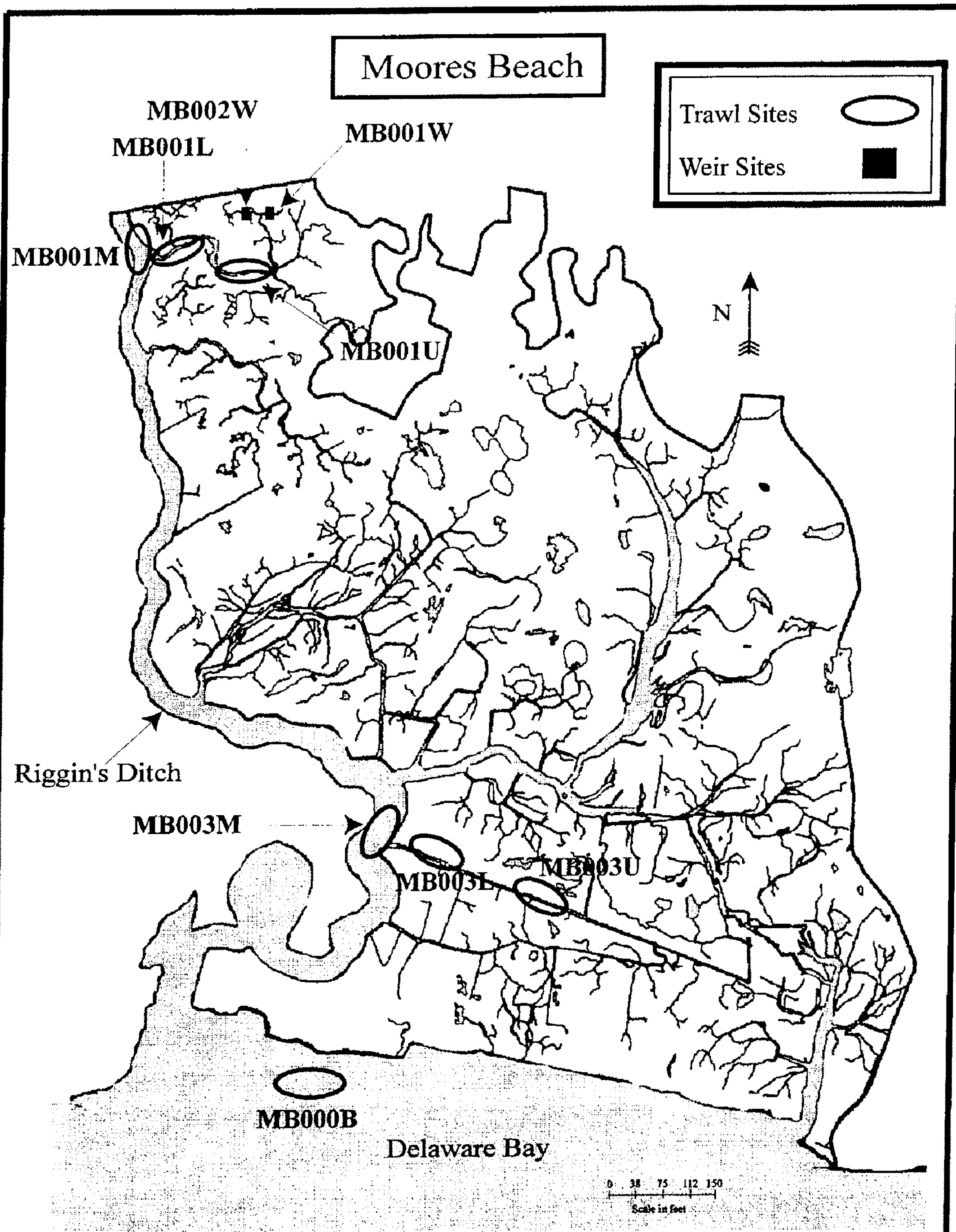



Figure 7-5 Moores Beach sampling sites (reference) in Delaware Bay during 2003.

Alloway Creek

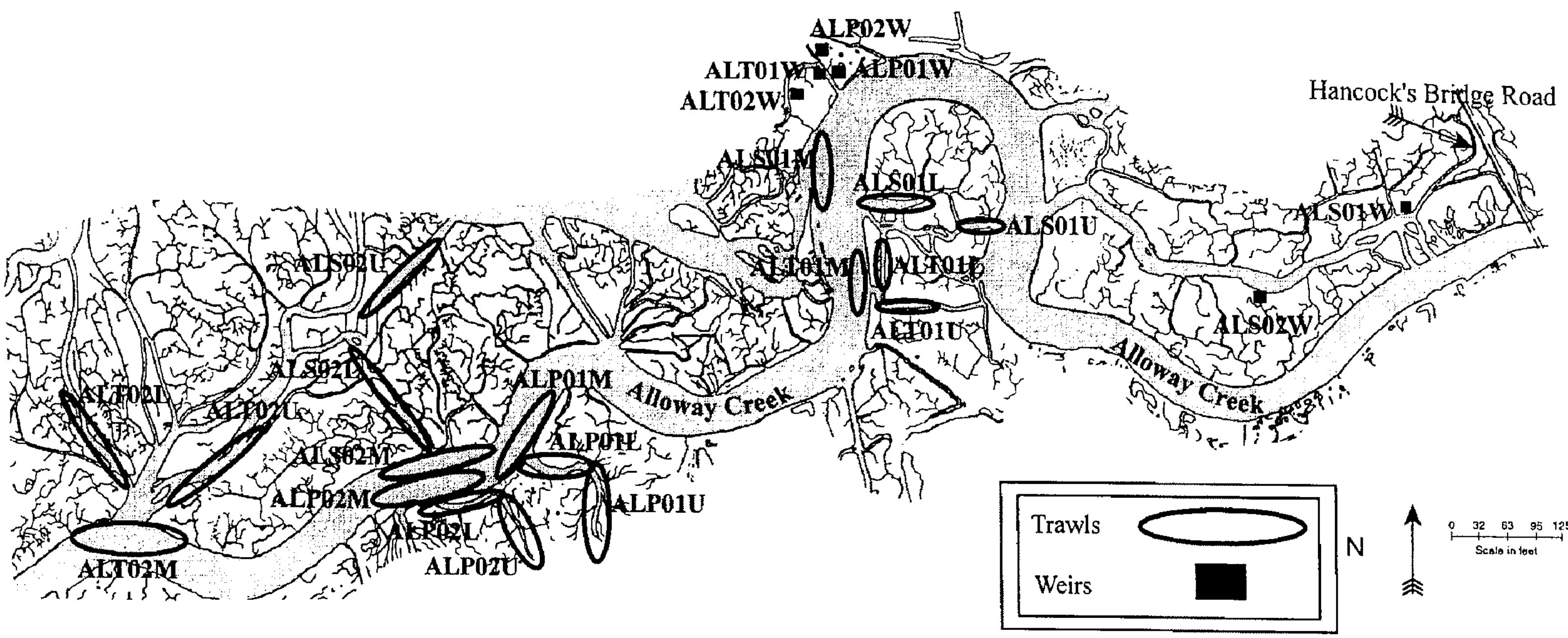



Figure 7-6 Alloway Creek Sampling sites in Delaware Bay during 2003.
ALP = Alloway-*Phragmites* (reference) ALS = Alloway-*Spartina* (reference) ALT = Alloway-Treated (restoration)

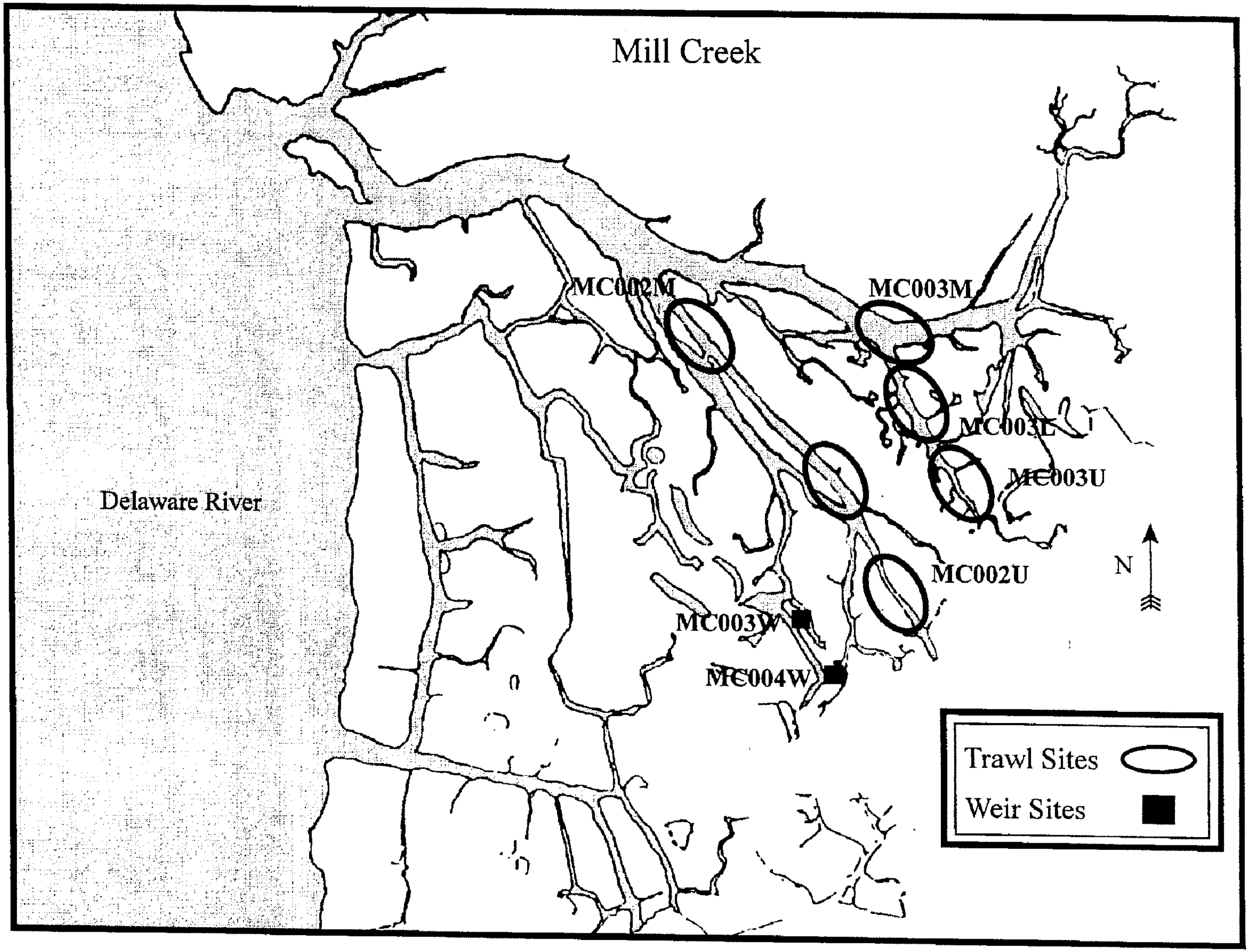



Figure 7-7 Mill Creek sampling sites (restoration) in Delaware Bay during 2003.

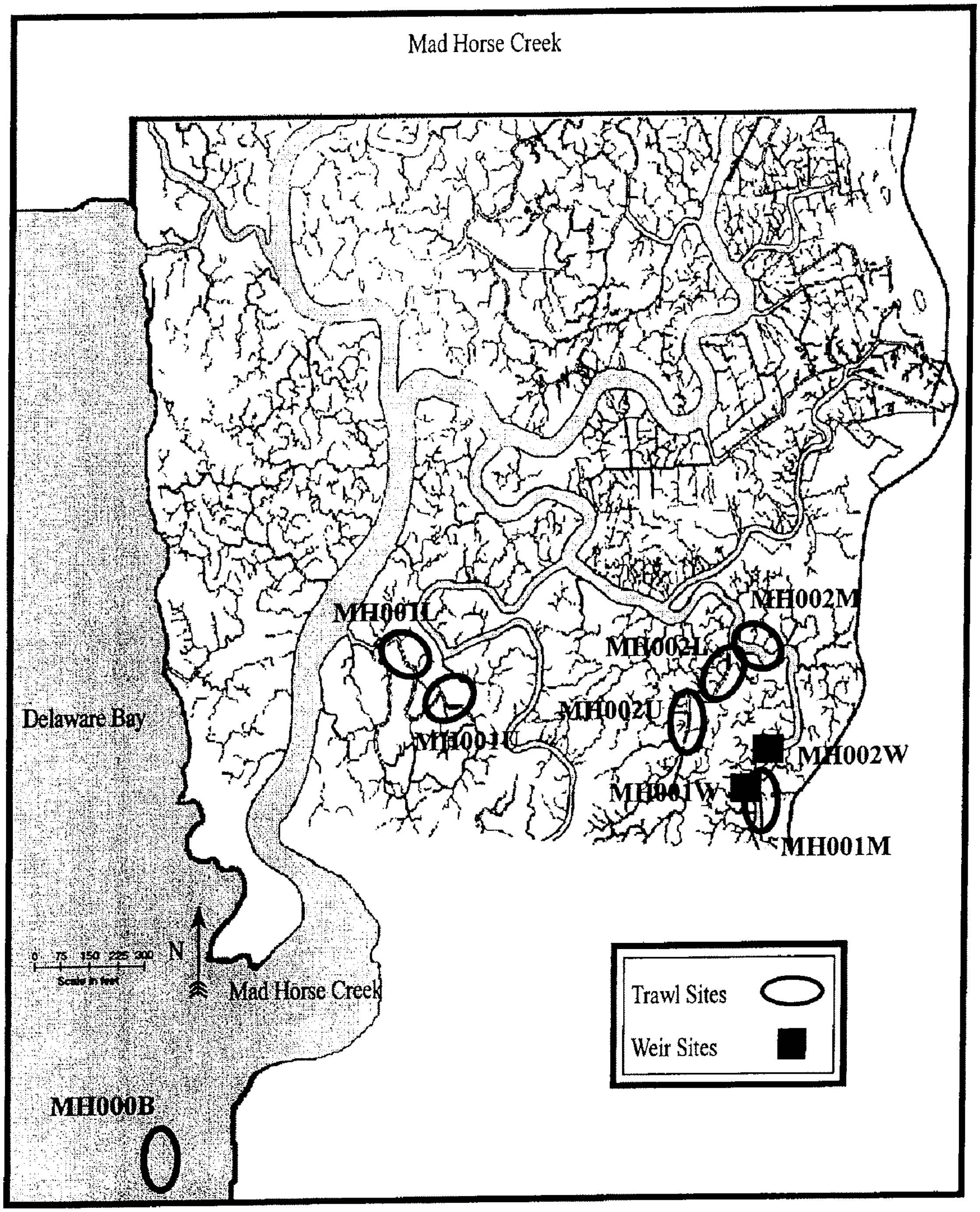



Figure 7-8. Mad Horse Creek sampling sites (reference) in Delaware Bay during 2003.

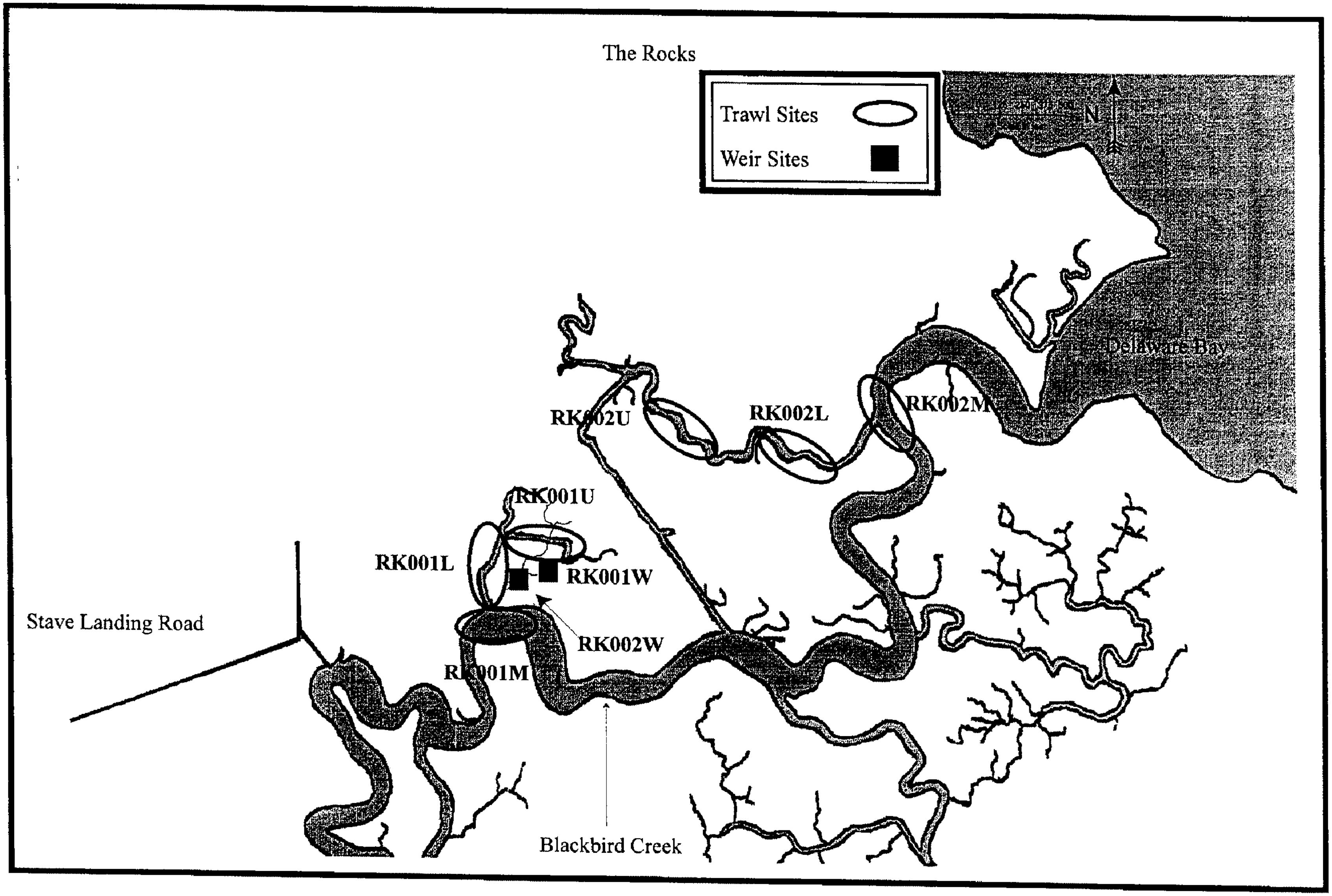



Figure 7-9 The Rocks sampling sites (restoration) in Delaware Bay during 2003.

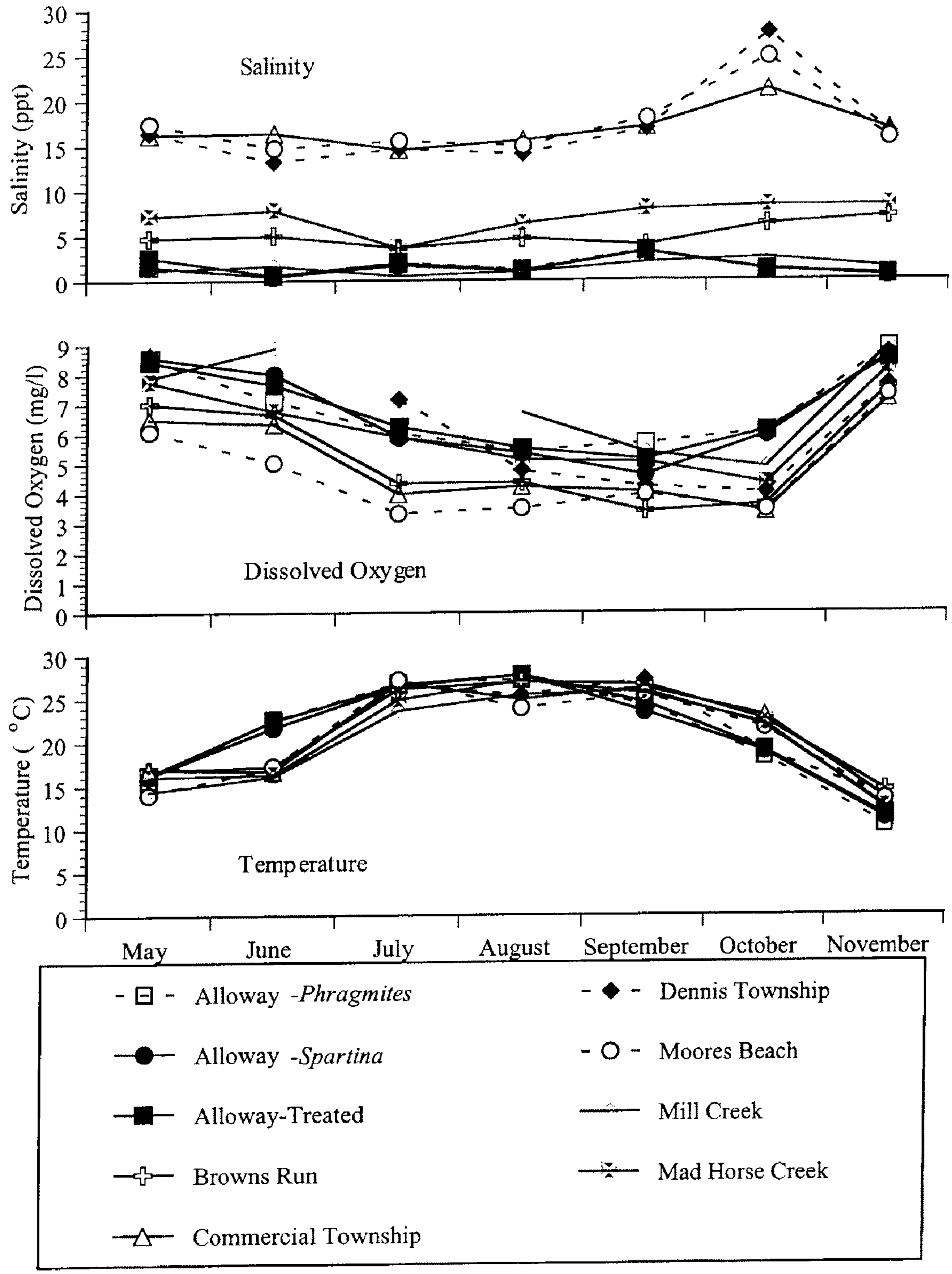



Figure 7-10. Selected physical parameters at regularly sampled sites in Delaware Bay marsh study sites during 2003.

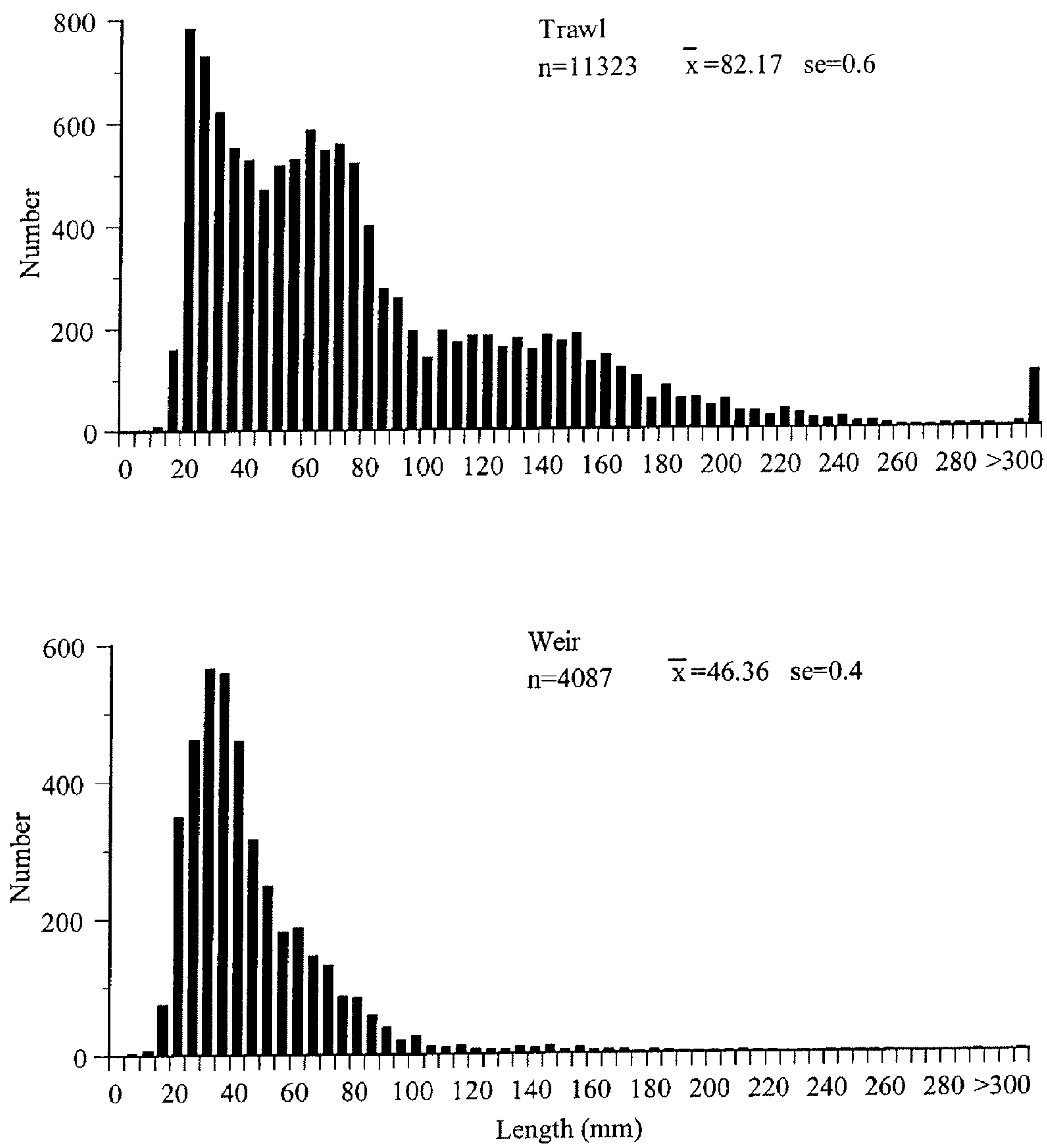



Figure 7-11. Size distribution of fish collected from all large marsh creeks by otter trawl and all small marsh creeks by weirs from May to November 2003.

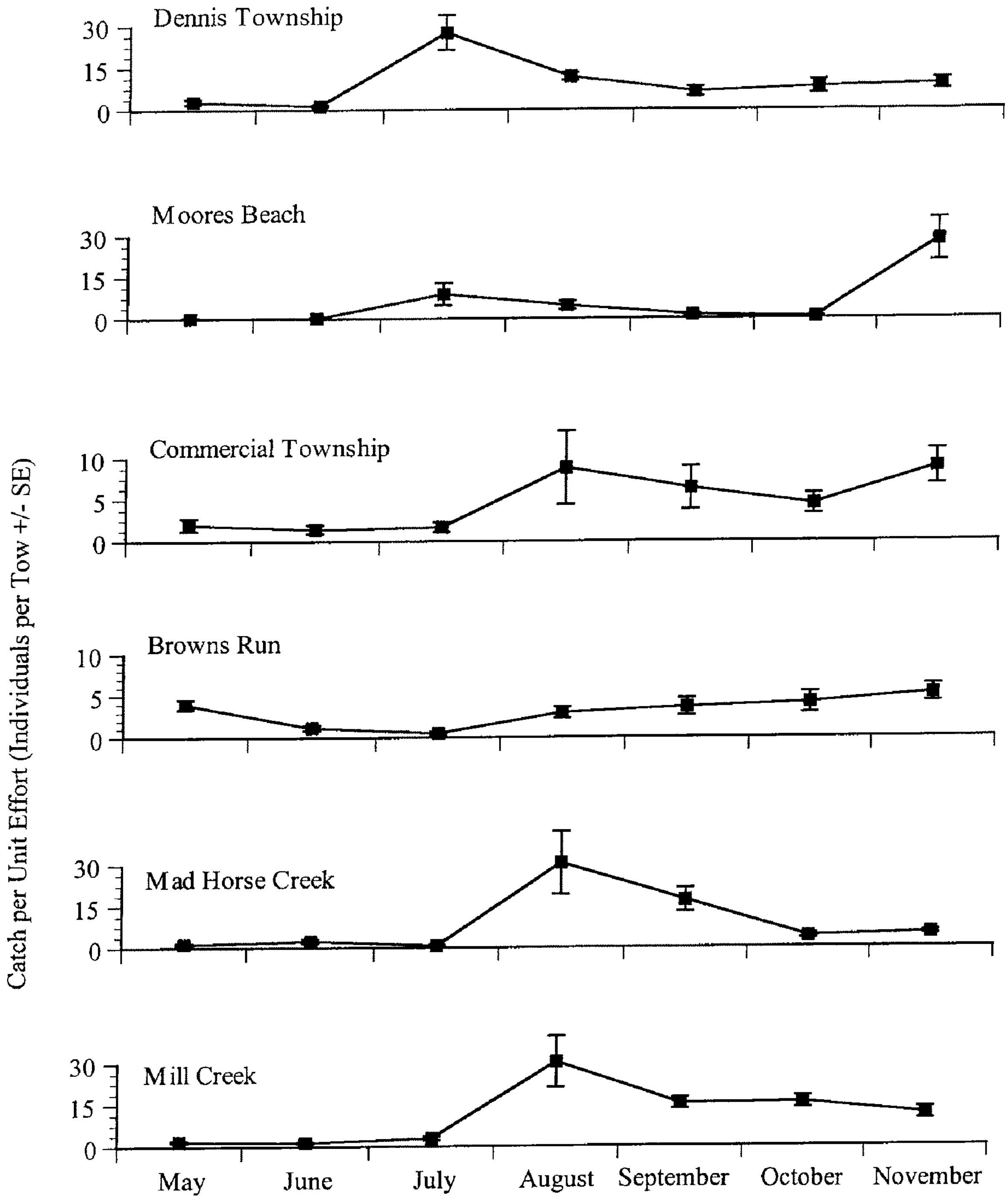



Figure 7-12. Abundance by month for all fish caught in large marsh creeks by otter trawls for all regularly sampled sites during 2003.

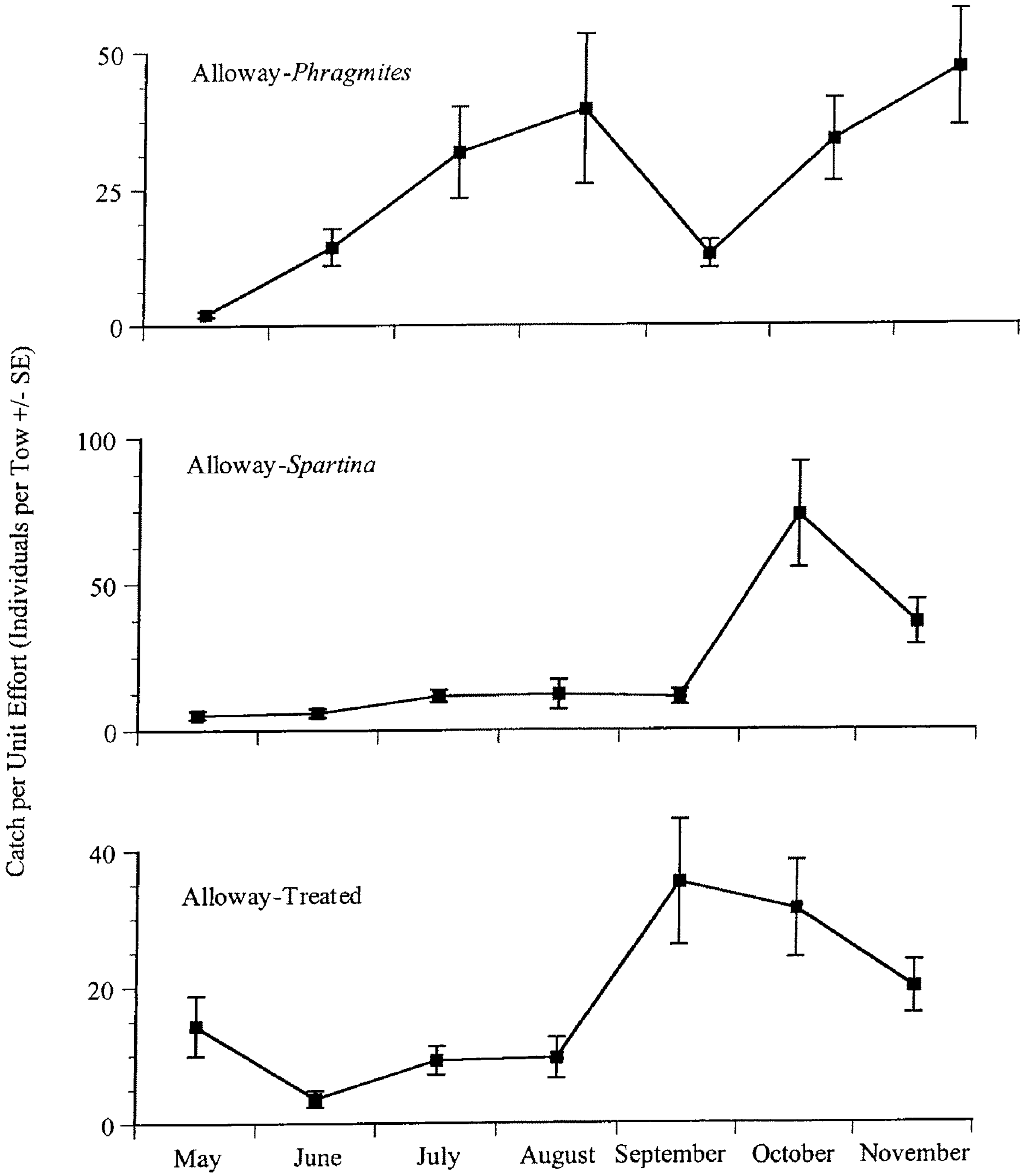



Figure 7-12 (con't). Abundance by month for all fish caught in large marsh creeks by otter trawls for all regularly sampled sites during 2003.

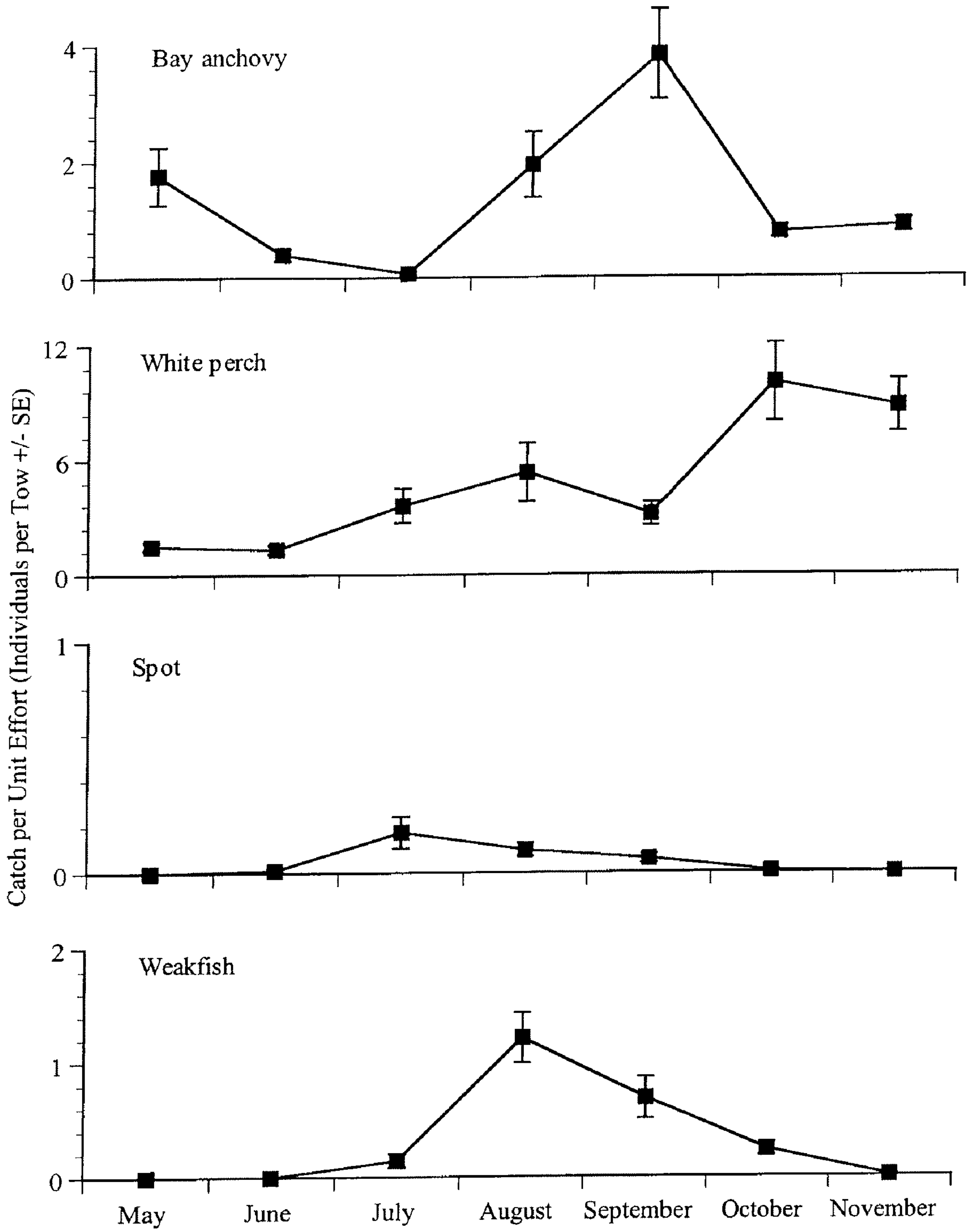



Figure 7-13. Abundance by month of four target species caught in large marsh creeks with otter trawls at all regularly sampled sites in 2003.

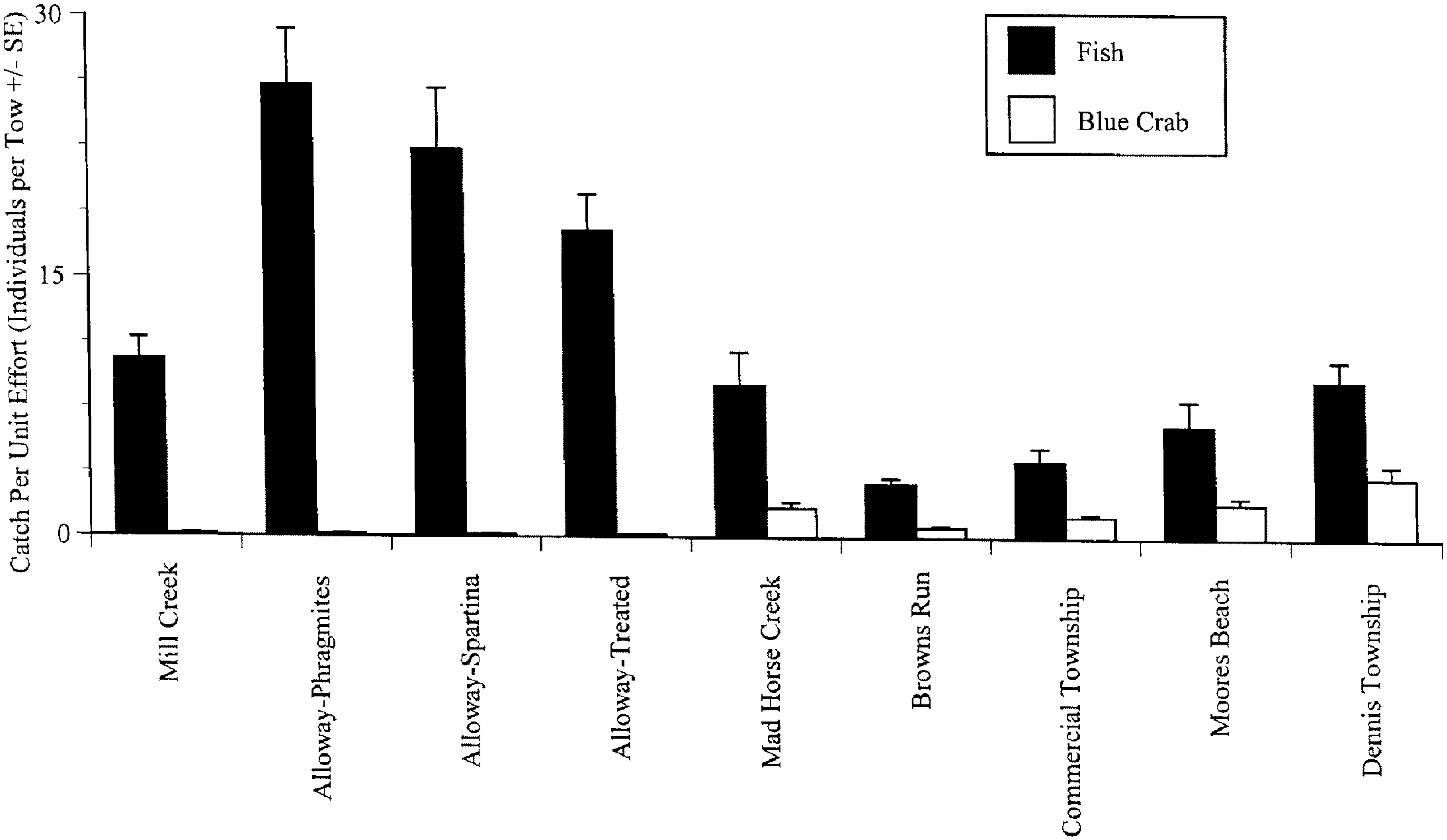



Figure 7-14. Abundance of fish and blue crabs collected by otter trawl from large marsh creeks at regularly sampled sites on Delaware Bay during 2003.

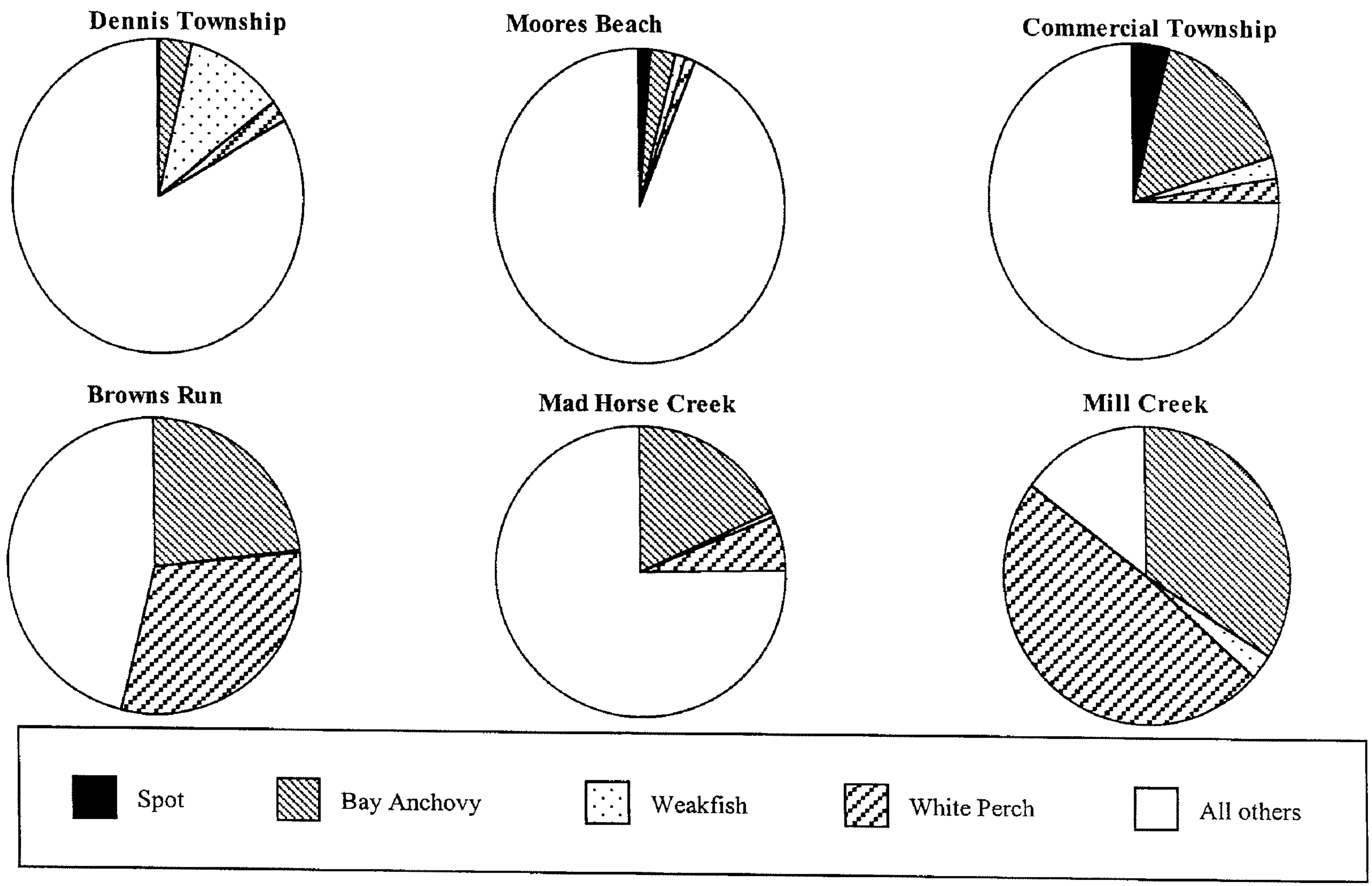



Figure 7-15. Relative abundances of target species and all other species based on large marsh creek trawl catches for regularly sampled sites in Delaware Bay, May-November 2003.

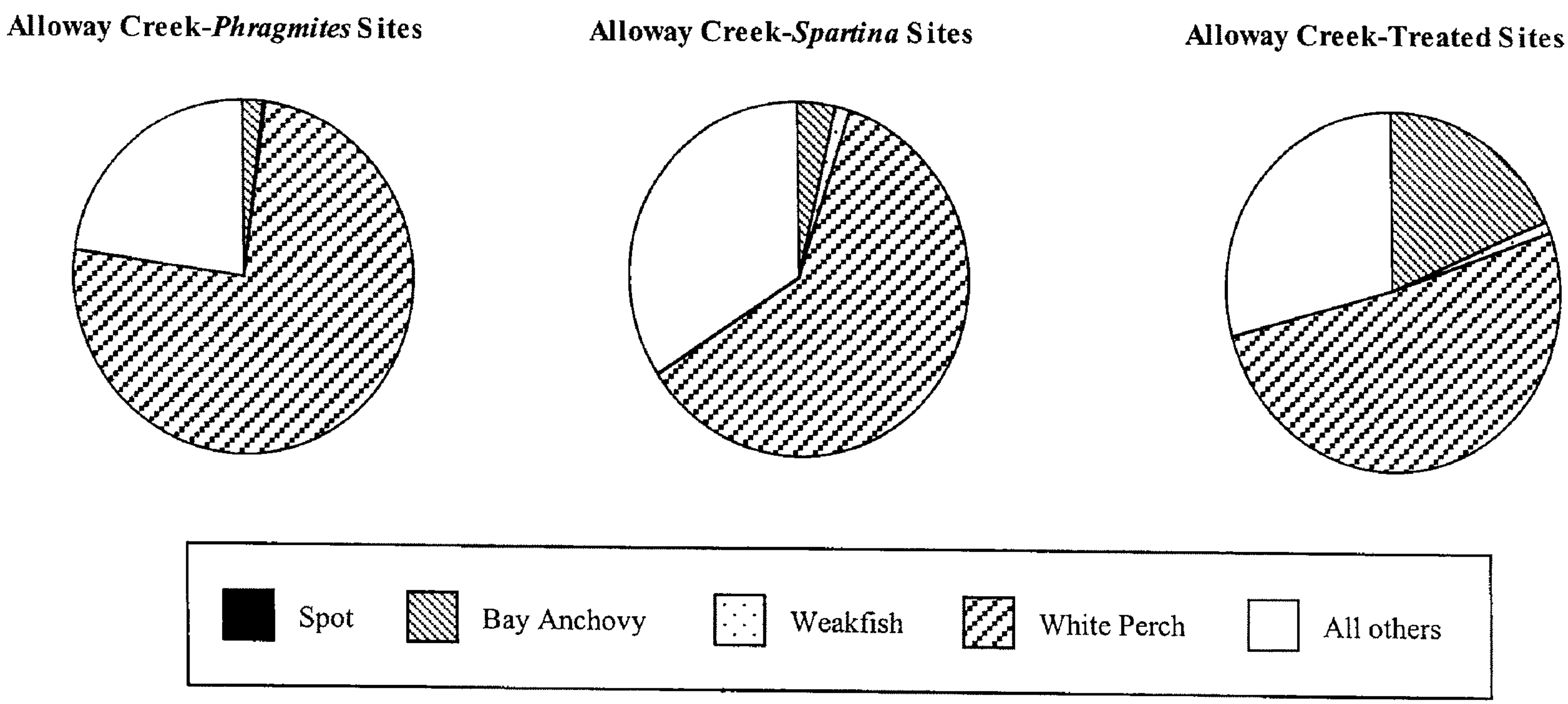



Figure 7-15 (con't). Relative abundances of target species and all other species based on large marsh creek trawl catches for Alloway Creek sites in Delaware Bay, May-November 2003.

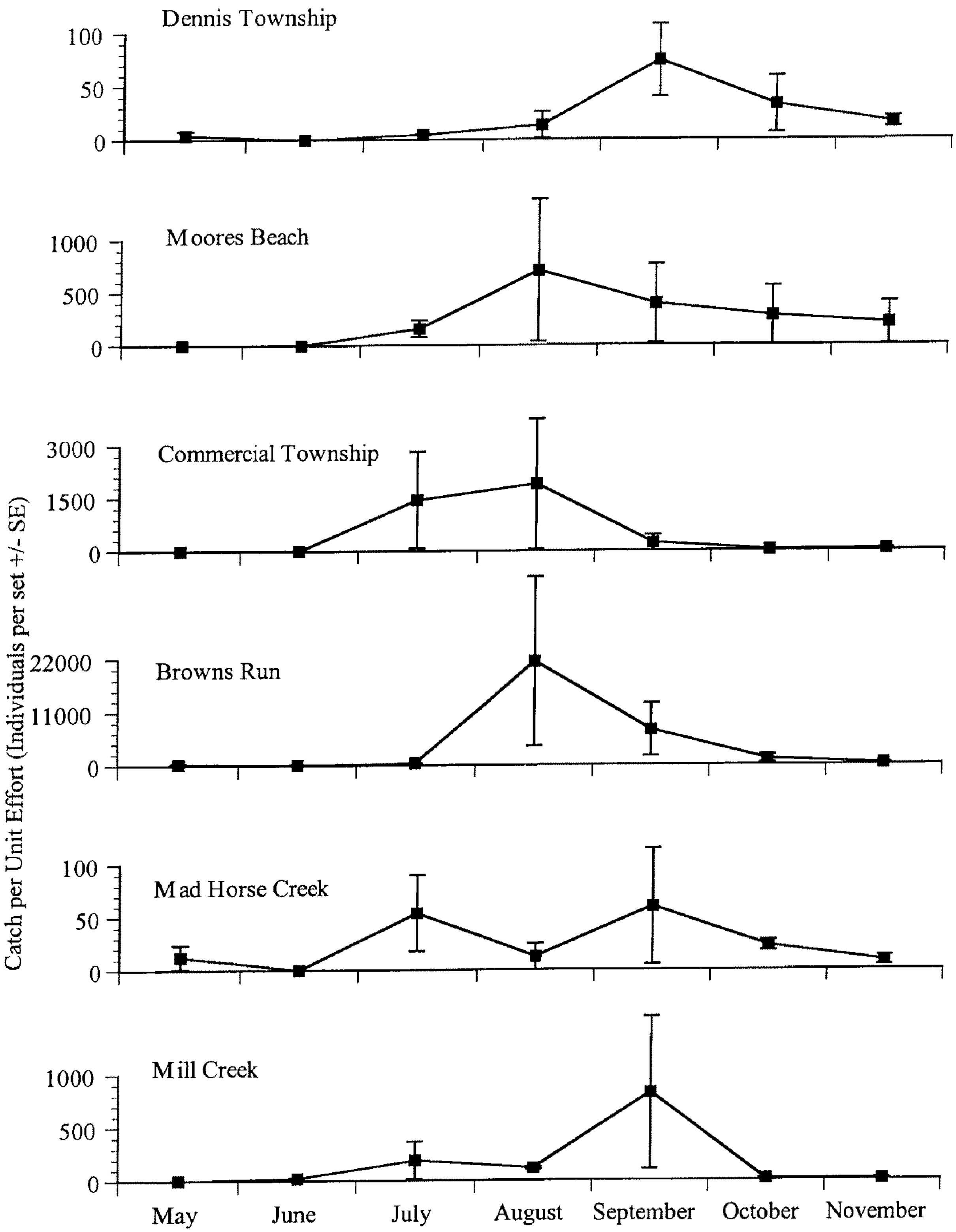



Figure 7-16. Monthly abundance for all fish caught in small marsh creeks with weirs during 2003.

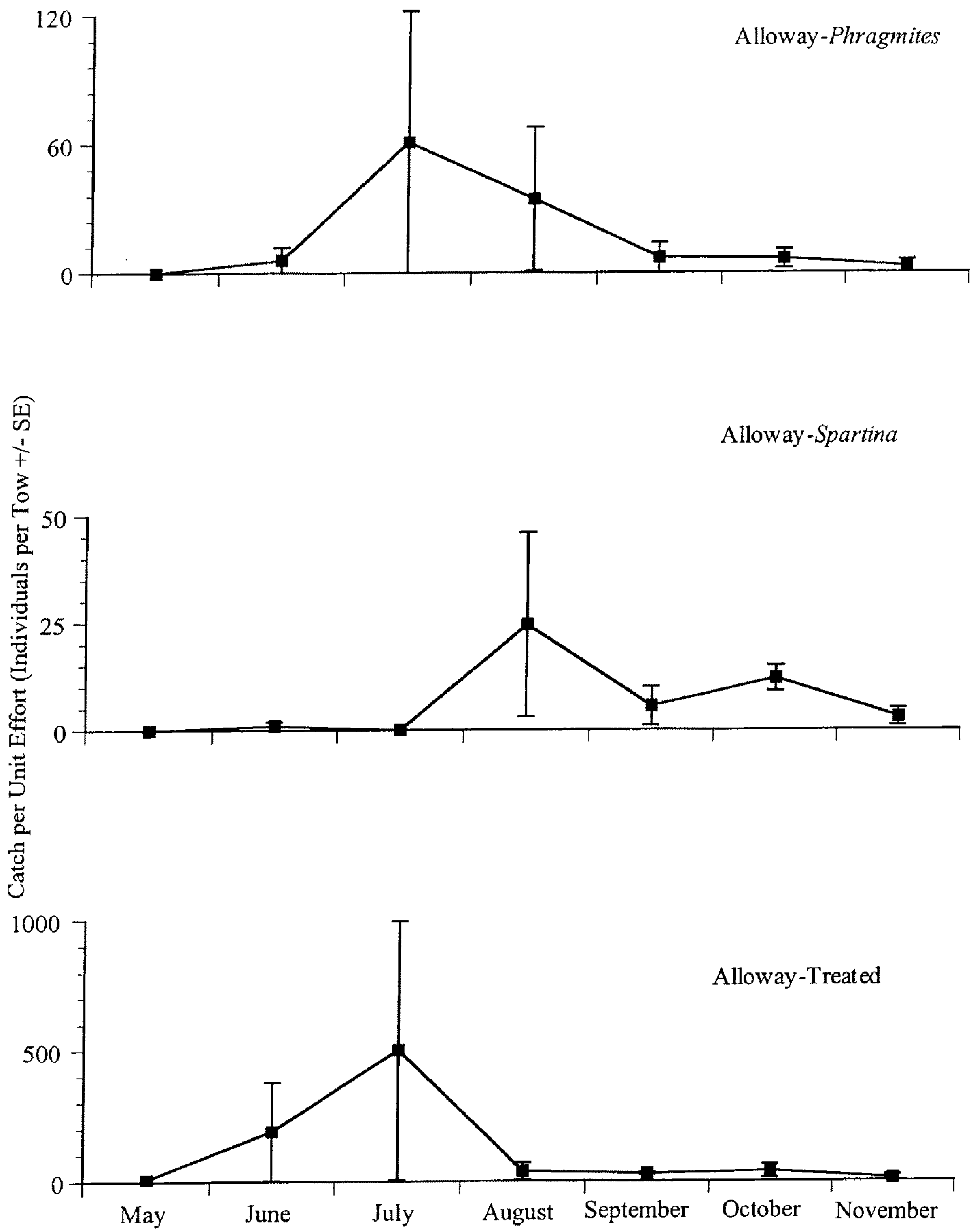



Figure 7-16 (con't). Monthly abundance for all fish caught in small marsh creeks with weirs during 2003.

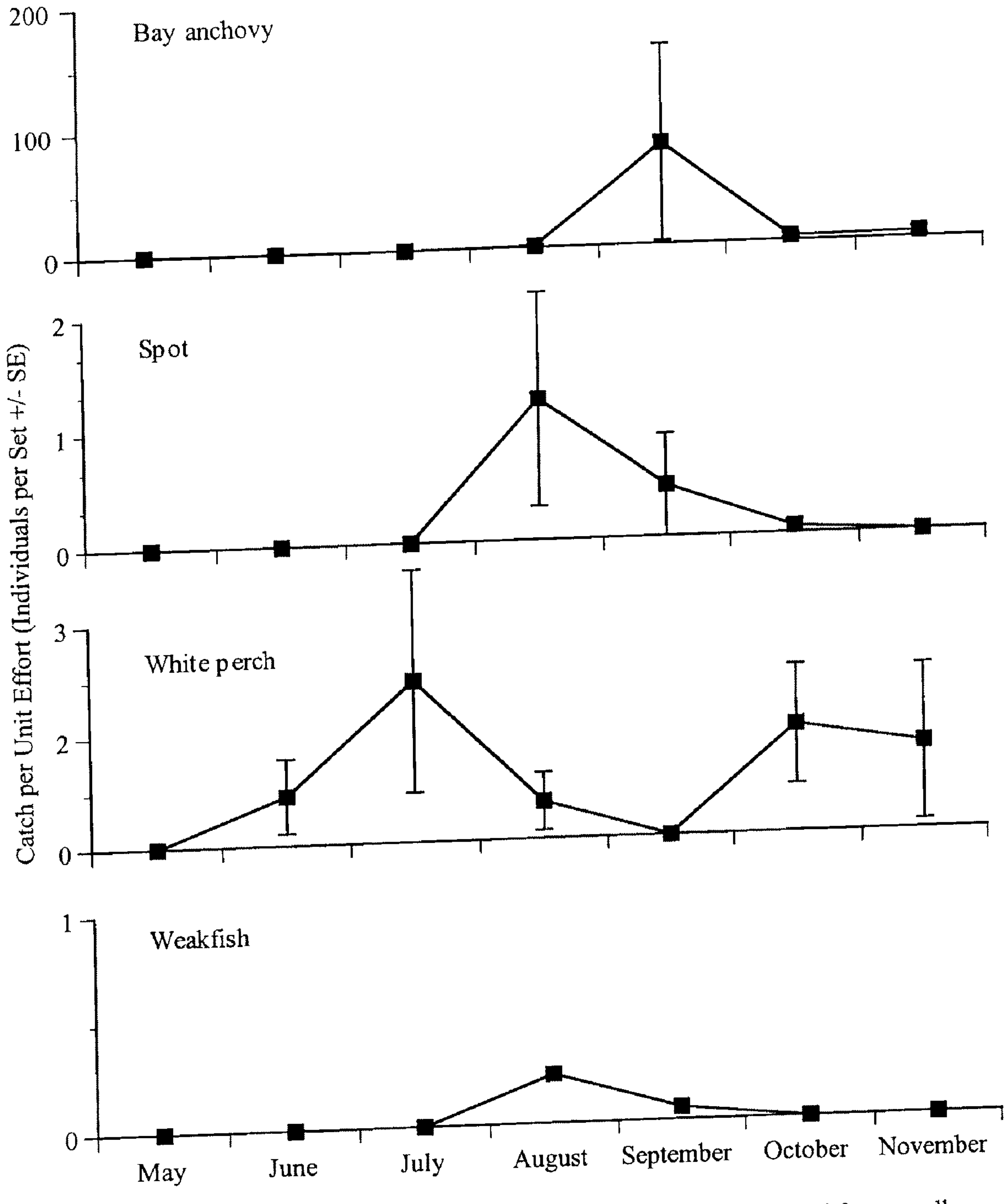



Figure 7-17. Composite abundance of the four target species collected from small marsh creeks using weirs at all the sites in Delaware Bay during 2003.

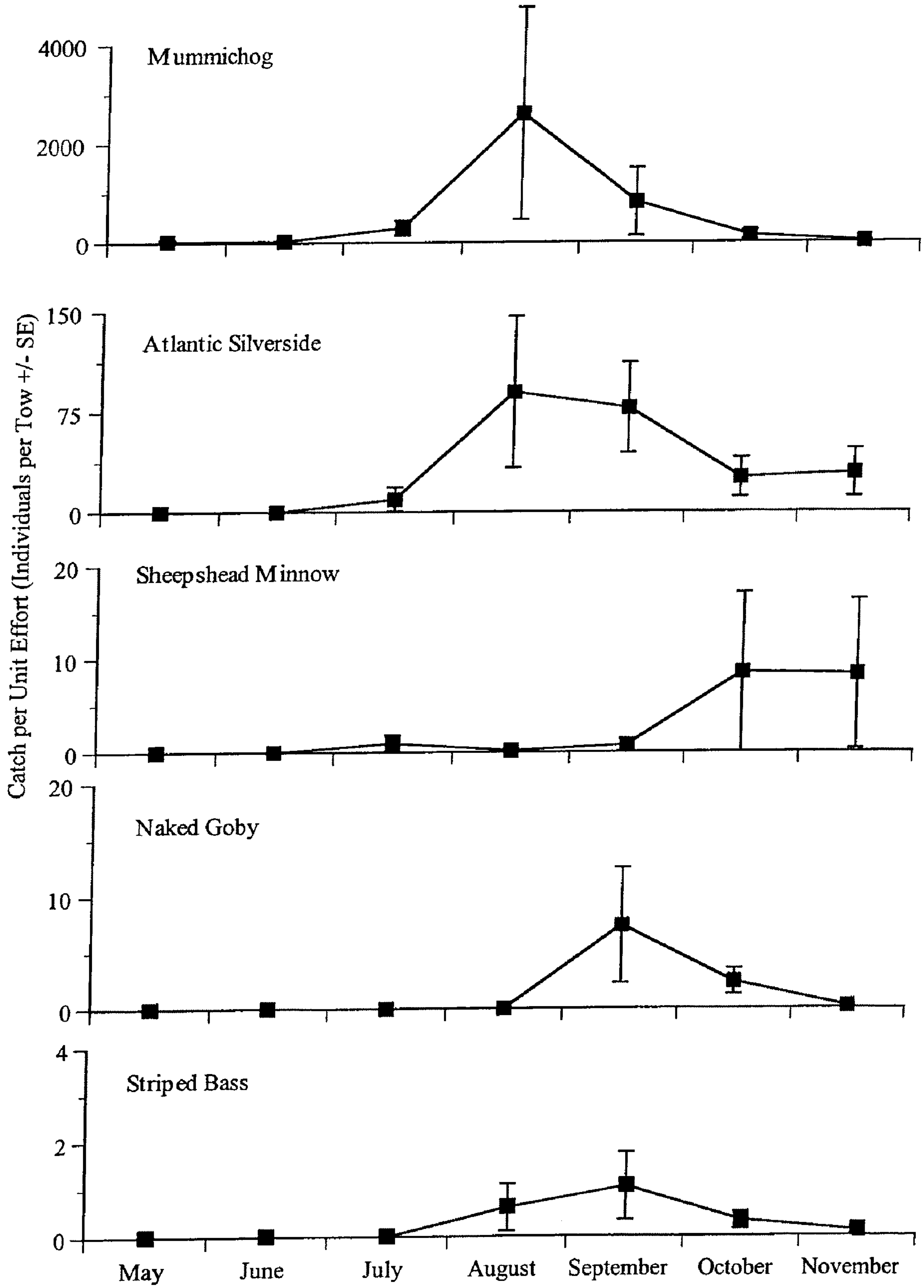



Figure 7-18. Abundance of the five most abundant non-target species collected from small marsh creeks using weirs across all sites in the Delaware Bay during 2003.

**Bay anchovy**

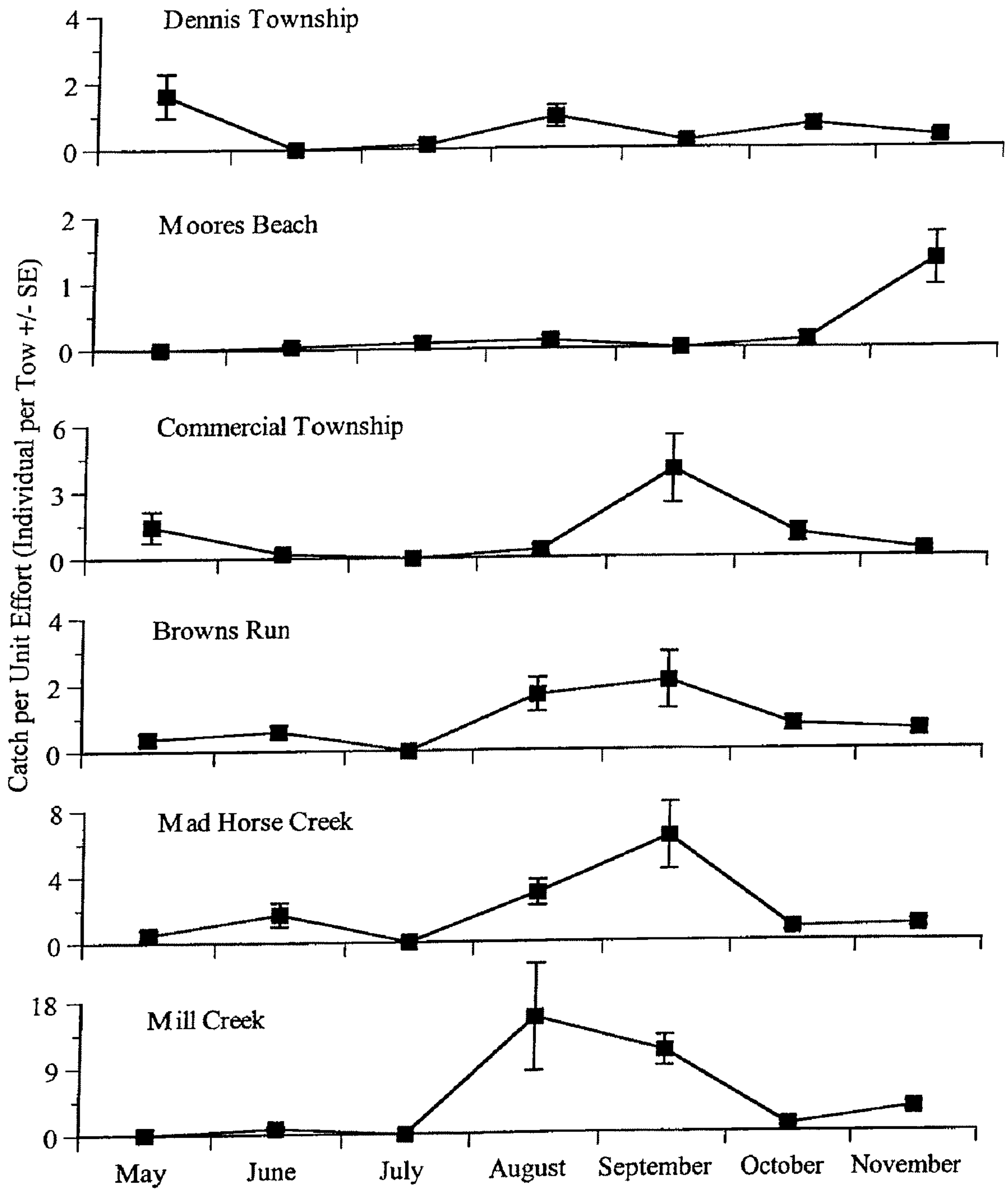



Figure 7-19. Monthly abundance for bay anchovy caught in large marsh creeks with otter trawls during 2003.

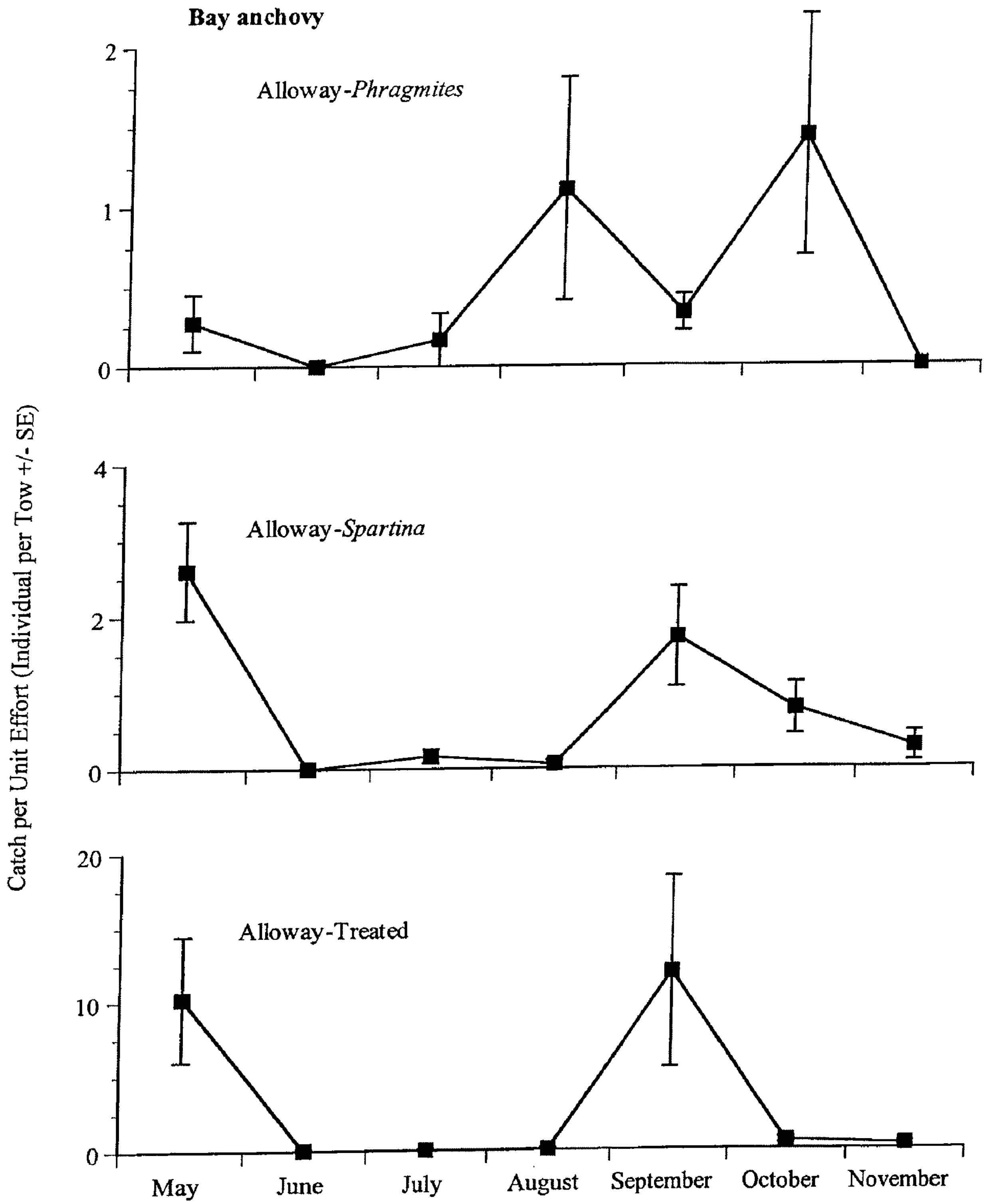



Figure 7-19 (con't). Monthly abundance for bay anchovy caught in large marsh creeks with otter trawls during 2003.

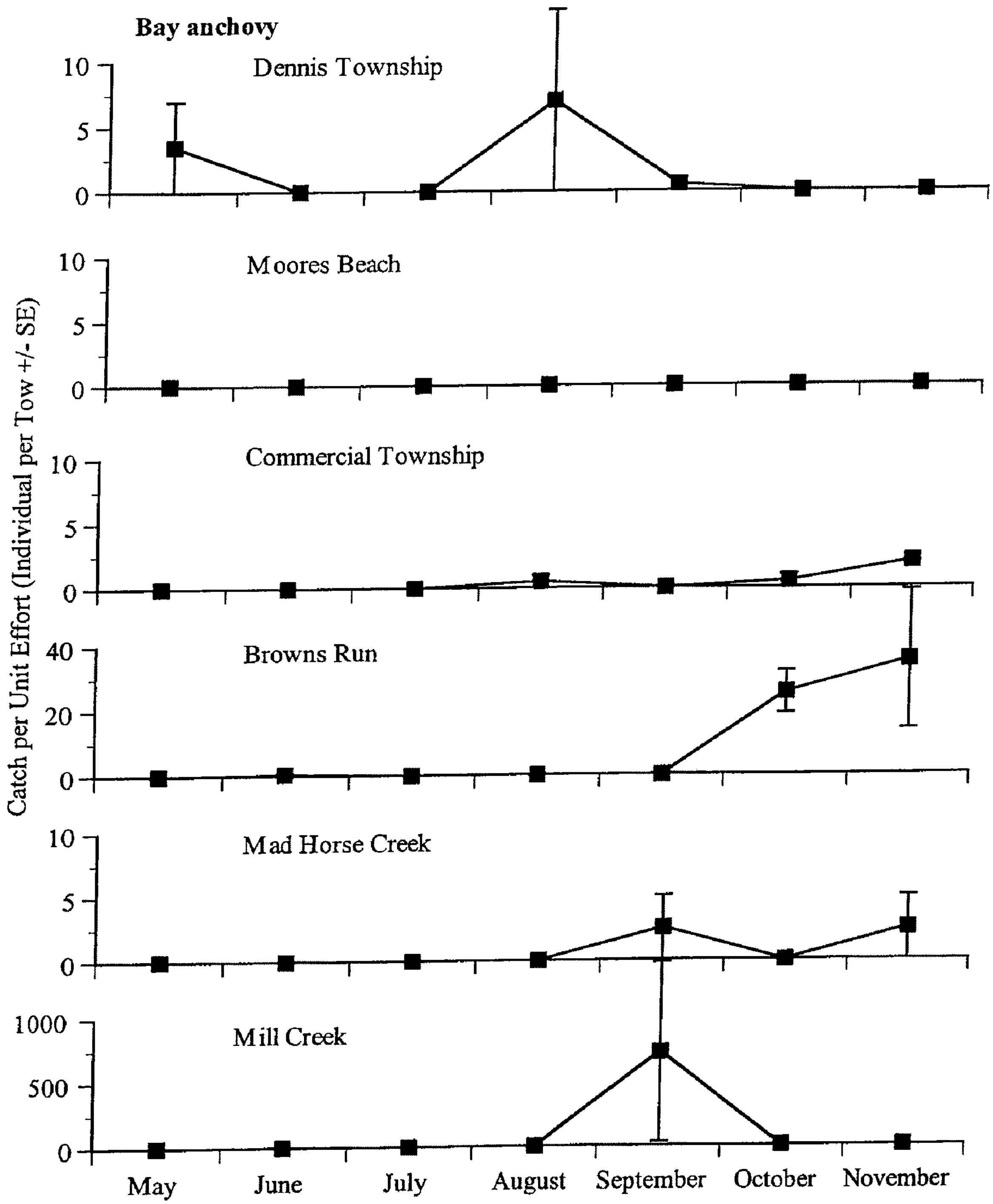



Figure 7-20. Monthly abundance for bay anchovy caught in small marsh creeks with weirs in the Delaware Bay during 2003.

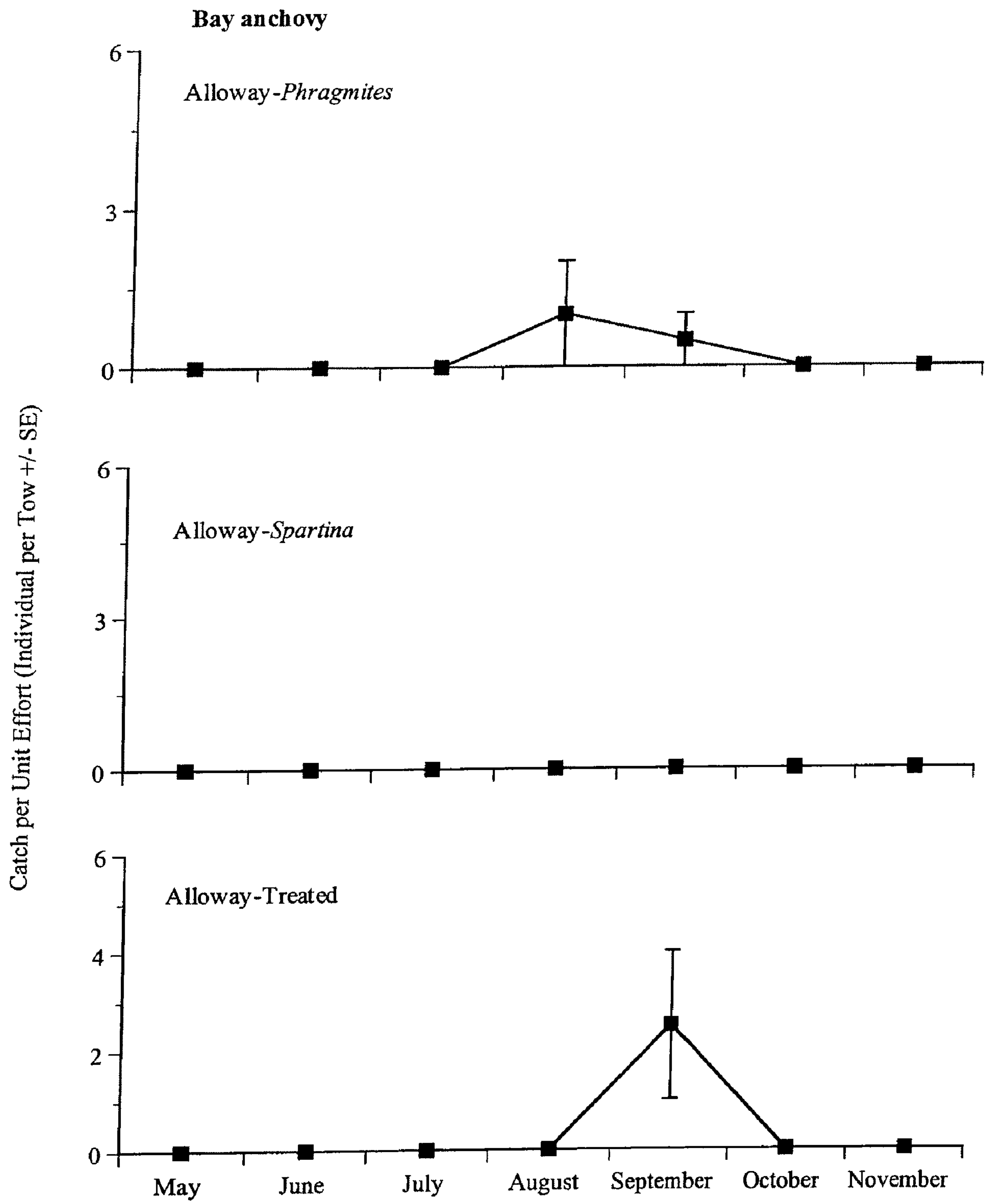



Figure 7-20 (con't). Monthly abundance for bay anchovy caught in small marsh creeks with weirs in the Delaware Bay during 2003.

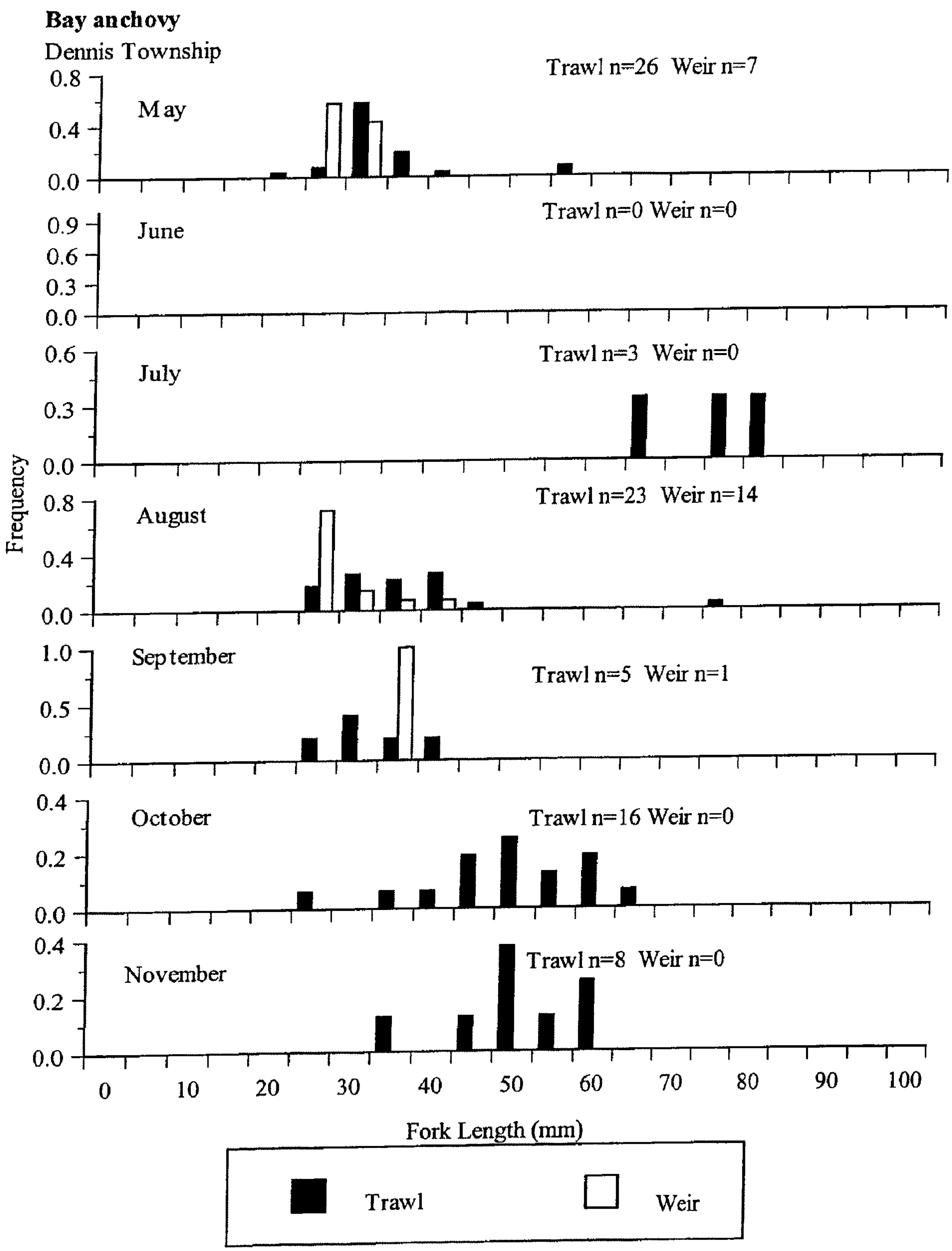



Figure 7-21. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Dennis Township during 2003.

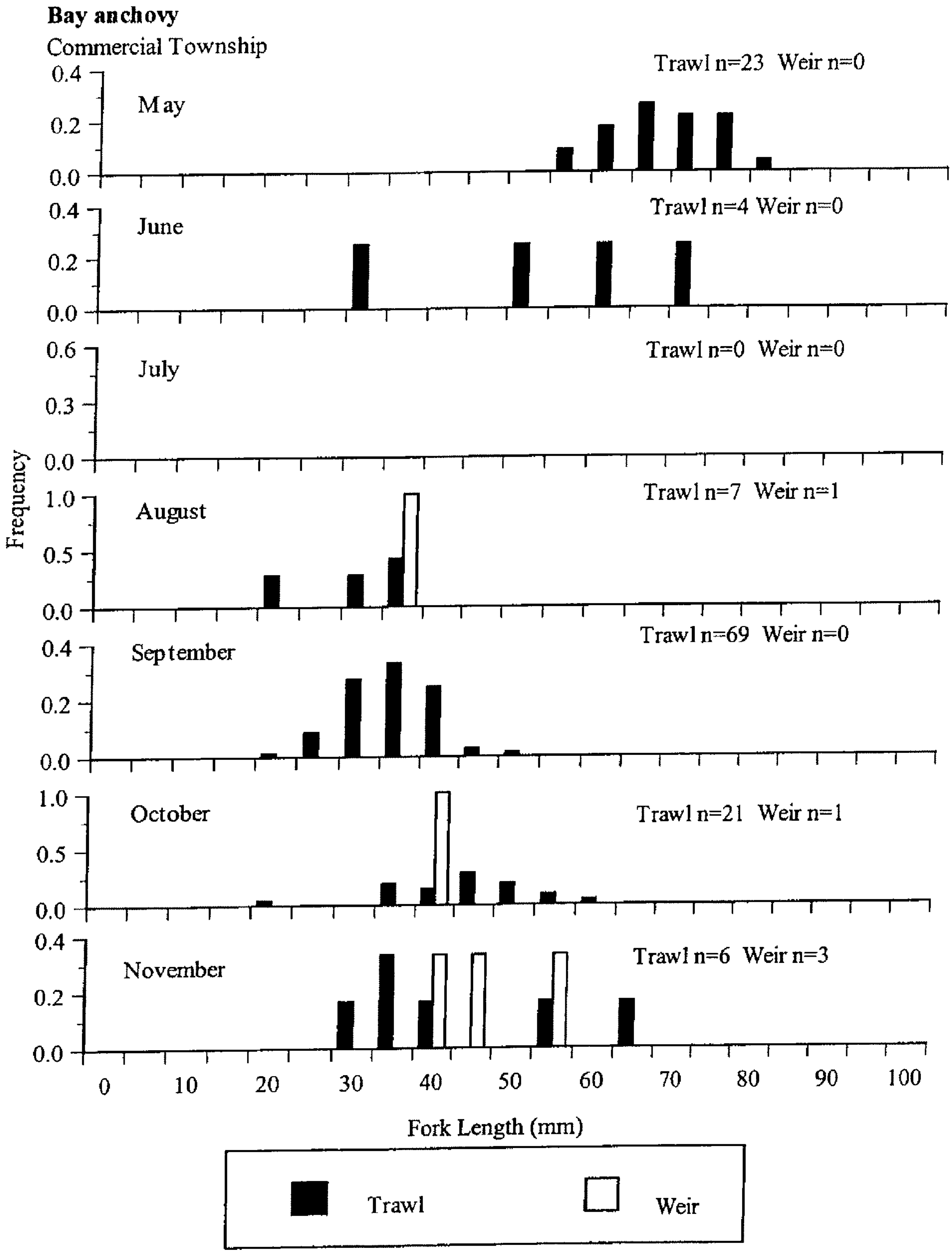



Figure 7-22. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Commercial Township during 2003.

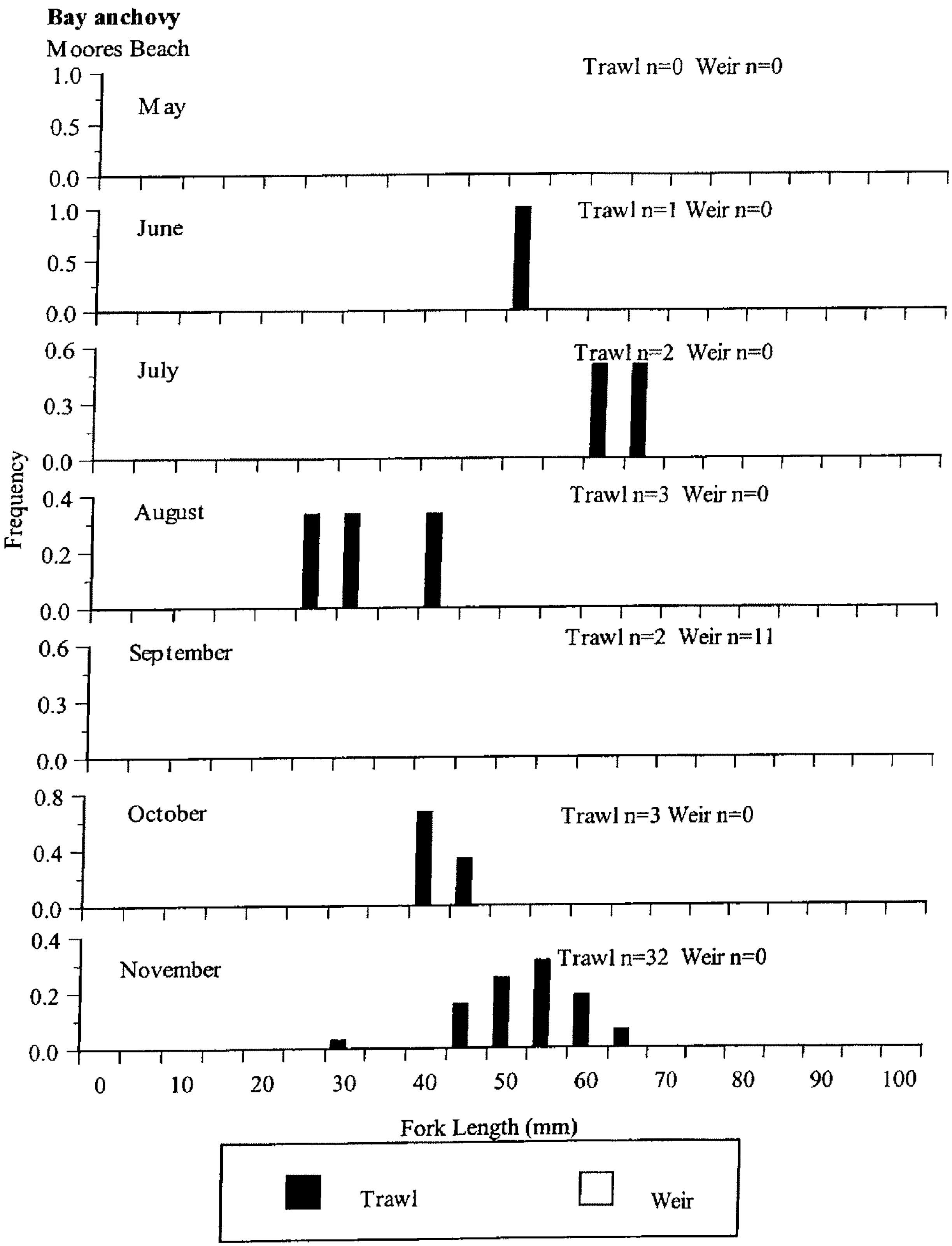



Figure 7-23. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Moores Beach during 2003.

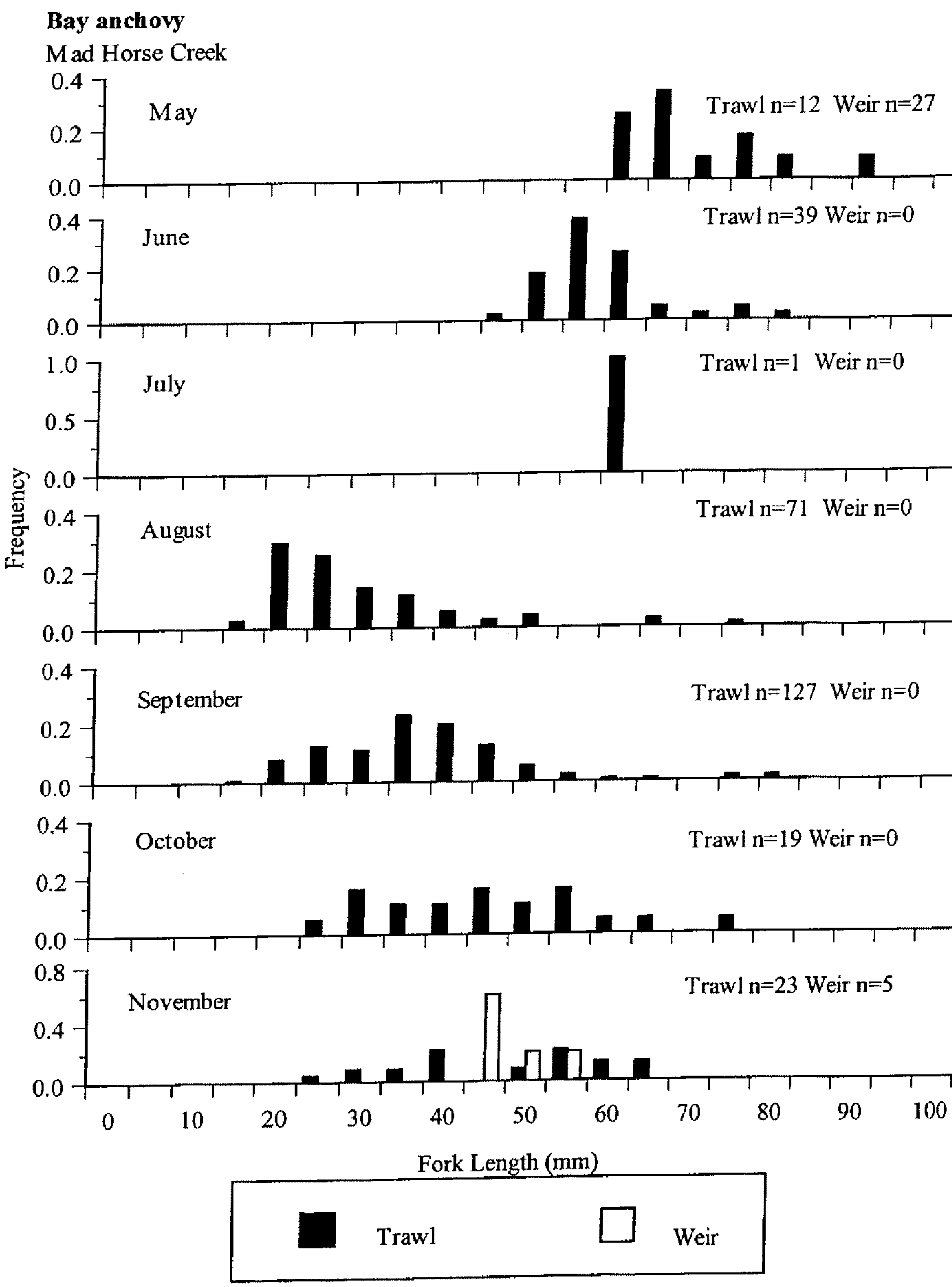



Figure 7-24. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mad Horse Creek during 2003.

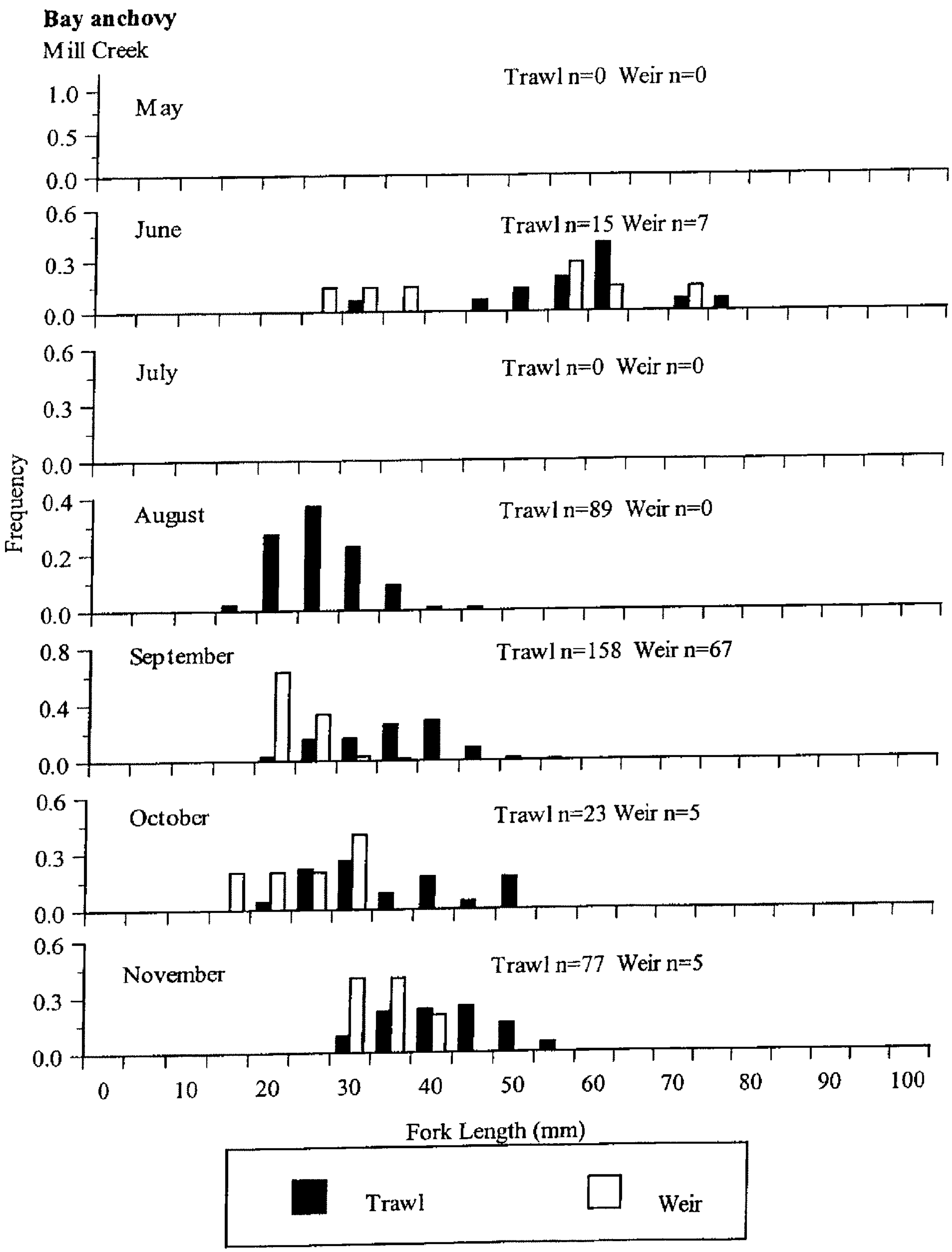



Figure 7-25. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mill Creek during 2003.

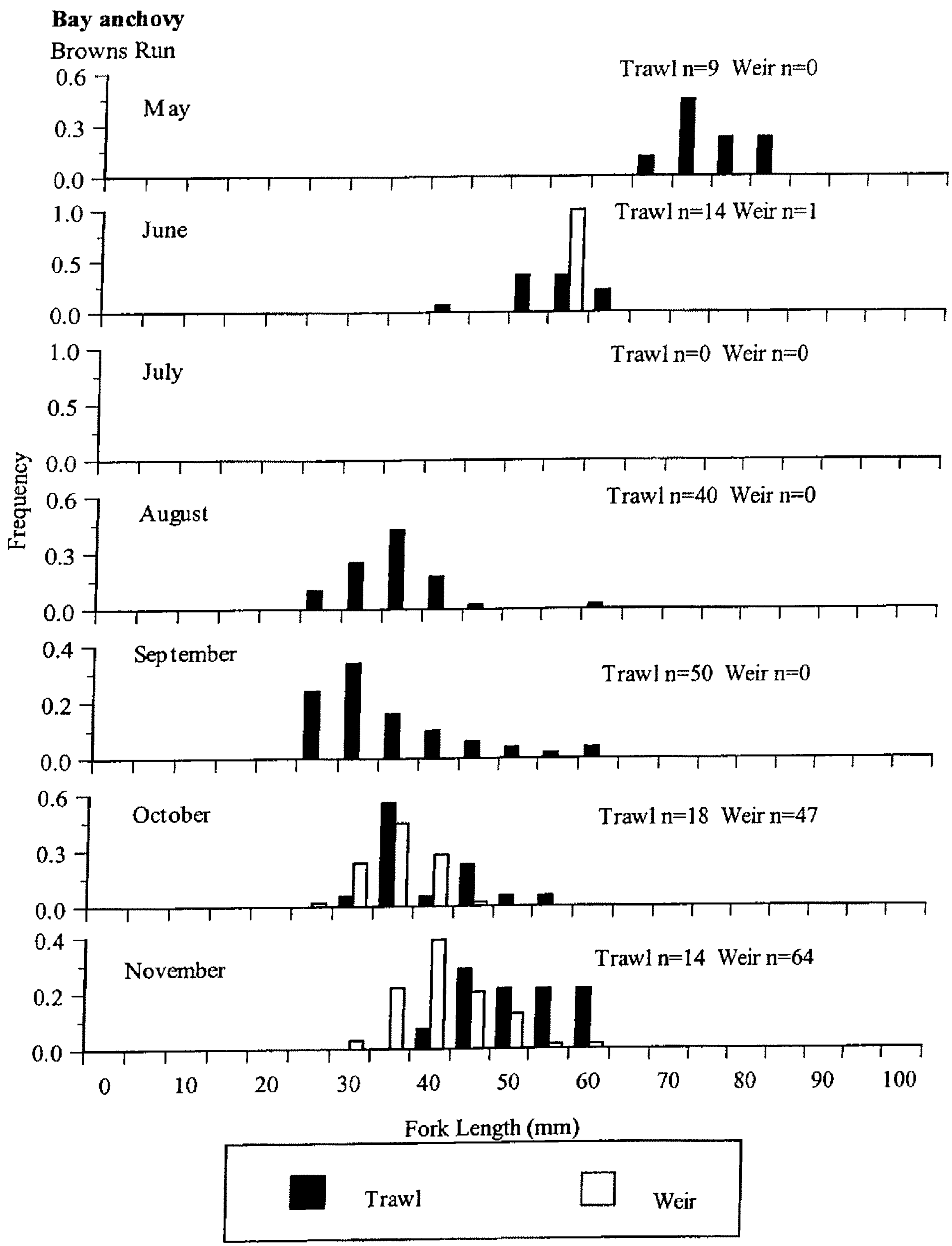



Figure 7-26. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Browns Run during 2003.

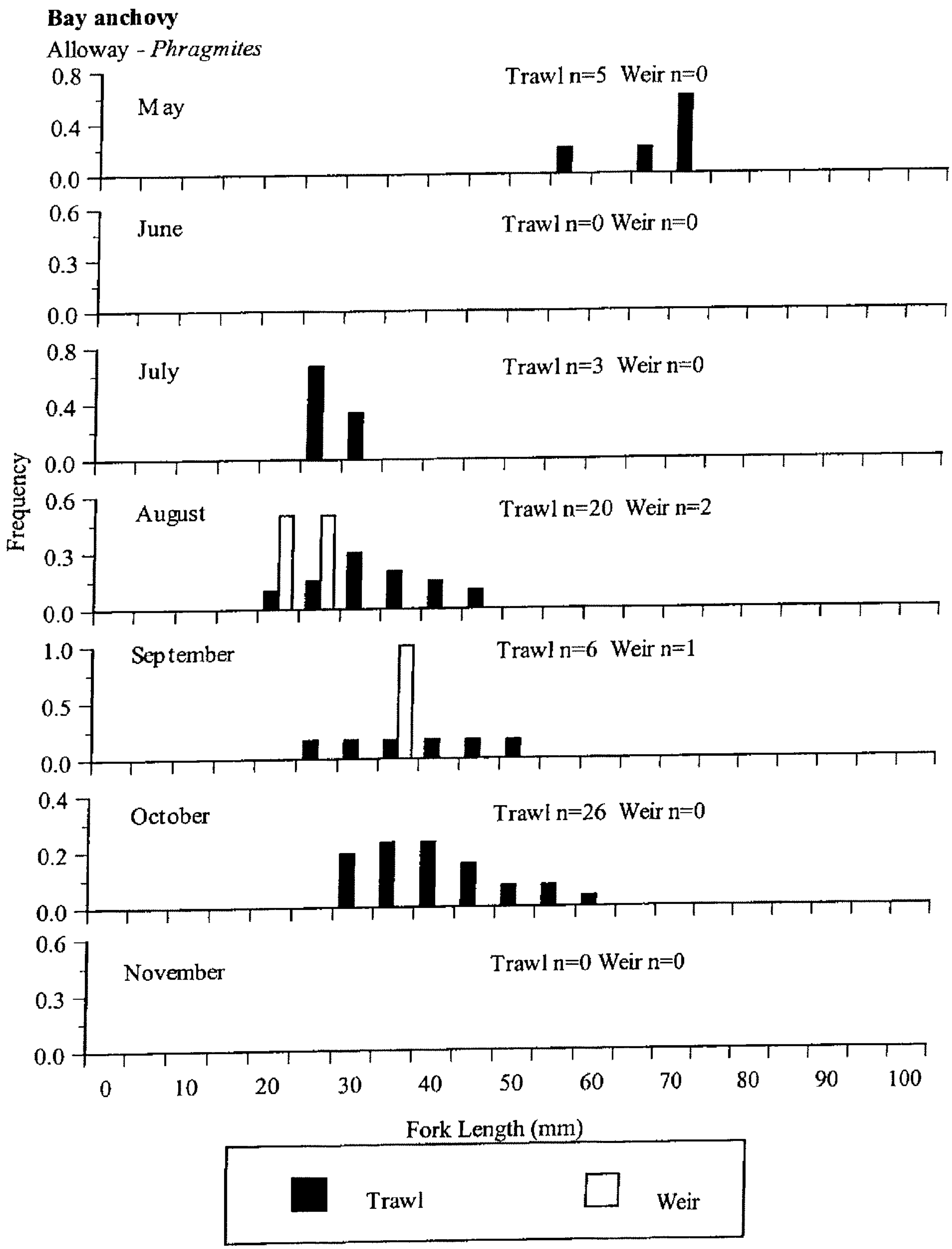



Figure 7-27. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Phragmites* site during 2003.

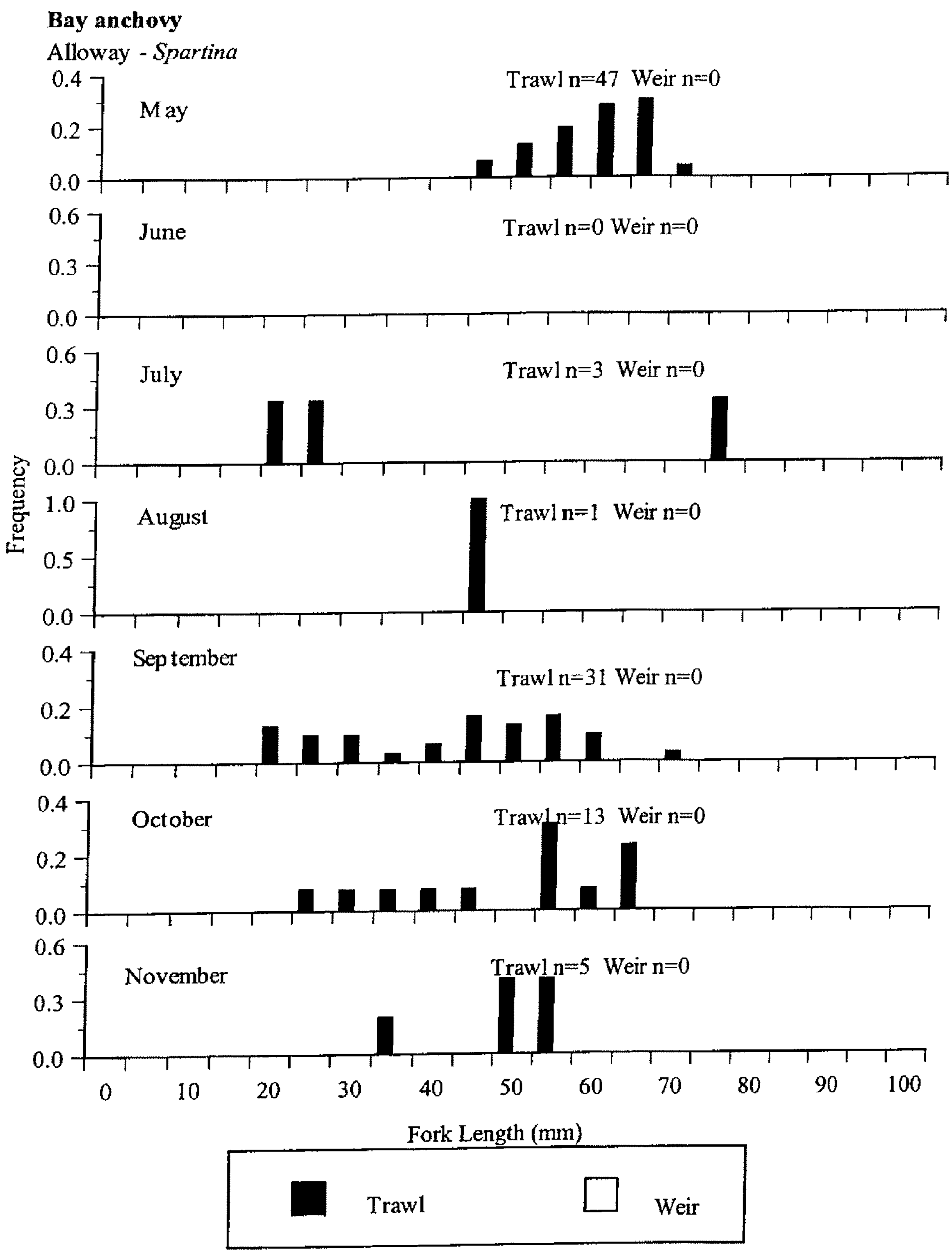



Figure 7-28. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Spartina* site during 2003.

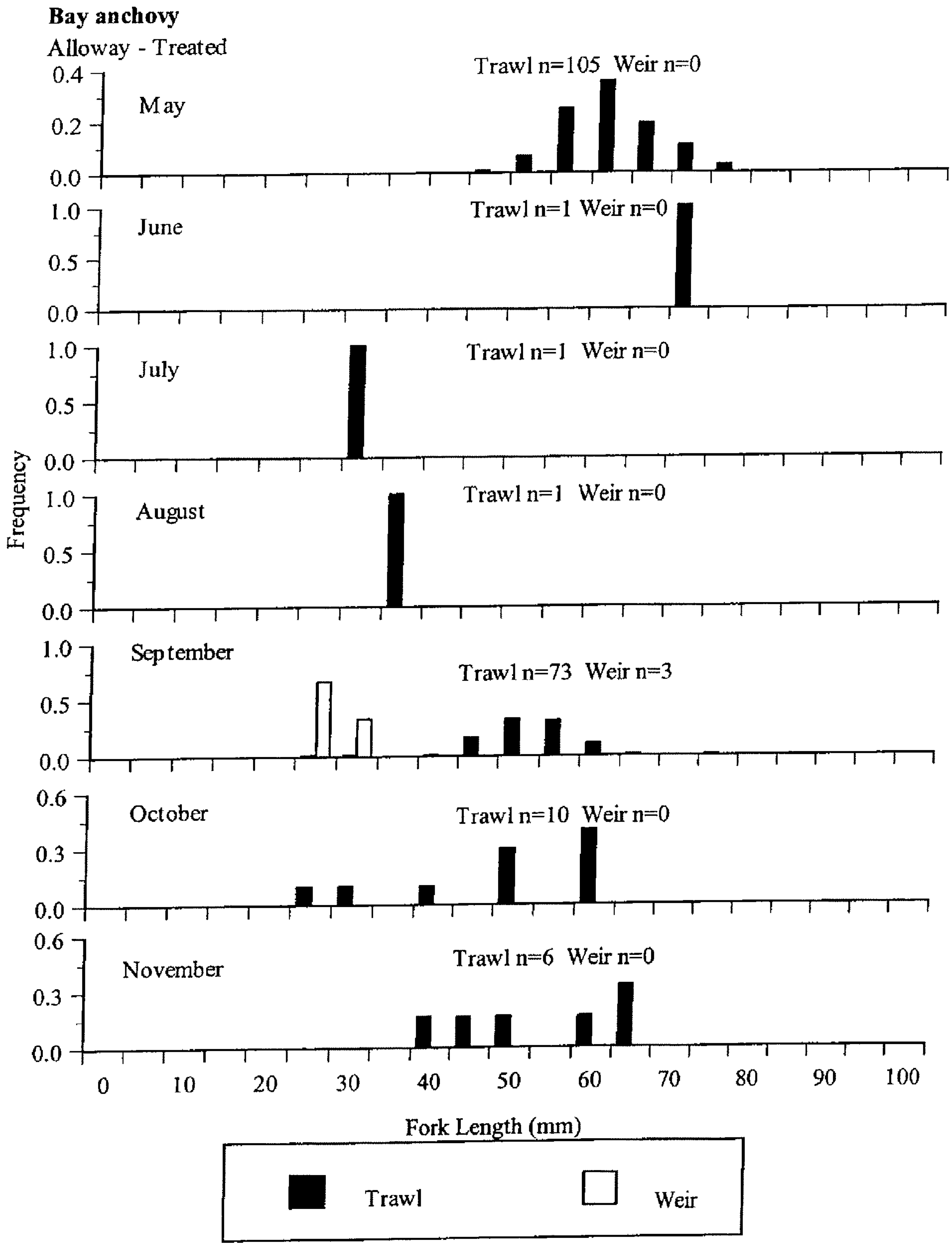



Figure 7-29. Size distribution of bay anchovy from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek Treated during 2003.

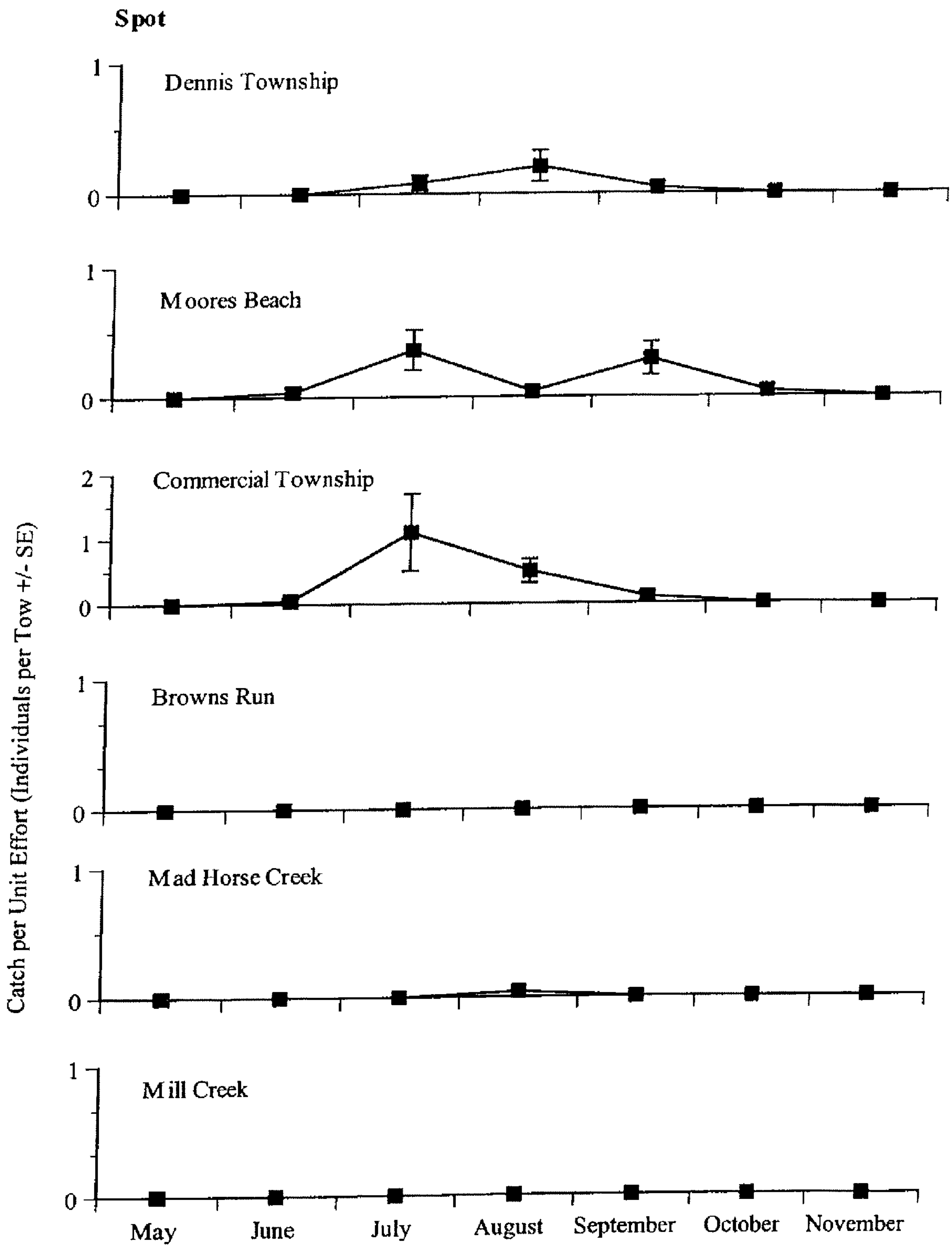



Figure 7-30. Monthly abundance for spot caught in large marsh creeks with otter trawls during 2003.

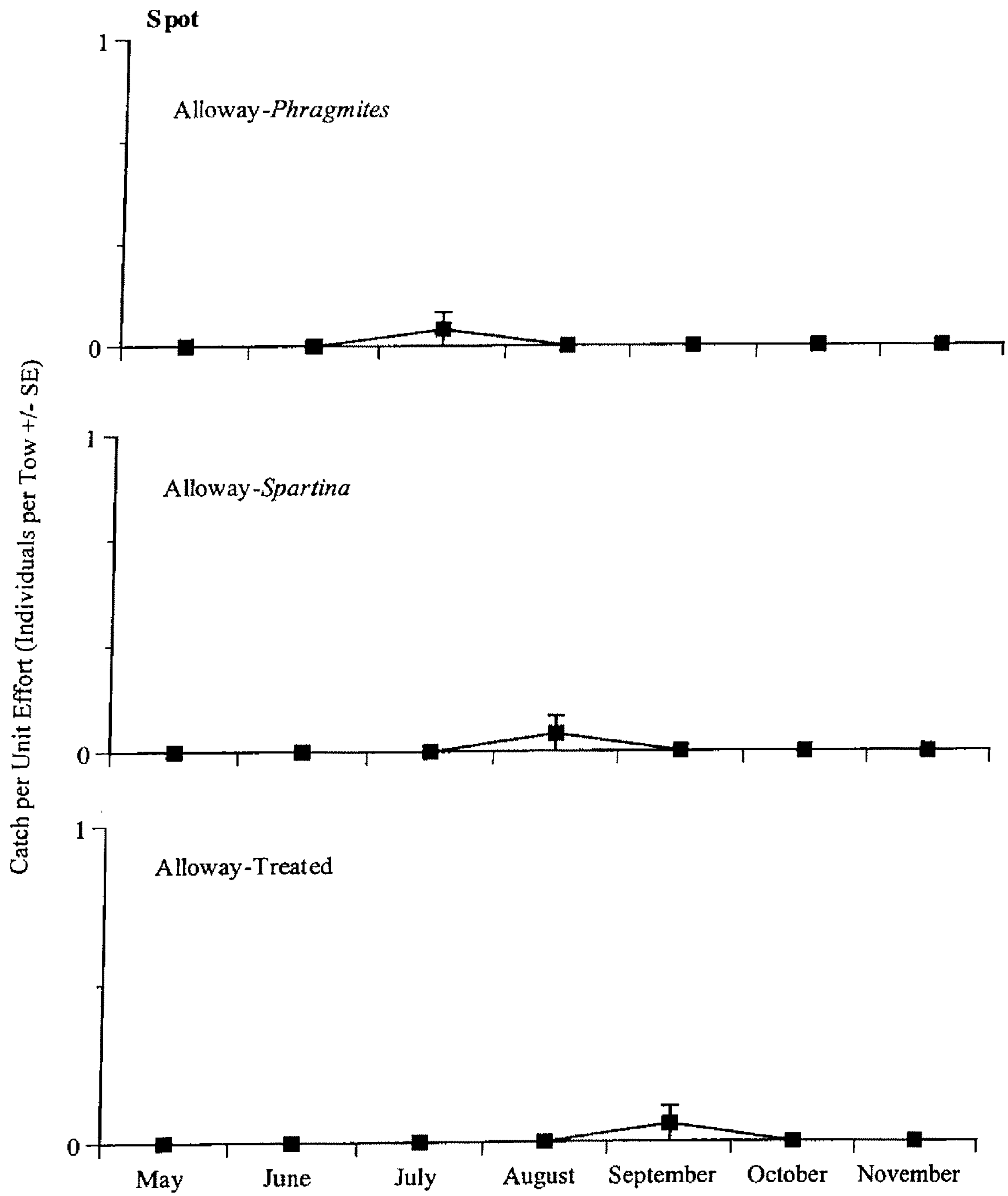



Figure 7-30 (con't). Monthly abundance for spot caught in large marsh creeks with otter trawls during 2003.

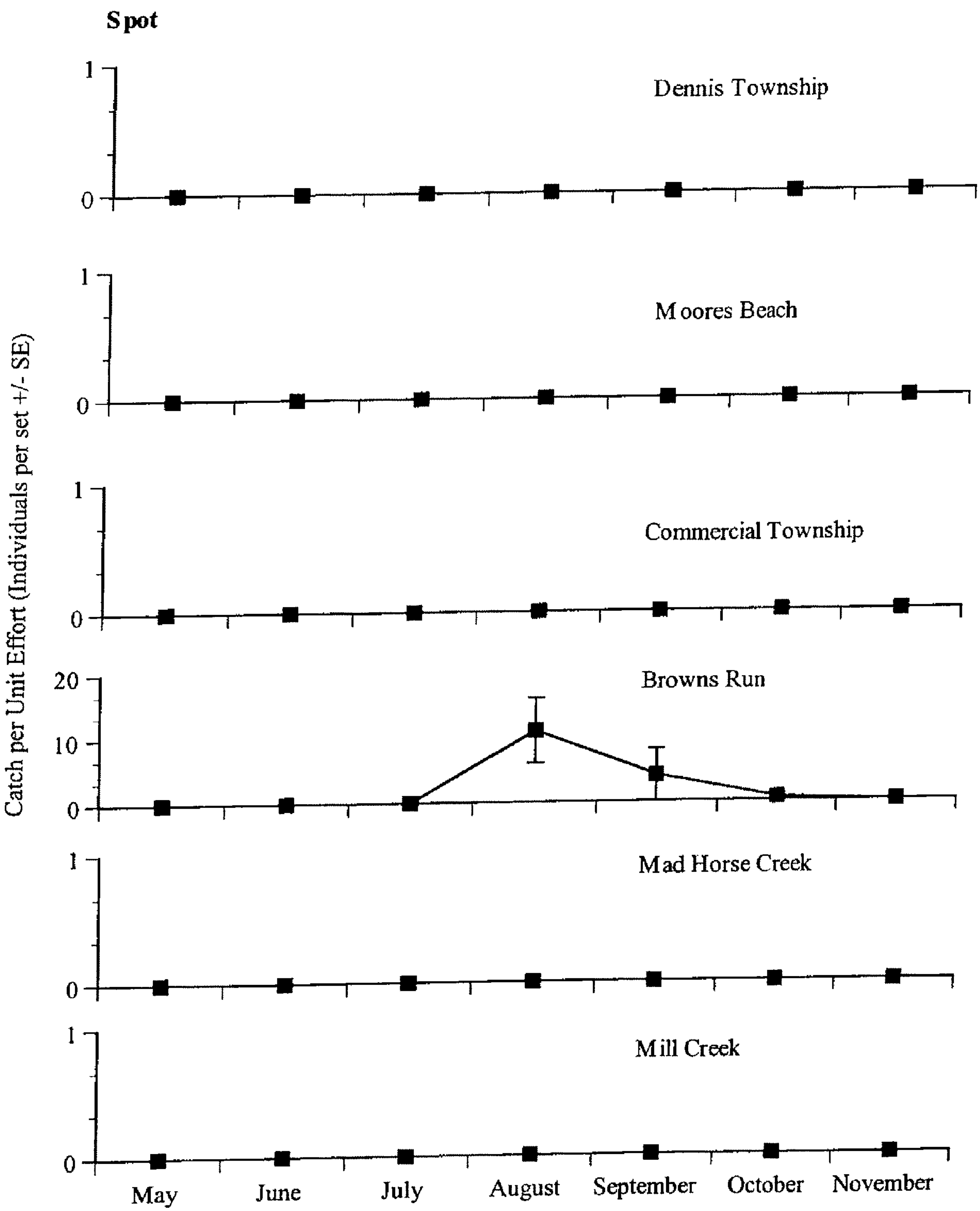



Figure 7-31. Monthly abundance for spot caught in small marsh creeks with weirs during 2003.

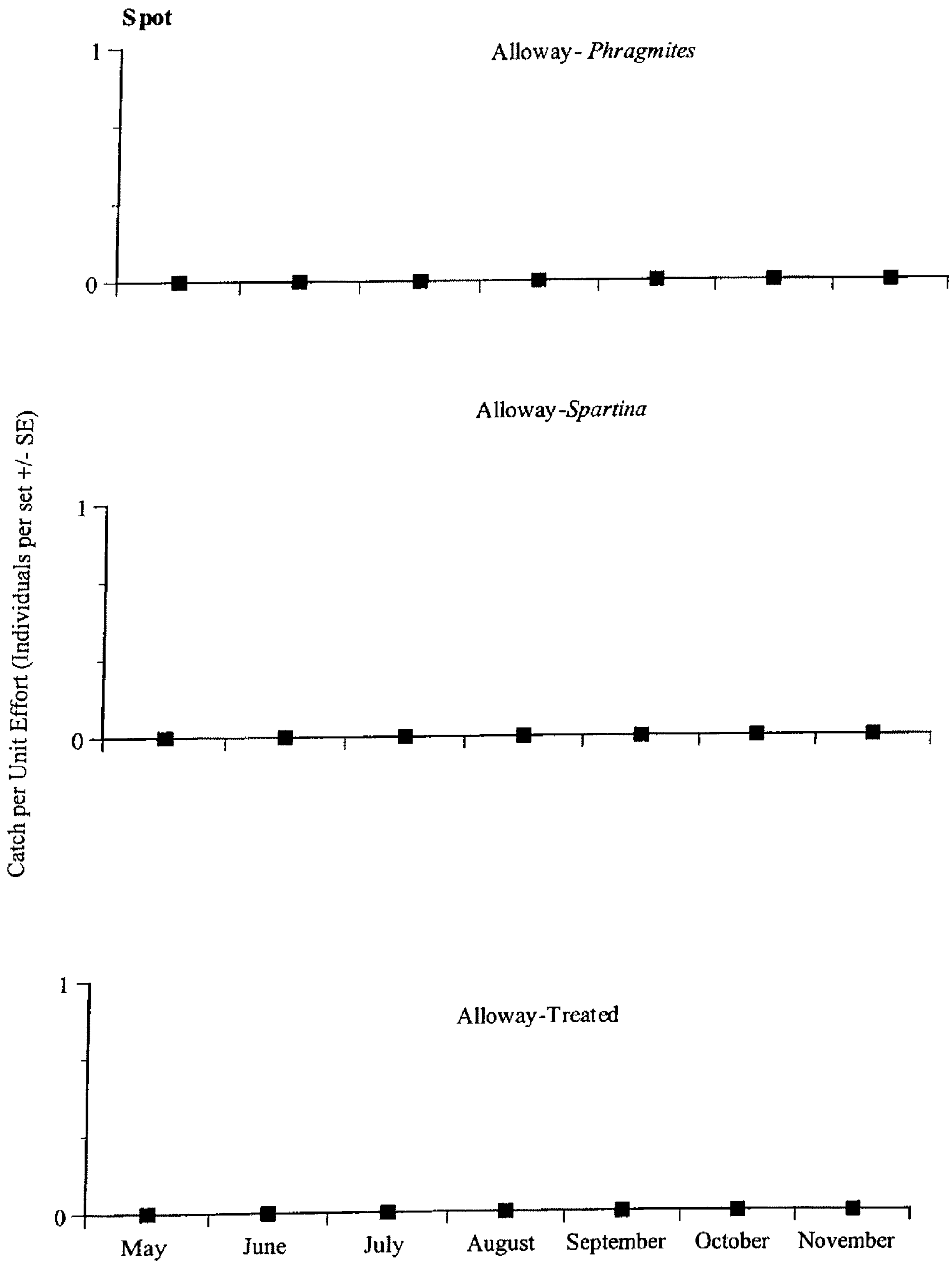



Figure 7-31 (con't). Monthly abundance for spot caught in small marsh creeks with weirs during 2003.

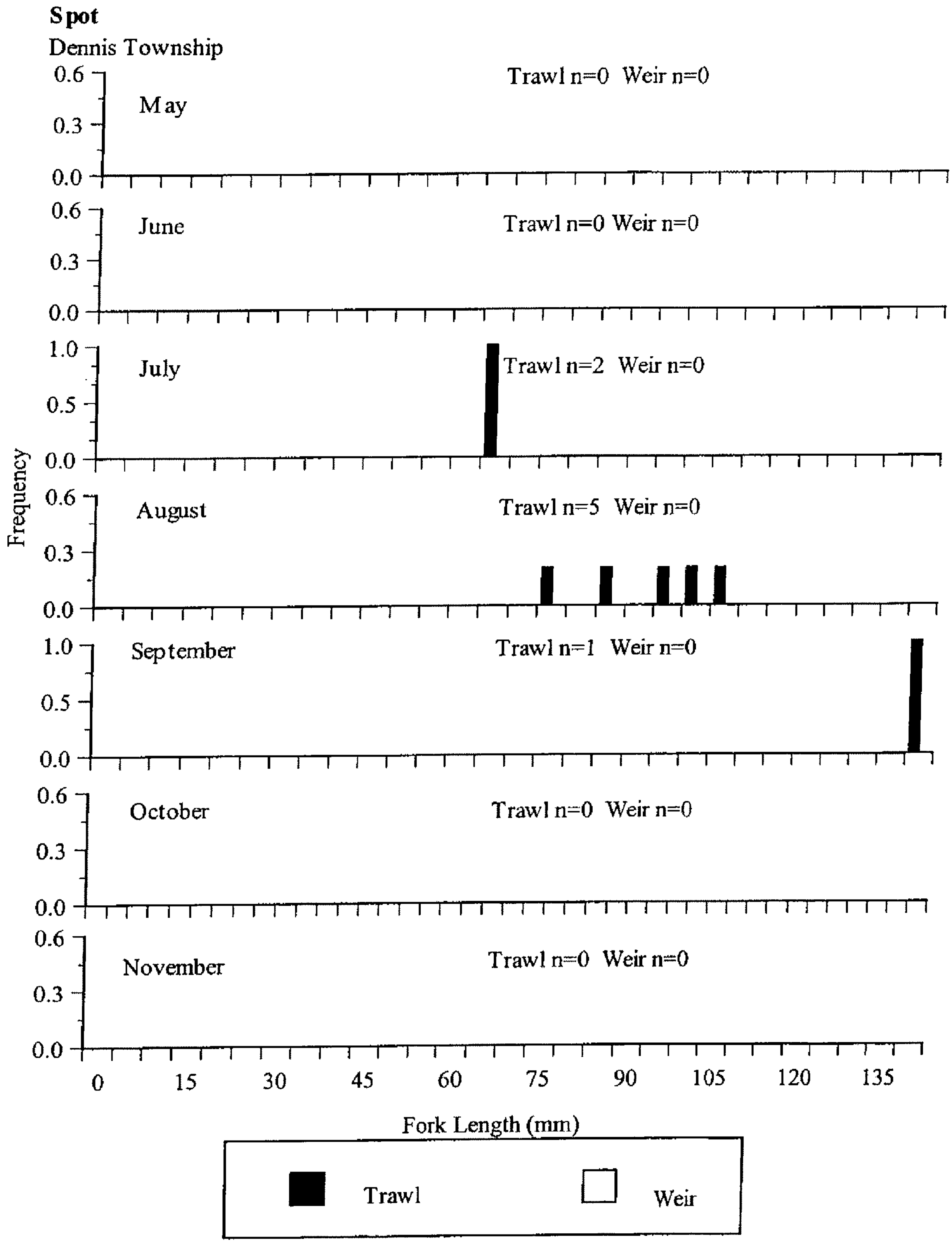



Figure 7-32. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Dennis Township during 2003.

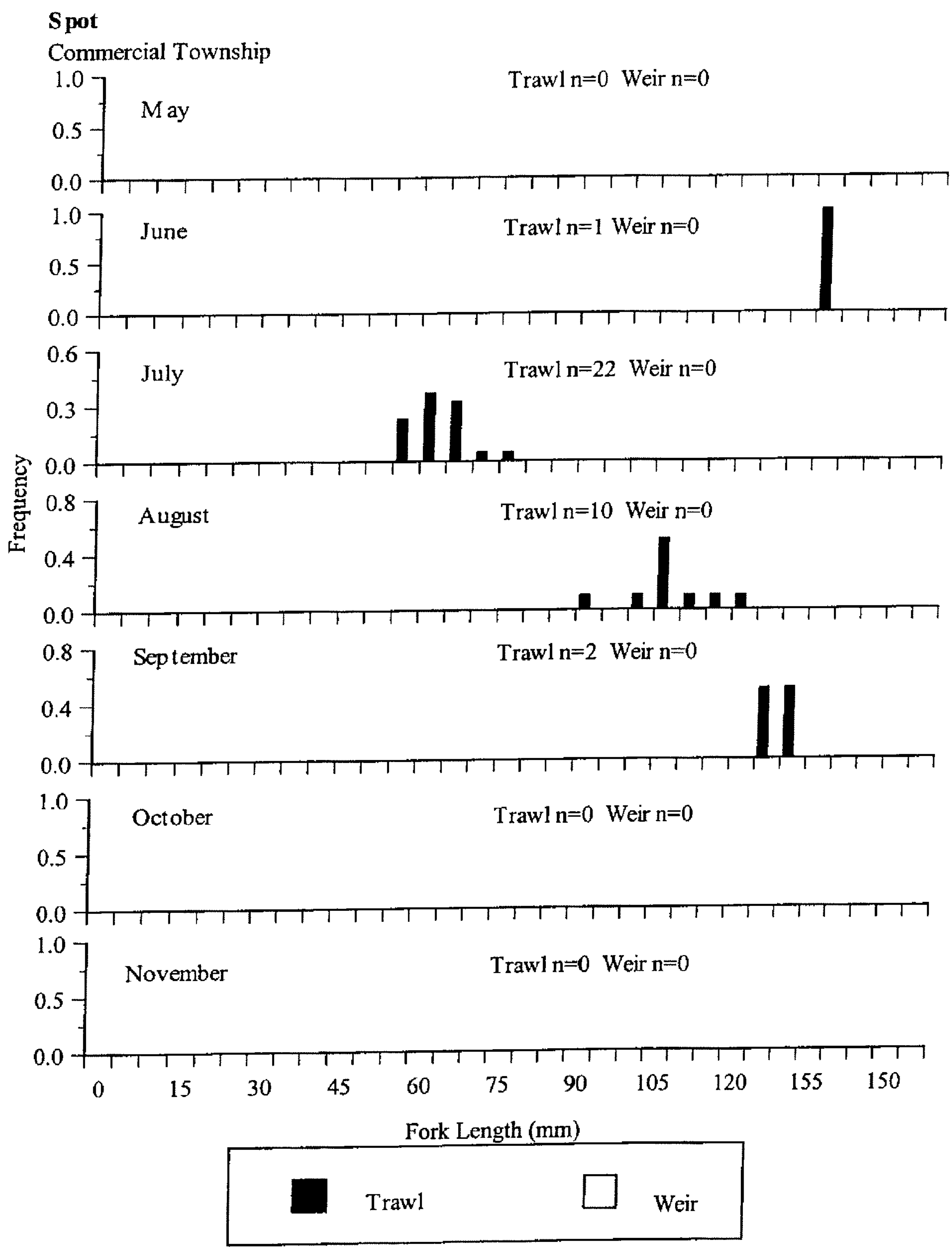



Figure 7-33. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Commercial Township during 2003.

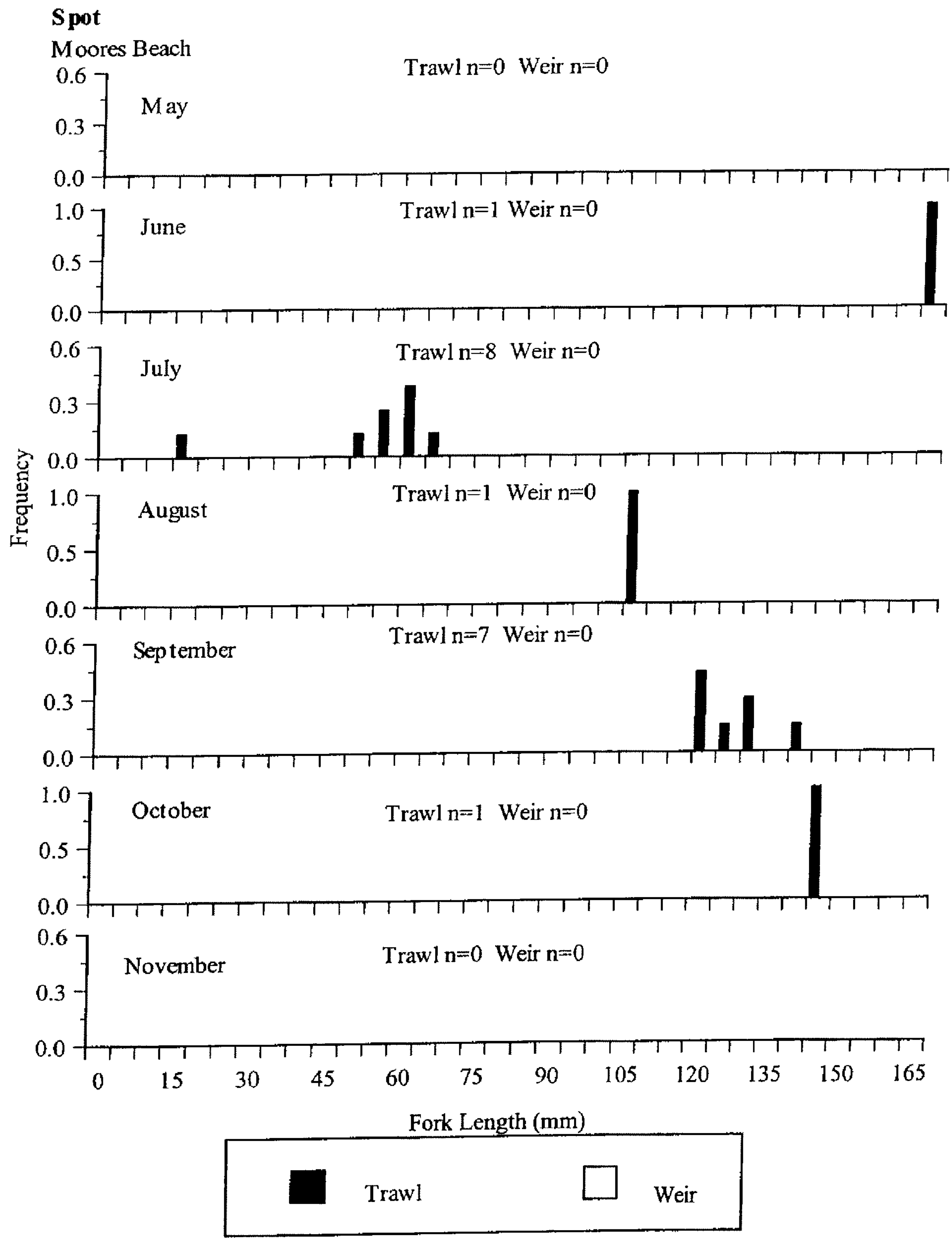



Figure 7-34. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Moores Beach during 2003.

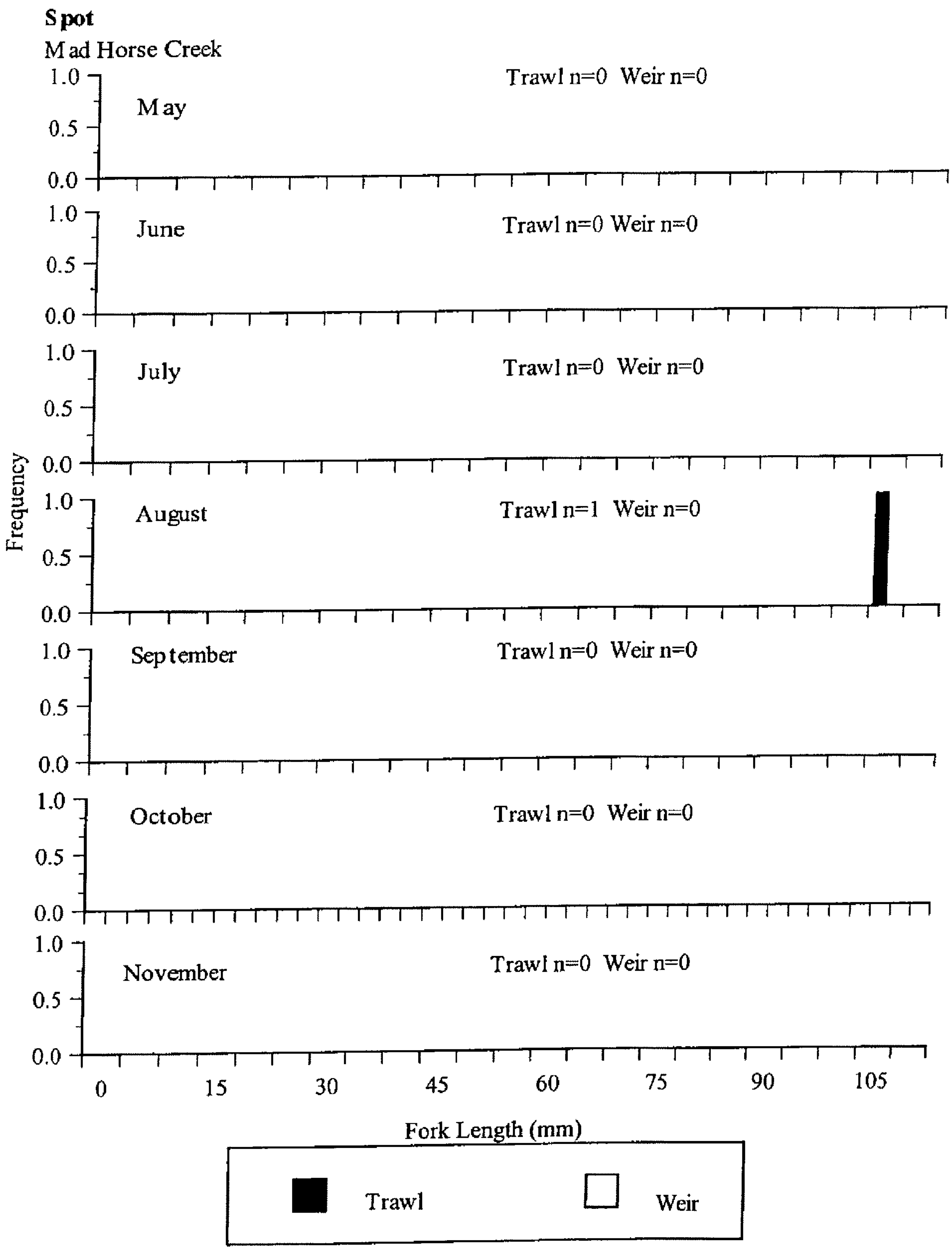



Figure 7-35. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mad Horse Creek during 2003.

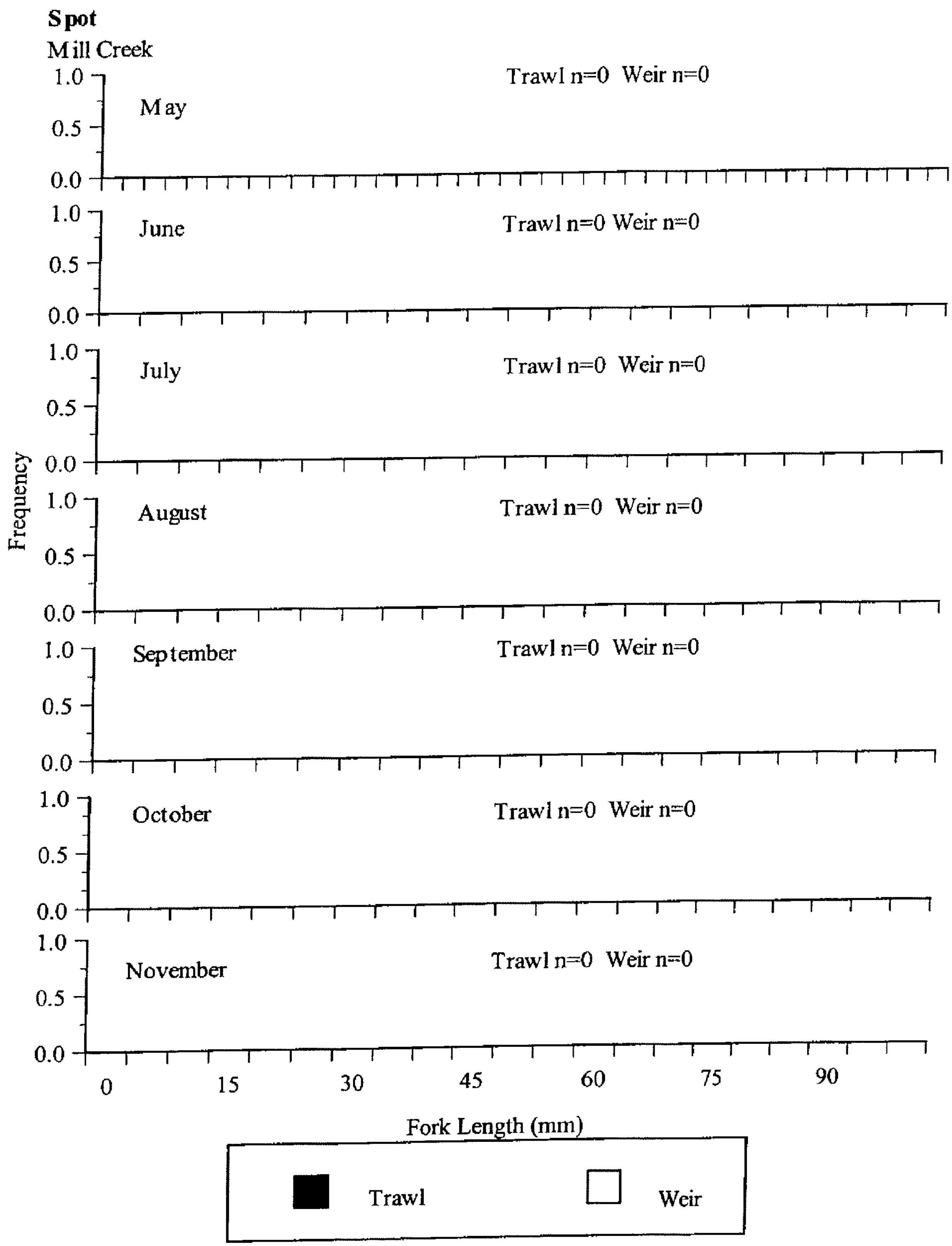



Figure 7-36. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mill Creek during 2003.

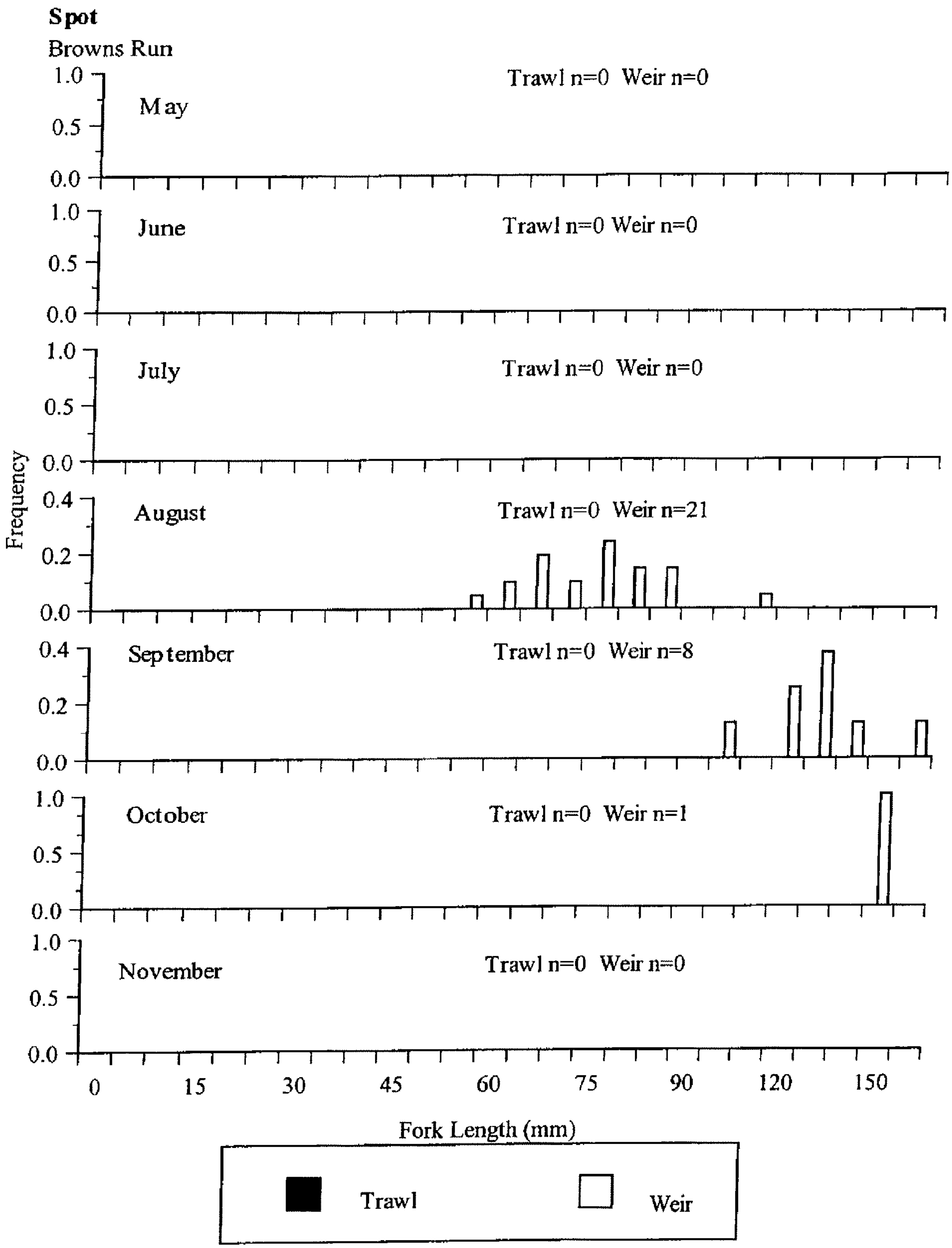



Figure 7-37. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Browns Run during 2003.

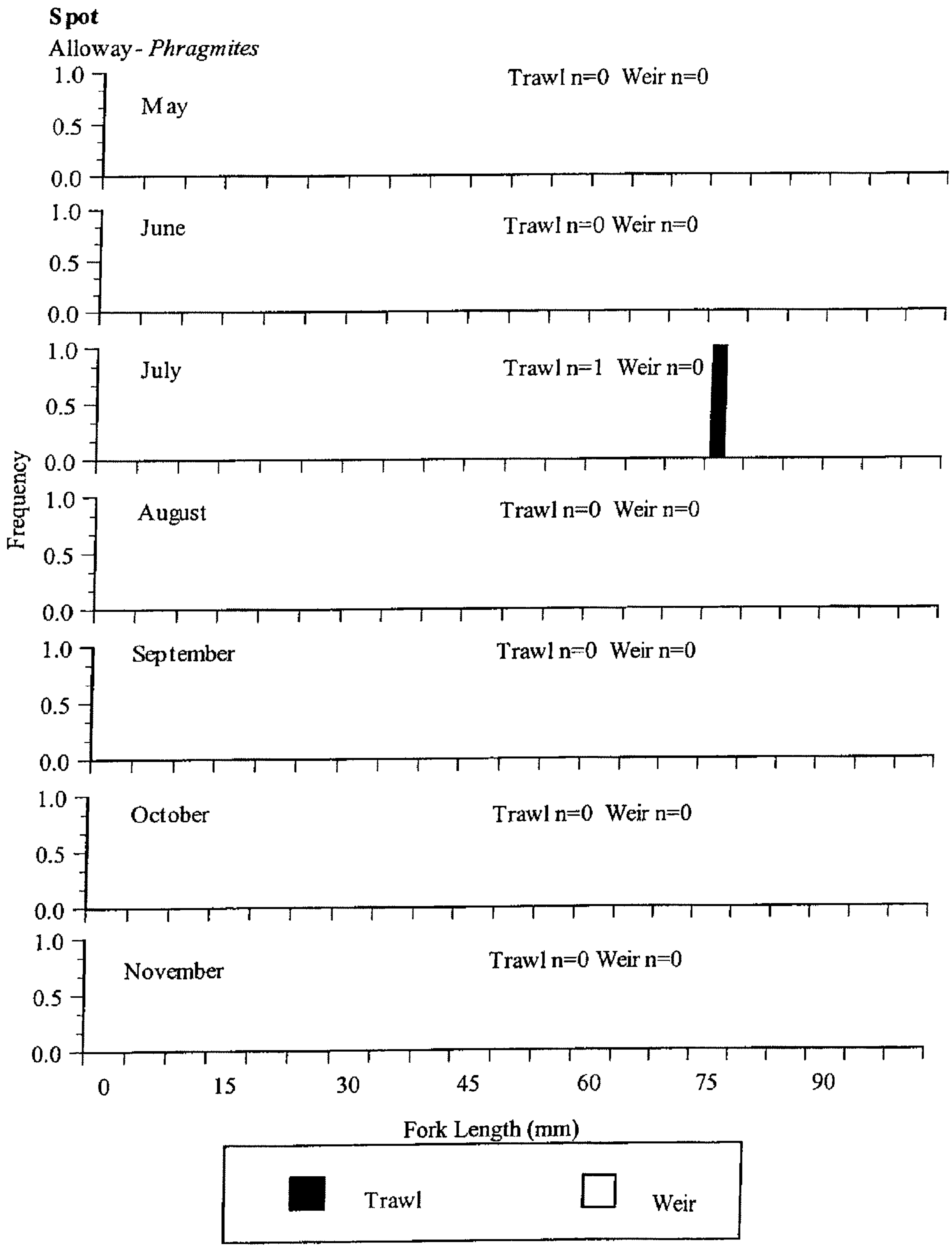



Figure 7-38. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Phragmites* site during 2003.

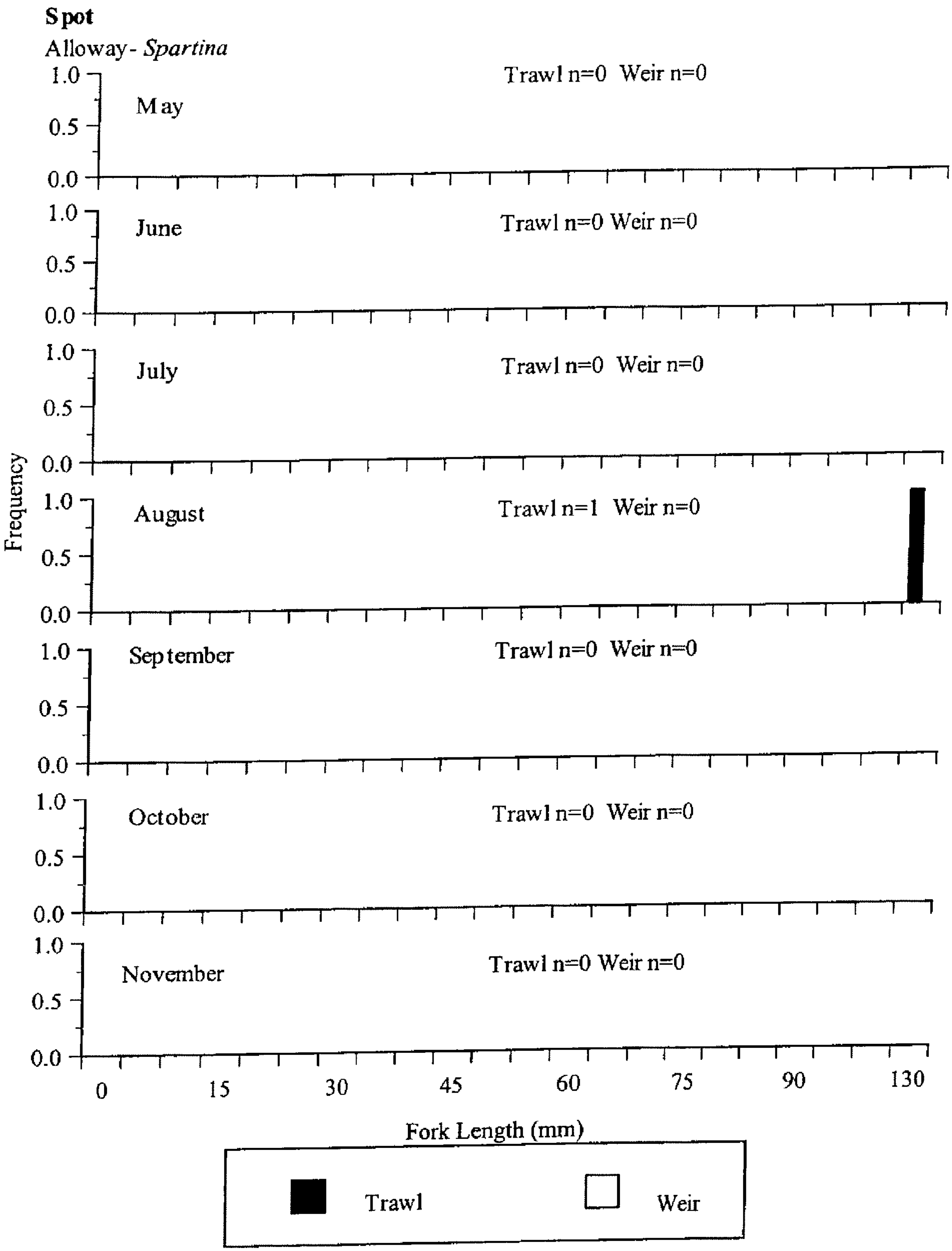



Figure 7-39. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Spartina* site during 2003.

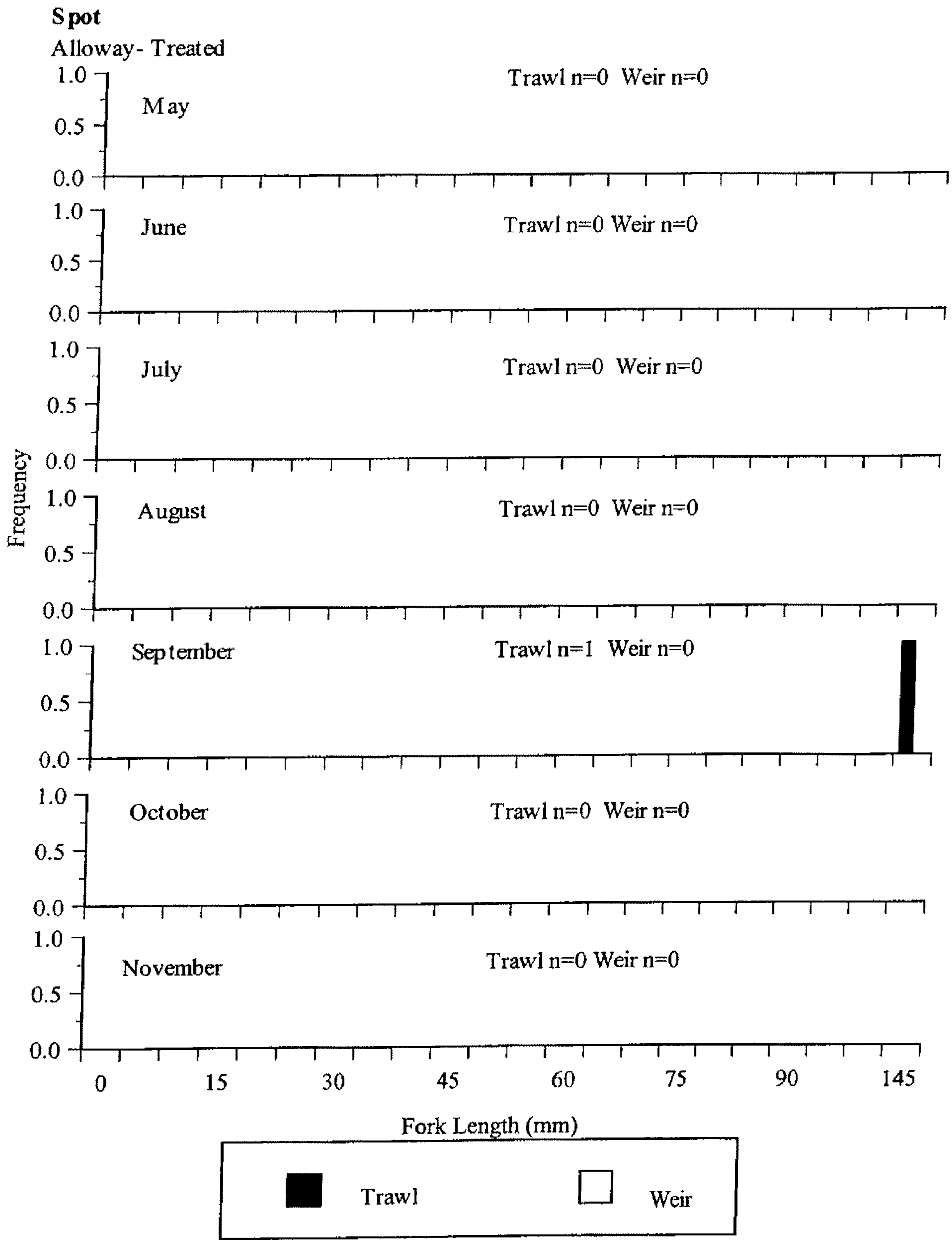



Figure 7-40. Size distribution of spot from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek Treated site during 2003.

**Weakfish**

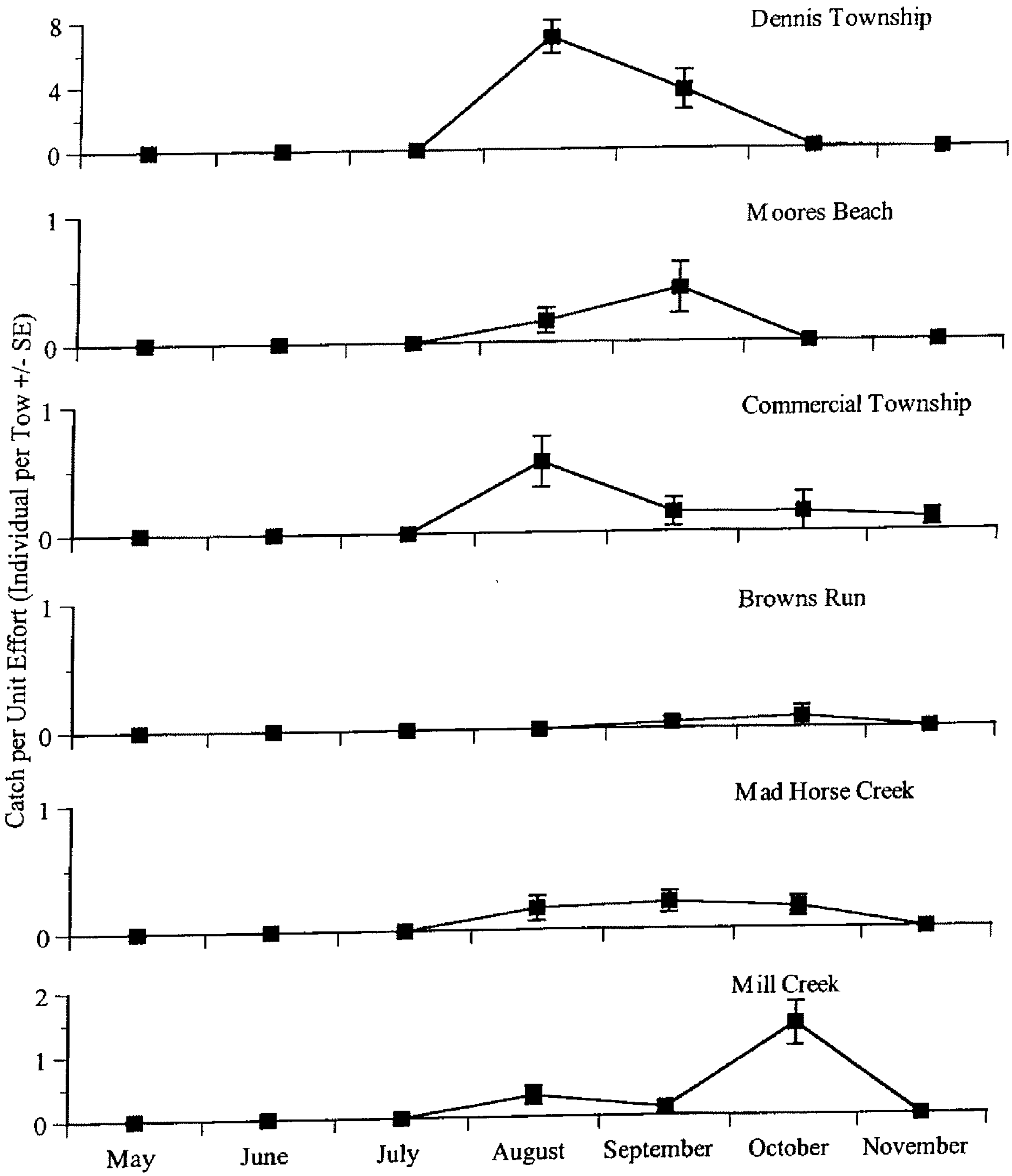



Figure 7-41. Monthly abundance for weakfish caught in large marsh creeks with otter trawls during 2003.

**Weakfish**

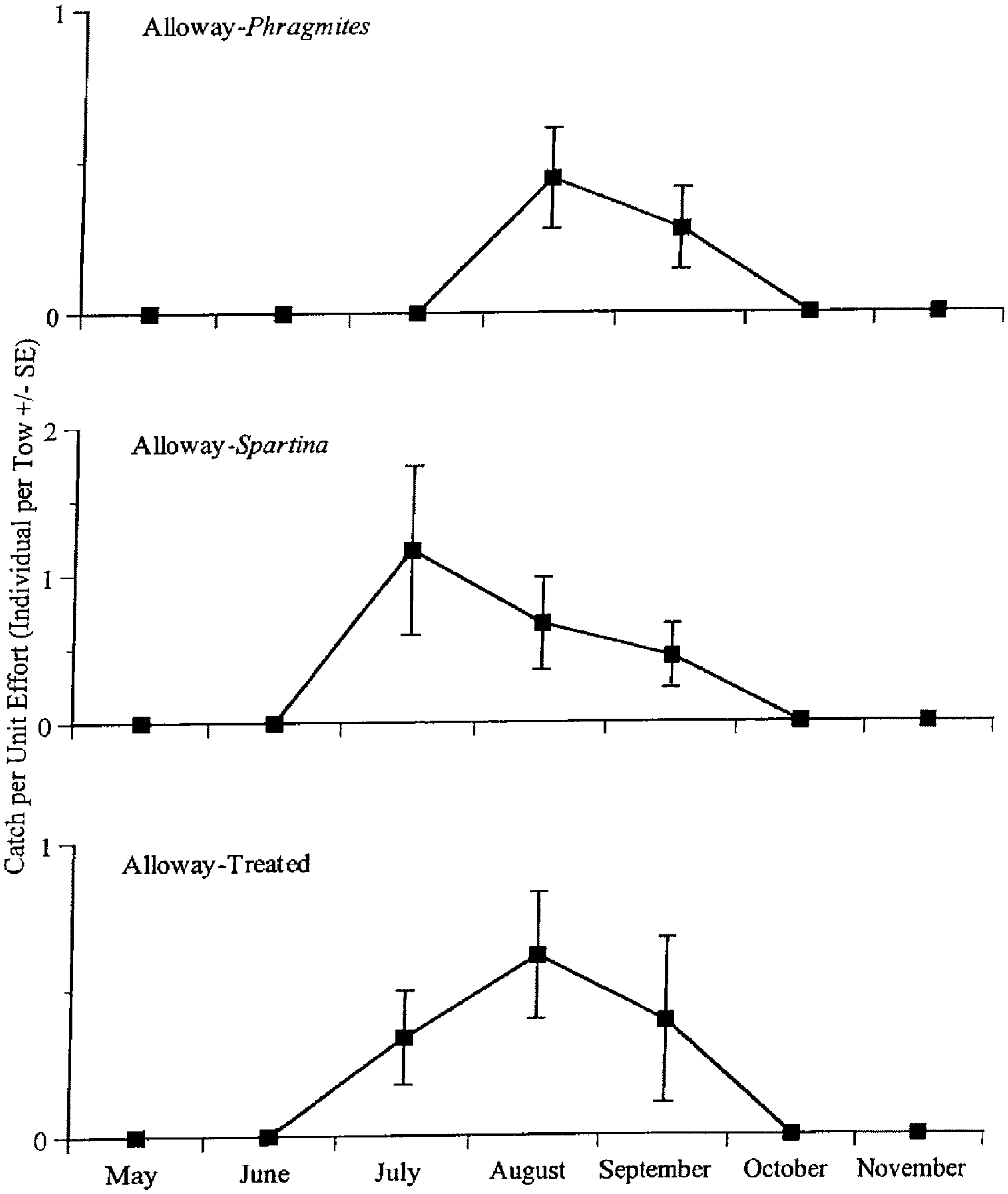



Figure 7-41 (con't). Monthly abundance for weakfish caught in large marsh creeks with otter trawls during 2003.

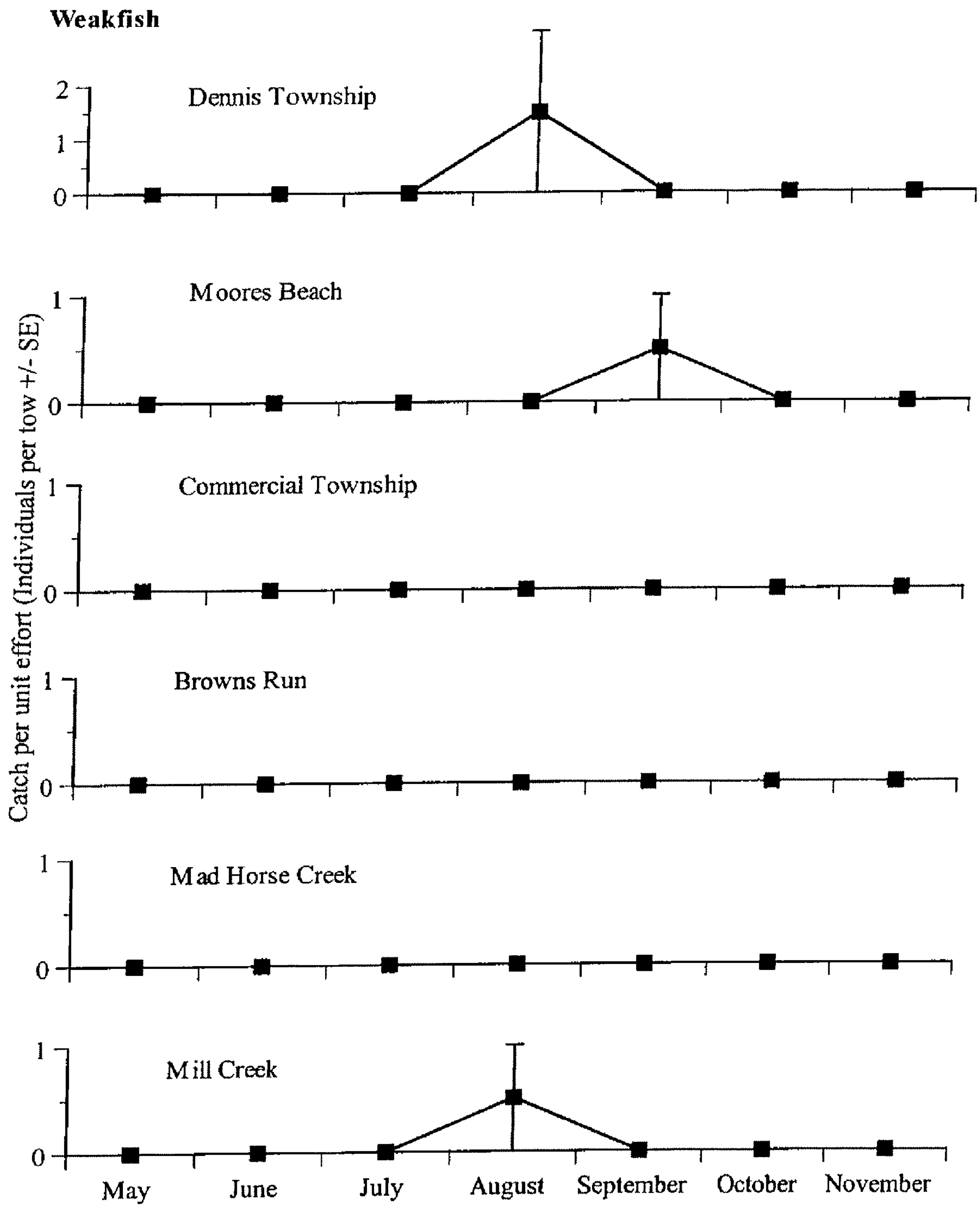



Figure 7-42. Monthly abundance for weakfish caught in small marsh creeks (weirs) at all regularly sampled sites in the Delaware Bay during 2003.

**Weakfish**

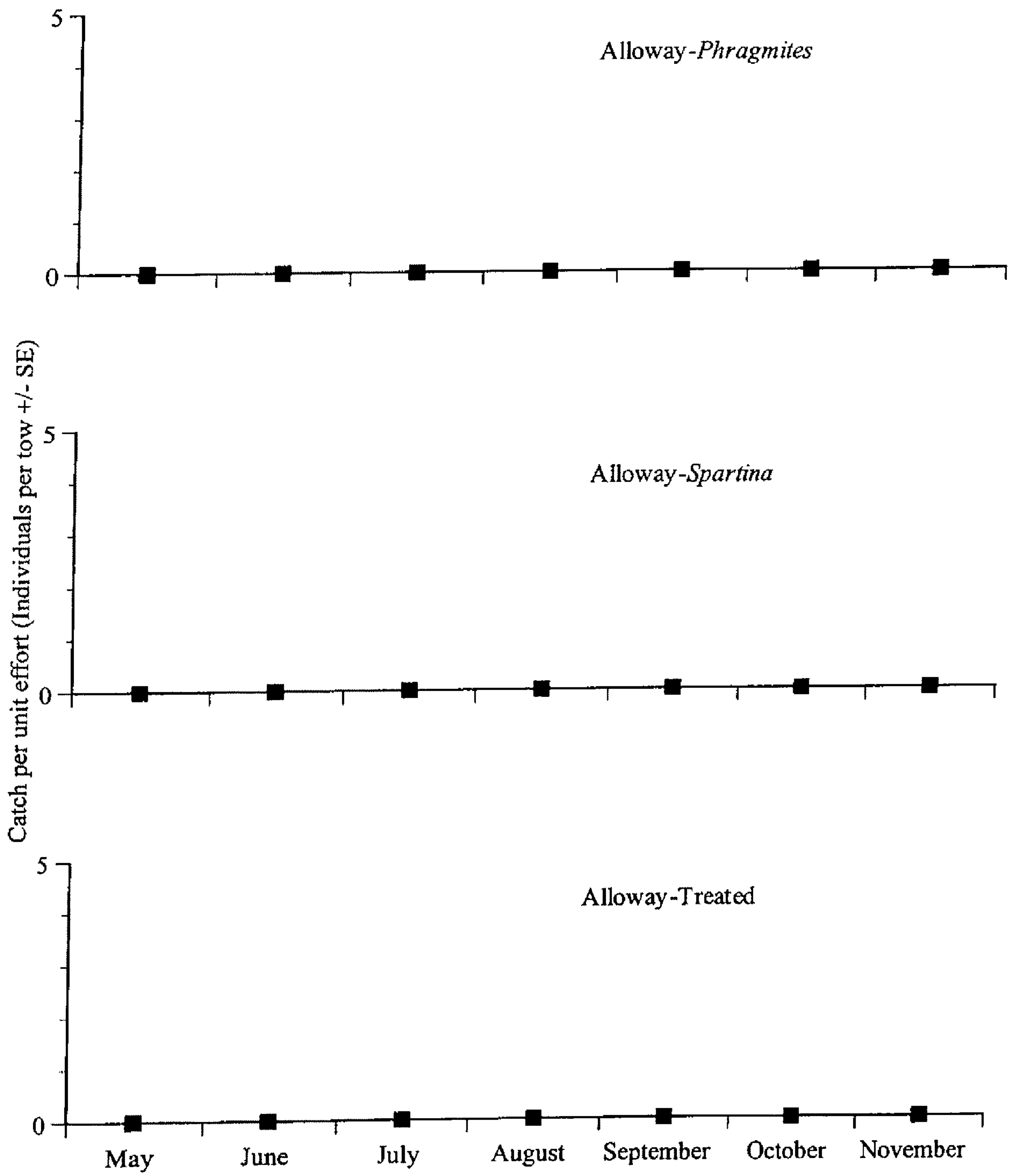



Figure 7-42 (con't). Monthly abundance for weakfish caught in small marsh creeks (weirs) at all regularly sampled sites in the Delaware Bay during 2003.

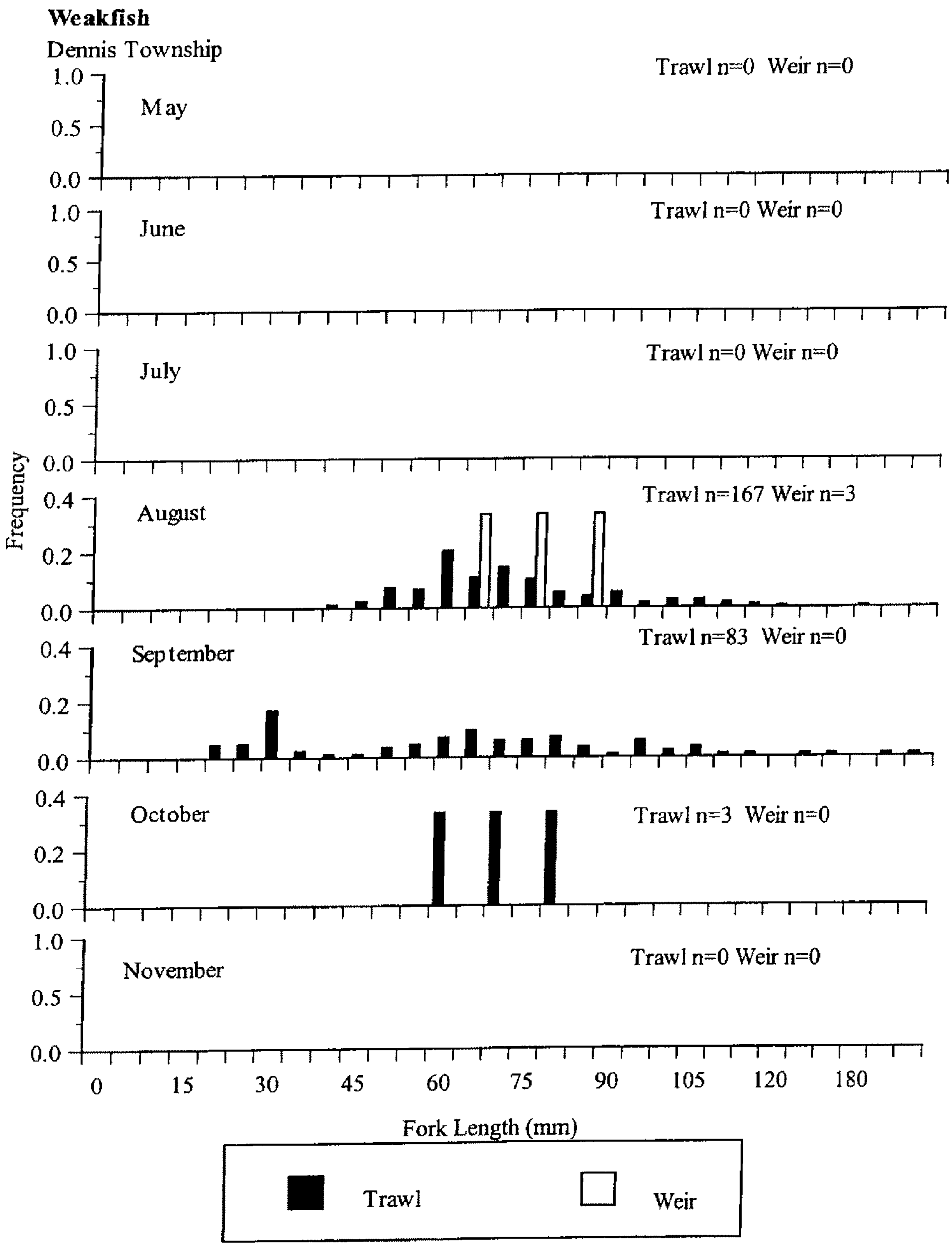



Figure 7-43. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Dennis Township during 2003.

**Weakfish**

Commerical Township

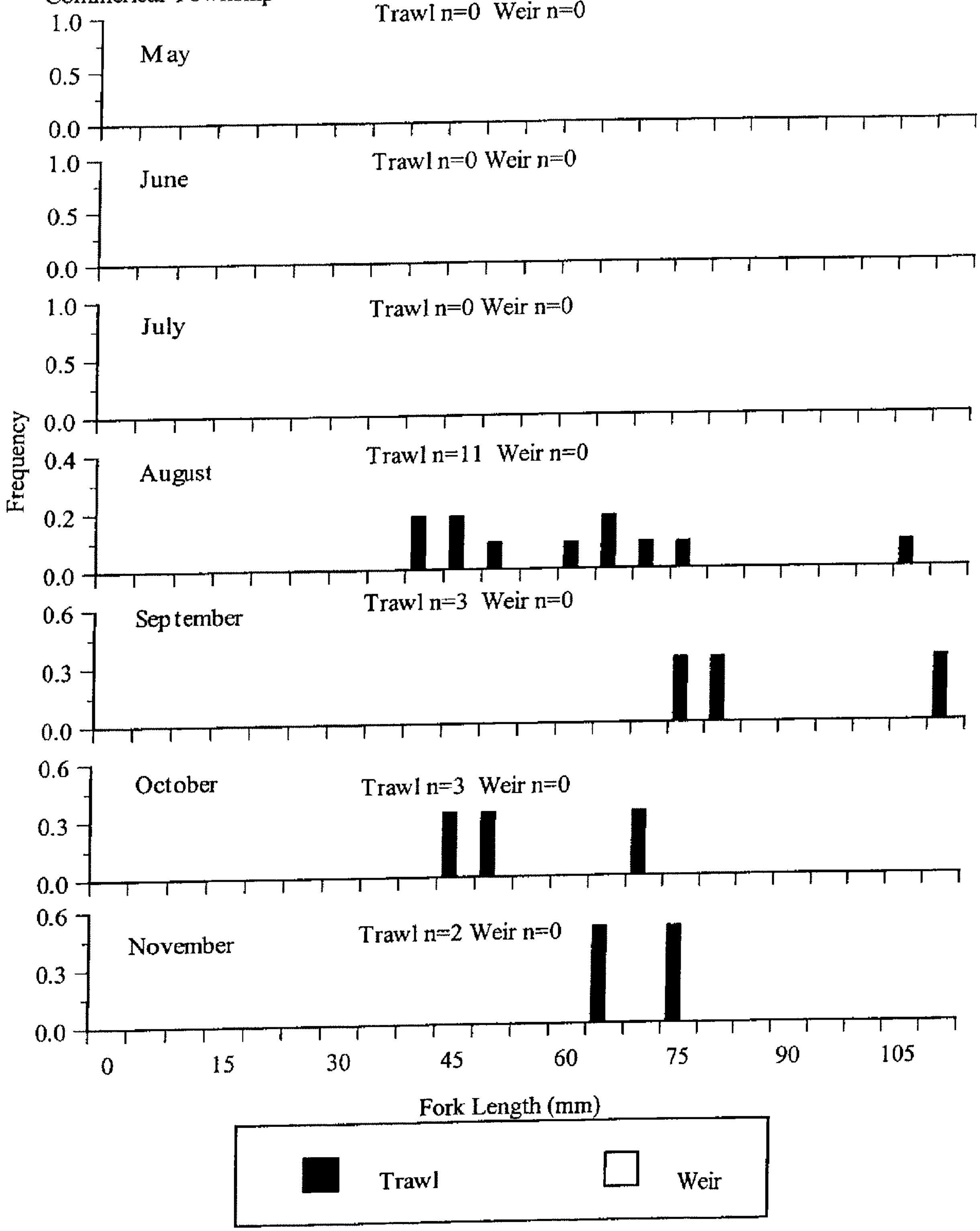



Figure 7-44. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Commerical Township during 2003.

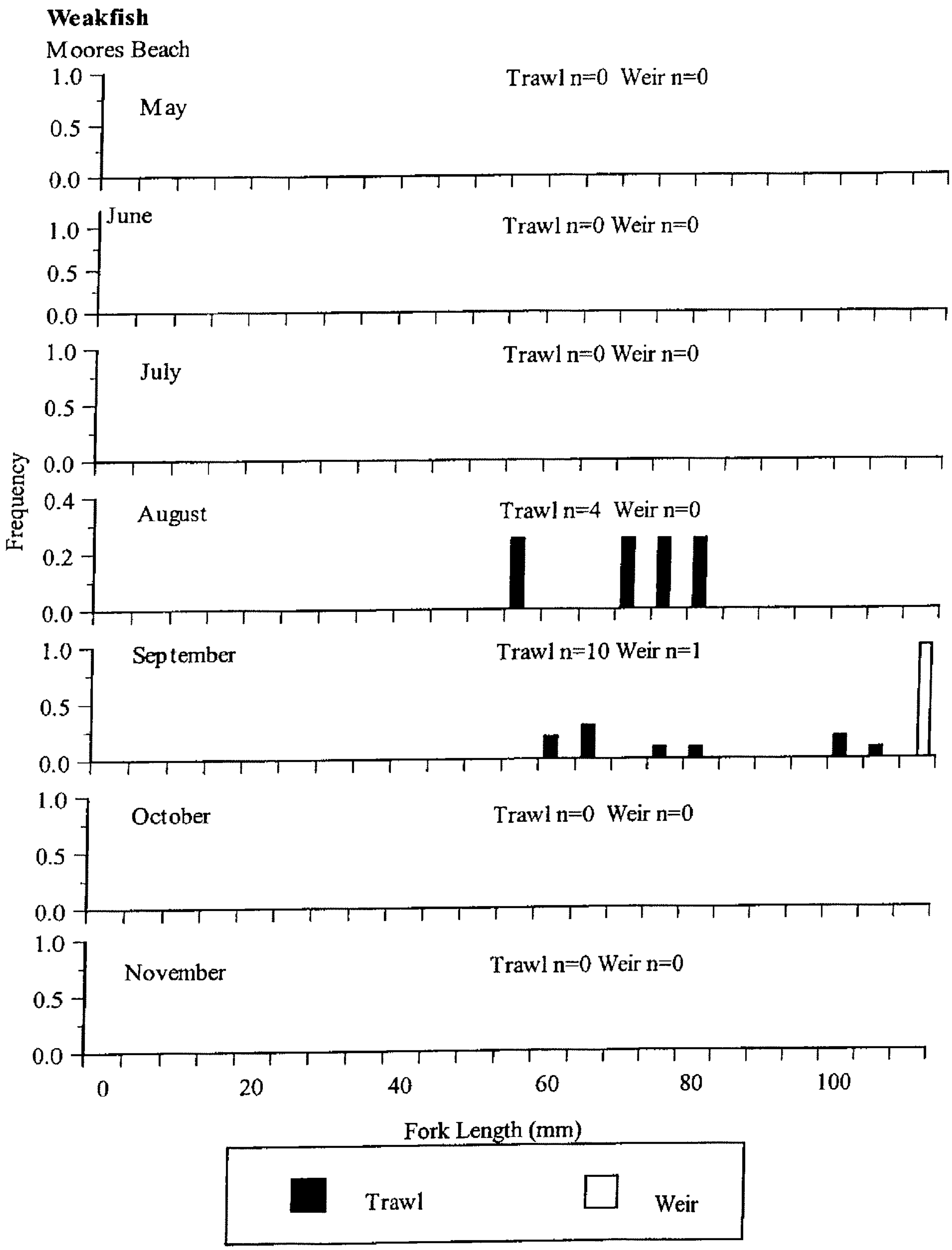



Figure 7-45. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Moores Beach during 2003.

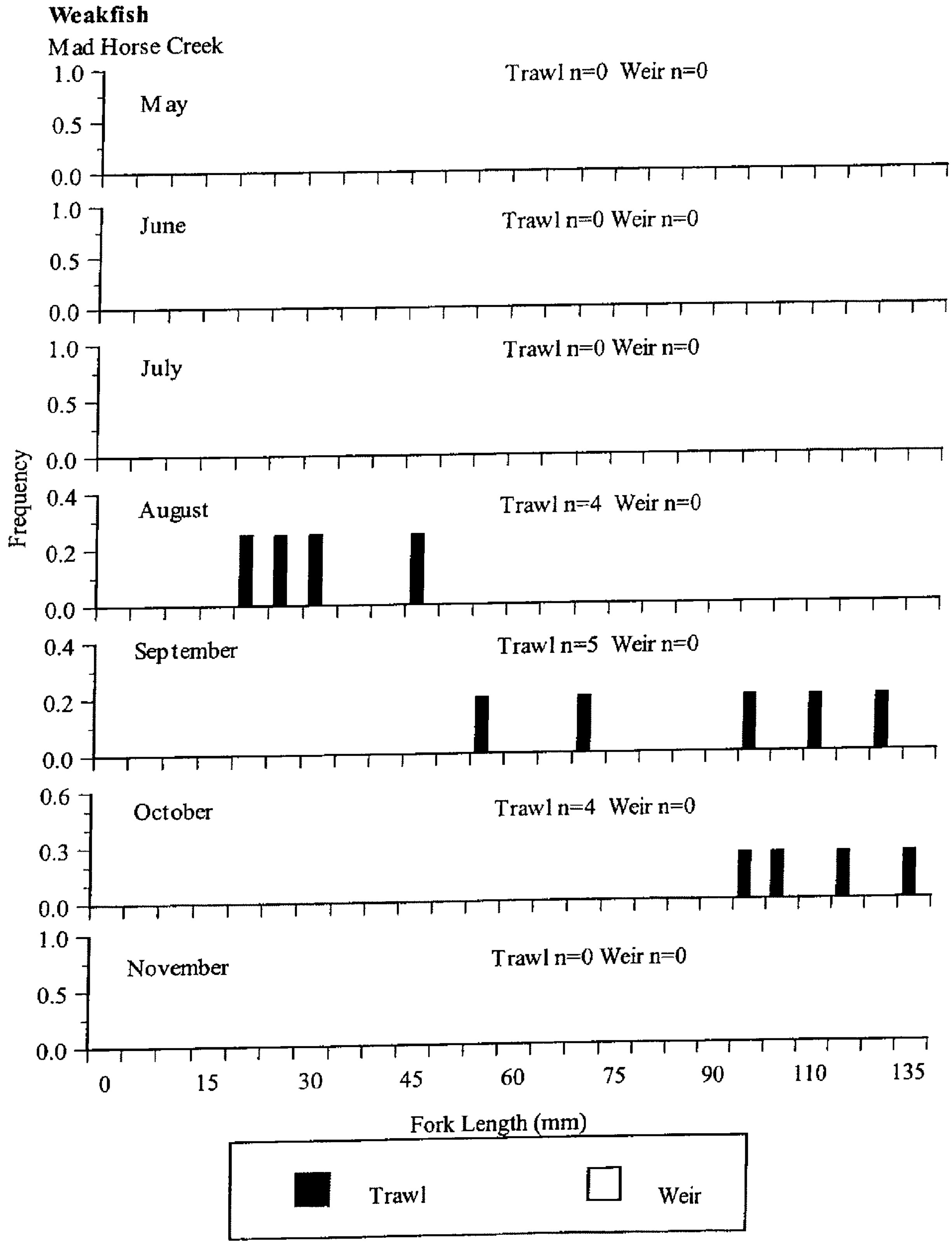



Figure 7-46. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mad Horse Creek during 2003.

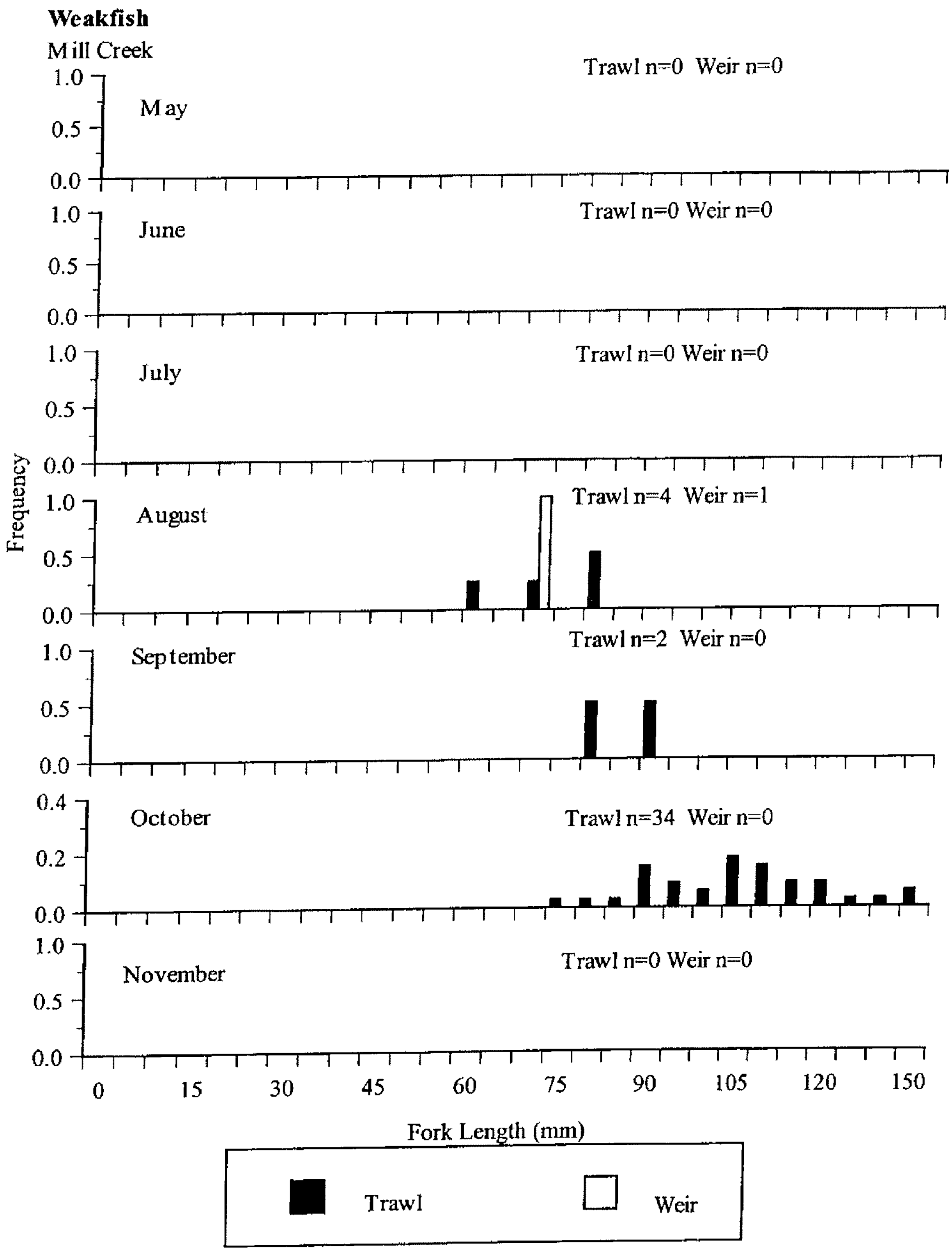



Figure 7-47. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mill Creek during 2003.

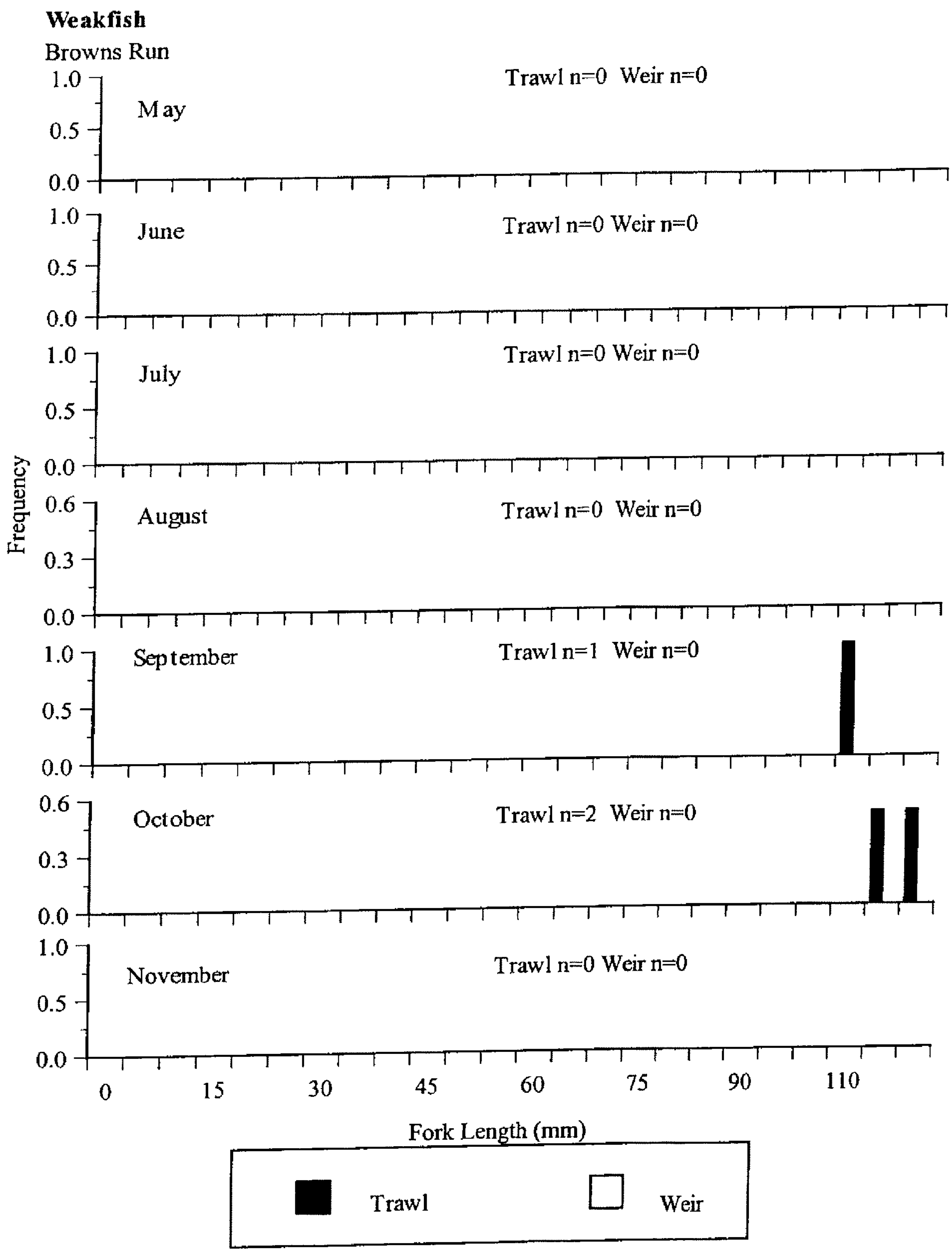



Figure 7-48. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Browns Run during 2003.

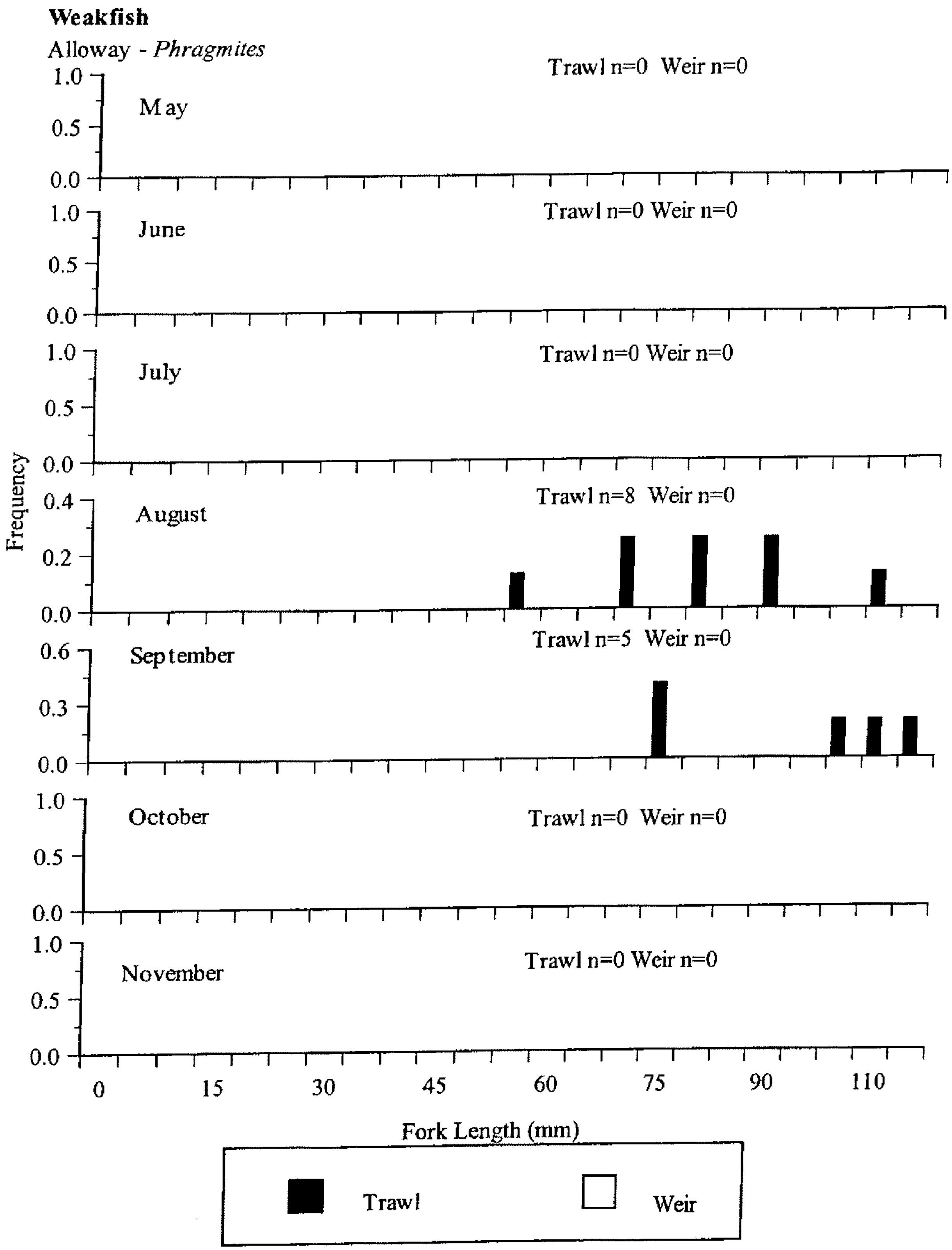



Figure 7-49. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Phragmites* site during 2003.

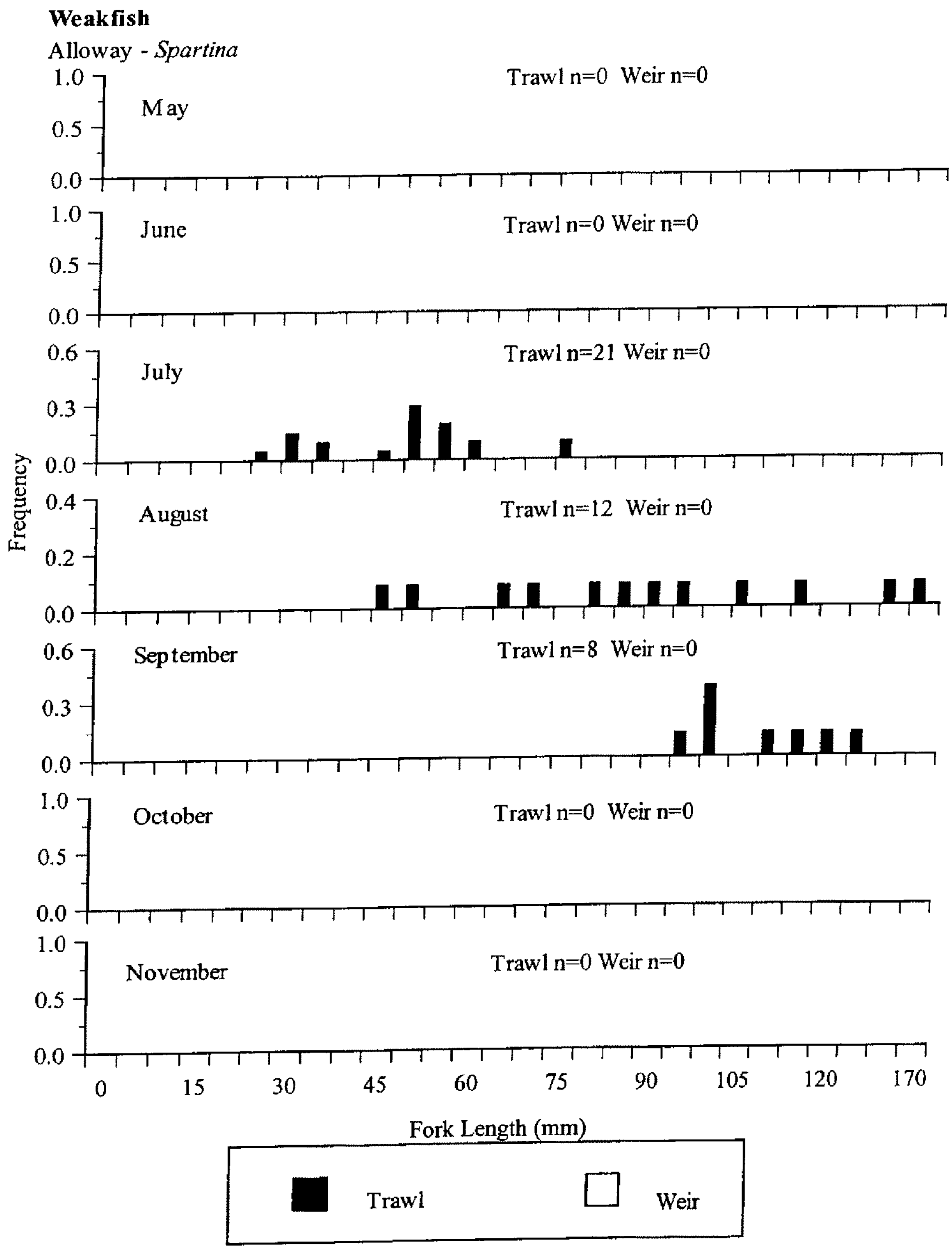



Figure 7-50. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Spartina* site during 2003.

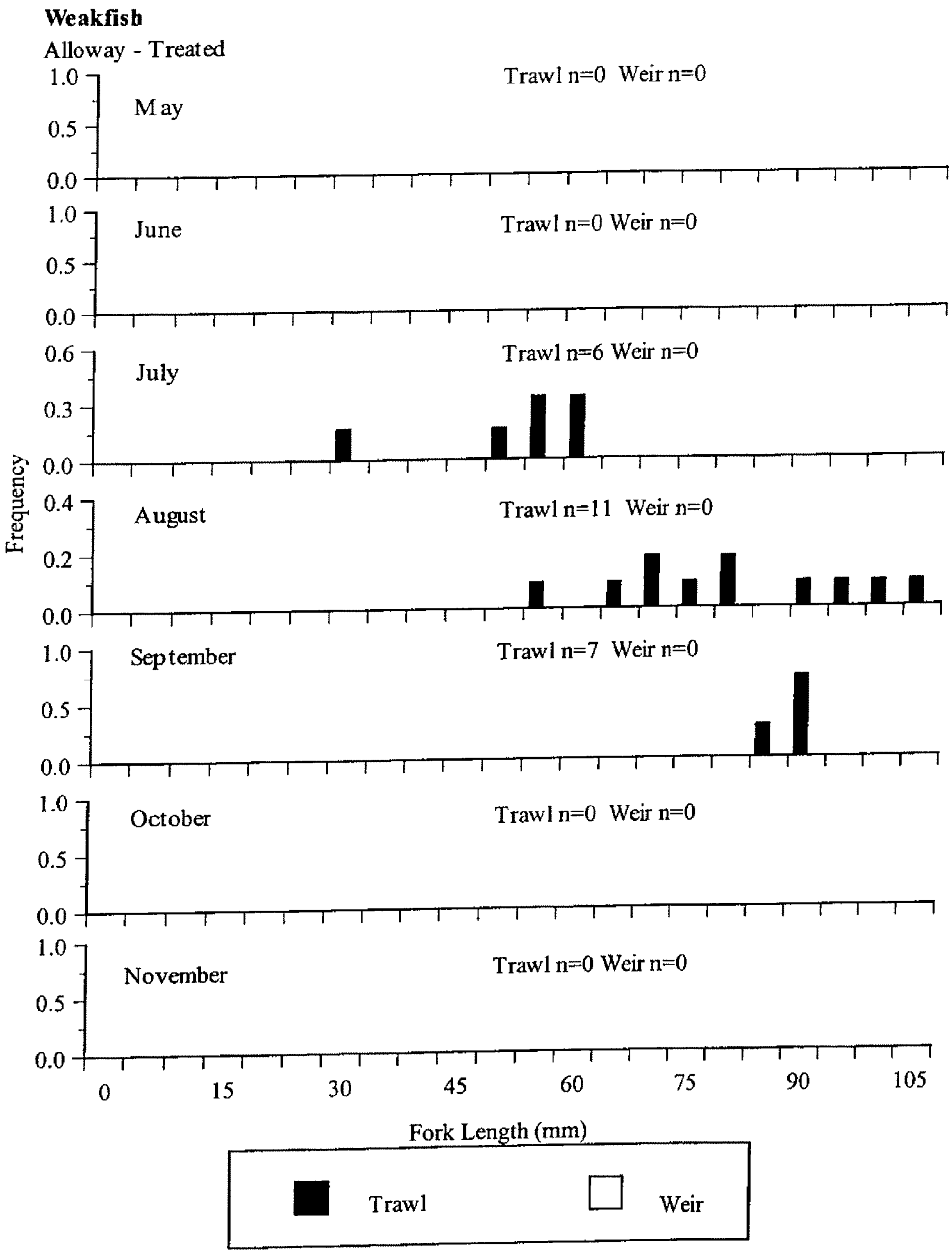



Figure 7-51. Size distribution of weakfish from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek Treated site during 2003.

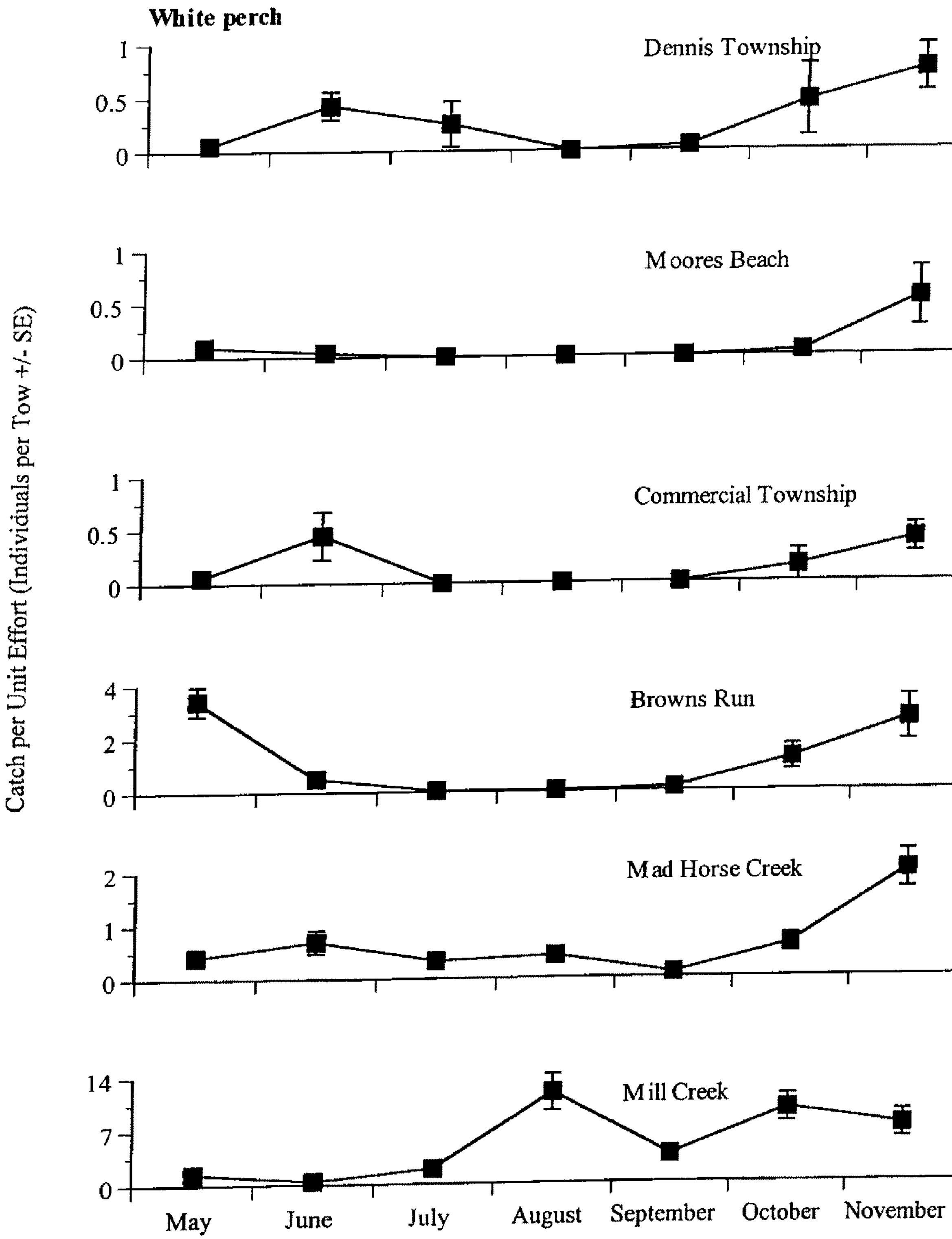



Figure 7-52. Monthly abundance for white perch caught in large marsh creeks with otter trawls during 2003.

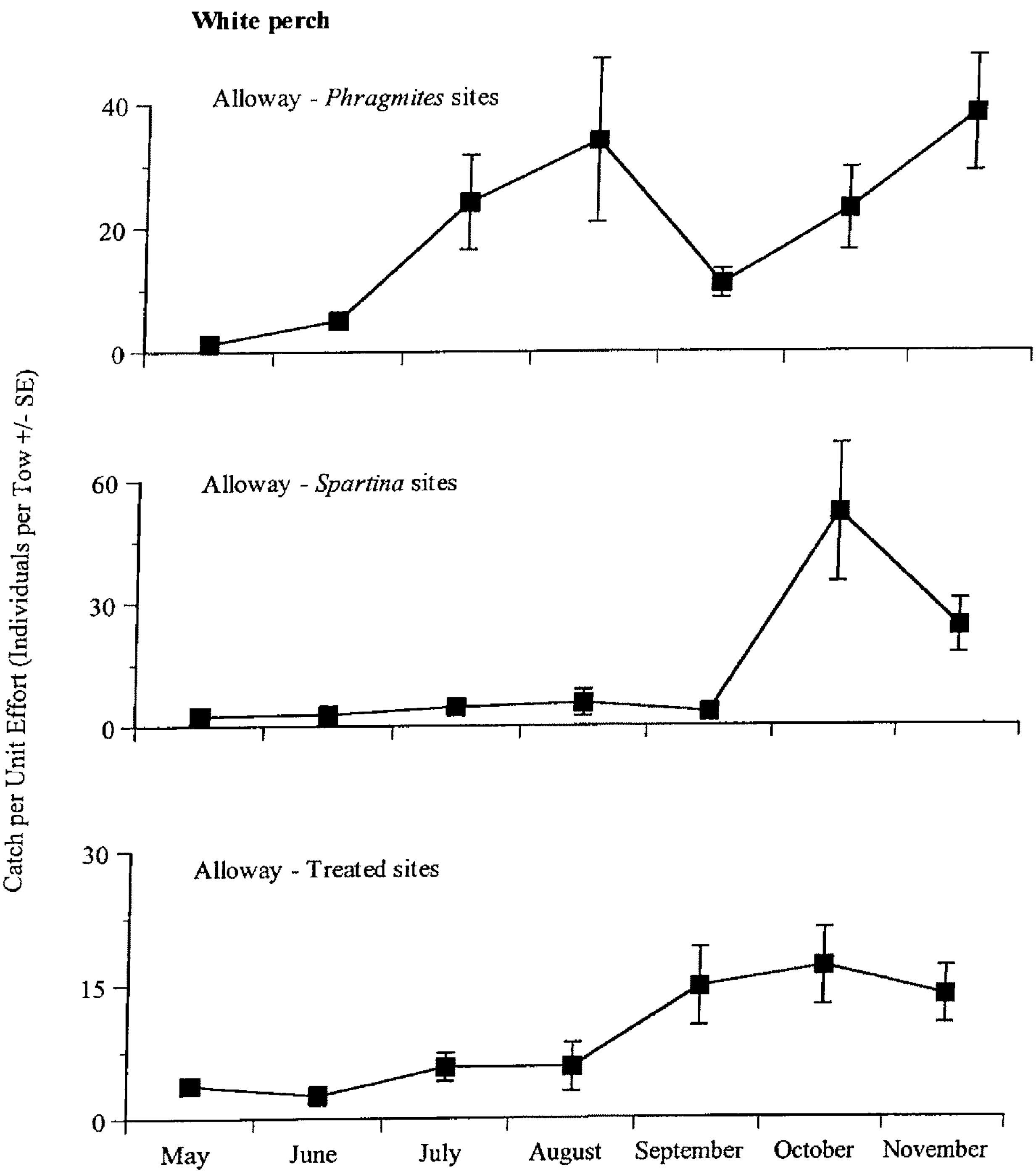



Figure 7-52 (con't). Monthly abundance for white perch caught in large marsh creeks with otter trawls during 2003.

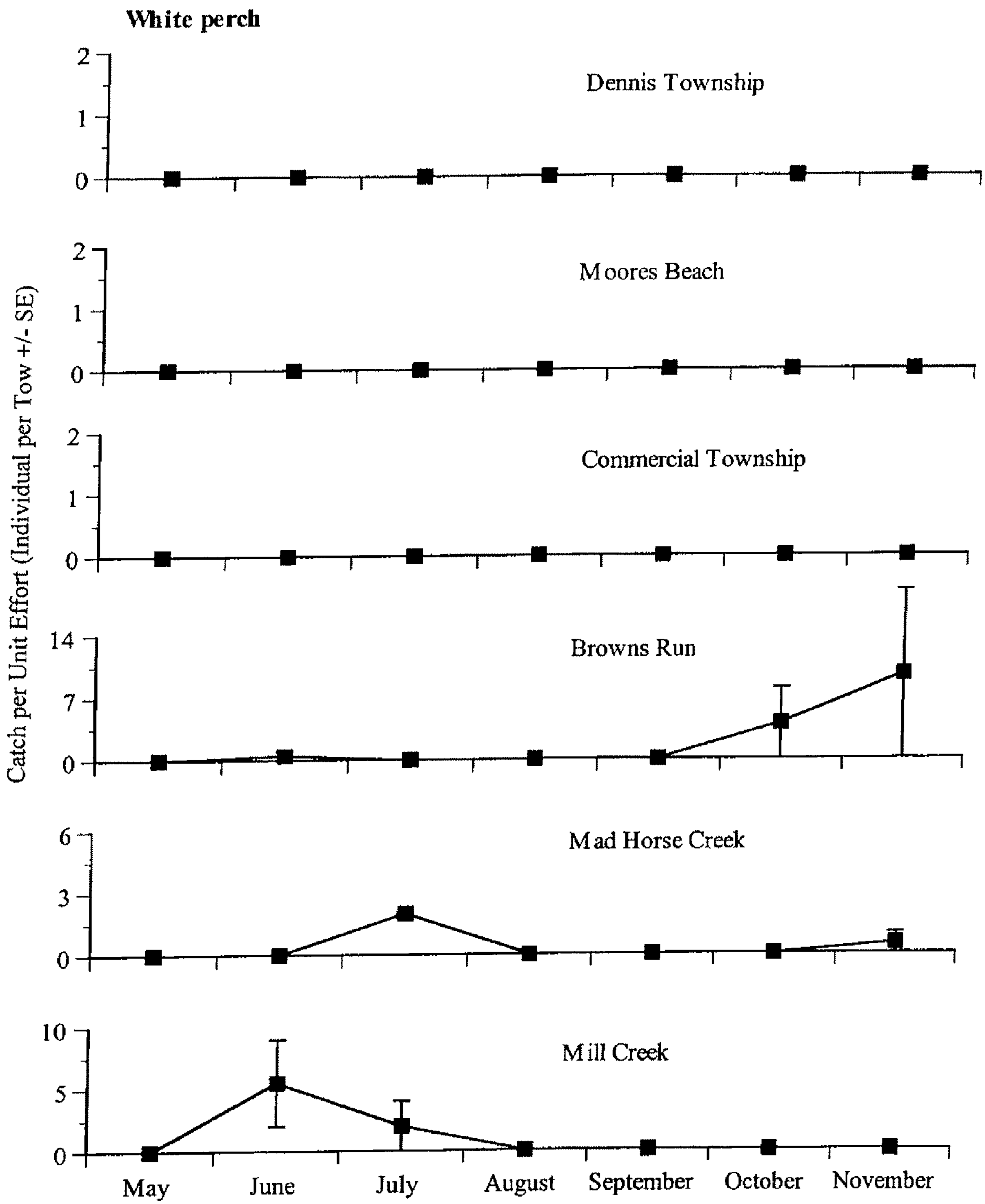



Figure 7-53. Monthly abundance for white perch caught in small marsh creeks (weirs) during 2003.

**White perch**

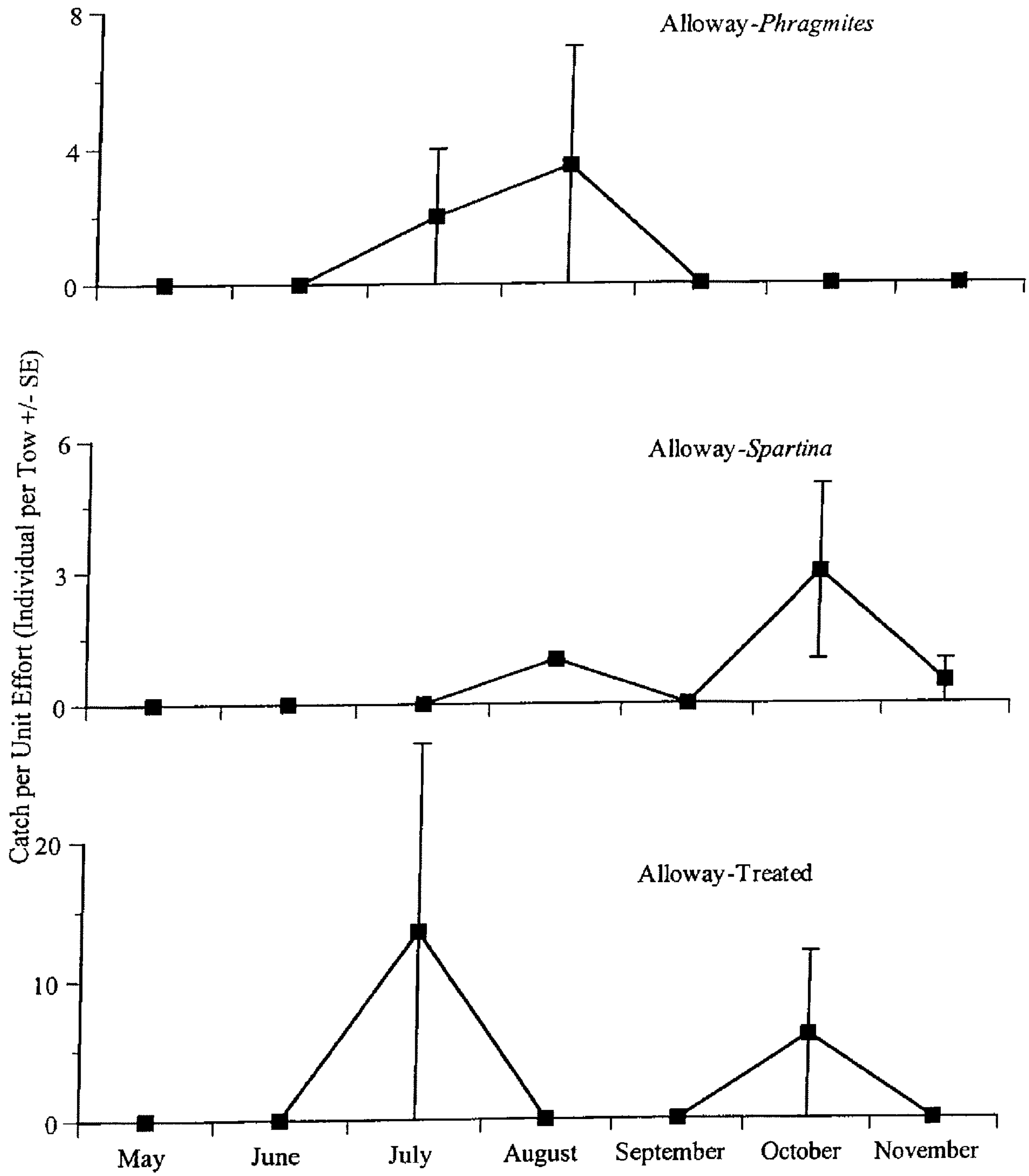



Figure 7-53 (con't). Monthly abundance for white perch caught in small marsh creeks (weirs) during 2003.

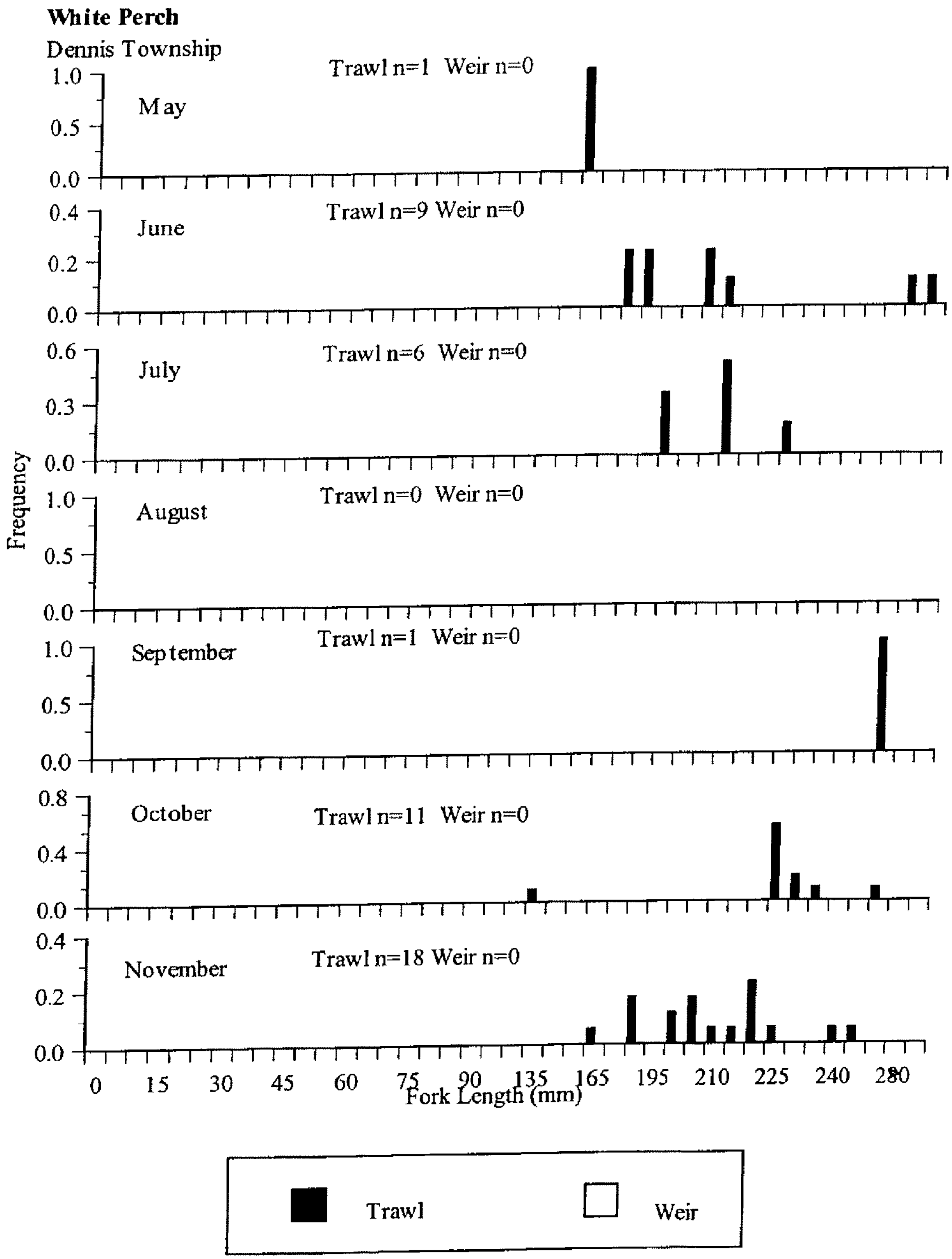



Figure 7-54. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Dennis Township during 2003.

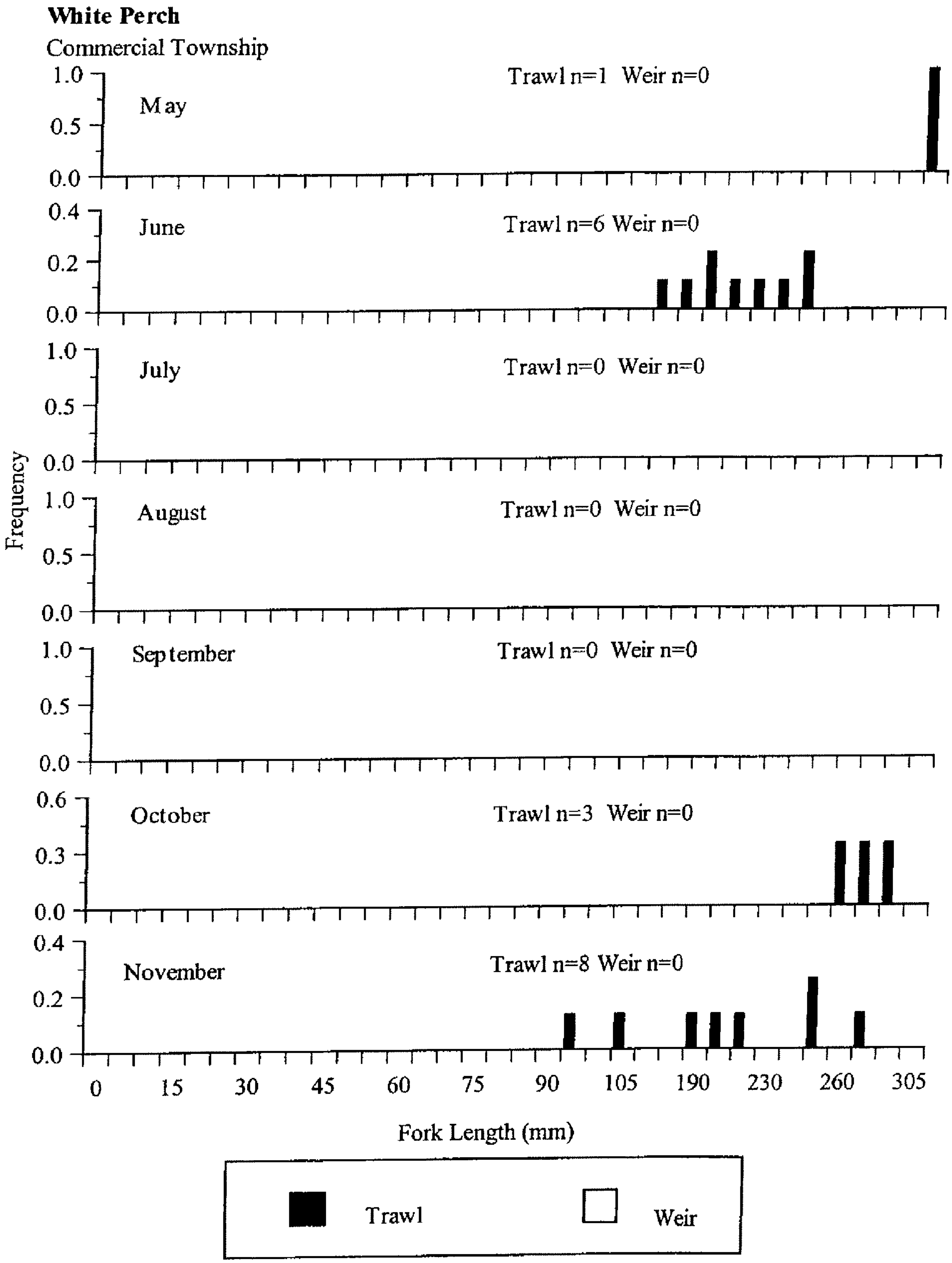



Figure 7-55. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Commercial Township during 2003.

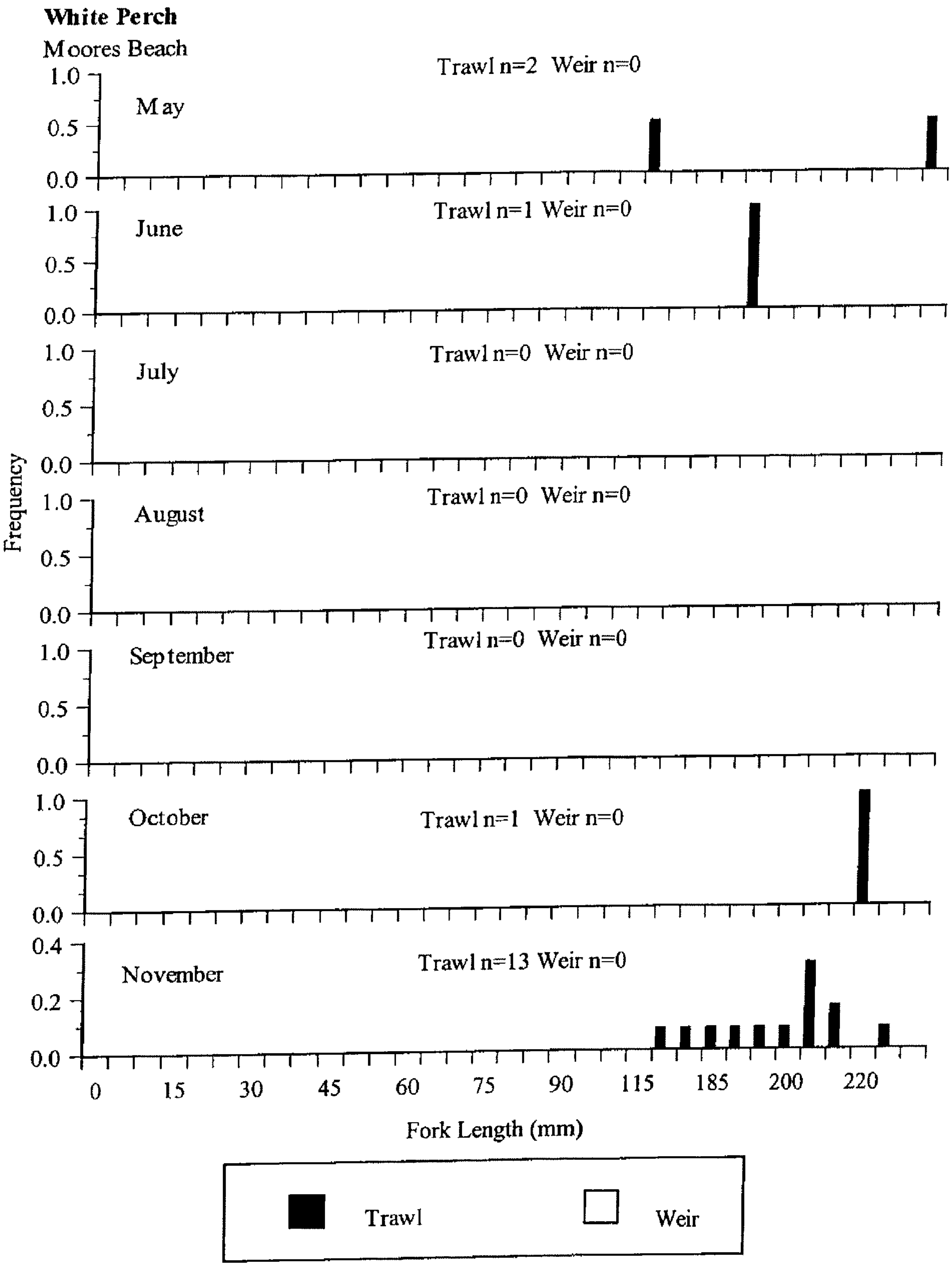



Figure 7-56. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Moores Beach during 2003.

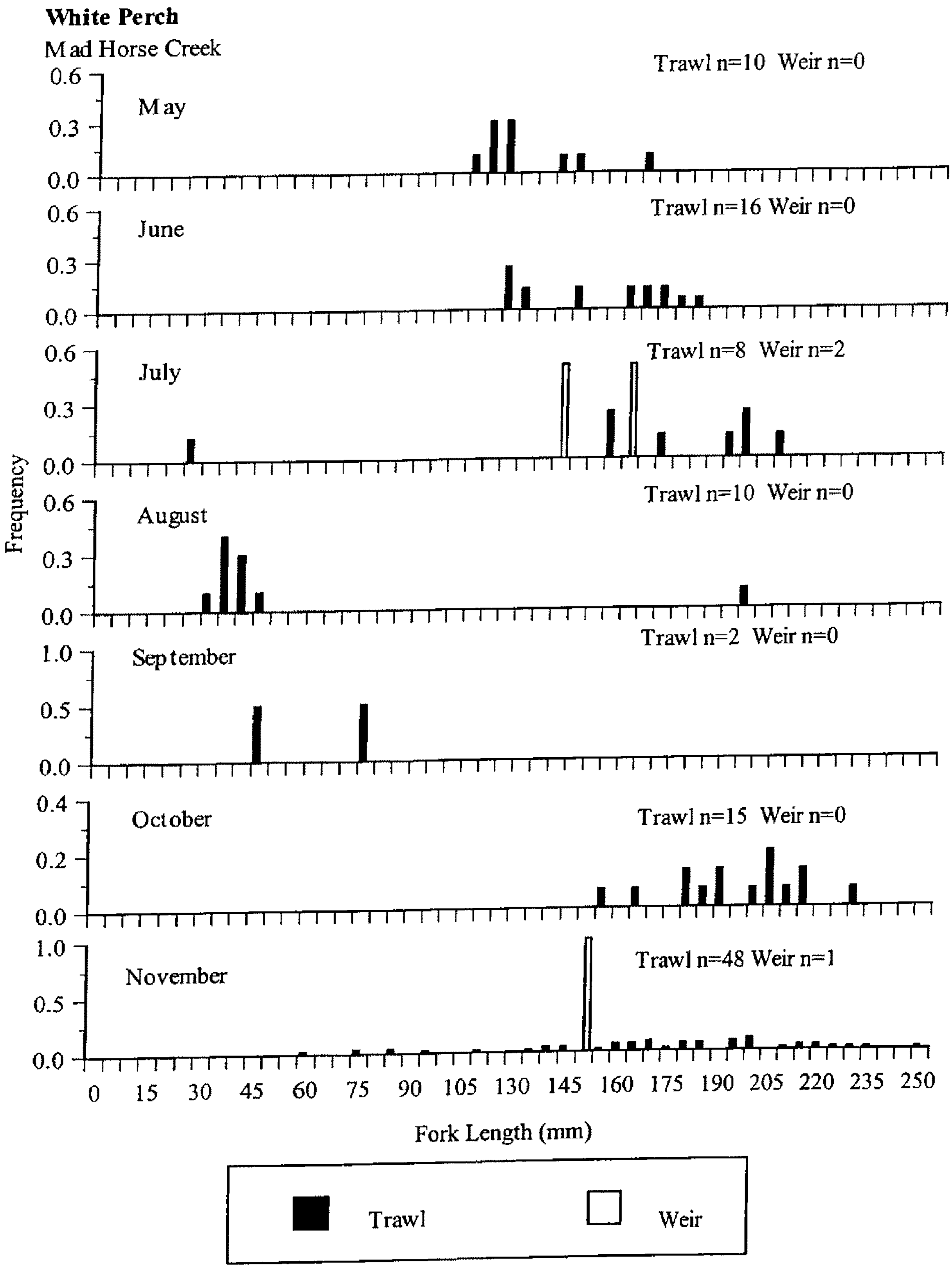



Figure 7-57. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mad Horse Creek during 2003.

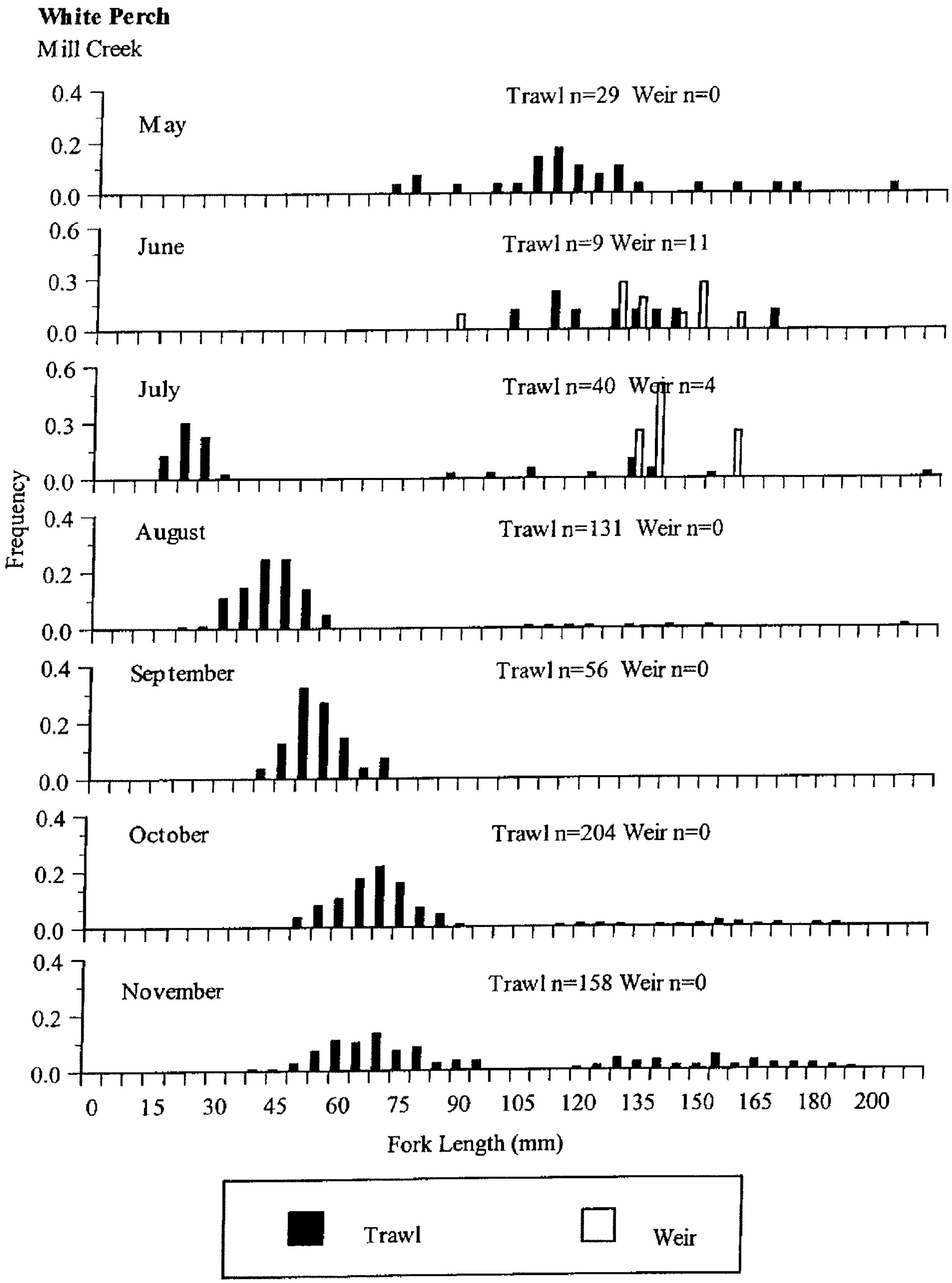



Figure 7-58. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Mill Creek during 2003.

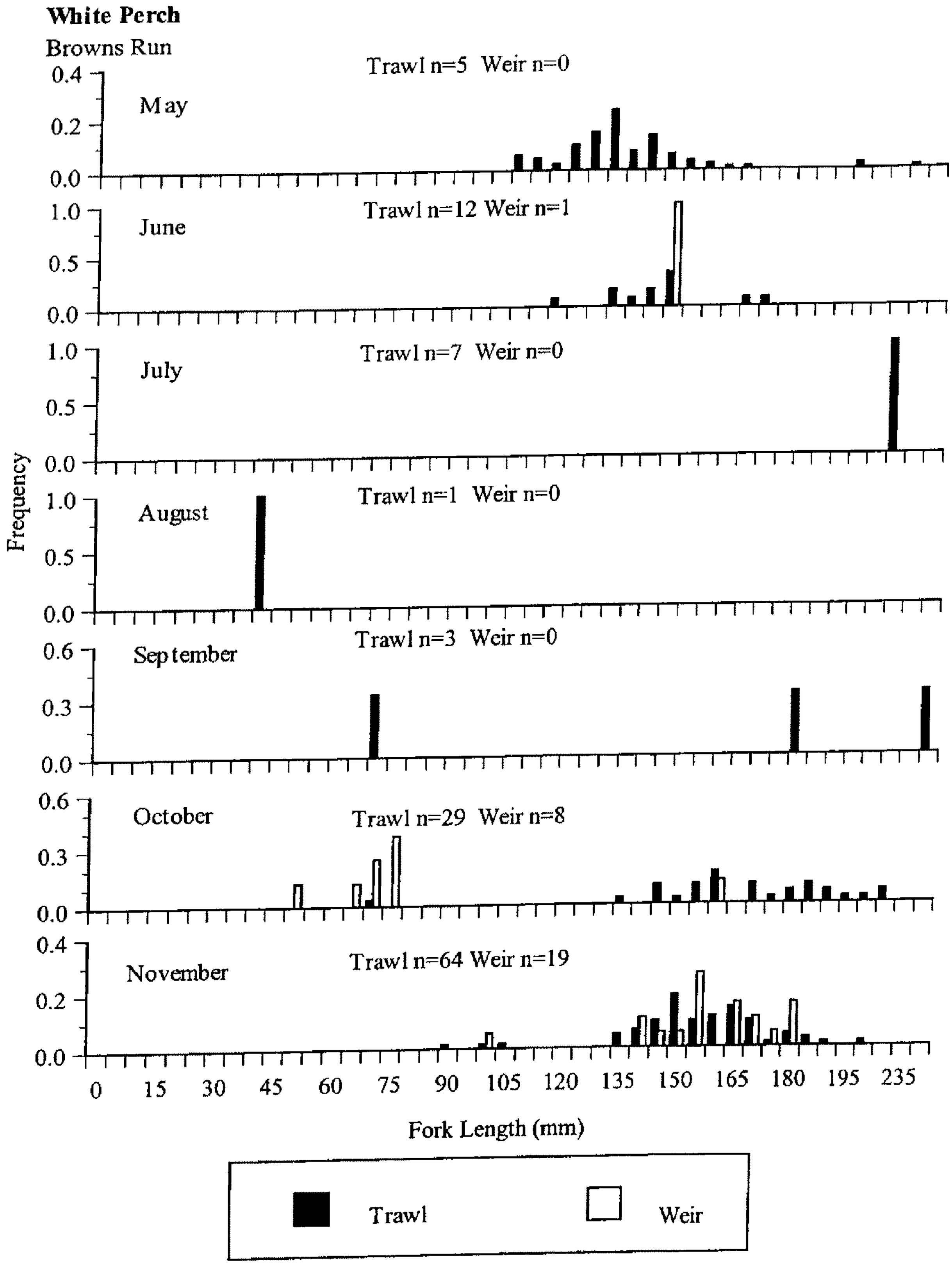



Figure 7-59. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Browns Run during 2003.

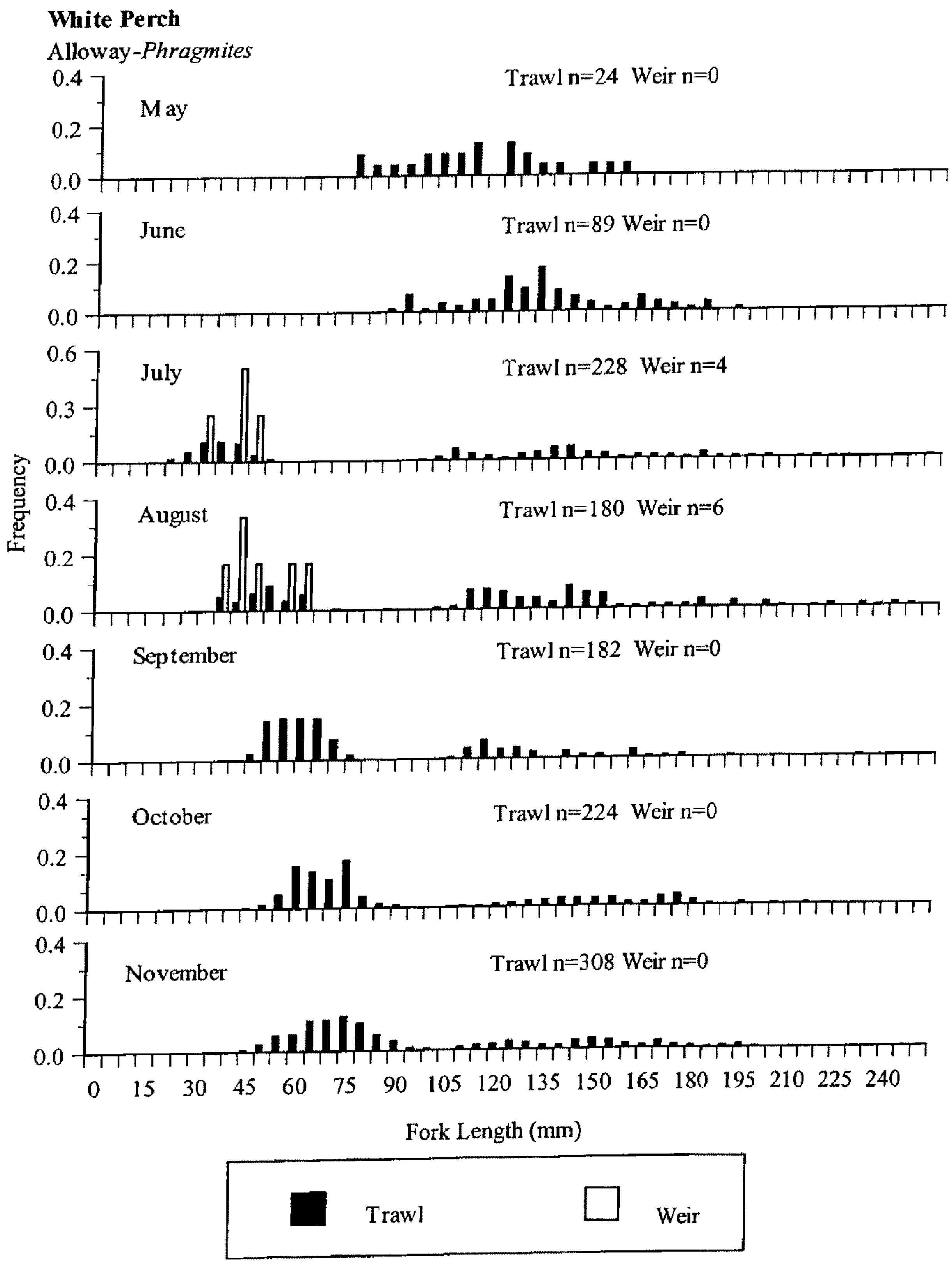



Figure 7-60. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Phragmites* site during 2003.

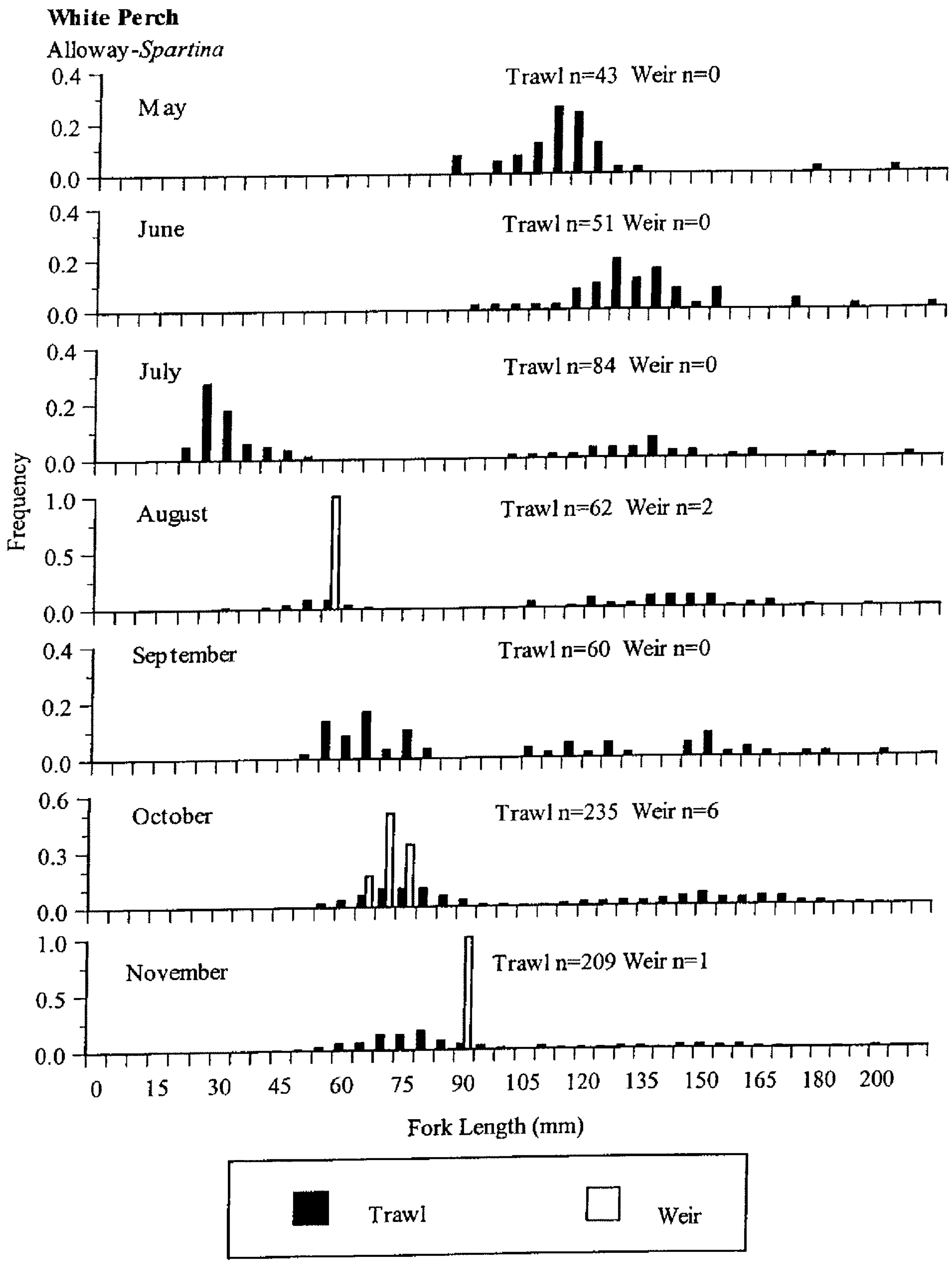



Figure 7-61. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek *Spartina* site during 2003.

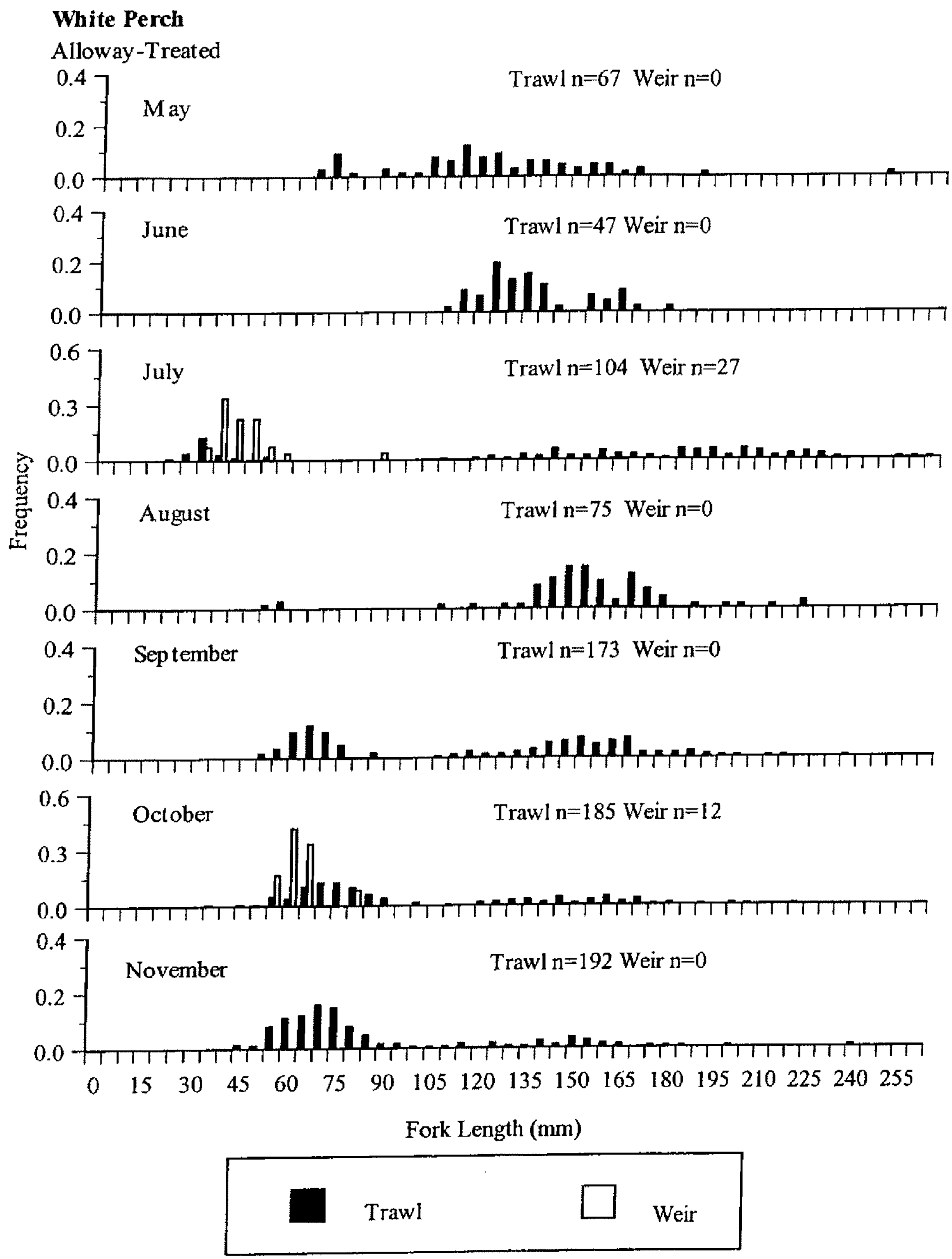



Figure 7-62. Size distribution of white perch from large marsh creeks (otter trawl) and small marsh creeks (weir) at Alloway Creek Treated site during 2003.

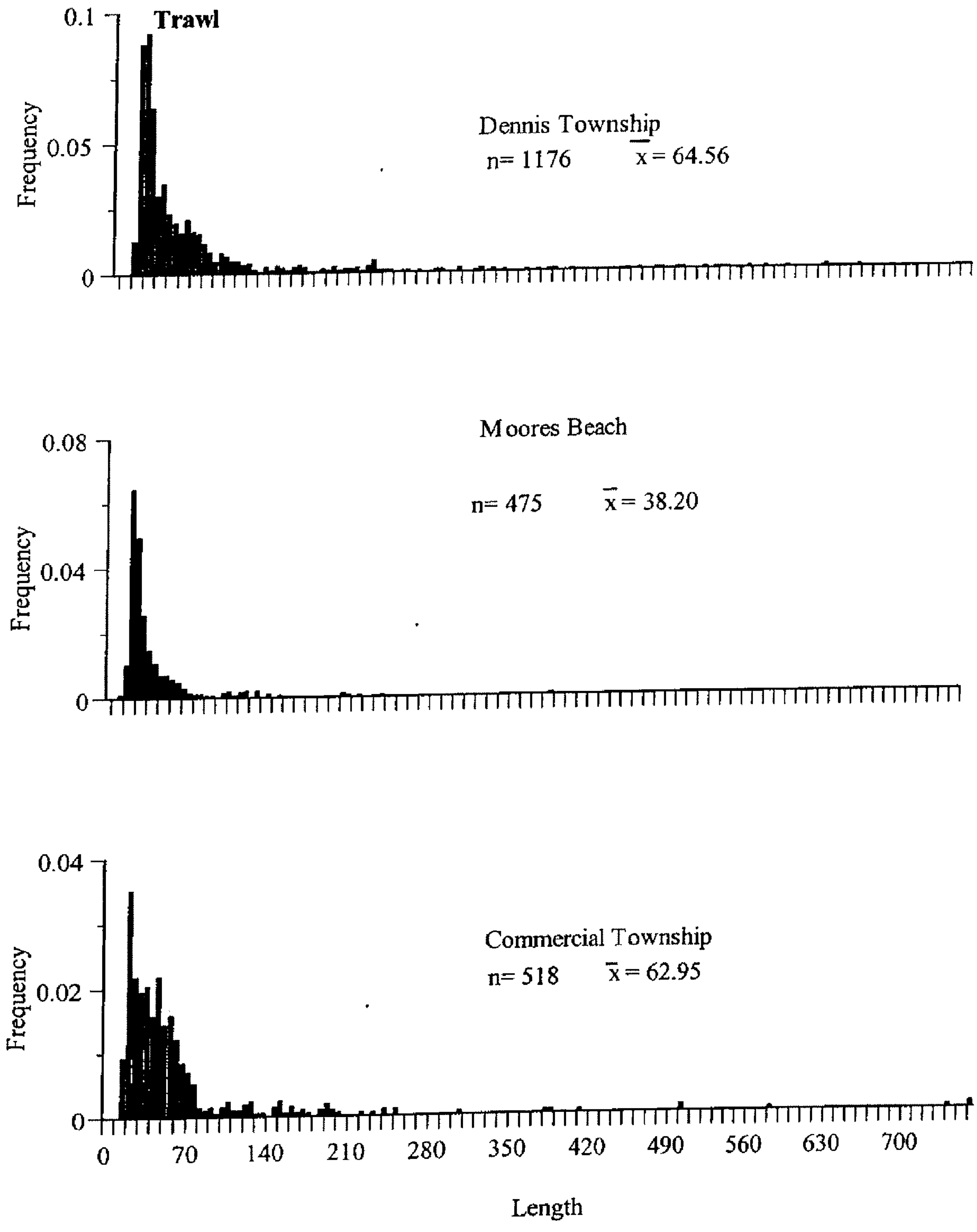



Figure 7-63. Length frequency distribution for all fish as collected by otter trawl in constructed large marsh creeks at Dennis Township and Commercial Township restoration sites and creeks of similar stream order at Moores Beach during 200.

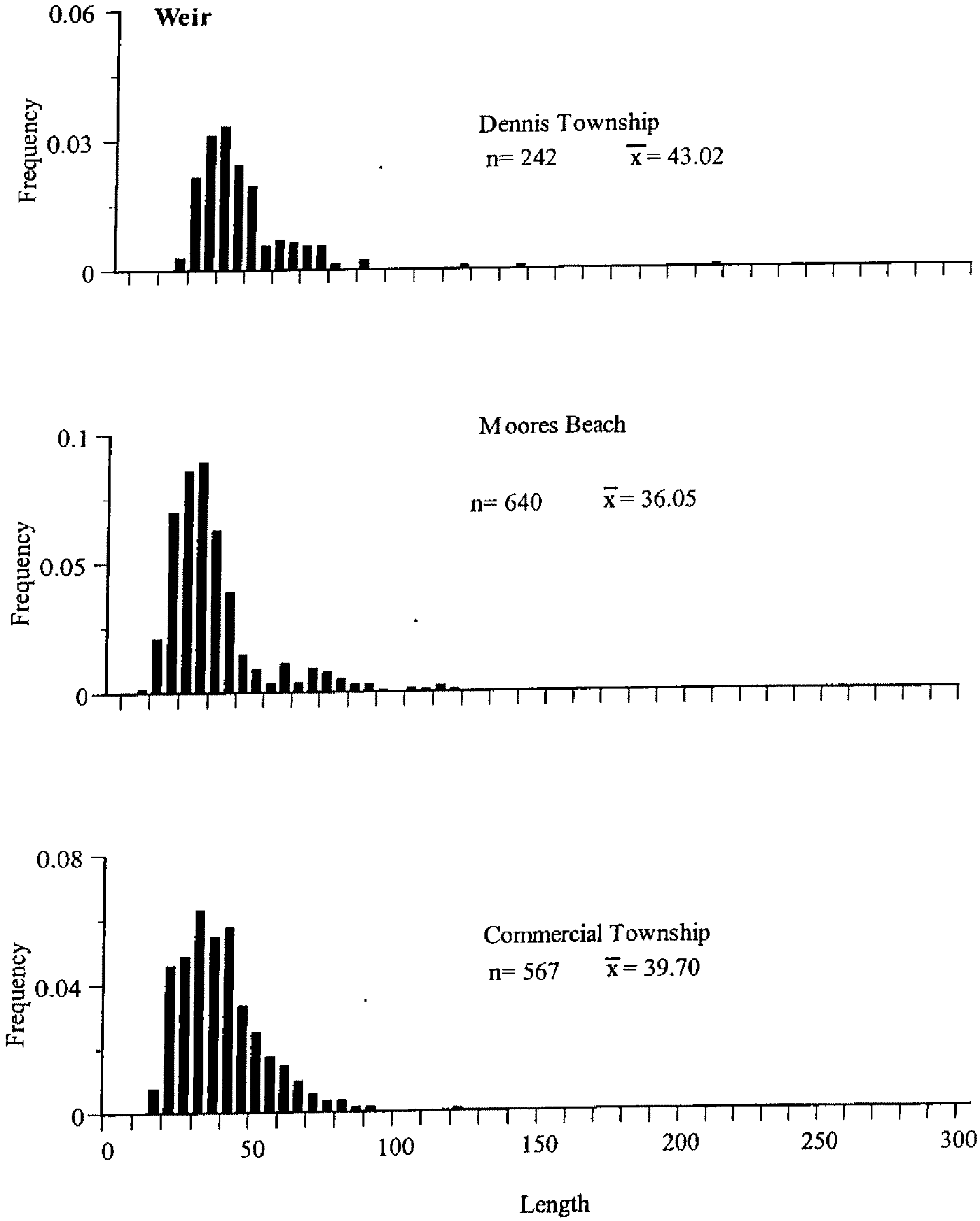



Figure 7-64. Length frequency distribution for all fish as collected by weirs in constructed small marsh creeks at Dennis Township and Commercial Township restoration sites and creeks of similar stream order at Moores Beach during 2003.

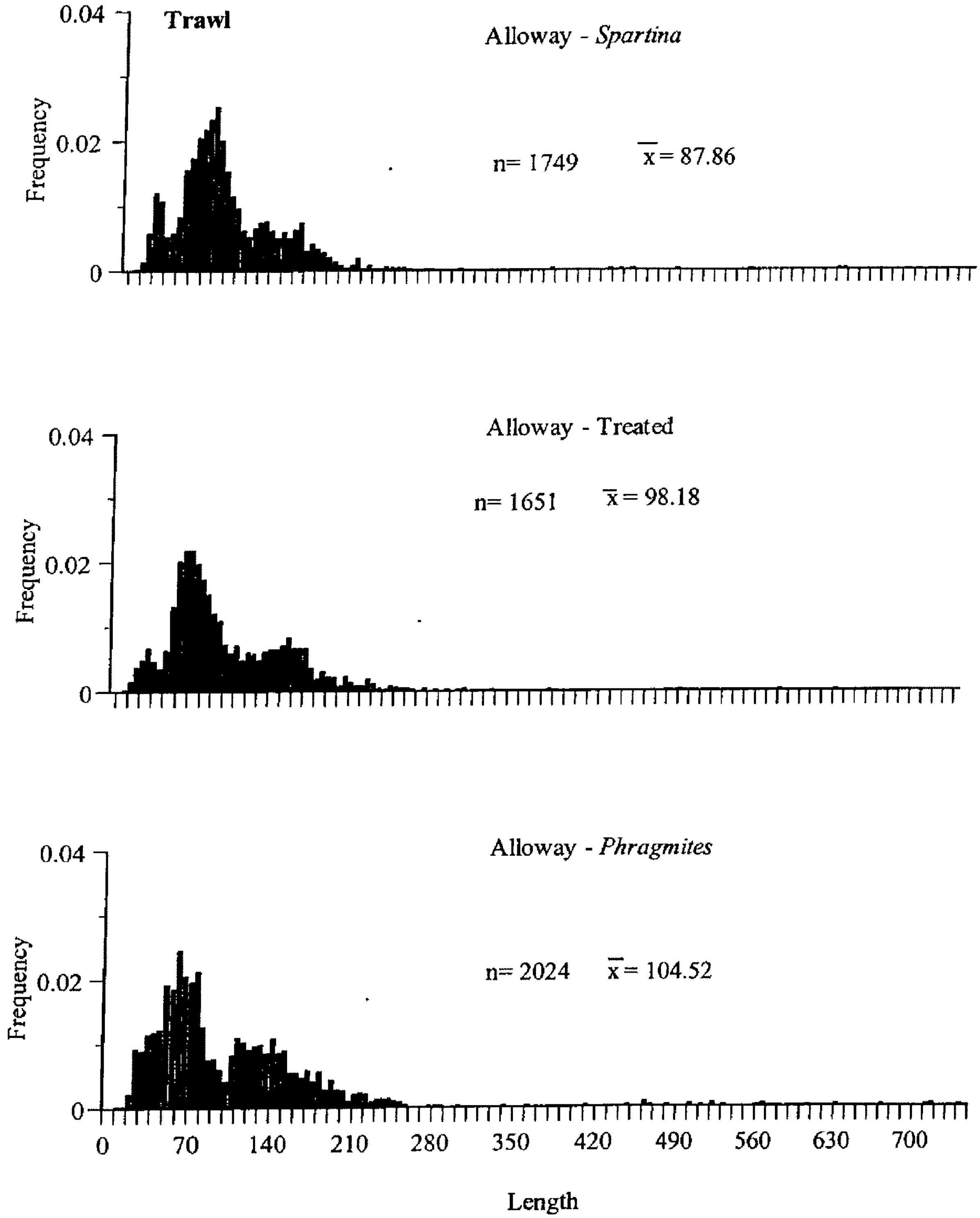



Figure 7-65. Length frequency distribution for all fish as collected in large marsh creeks by otter trawl at the Alloway Creek reference and treated sites during 2003.

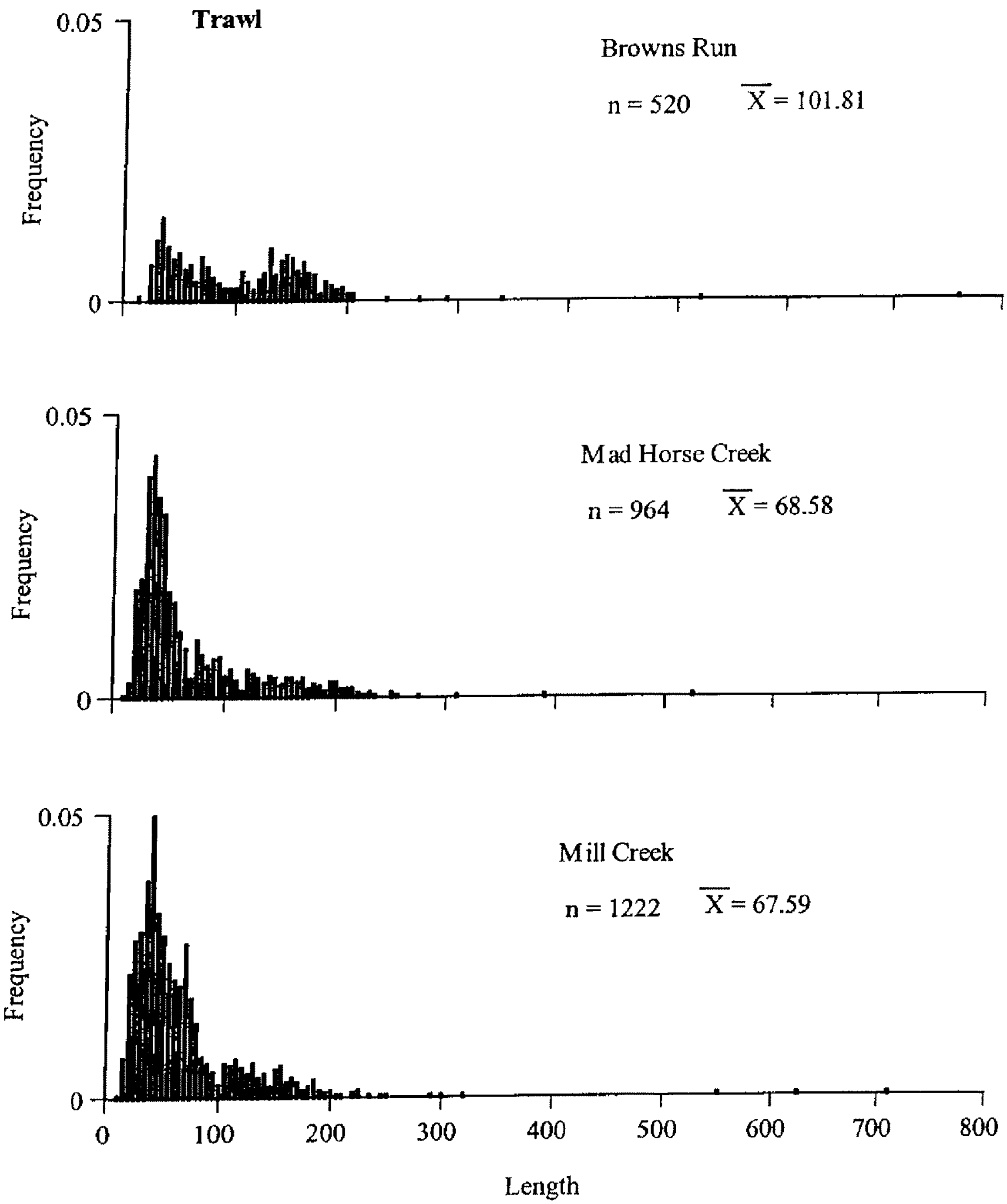



Figure 7-66. Length frequency distribution for all fish as collected in large marsh creeks by otter trawl at restoration sites (Mill Creek and Browns Run) and the reference site (Mad Horse Creek) during 2003.

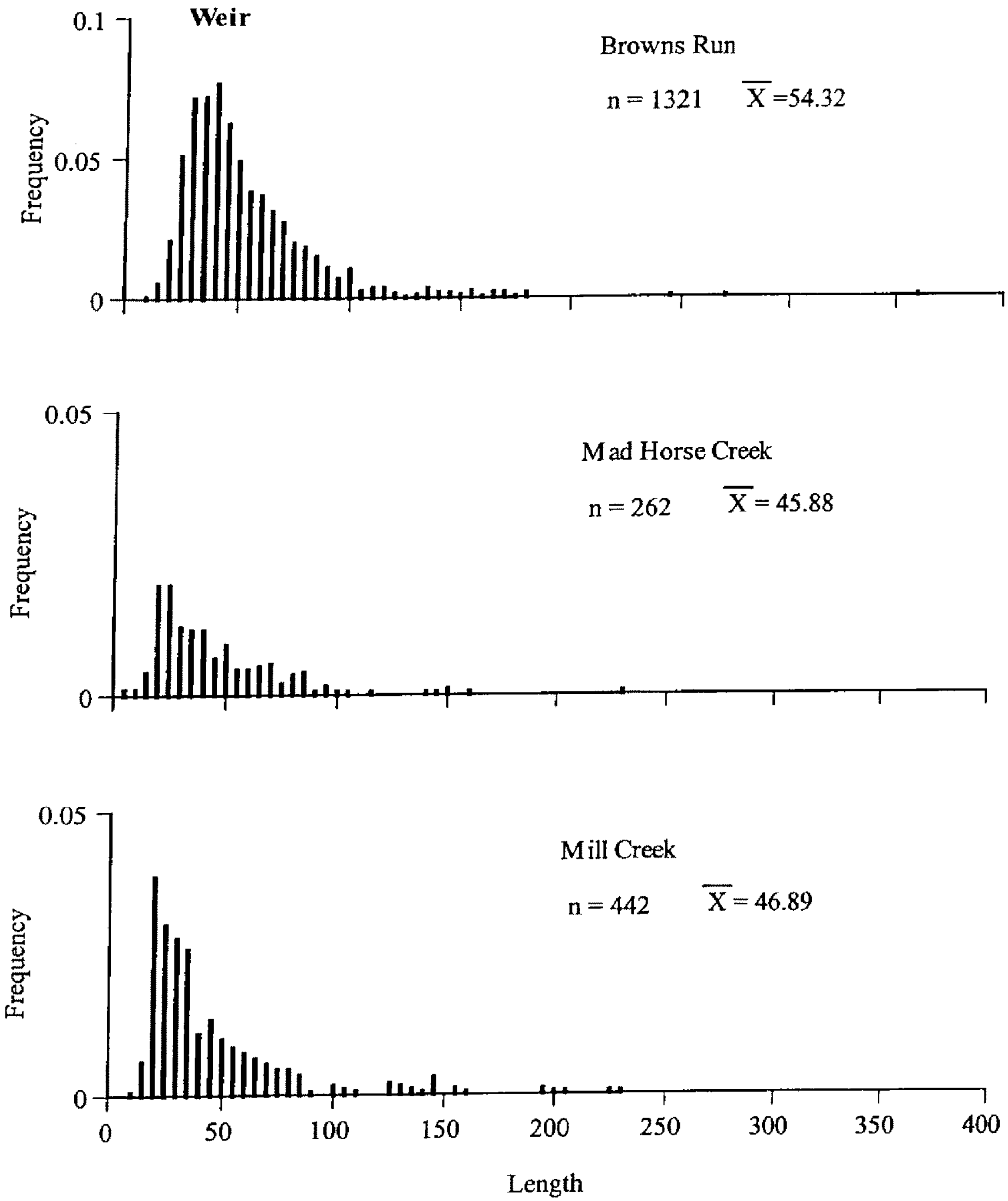



Figure 7-67. Length frequency distribution for all fish as collected in small marsh creeks by weir at restoration sites (Mill Creek and Browns Run) and the reference site (Mad Horse Creek) during 2003.

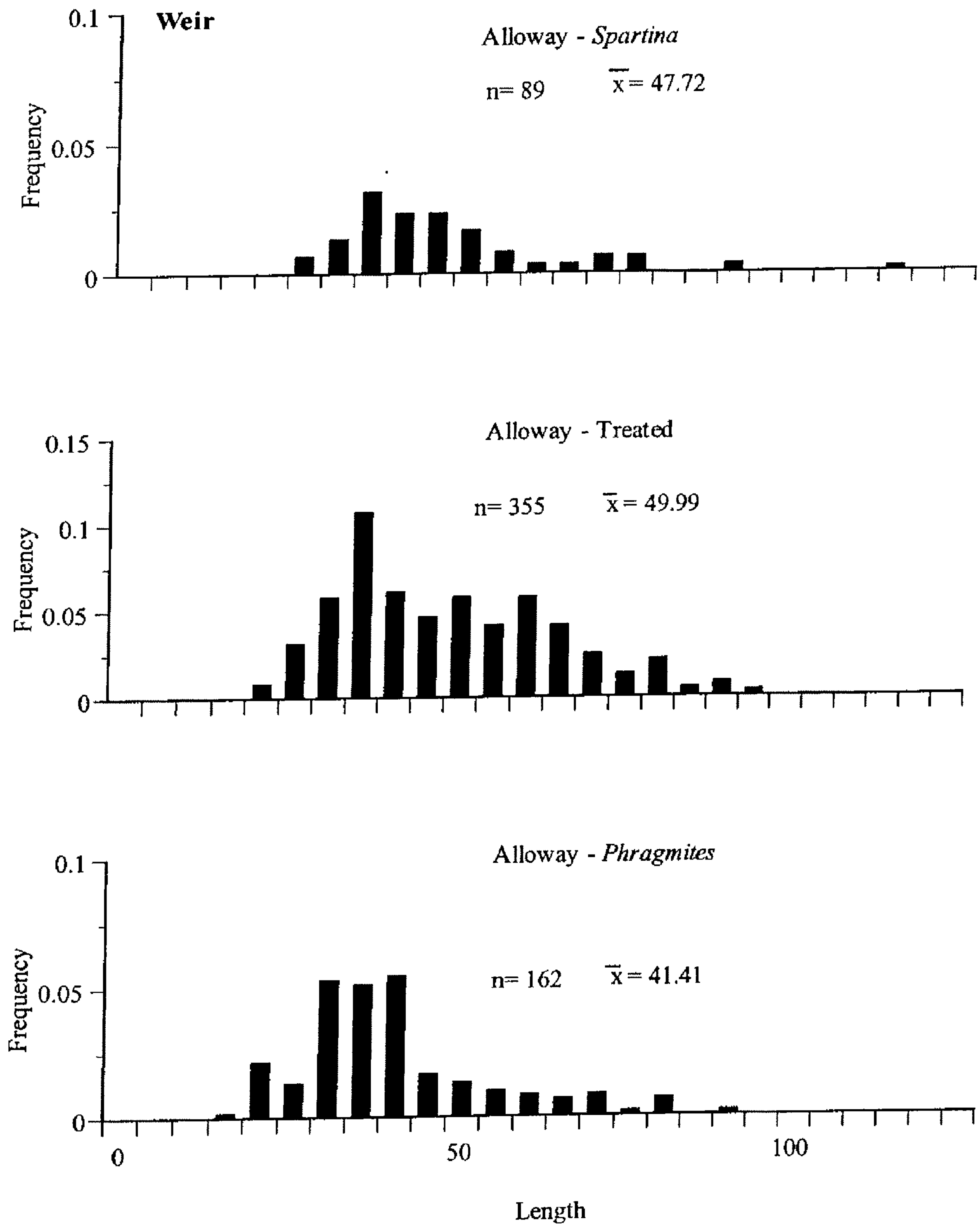



Figure 7-68. Length frequency distribution for all fish as collected in small marsh creeks by weirs at the Alloway Creek reference (*Spartina* and *Phragmites*) treated sites during 2003.

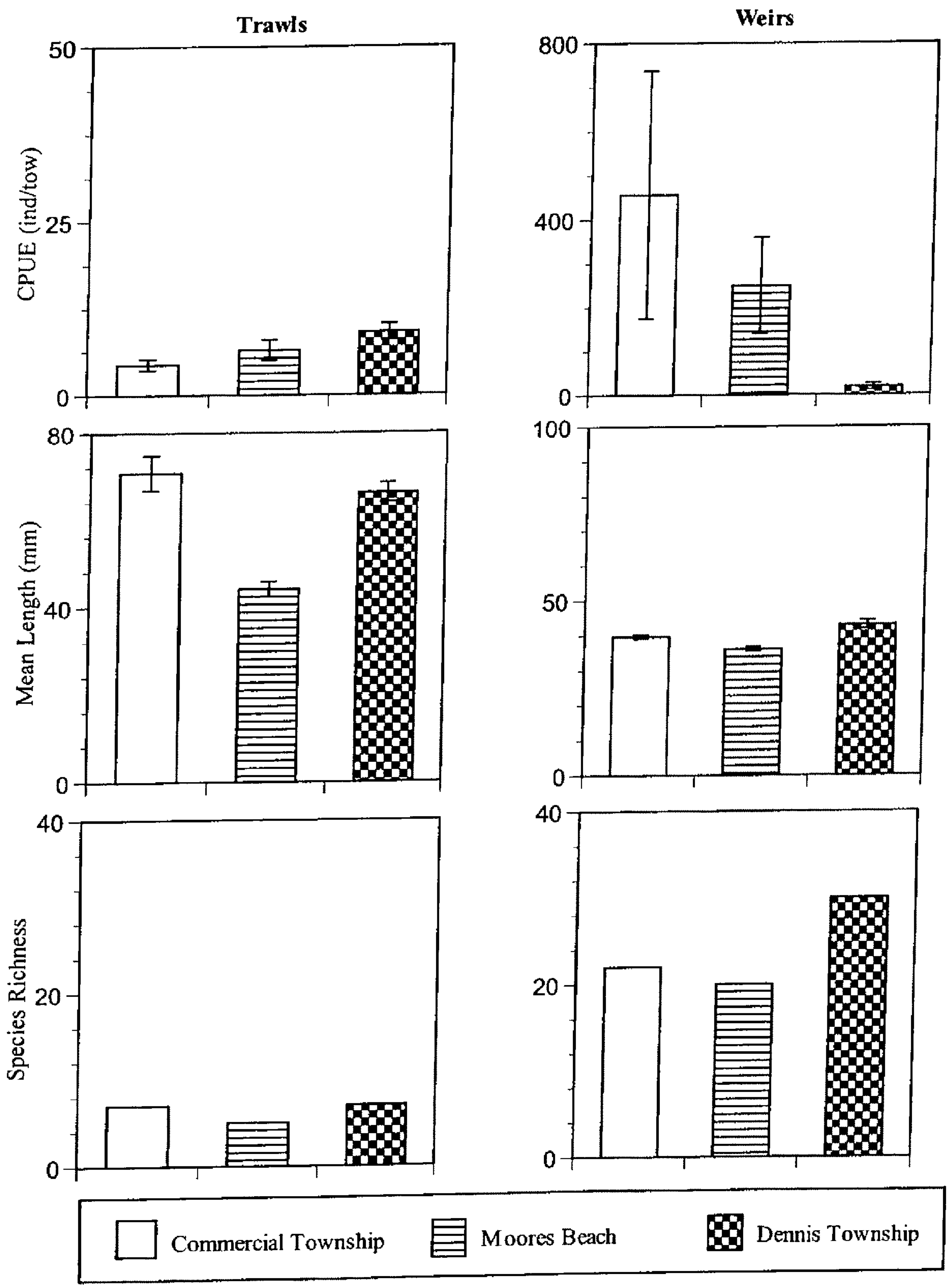



Fig. 7-69. Comparisons of abundance, fish length and species richness among restored (Dennis and Commercial Townships) and reference (Moores Beach) marshes from large and small creeks during 2003.

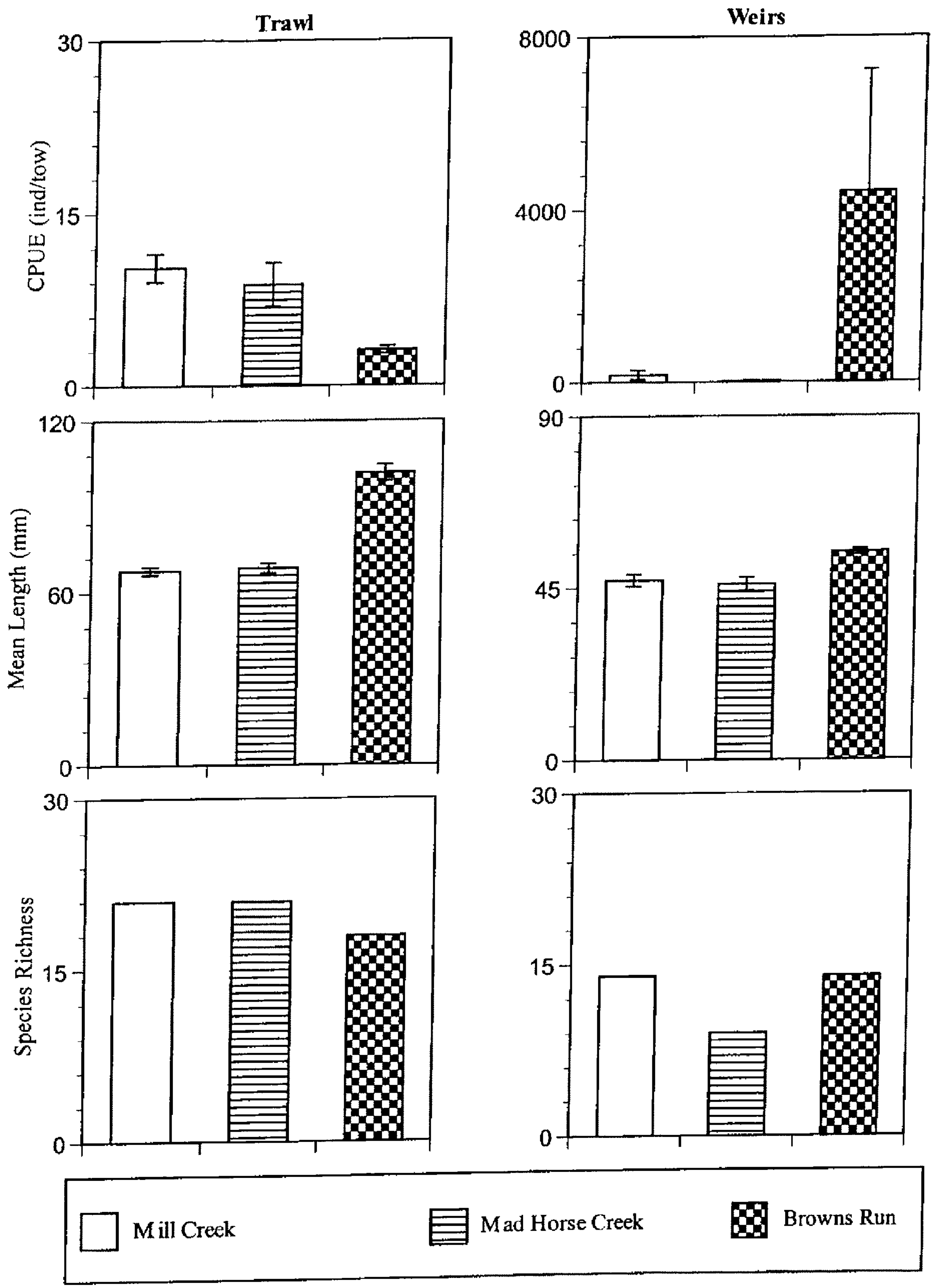



Fig. 7-70. Comparison of abundance, fish length and species richness among restored (Mill Creek and Browns Run) and reference (Mad Horse Creek) marshes from large and small marsh creeks during 2003.

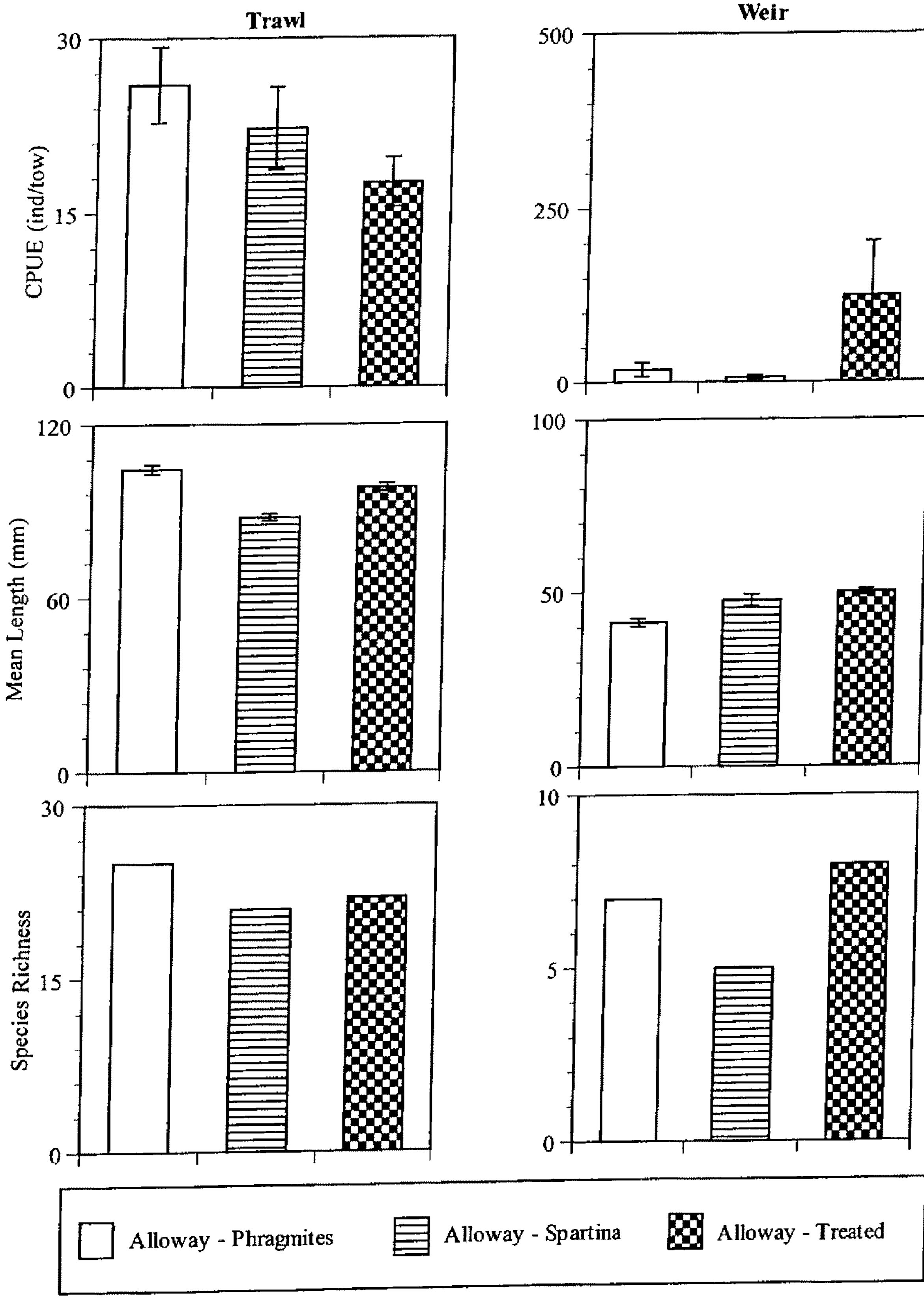



Fig. 7-71. Comparison of abundance, fish length and species richness among Treated and *Phragmites* sites compared to reference (*Spartina* sites) from large and small marsh creeks at Alloway Creek during 2003.

## TABLE OF CONTENTS

## TABLE OF CONTENTS (CONTINUED)

## TABLE OF CONTENTS (CONTINUED)

## TABLE OF CONTENTS (CONTINUED)

**TABLES**

## TABLE OF CONTENTS (CONTINUED)

**FIGURES**

# TABLE OF CONTENTS (CONTINUED)

## TABLE OF CONTENTS (CONTINUED)

## APPENDIX D - MACROPHYTE QUADRAT DATA - TRANSECTS



## APPENDIX E - MACROPHYTE QUADRAT DATA - PLOTS

**TABLE OF CONTENTS (CONTINUED)**

# INTRODUCTION

As a component of its Estuary Enhancement Program (EEP), Public Service Enterprise Group (PSEG) has initiated a Biological Monitoring Program for the Delaware Estuary pursuant to Special Condition Section H.6 (a) of the NJPDES Permit (No. NJ0005622) for the Salem Generating Station. A Biological Monitoring Work Plan (BMWP) was prepared by PSEG in January 1995 to establish a framework for monitoring representative restored wetlands and reference sites that included a detrital production monitoring component. This BMWP was reviewed by the Monitoring Advisory Committee (MAC) and submitted to the New Jersey Department of Environmental Protection (NJDEP) pursuant to Special Condition Section H.6.

In accordance with the BMWP, detrital production monitoring was conducted in 2003 by PSEG. This monitoring included peak growing season (August) sampling at two reference marshes in New Jersey and five wetland restoration sites in New Jersey and Delaware. False color infrared (CIR) aerial photographs were also acquired of the reference marshes and wetland restoration sites on August 24, 2003. These photographs were utilized to map the extent of the various vegetation cover types present on each of these sites.

## MATERIALS AND METHODS

This section describes the materials and methods used in the collection of detrital production data in 2003 and subsequent data analysis. Elements of the 2003 work scope included:

- Collection of percent coverage, height and flowering status data within quadrats located along transects and within plots;
- Collection of macrophyte and litter samples;
- Processing (i.e., weighing) of macrophyte samples in the laboratory;
- Data analysis (e.g., mean, standard deviation, standard error) of present cover, height and biomass data;
- Acquisition and interpretation of CIR aerial photography.

## SITE LOCATIONS

The locations of the EEP restoration sites and reference marshes are shown in Figure 8-1. CIR aerial photography was acquired at all sites for the purpose of mapping the extent of the vegetation communities present. Field data collection in 2003 occurred in New Jersey at five sites: the Mad Horse Creek and Moores Beach reference marshes; the Commercial Township Salt Hay Farm Wetland Restoration Site; and the Alloway Creek and Cohansey River Watershed Wetland Restoration Sites. Field data collection also occurred at two wetland restoration sites in Delaware: The Rocks and Cedar Swamp. A brief description of each site is provided in the following paragraphs.

### Reference Marshes

The two reference marshes selected in accordance with the BMWP were Mad Horse Creek and Moores Beach West (Moores Beach). Mad Horse Creek is an oligohaline (salinity 0-5 ppt) marsh, most of which had not been previously used for salt hay farming operations. The 3,942-acre portion of the marsh selected as a reference site is considered to represent a good example of natural hydrology and drainage patterns, and represents a mature vegetative marsh community. In 2003, most (76.6 percent) of the marsh area was vegetated with *Spartina* spp. and other desirable naturally occurring marsh vegetation. This site also included a substantial area of internal water areas (13.6 percent) of the marsh area in 2003.

Moores Beach is a mesohaline (salinity 5-18 ppt) marsh that “naturally restored” following storm damage to its berms in 1972. By 1992, most of the areas that were in salt hay production in 1960 had been converted to low marsh dominated by *Spartina alterniflora.* The low marsh succession was accomplished by natural processes. The marsh area designated as the reference site encompassed approximately 1,185 acres, most of which (84.1 percent of the marsh area) were vegetated with *Spartina* spp. and other desirable naturally occurring marsh vegetation in 2003.

### Salt Hay Farm Wetland Restoration Sites

Three New Jersey salt hay farms, located in Commercial Township, Maurice River Township and Dennis Township, have been restored to normal daily tidal flow by PSEG under the EEP. The Dennis Township and Maurice River Township salt hay farm sites have reached their targeted coverage of *Spartina alterniflora* and other desirable marsh species, and are not included in this chapter of the 2003 Annual Report. Detrital production monitoring has continued at the Commercial Township Salt Hay Farm Wetland Restoration Site (Commercial Township Site), which is located in Cumberland County and contains 2,894 acres within the restoration boundary.

The Commercial Township Site is bounded to the east by the Village of Bivalve and Maurice River Township, to the south by the Delaware Estuary, to the west by Dividing, Indian, and Hansey Creeks and to the north by rural properties and the Village of Port Norris. The restoration site is situated along the southern New Jersey shoreline of the Delaware Estuary at the northern margin of the Maurice River Township Cove, approximately 18 miles northwest of

Cape May Point. For at least three generations, the area between Dividing Creek and the Maurice River Township had been farmed commercially; earthen dikes had been constructed to enhance the production of salt hay *(Spartina patens* and *Distichlis spicata)*. As a result of storms during early 1996, a number of breaches in the perimeter dike occurred; despite attempts to repair these, much of the salt hay farming area was inundated during the 1996 growing season. However, salt hay farming was continued on some areas in the western portion of the site. The construction phase (dredging, dike breaching, etc.) of the wetland restoration was completed in the fall of 1997, returning daily tidal flows to the wetland restoration area of the site.

**New Jersey *Phragmites* Dominated Sites**

The Alloway Creek and Cohansey River Watershed Wetland Restoration Sites are both *Phragmites*-dominated sites that had been historically diked and farmed. Based on a review of historical aerial photography, *Phragmites* originally became established on dike areas and then spread to the adjacent marshes.

The Alloway Creek Watershed Wetland Restoration Site (The Alloway Creek Site) is located in Elsinboro and Lower Alloways Creek Townships, Salem County, NJ. The Alloway Creek Site encompasses approximately 3,096 acres that include the wetland restoration area and adjacent buffer. The wetland restoration area is comprised of approximately 1600 acres; *Phragmites* covered approximately 58.7 percent of the wetland restoration area in 1996, prior to initial restoration activities. The wetland restoration area is subject to tidal influence from the Delaware River, via Alloways Creek, Straight Ditch and Mill Creek. The Alloway Creek Site is bound to the east by the Salem-Hancocks Bridge Road, to the north by the Fort Elfsborg-Hancocks Bridge Rd, tidal marsh and agricultural fields to the west by the Delaware River, and to the south primarily by the Alloways Creek.

The Cohansey River Watershed Wetland Restoration Site (The Cohansey River Site) is located in Fairfield and Hopewell Townships, Cumberland County, NJ. Within its restoration boundary, this site encompasses 909 acres of previously impounded coastal marsh (the wetland restoration area) that have been divided into two areas – the Green Swamp Area and the Browns Run Area. The Green Swamp Area (Fairfield Township) includes tidal marsh and adjacent upland and freshwater wetland areas and is bordered to the north by the Cohansey River and to the east, south, and west by residential development, tidal marsh, and agricultural fields. The Browns Run Area (Hopewell Township) is located to the northwest across the Cohansey River from the Green Swamp Area and includes tidal marsh and adjacent freshwater wetland and upland areas. *Phragmites* covered 389 acres (42.7 percent) of the wetland restoration site prior to the initiation of wetland restoration activities by PSEG in 1996.

**Delaware *Phragmites* Dominated Sites**

Prior to 1999, five restoration sites were monitored in Delaware. PSEG selected to continue restoration activities at two of these sites, The Rocks and Cedar Swamp. Wetland restoration activities were initiated at these two Delaware *Phragmites*-dominated sites by the Delaware Department of Natural Resources and Environmental Control (DNREC) in 1995. A brief description of the pre-restoration conditions at each site based on interpretations of 1993 aerial photography is provided in the following paragraphs.

The restoration area at The Rocks is comprised of 737 acres and is located approximately 2.3 miles south of Silver Run and 4.0 miles southeast of Odessa in Appoquinimink Hundred, New Castle County, Delaware. This site is part of a continuous tidal marsh community, referred to as the Appoquinimink River-Blackbird Creek System, which extends north and south for several miles. The site is bounded to the east by the Delaware River, to the north by Appoquinimink River, to the west by Stave Landing Road and to the south by Blackbird Creek. Stave Landing Road provides access to The Rocks from the west. *Phragmites* covered 86.9 percent of the vegetated marsh plain in 1993 prior to the initiation of restoration activities by DNREC.

The restoration area at Cedar Swamp is comprised of 1,863 acres and is located approximately 2.6 miles south of The Rocks in Blackbird Hundred, New Castle County, Delaware. This site is bounded to the east by the Delaware Bay. To the north the site is bounded by farmland and Cedar Swamp Road, and to the west and south by farmland, woodland, and contiguous tidal marsh. The boundary between the Delaware River and the Delaware Bay is located at the northeast side of the site, at Liston Point. Collins Beach Road provides access to a public boat ramp and parking area in the southeast corner of the site. Public access to the northern side of the site is available via Cedar Swamp Road. In addition to public hunting and wildlife observation, Cedar Swamp is used as an anchorage for commercial and recreational crabbing and fishing boats. Historically, the site was used for hunting and included a coastal recreation resort. *Phragmites* covered 71.7 percent of the wetland restoration area prior to the initiation of wetland restoration activities by DNREC.

## AERIAL MAPPING

False color infrared (CIR) aerial photography was acquired for all reference and restoration sites in New Jersey and Delaware on August 24, 2003. This photography was acquired at a nominal scale of 1:9600 (i.e., 1 in = 800 ft). The time of acquisition was selected to provide images of the sites at the end of the growing season during the mid-day period and at low tide.

### Camera, Aircraft, and Film Type

To obtain the aerial photography, a Wild-RC30 camera with a Wild Universal Aviogon/4-S lens and a nominal focal length of 153 mm was flown in a Cessna Piper aircraft. Kodak Aerochrome Infrared Film 2443, an infrared-sensitive, false color reversal film, was used for the CIR. This film has medium resolving power and fine grain which emphasizes differences between vegetation types that are visually similar as well as differences in infrared reflectance.

The aerial photography was acquired following standard specifications for stereo coverage. The forward overlap (overlap in the direction of flight) was 60 percent. The sidelap between overlapping parallel flight lines of vertical photography was 30 percent. Any series of two or more consecutive photographs within a flight line were not to be crabbed in excess of three (3) degrees relative to the plotted line of flight, and the differential crab between any two consecutive exposures within a flight line did not exceed three (3) degrees. The tilt within a single frame did not exceed three (3) degrees nor did the difference in tilt between two consecutive frames within flight lines exceed four (4) degrees. The average tilt for all negatives of the same nominal scale did not exceed one (1) degree.

Once the aerial photography was secured, the original photographic negatives were developed through automated processing equipment and RC paper contact prints (9in x 9in) and diapositives of each negative were produced. One set of film diapositives was printed from the original aerial photography using an automatic dodging printer having a flat platen on cut sheets of Kodak Aerographic Duplicating (ESTAR Thick Base) Film No. 4421. This set was used for the vegetation mapping photo interpretation process.

To allow for quick referencing of the aerial flight, an aerial photographic line index of the photography was produced utilizing minifications of each exposure and referencing photographs to each other using Photoshop® software. The index references each flight line and exposure on the index map by site.

**Geodetic Control**

Available existing horizontal and vertical controls, as well as controls acquired in 1996, were used to establish geodetic control for the mapping. All external control (used to control the final network adjustment) was based entirely on first order stations as published by the National Geodetic Survey. Stations were located for photo-identifiability (e.g., targets were painted, where surfaces allow, with high visibility traffic paint). Where surfaces did not permit painting, targets consisted of weather-proof plastic material. Target legs measured 12 inches in width and seven feet in length.

GPS survey techniques were used for establishing photo control at these sites using ground-based rapid static procedures. Rapid static GPS uses dual-frequency receivers to occupy the stations for 8-15 minutes compared to 30-45 minutes using dual frequency receivers in a static mode and 60-75 minutes using single-frequency static methods. The accuracy of the GPS-derived orthometric heights is enhanced by occupying a number of existing benchmarks throughout the project area, and using *Geoid93*—geoidal height interpolation and modeling software from the National Geodetic Survey (NGS)—to model the undulations, or the separation of the modeled sea level surface (the geoid) from the idealized mathematical representation of the earth as an ellipsoid of revolution.

All GPS surveys were performed to exceed the first order horizontal specification (0.01 m + 10 ppm). A sufficient number of existing National Geodetic Reference System (NGRS) stations was used as external control. When the vertical control was done using static mode GPS, a sufficient number (at least 6) of well-distributed benchmarks was included in the network. These known orthometric heights were used along with geoid heights derived from *Geoid93* to obtain orthometric heights of all stations in the network. The network was designed so that loop closures may be analyzed for verification.

GPS data collected in the field were downloaded from the receivers to a computer and processed using the GP Survey® software package from Trimble Navigation, Ltd. The baseline processor is known as WAVE (Weighted Ambiguity and Vector Estimation), which is optimized for dual frequency data. This program checks the data as it is downloaded, allowing editing of items such as station name, height of instrument, and so forth. The data is processed in batch mode, with no operator interaction required. Only integer biased fixed solutions are used. The results are examined to identify suspect lines. When a baseline has a low ratio and/or a high reference variance, it must be checked by loop closures. The network is designed to enable the verification of all lines. The results are sent by high-speed modem link for analysis by an experienced geodetic engineer. If any re-observations are required, they can be performed before the GPS crew leaves the site. Office processing consists of analyzing the results to determine if any manual reprocessing is necessary. Results deemed acceptable are combined to form a network. This network is then adjusted by TRIMNET, a least squares adjustment package from Trimble Navigation, Ltd.

**Aerotriangulation**

Analytical aerotriangulation was performed for the CIR aerial photography obtained in August 2003. The aerial film negatives were digitally scanned at 22.5 microns and the scanned images were used in the analytical aerotriangulation process on Socet Set® softcopy workstations utilizing Socet Set® Multi-Sensor Triangulation System (MST) software. Data capture was performed with the Automation Point Measurement program (APM). The identification and numbering of pass points and tie points between contiguous strips, was performed by the APM program. This data was then edited with the Interactive Point Measurement program (IPM). The editing process reduces the point residual error, point placement and the addition of ground control. The data was corrected for radial lens distortion and film deformation, and a non-airborne simultaneous adjustment was performed. The data was then exported into the program system BLUH to perform the data reduction and final adjustment. BLUH performs the automatic elimination of systematic image effects through the use of additional parameters. Simultaneous Adjustment is carried out and the data is exported into Socet Set® software for the stereo compilation process.

**Stereo compilation**

Stereo compilation was accomplished by the stereo digitizing of map elements, extracted from the 2003 CIR aerial photography using precision Socet Set® softcopy workstations. The scanned images were arranged in overlapping pairs, (commonly referred to as a stereo model) and were then imported into the softcopy workstations for compilation. The analytical solutions, aerial calibration, and geodetic control data, developed in the previous steps of the mapping process are used to accurately register the imagery. This process involves mathematically orienting the stereo model within the instrument to create a stereoscopic three-dimensional image that the photogrammetrist interprets and compiles to build a vector land base of the mapping features as seen in the softcopy workstation. Such map features include:

- Center lines of channels between one and five feet in width;
- Edges of channels greater than five feet in width;

- Ponded areas;
- Dikes, dike breaches and internal berms; and
- Miscellaneous roadways.

Digital Elevation Models (DEM) were also developed to support the production of digital orthophotographs by taking a file containing break lines (digitized points that are connected by a line) which have been placed at all breaks in terrain, and mass points placed at strategic locations (tops, depressions, road intersections, and so forth) and linking them together to form the triangulated irregular network, or TIN. Generally, break lines will be shown at all terrain breaks, drains, tops of banks, ridges, valleys, bases of hills, edges of plateaus, road edges, and so forth. All vector information (map data) was tiled to match PSEG's existing tiling scheme (4,000 ft x 8,000 ft).

**Digital Orthophotography**

An Intergraph Digital Ortho Production System was used for generating digital orthophotography of the reference and restoration sites. The system includes the Zeiss/Intergraph PhotoScan PS1 digital transmissive scanner, six Intergraph workstations with JPEG Compression boards, and more than 40 gigabytes of disk storage capacity. The following steps comprise the general digital orthophoto workflow:

**Scanning.** Each diapositive was scanned three times using red, green, and blue filters. Each scan pass detects the film's emulsion layers that are sensitive to a corresponding spectral bandwidth. Scanning is performed in a manner that duplicates the film as it is exposed to maintain the relationships between the individual colors in the film.

**DEM Production.** Mass point and break lines were merged into blocks and the coordinate system, global origin and working units were set using Intergraph's MGE Terrain Modeler software package. A TIN surface model was developed for each site and, from that surface representation, a grid model was created at an appropriate interval to support orthorectification.

**Image Orientations.** After an exposure was scanned, the fiducial marks were measured using Image Station Digital Orientation (ISDO) software to determine the Interior Orientation (IO) of the image. This step relates the scanned image to the USGS camera calibration report and determines the geometric relationship between the two. Residual errors are normally less than 10 microns for a diapositive. If the root mean square error (RMSE) was excessive, the exposure was re-scanned. If the error was repeated, the diapositive was rejected and remade.

The Exterior Orientation (EO) was performed by relating measured pug mark positions with the corresponding ground coordinates to determine the exact location of the camera at the time of exposure. Known as the space resection, this position consists of the X, Y, and Z coordinates of the camera and the three rotation angles that describe the tip, tilt, and yaw of the aircraft.

Convergence statistics should not exceed National Map Accuracy Standards (NMAS) standards for the scale of photography.

**Digital Orthorectification.** Digital orthophoto processing is a reiterative process that combines input from photography, analytics, and a DEM. The Intergraph Image Station Rectifier (IISR) software mathematically calculates the true orthogonal position and brightness value for each pixel within the digital orthophoto. This is accomplished by differentially resampling the input data both spatially and radiometrically to calculate a new rectified pixel.

The central portion of every exposure from the stereo model was scanned and rectified. Using only the central portion of each exposure reduces the effect of vignetting (uneven exposure that results in darker margins around the diapositives). This is especially important with color infrared photography as it is very susceptible to change in exposure level. Following rectification, the coordinates of photo-identifiable points within the rectified image were compared to the actual ground coordinate of that point. The distance between the observed point and the true coordinate is used to quantify the accuracy of the orthophoto in terms of the NMAS for the mapping scale. These values were included with the result of the interior and exterior orientation analysis. The ortho image was also viewed against the vectorized break lines and other planimetric features to ensure correlation with the DEM file. Compiled features such as stream edges and road center lines are readily identifiable and were used to assess the overall accuracy of the orthophoto.

### Mapsheet Generation and Output

Automated procedures were used to merge two or more overlapping images together and generate a specified mapsheet (4,000 ft in a north-south direction and 8,000ft in an east-west direction). Using the AutoOrtho (ISAO) software developed by Intergraph and TRIFID Corporation, digital imagery can be mosaiced, tone-matched, and feathered into a single continuous seam-free image that can be edge matched against the adjacent sheets to check for continuity of features and contrast. All digital orthophoto files were produced as Intergraph type 28 RGB 24-bit files with a standard color table attached to it so that plotting and display characteristics are consistent among the files.

### Vegetation Mapping

Mapping of marsh vegetation types on the wetland restoration and reference sites utilized the 2003 CIR aerial photography acquired for vector mapping and digital orthophotograph production. CIR photography is a three layer (cyan, yellow and magenta) film that has been widely used for crop and natural vegetation studies because image color formation is dependent upon reflected energy in the red and green portion of the visible spectrum as well as the near-infrared. An object that reflects only infrared energy will expose the cyan layer of the film, leaving the yellow and magenta layers that combine in a subtractive mixture to form a red image when viewed by transmitted light.

Plant leaves reflect a significant amount of green energy and partially expose the yellow layer in addition to almost complete exposure of the cyan layer by the infrared - leaving the magenta layer and a varying parts of the yellow layer with an image color ranging from magenta to red. The more green energy that is reflected by a given vegetation cover, the less yellow layer remains and the more magenta the images of that type appears. Because of species differences in leaf structure and chlorophyll content, separation of species dominated areas on CIR photography often can be based on this variation in red to magenta color. Since wet soil and water reflect little in the wavelengths that CIR film is sensitive to, these areas appear dark (unexposed) on the image.

A team of scientists familiar with the vegetation and physical features of the reference and restoration sites interpreted the CIR photography by identifying color/texture characteristics (i.e., signatures) of the various cover types present. The various areas of species-dominated polygons or other site features (e.g., mud flats) identified on the CIR aerial photography were delineated digitally while viewing the orthophotograph on the computer monitor. On-screen digitizing of cover type boundaries was performed using AutoCAD LT 2000™. Each polygon mapped in this way was assigned an identifying code consisting of the year, cover type designation, and a sequential polygon number for that cover type. Thus, each polygon was given a unique alphanumeric identification that linked the polygon to an external Microsoft Access™ database. AutoCAD Map 2® Release 14.0 software was utilized to further process the data. The minimum mapping unit (MMU) employed for the digitizing effort was one acre. In order to be identified as a given cover type, it is generally necessary that the vegetative cover of the polygon exceed 30 percent. Thus areas mapped as "mud flat" may support vegetation below the 30 percent mapping threshold. This is consistent with the approach utilized by the USFWS in the preparation of NWI maps, where areas supporting less than 30 percent cover are identified as unvegetated (Tiner 1998).

**Quantitative Geomorphologic Evaluation**

A quantitative evaluation of the geomorphologic features was conducted based on the geomorphological mapping compiled from the August 2003 CIR photography. The following parameters were determined as part of the quantitative geomorphologic evaluation:

- Channel classification (order)
- Determination of the total number of channels in each order
- Calculation of bifurcation ratio
- Channel frequency
- Total length (sinuous length)
- Total linear length
- Average channel length
- Channel length ratio
- Percent of total channel length
- Average channel sinuosity
- Drainage density

An approach to geomorphological classification of stream channels was developed by Horton (1945), who emphasized topographic characteristics of the drainage area and gave a hierarchical order to every channel in the drainage basin in his stream-ordering technique. The Horton method utilizes a "top-down" approach to determine the order of the drainage channels, where the smaller streams have lower-order numbers and the central channel is assigned the highest-order number.

Strahler (1957) modified the Horton system by starting the next highest order at the confluence of two tributaries of lower order. Strahler's method is based on the premise that, for a sufficiently large sample size, order number is directly proportional to relative watershed dimensions, channel size, and volume of stream discharge. Also, because the order number is a dimensionless value, two drainage basins of different sizes can be compared at corresponding points through the use of order numbers.

The analytical channel geomorphology tools of Horton (1945) and Strahler (1957), as referenced in Chow (1964, 1988) (order analysis) were developed for evaluating mature stream systems and to aid in the design of stream restoration projects. An implicit assumption of order analysis is that the evaluation is done for sites with comparable channel orders. While this technique is appropriate for mature stream systems, it is not as effective for rapidly developing (i.e., recently restored) salt marsh tidal channel systems in which the number and order of channels can change dramatically over a short time period.

The development of small channels through natural restoration processes dramatically changes the order number of the largest channels. The change in order number with channel development makes it extremely difficult to relate channel dimension with channel order. Because the number of small channels at a restoration site increases as the site matures, the classical channel ordering method makes it appear as if the number of large inlet channels also varies over time. This is because the increase in small channels causes the order number assigned to the largest channels to increase as well.

This increase in order number for the largest channels made comparison between years and among sites extremely difficult at the PSEG restoration sites. In some instances it was not possible to match channel size (dimensions) with channel order, since each channel system changed independently of other systems at a site, and among sites. As a result, it was impossible to track what was happening over time in the smaller streams. Knowing what was happening in the smaller streams was critical, since these small marsh channels provide pathways for tidal waters to access the marsh plain. Additionally, these small marsh channels provide conduits for fish access and detrital export. Therefore, analyzing changes of these small tidal channels is one of the most critical aspects for assessing restoration success.

To address the difficulties associated with application of the "top-down" channel order approach, the hydrogeomorphic analysis technique utilized for this project was modified to be more useful with a dynamic system. Using this hydrogeomorphic class technique ensures that the largest channels are always the lowest number (first class), and that increasing order numbers are assigned to the rapidly changing smaller channels.

Using the "bottom-up" approach, the main inlet from the Delaware Bay or other major water body (e.g. West Creek, Riggins Ditch) was designated a first-class channel. The procedures outlined below were then followed to determine the class designations of channels to be analyzed at each site.

(1) A second-class channel begins where a first-class channel splits into two separate, comparably sized double-lined channels (double-lined channels are greater than five ft wide). If one of these two channels is less than half the size of the other channel, the smaller channel becomes a second-class channel and the other remains a first-class channel.

(2) When a second-class channel splits, the above-stated procedure is applied to identify these branches as third class, fourth class, etc. This rule is only applicable to double-lined channels (i.e., > 5 ft wide).

(3) Any single-lined channel (i.e., <5 ft wide) coming off a double-lined channel is a third-class channel. However, if that double-lined channel is already a third-class channel or greater, then that single-lined channel will be one class higher than the double-lined channel it branches from.

(4) With any split of a single-lined channel, those two channels will be one class higher than the channel they are splitting from.

The method used to derive the geomorphological analysis of the reference marshes and wetland restoration sites utilizes the attributes of both AutoCAD® and Arc View® software. This software quantifies the number of channels of each order that occur on a site as well as derive the various length measurements that are utilized to characterize the channel systems on the sites, as described below:

**Bifurcation Ratio ($R_B$).** The bifurcation ratio, or $R_B$, is the ratio of the number of channels of one class to the number of channels of the next lower class.

$$R_B = N_n \ / N_{n-1}$$

**Channel Frequency ($F_C$).** The channel frequency, or $F_C$, is the number of channels for all classes ($N_T$) per unit area.

**Total length (sinuous length) (L).** The total sinuous length, or L, for channels in each class is the centerline length along the channel course from the start of a channel of one class to the beginning of the channel of next lower class.

**Total linear length (straight line length) (SL)**. The straight line length, or SL, is the length for channels in each class is measured as the straight line distance from the start of the channel of one class to the beginning of the channel of next lower class.

**Average channel length ($L_{n\ avg}$).** The average channel length, or $L_{n\ avg}$, is the total length of channels of a given class divided by the number of channels in that class.

$$L_{n\ avg} = L_n / N_n$$

**Channel length ratio ($R_L$).** The channel length ratio, or $R_L$, is the ratio of the average length of channels in one class to the average length of channels in the next higher class.

$$R_L = L_n / L_{n+1}$$

**Percent of total channel length (%CL).** The percent of total channel length, or %CL, provides information on the proportion of each channel class in the site. This value is calculated by dividing the total length of channels in one class (Ln) by the total length of channels of all classes (LT) and multiplying by 100%.

$$\%CL = L_n / L_T \times 100\%$$

**Average channel sinuosity ($S_{avg}$).** The average channel sinuosity, or $S_{avg}$, is the ratio of the average length of channels of a given class to the average straight line length for channels in that class.

$$S_{avg} = L_{n\ avg} / SL_{n\ avg}$$

**Drainage density (D).** The drainage density, or D, is the total length of channels of all classes divided by the area of the site.

## VEGETATION TRANSECTS

Detrital production data were collected in August 2003 along transects located at the Mad Horse Creek and Moores Beach reference marshes (Figures 8-2 and 8-3, respectively); the Commercial Township Site (Figure 8-4); the Alloway Creek Watershed and Cohansey River Watershed (Browns Run Area) Sites (Figures 8-5 and 8-6), and The Rocks and Cedar Swamp Sites in Delaware (Figures 8-7 and 8-8). Random quadrats (0.25 $m^2$) were located as described below along each of the transect alignments shown in these figures. Macrophyte production data were collected within these quadrats as described in the following sections. The original transects at the restoration sites and the reference marshes were established as part of the 1995 detrital production monitoring effort. Two of the reference site transects were relocated in 1996, Mad Horse Creek Transect 3 (shown as MHT3A in Figure 8-2) and Moores Beach Transect 1 (shown as MBT1A in Figure 8-3). The former was relocated for a property access purpose; the latter to eliminate the excessive edge habitat that the original alignment traversed. The Rocks and Cedar Swamp transects were established for the 1999 sampling effort.

Each transect sampled in 2003 was divided into community segments, with each segment traversing a portion of the total transect length dominated by a given species. In the event that two or more species were determined to be co-dominants, the community segment was identified as such. This method is further discussed in the following section.

The collection of field data (e.g., percent aerial cover) and clipping of samples of macrophytes for laboratory processing occurred within the randomly selected quadrats located along the community segments of each transect. Each quadrat was identified by an alpha-numeric code designating its associated transect and sampling event, the type of data collected at the quadrat and its position along the transect. As an example, MHT1-03-OQ18 indicates that the quadrat was sampled along Mad Horse Creek Transect 1 (MHT1-03) during 2003. The data collected was an ocular estimate of percent cover within the quadrat area (O), and the quadrat was the eighteenth sampled along the transect (Q18). Similarly, MHT1-03-CQ1 indicates that the quadrat was sampled along Mad Horse Creek Transect 1 during 2003 (MHT1-03). In this instance, percent cover data were collected and the quadrat area was clipped for standing crop determinations (C). The quadrat was the first sampled along the transect (Q1).

The method for establishing the random location of the quadrats is as follows:

Each transect at the wetland restoration sites was traversed, and length and number of plant communities (i.e., community segments) and open water and mudflat areas crossed were recorded on an appropriate data sheet (Appendix A, Exhibit A-1). A Magellan Meridian® global position system (GPS) unit was utilized to determine the lengths of each plant community traversed and the locations of channels and other geomorphic features. The community designations determined as a result of this effort served as the basis for the selection of quadrat locations.

The appropriate number and location of quadrats sampled utilizing the appropriate data form (Appendix A, Exhibits A-2 and A-3) was determined as follows:

1. Two quadrats per dominant species type traversed along the transect (e.g., *Spartina patens* dominated, *Spartina alterniflora* dominated) were randomly located. Within these quadrats, standing crop collections ("clips") were made. To locate these "clip" quadrat locations, two community segments of the transect dominated by the same species were randomly selected from the total number of similarly dominated segments[1]. A quadrat location was then randomly selected within each segment.

2. Additional quadrats were randomly located along the transect length within which only ocular estimates of percent cover were made (i.e., "ocular" quadrats). The number of ocular quadrats was determined by multiplying three by the total number of biomass clip quadrats (maximum 22).

Clip or ocular quadrats were located one meter to the side of the transect alignment so as to avoid sampling areas that were previously walked over. The side (right/left) of the transect to which the quadrat was placed was alternated between sample points.

[1] In the event that only one transect segment was dominated by a given species, both clip quadrats were randomly located within that segment.

At the reference marshes, community data collected during the 1996 sampling effort were used to determine the appropriate number and location of quadrats to be sampled (according to the procedures outlined above) during the 2003 effort.

## QUADRAT SAMPLING

Sampling within the 0.25 $m^2$ quadrats located along the transects as described above was conducted utilizing the field procedures described below:

### Percent Aerial Coverage

Within each 0.25 $m^2$ quadrat, the percent of plant foliar and stem aerial coverage (as viewed from above by an observer standing at a point adjacent to the quadrat) was visually estimated using the following percent coverage categories:

0% = open water or bare sediment
<1% = plants sparsely or very sparsely present
5% = plants covering from 1 to 10% of the area
15% = plants covering from 11 to 20% of the area
25% = plants covering from 21 to 30% of the area
35% = plants covering from 31 to 40% of the area
45% = plants covering from 41 to 50% of the area
55% = plants covering from 51 to 60% of the area
65% = plants covering from 61 to 70% of the area
75% = plants covering from 71 to 80% of the area
85% = plants covering from 81 to 90% of the area
95% = plants covering from 91 to 100% of the area

The process of determining the percent coverage for each species occurring in a quadrat first involved estimating of the total percent coverage of all plants within the 0.25 $m^2$ quadrat area. This total was then subdivided into individual percentages for each species within the quadrat and entered onto an appropriate data sheet (Appendix A - Exhibit 2 for clip quadrats; Exhibit 3 for ocular quadrats).

### Canopy Height

Canopy height was determined for each species by measuring the height of a mid-sized plant occurring within the quadrat. These data were entered onto an appropriate data sheet (Appendix A - Exhibit 2 for clip quadrats; Exhibit 3 for ocular quadrats).

**Flowering status**

During each sampling event, plant species occurring within each quadrat were noted as being either flowering or non-flowering at the time of sampling. The flowering status was recorded on the appropriate data sheet (Appendix A - Exhibit 2 for clip quadrats; Exhibit 3 for ocular quadrats).

**Above-ground Biomass Collection**

A vertical photograph was taken of each "clip" quadrat area and all living and standing non-living dominant/co-dominant vegetation within the quadrat was cut within 1 cm of the sediment, separated by species and placed in labeled paper bags. Unattached surface litter from within the quadrat area was also collected and placed in labeled paper bags.

## VEGETATION PLOTS

To supplement the collection of field data within quadrats along transects in 2003, additional 0.25 $m^2$ quadrat sampling was conducted within three 60 m x 60 m "plots". These plots were selectively located at each reference marsh to collect macrophyte productivity data from areas appearing to be of relatively uniform species composition, coverage and height (Figures 8-2 and 8-3). Three plots were also located at the Commercial Township, Alloway Creek Watershed, and Cohansey River Watershed (Browns Run area) Sites in New Jersey (Figure 8-4, 8-5 and 8-6). One plot was located at The Rocks and Cedar Swamp Sites in Delaware (Figures 8-7 and 8-8). The corners of these plots were marked with PVC pipes and located using Global Positioning System (GPS) methods to provide a permanent record of the sampling location.

The primary purpose of this supplemental sampling was to determine the peak live standing crop in areas that could be located on the late August/early September 2003 CIR photography, since a 3,600 $m^2$ area appears as an approximately 0.2 $cm^2$ area (0.4 cm x 0.4 cm) on a 2X enlargement (1:4,800) of the 1:9,600 scale CIR aerial photography.

**Quadrat Locations**

Each of the eighteen 3,600 $m^2$ plot areas (60 m x 60 m) listed above was stratified into nine 400 $m^2$ sub-areas (20 m x 20 m). One 0.25 $m^2$ quadrat was randomly located within each sub-area, for a total of 9 quadrats per plot. Each quadrat was identified by an alpha-numeric code designating the site, plot number and quadrat number. As an example, MHP1-03-CQ5 indicates that the quadrat was sampled within Mad Horse Creek Plot 1 (MHP1) during 2003 (03). The quadrat area was clipped for standing crop determination (CQ) and it was the fifth sampled within the plot (5).

## Quadrat Sampling

Percent coverage, height and flowering status data were collected in each quadrat as described previously and recorded on the appropriate data sheet (Appendix A – Exhibit A-4). Above ground biomass collection was performed as described previously. Samples were then transported to and processed in the laboratory as described below.

## MACROPHYTE LABORATORY PROCESSING

In the laboratory, each sample was dried to a constant weight at $60^{o}$ C. Following drying, the plant materials collected from each quadrat were weighed to the nearest 0.01 g and entered onto the laboratory data sheet (Appendix A – Exhibit A-5). The data was then entered into an EXCEL spreadsheet for subsequent statistical analysis.

# RESULTS

## COVER TYPE MAPPING

### Cover Type Descriptions

The CIR aerial photography acquired on August 24, 2003 was interpreted to map the extent of the various cover types present on the wetland restoration and reference sites at the time of peak standing crop. The cover types identified at the various sites were delineated by mapped polygons[2] representing areas of each site that are either dominated by listed species (i.e., vegetation community types) or represent identifiable land/water features (e.g., developed land, agricultural land, open water, mud flat). In areas where two or more species dominate a vegetation community, multiple species were listed.

The acreage and percent coverage of each individual cover type (e.g., species or group of species) for the reference marshes and the "wetland restoration area" of each wetland restoration site is provided in Tables 8-1 through 8-5. The wetland restoration area generally occurs within the overall "site boundary" and was determined based on the mapping of the tidal wetland/upland edges. These tables group the cover types under the following categories:

- Upland/developed land;
- *Spartina*/other desirable marsh vegetation;
- Desirable marsh vegetation/*Phragmites*
- *Phragmites*-dominated vegetation;
- Non-vegetated marsh plain;
- Internal water areas; and
- Open water.

[2] The minimum polygon area for vegetation stands is approximately 1 acre.

The extent of each cover category at each of the reference marshes and wetland restoration sites is shown in Appendix B, Figures B-1 to B-7. These figures also show the wetland restoration area boundaries for each site. General descriptions of the various cover categories that appear on these figures and the individual cover types that they represent are provided in the following paragraphs.

i. *Spartina spp*. and Other Desirable Marsh Vegetation

While restoration of *Spartina alterniflora* as a dominant species is desirable, there are numerous other species that contribute to estuarine productivity and are indicative of a fully functional marsh ecosystem. Such species include, but are not limited to: *Spartina cynosuroides, Spartina patens, Distichlis spicata, Scirpus robustus*, *Scirpus olneyi, Typha latifolia, Pluchea purpurascens, Acorus calamus, Eleocharis parvula,* and *Echinachloa walteri*. Areas that are predominated by *Spartina alterniflora* or another desirable marsh species are included in this category. Where other species are co-dominants with *Spartina alterniflora*, these species are also indicated in the type designation (e.g., *Spartina alterniflora*/*Amaranthus cannabinus*). Where sparse clumps of *Spartina alterniflora* occur in mud flat areas, these areas are designated in a similar manner (e.g., *Spartina alterniflora*/Mud flat). In the event that mud flat predominates an area, the order of the type name is reversed (i.e., Mud flat/*Spartina alterniflora*).

a. *Spartina alterniflora*

The *Spartina alterniflora* cover type represents areas that have developed "complete" coverage by this species. The percent coverage of the marsh plain by *Spartina alterniflora* in these areas generally ranges between 80 and 90 percent. This cover type represents both tall and short forms. The tall form reaches heights of between 120 and 200 cm and occurs along the margins of creeks, guts, channels, and in other areas that are subject to daily tidal inundation. Short form plants are generally 30 to 60 cm high and occur either in areas of higher marsh surface elevation or on the normally flooded marsh plain inland from the creek channels. In some cases other species, including *Spartina cynosuroides, Scirpus robustus*, and *Amaranthus cannabinus*, also occur as co-dominants in this community.

b. Salt Hay

The salt hay cover type represents areas of the Commercial Township Site vegetated with *Spartina patens, Distichlis spicata*, and *Juncus gerardii.* This cover type was present prior to the restoration of tidal flow to this site. These areas were actively managed for salt hay production, which involved, among other things, periodic inundation and mowing.

c. *Spartina patens*

The *Spartina patens* cover type is typically found in natural high-marsh areas that are at an elevation between mean high and mean higher high water (MHW and MHHW, respectively). These areas are usually dominated by *Spartina patens*.

d. High Marsh

The high marsh cover type includes a variety of coastal species that are generally found at an elevation above MHW. Depending on the particular location, it may contain *Spartina patens, Distichlis spicata*, *Iva frutescens*, *Baccharis halimifolia*, *Panicum virgatum*, and *Phragmites*.

e. *Typha* spp.

The *Typha* spp. cover type includes areas dominated by *Typha latifolia* and *Typha angustifolia*. These species generally occur in the lower-salinity areas of the estuary and have become established over large areas of the *Phragmites*-dominated sites following the application of a glyphosate-based herbicide with surfactant.

f. Mixed Marsh

The mixed marsh cover includes a mixture of desirable naturally occurring marsh vegetation and *Phragmites*, with no individual species dominating over large-enough areas to be interpreted as species-dominated polygons. Species that may be found in this community type include *Spartina alterniflora, Spartina cynosuroides, Typha latifolia, Typha angustifolia, Scirpus robustus, Scirpus olneyi, Echinochloa walteri, Atriplex patula* and *Phragmites* (usually a stunted growth form). This cover type developed over large areas of the Delaware *Phragmites*-dominated sites in 1997 after treatment with Rodeo® (a glyphosate-based herbicide) in 1995 and burning in 1996. *Phragmites* remains as a co- or sub-dominant species in mixed marsh areas, occurring in small (<1 acre) colonies or as individual plants within areas of desirable vegetation.

g. Recovering Desirable Species Area

These areas, historically, were dominated by desirable marsh vegetation, (i.e.,. *Spartina alterniflora, Spartina cynosuroides*). In recent years, these areas have been severely damaged by foraging snow geese and muskrats, turning them completely to mud flat.

ii. Desirable Marsh Vegetation and *Phragmites*

At the *Phragmites*-dominated wetland restoration sites in New Jersey and Delaware, areas mapped as Desirable Marsh Vegetation/*Phragmites* represent portions of each site that are vegetated with a variety of desirable marsh species, as well as *Phragmites*. Desirable species occurring in these areas include those listed above. *Phragmites* is also a co- or sub-dominant species within areas mapped as this category. These areas are primarily within the *Phragmites*-dominated wetland restoration sites and usually represent areas that, prior to initial restoration activities, were monotypic stands of *Phragmites*. *Phragmites* has been reduced in dominance as a result of the spray and burn treatments that have occurred at these sites, but remains a component of the vegetation community present in the years immediately following treatment.

iii. *Phragmites*-Dominated Vegetation

This cover category includes larger areas (>1 acre) dominated by living monotypic stands of *Phragmites* and areas treated with a glyphosate-based herbicide with surfactant that have remaining dead culms present (e.g., areas that have not been burned).

a. *Phragmites australis*

Stands of *Phragmites* occur at both the reference marshes and the wetland restoration sites. At the reference marshes and salt hay farm restoration sites, this community is usually found as an isolated cover type in disturbed areas such as dikes, ditch and road edges, and on natural creek levees. At the *Phragmites*-dominated sites, the cover type had occurred over large areas of the marsh plain prior to the initiation of the restoration activities. Although *Phragmites* usually forms monotypic stands, species such as *Iva frutescens*, *Baccharis halimifolia*, and *Atriplex patula* may also be present in this community, especially along the upland edge.

b. Dead *Phragmites australis*

Monotypic stands of *Phragmites* that were treated with a glyphosate-based herbicide with surfactant, but were not burned are delineated as the dead *Phragmites australis* cover type. This type is included in the *Phragmites*-dominated vegetation category because the dead culms mask the underlying vegetation; therefore, the establishment of desirable marsh vegetation cannot be interpreted from the aerial photography. As these culms are removed by natural processes (e.g., storm tides, ice flows) or by mechanical means through continued restoration activities, the marsh plain will be exposed and these areas will likely become vegetated with *Spartina alterniflora* or other desirable naturally occurring marsh vegetation.

iv. Non-Vegetated Marsh Plain

Various cover types within the marsh plain that are not vegetated[3] by macrophytes are included in this category.

a. Mud Flat

At the restoration sites, mud flat is primarily a transitional cover type that precedes the establishment of desirable vegetation. Mud flat areas that were exposed (i.e., not covered by water) at the time of the CIR aerial photography were delineated as this cover type. During many high tides these areas are inundated. Sparse (< 30 percent cover) vegetation may be present that cannot be detected on the CIR aerial photography. This vegetation may be dominated by *Phragmites* or *Spartina spp*. and other desirable naturally occurring marsh vegetation. Algal mats may also be present over much of the mud flat areas; however, no algal mats were detected on the 2003 CIR aerial photography.

[3] Areas considered to be non-vegetated may support sparse vegetative cover. To be mapped as vegetated, it is generally necessary that greater than 30 percent of the marsh surface be covered by macrophytes.

b. Algal Mat

Mud flats covered by cohesive mats of filamentous algae or a filamentous or gelatinous mat of cyanobacteria have been categorized as algal mat. This cover type is present over many areas, but is not always identifiable on the CIR aerial photography because of differences in the sun's reflection off the marsh surface and sediment deposition onto the algal mat.

c. Beach Community

Sand beaches and other unvegetated sandy areas are included in this cover type. These areas are mainly associated with the Delaware Bayshore.

d. Dredged Material

Materials removed during channel construction at the salt hay farm wetland restoration sites were used to create high marsh areas. Because these areas were only recently completed at the Commercial and Maurice River Township Townships Sites, they are largely unvegetated. Observations of these areas during the 2003 growing season indicate that sparse vegetation is becoming established. When the vegetation becomes established, these areas are expected to be categorized as high marsh.

e. Former Forest

This cover type occurs in former forest areas that are being inundated by high tides. Numerous dead trees remain standing in these areas. The species replacing the former forest community include a variety of tidal marsh species, such as *Spartina alterniflora*, *Spartina patens, Distichlis spicata*, *Atriplex patula*, and *Iva frutescens.* Along the upland edge, species such as *Panicum virgatum* and *Phragmites* may also occur. Where these species predominate the marsh plain of former forest areas, the polygon is considered to be a cover category for that species (i.e., *Spartina alterniflora*/former forest would be within the *Spartina* spp. and other desirable marsh vegetation cover category). This cover type occurs primarily at the Commercial Township Site and includes forested areas that have been periodically flooded by tidal flows as a result of breaches (planned and unplanned) in the perimeter dikes.

f. *Phragmites* Wrack

In some areas, the marsh plain is covered by fallen dead *Phragmites* stems that have been deposited by the tides obscuring the marsh surface. These areas are delineated as the *Phragmites* wrack cover type.

v. Internal Water Areas

Areas that were covered by surface water at the time of the aerial photography (low tide) were designated as open water. Open water includes the subtidal areas of tidal creeks, guts, channels, ditches, and areas of ponded water within the marsh. These areas generally do not support any significant vegetation.

a. Interior Channels

This cover type consists of water areas within interior channels at the reference marshes and wetland restoration sites. Interior channels greater than five feet wide at the time of the aerial photography (low tide) are included. If a named tributary is within the site, it is also considered an interior channel (e.g., Mad Horse Creek is within that reference marsh, and is, therefore, an interior channel).

b. Ponded Water

The ponded water cover type represents areas within the reference marsh and wetland restoration sites that are hydrologically isolated and remain inundated at low tide.

vi. Open Water

The open water category includes small portions of major water bodies (e.g., Delaware Bay, Cohansey River, Alloway Creek) adjacent to the various restoration sites or reference marshes that occur within the site boundaries.

**Site Descriptions**

Discussions of the cover type composition in 2003 at each of the reference marshes and wetland restoration sites are provided in this section. Reference marshes are discussed first, followed by salt hay farm restoration sites, New Jersey *Phragmites*-dominated restoration sites, and Delaware *Phragmites*-dominated restoration sites.

Detailed information on cover type areas for the 2003 monitoring year are presented in Tables 8-1 through 8-5. The percentage of the total marsh area[4] for applicable cover types has been calculated and is included in these tables. Maps showing the 2003 vegetative cover of each reference marsh and wetland restoration site are provided in Appendix B. These maps correspond to the reference marsh and wetland restoration area cover type data presented in Tables 8-1 through 8-5 and show the areas of each site that are vegetated as per the categories below.

- Areas mapped as ***Spartina*-Dominated/Other Desirable Marsh Vegetation** represent portions of each site that are dominated by species such as *Spartina alterniflora, Spartina patens, Scirpus robustus, Typha angustifolia, Typha latifolia, Echinochloa walteri,*

[4] The total marsh area excludes: 1) areas of each reference marsh and wetland restoration site that are above MHHW, as defined by vegetation interpretation; and 2) tidal wetland areas that were not affected by PSEG's wetland restoration activities at a given site. The latter includes areas that were outside of the salt hay farming dikes at the time of PSEG's acquisition of the site and areas landward of upland dikes that were constructed by PSEG as part of the wetland restoration designs for the sites.

*Amaranthus cannabinus,* and *Peltandra virginica*. *Phragmites* is not a dominant in these areas.

- At the *Phragmites*-dominated wetland restoration sites in New Jersey and Delaware, areas mapped as **Desirable Marsh Vegetation/*Phragmites*** represent portions of each site that are vegetated with a variety of desirable marsh species, as well as *Phragmites* and/or Dead *Phragmites*. Desirable species occurring in these areas include those listed above. The wetland restoration sites have this category divided into 2 sub-categories; *Phragmites* co-dominant or sub-dominant, and dead *Phragmites* co-dominant or sub dominant. These occur as small colonies (< 1 acre) or as individual plants within areas of desirable marsh vegetation. The cover types that are represented within these areas include all of the types listed in Tables 8-3 through 8-5 that include *Phragmites or* Dead *Phragmites* as an identified species, regardless of its relative dominance in the type (e.g., areas listed as *Spartina alterniflora/* Dead *Phragmites* as well as areas listed as *Spartina alterniflora/Typha* spp./*Phragmites*).

Areas mapped as ***Phragmites*-Dominated** represent larger areas (>1 acre) of living, monotypic stands of *Phragmites* as well as areas treated with a glyphosate-based herbicide that have remaining dead culms. This mapping category is divided into 2 sub-categories. Dominant Dead *Phragmites* having stands of dead culms following treatment and dominant *Phragmites* having living stands which may be full growth (untreated) or regrowth following treatment with a glyphosate-based herbicide. Continued wetland restoration efforts will be required in order to control *Phragmites* in these areas.

- Areas mapped as **Non-Vegetated Marsh Plain** include mud flats, with or without sparse (< 30 percent cover) vegetation; inundated forest areas prior to revegetation; dredged material (high marsh creation areas); and areas covered by *Phragmites* wrack.

- Areas mapped as **Ponded Water** represent internal portions of each site over which standing water could be seen on the annual CIR aerial photography acquired at low tide.

- Areas mapped as **Channel** represent water areas greater than five feet wide within interior channels.

- Areas mapped as **Open Water** represent small portions of major water bodies within the site and wetland restoration area boundaries.

### Reference Marshes

The extent of each cover category at the reference marshes was based on the interpretation of the 2003 CIR aerial photography as shown in Figures B-1 (Mad Horse Creek) and B-2 (Moores Beach) in Appendix B. The acreage of the vegetation cover categories and cover types mapped in 2003 within each of the reference marshes and the relative percent of the total marsh area that each type represents are summarized in Table 8-1. *Spartina* spp./Other Desirable Marsh Vegetation comprised the majority of the marsh plain at both reference marshes. This cover category ranged from 80.1 percent of the total marsh plain at Mad Horse Creek to 86.0 percent of the total marsh plain at Moores Beach. Within this cover category, *Spartina alterniflora* was the predominant cover type at Mad Horse Creek and *Spartina alterniflora* was the predominant cover type at Moores Beach.

At Mad Horse Creek, 73.8 percent of the marsh plain was covered by *Spartina alterniflora*. Other desirable marsh species present included areas of high marsh/*P. australis* (1.3%), high marsh (1.1%), and *Spartina alterniflora*/*Phragmites australis* (1.1%). *Phragmites australis* dominated over areas representing 4.4 percent of the marsh plain at Mad Horse Creek. Non-vegetated Marsh Plain and Open Water made up 1.8 percent and 0.1 percent, respectively, of the marsh plain. Interior Water Areas, primarily channels, made up 13.5 percent.

At Moores Beach, 74.6 percent of the marsh plain was covered by *Spartina alterniflora* and. *Spartina alterniflora*/Mud Flat comprised an additional 6.3 percent of the marsh plain. *Phragmites australis* dominated over areas representing 4.7 percent of the marsh plain. Non-vegetated Marsh Plain and Internal Water Areas made up 4.7 percent and 4.5 percent, respectively, of this reference marsh.

**Commercial Township Salt Hay Farm Restoration Site**

The extent of each cover category and cover type at the Commercial Township Salt Hay Farm Wetland Restoration Site based on the interpretation of the 2003 CIR aerial photography is shown in Figures B-3 in Appendix B. The acreage of the vegetation cover categories and cover types mapped within the salt hay farm restoration site and the relative percent of the total marsh area that each type represents are summarized in Table 8-2.

*Spartina* spp./Other Desirable Marsh Vegetation (36.1%) and Non-vegetated Marsh Plain (46.8%) were the dominant cover categories at the Commercial Township Site in 2003. *Spartina alterniflora* and *Spartina alterniflora* / Mud Flat made up 13.0% and 16.2% of the total marsh area, respectively. Mud flat (23.9%) and Mud flat/*Spartina alterniflora* (21.4%) were the most prevalent non-vegetated cover types. Overall, *Spartina alterniflora* is dominant or present over areas totaling to 36.1% of the total marsh area. *Phragmites* Dominated vegetation comprised 4.1 percent of the total marsh area and was also present within areas mapped as *Spartina* spp./Other Desirable Marsh Vegetation with *Phragmites* cover category (2.2%). Internal water areas were primarily ponded water (7.7%) and channels (4.4%).

**New Jersey *Phragmites*-Dominated Restoration Sites**

**Alloway Creek Site**

The extent of each cover category at the Alloway Creek Site based on the interpretation of the 2003 CIR aerial photography is shown in Figure B-4 in Appendix B. The acreage of the vegetation cover categories, cover types mapped and the relative percent of the total marsh area that each type represents are summarized in the Table 8-3.

*Spartina spp*./Other Desirable Marsh Vegetation comprised 60.3 percent of the total marsh at the Alloway Creek Site in 2003. Individual cover types present within this cover category included: *Spartina alterniflora* (28.4%) and *Spartina alterniflora/*desirable mixed marsh (10.2%), *Spartina alterniflora*/Mud Flat (5.2%) and desirable mixed marsh (4.3%). *Spartina spp*./Other Desirable Marsh Vegetation with *Phragmites* comprised 8.0 percent of the total. The *Phragmites* dominated cover category represented 20.9 percent of the total marsh area. Most of this coverage was represented by live *Phragmites australis* dominated stands (15.0%). *Phragmites australis* alone dominated 8.7 percent, while *Phragmites australis*/Desirable mixed marsh represented 5.6 percent. Dead *Phragmites australis* and Dead *Phragmites australis*/desirable mixed marsh represented an additional 2.9 percent and 1.5 percent of the total marsh area, respectively. Non-vegetated marsh plain comprised 5.4 percent of the total marsh area, with mud flat (3.6%) and mud flat / *Spartina alterniflora* (1.6%) representing most of this area. Internal water areas (13.1%) were comprised almost entirely of channels (13.1%), with ponded water representing 0.1 percent.

**Cohansey River Site**

The extent of each cover category at the Cohansey River Site based on the interpretation of the 2003 CIR aerial photography is shown in Figure B-5 in Appendix B. The acreage of the vegetation cover categories and cover types mapped within each of the individual areas that comprise the restoration site and the relative percent of the total marsh area that each type represents are summarized in Table 8-4.

*Spartina spp*./Other Desirable Marsh Vegetation was dominant over 78.0 percent of the Cohansey River Watershed Site in 2003, with less than one percent of this total containing live *Phragmites*. *Phragmites/Dead Phragmites* dominated areas represented 8.8 percent of the restoration area - representing 5.7 percent of the Green Swamp area and 11.2 percent of the Browns Run area. The Non-vegetated Marsh Plain cover category comprised 4.8 percent of the Cohansey River Site. Internal Water Areas and Open Water cover categories comprised 6.9 and 1.0 percent, respectively, of the total marsh plain for the site.

**Browns Run Area.** *Spartina spp*./Other Desirable Marsh Vegetation comprised 78.0 percent of the total marsh at the Browns Run Area in 2003. Individual cover types that make up this cover category included: *Spartina alterniflora* (35.0%), *Spartina alterniflora*/*Spartina cynosuroides* (15.4%), *Spartina alterniflora/Spartina cynosuroides/Amaranthus cannabinus (12.1%),* recovering desirable species areas (8.8%). Areas of *Spartina spp*./Other Desirable Marsh Vegetation with *Phragmites australis* represented only 1.1 percent of this category. *Phragmites* dominated vegetation totaled 11.2 percent with live *Phragmites australis* representing most (6.9%) of the category coverage, followed by *Phragmites australis/Spartina alterniflora* (2.9%). Dead *Phragmites* dominated areas represented 1.2 percent of this cover category cover category. The Non-vegetated Marsh Plain (3.0%) cover category was comprised primarily of Mud Flat (1.4%). Internal water areas were comprised of channels (6.6%) and ponded water (0.1%).

**Green Swamp Area.** *Spartina spp*./Other Desirable Marsh Vegetation comprised 77.9 percent of the total marsh at the Green Swamp Area in 2003. Individual cover types present within this cover category included: *Spartina alterniflora* (55.4%), recovering desirable species area (14.4%) and *Spartina alterniflora*/Mud flat (5.6%). Areas of *Spartina spp.*/Other Desirable Marsh Vegetation with *Phragmites australis* represented only 0.7 percent of this category. *Phragmites* dominated vegetation totaled 5.7 percent with areas of dead *Phragmites australis* representing most (3.1%) of the category coverage, followed by live *Phragmites australis* (1.4%). The Non-vegetated Marsh Plain (7.3%) cover category consisted of Mud flat (2.7%), Mud flat/*Spartina alterniflora* (2.4%) and Wrack (1.5%). Internal water areas were comprised primarily of channels (7.2%) with minimal ponded water (0.1%).

### Delaware *Phragmites* Dominated Restoration Sites

The extent of each cover category at the Delaware *Phragmites* dominated wetland restoration sites based on the interpretation of the 2003 CIR aerial photography is shown in Figures B-6 (The Rocks) and B-7 (Cedar Swamp) in Appendix B. The acreage of the vegetation cover categories and cover types mapped within each restoration site and the relative percent of the total marsh area that each type represents are summarized in Table 8-5.

**The Rocks.** *Spartina spp.*/Other Desirable Marsh Vegetation was the dominant cover category at The Rocks Site in 2003, with coverage over 76.6 percent of the restoration area. Desirable mixed marsh (18.0%), *Spartina alterniflora*/Desirable mixed marsh (14.7%), Desirable Mixed Marsh/*Phragmites australis* (14.0%), and Mixed Marsh (9.8%) were the most extensive cover types within this cover category. *Phragmites australis* dominated areas represented 18.8 percent of the wetland restoration area, most of which (11.0%) was classified as Dead *Phragmites australis* (stems remaining from prior years treatment with glyphosate-based herbicide). Only 4.4 percent of the restoration area supported monotypic stands of live *Phragmites australis*. Non-vegetated marsh plain comprised 1.3 percent and Internal Water Areas comprised 3.2 percent of the total marsh.

**Cedar Swamp.** *Spartina spp.*/Other Desirable Marsh Vegetation was a dominant cover category at The Rocks Site in 2003, with coverage over 76.3 percent of the restoration area. Desirable mixed marsh (26.1%), *Spartina alterniflora/Spartina cynosuroides* (14.5%), and *Spartina alterniflora* (12.6%) were the most extensive cover types within this cover category. *Phragmites australis* dominated areas represented 11.6 percent of the wetland restoration area. A total of 8.8 percent of the restoration area supported monotypic stands of live *Phragmites australis*. Non-vegetated marsh plain comprised 4.5 percent and Internal Water Areas comprised 7.6 percent of the total restoration area.

## GEOMORPHOLOGIC MAPPING

Maps showing existing hydraulic features as interpreted from the August 2003 CIR aerial photography of the reference marshes and wetland restoration sites are provided in Appendix C. Mapped features include:

- Center lines of channels between one and five feet in width;
- Edges of channels greater than five feet in width;
- Ponded areas;
- Dikes, dike breaches and internal berms; and
- Miscellaneous roadways.

These maps present the extent of channel systems and other water areas (e.g., ponded areas) as interpreted from the above-referenced photography for these sites. Comments regarding the mapping of the sites are provided in the following paragraphs.

**Reference Marshes**

Mapping of channel systems at the Mad Horse Creek and Moores Beach was completed in 2003 from the same CIR aerial photography utilized for vegetation cover mapping (Figures C-1 and C-2). Data representing the geomorphological characteristics of Mad Horse Creek and Moores Beach are presented in Table 8-6.

**Commercial Township Salt Hay Farm Wetland Restoration Site**

Restoration at the Commercial Township Site was completed in November 1997. Therefore, the mapping of the hydrologic features based on the 2003 aerial photography (Figure C-3) represents conditions approximately four and one half years post restoration. Data representing the geomorphological characteristics of the Commercial Township is presented in Table 8-6.

**New Jersey *Phragmites*-Dominated Sites**

The channel systems at the Alloway Creek Site and Cohansey River Site are shown on Figures C-4 through C-6 in Appendix C. Separate maps are provided for both the Green Swamp and Browns Run areas of the Cohansey River Site. Data representing the geomorphological characteristics of the Alloway Creek Site and Cohansey River Site are presented in Table 8-6.

**Delaware *Phragmites*-Dominated Sites**

The channel systems at The Rocks and Cedar Swamp Delaware wetland restoration sites are shown on Figures C-7 and C-8 in Appendix C. Data representing the geomorphological characteristics of The Rocks and Cedar Swamp are presented in Table 8-6.

## REFERENCE MARSH TRANSECT SAMPLING

Quadrat sampling was conducted during the peak (August) 2003 growing season at the Mad Horse Creek and Moores Beach reference marshes. Percent cover, species identification, flowering status, and height data were collected from both clip and ocular quadrats. Standing crop data (live standing and dead standing) and litter were collected from clip quadrats only.

The field and lab data representing the clip and ocular quadrats along the reference marsh transects during the peak season 2003 macrophyte sampling events are presented in Appendix D. The individual 2003 quadrat data, as well as the means, for percent cover, height (*Spartina alterniflora* and *Spartina cynosuroides*), live standing crop, dead standing crop, and litter for each transect and for all transects at each reference marsh are presented in Appendix D, Tables D-1 and D-2. For each site these means were calculated for: 1) *Spartina alterniflora* dominated[5] (S-d) quadrats, 2) non-*Spartina alterniflora* dominated (e.g., *Phragmites* dominated) quadrats, and 3) for all quadrats.

While the tables in Appendix D present all macrophyte field and laboratory data in detail, several tables have been prepared which summarize the reference marsh transect data collected during the peak growing season. Table 8-7 presents a summary of percent cover by dominance type (*Spartina alterniflora* dominated, non-*Spartina alterniflora* dominated, and all species) for all quadrats (clip and ocular). A summary of percent cover and standing crop data, from clip quadrats only is presented in Table 8-8. The mean percent cover (and mean standing crop), standard error of the mean, standard deviation, minimum, maximum, and number of quadrats for each dominance type are provided in both tables. In addition to the summaries by site, summaries by transect also have been prepared. Table 8-9 presents the means and measures of dispersion (standard error of the mean and standard deviation) by transect for percent cover, height, and standing crop. Data from both clip and ocular quadrats, as applicable, have been used in the calculations in Table 8-9.

**Species Composition**. *Spartina alterniflora* was by far the dominant species sampled along transects at the Mad Horse Creek and Moores Beach reference marshes in 2003, occurring in 88 and 100 percent of the quadrats sampled at each site, respectively. Additional species found to be present in the quadrats at the reference marshes are presented in Table 8-10.

**Percent Cover.** Peak season 2003 percent cover was estimated within all (ocular and clip) quadrats sampled at each reference marsh during the peak season sampling event. The total number of quadrats sampled and number of *Spartina* dominated (S-d) quadrats were as follows:

| Site | Peak Season (#) |
|---|---|
| Mad Horse Creek | 63 (55 S-d) |
| Moores Beach | 24 (24 S-d) |

The mean percent coverage (± SE) for all quadrats in the 2003 sampling event at each reference marsh is graphically shown in Figure 8-7 and was as follows:

| Site | Peak Season (#) |
|---|---|
| Mad Horse Creek | 72 (±2) |
| Moores Beach | 71 (±3) |

5 *Spartina alterniflora* dominated quadrats include those dominated by *Spartina cynosuroides* where it occurs as a dominant species.

The mean percent cover for *Spartina alterniflora* dominated and non-*Spartina alterniflora* dominated quadrats is shown in Figure 8-7. Histograms illustrating the distribution of percent cover determinations for all *Spartina alterniflora* dominated quadrats sampled at the reference marshes are presented in Figures 8-10 and 8-11. As shown in these figures, most (31/55) of the peak season *Spartina alterniflora* dominated quadrats at the Mad Horse Creek reference marsh were within the range of 75 to 95 percent aerial cover. At Moores Beach half (12/24) of *Spartina alterniflora* dominated quadrats were within the range of 75 to 95 percent aerial cover.

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at each reference marsh during the 2003 peak season sampling event. For *Spartina alterniflora* dominated quadrats (which include *Spartina alterniflora* and *Spartina cynosuroides),* the mean height (±SE) for the 2003 sampling event at each reference marsh was as follows:

| Site | Peak Season (cm) |
|---|---|
| Mad Horse Creek | 141 (±12) |
| Moores Beach | 117 (±4) |

Heights of other species measured within quadrats during the 2003 peak season are presented in Tables D-1 and D-2 (Appendix D).

**Flowering Status**. The marsh species noted as flowering at the reference marshes at the time of the 2003 peak season sampling event were *Spartina alterniflora, Spartina cynosuroides, Scirpus robustus, Phragmites australis, Distichlis spicata,* and *Amaranthus cannabinus*. In the majority of quadrats, *Spartina alterniflora* was not in flower.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each reference marsh based on collections of standing living plant materials from clip quadrats along transects. The total number of clip quadrats as well as *Spartina* dominated (S-d) clip quadrats at each reference site were as follows:

| Site | Peak Season (#) |
|---|---|
| Mad Horse Creek | 16 (13 S-d) |
| Moores Beach | 6 (6 S-d) |

The mean values (±SE) for live standing crop in *Spartina alterniflora* dominated quadrats, non-*Spartina alterniflora* dominated quadrats, and all quadrats sampled at each reference marsh in 2003 are presented in Table 8-8 and shown in Figure 8-12. The mean live standing crop for all quadrats was as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Mad Horse Creek | 1225(±148) |
| Moores Beach | 1152(±295) |

**Dead Standing Crop**. Dead standing crop was determined for each reference marsh based on collections of standing dead plant materials from clip quadrats along transects. The mean values (±SE) for dead standing crop in *Spartina alterniflora* dominated quadrats, non-*Spartina alterniflora* dominated quadrats, and all quadrats sampled at each reference marsh in 2003 are presented in Table 8-8. The mean values (±SE) for dead standing crop for all quadrats at each reference marsh were as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Mad Horse Creek | 104(±52) |
| Moores Beach | 19(±19) |

**Litter.** Plant litter biomass present on the marsh surface was determined based on collection of unattached dead plant materials within clip quadrats along transects at the reference marshes. The mean values (±SE) for litter in *Spartina alterniflora* dominated quadrats, non-*Spartina alterniflora* dominated quadrats, and all quadrats sampled at each reference marsh in 2003 are presented in Table 8-8. The mean values (±SE) for litter biomass in all quadrats at each reference marsh were as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Mad Horse Creek | 143(±43) |
| Moores Beach | 44(±10) |

The above tabulations are based on the pooled data for all quadrats *(Spartina alterniflora* dominated and non-*Spartina alterniflora* dominated) in all transects at the reference marshes during the peak growing season. The following sections present a summary of data from Tables D-1 and D-2 (Appendix D) for quadrats along transects at each reference marsh.

**Mad Horse Creek - Transects**

The field and laboratory data representing the clip and ocular quadrats along the Mad Horse Creek transects during the peak season 2003 macrophyte sampling events are presented in Table D-1, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter for each transect are also presented on this table. These means were calculated independently for 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was by far the dominant species present in quadrats sampled along transects at Mad Horse Creek, occurring in approximately 83 percent of the quadrats. Some additional species found to be present in the quadrats at Mad Horse Creek (in order of frequency of occurrence) were *Spartina patens* and *Spartina cynosuroides*.

**Percent Cover**. The mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at Mad Horse Creek during the 2003 peak growing season are presented in Table 8-9. Field data for each quadrat are presented in Table D-1 (Appendix D). The total number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| MHT1 | 23 (20 S-d) |
| MHT2 | 8 (8 S-d) |
| MHT3 | 32 (27 S-d) |

The mean percent cover (± SE) for all quadrats along each transect in 2003, and for *Spartina alterniflora* dominated quadrats (shown graphically in Figure 8-13) only were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| MHT1 | 63 (±4) | 59 (±4) |
| MHT2 | 73 (±3) | 73 (±3) |
| MHT3 | 79 (±2) | 78 (±3) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at Mad Horse Creek during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and/or *Spartina cynosuroides* was as follows:

| Transect | Peak Season (cm) |
|---|---|
| MHT1 | 142 (±7) |
| MHT2 | 149 (±5) |
| MHT3 | 138 (±4) |

Heights for other species of vegetation present in the quadrats in 2003 are presented in Table D-1.

**Live Standing Crop**. Live standing crop was determined for each transect at Mad Horse Creek based on collections of living standing plant materials from clip quadrats along each transect.

The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| MHT1 | 6 (5 S-d) |
| MHT2 | 2 (2 S-d) |
| MHT3 | 8 (6 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the 2003 peak season sampling of Mad Horse Creek transects, and for all *Spartina alterniflora* dominated clip quadrats, were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MHT1 | 1298 (±361) | 1382 (±430) |
| MHT2 | 1573 (±158) | 1573 (±158) |
| MHT3 | 1085 (±124) | 971 (±134) |

Mean live standing crop determinations for *Spartina alterniflora* dominated quadrats only sampled during the 2003 peak season are shown graphically in Figure 8-13.

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of Mad Horse Creek transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MHT1 | 217 (±127) | 113 (±89) |
| MHT2 | 0(±0) | 0 (±0) |
| MHT3 | 45 (±30) | 25 (±25) |

**Litter**. The mean values (±SE) for litter biomass in clip quadrats during the 2003 peak season sampling of Mad Horse Creek transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MHT1 | 125 (±43) | 101 (±45) |
| MHT2 | 222 (±184) | 222 (±184) |
| MHT3 | 137 (±75) | 59 (±21) |

**Moores Beach - Transects**

The field and laboratory data representing clip and ocular quadrats along Moores Beach transects during the 2003 peak season macrophyte sampling events are presented in Table D-2, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. The means were calculated independently for: 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was the only species present in quadrats sampled along transects at Moores Beach, occurring in 100 percent of the quadrats in 2003.

**Percent Cover**. The mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at Moores Beach during the 2003 peak growing season are presented in Table 8-9. Field data for each quadrat are presented in Table D-2. The total number of quadrats (clip and ocular) from which percent cover data were collected along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| MBT1 | 8 (8 S-d) |
| MBT2 | 8 (8 S-d) |
| MBT3 | 8 (8 S-d) |

The mean percent cover (±SE) for all quadrats along each transect, and for all *Spartina alterniflora* dominated quadrats (shown graphically in Figure 8-13) were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| MBT1 | 66(±5) | 66(±5) |
| MBT2 | 81(±3) | 81(±3) |
| MBT3 | 68(±4) | 68(±4) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at Moores Beach during the 2003 peak season sampling event. The mean height (±SE) for *Spartina* dominated quadrats (which included *Spartina alterniflora* and *Spartina cynosuroides*) at Moores Beach was as follows:

| Transect | Peak Season (cm) |
|---|---|
| MBT1 | 137(±16) |
| MBT2 | 124 (±6) |
| MBT3 | 92 (±8) |

**Live Standing Crop**. Live standing crop was determined for each transect at Moores Beach based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats sampled along each transect in 2003 was as follows:

| Transect | Peak Season (#) |
|---|---|
| MBT1 | 2 (2 S-d) |
| MBT2 | 2 (2 S-d) |
| MBT3 | 2 (2 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the 2003 peak season sampling of Moores Beach transects, and for all *Spartina alterniflora* dominated clip quadrats, were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MBT1 | 1485 (±982) | 1485 (±982) |
| MBT2 | 936 (±39) | 936 (±39) |
| MBT3 | 1035 (±414) | 1035 (±414) |

Live standing crop determinations for the 2003 peak season are shown graphically in Figure 8-14.

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of Moores Beach transects, and for all *Spartina alterniflora* dominated clip quadrats, were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MBT1 | 0(±0) | 0(±0) |
| MBT2 | 0 (±0) | 0 (±0) |
| MBT3 | 57 (±57) | 57 (±57) |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of Moores Beach transects, and for all *Spartina alterniflora* dominated clip quadrats, were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (gdw/m$^2$) |
|---|---|---|
| MBT1 | 29 (±17) | 29 (±17) |
| MBT2 | 70 (±6) | 70 (±6) |
| MBT3 | 34 (±17) | 34 (±17) |

## REFERENCE MARSH PLOT SAMPLING

The field and laboratory data representing clip quadrats within 60 m x 60 m plots during the peak season 2003 macrophyte sampling event are presented in Appendix E. The individual quadrat data as well as means for percent cover and live standing crop are presented in Tables E-1 (Mad Horse Creek) and E-2 (Moores Beach). Summary data for each plot, and for each reference marsh are presented in Table 8-11. The summary data includes mean percent cover, live standing crop and dead standing crop as well as measures of dispersion (standard deviation, standard error of the mean, minimum and maximum). Because the plots were located to provide representative data for selected *Spartina alterniflora* dominated areas of each site, means and measures of dispersion have not been calculated for *Spartina alterniflora* dominated quadrats separately.

The percent cover and standing crop data for the Mad Horse Creek and Moores Beach plots as a whole are presented here, followed by a discussion of individual plots within each location.

**Percent Cover**. Peak season 2003 percent cover was estimated within randomly sampled quadrats in three 60 m x 60 m plots located at each reference marsh. Since each plot contained nine (9) randomly located quadrats, the total number of percent cover estimates for each reference marsh was twenty-seven (27). The mean percent coverage (±SE) for all quadrats at each reference marsh was as follows:

| Site | Peak Season (%) |
|---|---|
| Mad Horse Creek | 72 (±2) |
| Moores Beach | 51 (±4) |

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each reference marsh based on collections of standing living plant materials from the 27 quadrats within each of the 60 m x 60 m plots at each of the reference marshes. The mean live standing crop (±SE) for all quadrats at each reference marsh was as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Mad Horse Creek | 1050 (±76) |
| Moores Beach | 1048 (±70) |

The following sections present data for individual 60 m x 60 m plots at each reference marsh in 2003.

### Mad Horse Creek - Plots

Three 60 m x 60 m plots were sampled at Mad Horse Creek in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop. Individual quadrat data are presented in Table E-1.

**Percent Cover**. The peak season 2003 mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum), for each plot are presented in Table 8-11. The mean percent cover (±SE) for each plot is graphically shown in Figure 8-15 and was as follows:

| Plot | Peak Season (%) |
|---|---|
| MHP1 | 81 (±4) |
| MHP2 | 71 (±3) |
| MHP3 | 64 (±3) |

**Live Standing Crop**. The peak season 2003 mean live standing crop as well as measures of distribution around the mean for each plot is presented in Table 8-11. The mean live standing crop (±SE) for each plot is graphically shown in Figure 8-16 and was as follows:

| Plot | Peak Season (gdw/$m^2$) |
|---|---|
| MHP1 | 1123 (±148) |
| MHP2 | 950 (±101) |
| MHP3 | 1076 (±150) |

**Moores Beach - Plots**

Three 60 m x 60 m plots were sampled at Moores Beach in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop. Individual quadrat data are presented in Table E-2.

**Percent cover**. The peak season 2003 mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum), for each plot are presented in Table 8-11. The mean percent cover (±SE) for each plot is graphically shown in Figure 8-15 and was as follows:

| Plot | Peak Season (%) |
|---|---|
| MBP1 | 64 (±5) |
| MBP2 | 36 (±4) |
| MBP3 | 53 (±6) |

**Live standing crop**. The peak season 2003 mean live standing crop as well as measures of dispersion for each plot are presented in Table 8-11. The mean live standing crop (±SE) for each plot is graphically shown in Figure 8-16 and were as follows:

| Plot | Peak Season (gdw/m$^2$) |
|---|---|
| MBP1 | 1182 (±119) |
| MBP2 | 804 (±123) |
| MBP3 | 1156 (±81) |

## COMMERCIAL TOWNSHIP SALT HAY FARM WETLAND RESTORATION SITE SAMPLING

### Commercial Township Site - Transects

The field and laboratory data representing the clip and ocular quadrats along transects at the Commercial Township Site during the 2003 peak season macrophyte sampling event are presented in Table D-3 in Appendix D. The individual quadrat data, as well as the means for percent cover, height (*Spartina alterniflora* and *Spartina cynosuroides*), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. For each transect, these means were calculated independently for: 1) *Spartina alterniflora* dominated (S-d) quadrats, 2) other (e.g., *Phragmites* dominated) quadrats, and 3) the site as a whole. Tables 8-7, 8-8, and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop, and litter biomass as previously described. The mean percent cover and live standing crop for the 2003 peak growing season also are presented graphically in Figures 8-17 and 8-18, respectively.

Data were collected from both clip and ocular quadrats. Percent cover, species identification, flowering status and height data were collected from both clip and ocular quadrats; live standing crop, dead standing crop, and litter biomass were collected from clip quadrats only.

**Species Composition**. Vegetation data were collected from only three out of four transects at the Commercial Township Site because one transect (Transect 4) traverses non-vegetated marsh area. *Spartina alterniflora* was the most common dominant species present in quadrats sampled at the Commercial Township Site in 2003. The marsh area traversed by Transect 4 remained unvegetated in 2003, thus no vegetation was measured or sampled along this transect. *Spartina alterniflora* was dominant in approximately 66 percent of the quadrats along Transects 1 – 3. No other marsh species occurred in quadrats at the Commercial Township Site in 2003. Thus, the other 34% of the quadrats sampled were predominantly mudflat.

**Percent Cover**. The mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at the Commercial Township Site during the 2003 peak growing season are presented in Table 8-9. Field data for each quadrat are presented in Table D-3. The number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| CTT1 | 8 (8 S-d) |
| CTT2 | 8 (4 S-d) |
| CTT3 | 8 (4 S-d) |
| CTT4 | Flooded/Non-vegetated |

The mean percent cover (±SE) for all quadrats along each transect, and for *Spartina alterniflora* dominated quadrats (shown graphically in Figure 8-20,) were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| CTT1 | 80 (±5) | 80 (±5) |
| CTT2 | 44 (±17) | 88 (±7) |
| CTT3 | 46 (±17) | 91 (±4) |
| CTT4 | Flooded/Non-vegetated | Flooded/Non-vegetated |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the Commercial Township Site during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and *Spartina cynosuroides* were as follows:

| Transect | Peak Season (cm) |
|---|---|
| CTT1 | 158 (±5) |
| CTT2 | 225 (±15) |
| CTT3 | 228 (±26) |
| CTT4 | Flooded/Non-vegetated |

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each transect at the site based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| CTT1 | 2 (2 S-d) |
| CTT2 | 2 (2 S-d) |
| CTT3 | 2 (2 S-d) |
| CTT4 | Flooded/Non-vegetated |

The mean values (±SE) for live standing crop in all clip quadrats during the peak season sampling of the Commercial Township Site transects, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-21), were as follows:

| Transect | All Quadrats (gdw/$m^2$) | S-d Quadrats (gdw/$m^2$) |
|---|---|---|
| CTT1 | 896 (±192) | 896 (±192) |
| CTT2 | 2803 (±1887) | 2803 (±1887) |
| CTT3 | 3324 (±2489) | 3324(±2489) |
| CTT4 | Flooded/Non-vegetated | Flooded/Non-vegetated |

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of the Commercial Township Site transects, and for *Spartina alterniflora*-dominated quadrats only, were as follows:

| Transect | All Quadrats (gdw/$m^2$) | S-d Quadrats (gdw/$m^2$) |
|---|---|---|
| CTT1 | n/a | n/a |
| CTT2 | n/a | n/a |
| CTT3 | n/a | n/a |
| CTT4 | Flooded/Non-vegetated | Flooded/Non-vegetated |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of the Commercial Township Site transects, and for *Spartina alterniflora*-dominated quadrats only, were as follows:

| Transect | All Quadrats (gdw/$m^2$) | S-d Quadrats (gdw/$m^2$) |
|---|---|---|
| CTT1 | 385 (±92) | 385 (±92) |
| CTT2 | 15(±2) | 15(±2) |
| CTT3 | 7(±4) | 7(±4) |
| CTT4 | Flooded/Non-vegetated | Flooded/Non-vegetated |

**Commercial Township Site Plots**

Three 60 m x 60 m plots were sampled at the Commercial Township Site in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop, except where mud flats or areas of *Phragmites* (living or wrack) occurred. Individual quadrat data are presented in Appendix E, Table E-3.

**Percent Cover**. The 2003 peak season mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum), for the plots at each site are presented in Table 8-11. The mean percent cover for the plots at the Commercial Township Site (graphically shown in Figure 8-22) were as follows:

| Transect | Peak Season (%) |
|---|---|
| CTP1 | 36 (±10) |
| CTP2 | 34 (±10) |
| CTP3 | 38 (±12) |

**Live Standing Crop**. The 2003 peak season mean live standing crop as well as measures of dispersion for the plots at each site are presented in Table 8-11. The mean live standing crop for the plots at the Commercial Township Site (graphically shown in Figure 8-23) were as follows:

| Transect | Peak Season (gdw/$m^2$) |
|---|---|
| CTP1 | 1371(±379) |
| CTP2 | 677 (±245) |
| CTP3 | 1001 (±345) |

## *PHRAGMITES*-DOMINATED RESTORATION SITES TRANSECT SAMPLING

### New Jersey *Phragmites* Dominated Restoration Sites Transects

The field and laboratory data representing the clip and ocular quadrats along transects at the Alloway Creek and Cohansey River Sites during the 2003 peak season macrophyte sampling event are presented in Tables D-4 and D-5, in Appendix D. The individual quadrat data, as well as the means for percent cover, height (*Spartina alterniflora* and *Spartina cynosuroides*), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. For each transect, these means were calculated independently for: 1) *Spartina alterniflora*-dominated (S-d) quadrats, 2) other (e.g., *Phragmites* dominated) quadrats, and 3) the site as a whole. Tables 8-7, 8-8, and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop, and litter biomass as previously described. The average percent cover and live standing crop for the peak growing season also are presented graphically in Figures 8-17 and 8-18, respectively.

Data were collected from both clip and ocular quadrats. Percent cover, species identification, flowering status and height data were collected from both clip and ocular quadrats; live standing crop, dead standing crop, and litter biomass were collected from clip quadrats only.

**Species Composition**. *Spartina alterniflora* was the most common dominant species present in quadrats sampled at the Alloway Creek Site in 2003, occurring as a dominant in 65 percent of the quadrats. *Phragmites australis* was dominant in approximately 14 percent of the quadrats. Ten other desirable marsh species in quadrats at the Alloway Creek Site at lower frequencies.

*Spartina alterniflora* was by far the most common dominant species present in quadrats sampled along transects at the Cohansey River Site in 2003, dominating in 94 percent of the quadrats. *Phragmites australis* did not occur in any of the quadrats sampled. Other species present included *Spartina cynosuroides, Amaranthus cannabinus,* and *Scirpus robustus*.

**Percent Cover.** Percent cover was estimated within all (ocular and clip) quadrats sampled at the sites during the 2003 peak season sampling event. A total of 72 quadrats were sampled along transects at the Alloway Creek Site and 32 quadrats were sampled at the Cohansey River Site. The mean percent cover (±SE) for all quadrats (graphically shown in Figure 8-17) were as follows:

| Site | Peak Season (%) |
|---|---|
| Alloway Creek | 56 (±3) |
| Cohansey River | 66 (±5) |

Figures 8-24 and 8-25 show the percent cover groupings for *Spartina alterniflora* dominated quadrats at the Alloway Creek Site and Cohansey River Site, respectively.

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the site during the 2003 peak growing season sampling event. For *Spartina alterniflora* dominated quadrats (which include *Spartina alterniflora* and *Spartina cynosuroides),* the mean heights (±SE) at the Alloway Creek and Cohansey River Sites were as follows:

| Site | Peak Season (cm) |
|---|---|
| Alloway Creek | 142 (±10) |
| Cohansey River | 150 (±5) |

Heights for other species of vegetation present in the quadrats are presented in Table D-4 and D-5.

**Flowering Status**. Of the nine species identified in quadrats at the Alloway Creek site, most were flowering in at least some of the quadrats at the time of the 2003 peak season sampling. *Spartina alterniflora* and *Spartina cynosuroides* were flowering at the Cohansey River Site. The flowering status for species within each quadrat at the Alloway Creek Site and Cohansey River Site in 2003 is provided in Tables D-4 and D-5, respectively.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for the Alloway Creek and Cohansey River sites based on collections of standing living plant materials from clip quadrats along transects. The number of clip quadrats along each transect was as follows:

| Site | Peak Season (#) |
|---|---|
| Alloway Creek | 18 (10 S-d) |

| | |
|---|---|
| Cohansey River | 8 (8 S-d) |

The mean value (±SE) for live standing crop at each site is shown in Figure 8-18 and was as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Alloway Creek | 911 (±127) |
| Cohansey River | 1186 (±231) |

In addition to the mean live standing crop for all quadrats in the restoration sites, the mean live standing crop values for *Spartina alterniflora* dominated and non-*Spartina alterniflora* dominated quadrats were calculated and are presented in Table 8-8.

**Dead Standing Crop**. Peak season 2003 dead standing crop was determined based on collections of standing dead plant materials from clip quadrats along transects at the restoration sites. The mean values (±SE) for dead standing crop were as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Alloway Creek | 79 (±51) |
| Cohansey River | 7 (±7) |

**Litter.** The plant litter biomass present on the marsh surface in 2003 was determined based on collection of unattached dead plant materials within clip quadrats along transects at the restoration sites. The mean value (±SE) for litter biomass at the site was as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| Alloway Creek | 146 (±34) |
| Cohansey River | 59 (±19) |

The above discussions are based on the pooled data for all quadrats at the Alloway Creek Site and Cohansey River Site during the peak growing season. The following sections present a summary of data from Appendix D, Tables D-4 and D-5 for quadrats along individual transects at each site.

**Alloway Creek Watershed Site - Transects**

The field and laboratory data representing the clip and ocular quadrats along the Alloway Creek Site transects during the peak season 2003 macrophyte sampling event are presented in Table D-4, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. These means were calculated independently for: 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was the most common dominant species present in quadrats sampled at the Alloway Creek Site, dominating in 65 percent of the quadrats. *Phragmites australis* was dominant in approximately 14 percent of the quadrats. Ten other species were also identified in quadrats at the Alloway Creek Site. These included *Echinochloa walteri, Typha angustifolia, Typha latifolia, Scirpus robustus, Pluchea purpurascens,* and *Peltandra virginica.*

**Percent Cover**. The peak season 2003 mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at the Alloway Creek Site are presented in Table 8-9. Field data for each quadrat are presented in Table D-4. The number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| ACWT1 | 24 (18 S-d) |
| ACWT2 | 8 (8 S-d) |
| ACWT3 | 16 (10 S-d) |
| ACWT4 | 24 (11 S-d) |

The mean percent cover (±SE) for all quadrats along each transect, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-20), were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| ACWT1 | 70 (±4) | 70 (±4) |
| ACWT2 | 73 (±5) | 73 (±5) |
| ACWT3 | 52 (±7) | 61 (±8) |
| ACWT4 | 39 (±6) | 63 (±8) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the Alloway Creek Site during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and *Spartina cynosuroides* for each transect at the site was as follows:

| Transect | Peak Season (cm) |
|---|---|
| ACWT1 | 148 (±5) |
| ACWT2 | 154 (±11) |
| ACWT3 | 114 (±7) |
| ACWT4 | 145 (±11) |

Heights for other species of vegetation present in the quadrats are presented in Table D-4.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each transect at the site based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| ACWT1 | 6 (4 S-d) |
| ACWT2 | 2 (2 S-d) |
| ACWT3 | 4 (2 S-d) |
| ACWT4 | 6 (2 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the 2003 peak season sampling of the Alloway Creek Site transects, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-21), were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| ACWT1 | 1123 (±258) | 1206 (±400) |
| ACWT2 | 1287(±270) | 1287(±270) |
| ACWT3 | 821 (±273) | 859 (±188) |
| ACWT4 | 634 (±171) | 1100 (±184) |

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of the Alloway Creek Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| ACWT1 | 28 (±16) | 24 (±21) |
| ACWT2 | 9 (±9) | 9(±9) |
| ACWT3 | 56 (±55) | 1 (±1) |
| ACWT4 | 169 (±148) | n/a |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of the Alloway Creek Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| ACWT1 | 232 (±63) | 250 (±97) |
| ACWT2 | 162(±102) | 162 (±102) |
| ACWT3 | 94 (±72) | 30 (±30) |
| ACWT4 | 90 (±49) | 44 (±44) |

## Cohansey River Watershed Site- Transects

The field and laboratory data representing the clip and ocular quadrats along the Cohansey River Site transects during the peak season 2003 macrophyte sampling event are presented in Table D-5, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter biomass for each transect are also presented in this table. These means were calculated independently for: 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was by far the most common dominant species present in quadrats sampled along transects at the Cohansey River Site, dominating in 94 percent of the quadrats. Other species occurring in the sampled quadrats included *Spartina cynosuroides, Amaranthus cannabinus, Polygonum punctatum* and *Scirpus robustus.*

**Percent Cover**. The 2003 peak season 2003 mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at the Cohansey River Site are presented in Table 8-9. Field data for each quadrat are presented in Table D-5. The number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| BRT1 | 8 (8 S-d) |
| BRT2 | 8 (7 S-d) |
| BRT3 | 8 (7 S-d) |
| BRT4 | 8 (8 S-d) |

The mean percent cover (±SE) for all quadrats along each transect, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-20), were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| BRT1 | 74 (±4) | 74 (±4) |
| BRT2 | 44 (±9) | 51 (±7) |
| BRT3 | 58 (±11) | 66 (±9) |
| BRT4 | 89 (±6) | 89 (±6) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the Cohansey River Site during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and *Spartina cynosuroides* for each transect at the site was as follows:

| Transect | Peak Season (cm) |
|---|---|
| BRT1 | 165 (±13) |
| BRT2 | 115 (±16) |
| BRT3 | 146 (±18) |
| BRT4 | 167 (±14) |

Heights for other species of vegetation present in the quadrats are presented in Table D-5.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each transect at the site based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| BRT1 | 2 (2 S-d) |
| BRT2 | 2 (2 S-d) |
| BRT3 | 2 (2 S-d) |
| BRT4 | 2 (2 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the peak season sampling of the Cohansey River Site transects, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-21), were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| BRT1 | 2066 (±399) | 2066 (±399) |
| BRT2 | 1007 (±123) | 1007 (±123) |
| BRT3 | 1029 (±306) | 1029 (±306) |
| BRT4 | 643 (±321) | 643 (±321) |

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of the Cohansey River Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| BRT1 | 30 (±30) | 30 (±30) |
| BRT2 | n/a | n/a |
| BRT3 | n/a | n/a |
| BRT4 | n/a | n/a |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of the Cohansey River Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| BRT1 | 53 (±14) | 53 (±14) |
| BRT2 | 75 (±55) | 112 (±69) |
| BRT3 | 33(±1) | 33(±1) |
| BRT4 | 38(±38) | 38(±38) |

**Delaware *Phragmites* Dominated Restoration Sites Transect Sampling**

The field and laboratory data representing the clip and ocular quadrats along transects at The Rocks and Cedar Swamp Sites in Delaware during the 2003 peak season macrophyte sampling event are presented in Tables D-6 and D-7, in Appendix D. The individual quadrat data, as well as the means for percent cover, height (*Spartina alterniflora* and *Spartina cynosuroides*), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. For each transect, these means were calculated independently for: 1) *Spartina alterniflora*-dominated (S-d) quadrats, 2) other (e.g., *Phragmites* dominated) quadrats, and 3) the site as a whole. Tables 8-7, 8-8, and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop, and litter biomass as previously described. The average percent cover and live standing crop for the peak-growing season also are presented graphically in Figures 8-17 and 8-18, respectively.

Data were collected from both clip and ocular quadrats. Percent cover, species identification, flowering status and height data were collected from both clip and ocular quadrats; live standing crop, dead standing crop, and litter biomass were collected from clip quadrats only.

**Species Composition**. *Spartina alterniflora* was the most common dominant species present in quadrats sampled at The Rocks Site, dominating in approximately 40 percent of the quadrats. *Scirpus olneyi* and *Pluchea purpurascens* also occurred as dominant species in 13 and 11 percent of the quadrats, respectively. The high diversity of the vegetation cove of The Rocks site is evidenced by the fifteen other species that occurred in the quadrats sampled in 2003.

*Spartina alterniflora* was also the most common dominant species present in quadrats sampled along transects at the Cedar Swamp Site, dominating in approximately 59 percent of the quadrats. *Spartina cynosuroides* was dominant in 30 percent of the quadrats. *Phragmites australis* was dominant in 6 percent of all quadrats. Other species present included *Scirpus robustus, Spartina patens* and *Pluchea purpurascens.*

**Percent Cover.** Percent cover was estimated within all (ocular and clip) quadrats sampled at the sites during the 2003 peak season sampling event. A total of 94 quadrats were sampled along transects at The Rocks Site and 80 quadrats were sampled at the Cedar Swamp Site. The mean percent cover (±SE) for all quadrats during the 2003 peak season sampling event at the Delaware *Phragmites* dominated wetland restoration sites (graphically shown in Figure 8-17) were as follows:

| Site | Peak Season (%) |
|---|---|
| The Rocks | 67 (±2) |
| Cedar Swamp | 65 (±2) |

Figures 8-26 and 8-27 show the percent cover groupings for *Spartina alterniflora* dominated quadrats at The Rocks and Cedar Swamp Sites, respectively.

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the site during the peak growing season sampling event. For *Spartina alterniflora* dominated quadrats (which include *Spartina alterniflora* and *Spartina cynosuroides),* the mean height (±SE) for the 2003 sampling event at each Delaware Phragmites-dominated restoration site was as follows:

| Site | Peak Season (cm) |
|---|---|
| The Rocks | 133 (±10) |
| Cedar Swamp | 159 (±12) |

Heights for other species of vegetation present in the quadrats are presented in Table D-6 and D-7.

**Flowering Status**. Of the eighteen species identified in quadrats at The Rocks Site in 2003, most were flowering in at least some of the quadrats. Species present at the Cedar Swamp Site were also flowering in some of the quadrats during the peak season sampling event. Detailed information on the flowering status for species within each quadrat at The Rocks and Cedar Swamp Sites is provided in Tables D-6 and D-7.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for the site based on collections of standing living plant materials from clip quadrats along transects. The number of clip quadrats along each transect was as follows:

| Site | Peak Season (#) |
|---|---|
| The Rocks | 26 (10 S-d) |
| Cedar Swamp | 20 (15 S-d) |

The mean value (±SE) for live standing crop at each site is shown in Figure 8-17 and was as follows:

| Site | Peak Season (gdw/m$^2$) |
|---|---|
| The Rocks | 831 (±111) |
| Cedar Swamp | 1032 (±135) |

In addition to the mean live standing crop for all quadrats in the restoration site, the mean live standing crop values for *Spartina alterniflora* dominated and non-*Spartina alterniflora* dominated quadrats were calculated and are presented in Table 8-8.

**Dead Standing Crop**. Peak season 2003 dead standing crop was determined based on collections of standing dead plant materials from clip quadrats along transects at the restoration sites. The mean values (±SE) for dead standing crop were as follows:

| Site | Peak Season (gdw/$m^2$) |
|---|---|
| The Rocks | 185 (±60) |
| Cedar Swamp | 118 (±33) |

**Litter.** The peak season 2003 plant litter biomass present on the marsh surface was determined based on collection of unattached dead plant materials within clip quadrats along transects at the restoration sites. The mean value (±SE) for litter biomass at the site was as follows:

| Site | Peak Season (gdw/$m^2$) |
|---|---|
| The Rocks | 165 (±33) |
| Cedar Swamp | 143 (±25) |

The above discussions are based on the pooled data for all quadrats at The Rocks and Cedar Swamp Sites during the peak growing season. The following sections present a summary of data from Appendix D, Tables D-6 and D-7 for quadrats along individual transects at each site.

**The Rocks Site - Transects**

The field and laboratory data representing the clip and ocular quadrats along The Rocks Site transects during the peak season 2003 macrophyte sampling event are presented in Table D-6, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. These means were calculated independently for: 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was the most common dominant species present in quadrats sampled at The Rocks Site. It was dominant in approximately 40 percent of the quadrats. *Scirpus olneyi* and *Pluchea purpurascens* were the next most dominant species. They were dominant in approximately 13 and 11 percent of the quadrats, respectively. Fifteen other species were identified in quadrats at The Rocks Site.

**Percent Cover**. The mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at The Rocks Site during the 2003 peak growing season are presented in Table 8-9. Field data for each quadrat are presented in Table D-6. The number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| TRT1 | 16 (13 S-d) |
| TRT2 | 30 (9 S-d) |
| TRT3 | 32 (14 S-d) |
| TRT4 | 16 (9 S-d) |

The mean percent cover (±SE) for all quadrats along each transect, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-28), were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| TRT1 | 73 (±2) | 72 (±3) |
| TRT2 | 61 (±5) | 83 (±5) |
| TRT3 | 65 (±4) | 59 (±6) |
| TRT4 | 74 (±7) | 74 (±9) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at The Rocks Site during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and *Spartina cynosuroides* for each transect at the site was as follows:

| Transect | Peak Season (cm) |
|---|---|
| TRT1 | 143 (±7) |
| TRT2 | 134 (±8) |
| TRT3 | 133 (±11) |
| TRT4 | 110 (±5) |

Heights for other species of vegetation present in the quadrats are presented in Table D-6.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each transect at the site based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| TRT1 | 4 (2 S-d) |
| TRT2 | 8 (2 S-d) |
| TRT3 | 10 (4 S-d) |
| TRT4 | 4 (2 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the peak season sampling of The Rocks Site transects, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-29), were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| TRT1 | 1,076 (±42) | 1,063 (±102) |
| TRT2 | 774 (±287) | 1937 (±15) |
| TRT3 | 772 (±179) | 658(±84) |
| TRT4 | 850 (±114) | 1,041 (±44) |

**Dead Standing Crop**. The peak season 2003 mean values (±SE) for dead standing crop in all clip quadrats during the peak season sampling of The Rocks Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| TRT1 | 60(±31) | 8(±1) |
| TRT2 | 474 (±151) | 55 (±55) |
| TRT3 | 25(±15) | 56 (±33) |
| TRT4 | 133 (±79) | n/a |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of The Rocks Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| TRT1 | 134 (±125) | 15(±15) |
| TRT2 | 212 (±61) | 46 (±46) |
| TRT3 | 168(±55) | 137 (±43) |
| TRT4 | 95 (±13) | 97 (±4) |

**Cedar Swamp Site - Transects**

The field and laboratory data representing the clip and ocular quadrats along the Cedar Swamp Site transects during the peak season 2003 macrophyte sampling event are presented in Table D-7, in Appendix D. The means for percent cover, species height (*Spartina alterniflora* dominated only), live standing crop, dead standing crop and litter biomass for each transect are also presented on this table. These means were calculated independently for: 1) *Spartina alterniflora* dominated quadrats along each transect, 2) other (e.g., *Phragmites* dominated) quadrats along each transect, and 3) for all quadrats along each transect. Means of each type also were calculated for the site as a whole (i.e., means of all quadrats along all transects). Tables 8-7, 8-8 and 8-9 provide summary information for percent cover, height, live standing crop, dead standing crop and litter biomass as previously described.

**Species Composition**. *Spartina alterniflora* was the most common dominant species present in quadrats sampled along transects at the Cedar Swamp Site, dominating in approximately 59 percent of the quadrats. *Spartina cynosuroides* was dominant in 30 percent of the quadrats. *Phragmites australis* was dominant in 6 percent of all quadrats. Other species present included *Scirpus robustus, Spartina patens* and *Pluchea purpurascens.*

**Percent Cover**. The mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation), for quadrats along each transect at the Cedar Swamp Site during the 2003 peak growing season are presented in Table 8-9. Field data for each quadrat are presented in Table D-7. The number of quadrats (clip and ocular) along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| CST1 | 16 (16 S-d) |
| CST2 | 24 (21 S-d) |
| CST3 | 24 (19 S-d) |
| CST4 | 16 (15 S-d) |

The mean percent cover (±SE) for all quadrats along each transect, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-28), were as follows:

| Transect | All Quadrats (%) | S-d Quadrats (%) |
|---|---|---|
| CST1 | 58 (±6) | 58 (±6) |
| CST2 | 64 (±3) | 65 (±3) |
| CST3 | 65 (±5) | 61 (±5) |
| CST4 | 74 (±3) | 75 (±3) |

**Vegetation Height**. The average height of each plant species present was measured for all (ocular and clip) quadrats sampled at the Cedar Swamp Site during the 2003 peak season sampling event. For *Spartina* dominated quadrats, the mean height (±SE) of *Spartina alterniflora* and *Spartina cynosuroides* for each transect at the site was as follows:

| Transect | Peak Season (cm) |
|---|---|
| CST1 | 157 (±8) |
| CST2 | 177 (±10) |
| CST3 | 154 (±11) |
| CST4 | 136 (±6) |

Heights for other species of vegetation present in the quadrats are presented in Table D-7.

**Live Standing Crop**. Peak season 2003 live standing crop was determined for each transect at the site based on collections of living standing plant materials from clip quadrats along each transect. The number of clip quadrats along each transect was as follows:

| Transect | Peak Season (#) |
|---|---|
| CST1 | 4 (4 S-d) |
| CST2 | 6 (5 S-d) |
| CST3 | 6 (3 S-d) |
| CST4 | 4 (3 S-d) |

The mean values (±SE) for live standing crop in all clip quadrats during the 2003 peak season sampling of the Cedar Swamp Site transects, and for *Spartina alterniflora*-dominated quadrats only (shown graphically in Figure 8-29), were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| CST1 | 1293 (±322) | 1293 (±322) |
| CST2 | 719 (±154) | 744 (±186) |
| CST3 | 1105 (±273) | 1453 (±499) |
| CST4 | 1132 (±385) | 1306(±486) |

**Dead Standing Crop**. The mean values (±SE) for dead standing crop in all clip quadrats during the 2003 peak season sampling of the Cedar Swamp Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| CST1 | 54 (±31) | 54 (±31) |
| CST2 | 83 (±47) | 89 (±57) |
| CST3 | 185 (±48) | 271 (±63) |
| CST4 | 134 (±131) | 175 (±175) |

**Litter**. The mean values (±SE) for litter biomass in all clip quadrats during the 2003 peak season sampling of the Cedar Swamp Site transects were as follows:

| Transect | All Quadrats (gdw/m$^2$) | S-d Quadrats (%) |
|---|---|---|
| CST1 | 148 (±22) | 148 (±22) |
| CST2 | 126 (±26) | 125 (±32) |
| CST3 | 222 (±64) | 147 (±49) |
| CST4 | 43 (±19) | 41 (±26) |

## *PHRAGMITES* DOMINATED RESTORATION SITE PLOT SAMPLING

### New Jersey *Phragmites* Dominated Restoration Site Plots

### Alloway Creek Watershed Site -Plots

Three 60 m x 60 m plots were sampled at the Alloway Creek Site in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop, except where mud flats or areas of *Phragmites* wrack occurred. Individual quadrat data are presented in Appendix E, Table E-4.

**Percent Cover**. The peak season 2003 mean percent aerial cover, as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum), for the plots at each site are presented in Table 8-11. The mean percent cover for the plots at the Alloway Creek Site (graphically shown in Figure 8-22) was as follows:

| Plot | Peak Season (%) |
|---|---|
| ACWP1 | 72 (±14) |
| ACWP2 | 65 (±10) |
| ACWP3 | 74 (±11) |

**Live Standing Crop**. The peak season 2003 mean live standing crop as well as measures of dispersion for the plots at each site are presented in Table 8-11. The mean live standing crop for the plots at the Alloway Creek Site (graphically shown in Figure 8-23) were as follows:

| Plot | Peak Season (gdw/m$^2$) |
|---|---|
| ACWP1 | 909 (±192) |
| ACWP2 | 996 (±183) |
| ACWP3 | 1,268 (±216) |

### Cohansey River Watershed Site – Plots

Three 60 m x 60 m plots were sampled at the Cohansey River Site in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop, except where mud flats or areas of *Phragmites* wrack occurred. Individual quadrat data are presented in Appendix E, Table E-5.

**Percent Cover**. The mean percent aerial cover as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum) for the plots at each site are presented in Table 8-11. The mean percent cover for the plots at the Cohansey River Site (graphically shown in Figure 8-22) was as follows:

| Plot | Peak Season (%) |
|---|---|
| BRP1 | 46 (±10) |
| BRP2 | 63 (±8) |
| BRP3 | 72 (±5) |

**Live Standing Crop**. The peak season 2003 mean live standing crop as well as measures of dispersion for the plots at each site is presented in Table 8-11. The mean live standing crop values for the plots at the Cohansey River Site (graphically shown in Figure 8-23) were as follows:

| Plot | Peak Season (gdw/$m^2$) |
|---|---|
| BRP1 | 731 (±199) |
| BRP2 | 837 (±146) |
| BRP3 | 1259 (±171) |

**Delaware Site Plots**

One 60 m x 60 m plot was sampled at The Rocks and Cedar Swamp Sites in August 2003. Nine (9) quadrats were sampled within each plot for percent cover and live standing crop, except where mudflats or areas of *Phragmites* wrack occurred. These areas were not sampled for standing crop. Individual quadrat data are presented in Appendix E, Tables E-6 and E-7.

**Percent Cover**. The peak season 2003 mean percent aerial cover as well as measures of dispersion (standard error of the mean, standard deviation, minimum and maximum) for the plots at each site are presented in Table 8-11. The mean percent cover values for the plots at each site (graphically shown in Figure 8-22) were as follows:

| Site | Peak Season (%) |
|---|---|
| The Rocks (TRP1) | 59 (±8) |
| Cedar Swamp (CSP1) | 66 (±4) |

**Live Standing Crop**. The peak season 2003 mean live standing crop as well as measures of dispersion for the plots at each site are presented in Table 8-11. The mean live standing crop values for the plots at each site (graphically shown in Figure 8-23) were as follows:

| Site | Peak Season (gdw/$m^2$) |
|---|---|
| The Rocks (TRP1) | 781 (±219) |
| Cedar Swamp (CSP1) | 1016 (±84) |

# DISCUSSION

## COVER TYPE MAPPING

Cover category and cover type mapping and area determinations were completed for two reference marshes and five wetland restoration sites in 2003. This mapping is presented as a series of seven maps within Appendix B and detailed listings of the area of the various cover types within the mapped cover categories are provided in Tables 8-1 through 8-5. The mapping represents wetland systems ranging from relatively stable reference marshes to sites at various phases of post-restoration development. The completion of the restoration of normal tidal inundation and drainage of the marsh at the Commercial Township Site has promoted the spread of the *Spartina alterniflora* communities at that site. Glyphosate-based herbicide applications at the Alloway Creek Watershed and Cohansey River Watershed Sites in New Jersey and Cedar Swamp and The Rocks in Delaware have maintained progress in controlling *Phragmites australis* at these sites and resulted in the expansion of *Spartina alterniflora* and other desirable marsh species as dominant species at these sites in 2003.

## GEOMORPHOLOGIC MAPPING

### Commercial Township Wetland Restoration Site

Evidence of successful wetland restoration at the Commercial Township Site is provided by the quantitative analysis of 2003 geomorphology mapping. The drainage density in 2003 (476 ft/ac) was higher than found for the Moores Beach Reference Marsh in 2003 (424 ft/acre). This drainage density represents is evidence of progress in the development of a natural channel systems since 2002, when the drainage density was 374 ft/acre. The channel frequency at the Commercial Township Site in 2003 (5.0 channels/acre) was also higher than that found in Moores Beach in 2003 (4.2 channels/acre). The drainage frequency data are a further indication of the progress in channel development that occurred since 2002, when the channel frequency was 3.7 channels/acre.

### *Phragmites* Dominated Sites

The drainage density at the Mad Horse Creek Reference Marsh in 2003 was 683 ft/acre. The drainage density values for the Alloway Creek and Cohansey River Sites in 2003 were 464 ft/acre and 668 ft/acre, respectively. Drainage Densities for the *Phragmites* dominated sites in Delaware ranged from 331 ft/acre at The Rocks to 367 ft/acre at Cedar Swamp. All densities other than for the Cohansey River Site are below that for the Mad Horse Creek Reference Marsh.

The channel frequency for the Mad Horse Creek Reference Marsh in 2003 was 8.5 channels/acre. Channel frequency values for the Alloway Creek and Cohansey River Sites in 2003 were 4.2 channels/acre and 8.3 channels/acre, respectively. The Rocks and Cedar Swamp 2003 channel frequencies were 2.9 channels/acre and 3.1 channels/acre, respectively. Although the drainage densities and the channel frequency data from the reference site and the Cohansey River Site are similar, all *Phragmites* dominated restorations site channel frequencies were lower than for the Mad Horse Creek Reference Marsh values in 2003.

## MACROPHYTE PRODUCTION AT THE REFERENCE MARSHES IN 2003

The Mad Horse Creek and Moores Beach reference marshes are all *Spartina alterniflora* dominated tidal wetland systems. In each system, *Spartina alterniflora* occurs as the dominant species and represents the majority of the vegetative cover and macrophyte standing crop as measured during the peak 2003 growing season. While non-*Spartina alterniflora* dominated quadrats were also sampled, the following discussion is limited to data representing *Spartina alterniflora* dominated areas that represent the majority of the marsh area of each site. In this way, the greater variability that is typical of the data for non-*Spartina alterniflora* dominated quadrats is excluded from interpretation of the data.

**Percent Coverage**. The mean percent coverage within all *Spartina alterniflora* dominated quadrats (clip and ocular) sampled during the 2003 peak season was 71 percent at Moores Beach and 72 percent at Mad Horse Creek (Figure 8-9).

**Height**. The mean macrophyte height measurement within *Spartina alterniflora* dominated clip and ocular quadrats along transects at the Mad Horse Creek site in 2003 was 141 cm, while the mean for the Moores Beach quadrats was 111 cm. Plants greater than 90 cm tall at peak height to be considered tall-form, and plants less than 90 cm short-form, (Gross et al,1991). Tiner (1987) states that short form plants are generally less than 60 cm tall. *Spartina alterniflora* height measurements at Mad Horse Creek in 2003 were indicative of the tall form of this species, while measurements at Moores Beach indicate the presence of both the tall form and short form.

**Above-ground Net Primary Production**. Extensive studies of the net primary production of *Spartina alterniflora* have been conducted along the Atlantic and Gulf coasts of the United States. Mitsch and Gosselink (1993) provide a comparison of many of the measured values, ranging from 330 gdw/m$^2$/yr to 3,700 gdw/m$^2$/yr. Higher above-ground productivity is generally found in southern coastal plain marshes than those in northern latitudes. Turner (1976) states that this higher production is related to a greater influx of solar energy and a longer growing season. The relatively high productivity of some southern marshes may also be associated with higher nutrient import associated with sediments deposited by rivers of that region (White et al. 1978)

One of the methods that has been utilized to measure net primary production in tidal marshes is the Peak Standing Crop (PSC) Method. In the PSC Method, the average peak living standing crop over 2 or more consecutive years is used to represent annual net primary productivity (Hsieh 1997). Hsieh lists the following four assumptions relating to the use of the PSC Method:

1. There is no carry-over in living standing crop from one year to another.
2. There is no significant mortality during the growing season.
3. There is no significant growth after the peak of living standing crop.
4. There is no significant grazing.

Since the PSC Method does not account for growing season mortality or loss of live standing crop biomass due to tidal flux and decomposition, the estimates derived from the method are minimum production values.

Annual production estimates (gdw/m$^2$) were determined at both reference marshes using the PSC Method and the pooled data for all clip quadrats sampled along transects and from clip quadrats within sample plots established during the peak growing season of 2003. The mean dry weight of live standing macrophytes collected from within *Spartina alterniflora* dominated quadrats sampled along transects during the peak season was 1152 gdw/m$^2$ at Moores Beach and 1225 gdw/m$^2$ at Mad Horse Creek (Table 8-8 and Figure 8-12). Values for quadrats within the three 60 m x 60 m plots established at each site were 1048 gdw/m$^2$ at Moores Beach and 1050 gdw/m$^2$ at Mad Horse Creek (Table 8-11 and Figure 8-15). The highest peak standing crop values for both transects and plots were documented at the Mad Horse Creek reference marsh.

Mitsch and Gosselink (1993) list several primary production determinations for *Spartina alterniflora* marshes derived utilizing the PSC Method as follows:

| | Kaswadji et al. (1990) | Kirby and Gosselink (1976) | Hopkinson et al (1980) | Shew et al (1981) |
|---|---|---|---|---|
| Peak Standing Crop (gdw/m$^2$/yr) | 831 ± 41 | 903[11] | 754 | 242 |

White et al. (1978) list two additional peak above-ground biomass determinations in North Carolina and New Jersey as 1,320 gdw/m$^2$ and 1,592 gdw/m$^2$, respectively. Gross et al. (1991) sampled monthly in both short-form and tall-form *Spartina alterniflora* stands near Lewes, Delaware. They found live aboveground *Spartina alterniflora* during September to range from approximately 500 gdw/m$^2$ to 1,500 gdw/m$^2$ in short form and tall form stands, respectively. The peak aboveground biomass determined during 2003 at Mad Horse Creek restoration site are within the ranges of values reported in the literature.

## REFERENCE SITE VARIABILITY

The data presented in the Results section includes peak season 2003 data derived from quadrats located along individual transects at the Mad Horse Creek and Moores Beach reference marshes. These data provide the opportunity to evaluate differences in the vegetative cover present over the sites. Summary discussions of these data for each site during the peak season are presented in the following paragraphs.

**Mad Horse Creek.** Nearly all of the quadrats sampled along each of the three transects at the Mad Horse Creek reference site in 2003 were *Spartina alterniflora* dominated. The mean percent coverage for *Spartina alterniflora* dominated quadrats was highest along Transect 3 (78±3%), followed by Transect 2 (73±3%) and Transect 1 (59± 4%). Mean vegetation heights were similar among the transects and ranged from 138 cm to 149 cm. Transect 2 had a mean live standing crop of 1573 ±158 gdw/m$^2$ followed by Transect 1 (1382 ±430 gdw/m$^2$) and Transect 3 (971 ±134 gdw/m$^2$). The mean biomass of dead standing crop was 113 ±89 gdw/m$^2$ at Transect 1, 25 ±25 gdw/m$^2$ at Transect 3 and there was no dead standing crop to sample at Transect 2. Litter weights were highest along Transect 2 (222 ±184 gdw/m$^2$), followed by Transect 1 (101 ±45 gdw/m$^2$) and Transect 3 (59 ±21 gdw/m$^2$).

**Moores Beach**. All of the quadrats sampled along the three transects at the Moores Beach reference marsh in 2003 were *Spartina alterniflora* dominated. The mean percent coverage values for *Spartina alterniflora* dominated quadrats was highest along Transect 2 (81 ±3%) followed by Transect 3 (68 ±4%) and Transect 1 (66 ± 5%). The mean vegetation height was highest along Transect 1 (137 ±16 cm) followed by Transects 2 and 3 (124±6 cm and 92±8 cm, respectively). The mean live standing crop was highest along Transect 1 (1485 ±982 gdw/m$^{-2}$) followed by Transect 3 (1035±414 gdw/m$^{-2}$) and Transect 2 (936 ±39 gdw/m$^{-2}$). Dead standing vegetation was only encountered along Transect 3, where the standing crop was 57 ±57 gdw/m$^2$. Litter weights were highest along Transect 2 (70 ±6 gdw/m$^2$), followed by Transect 3 (34 ±17 gdw/m$^2$) and Transect 1 (29 ±17 gdw/m$^2$).

## MACROPHYTE PRODUCTION AT COMMERCIAL TOWNSHIP SALT HAY FARM SITE IN 2003

One of the four transects at the Commercial Township Site traverses an area of the site that remains flooded or saturated during low tide and remains non-vegetated. Of the 24 quadrats sampled at the Commercial Township Site along the other three transects, 16 were *Spartina alterniflora* dominated. The mean peak season 2003 live standing crop collected from *Spartina alterniflora* dominated clip quadrats at the Commercial Township Site (2341 ±933 gdw/m$^2$) is above the range of values found for individual transects at the Moores Beach Reference Marsh in 2003 (936 ±39 gdw/m$^{-2}$ - 1485 ±982 gdw/m$^{-2}$).

## MACROPHYTE PRODUCTION AT NEW JERSEY *PHRAGMITES* DOMINATED SITES IN 2003

Of the 72 quadrats sampled at the Alloway Creek Watershed, 47 were *Spartina alterniflora* dominated. The mean peak season 2003 live standing crop collected from *Spartina alterniflora* dominated clip quadrats at the Alloway Creek Site (1132±164 gdw/m$^2$) is within the range of values found for individual transects at the Mad Horse Creek Reference Marsh in 2003 (971 ±134 gdw/m$^2$ - 1573 ±158 gdw/m$^2$).

Of the 32 quadrats sampled at the Cohansey River Site, 30 were *Spartina alterniflora* dominated. The mean peak season 2003 live standing crop collected from *Spartina alterniflora* dominated clip quadrats at the Cohansey River Site (1186 ±231 gdw/m$^2$) is within the range of values found for individual transects at the Mad Horse Creek Reference Marsh in 2003 (971 ±134 gdw/m$^2$ - 1573 ±158 gdw/m$^2$).

## MACROPHYTE PRODUCTION AT DELAWARE *PHRAGMITES* DOMINATED SITES IN 2003

Of the 94 quadrats sampled at The Rocks Site, 45 were *Spartina alterniflora* dominated. The mean peak season 2003 live standing crop collected from *Spartina alterniflora* dominated clip quadrats at The Rocks (1071 ±160 gdw/m$^2$) is within the range of values found for individual transects at the Mad Horse Creek Reference Marsh in 2003 (971 ±134 gdw/m$^2$ - 1573 ±158 gdw/m$^2$).

Of the 80 quadrats sampled at the Cedar Swamp Site, 71 were *Spartina alterniflora* dominated. The mean peak season 2003 live standing crop collected from *Spartina alterniflora* dominated clip quadrats at Cedar Swamp (1145 ±170 gdw/m$^2$) is within the range of values found for individual transects at the Mad Horse Creek Reference Marsh in 2003 (971 ±134 gdw/m$^2$ - 1573 ±158 gdw/m$^2$).

## LITERATURE CITED


Blanchard, G.F., J.M. Guarini, P. Richard, P. Gros and F. Mornet. 1996. Quantifying the short-term temperature effect.

Canfield, D.D. and D.J. Des Marais. 1993. Biogeochemical cycles of carbon, sulfur and free oxygen in a microbial mat. Geochimica et Cosmochimica Acta 57:3971-3984.

Chow, V. 1964. Handbook of Applied Hydrology. McGraw-Hill Book Company, New York, NY, pp 43-45.

Chow, V., D. R. Maidment and L.W. Mays. 1988. Applied Hydrology. McGraw-Hill, Inc. Publishers, New York, NY. pp. 166-170.

Gross, M.F., M.A. Hardisky, P.L. Wolf, and V. Klemas. 1991. Relationship between aboveground and below ground biomass of *Spartina alterniflora* (smooth cordgrass).Estuaries 14(2):180-191

Hopkinson, C.S., J.G. Gosselink, and R.T. Parrondo. 1980. Production of coastal Louisiana marsh plants calculated from phenometric techniques. Ecology 61(5):1091-1098

Horton, R.E. 1945. Erosional development of streams and their drainage basins: Hydrophysical approach to quantitative morphology. Reprinted from Geological Society of America Bulletin 56: 275-370.

Hsieh, Y-P. 1997. Aboveground net primary productivity of vascular plants. In: Coultas and Hsieh, Eds., Ecology and Management of Tidal Marshes. St. Lucie Press, Delray Beach, Florida pp. 111-130

Joye, S.B., M.L. Mazzotta and J.T. Hollibaugh. 1996. Community metabolism in microbial mats: the occurrence of biologically-mediated iron and manganese reduction. Estuarine and Coastal Shelf Science 43:747-766.

Kaswadji, R.F., J.G. Gosselink, and R.E. Turner. 1990. Estimation of primary production using five different methods in a *Spartina alterniflora* marsh. Wetlands Ecology and Management 1(2):57-64.

Kirby, C.J., and J.G. Gosselink. 1976. Primary production in a Louisiana gulf coast *Spartina alterniflora* marsh. Ecology (57):1052-1059.

McIntyre, H.L. and J.J. Cullen. 1995. Fine-scale vertical resolution of chlorophyll and photosynthetic parameters in shallow-water benthos. Marine Ecology Progress Series 122:227-237.

Mitsch, W.J. and J.G. Gosselink, 1993. Wetlands. Second Edition. Van Nostrand Reinhold

Company, New York.

Public Service & Electric Gas Company 1995. Detrital Production Monitoring Report - Delaware Bay Estuary, Prepared for PSEG by EA Engineering, Science, and Technology, Inc.

Round, F.E. 1979. Occurrence and rhythmic behavior of *Tropodoneis lepidoptera* in the epipelon of Barnstable, Harbor Massachusetts, USA. Marine Biology 54: 215-217.

Shew, D.M., R.A. Linthurst, and E.D. Seneca. 1981. Comparison of production computation methods in a southeastern North Carolina *Spartina alterniflora* marsh. Estuaries 4:97-109

Squires, E.R. and R.E. Good. 1974. Seasonal changes in the productivity, caloric content and chemical composition of a population of saltmarsh cordgrass (*Spartina alterniflora*). Chesapeake Science 15(2):63-71.

Steel, T.J. and K. Pye. 1997. The Development of Saltmarsh Tidal Creek Networks: Evidence from the UK. Proceedings of the 1997 Canadian Coastal Conference - Abstracts.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions of the American Geophysical Union 38: 913-920.

Strickland, J.D. and T.R. Parsons. 1972. A practical handbook of seawater analysis, 2nd ed. Bulletin of the Fisheries Research Board of Canada 167.

Stroud, L.M. and A.W. Cooper. 1968. Color-infrared aerial photographic interpretation and net primary productivity of a regularly flooded North Carolina salt marsh. Water Resource Institute, University of North Carolina. Report Number 14.

Sundback, K., P. Nilsson, C. Nilsson and B. Jonsson. 1996. Balance between autotrophic and heterotrophic components and processes in microbenthic communities of sandy sediments: a field study. Estuarine, Coastal and Shelf Science 43:689-706.

Tiner, R.W. 1987. A field guide to coastal wetland plants of the northeastern United States. The University of Amherst Press. Amherst, Massachusetts.

Turner, R.E. 1976. Geographic variation in salt marsh macrophytic production: a review. Contributions in Marine Science 20:47-68.

Valiela, Ivan. 1995. Marine Ecological Processes. Second Edition. Springer, NY 686pp.

White, D.A., T.E. Weiss, J.M. Trapani, and L.B. Thien. 1978. Productivity and decomposition of the dominant salt marsh plants in Louisiana. Ecology 59(4):751-759.

**Table 8-1**
**2003 Reference Marsh Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Mad Horse Creek** **Acres** | **Mad Horse Creek** **Percent of Total Marsh** [a] | **Moores Beach** **Acres** | **Moores Beach** **Percent of Total Marsh** [a] |
|---|---|---|---|---|
| ***Spartina* spp./ Other Desirable Marsh Vegetation** | | | | |
| ***w/o Phragmites*** | | | | |
| *Spartina alterniflora* | 2827 | 73.8% | 955 | 74.6% |
| *S. alterniflora* / Beach | 0 | 0.0% | 8 | 0.6% |
| *S. alterniflora* / High Marsh | 3 | 0.1% | 0 | 0.0% |
| *S. alterniflora* / Mud Flat | 25 | 0.7% | 80 | 6.3% |
| *S. alterniflora* / Ponded Water | 0 | 0.0% | 1 | 0.1% |
| *S. alterniflora* / Wrack | 0 | 0.0% | 2 | 0.2% |
| *S. alterniflora* / Wrack / Mud Flat | 0 | 0.0% | 2 | 0.1% |
| Salt Hay *(S. patens;D.spicata; J. gerardii)* | 0 | 0.0% | 2 | 0.1% |
| Salt Hay / Beach | 0 | 0.0% | 0 | 0.0% |
| Salt Hay */ S. alterniflora* | 0 | 0.0% | 8 | 0.6% |
| Desirable Mixed Marsh | 33 | 0.9% | 0 | 0.0% |
| Dead *S. alterniflora/ S. alterniflora* | 1 | 0.0% | 0 | 0.0% |
| High Marsh | 43 | 1.1% | 8 | 0.6% |
| High Marsh / Deciduous Forest | 0 | 0.0% | 2 | 0.1% |
| High Marsh / Salt Hay | 0 | 0.0% | 3 | 0.2% |
| High Marsh / *S. alterniflora* | 0 | 0.0% | 5 | 0.4% |
| Dead Trees / High Marsh | 0 | 0.0% | 0 | 0.0% |
| *subtotal w/o Phragmites* | 2933 | 76.6% | 1076 | 84.1% |
| ***w/ Phragmites*** | | | | |
| *S. alterniflora* / *P. australis* | 41 | 1.1% | 0 | 0.0% |
| *S. alterniflora* / *P. australis* / Beach | 2 | 0.0% | 0 | 0.0% |
| *S. alterniflora* / *P. australis* / *Phragmites* Wrack | 2 | 0.0% | 0 | 0.0% |
| Mixed Marsh | 28 | 0.7% | 0 | 0.0% |
| High Marsh / *P. australis* | 49 | 1.3% | 25 | 1.9% |
| High Marsh / *P. australis / S. alterniflora* | 16 | 0.4% | 0 | 0.0% |
| *subtotal w/ Phragmites* | 137 | 3.1% | 25 | 1.9% |
| **Subtotal** | **3069** | **80.1%** | **1101** | **86.0%** |
| ***Phragmites* Dominated Vegetation** | | | | |
| *Phragmites australis* | 137 | 3.6% | 9 | 0.7% |
| *P. australis* / High Marsh | 6 | 0.2% | 47 | 3.7% |
| *P. australis* / Dead Trees | 0 | 0.0% | 4 | 0.3% |
| *P. australis* / *S. alterniflora* | 22 | 0.6% | 0 | 0.0% |
| *P. australis* / *S. alterniflora* / High Marsh | 0 | 0.0% | 0 | 0.0% |
| *P. australis* / *S. alterniflora* / Wrack | 2 | 0.0% | 0 | 0.0% |
| **Subtotal** | **167** | **4.4%** | **60** | **4.7%** |
| **Non-vegetated Marsh Plain** | | | | |
| Mud Flat | 33 | 0.9% | 32 | 2.5% |
| Mud Flat / *Spartina alterniflora* | 34 | 0.9% | 21 | 1.7% |
| Mud Flat / *Spartina alterniflora* / Beach | 0 | 0.0% | 0 | 0.0% |
| Mud Flat / Beach | 0 | 0.0% | 1 | 0.1% |
| Mud Flat / Beach / *Spartina alterniflora* | 0 | 0.0% | 0 | 0.0% |
| Beach | 2 | 0.1% | 0 | 0.0% |
| Beach / Mud Flat | 0 | 0.0% | 1 | 0.1% |
| Beach / *S. alterniflora* | 0 | 0.0% | 4 | 0.3% |
| *Phragmites* Wrack | 0 | 0.0% | 0 | 0.0% |
| **Subtotal** | **70** | **1.8%** | **60** | **4.7%** |

**Table 8-1**
**2003 Reference Marsh Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Mad Horse Creek** | | **Moores Beach** | |
|---|---|---|---|---|
| | **Acres** | **Percent of Total Marsh** [a] | **Acres** | **Percent of Total Marsh** [a] |
| **Internal Water Areas** | | | | |
| Channels (>5 ft. wide at low tide) | 515 | 13.5% | 44 | 3.4% |
| Ponded Water | 4 | 0.1% | 13 | 1.1% |
| Ponded Water / *S. alterniflora* | 0 | 0.0% | 0 | 0.0% |
| **Subtotal** | **519** | **13.6%** | **57** | **4.5%** |
| **Open Water** | | | | |
| Delaware Bay | 5 | 0.1% | 1 | 0.1% |
| **Upland Vegetation / Miscellaneous Cover Categories** | | | | |
| **Subtotal** [b] | **112** | -- | **79** | -- |
| **Total Marsh Area** | **3830** | **100.0%** | **1280** | **100.0%** |
| **Total Site Area** | **3942** | -- | **1359** | -- |

[a] Includes water areas, but does not include upland developed land on the site.

[b] Cover category subtotals may not reflect sum of individual cover type acreages due to rounding.

**Table 8-2**
**2003 Commercial Township Salt Hay Farm Wetland Restoration Sites - Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Acres** | **Percent of Total Marsh** |
|---|---|---|
| ***Spartina spp*. /Other Desirable Marsh Vegetation** | | |
| ***w/o P. australis*** | | |
| Desirable Mixed Marsh | 9 | 0.3% |
| Desirable Mixed Marsh / Mud Flat | 19 | 0.7% |
| Desirable Mixed Marsh / Mud Flat / Wrack | 23 | 0.8% |
| High Marsh | 6 | 0.2% |
| High Marsh / Mud Flat | 0 | 0.0% |
| Salt Hay (*S. patens* ; *D. spicata* ; *J .gerardii* ) | 1 | 0.0% |
| Salt Hay / *S. alterniflora* | 1 | 0.0% |
| Salt Hay / Mud Flat | 3 | 0.1% |
| *Spartina alterniflora* | 378 | 13.0% |
| *S. alterniflora* / Dead Trees | 14 | 0.5% |
| *S. alterniflora* / Desirable Mixed Marsh | 1 | 0.0% |
| *S. alterniflora* / Dredged Material | 11 | 0.4% |
| *S. alterniflora* / High Marsh | 10 | 0.4% |
| *S. alterniflora* / Mud Flat | 470 | 16.2% |
| *S. alterniflora* / Mud Flat / Wrack | 9 | 0.3% |
| *S. alterniflora* / Pond | 1 | 0.0% |
| *S. alterniflora* / Beach | 0 | 0.0% |
| *S. alterniflora* / Wrack | 17 | 0.6% |
| *S. alterniflora* / Wrack / Mud Flat | 10 | 0.3% |
| *subtotal w/o P. australis* | *983* | *34.0%* |
| ***w/ P. australis*** | | |
| High Marsh / *P. australis* | 0 | 0.0% |
| Mixed Marsh | 10 | 0.3% |
| Mixed Marsh / Mud Flat | 4 | 0.1% |
| Salt Hay / *P. australis* | 10 | 0.3% |
| *S. alterniflora* / *P. australis* | 32 | 1.1% |
| *S. alterniflora* / *P. australis* / Dike | 0 | 0.0% |
| *S. alterniflora* / *P. australis* / Mud Flat | 1 | 0.0% |
| *S. alterniflora* / *P. australis* / Wrack | 6 | 0.2% |
| *subtotal w/ P. australis* | *63* | *2.2%* |
| **Subtotal** | **1046** | **36.1%** |

**Table 8-2**
**2003 Commercial Township Salt Hay Farm Wetland Restoration Sites - Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Acres** | **Percent of Total Marsh** |
|---|---|---|
| ***P. australis* Dominated Vegetation** | | |
| Dead *P. australis* / Mud Flat | 1 | 0.1% |
| Dead *P. australis* / *P. australis* | 4 | 0.1% |
| Dead *P. australis* / *P. australis* / Mud Flat | 0 | 0.0% |
| *subtotal -* Dead *P. australis* | *5* | *0.2%* |
| *P. australis* Dominant | | |
| *Phragmites australis* | 55 | 1.9% |
| *P. australis* / Dead *P. australis* | 1 | 0.0% |
| *P. australis* / Dead *P. australis* / Salt Hay | 2 | 0.1% |
| *P. australis* / Dead Trees | 4 | 0.1% |
| *P. australis* / Dike | 2 | 0.1% |
| *P. australis* / High Marsh | 18 | 0.6% |
| *P. australis* / Mud Flat | 14 | 0.5% |
| *P. australis* / *S. alterniflora* | 15 | 0.5% |
| *P. australis* / *S. alterniflora* / Dead *P. australis* | 0 | 0.0% |
| *P. australis* / *S. alterniflora* / Mud Flat | 0 | 0.0% |
| *P. australis* / Salt Hay | 0 | 0.0% |
| *P. australis* / Salt Hay / Mud Flat | 3 | 0.1% |
| *subtotal - P. australis* | *114* | *3.9%* |
| **Subtotal** | **119** | **4.1%** |
| **Non-Vegetated Marsh Plain** | | |
| Dredged Material | 1 | 0.0% |
| Dredged Material / *S. alterniflora* | 9 | 0.3% |
| Dredged Material / Wrack | 0 | 0.0% |
| Mud Flat | 692 | 23.9% |
| Mud Flat / *P. australis* | 15 | 0.5% |
| Mud Flat / Salt Hay | 3 | 0.1% |
| Mud Flat/ *S. alterniflora* | 620 | 21.4% |
| Mud Flat / *S. alterniflora* / Dead Trees | 0 | 0.0% |
| Mud Flat / *S. alterniflora* / *P. australis* | 8 | 0.3% |
| Mud Flat / Wrack | 0 | 0.0% |
| Wrack | 2 | 0.1% |
| Wrack / *S. alterniflora* | 3 | 0.1% |
| **Subtotal** | **1355** | **46.8%** |

**Table 8-2**
**2003 Commercial Township Salt Hay Farm Wetland Restoration Sites - Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Acres** | **Percent of Total Marsh** |
|---|---|---|
| **Internal Water Areas** | | |
| Channels (>5 ft. wide at low tide) | 127 | 4.4% |
| Ponded Water | 223 | 7.7% |
| Ponded Water / *S. alterniflora* | 0 | 0.0% |
| **Subtotal** | **350** | **12.1%** |
| **Open Water** | | |
| Delaware Bay | 0 | 0.0% |
| **Upland Vegetation / Miscellaneous Cover Categories**[b] | | |
| **Subtotal** [c] | **24** | **0.8%** |
| **Total Site Area** | **2894** | **100%** |

[a] Areas listed are for portions of the site within the Wetland Restoration Area Boundary, a Figures B-3 and B-4.

[b] Areas of upland / developed land listed, are in most cases due to annual variability in the edge cover types and should not be interpreted as an effect of wetland restoration.

[c] Cover category subtotals may not reflect sum of individual cover type acreages due to rc

**Table 8-3**
**2003 Alloway Creek Watershed Wetland Restoration Site -**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Alloway Creek Watershed** [a] | |
|---|---|---|
| | **Acres** | **Percent of Total Marsh** |
| ***Spartina* spp./ Other Desirable Marsh Vegetation** | | |
| Desirable Mixed Marsh | 69 | 4.3% |
| Desirable Mixed Marsh / Mud Flat | 9 | 0.6% |
| *Echinochloa walteri* | 2 | 0.1% |
| *E. walteri /* Desirable Mixed Marsh | 20 | 1.3% |
| *E. walteri / S. alterniflora* | 13 | 0.8% |
| *Eleocharis spp.* | 0 | 0.0% |
| High Marsh | 3 | 0.2% |
| *Spartina alterniflora* | 455 | 28.4% |
| *S. alterniflora* / Desirable Mixed Marsh | 164 | 10.2% |
| *S. alterniflora / E. walteri* | 6 | 0.4% |
| *S. alterniflora* / Mud Flat | 84 | 5.2% |
| *S. alterniflora / Pluchea purpurascens* | | 0.0% |
| *S. cynosuroides / S. alterniflora* | 0 | 0.0% |
| *subtotal w/o P. australis* | *825* | *51.5%* |
| *w/ Dead P. australis* | | |
| *S. alterniflora /* Dead *P. australis* | 13 | 0.8% |
| *subtotal w/ Dead P. australis* | *13* | *0.8%* |
| *w/ P. australis* | | |
| Desirable Mixed Marsh / *P. australis* | 6 | 0.4% |
| *E. walteri /* Mixed Marsh | 5 | 0.3% |
| High Marsh / *P. australis* | 2 | 0.1% |
| Mixed Marsh | 27 | 1.7% |
| *S. alterniflora /* Mixed Marsh | 24 | 1.5% |
| *S. alterniflora / P. australis* | 54 | 3.4% |
| *Typha spp. /* Mixed Marsh | 6 | 0.4% |
| *Typha spp. / P. australis* | 4 | 0.2% |
| *subtotal w/ P. australis* | 128 | 8.0% |
| **Subtotal** [a] | **966** | **60.3%** |

**Table 8-3**
**2003 Alloway Creek Watershed Wetland Restoration Site -**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Alloway Creek Watershed** [a] | |
|---|---|---|
| | **Acres** | **Percent of Total Marsh** |
| ***P. australis* Dominated Vegetation** | | |
| *Dead P. australis* Dominant | | |
| Dead *P. australis* | 46 | 2.9% |
| Dead *P. australis /* Desirable Mixed Marsh | 24 | 1.5% |
| Dead *P. australis / E. walteri* | 0 | 0.0% |
| Dead *P. australis /* Mixed Marsh | 16 | 1.0% |
| Dead *P. australis / P. australis* | 4 | 0.2% |
| Dead *P. australis / S. alterniflora* | 5 | 0.3% |
| ***Subtotal*** | ***95*** | ***5.9%*** |
| *P. australis* Dominant | | |
| *Phragmites australis* | 139 | 8.7% |
| *P. australis /* Desirable Mixed Marsh | 90 | 5.6% |
| *P. australis /* Mud Flat | 1 | 0.1% |
| *P. australis / S. alterniflora* | 10 | 0.6% |
| ***Subtotal*** | ***240*** | ***15.0%*** |
| **Subtotal** [a] | **335** | **20.9%** |
| **Non-Vegetated Marsh Plain** | | |
| Beach | 0 | 0.0% |
| Beach / Desirable Mixed Marsh | 0 | 0.0% |
| Mud Flat | 57 | 3.6% |
| Mud Flat / Desirable Mixed Marsh | 3 | 0.2% |
| Mud Flat / *P. australis* | 0 | 0.0% |
| Mud Flat / *S. alterniflora* | 25 | 1.6% |
| Wrack | 1 | 0.1% |
| **Subtotal** | **86** | **5.4%** |
| **Internal Water Areas** | | |
| Channels (>5 ft. wide at low tide) | 209 | 13.1% |
| Ponded Water | 1 | 0.1% |
| **Subtotal** | **211** | **13.1%** |
| **Open Water** | | |
| Delaware River/Alloway Creek | 1 | 0.1% |
| **Upland Vegetation / Miscellaneous Cover Categories** | | |
| Agricultural | 0 | 0.0% |
| Deciduous Forest | 1 | 0.1% |
| Deciduous Forest / High Marsh | | 0.0% |
| Developed | 0 | 0.0% |
| Old Field | 0 | 0.0% |
| Road | 0 | 0.0% |
| Upland Island | 1 | 0.1% |
| **Subtotal** | **3** | **0.2%** |
| **Total Area** | **1601** | **100.0%** |

[a] Cover category subtotals may not reflect sum of individual acreages due to rounding.

**Table 8-4**
**2003 Cohansey River Watershed Wetland Restoration Site -**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Browns Run Area** | | **Green Swamp Area** | | **Cohansey River Watershed [a]** | |
|---|---|---|---|---|---|---|
| | **Acres** | **Percent of Total Marsh** | **Acres** | **Percent of Total Marsh** | **Acres** | **Percent of Total Marsh** |
| ***Spartina spp.* / Other Desirable Marsh Vegetation** | | | | | | |
| ***w/o P. australis*** | | | | | | |
| Desirable Mixed Marsh | 0 | 0.0% | 4 | 0.9% | 4 | 0.4% |
| High Marsh | 0 | 0.1% | 0 | 0.0% | 0 | 0.0% |
| Recovering Desirable Species Area | 45 | 8.8% | 56 | 14.4% | 102 | 11.2% |
| *Spartina alterniflora* | 181 | 35.0% | 217 | 55.4% | 398 | 43.8% |
| *S. alterniflora / A. cannabinus* | 0 | 0.1% | 0 | 0.0% | 0 | 0.1% |
| *S. alterniflora / A. cannabinus / S. cynosuroides* | 15 | 2.9% | 0 | 0.0% | 15 | 1.6% |
| *S. alterniflora* / Desirable Mixed Marsh | 2 | 0.4% | 0 | 0.0% | 2 | 0.2% |
| *S. alterniflora* / Mud Flat | 10 | 2.0% | 22 | 5.6% | 32 | 3.6% |
| *S. alterniflora / Spartina cynosuroides* | 80 | 15.4% | 0 | 0.0% | 80 | 8.8% |
| *S. alterniflora / S. cynosuroides / A. cannabinus* | 63 | 12.1% | 0 | 0.0% | 63 | 6.9% |
| *S. cynosuroides / S. alterniflora* | 0 | 0.1% | 1 | 0.1% | 1 | 0.1% |
| *subtotal w/o P. australis* | *397* | *76.8%* | *300* | *76.5%* | *697* | *76.7%* |
| *w/ Dead P. australis* | | | | | | |
| *S. alterniflora* / Dead *P. australis* | 1 | 0.1% | 3 | 0.7% | 3 | 0.4% |
| *subtotal w/ Dead P. australis* | *1* | *0.1%* | *3* | *0.7%* | *3* | *0.4%* |
| *w/ P. australis* | | | | | | |
| Mixed Marsh | 0 | 0.0% | 1 | 0.2% | 1 | 0.1% |
| *S. alterniflora / P. australis* | 6 | 1.1% | 0 | 0.1% | 6 | 0.7% |
| *S. alterniflora / P. australis* / Mud Flat | 0 | 0.0% | 2 | 0.4% | 2 | 0.2% |
| *subtotal w/ P. australis* | *6* | *1.1%* | *3* | *0.7%* | *9* | *0.9%* |
| ***Subtotal [b]*** | ***404*** | ***78.0%*** | ***305*** | ***77.9%*** | ***709*** | ***78.0%*** |
| ***P. australis* Dominated Vegetation** | | | | | | |
| *Dead P. australis* Dominant | | | | | | |
| Dead *P. australis* | 0 | 0.1% | 0 | 0.0% | 0 | 0.0% |
| Dead *P. australis / P. australis* | 4 | 0.7% | 12 | 3.0% | 15 | 1.7% |
| Dead *P. australis / S. alterniflora* | 2 | 0.4% | 0 | 0.1% | 3 | 0.3% |
| *subtotal - Dead P. australis* | *6* | *1.2%* | *12* | *3.1%* | *18* | *2.0%* |
| *P. australis* Dominant | | | | | | |
| *Phragmites australis* | 36 | 6.9% | 6 | 1.4% | 42 | 4.6% |
| *P. australis* / Dead *P. australis* | 0 | 0.0% | 0 | 0.1% | 1 | 0.1% |
| *P. australis* / Dead *P. australis / S. alterniflora* | 0 | 0.0% | 0 | 0.1% | 0 | 0.1% |
| *P. australis* / High Marsh | 0 | 0.1% | 3 | 0.7% | 3 | 0.3% |
| *P. australis / S. alterniflora* | 15 | 2.9% | 1 | 0.2% | 16 | 1.8% |
| *P. australis* / Wrack | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| *subtotal - P. australis* | *52* | *10.0%* | *10* | *2.6%* | *62* | *6.8%* |
| ***Subtotal*** | ***58*** | ***11.2%*** | ***22*** | ***5.7%*** | ***80*** | ***8.8%*** |
| **Non-vegetated Marsh Plain** | | | | | | |
| Mud Flat | 7 | 1.4% | 11 | 2.7% | 18 | 2.0% |
| Mud Flat / Dead *P. australis* | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Mud Flat / *Eleocharis spp.* | 0 | 0.0% | 2 | 0.6% | 2 | 0.2% |
| Mud Flat / S. *alterniflora* | 3 | 0.6% | 9 | 2.4% | 13 | 1.4% |
| Wrack | 4 | 0.9% | 6 | 1.5% | 11 | 1.2% |
| Wrack / *S. alterniflora* | 0 | 0.1% | | 0.0% | 0 | 0.0% |
| ***Subtotal*** | ***15*** | ***3.0%*** | ***28*** | ***7.3%*** | ***44*** | ***4.8%*** |

**Table 8-4**
**2003 Cohansey River Watershed Wetland Restoration Site -**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | **Browns Run Area** | | **Green Swamp Area** | | **Cohansey River Watershed** [a] | |
|---|---|---|---|---|---|---|
| | **Acres** | **Percent of Total Marsh** | **Acres** | **Percent of Total Marsh** | **Acres** | **Percent of Total Marsh** |
| **Internal Water Areas** | | | | | | |
| Channels (>5 ft. wide at low tide) | 34 | 6.6% | 28 | 7.2% | 62 | 6.9% |
| Ponded Water | 0 | 0.1% | 0 | 0.1% | 1 | 0.1% |
| ***Subtotal*** | ***34*** | ***6.6%*** | ***29*** | ***7.3%*** | ***63*** | ***6.9%*** |
| **Open Water** | | | | | | |
| Cohansey River | 4 | 0.7% | 5 | 1.4% | 9 | 1.0% |
| **Upland Vegetation / Miscellaneous Cover Categories** | | | | | | |
| ***Subtotal*** | ***2*** | ***0.4%*** | ***2*** | ***0.4%*** | ***4*** | ***0.4%*** |
| **Total Marsh Area** | **518** | **100.0%** | **392** | **100.0%** | **910** | **100.0%** |

[a] Acreages represent the total of the two areas that make up the Cohansey River Watershed Site.

[b] Cover category subtotals may not reflect sum of individual cover type acreages due to rounding.

**Table 8-5**
**2003 Delaware Wetland Restoration Sites - Cover Category Summary**
**PSEG Detrital Production Monitoring**

| Cover Category / Cover Type | The Rocks Acres | The Rocks Percent of Total Marsh[(a)] | Cedar Swamp Acres | Cedar Swamp Percent of Total Marsh[(a)] |
|---|---|---|---|---|
| ***Spartina spp.* / Other Desirable Vegetation** | | | | |
| *w/o P. australis* | | | | |
| *Aster spp.* | 0 | 0.0% | 1 | 0.0% |
| *Aster spp. / S. alterniflora* | 0 | 0.0% | 3 | 0.1% |
| Desirable Mixed Marsh | 132 | 18.0% | 485 | 26.1% |
| Desirable Mixed Marsh / Mud Flat | 0 | 0.0% | 1 | 0.1% |
| High Marsh | 4 | 0.5% | 7 | 0.4% |
| *S. olneyi /* Desirable Mixed Marsh | 8 | 1.1% | 0 | 0.0% |
| Salt Hay (*Spartina patens, Distichlis spicata, Juncus gerardii)* | 4 | 0.5% | 1 | 0.0% |
| Salt Hay / Desirable Mixed Marsh | 15 | 2.0% | 0 | 0.0% |
| Salt Hay / *S. alterniflora* | 0 | 0.0% | 0 | 0.0% |
| Salt Hay / *S. alterniflora / Scirpus robustus* | 0 | 0.0% | 13 | 0.7% |
| Salt Hay / *Scirpus olneyi* | 0 | 0.0% | 1 | 0.0% |
| *Spartina alterniflora* | 17 | 2.3% | 235 | 12.6% |
| *S. alterniflora /* Beach | 0 | 0.0% | 1 | 0.1% |
| *S. alterniflora* / Desirable Mixed Marsh | 108 | 14.7% | 0 | 0.0% |
| *S. alterniflora /* Mud Flat | 5 | 0.7% | 17 | 0.9% |
| *S. alterniflora / S. cynosuroides* | 0 | 0.0% | 271 | 14.5% |
| *S. alterniflora / S. cynosuroides* / Salt Hay | 0 | 0.0% | 0 | 0.0% |
| *S. alterniflora* / Salt Hay | 0 | 0.0% | 0 | 0.0% |
| *S. alterniflora* / Salt Hay / *Scirpus robustus* | 0 | 0.0% | 1 | 0.0% |
| *S. alterniflora* / Wrack | 0 | 0.0% | 1 | 0.0% |
| *Spartina cynosuroides* | 14 | 1.9% | 83 | 4.5% |
| *S. cynosuroides /* Mud Flat | 0 | 0.0% | 0 | 0.0% |
| *S. cynosuroides / S. alterniflora* | 10 | 1.3% | 39 | 2.1% |
| *Typha spp. / S. cynosuroides* | 1 | 0.2% | 0 | 0.0% |
| *subtotal w/o P. australis* | *317* | *43%* | *1159* | *62%* |
| *w/ Dead P. australis* | | | | |
| Desirable Mixed Marsh / Dead *P. australis* | 17 | 2.4% | 0 | 0.0% |
| *S. alterniflora /* Dead *P. australis* | 0 | 0.0% | 68 | 3.7% |
| *S. alterniflora / S. cynosuroides /* Dead *P. australis* | 0 | 0.0% | 2 | 0.1% |
| *S. cynosuroides /* Dead *P. australis* | 0 | 0.0% | 16 | 0.9% |
| *subtotal w/Dead P. australis* | *17* | *2%* | *87* | *5%* |
| *w/ P. australis* | | | | |
| Desirable Mixed Marsh */ P. australis* | 103 | 14.0% | 0 | 0.0% |
| High Marsh / *P. australis* | 0 | 0.0% | 2 | 0.1% |
| Mixed Marsh | 72 | 9.8% | 115 | 6.2% |
| Mixed Marsh / Dead *P. australis* | 33 | 4.5% | 0 | 0.0% |
| Mixed Marsh / Mud Flat | 0 | 0.1% | 0 | 0.0% |
| *S. alterniflora / P. australis* | 17 | 2.3% | 21 | 1.1% |
| *S. alterniflora / P. australis /* Dead *P. australis* | 0 | 0.0% | 5 | 0.3% |
| *S. alterniflora / P. australis /* Mud Flat | 0 | 0.0% | 0 | 0.0% |
| *S. alterniflora / S. cynosuroides / P. australis* | 0 | 0.0% | 17 | 0.9% |
| *S. cynosuroides / P. australis* | 3 | 0.4% | 6 | 0.3% |
| *S. cynosuroides / P. australis / S. alterniflora* | 0 | 0.0% | 2 | 0.1% |
| *S. cynosuroides / S. alterniflora / P. australis* | 0 | 0.0% | 6 | 0.3% |
| *subtotal w/ P. australis* | *229* | *31%* | *175* | *9%* |
| **Subtotal** | **563** | **76.6%** | **1421** | **76.3%** |

**Table 8-5**
**2003 Delaware Wetland Restoration Sites - Cover Category Summary**
**PSEG Detrital Production Monitoring**

| **Cover Category** / Cover Type | The Rocks | | Cedar Swamp | |
|---|---|---|---|---|
| | **Acres** | **Percent of Total Marsh[a]** | **Acres** | **Percent of Total Marsh[a]** |
| ***P. australis*** **Dominated Vegetation** | | | | |
| *Dead P. australis Dominant* | | | | |
| Dead *P. australis* | 7 | 1.0% | 20 | 1.1% |
| Dead *P. australis / Aster spp.* | 0 | 0.0% | 0 | 0.0% |
| Dead *P. australis /* Desirable Mixed Marsh | 46 | 6.3% | 0 | 0.0% |
| Dead *P. australis /* Mixed Marsh | 14 | 1.9% | 1 | 0.0% |
| Dead *P. australis* / Mud Flat | 0 | 0.1% | 4 | 0.2% |
| Dead *P. australis / P. australis* | 14 | 1.9% | 12 | 0.7% |
| Dead *P. australis / P. australis / S. alterniflora* | 0 | 0.0% | 4 | 0.2% |
| Dead *P. australis / S. alterniflora* | 2 | 0.2% | 11 | 0.6% |
| Dead *P. australis / S. alterniflora /* Mud Flat | 0 | 0.0% | 1 | 0.0% |
| *subtotal - Dead P. australis* | *84* | *11%* | *53* | *3%* |
| *P. australis Dominant* | | | | |
| *Phragmites australis* | 32 | 4.4% | 74 | 4.0% |
| *P. australis* / Dead *P. australis* | 0 | 0.1% | 17 | 0.9% |
| *P. australis* / Dead *P. australis /* Mud Flat | 0 | 0.0% | 4 | 0.2% |
| *P. australis /* High Marsh | 0 | 0.0% | 6 | 0.3% |
| *P. australis /* Mud Flat | 0 | 0.0% | 0 | 0.0% |
| *P. australis / S. alterniflora* | 19 | 2.6% | 44 | 2.4% |
| *P. australis / S. alterniflora /* Dead *P. australis* | 0 | 0.0% | 2 | 0.1% |
| *P. australis / S. cynosuroides* | 2 | 0.3% | 16 | 0.9% |
| *P. australis / S. cynosuroides / S. alterniflora* | 0 | 0.0% | 2 | 0.1% |
| *subtotal - P. australis* | *54* | *7.4%* | *164* | *8.8%* |
| **Subtotal** | **139** | **18.8%** | **217** | **11.6%** |
| **Non-vegetated Marsh Plain** | | | | |
| Beach | 1 | 0.1% | 1 | 0.1% |
| Beach / *S. alterniflora* | 0 | 0.0% | 0 | 0.0% |
| Mud Flat | 1 | 0.1% | 50 | 2.7% |
| Mud Flat / Beach | 0 | 0.0% | 0 | 0.0% |
| Mud Flat / Desirable Mixed Marsh | 0 | 0.0% | 0 | 0.0% |
| Mud Flat / *S. alterniflora* | 2 | 0.2% | 31 | 1.7% |
| **Subtotal** | **9** | **1.3%** | **84** | **4.5%** |
| **Internal Water Areas** | | | | |
| Channels (>5ft. wide at low tide) | 24 | 3.2% | 140 | 7.5% |
| Ponded Water | 0 | 0.0% | 0 | 0.0% |
| **Subtotal** | **24** | **3.2%** | **141** | **7.6%** |
| **Open Water** | | | | |
| Appoquinimink River | 0 | 0.0% | 0 | 0.0% |
| **Subtotal** | **0** | **0.0%** | **0** | **0.0%** |
| **Upland Vegetation / Miscellaneous Cover Categories** | | | | |
| **Subtotal [b]** | **0** | **--** | **0** | **--** |
| **Total Marsh Area** | **736** | **100%** | **1863** | **100%** |

[a] Includes water areas, but does not include upland developed land on the site.

[b] Cover category subtotals may not reflect sum of individual cover type acreages due to rounding.

Table 8-6
CHANNEL GEOMORPHOLOGY DATA FOR REFERENCE MARSHES (2000) AND RESTORATION SITES (2003)
PSEG EEP DETRITAL PRODUCTION MONITORING

| Site | Year | Channel Class | Number of Channels | Sinuous Length (feet) | | Site Area (acres) | Drainage Density (ft/acre) | Channel Frequency | % of Total Channel Length | Length Ratio | Bifurcation Ratio | Average Channel Sinuosity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Average | | | | | | | |
| **Mad Horse** | **2003** | 19 | 7 | 488 | 70 | 721 | 683 | 0.010 | 0.1% | -- | 0.8 | 1.1 |
| | | 18 | 9 | 377 | 42 | | | 0.012 | 0.1% | 0.8 | 0.6 | 1.0 |
| | | 17 | 15 | 766 | 51 | | | 0.021 | 0.2% | 2.0 | 0.5 | 1.2 |
| | | 16 | 28 | 1,156 | 41 | | | 0.039 | 0.2% | 1.5 | 0.8 | 1.1 |
| | | 15 | 37 | 1,997 | 54 | | | 0.051 | 0.4% | 1.7 | 0.6 | 1.1 |
| | | 14 | 61 | 3,188 | 52 | | | 0.085 | 0.6% | 1.6 | 0.6 | 1.1 |
| | | 13 | 101 | 5,171 | 51 | | | 0.140 | 1.0% | 1.6 | 1.0 | 1.1 |
| | | 12 | 100 | 5,397 | 54 | | | 0.139 | 1.1% | 1.0 | 0.6 | 1.2 |
| | | 11 | 168 | 9,344 | 56 | | | 0.233 | 1.9% | 1.7 | 0.6 | 1.1 |
| | | 10 | 267 | 14,553 | 55 | | | 0.370 | 3.0% | 1.6 | 0.7 | 1.2 |
| | | 9 | 382 | 20,506 | 54 | | | 0.529 | 4.2% | 1.4 | 0.6 | 1.1 |
| | | 8 | 597 | 34,638 | 58 | | | 0.827 | 7.0% | 1.7 | 0.7 | 1.2 |
| | | 7 | 876 | 58,810 | 67 | | | 1.214 | 11.9% | 1.7 | 0.8 | 1.2 |
| | | 6 | 1,067 | 74,044 | 69 | | | 1.479 | 15.0% | 1.3 | 1.0 | 1.1 |
| | | 5 | 1,053 | 77,574 | 74 | | | 1.460 | 15.7% | 1.0 | 1.2 | 1.2 |
| | | 4 | 844 | 77,666 | 92 | | | 1.170 | 15.8% | 1.0 | 1.9 | 1.2 |
| | | 3 | 456 | 66,966 | 147 | | | 0.632 | 13.6% | 0.9 | 16.9 | 1.2 |
| | | 2 | 27 | 28,659 | 1061 | | | 0.037 | 5.8% | 0.4 | 3.4 | 1.3 |
| | | 1 | 8 | 12,180 | 1523 | | | 0.011 | 2.5% | 0.4 | -- | 1.3 |
| | | **Total** | 6,096 | 492,994 | | | | 8.449 | 100.0% | | | |
| **Moore's Beach** | **2003** | 24 | 4 | 769 | 192 | 1359 | 424 | 0.003 | 0.1% | -- | 0.4 | 1.1 |
| | | 23 | 9 | 576 | 64 | | | 0.007 | 0.1% | 0.7 | 1.3 | 1.1 |
| | | 22 | 7 | 1,036 | 148 | | | 0.005 | 0.2% | 1.8 | 0.5 | 1.1 |
| | | 21 | 15 | 1,591 | 106 | | | 0.011 | 0.3% | 1.5 | 0.6 | 1.0 |
| | | 20 | 25 | 2,037 | 81 | | | 0.018 | 0.4% | 1.3 | 1.1 | 1.1 |
| | | 19 | 23 | 2,259 | 98 | | | 0.017 | 0.4% | 1.1 | 1.0 | 1.1 |
| | | 18 | 22 | 1,454 | 66 | | | 0.016 | 0.3% | 0.6 | 0.8 | 1.1 |
| | | 17 | 29 | 3,588 | 124 | | | 0.021 | 0.6% | 2.5 | 0.7 | 1.2 |
| | | 16 | 44 | 4,823 | 110 | | | 0.032 | 0.8% | 1.3 | 0.6 | 1.1 |
| | | 15 | 75 | 6,497 | 87 | | | 0.055 | 1.1% | 1.3 | 0.6 | 1.1 |
| | | 14 | 130 | 10,983 | 84 | | | 0.096 | 1.9% | 1.7 | 0.7 | 1.1 |
| | | 13 | 185 | 13,741 | 74 | | | 0.136 | 2.4% | 1.3 | 0.7 | 1.1 |
| | | 12 | 270 | 24,281 | 90 | | | 0.199 | 4.2% | 1.8 | 0.8 | 1.1 |
| | | 11 | 328 | 28,718 | 88 | | | 0.241 | 5.0% | 1.2 | 0.8 | 1.1 |
| | | 10 | 431 | 36,904 | 86 | | | 0.317 | 6.4% | 1.3 | 0.8 | 1.1 |
| | | 9 | 532 | 46,847 | 88 | | | 0.391 | 8.1% | 1.3 | 0.8 | 1.2 |
| | | 8 | 652 | 55,426 | 85 | | | 0.480 | 9.6% | 1.2 | 0.9 | 1.1 |
| | | 7 | 716 | 65,340 | 91 | | | 0.527 | 11.3% | 1.2 | 1.0 | 1.1 |
| | | 6 | 707 | 63,212 | 89 | | | 0.520 | 11.0% | 1.0 | 1.1 | 1.1 |
| | | 5 | 645 | 63,150 | 98 | | | 0.475 | 11.0% | 1.0 | 1.2 | 1.1 |
| | | 4 | 550 | 62,609 | 114 | | | 0.405 | 10.9% | 1.0 | 1.9 | 1.1 |
| | | 3 | 296 | 47,456 | 160 | | | 0.218 | 8.2% | 0.8 | 17.4 | 1.1 |
| | | 2 | 17 | 17,517 | 1030 | | | 0.013 | 3.0% | 0.4 | 2.1 | 1.3 |
| | | 1 | 8 | 15,413 | 1927 | | | 0.006 | 2.7% | 0.9 | -- | 1.2 |
| | | **Total** | 5,720 | 576,226 | | | | 4.209 | 100.0% | | | |

Table 8-6
CHANNEL GEOMORPHOLOGY DATA FOR REFERENCE MARSHES (2000) AND RESTORATION SITES (2003)
PSEG EEP DETRITAL PRODUCTION MONITORING

| Site | Year | Channel Class | Number of Channels | Sinuous Length (feet) | | Site Area (acres) | Drainage Density (ft/acre) | Channel Frequency | % of Total Channel Length | Length Ratio | Bifurcation Ratio | Average Channel Sinuosity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Average | | | | | | | |
| **Commercial Township** | **2003** | 31 | 2 | 78 | 39 | 2901 | 476 | 0.001 | 0.0% | -- | 1.0 | 1.0 |
| | | 30 | 2 | 209 | 105 | | | 0.001 | 0.0% | 2.7 | 2.0 | 1.0 |
| | | 29 | 1 | 45 | 45 | | | 0.000 | 0.0% | 0.2 | 0.5 | 1.1 |
| | | 28 | 2 | 68 | 34 | | | 0.001 | 0.0% | 1.5 | 1.0 | 1.0 |
| | | 27 | 2 | 146 | 73 | | | 0.001 | 0.0% | 2.1 | 1.0 | 1.0 |
| | | 26 | 2 | 108 | 54 | | | 0.001 | 0.0% | 0.7 | 1.0 | 1.0 |
| | | 25 | 2 | 90 | 45 | | | 0.001 | 0.0% | 0.8 | 1.0 | 1.0 |
| | | 24 | 2 | 38 | 19 | | | 0.001 | 0.0% | 0.4 | 0.3 | 1.1 |
| | | 23 | 7 | 439 | 63 | | | 0.002 | 0.0% | 11.5 | 0.9 | 1.1 |
| | | 22 | 8 | 272 | 34 | | | 0.003 | 0.0% | 0.6 | 0.7 | 1.1 |
| | | 21 | 11 | 589 | 54 | | | 0.004 | 0.0% | 2.2 | 0.6 | 1.0 |
| | | 20 | 18 | 1,759 | 98 | | | 0.006 | 0.1% | 3.0 | 0.6 | 1.1 |
| | | 19 | 31 | 2,426 | 78 | | | 0.011 | 0.2% | 1.4 | 0.6 | 1.1 |
| | | 18 | 49 | 4,315 | 88 | | | 0.017 | 0.3% | 1.8 | 0.6 | 1.1 |
| | | 17 | 76 | 6,273 | 83 | | | 0.026 | 0.5% | 1.5 | 0.7 | 1.1 |
| | | 16 | 113 | 9,949 | 88 | | | 0.039 | 0.7% | 1.6 | 0.7 | 1.1 |
| | | 15 | 166 | 14,030 | 85 | | | 0.057 | 1.0% | 1.4 | 0.8 | 1.1 |
| | | 14 | 200 | 16,969 | 85 | | | 0.069 | 1.2% | 1.2 | 0.8 | 1.1 |
| | | 13 | 265 | 21,992 | 83 | | | 0.091 | 1.6% | 1.3 | 0.7 | 1.1 |
| | | 12 | 370 | 30,145 | 81 | | | 0.128 | 2.2% | 1.4 | 0.7 | 1.1 |
| | | 11 | 537 | 43,105 | 80 | | | 0.185 | 3.1% | 1.4 | 0.7 | 1.1 |
| | | 10 | 751 | 61,907 | 82 | | | 0.259 | 4.5% | 1.4 | 0.7 | 1.1 |
| | | 9 | 1,017 | 83,499 | 82 | | | 0.351 | 6.1% | 1.3 | 0.7 | 1.1 |
| | | 8 | 1,365 | 106,190 | 78 | | | 0.471 | 7.7% | 1.3 | 0.8 | 1.1 |
| | | 7 | 1,758 | 138,392 | 79 | | | 0.606 | 10.0% | 1.3 | 0.8 | 1.1 |
| | | 6 | 2,096 | 181,125 | 86 | | | 0.723 | 13.1% | 1.3 | 0.9 | 1.1 |
| | | 5 | 2,360 | 209,868 | 89 | | | 0.814 | 15.2% | 1.2 | 1.1 | 1.1 |
| | | 4 | 2,168 | 209,345 | 97 | | | 0.747 | 15.2% | 1.0 | 2.0 | 1.1 |
| | | 3 | 1,079 | 168,491 | 156 | | | 0.372 | 12.2% | 0.8 | 30.0 | 1.1 |
| | | 2 | 36 | 42,392 | 1178 | | | 0.012 | 3.1% | 0.3 | 4.5 | 1.2 |
| | | 1 | 8 | 25,689 | 3211 | | | 0.003 | 1.9% | 0.6 | -- | 1.2 |
| | | **Total** | 14,504 | 1,379,945 | | | | 5.000 | 100.0% | | | |
| **Alloway Creek Watershed** | **2003** | 18 | 4 | 527 | 132 | 1,601 | 464 | 0.001 | 0.0% | -- | 0.6 | 1.1 |
| | | 17 | 5 | 219 | 44 | | | 0.002 | 0.0% | 6.0 | 0.5 | 1.1 |
| | | 16 | 6 | 430 | 72 | | | 0.003 | 0.1% | 1.5 | 0.5 | 1.0 |
| | | 15 | 12 | 458 | 38 | | | 0.007 | 0.1% | 2.2 | 0.5 | 1.1 |
| | | 14 | 20 | 925 | 46 | | | 0.013 | 0.2% | 1.8 | 0.6 | 1.1 |
| | | 13 | 30 | 2,055 | 69 | | | 0.021 | 0.4% | 1.9 | 0.7 | 1.1 |
| | | 12 | 42 | 3,007 | 72 | | | 0.028 | 0.5% | 1.4 | 0.5 | 1.1 |
| | | 11 | 85 | 6,396 | 75 | | | 0.058 | 1.1% | 2.1 | 0.6 | 1.1 |
| | | 10 | 134 | 9,393 | 70 | | | 0.101 | 1.8% | 1.7 | 0.6 | 1.1 |
| | | 9 | 243 | 17,992 | 74 | | | 0.159 | 3.3% | 1.8 | 0.6 | 1.1 |
| | | 8 | 421 | 31,132 | 74 | | | 0.245 | 5.0% | 1.5 | 0.7 | 1.1 |
| | | 7 | 696 | 51,644 | 74 | | | 0.370 | 7.5% | 1.5 | 0.7 | 1.1 |
| | | 6 | 962 | 77,798 | 81 | | | 0.510 | 11.7% | 1.6 | 0.8 | 1.2 |
| | | 5 | 1269 | 107,451 | 85 | | | 0.649 | 15.3% | 1.3 | 0.9 | 1.1 |
| | | 4 | 1432 | 145,915 | 102 | | | 0.709 | 19.7% | 1.3 | 1.3 | 1.2 |
| | | 3 | 1205 | 156,522 | 130 | | | 0.549 | 19.9% | 1.0 | 14.9 | 1.1 |
| | | 2 | 78 | 53,159 | 682 | | | 0.049 | 7.2% | 5.3 | 1.1 | 1.2 |
| | | 1 | 94 | 78,504 | 835 | | | 0.059 | 10.6% | 1.2 | -- | 1.2 |
| | | **Total** | 6,738 | 743,528 | | | | 3.498 | 100% | | | |

Table 8-6
CHANNEL GEOMORPHOLOGY DATA FOR REFERENCE MARSHES (2000) AND RESTORATION SITES (2003)
PSEG EEP DETRITAL PRODUCTION MONITORING

| Site | Year | Channel Class | Number of Channels | Sinuous Length (feet) | | Site Area (acres) | Drainage Density (ft/acre) | Channel Frequency | % of Total Channel Length | Length Ratio | Bifurcation Ratio | Average Channel Sinuosity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Average | | | | | | | |
| **Cohansey River Watershed** | **2003** | 15 | 2 | 207 | 103 | 908 | 668 | 0.002 | 0.0% | -- | 1.0 | 1.1 |
| | | 14 | 2 | 132 | 66 | | | 0.002 | 0.0% | 0.6 | 1.0 | 1.1 |
| | | 13 | 2 | 96 | 48 | | | 0.002 | 0.0% | 0.7 | 0.1 | 1.1 |
| | | 12 | 20 | 622 | 31 | | | 0.022 | 0.1% | 6.5 | 0.6 | 1.0 |
| | | 11 | 32 | 1,129 | 35 | | | 0.035 | 0.2% | 1.8 | 0.3 | 1.2 |
| | | 10 | 92 | 4,386 | 48 | | | 0.101 | 0.7% | 3.9 | 0.4 | 1.1 |
| | | 9 | 223 | 10,873 | 49 | | | 0.246 | 1.8% | 2.5 | 0.5 | 1.2 |
| | | 8 | 473 | 23,143 | 49 | | | 0.521 | 3.8% | 2.1 | 0.5 | 1.1 |
| | | 7 | 916 | 54,002 | 59 | | | 1.009 | 8.9% | 2.3 | 0.7 | 1.2 |
| | | 6 | 1,281 | 77,950 | 61 | | | 1.411 | 12.9% | 1.4 | 0.8 | 1.1 |
| | | 5 | 1,555 | 108,715 | 70 | | | 1.713 | 17.9% | 1.4 | 1.0 | 1.1 |
| | | 4 | 1,612 | 126,945 | 79 | | | 1.775 | 20.9% | 1.2 | 1.4 | 1.1 |
| | | 3 | 1,161 | 118,245 | 102 | | | 1.279 | 19.5% | 0.9 | 14.3 | 1.1 |
| | | 2 | 81 | 42,861 | 529 | | | 0.089 | 7.1% | 0.4 | 1.3 | 1.3 |
| | | 1 | 61 | 36,879 | 605 | | | 0.067 | 6.1% | 0.9 | -- | 1.2 |
| | | **Total** | 7,513 | 606,186 | | | | 8.274 | 100% | | | |
| **The Rocks** | **2003** | 18 | 2 | 101 | 101 | 737 | 331 | 0.003 | 0.0% | -- | 0.3 | 1.0 |
| | | 17 | 6 | 604 | 604 | | | 0.008 | 0.2% | 6.0 | 0.5 | 1.1 |
| | | 16 | 11 | 1,058 | 1058 | | | 0.015 | 0.4% | 1.8 | 0.5 | 1.2 |
| | | 15 | 22 | 796 | 796 | | | 0.030 | 0.3% | 0.8 | 0.7 | 1.0 |
| | | 14 | 30 | 2,148 | 2148 | | | 0.041 | 0.9% | 2.7 | 1.0 | 1.1 |
| | | 13 | 29 | 2,517 | 2517 | | | 0.039 | 1.0% | 1.2 | 0.8 | 1.1 |
| | | 12 | 36 | 2,032 | 2032 | | | 0.049 | 0.8% | 0.8 | 0.5 | 1.1 |
| | | 11 | 75 | 6,037 | 6037 | | | 0.102 | 2.5% | 3.0 | 0.9 | 1.1 |
| | | 10 | 82 | 5,513 | 5513 | | | 0.111 | 2.3% | 0.9 | 0.6 | 1.1 |
| | | 9 | 140 | 11,149 | 11149 | | | 0.190 | 4.6% | 2.0 | 0.8 | 1.1 |
| | | 8 | 181 | 16,475 | 16475 | | | 0.246 | 6.8% | 1.5 | 0.8 | 1.2 |
| | | 7 | 233 | 19,045 | 19045 | | | 0.316 | 7.8% | 1.2 | 0.8 | 1.1 |
| | | 6 | 279 | 26,175 | 26175 | | | 0.379 | 10.7% | 1.4 | 0.9 | 1.2 |
| | | 5 | 301 | 30,887 | 30887 | | | 0.408 | 12.7% | 1.2 | 1.0 | 1.1 |
| | | 4 | 300 | 37,782 | 37782 | | | 0.407 | 15.5% | 1.2 | 0.8 | 1.2 |
| | | 3 | 375 | 48,554 | 48554 | | | 0.509 | 19.9% | 1.3 | 22.1 | 1.1 |
| | | 2 | 17 | 14,074 | 14074 | | | 0.023 | 5.8% | 0.3 | 1.1 | 1.3 |
| | | 1 | 15 | 18,779 | 18779 | | | 0.020 | 7.7% | 1.3 | -- | 1.4 |
| | | **Total** | 2,134 | 243,725 | | | | 2.896 | 100% | | | |

Table 8-6
CHANNEL GEOMORPHOLOGY DATA FOR REFERENCE MARSHES (2000) AND RESTORATION SITES (2003)
PSEG EEP DETRITAL PRODUCTION MONITORING

| Site | Year | Channel Class | Number of Channels | Sinuous Length (feet) | | Site Area (acres) | Drainage Density (ft/acre) | Channel Frequency | % of Total Channel Length | Length Ratio | Bifurcation Ratio | Average Channel Sinuosity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Average | | | | | | | |
| **Cedar Swamp** | **2003** | 26 | 2 | 221 | 111 | 1732 | 367 | 0.001 | 0.0% | -- | 0.3 | 1.0 |
| | | 25 | 8 | 756 | 94 | | | 0.005 | 0.1% | 0.9 | 1.0 | 1.1 |
| | | 24 | 8 | 1,147 | 143 | | | 0.005 | 0.2% | 1.5 | 0.5 | 1.1 |
| | | 23 | 17 | 1,419 | 83 | | | 0.010 | 0.2% | 0.6 | 0.6 | 1.1 |
| | | 22 | 29 | 2,919 | 101 | | | 0.017 | 0.5% | 1.2 | 0.7 | 1.1 |
| | | 21 | 39 | 3,941 | 101 | | | 0.023 | 0.6% | 1.0 | 1.0 | 1.1 |
| | | 20 | 38 | 4,025 | 106 | | | 0.022 | 0.6% | 1.0 | 0.7 | 1.1 |
| | | 19 | 52 | 4,381 | 84 | | | 0.030 | 0.7% | 0.8 | 0.6 | 1.1 |
| | | 18 | 82 | 7,855 | 96 | | | 0.047 | 1.2% | 1.1 | 0.7 | 1.1 |
| | | 17 | 113 | 10,363 | 92 | | | 0.065 | 1.6% | 1.0 | 0.8 | 1.1 |
| | | 16 | 140 | 12,617 | 90 | | | 0.081 | 2.0% | 1.0 | 0.8 | 1.1 |
| | | 15 | 172 | 14,943 | 87 | | | 0.099 | 2.4% | 1.0 | 0.9 | 1.1 |
| | | 14 | 194 | 15,354 | 79 | | | 0.112 | 2.4% | 0.9 | 0.8 | 1.1 |
| | | 13 | 258 | 21,978 | 85 | | | 0.149 | 3.5% | 1.1 | 0.7 | 1.1 |
| | | 12 | 375 | 31,022 | 83 | | | 0.217 | 4.9% | 1.0 | 0.8 | 1.1 |
| | | 11 | 456 | 38,763 | 85 | | | 0.263 | 6.1% | 1.0 | 0.9 | 1.1 |
| | | 10 | 501 | 42,233 | 84 | | | 0.289 | 6.6% | 1.0 | 0.9 | 1.1 |
| | | 9 | 541 | 47,783 | 88 | | | 0.312 | 7.5% | 1.0 | 1.0 | 1.1 |
| | | 8 | 521 | 49,784 | 96 | | | 0.301 | 7.8% | 1.1 | 1.0 | 1.1 |
| | | 7 | 521 | 54,074 | 104 | | | 0.301 | 8.5% | 1.1 | 1.0 | 1.1 |
| | | 6 | 524 | 62,291 | 119 | | | 0.303 | 9.8% | 1.1 | 1.2 | 1.1 |
| | | 5 | 452 | 68,846 | 152 | | | 0.261 | 10.8% | 1.3 | 1.3 | 1.1 |
| | | 4 | 343 | 75,126 | 219 | | | 0.198 | 11.8% | 1.4 | 3.4 | 1.1 |
| | | 3 | 102 | 51,862 | 508 | | | 0.059 | 8.2% | 2.3 | 34.0 | 1.1 |
| | | 2 | 3 | 14,510 | 4837 | | | 0.002 | 2.3% | 9.5 | 3.0 | 1.0 |
| | | 1 | 1 | 972 | 972 | | | 0.001 | 0.2% | 0.2 | -- | 1.0 |
| | | **Total** | 5457 | 635,643 | | | | 3.152 | 100% | | | |

**TABLE 8-7**
**AERIAL COVER SUMMARY**
**2003 CLIP AND OCULAR QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Peak Season Percent Cover |
|---|---|
| **Mad Horse Creek Reference Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 70% |
| Standard Error of Mean | 2% |
| Standard Deviation | 17% |
| Minimum | 15% |
| Maximum | 100% |
| Count (n) | 55 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 88% |
| Standard Error of Mean | 2% |
| Standard Deviation | 5% |
| Minimum | 80% |
| Maximum | 95% |
| Count (n) | 8 |
| **All Quadrats** | |
| Mean | 72% |
| Standard Error of Mean | 2% |
| Standard Deviation | 17% |
| Minimum | 15% |
| Maximum | 100% |
| Count (n) | 63 |
| **Moores Beach Reference Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 71% |
| Standard Error of Mean | 3% |
| Standard Deviation | 13% |
| Minimum | 40% |
| Maximum | 95% |
| Count (n) | 24 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 0% |
| Standard Error of Mean | 0% |
| Standard Deviation | 0% |
| Minimum | 0% |
| Maximum | 0% |
| Count (n) | 0 |
| **All Quadrats** | |
| Mean | 71% |
| Standard Error of Mean | 3% |
| Standard Deviation | 13% |
| Minimum | 40% |
| Maximum | 95% |
| Count (n) | 24 |

**TABLE 8-7**
**AERIAL COVER SUMMARY**
**2003 CLIP AND OCULAR QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Peak Season Percent Cover |
|---|---|
| **Commercial Township Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 85% |
| Standard Error of Mean | 3% |
| Standard Deviation | 14% |
| Minimum | 50% |
| Maximum | 95% |
| Count (n) | 16 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 0% |
| Standard Error of Mean | 0% |
| Standard Deviation | 0% |
| Minimum | 0% |
| Maximum | 0% |
| Count (n) | 8 |
| **All Quadrats** | |
| Mean | 56% |
| Standard Error of Mean | 9% |
| Standard Deviation | 42% |
| Minimum | 0% |
| Maximum | 95% |
| Count (n) | 24 |

**TABLE 8-7**
**AERIAL COVER SUMMARY**
**2003 CLIP AND OCULAR QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Peak Season Percent Cover |
|---|---|
| **Alloway Creek Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 67% |
| Standard Error of Mean | 3% |
| Standard Deviation | 21% |
| Minimum | 5% |
| Maximum | 100% |
| Count (n) | 47 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 36% |
| Standard Error of Mean | 6% |
| Standard Deviation | 31% |
| Minimum | 0% |
| Maximum | 86% |
| Count (n) | 25 |
| **All Quadrats** | |
| Mean | 56% |
| Standard Error of Mean | 3% |
| Standard Deviation | 29% |
| Minimum | 0% |
| Maximum | 100% |
| Count (n) | 72 |
| **Cohansey River Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 71% |
| Standard Error of Mean | 4% |
| Standard Deviation | 22% |
| Minimum | 25% |
| Maximum | 100% |
| Count (n) | 30 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 0% |
| Standard Error of Mean | 0% |
| Standard Deviation | 0% |
| Minimum | 0% |
| Maximum | 0% |
| Count (n) | 2 |
| **All Quadrats** | |
| Mean | 66% |
| Standard Error of Mean | 5% |
| Standard Deviation | 27% |
| Minimum | 0% |
| Maximum | 100% |
| Count (n) | 32 |

**TABLE 8-7**
**AERIAL COVER SUMMARY**
**2003 CLIP AND OCULAR QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Peak Season Percent Cover |
|---|---|
| **The Rocks Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 71% |
| Standard Error of Mean | 3% |
| Standard Deviation | 21% |
| Minimum | 5% |
| Maximum | 100% |
| Count (n) | 45 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 63% |
| Standard Error of Mean | 4% |
| Standard Deviation | 25% |
| Minimum | 10% |
| Maximum | 100% |
| Count (n) | 49 |
| **All Quadrats** | |
| Mean | 67% |
| Standard Error of Mean | 2% |
| Standard Deviation | 23% |
| Minimum | 5% |
| Maximum | 100% |
| Count (n) | 94 |
| **Cedar Swamp Site** | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | |
| Mean | 65% |
| Standard Error of Mean | 2% |
| Standard Deviation | 19% |
| Minimum | 20% |
| Maximum | 90% |
| Count (n) | 71 |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | |
| Mean | 69% |
| Standard Error of Mean | 10% |
| Standard Deviation | 29% |
| Minimum | 20% |
| Maximum | 100% |
| Count (n) | 9 |
| **All Quadrats** | |
| Mean | 65% |
| Standard Error of Mean | 2% |
| Standard Deviation | 20% |
| Minimum | 20% |
| Maximum | 100% |
| Count (n) | 80 |

(a) Also includes *Spartina cynosuroides* dominated quadrats, when present.

(b) Includes quadrats dominated by *Spartina patens.*

**TABLE 8-8**
**SUMMARY OF 2003 CLIP QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Percent Cover | Biomass | | | | | |
|---|---|---|---|---|---|---|---|
| | | Live Standing | | Dead Standing | Litter | Total Standing | Total Biomass |
| | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ | gdw/m$^2$ | gdw/m$^2$ |
| **Mad Horse Creek Reference Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 71% | 1221 | 10,898 | 55 | 100 | 1,276 | 1,377 |
| Standard Error of Mean | 4% | 180 | 1,605 | 36 | 32 | | |
| Standard Deviation | 15% | 649 | 5,786 | 131 | 116 | | |
| Minimum | 50% | 589 | 5,254 | 0 | 0 | | |
| Maximum | 92% | 3101 | 27,667 | 467 | 405 | | |
| Count (n) | 13 | 13 | 13 | 13 | 13 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | | | | | | | |
| Mean | 87% | 1,243 | 11,090 | 315 | 329 | 1,558 | 1,888 |
| Standard Error of Mean | 4% | 189 | 1,682 | 218 | 164 | | |
| Standard Deviation | 8% | 327 | 2,913 | 378 | 284 | | |
| Minimum | 80% | 876 | 7,815 | 0 | 99 | | |
| Maximum | 95% | 1,501 | 13,394 | 735 | 647 | | |
| Count (n) | 3 | 3 | 3 | 3 | 3 | | |
| **All Quadrats** | | | | | | | |
| Mean | 74% | 1,225 | 10,934 | 104 | 143 | 1,329 | 1,472 |
| Standard Error of Mean | 4% | 148 | 1,321 | 52 | 43 | | |
| Standard Deviation | 15% | 592 | 5,284 | 209 | 173 | | |
| Minimum | 50% | 589 | 5,254 | 0 | 0 | | |
| Maximum | 95% | 3,101 | 27,667 | 735 | 647 | | |
| Count (n) | 16 | 16 | 16 | 16 | 16 | | |
| **Moores Beach Reference Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 69% | 1,152 | 10,280 | 19 | 44 | 1,171 | 1,216 |
| Standard Error of Mean | 8% | 295 | 2,634 | 19 | 10 | | |
| Standard Deviation | 19% | 723 | 6,452 | 47 | 25 | | |
| Minimum | 40% | 503 | 4,490 | 0 | 12 | | |
| Maximum | 85% | 2,466 | 22,004 | 115 | 76 | | |
| Count (n) | 6 | 6 | 6 | 6 | 6 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | | | |
| Mean | 0% | 0 | 0 | 0 | 0 | 0 | 0 |
| Standard Error of Mean | -- | -- | -- | -- | -- | | |
| Standard Deviation | -- | -- | -- | -- | -- | | |
| Minimum | 0% | 0 | 0 | 0 | 0 | | |
| Maximum | 0% | 0 | 0 | 0 | 0 | | |
| Count (n) | 0 | 0 | 0 | 0 | 0 | | |
| **All Quadrats** | | | | | | | |
| Mean | 69% | 1,152 | 10,280 | 19 | 44 | 1,171 | 1,216 |
| Standard Error of Mean | 8% | 295 | 2,634 | 19 | 10 | | |
| Standard Deviation | 19% | 723 | 6,452 | 47 | 25 | | |
| Minimum | 40% | 503 | 4,490 | 0 | 12 | | |
| Maximum | 85% | 2,466 | 22,004 | 115 | 76 | | |
| Count (n) | 6 | 6 | 6 | 6 | 6 | | |

**TABLE 8-8**
**SUMMARY OF 2003 CLIP QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Percent Cover | Biomass | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Live Standing | | Dead Standing | Litter | Total Standing | Total Biomass |
| | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ | $gdw/m^2$ | $gdw/m^2$ |
| **Commercial Township Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 76% | 2,341 | 20,887 | 0 | 136 | 2,341 | 2,477 |
| Standard Error of Mean | 7% | 933 | 8,325 | 0 | 82 | | |
| Standard Deviation | 18% | 2,286 | 20,392 | 0 | 202 | | |
| Minimum | 50% | 704 | 6,285 | 0 | 3 | | |
| Maximum | 95% | 5,812 | 51,859 | 0 | 477 | | |
| Count (n) | 6 | 6 | 6 | 6 | 6 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | | | |
| Mean | 0% | 0 | 0 | 0 | 0 | 0 | 0 |
| Standard Error of Mean | -- | -- | -- | -- | -- | | |
| Standard Deviation | -- | -- | -- | -- | -- | | |
| Minimum | 0% | 0 | 0 | 0 | 0 | | |
| Maximum | 0% | 0 | 0 | 0 | 0 | | |
| Count (n) | 0 | 0 | 0 | 0 | 0 | | |
| **All Quadrats** | | | | | | | |
| Mean | 76% | 2,341 | 20,887 | 0 | 136 | 2,341 | 2,477 |
| Standard Error of Mean | 7% | 933 | 8,325 | 0 | 82 | | |
| Standard Deviation | 18% | 2,286 | 20,392 | 0 | 202 | | |
| Minimum | 50% | 704 | 6,285 | 0 | 3 | | |
| Maximum | 95% | 5,812 | 51,859 | 0 | 477 | | |
| Count | 6 | 6 | 6 | 6 | 6 | | |

**TABLE 8-8**
**SUMMARY OF 2003 CLIP QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Percent Cover | Biomass: Live Standing gdw/m² | Biomass: Live Standing lb/acre | Biomass: Dead Standing gdw/m² | Biomass: Litter gdw/m² | Biomass: Total Standing gdw/m² | Biomass: Total Biomass gdw/m² |
|---|---|---|---|---|---|---|---|
| **Alloway Creek Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 70% | 1132 | 10,096 | 12 | 147 | 1,143 | 1,291 |
| Standard Error of Mean | 5% | 164 | 1,463 | 9 | 51 | | |
| Standard Deviation | 17% | 519 | 4,627 | 27 | 161 | | |
| Minimum | 25% | 528 | 4,707 | 0 | 0 | | |
| Maximum | 85% | 2315 | 20,657 | 88 | 449 | | |
| Count (n) | 10 | 10 | 10 | 10 | 10 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | | | | | | | |
| Mean | 46% | 635 | 5,664 | 164 | 144 | 798 | 942 |
| Standard Error of Mean | 8% | 161 | 1,434 | 110 | 46 | | |
| Standard Deviation | 23% | 455 | 4,056 | 310 | 129 | | |
| Minimum | 20% | 143 | 1,273 | 0 | 0 | | |
| Maximum | 85% | 1,422 | 12,691 | 906 | 307 | | |
| Count (n) | 8 | 8 | 8 | 8 | 8 | | |
| **All Quadrats** | | | | | | | |
| Mean | 59% | 911 | 8,126 | 79 | 146 | 990 | 1,136 |
| Standard Error of Mean | 5% | 127 | 1,136 | 51 | 34 | | |
| Standard Deviation | 23% | 540 | 4,821 | 214 | 143 | | |
| Minimum | 20% | 143 | 1,273 | 0 | 0 | | |
| Maximum | 85% | 2,315 | 20,657 | 906 | 449 | | |
| Count | 18 | 18 | 18 | 18 | 18 | | |
| **Cohansey River Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a`** | | | | | | | |
| Mean | 68% | 1,186 | 10,585 | 7 | 59 | 1,194 | 1,253 |
| Standard Error of Mean | 6% | 231 | 2,062 | 7 | 19 | | |
| Standard Deviation | 18% | 654 | 5,833 | 21 | 55 | | |
| Minimum | 50% | 322 | 2,871 | 0 | 0 | | |
| Maximum | 100% | 2,464 | 21,988 | 59 | 182 | | |
| Count (n) | 8 | 8 | 8 | 8 | 8 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | | | |
| Mean | 0% | 0 | 0 | 0 | 0 | 0 | 0 |
| Standard Error of Mean | -- | -- | -- | -- | -- | | |
| Standard Deviation | -- | -- | -- | -- | -- | | |
| Minimum | 0% | 0 | 0 | 0 | 0 | | |
| Maximum | 0% | 0 | 0 | 0 | 0 | | |
| Count (n) | 0 | 0 | 0 | 0 | 0 | | |
| **All Quadrats** | | | | | | | |
| Mean | 68% | 1,186 | 10,585 | 7 | 59 | 1,194 | 1,253 |
| Standard Error of Mean | 6% | 231 | 2,062 | 7 | 19 | | |
| Standard Deviation | 18% | 654 | 5,833 | 21 | 55 | | |
| Minimum | 50% | 322 | 2,871 | 0 | 0 | | |
| Maximum | 100% | 2,464 | 21,988 | 59 | 182 | | |
| Count | 8 | 8 | 8 | 8 | 8 | | |

**TABLE 8-8**
**SUMMARY OF 2003 CLIP QUADRAT TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| | Percent Cover | Biomass | | | | | |
|---|---|---|---|---|---|---|---|
| | | Live Standing | | Dead Standing | Litter | Total Standing | Total Biomass |
| | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ | gdw/m$^2$ | gdw/m$^2$ |
| **The Rocks Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 77% | 1071 | 9,556 | 35 | 86 | 1,106 | 1,192 |
| Standard Error of Mean | 4% | 160 | 1,425 | 17 | 24 | | |
| Standard Deviation | 11% | 505 | 4,505 | 53 | 75 | | |
| Minimum | 60% | 456 | 4,072 | 0 | 0 | | |
| Maximum | 100% | 1952 | 17,412 | 132 | 251 | | |
| Count (n) | 10 | 10 | 10 | 10 | 10 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | | | | | | | |
| Mean | 66% | 682 | 6,081 | 279 | 215 | 961 | 1,175 |
| Standard Error of Mean | 6% | 141 | 1,257 | 91 | 48 | | |
| Standard Deviation | 22% | 564 | 5,029 | 364 | 192 | | |
| Minimum | 30% | 53 | 472 | 0 | 0 | | |
| Maximum | 100% | 2,294 | 20,471 | 973 | 539 | | |
| Count (n) | 16 | 16 | 16 | 16 | 16 | | |
| **All Quadrats** | | | | | | | |
| Mean | 70% | 831 | 7,418 | 185 | 165 | 1,016 | 1,182 |
| Standard Error of Mean | 4% | 111 | 989 | 60 | 33 | | |
| Standard Deviation | 19% | 565 | 5,045 | 308 | 168 | | |
| Minimum | 30% | 53 | 472 | 0 | 0 | | |
| Maximum | 100% | 2,294 | 20,471 | 973 | 539 | | |
| Count | 26 | 26 | 26 | 26 | 26 | | |
| **Cedar Swamp Site** | | | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (a)** | | | | | | | |
| Mean | 63% | 1145 | 10,213 | 133 | 119 | 1,278 | 1,397 |
| Standard Error of Mean | 5% | 170 | 1,521 | 43 | 18 | | |
| Standard Deviation | 18% | 660 | 5,889 | 165 | 70 | | |
| Minimum | 30% | 361 | 3,217 | 0 | 0 | | |
| Maximum | 90% | 2391 | 21,335 | 525 | 235 | | |
| Count (n) | 15 | 15 | 15 | 15 | 15 | | |
| **Non-*Spartina alterniflora* dominated Quadrats Only (b)** | | | | | | | |
| Mean | 83% | 695 | 6,202 | 71 | 215 | 766 | 981 |
| Standard Error of Mean | 7% | 43 | 382 | 20 | 80 | | |
| Standard Deviation | 16% | 96 | 855 | 44 | 179 | | |
| Minimum | 70% | 596 | 5,315 | 10 | 51 | | |
| Maximum | 100% | 800 | 7,137 | 127 | 427 | | |
| Count (n) | 5 | 5 | 5 | 5 | 5 | | |
| **All Quadrats** | | | | | | | |
| Mean | 68% | 1,032 | 9,210 | 118 | 143 | 1,150 | 1,293 |
| Standard Error of Mean | 4% | 135 | 1,202 | 33 | 25 | | |
| Standard Deviation | 19% | 602 | 5,375 | 146 | 110 | | |
| Minimum | 30% | 361 | 3,217 | 0 | 0 | | |
| Maximum | 100% | 2,391 | 21,335 | 525 | 427 | | |
| Count | 20 | 20 | 20 | 20 | 20 | | |

(a) Also includes *Spartina cynosuroides* dominated quadrats, when present
(b) Includes quadrats dominated by *Spartina patens.*
(c) All quadrats are *Spartina alterniflora* at this site.

## TABLE 8-9
## SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA
## BY TRANSECTS
## PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Mad Horse Creek Reference Marsh - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 59% | 142 | 1382 | 113 | 101 |
| Standard Error of Mean | 4% | 7 | 430 | 89 | 45 |
| Standard Deviation | 18% | 31 | 962 | 199 | 100 |
| Count (*n*) | 20 | 21 | 5 | 5 | 5 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 87% | -- | 876 | 735 | 243 |
| Standard Error of Mean | 3% | -- | -- | -- | -- |
| Standard Deviation | 6% | -- | -- | -- | -- |
| Count (*n*) | 3 | -- | 1 | 1 | 1 |
| **All Quadrats** | | | | | |
| Mean | 63% | -- | 1298 | 217 | 125 |
| Standard Error of Mean | 4% | -- | 361 | 127 | 43 |
| Standard Deviation | 20% | -- | 885 | 310 | 106 |
| Count (*n*) | 23 | -- | 6 | 6 | 6 |
| **Mad Horse Creek Marsh - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 73% | 149 | 1573 | -- | 222 |
| Standard Error of Mean | 3% | 5 | 158 | -- | 184 |
| Standard Deviation | 9% | 13 | 224 | -- | 260 |
| Count (*n*) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 73% | -- | 1573 | -- | 222 |
| Standard Error of Mean | 3% | -- | 158 | -- | 184 |
| Standard Deviation | 9% | -- | 224 | -- | 260 |
| Count (n) | 8 | -- | 2 | 2 | 2 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing $gdw/m^2$ | Dead Standing $gdw/m^2$ | Litter $gdw/m^2$ |
| **Mad Horse Creek Reference Marsh - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 78% | 138 | 971 | 25 | 59 |
| Standard Error of Mean | 3% | 4 | 134 | 25 | 21 |
| Standard Deviation | 15% | 21 | 328 | 60 | 51 |
| Count (*n* ) | 27 | 32 | 6 | 6 | 6 |
| **Non - *Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 89% | -- | 1426 | 105 | 373 |
| Standard Error of Mean | 2% | -- | -- | -- | -- |
| Standard Deviation | 5% | -- | -- | -- | -- |
| Count (*n* ) | 5 | -- | 2 | 2 | 2 |
| **All Quadrats** | | | | | |
| Mean | 79% | -- | 1085 | 45 | 137 |
| Standard Error of Mean | 2% | -- | 124 | 30 | 75 |
| Standard Deviation | 14% | -- | 351 | 85 | 211 |
| Count (n) | 32 | -- | 8 | 8 | 8 |
| **Moores Beach Reference Marsh - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 66% | 137 | 1485 | 0 | 29 |
| Standard Error of Mean | 5% | 16 | 982 | 0 | 17 |
| Standard Deviation | 15% | 44 | 1388 | 0 | 24 |
| Count (*n* ) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n* ) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 66% | -- | 1485 | 0 | 29 |
| Standard Error of Mean | 5% | -- | 982 | 0 | 17 |
| Standard Deviation | 15% | -- | 1388 | 0 | 24 |
| Count (*n* ) | 8 | -- | 2 | 2 | 2 |

# TABLE 8-9
# SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA
# BY TRANSECTS
# PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Moores Beach Reference Marsh - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 81% | 124 | 936 | 0 | 70 |
| Standard Error of Mean | 3% | 6 | 39 | 0 | 6 |
| Standard Deviation | 9% | 18 | 55 | 0 | 8 |
| Count (*n*) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 81% | -- | 936 | 0 | 70 |
| Standard Error of Mean | 3% | -- | 39 | 0 | 6 |
| Standard Deviation | 9% | -- | 55 | 0 | 8 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |
| **Moore's Beach Reference Marsh - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 68% | 92 | 1035 | 57 | 34 |
| Standard Error of Mean | 4% | 8 | 414 | 57 | 17 |
| Standard Deviation | 10% | 24 | 586 | 81 | 24 |
| Count (*n*) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 68% | -- | 1035 | 57 | 34 |
| Standard Error of Mean | 4% | -- | 414 | 57 | 17 |
| Standard Deviation | 10% | -- | 586 | 81 | 24 |
| Count(n) | 8 | -- | 2 | 2 | 2 |

# TABLE 8-9
# SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA
# BY TRANSECTS
# PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Commercial Township Site - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 80% | 158 | 896 | 0 | 385 |
| Standard Error of Mean | 5% | 5 | 192 | 0 | 92 |
| Standard Deviation | 15% | 15 | 271 | 0 | 130 |
| Count (*n*) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 80% | -- | 896 | 0 | 385 |
| Standard Error of Mean | 5% | -- | 192 | 0 | 92 |
| Standard Deviation | 15% | -- | 271 | 0 | 130 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |
| **Commercial Township Site - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 88% | 225 | 2803 | 0 | 15 |
| Standard Error of Mean | 7% | 15 | 1887 | 0 | 2 |
| Standard Deviation | 15% | 30 | 2669 | 0 | 2 |
| Count (*n*) | 4 | 4 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 0% | -- | -- | -- | -- |
| Standard Error of Mean | 0% | -- | -- | -- | -- |
| Standard Deviation | 0% | -- | -- | -- | -- |
| Count (*n*) | 4 | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 44% | -- | 2803 | 0 | 15 |
| Standard Error of Mean | 17% | -- | 1887 | 0 | 2 |
| Standard Deviation | 48% | -- | 2669 | 0 | 2 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Commercial Township Site - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 91% | 228 | 3324 | -- | 7 |
| Standard Error of Mean | 4% | 26 | 2489 | -- | 4 |
| Standard Deviation | 7% | 52 | 3520 | -- | 6 |
| Count (*n*) | 4 | 4 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 0% | -- | -- | -- | -- |
| Standard Error of Mean | 0% | -- | -- | -- | -- |
| Standard Deviation | 0% | -- | -- | -- | -- |
| Count (*n*) | 4 | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 46% | -- | 3324 | 0 | 7 |
| Standard Error of Mean | 17% | -- | 2489 | 0 | 4 |
| Standard Deviation | 49% | -- | 3520 | 0 | 6 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |
| **Commercial Township Site - Transect 4** | | | | | |
| Transect flooded - No live vegetation along transect - no data collected | | | | | |
| **Alloway Creek Watershed Site - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 70% | 148 | 1206 | 24 | 250 |
| Standard Error of Mean | 4% | 5 | 400 | 21 | 97 |
| Standard Deviation | 19% | 23 | 799 | 43 | 195 |
| Count (*n*) | 18 | 18 | 4 | 4 | 4 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 72% | -- | 956 | 35 | 194 |
| Standard Error of Mean | 7% | -- | 24 | 33 | 10 |
| Standard Deviation | 18% | -- | 35 | 46 | 14 |
| Count (*n*) | 6 | -- | 2 | 2 | 2 |
| **All Quadrats** | | | | | |
| Mean | 70% | -- | 1123 | 28 | 232 |
| Standard Error of Mean | 4% | -- | 258 | 16 | 63 |
| Standard Deviation | 18% | -- | 633 | 39 | 154 |
| Count (*n*) | 24 | -- | 6 | 6 | 6 |

## TABLE 8-9
## SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA
## BY TRANSECTS
## PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/$m^2$ | Dead Standing gdw/$m^2$ | Litter gdw/$m^2$ |
| **Alloway Creek Watershed Site - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 73% | 154 | 1287 | 9 | 162 |
| Standard Error of Mean | 5% | 11 | 270 | 9 | 102 |
| Standard Deviation | 13% | 31 | 382 | 13 | 145 |
| Count (*n*) | 8 | 8 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 73% | -- | 1287 | 9 | 162 |
| Standard Error of Mean | 5% | -- | 270 | 9 | 102 |
| Standard Deviation | 13% | -- | 382 | 13 | 145 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |
| **Alloway Creek Watershed Site - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 61% | 114 | 859 | 1 | 30 |
| Standard Error of Mean | 8% | 7 | 188 | 1 | 30 |
| Standard Deviation | 25% | 21 | 265 | 1 | 43 |
| Count (*n*) | 10 | 10 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 36% | -- | 783 | 111 | 157 |
| Standard Error of Mean | 13% | -- | 640 | 111 | 150 |
| Standard Deviation | 33% | -- | 905 | 157 | 212 |
| Count (*n*) | 6 | -- | 2 | 2 | 2 |
| **All Quadrats** | | | | | |
| Mean | 52% | -- | 821 | 56 | 94 |
| Standard Error of Mean | 7% | -- | 273 | 55 | 72 |
| Standard Deviation | 30% | -- | 546 | 111 | 145 |
| Count (*n*) | 16 | -- | 4 | 4 | 4 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Alloway Creek Watershed Site - Transect 4** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 63% | 145 | 1100 | 0 | 44 |
| Standard Error of Mean | 8% | 11 | 184 | 0 | 44 |
| Standard Deviation | 25% | 40 | 260 | 0 | 63 |
| Count (*n*) | 11 | 14 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 19% | -- | 400 | 254 | 112 |
| Standard Error of Mean | 5% | -- | 114 | 219 | 72 |
| Standard Deviation | 19% | -- | 228 | 438 | 143 |
| Count (*n*) | 13 | -- | 4 | 4 | 4 |
| **All Quadrats** | | | | | |
| Mean | 39% | -- | 634 | 169 | 90 |
| Standard Error of Mean | 6% | -- | 171 | 148 | 49 |
| Standard Deviation | 31% | -- | 419 | 363 | 120 |
| Count (*n*) | 24 | -- | 6 | 6 | 6 |
| **Cohansey River Site - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 74% | 165 | 2066 | 30 | 53 |
| Standard Error of Mean | 4% | 13 | 399 | 30 | 14 |
| Standard Deviation | 12% | 39 | 564 | 42 | 19 |
| Count (*n*) | 8 | 9 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 74% | -- | 2066 | 30 | 53 |
| Standard Error of Mean | 4% | -- | 399 | 30 | 14 |
| Standard Deviation | 12% | -- | 564 | 42 | 19 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing $gdw/m^2$ | Dead Standing $gdw/m^2$ | Litter $gdw/m^2$ |
| **Cohansey River Site - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 51% | 115 | 1007 | 0 | 112 |
| Standard Error of Mean | 7% | 16 | 123 | 0 | 69 |
| Standard Deviation | 17% | 42 | 174 | 0 | 98 |
| Count (*n*) | 7 | 7 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 0% | -- | -- | 0 | 0 |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | 1 | -- | -- | 1 | 1 |
| **All Quadrats** | | | | | |
| Mean | 44% | -- | 1007 | 0 | 75 |
| Standard Error of Mean | 9% | -- | 123 | 0 | 55 |
| Standard Deviation | 24% | -- | 174 | 0 | 95 |
| Count (*n*) | 8 | -- | 2 | 3 | 3 |
| **Cohansey River Site - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 66% | 146 | 1029 | 0 | 33 |
| Standard Error of Mean | 9% | 18 | 306 | 0 | 1 |
| Standard Deviation | 23% | 53 | 433 | 0 | 1 |
| Count (*n*) | 7 | 9 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c) (d)** | | | | | |
| Mean | 0% | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | 1 | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 58% | -- | 1029 | 0 | 33 |
| Standard Error of Mean | 11% | -- | 306 | 0 | 1 |
| Standard Deviation | 32% | -- | 433 | 0 | 1 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |

# TABLE 8-9
# SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA BY TRANSECTS
# PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Cohansey River Site - Transect 4** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 89% | 167 | 643 | 0 | 38 |
| Standard Error of Mean | 6% | 14 | 321 | 0 | 38 |
| Standard Deviation | 17% | 43 | 454 | 0 | 54 |
| Count (*n*) | 8 | 9 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 89% | -- | 643 | 0 | 38 |
| Standard Error of Mean | 6% | -- | 321 | 0 | 38 |
| Standard Deviation | 17% | -- | 454 | 0 | 54 |
| Count (*n*) | 8 | -- | 2 | 2 | 2 |
| **The Rocks Site - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 72% | 143 | 1063 | 8 | 15 |
| Standard Error of Mean | 3% | 7 | 102 | 1 | 15 |
| Standard Deviation | 10% | 28 | 144 | 2 | 21 |
| Count (*n*) | 13 | 16 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 80% | -- | 1089 | 112 | 254 |
| Standard Error of Mean | 6% | -- | 7 | 20 | 254 |
| Standard Deviation | 10% | -- | 10 | 28 | 359 |
| Count (*n*) | 3 | -- | 2 | 2 | 2 |
| **All Quadrats** | | | | | |
| Mean | 73% | -- | 1076 | 60 | 134 |
| Standard Error of Mean | 2% | -- | 42 | 31 | 125 |
| Standard Deviation | 10% | -- | 85 | 62 | 249 |
| Count (*n*) | 16 | -- | 4 | 4 | 4 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **The Rocks Site - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 83% | 134 | 1937 | 55 | 46 |
| Standard Error of Mean | 5% | 8 | 15 | 55 | 46 |
| Standard Deviation | 15% | 28 | 21 | 78 | 66 |
| Count (*n*) | 9 | 12 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 52% | -- | 386 | 613 | 267 |
| Standard Error of Mean | 5% | -- | 183 | 163 | 66 |
| Standard Deviation | 24% | -- | 449 | 400 | 162 |
| Count (*n*) | 21 | -- | 6 | 6 | 6 |
| **All Quadrats** | | | | | |
| Mean | 61% | -- | 774 | 474 | 212 |
| Standard Error of Mean | 5% | -- | 287 | 151 | 61 |
| Standard Deviation | 26% | -- | 812 | 427 | 173 |
| Count (*n*) | 30 | -- | 8 | 8 | 8 |
| **The Rocks Site - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 59% | 133 | 658 | 56 | 137 |
| Standard Error of Mean | 6% | 11 | 84 | 33 | 43 |
| Standard Deviation | 22% | 42 | 167 | 66 | 87 |
| Count (*n*) | 14 | 16 | 4 | 4 | 4 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 70% | -- | 848 | 5 | 189 |
| Standard Error of Mean | 5% | -- | 301 | 3 | 89 |
| Standard Deviation | 21% | -- | 738 | 8 | 219 |
| Count (*n*) | 18 | -- | 6 | 6 | 6 |
| **All Quadrats** | | | | | |
| Mean | 65% | -- | 772 | 25 | 168 |
| Standard Error of Mean | 4% | -- | 179 | 15 | 55 |
| Standard Deviation | 22% | -- | 567 | 47 | 173 |
| Count (*n*) | 32 | -- | 10 | 10 | 10 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **The Rocks Site - Transect 4** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 74% | 110 | 1041 | 0 | 97 |
| Standard Error of Mean | 9% | 5 | 44 | 0 | 4 |
| Standard Deviation | 28% | 15 | 62 | 0 | 6 |
| Count (*n*) | 9 | 9 | 2 | 2 | 2 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 73% | -- | 660 | 265 | 94 |
| Standard Error of Mean | 11% | -- | 61 | 52 | 31 |
| Standard Deviation | 30% | -- | 87 | 73 | 44 |
| Count (*n*) | 7 | -- | 2 | 2 | 2 |
| **All Quadrats** | | | | | |
| Mean | 74% | -- | 850 | 133 | 95 |
| Standard Error of Mean | 7% | -- | 114 | 79 | 13 |
| Standard Deviation | 28% | -- | 228 | 159 | 26 |
| Count (*n*) | 16 | -- | 4 | 4 | 4 |
| **Cedar Swamp Site - Transect 1** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 58% | 157 | 1293 | 54 | 148 |
| Standard Error of Mean | 6% | 8 | 322 | 31 | 22 |
| Standard Deviation | 24% | 31 | 644 | 63 | 44 |
| Count (*n*) | 16 | 17 | 4 | 4 | 4 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (d)** | | | | | |
| Mean | -- | -- | -- | -- | -- |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | -- | -- | -- | -- | -- |
| **All Quadrats** | | | | | |
| Mean | 58% | -- | 1293 | 54 | 148 |
| Standard Error of Mean | 6% | -- | 322 | 31 | 22 |
| Standard Deviation | 24% | -- | 644 | 63 | 44 |
| Count (*n*) | 16 | -- | 4 | 4 | 4 |

**TABLE 8-9**
**SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA**
**BY TRANSECTS**
**PSEG EEP DETRITAL MONITORING PROGRAM**

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Cedar Swamp Site - Transect 2** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 65% | 177 | 744 | 89 | 125 |
| Standard Error of Mean | 3% | 10 | 186 | 57 | 32 |
| Standard Deviation | 13% | 51 | 416 | 126 | 72 |
| Count (*n*) | 21 | 24 | 5 | 5 | 5 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 53% | -- | 757 | 50 | 131 |
| Standard Error of Mean | 12% | -- | -- | -- | -- |
| Standard Deviation | 21% | -- | -- | -- | -- |
| Count (*n*) | 3 | -- | 1 | 1 | 1 |
| **All Quadrats** | | | | | |
| Mean | 64% | -- | 719 | 83 | 126 |
| Standard Error of Mean | 3% | -- | 154 | 47 | 26 |
| Standard Deviation | 14% | -- | 377 | 114 | 64 |
| Count (*n*) | 24 | -- | 6 | 6 | 6 |
| **Cedar Swamp Site - Transect 3** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 61% | 154 | 1453 | 271 | 147 |
| Standard Error of Mean | 5% | 11 | 499 | 63 | 49 |
| Standard Deviation | 20% | 50 | 864 | 109 | 84 |
| Count (*n*) | 19 | 20 | 3 | 3 | 3 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 78% | -- | 757 | 99 | 298 |
| Standard Error of Mean | 15% | -- | 37 | 14 | 110 |
| Standard Deviation | 34% | -- | 65 | 25 | 191 |
| Count (*n*) | 5 | -- | 3 | 3 | 3 |
| **All Quadrats** | | | | | |
| Mean | 65% | -- | 1105 | 185 | 222 |
| Standard Error of Mean | 5% | -- | 273 | 48 | 64 |
| Standard Deviation | 24% | -- | 668 | 118 | 156 |
| Count (*n*) | 24 | -- | 6 | 6 | 6 |

## TABLE 8-9
## SUMMARY OF 2003 CLIP and OCULAR QUADRAT DATA
## BY TRANSECTS
## PSEG EEP DETRITAL MONITORING PROGRAM

| | Peak Season | | | | |
|---|---|---|---|---|---|
| | | | Biomass | | |
| | Percent Cover | Height (a) (cm) | Live Standing gdw/m$^2$ | Dead Standing gdw/m$^2$ | Litter gdw/m$^2$ |
| **Cedar Swamp Site - Transect 4** | | | | | |
| ***Spartina alterniflora* dominated Quadrats Only (b)** | | | | | |
| Mean | 75% | 136 | 1306 | 175 | 41 |
| Standard Error of Mean | 3% | 6 | 486 | 175 | 26 |
| Standard Deviation | 13% | 22 | 841 | 303 | 45 |
| Count (*n*) | 15 | 15 | 3 | 3 | 3 |
| **Non -*Spartina alterniflora* dominated Quadrats Only (c)** | | | | | |
| Mean | 70% | -- | 610 | 10 | 51 |
| Standard Error of Mean | -- | -- | -- | -- | -- |
| Standard Deviation | -- | -- | -- | -- | -- |
| Count (*n*) | 1 | -- | 1 | 1 | 1 |
| **All Quadrats** | | | | | |
| Mean | 74% | -- | 1132 | 134 | 43 |
| Standard Error of Mean | 3% | -- | 385 | 131 | 19 |
| Standard Deviation | 12% | -- | 770 | 261 | 37 |
| Count (*n*) | 16 | -- | 4 | 4 | 4 |

(a) Height calculations include values for *S. alterniflora* and *S. cynosuriodes* from Spartina-dominated quadrats only.
(b) Also includes *Spartina cynosuroides* dominated quadrats, when present.
(c) Includes quadrats dominated by *Spartina patens.*
(d) All quadrats in this transect were *Spartina* -dominated.

**Table 8-10**
**2003 Species Occurrence At Reference Marshes**
**PSEG Detrital Production Monitoring**

| Species [a] | Reference Marsh | |
|---|---|---|
| | Mad Horse Creek | Moores Beach |
| *Amaranthus cannabinus* | X* | |
| *Distichlis spicata* | X | X* |
| *Phragmites australis* | X* | |
| *Spartina alterniflora* | X* | |
| *Spartina cynosuroides* | X* | |
| *Spartina patens* | X* | |
| *Scirpus robustus* | X | |

[a] Species listed were present within quadrats along sampling transects.
* Present as a dominant (>20 percent relative cover) in some quadrats.

## TABLE 8-11
## SUMMARY OF 2003 PLOT DATA
## PSEG EEP VEGETATION MONITORING

| | Percent Cover | Live Standing Biomass | |
|---|---|---|---|
| | | gdw/m2 | lb/acre |
| **Mad Horse Creek Reference Site** | | | |
| **Plot 1 (MHP1)** | | | |
| Mean | 81% | 1,123 | 10,023 |
| Standard Error of Mean | 4% | 148 | 1,321 |
| Standard Deviation | 13% | 444 | 3,963 |
| Minimum | 50% | 511 | 4,563 |
| Maximum | 95% | 2,101 | 18,744 |
| Count (n) | 9 | 9 | |
| **Plot 2 (MHP2)** | | | |
| Mean | 71% | 950 | 8,473 |
| Standard Error of Mean | 3% | 101 | 899 |
| Standard Deviation | 10% | 302 | 2,698 |
| Minimum | 50% | 481 | 4,288 |
| Maximum | 80% | 1,509 | 13,468 |
| Count (n) | 9 | 9 | |
| **Plot 3 (MHP3)** | | | |
| Mean | 64% | 1,076 | 9,598 |
| Standard Error of Mean | 3% | 150 | 1,339 |
| Standard Deviation | 10% | 450 | 4,018 |
| Minimum | 50% | 489 | 4,365 |
| Maximum | 80% | 2,000 | 17,848 |
| Count (n) | 9 | 9 | |
| **All Plots** | | | |
| Mean | 72% | 1,050 | 9,365 |
| Standard Error of Mean | 2% | 76 | 680 |
| Standard Deviation | 13% | 396 | 3,533 |
| Minimum | 50% | 481 | 4,288 |
| Maximum | 95% | 2,101 | 18,744 |
| Count (n) | 27 | 27 | |

# TABLE 8-11
# SUMMARY OF 2003 PLOT DATA
# PSEG EEP VEGETATION MONITORING

| | Percent | Live Standing Biomass | |
|---|---|---|---|
| | Cover | gdw/m2 | lb/acre |
| **Moores Beach Reference Site** | | | |
| **Plot 1 (MBP1)** | | | |
| Mean | 64% | 1,182 | 10,550 |
| Standard Error of Mean | 5% | 119 | 1,065 |
| Standard Deviation | 16% | 358 | 3,194 |
| Minimum | 40% | 613 | 5,468 |
| Maximum | 85% | 1,877 | 16,745 |
| Count (n) | 9 | 9 | |
| **Plot 2 (MBP2)** | | | |
| Mean | 36% | 804 | 7,176 |
| Standard Error of Mean | 4% | 123 | 1,099 |
| Standard Deviation | 12% | 370 | 3,297 |
| Minimum | 15% | 269 | 2,401 |
| Maximum | 60% | 1,621 | 14,461 |
| Count (n) | 9 | 9 | |
| **Plot 3 (MBP3)** | | | |
| Mean | 53% | 1,156 | 10,314 |
| Standard Error of Mean | 6% | 81 | 723 |
| Standard Deviation | 17% | 243 | 2,168 |
| Minimum | 20% | 841 | 7,505 |
| Maximum | 70% | 1,529 | 13,644 |
| Count (n) | 9 | 9 | |
| **All Plots** | | | |
| Mean | 51% | 1,048 | 9,346 |
| Standard Error of Mean | 4% | 70 | 620 |
| Standard Deviation | 19% | 361 | 3,223 |
| Minimum | 15% | 269 | 2,401 |
| Maximum | 85% | 1,877 | 16,745 |
| Count (n) | 27 | 27 | |

**TABLE 8-11**
**SUMMARY OF 2003 PLOT DATA**
**PSEG EEP VEGETATION MONITORING**

| | Percent | Live Standing Biomass | |
|---|---|---|---|
| | Cover | gdw/m2 | lb/acre |
| **Commercial Township Site** | | | |
| **Plot 1 (CTP1)** | | | |
| Mean | 36% | 1,371 | 12,228 |
| Standard Error of Mean | 10% | 379 | 3,379 |
| Standard Deviation | 30% | 1,136 | 10,136 |
| Minimum | 0% | 0 | 0 |
| Maximum | 75% | 3,294 | 29,385 |
| Count (n) | 9 | 9 | |
| **Plot 2 (CTP2)** | | | |
| Mean | 34% | 677 | 6,043 |
| Standard Error of Mean | 10% | 245 | 2,182 |
| Standard Deviation | 29% | 734 | 6,547 |
| Minimum | 0% | 0 | 0 |
| Maximum | 80% | 2,092 | 18,664 |
| Count (n) | 9 | 9 | |
| **Plot 3 (CTP3)** | | | |
| Mean | 38% | 1,001 | 8,930 |
| Standard Error of Mean | 12% | 345 | 3,078 |
| Standard Deviation | 37% | 1,035 | 9,234 |
| Minimum | 0% | 0 | 0 |
| Maximum | 85% | 2,728 | 24,343 |
| Count (n) | 9 | 9 | |
| **All Plots** | | | |
| Mean | 36% | 1,016 | 9,067 |
| Standard Error of Mean | 6% | 190 | 1,696 |
| Standard Deviation | 31% | 988 | 8,813 |
| Minimum | 0% | 0 | 0 |
| Maximum | 85% | 3,294 | 29,385 |
| Count (n) | 27 | 27 | |

**TABLE 8-11**
**SUMMARY OF 2003 PLOT DATA**
**PSEG EEP VEGETATION MONITORING**

| | Percent Cover | Live Standing Biomass | |
|---|---|---|---|
| | | gdw/m2 | lb/acre |
| **Alloway Creek Watershed Site** | | | |
| **Plot 1 (ACWP1)** | | | |
| Mean | 72% | 909 | 8,111 |
| Standard Error of Mean | 14% | 192 | 1,714 |
| Standard Deviation | 43% | 576 | 5,141 |
| Minimum | 0% | 0 | 0 |
| Maximum | 100% | 1,492 | 13,315 |
| Count (n) | 9 | 9 | |
| **Plot 2 (ACWP2)** | | | |
| Mean | 65% | 996 | 8,887 |
| Standard Error of Mean | 10% | 183 | 1,630 |
| Standard Deviation | 29% | 548 | 4,891 |
| Minimum | 5% | 257 | 2,290 |
| Maximum | 100% | 1,710 | 15,254 |
| Count (n) | 9 | 9 | |
| **Plot 3 (ACWP3)** | | | |
| Mean | 74% | 1,268 | 11,312 |
| Standard Error of Mean | 11% | 216 | 1,931 |
| Standard Deviation | 32% | 649 | 5,794 |
| Minimum | 0% | 0 | 0 |
| Maximum | 100% | 2,455 | 21,905 |
| Count (n) | 9 | 9 | |
| **All Plots** | | | |
| Mean | 70% | 1,058 | 9,437 |
| Standard Error of Mean | 7% | 114 | 1,014 |
| Standard Deviation | 34% | 590 | 5,268 |
| Minimum | 0% | 0 | 0 |
| Maximum | 100% | 2,455 | 21,905 |
| Count (n) | 27 | 27 | |

**TABLE 8-11**
**SUMMARY OF 2003 PLOT DATA**
**PSEG EEP VEGETATION MONITORING**

| | Percent Cover | Live Standing Biomass gdw/m2 | Live Standing Biomass lb/acre |
|---|---|---|---|
| **Cohansey River Site** | | | |
| **Plot 1 (BRP1)** | | | |
| Mean | 46% | 731 | 6,520 |
| Standard Error of Mean | 10% | 199 | 1,777 |
| Standard Deviation | 30% | 598 | 5,331 |
| Minimum | 0% | 0 | 0 |
| Maximum | 80% | 1,689 | 15,067 |
| Count (n) | 9 | 9 | |
| **Plot 2 (BRP2)** | | | |
| Mean | 63% | 837 | 7,466 |
| Standard Error of Mean | 8% | 146 | 1,298 |
| Standard Deviation | 23% | 437 | 3,895 |
| Minimum | 30% | 147 | 1,311 |
| Maximum | 85% | 1,326 | 11,827 |
| Count (n) | 9 | 9 | |
| **Plot 3 (BRP3)** | | | |
| Mean | 72% | 1,259 | 11,234 |
| Standard Error of Mean | 5% | 171 | 1,524 |
| Standard Deviation | 14% | 512 | 4,572 |
| Minimum | 45% | 502 | 4,478 |
| Maximum | 90% | 2,138 | 19,072 |
| Count (n) | 9 | 9 | |
| **All Plots** | | | |
| Mean | 60% | 942 | 8,407 |
| Standard Error of Mean | 5% | 106 | 946 |
| Standard Deviation | 25% | 551 | 4,914 |
| Minimum | 0% | 0 | 0 |
| Maximum | 90% | 2,138 | 19,072 |
| Count (n) | 27 | 27 | |

**TABLE 8-11**
**SUMMARY OF 2003 PLOT DATA**
**PSEG EEP VEGETATION MONITORING**

| | Percent Cover | Live Standing Biomass | |
|---|---|---|---|
| | | gdw/m2 | lb/acre |
| **The Rocks Site** | | | |
| **Plot 1 (TRP1)** | | | |
| Mean | 59% | 781 | 6,968 |
| Standard Error of Mean | 8% | 219 | 1,958 |
| Standard Deviation | 24% | 658 | 5,875 |
| Minimum | 25% | 36 | 323 |
| Maximum | 90% | 2,326 | 20,755 |
| Count (n) | 9 | 9 | |
| **Cedar Swamp Site** | | | |
| **Plot 1 (CSP1)** | | | |
| Mean | 66% | 1,016 | 9,064 |
| Standard Error of Mean | 4% | 84 | 753 |
| Standard Deviation | 11% | 253 | 2,258 |
| Minimum | 46% | 709 | 6,328 |
| Maximum | 80% | 1,509 | 13,460 |
| Count (n) | 9 | 9 | |

I:\Projects\01E04113.00 (EEP 2001 DETRITAL PRODUCTION)\Mapping\FIGURE1.dwg, 04/15/2003 02:54:33 PM

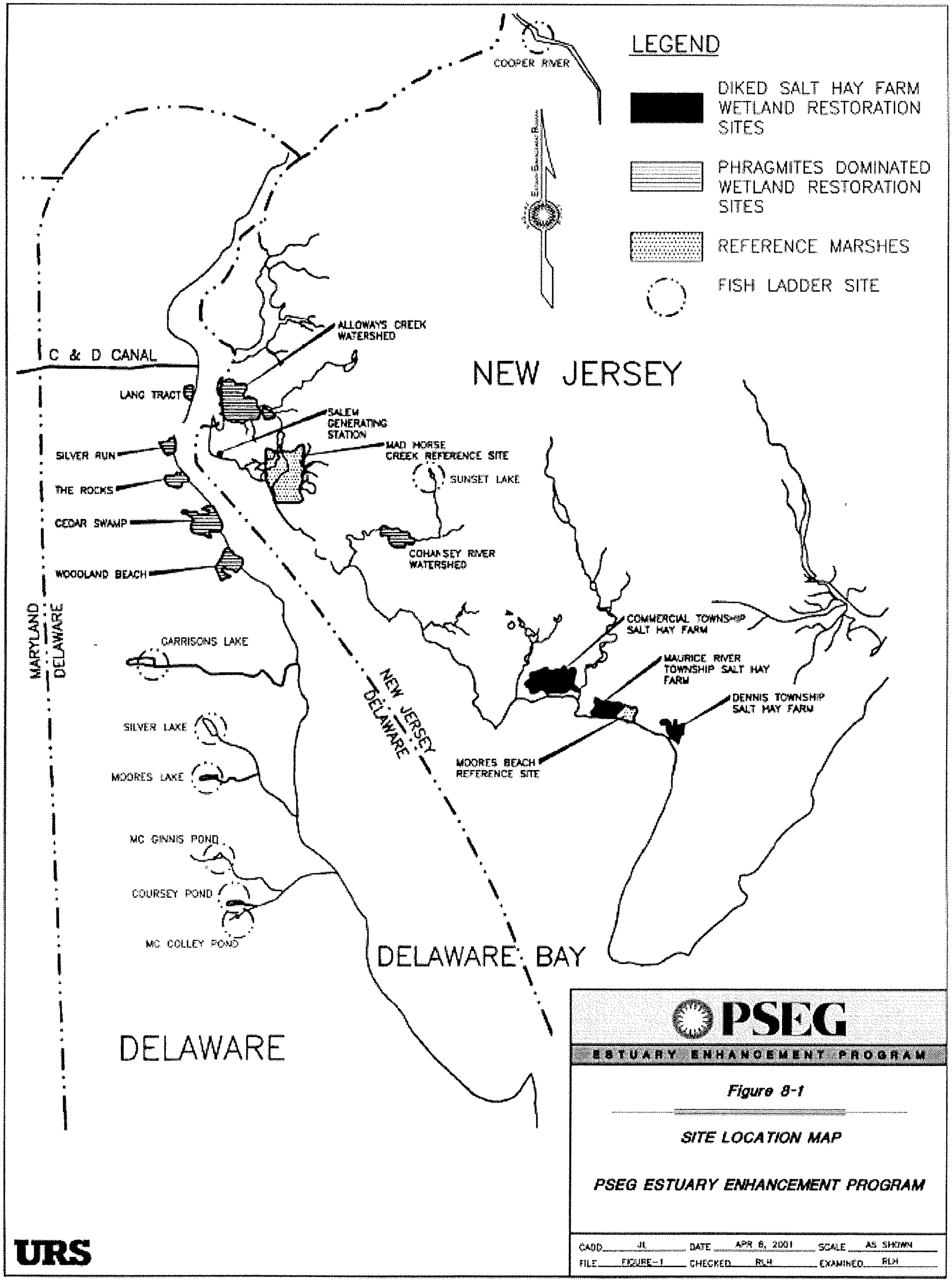
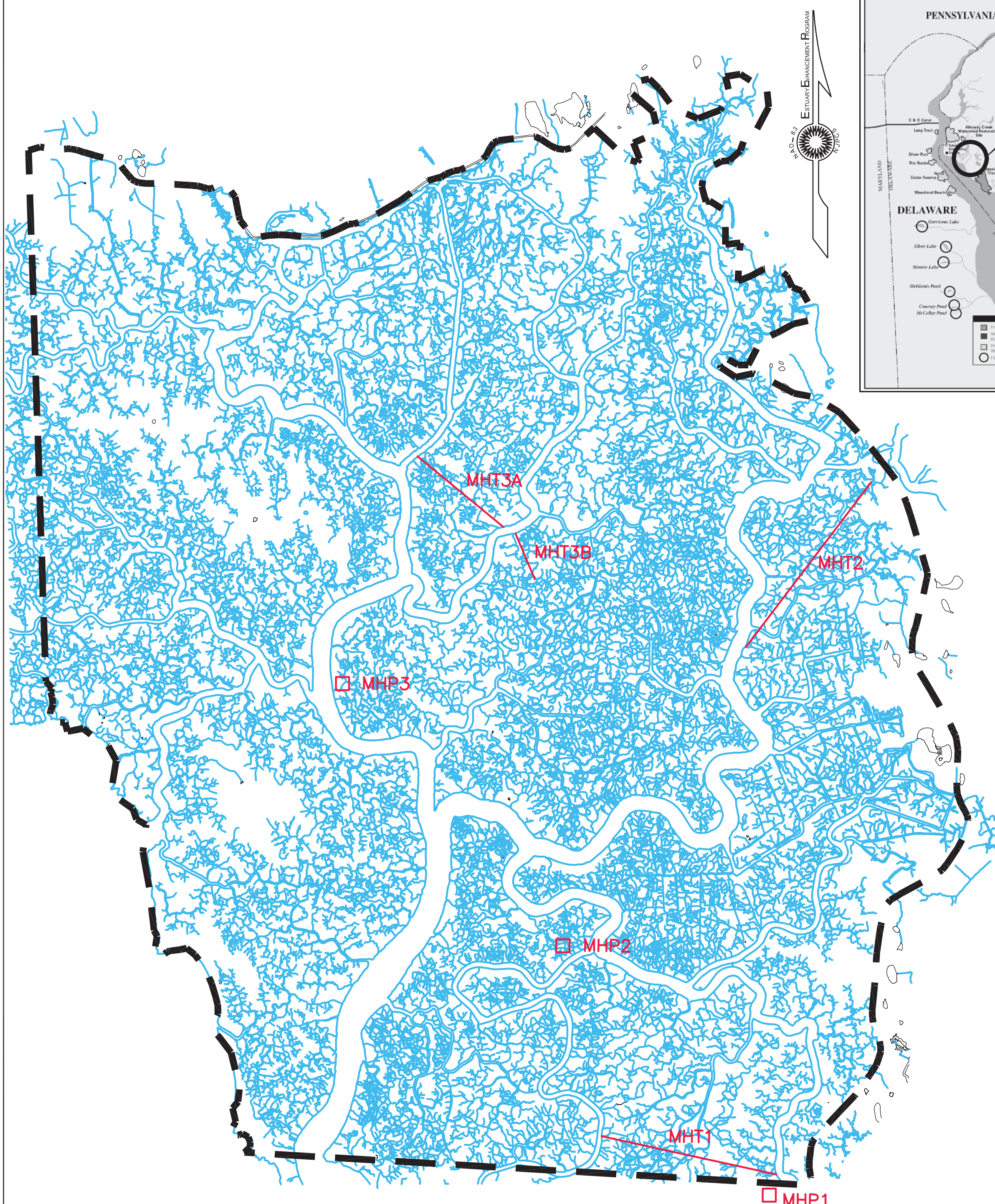
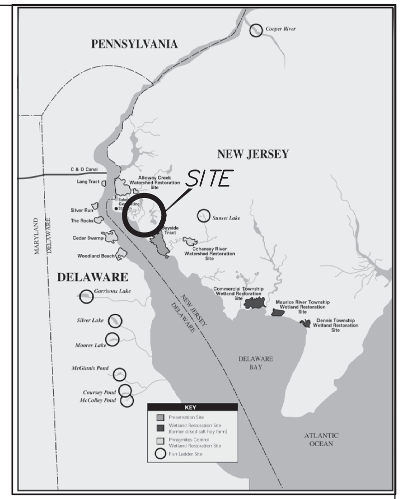



*Figure 8-1*

*SITE LOCATION MAP*

*PSEG ESTUARY ENHANCEMENT PROGRAM*




**NOTE:**

MHT1 MAD HORSE CREEK VEGETATION TRANSECT 1
MHT2 MAD HORSE CREEK VEGETATION TRANSECT 2
MHT3 MAD HORSE CREEK VEGETATION TRANSECT 3
MHP1 MAD HORSE CREEK VEGETATION PLOT 1
MHP2 MAD HORSE CREEK VEGETATION PLOT 2
MHP3 MAD HORSE CREEK VEGETATION PLOT 3

**LEGEND**

- SITE BOUNDARY
- EXISTING SURFACE WATER FEATURE
- TRANSECT
- 60m x 60m PLOT

FEET 0 1200 2400 3600
METERS 0 576 1152

URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

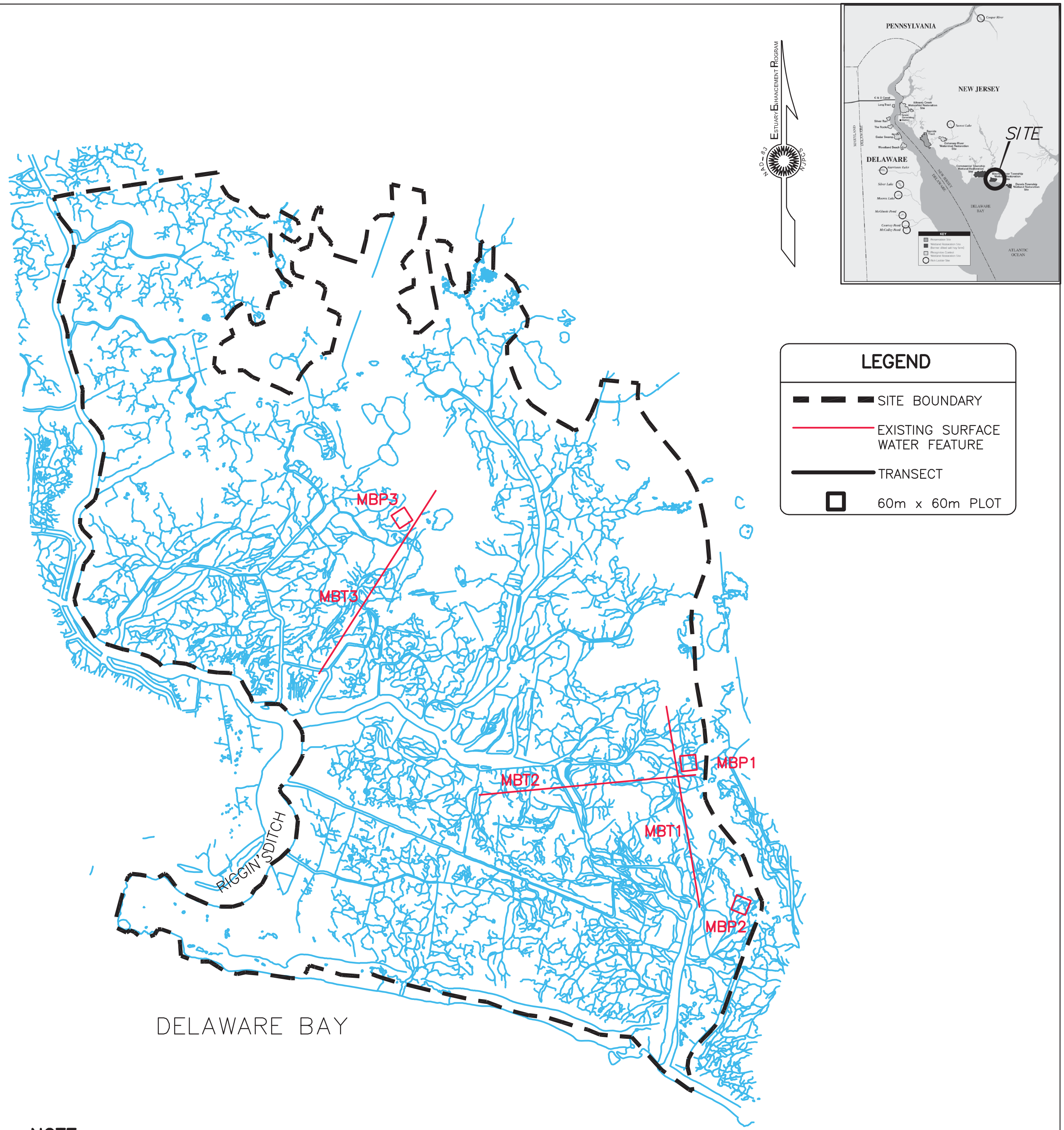
*Figure 8–2*

*MADHORSE CREEK REFERENCE MARSH*

*2003 VEGETATION MONITORING TRANSECTS AND PLOTS*

*LOWER ALLOWAYS CREEK TOWNSHIP SALEM COUNTY, NEW JERSEY*

CADD JL DATE MAY 9, 2004 SCALE AS SHOWN
FILE 03_MH_TRA CHECKED RLH EXAMINED RLH




**NOTE:**

MBT1 MOORES BEACH VEGETATION TRANSECT 1

MBT2 MOORES BEACH VEGETATION TRANSECT 2

MBT3 MOORES BEACH VEGETATION TRANSECT 3

MBP1 MOORES BEACH VEGETATION PLOT 1

MBP2 MOORES BEACH VEGETATION PLOT 2

MBP3 MOORES BEACH VEGETATION PLOT 3

FEET 0 900 1800 2700

METERS 0 432 864

URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

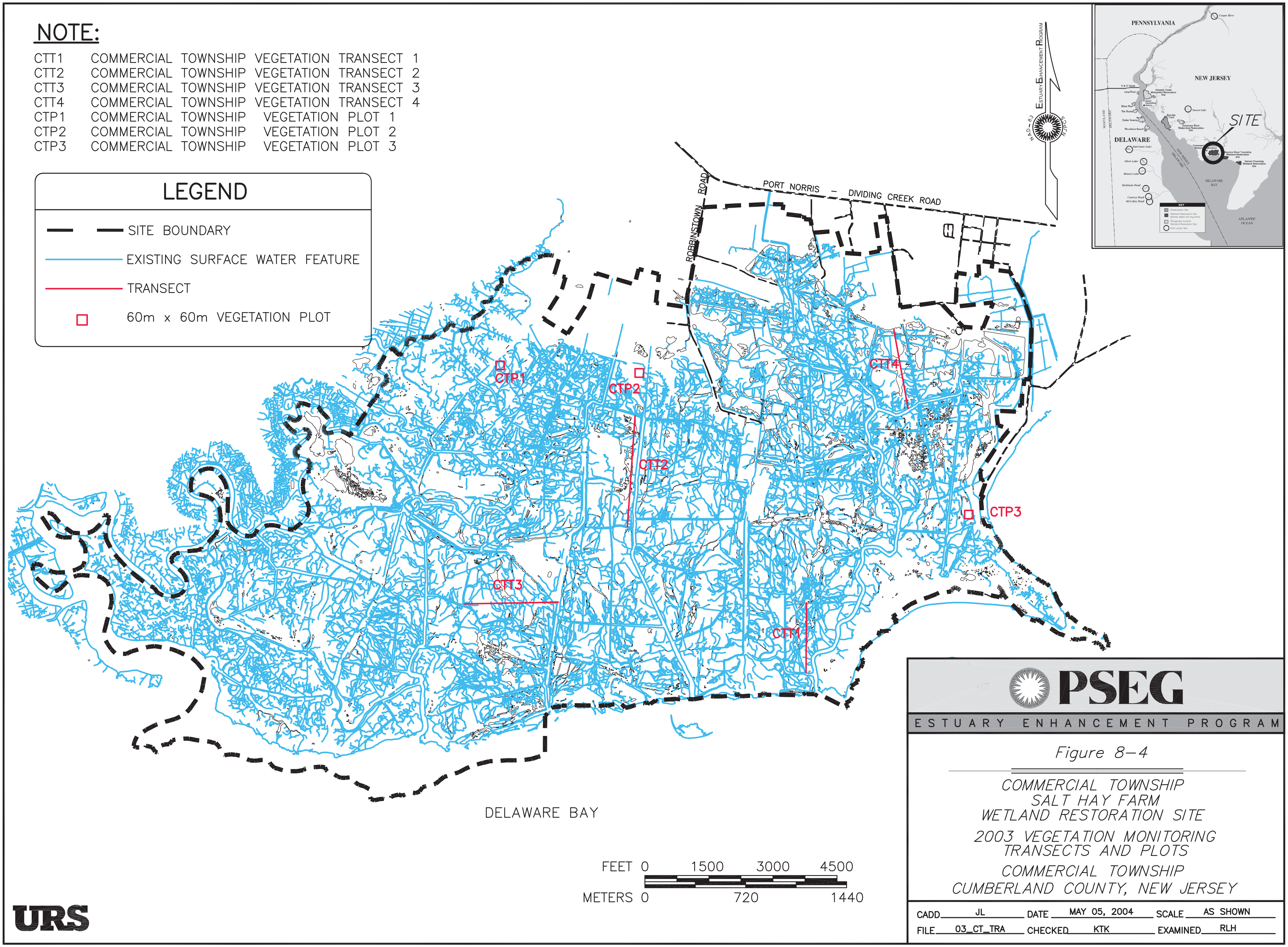
*Figure 8-3*

*MOORES BEACH REFERENCE MARSH*

*2003 VEGETATION MONITORING TRANSECTS AND PLOTS*

*MAURICE RIVER TOWNSHIP*
*CUMBERLAND COUNTY, NEW JERSEY*

| | | |
|---|---|---|
| CADD JL | DATE MAY 9, 2004 | SCALE AS SHOWN |
| FILE 03_MB_TRA | CHECKED RLH | EXAMINED RLH |




**PSEG**

ESTUARY ENHANCEMENT PROGRAM

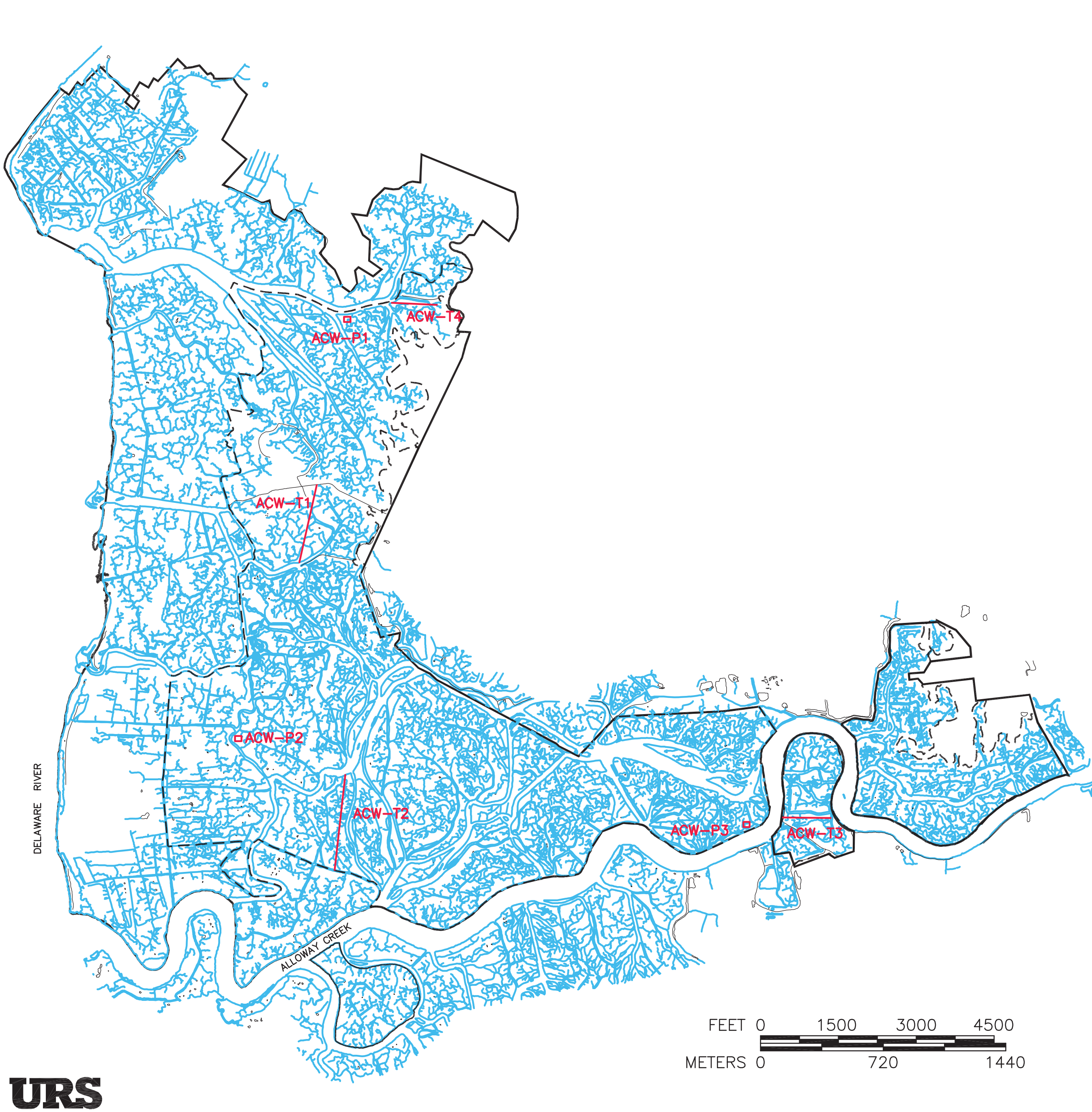
*Figure 8–4*

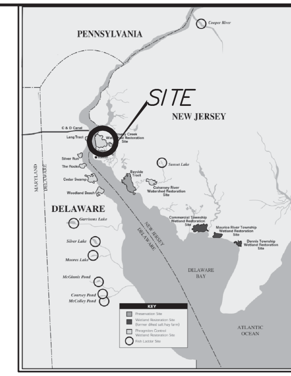
*COMMERCIAL TOWNSHIP*
*SALT HAY FARM*
*WETLAND RESTORATION SITE*

*2003 VEGETATION MONITORING*
*TRANSECTS AND PLOTS*

*COMMERCIAL TOWNSHIP*
*CUMBERLAND COUNTY, NEW JERSEY*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 05, 2004 | SCALE | AS SHOWN |
| FILE | 03_CT_TRA | CHECKED | KTK | EXAMINED | RLH |




## LEGEND

- SITE BOUNDARY
- WETLAND RESTORATION AREA BOUNDARY
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS
- TRANSECT
- 60 x 60m PLOT

## NOTE:

**ACWT1** ALLOWAY CREEK WATERSHED TRANSECT 1
**ACWT2** ALLOWAY CREEK WATERSHED TRANSECT 2
**ACWT3** ALLOWAY CREEK WATERSHED TRANSECT 3
**ACWT4** ALLOWAY CREEK WATERSHED TRANSECT 4
**ACWP1** ALLOWAY CREEK WATERSHED VEGETATION PLOT 1
**ACWP2** ALLOWAY CREEK WATERSHED VEGETATION PLOT 2
**ACWP3** ALLOWAY CREEK WATERSHED VEGETATION PLOT 3

URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

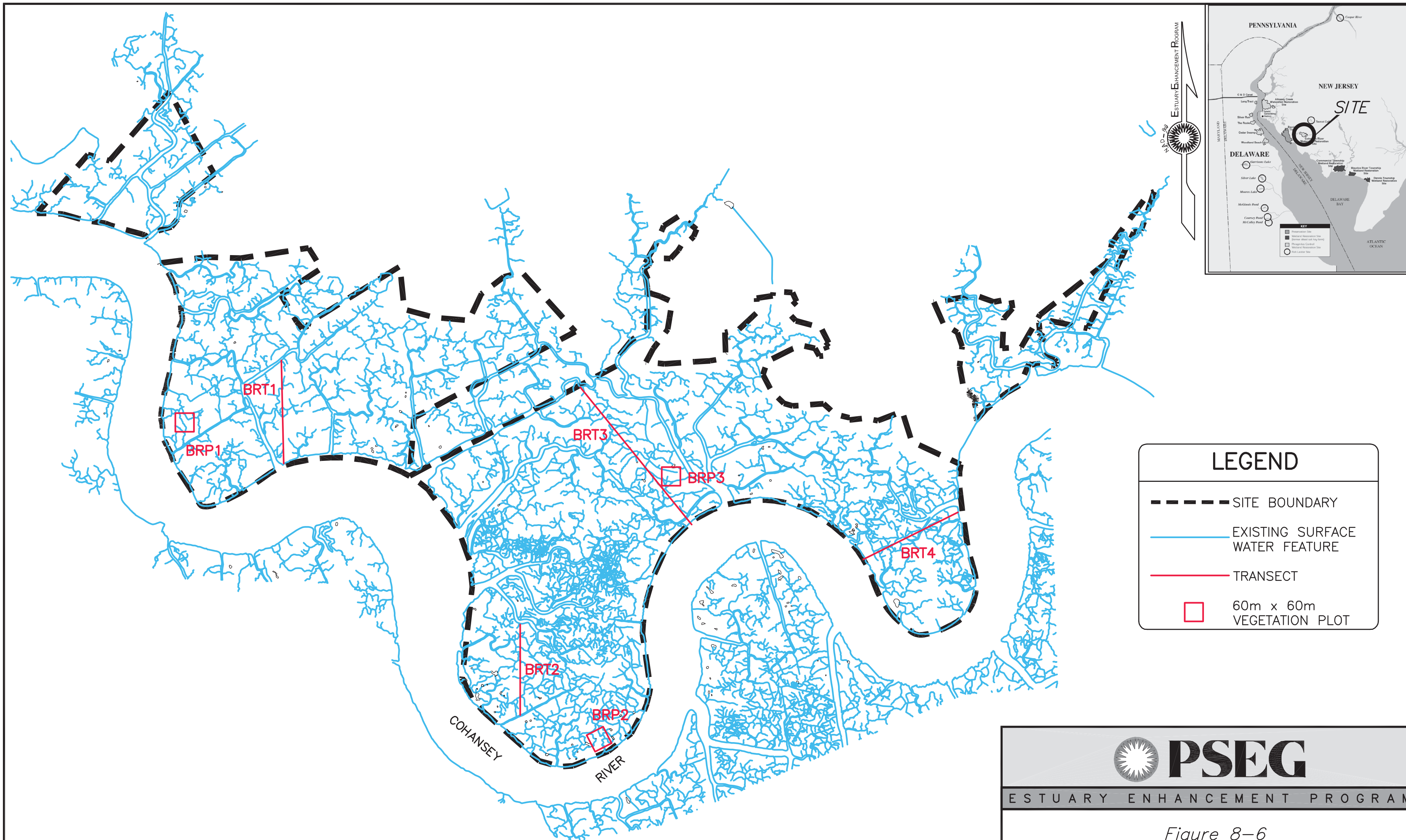
*Figure 8–5*

ALLOWAY CREEK SITE
WATERSHED WETLAND RESTORATION SITE

2003 VEGETATION MONITORING
TRANSECTS AND PLOTS

ELSINBORO TOWNSHIP
SALEM COUNTY, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 5, 2004 | SCALE | AS SHOWN |
| FILE | 03 ACW TRA | CHECKED | RLH | EXAMINED | RLH |




## NOTE:

BRT1 BROWNS RUN VEGETATION TRANSECT 1
BRT2 BROWNS RUN VEGETATION TRANSECT 2
BRT3 BROWNS RUN VEGETATION TRANSECT 3
BRT4 BROWNS RUN VEGETATION TRANSECT 4
BRP1 BROWNS RUN VEGETATION PLOT 1
BRP2 BROWNS RUN VEGETATION PLOT 2
BRP3 BROWNS RUN VEGETATION PLOT 3

FEET 0 750 1500 2250
METERS 0 360 720

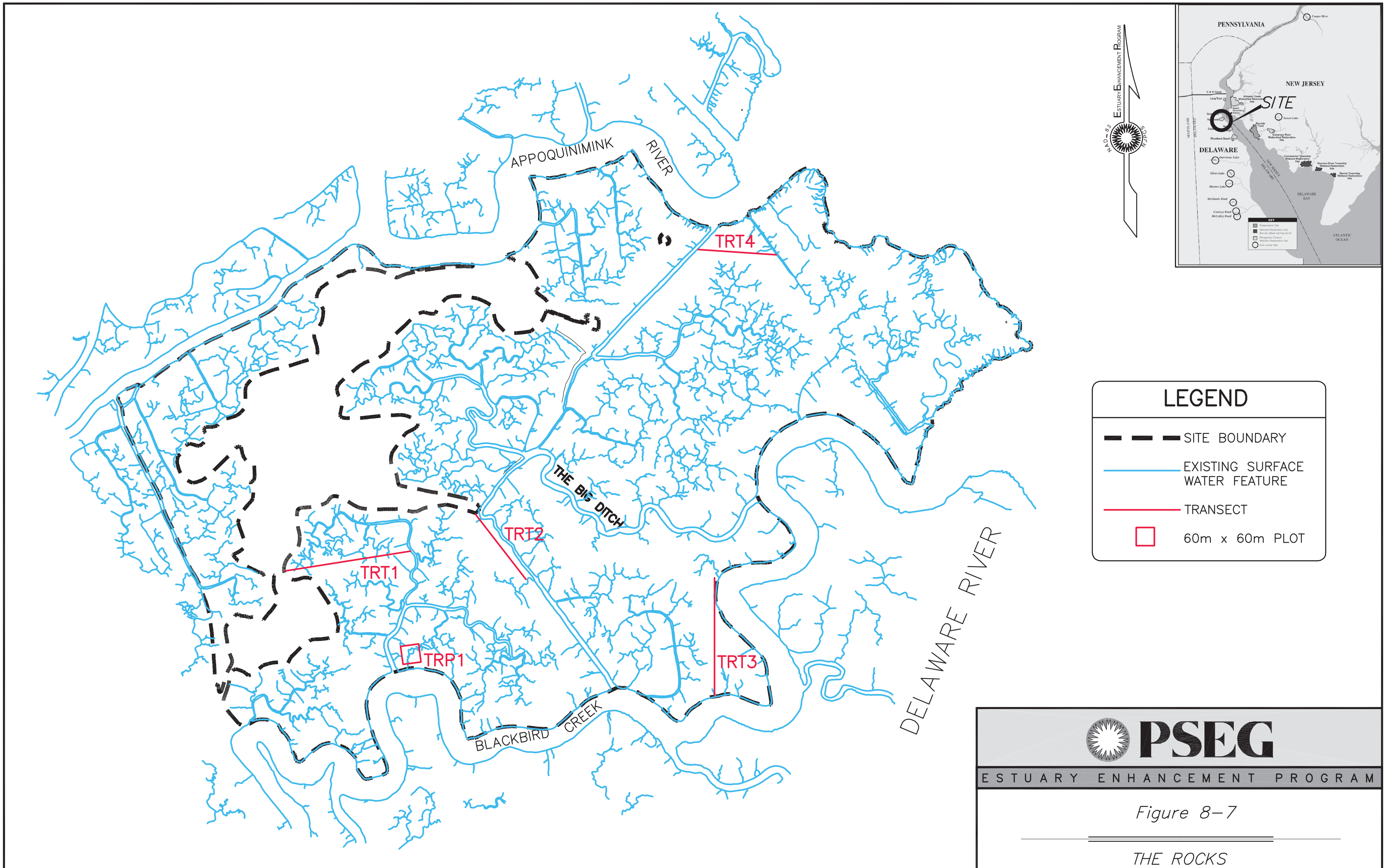
URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

Figure 8–6

BROWNS RUN AREA – COHANSEY RIVER WATERSHED WETLAND RESTORATION SITE
2003 VEGETATION MONITORING TRANSECTS AND PLOTS
HOPEWELL TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

CADD JL DATE MAY 05, 2004 SCALE AS SHOWN
FILE 03_BR_TRA CHECKED RLH EXAMINED RLH




NOTE:

TRT1 THE ROCKS VEGETATION TRANSECT 1
TRT2 THE ROCKS VEGETATION TRANSECT 2
TRT3 THE ROCKS VEGETATION TRANSECT 3
TRT4 THE ROCKS VEGETATION TRANSECT 4
TRP1 THE ROCKS VEGETATION PLOT 1

URS

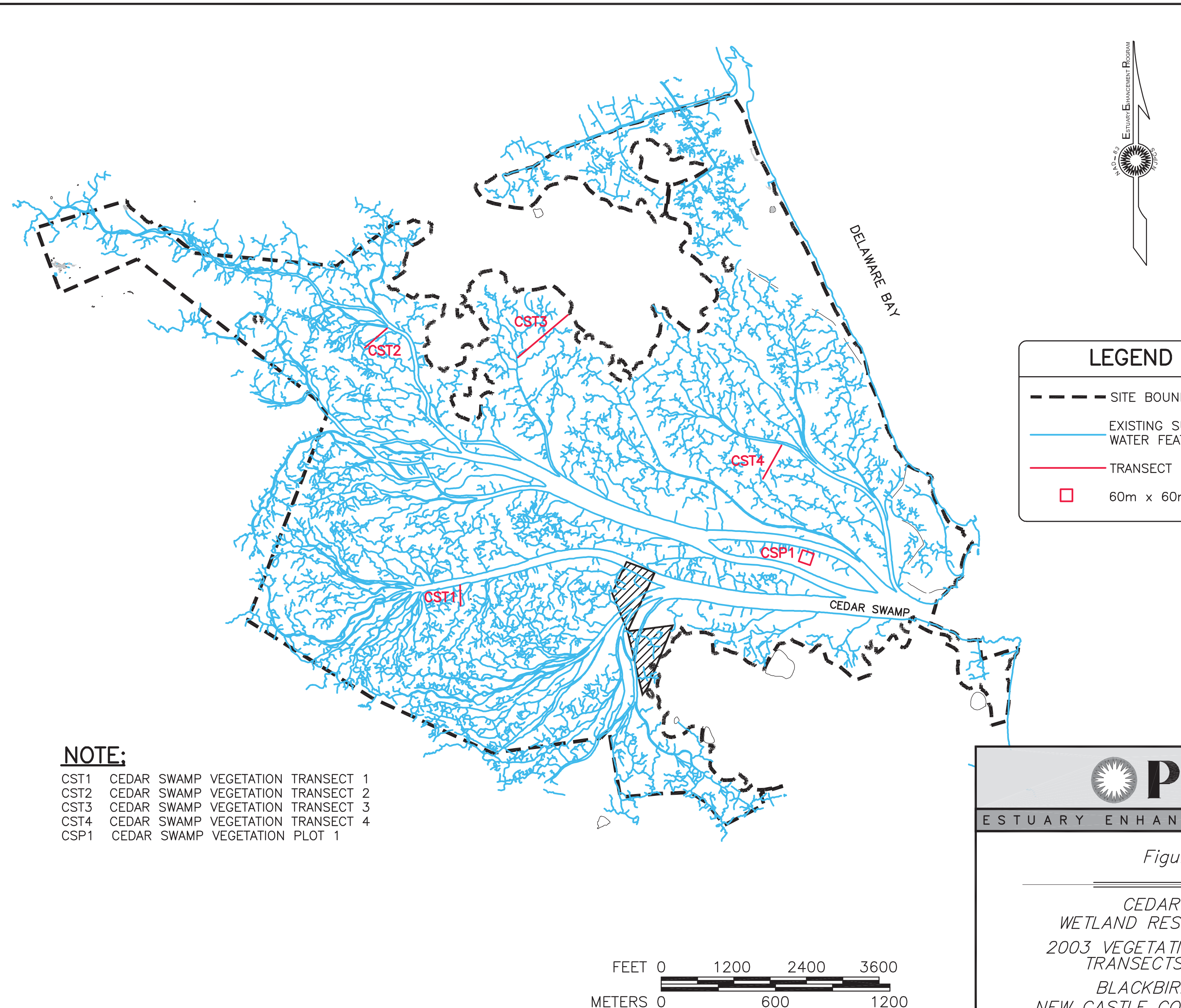
PSEG

ESTUARY ENHANCEMENT PROGRAM

Figure 8–7

THE ROCKS
WETLAND RESTORATION SITE
2003 VEGETATION MONITORING
TRANSECTS AND PLOT
APPOQUINIMINK HUNDRED
NEW CASTLE COUNTY, DELAWARE

CADD JL DATE MAY 11, 204 SCALE AS SHOWN
FILE 03_TR_TRA CHECKED RLH EXAMINED RLH




NOTE:

CST1 CEDAR SWAMP VEGETATION TRANSECT 1
CST2 CEDAR SWAMP VEGETATION TRANSECT 2
CST3 CEDAR SWAMP VEGETATION TRANSECT 3
CST4 CEDAR SWAMP VEGETATION TRANSECT 4
CSP1 CEDAR SWAMP VEGETATION PLOT 1

URS

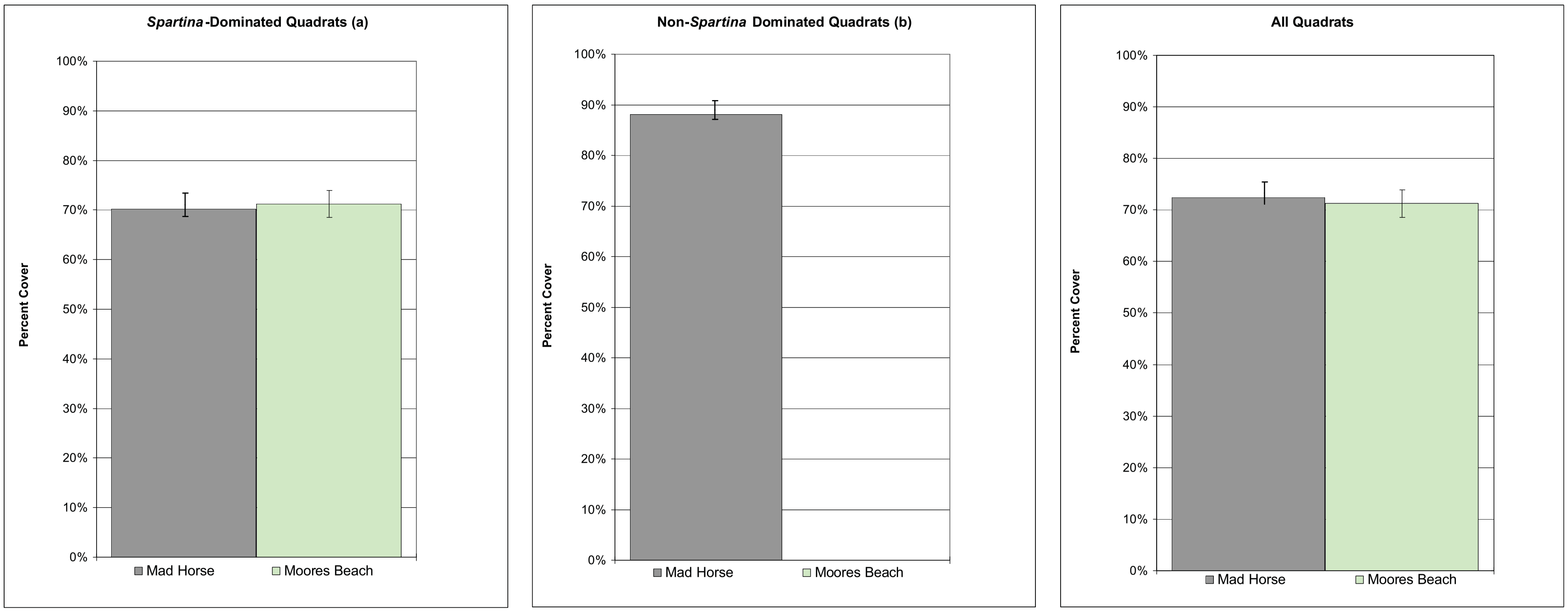
PSEG
ESTUARY ENHANCEMENT PROGRAM

Figure 8–8

CEDAR SWAMP
WETLAND RESTORATION SITE
2003 VEGETATION MONITORING
TRANSECTS AND PLOT
BLACKBIRD HUNDRED
NEW CASTLE COUNTY, DELAWARE

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 5, 2004 | SCALE | AS SHOWN |
| FILE | 03_CS-TRA | CHECKED | RLH | EXAMINED | RLH |

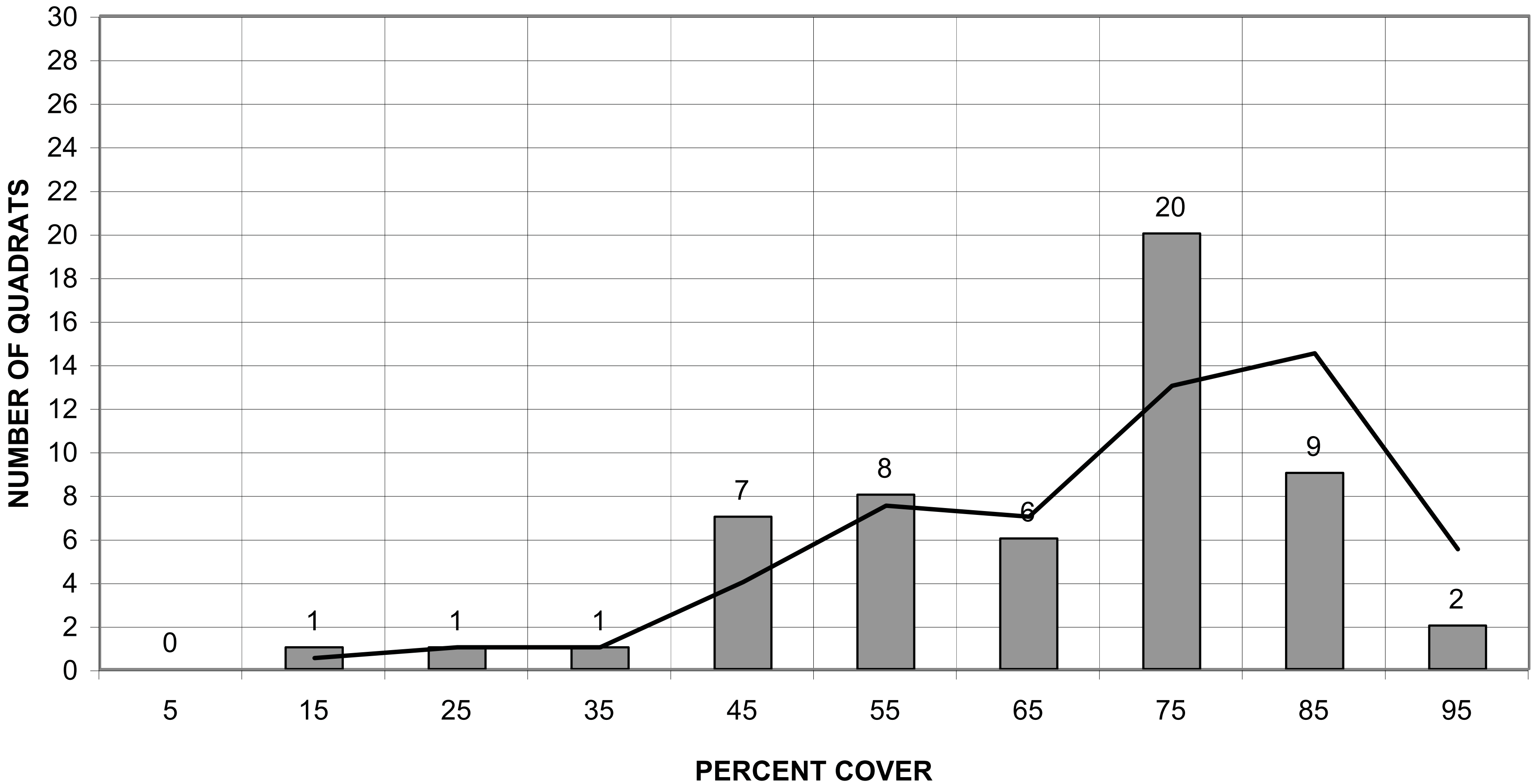
**FIGURE 8-9**
**MEAN PERCENT COVER**
**2003 REFERENCE MARSH TRANSECT DATA**




(a) Also includes *Spartina cynosuroides* dominated quadrats, when present.
(b) Includes quadrats dominated by *Spartina patens* , if present.
Error bar represents +/- one Standard Error of the Mean.

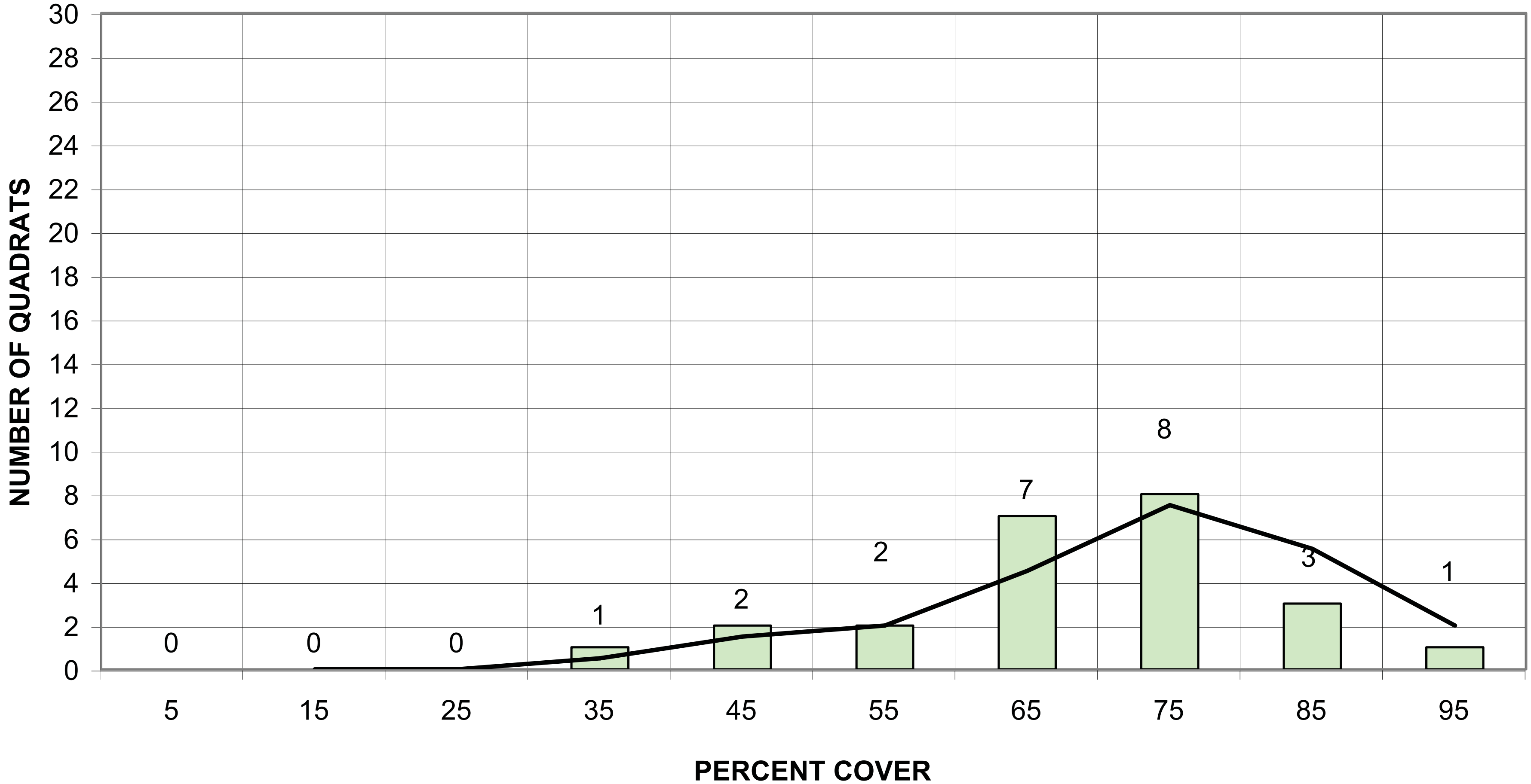
MH = Mad Horse Creek Reference Marsh
MB = Moores Beach Reference Marsh

**FIGURE 8-10**
**2003 PERCENT COVER GROUPINGS**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**MAD HORSE CREEK REFERENCE MARSH TRANSECTS**



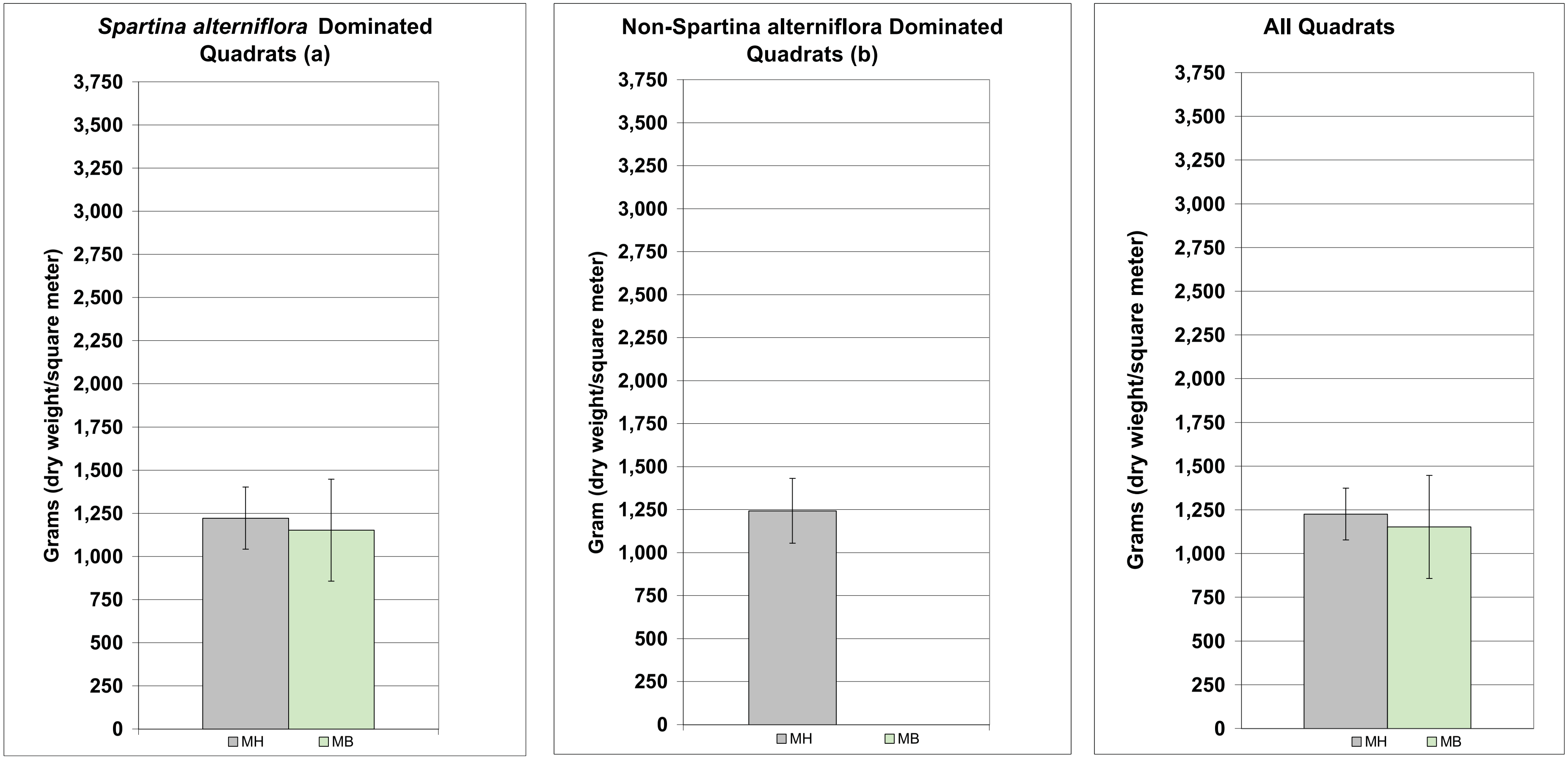

(a) Includes *S. cynosuroides* dominated quadrats, when present.

**FIGURE 8-11**
**2003 PERCENT COVER GROUPINGS**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**MOORES BEACH REFERENCE MARSH TRANSECTS**




(a) Includes *S. cynosuroides* dominated quadrats, when present.

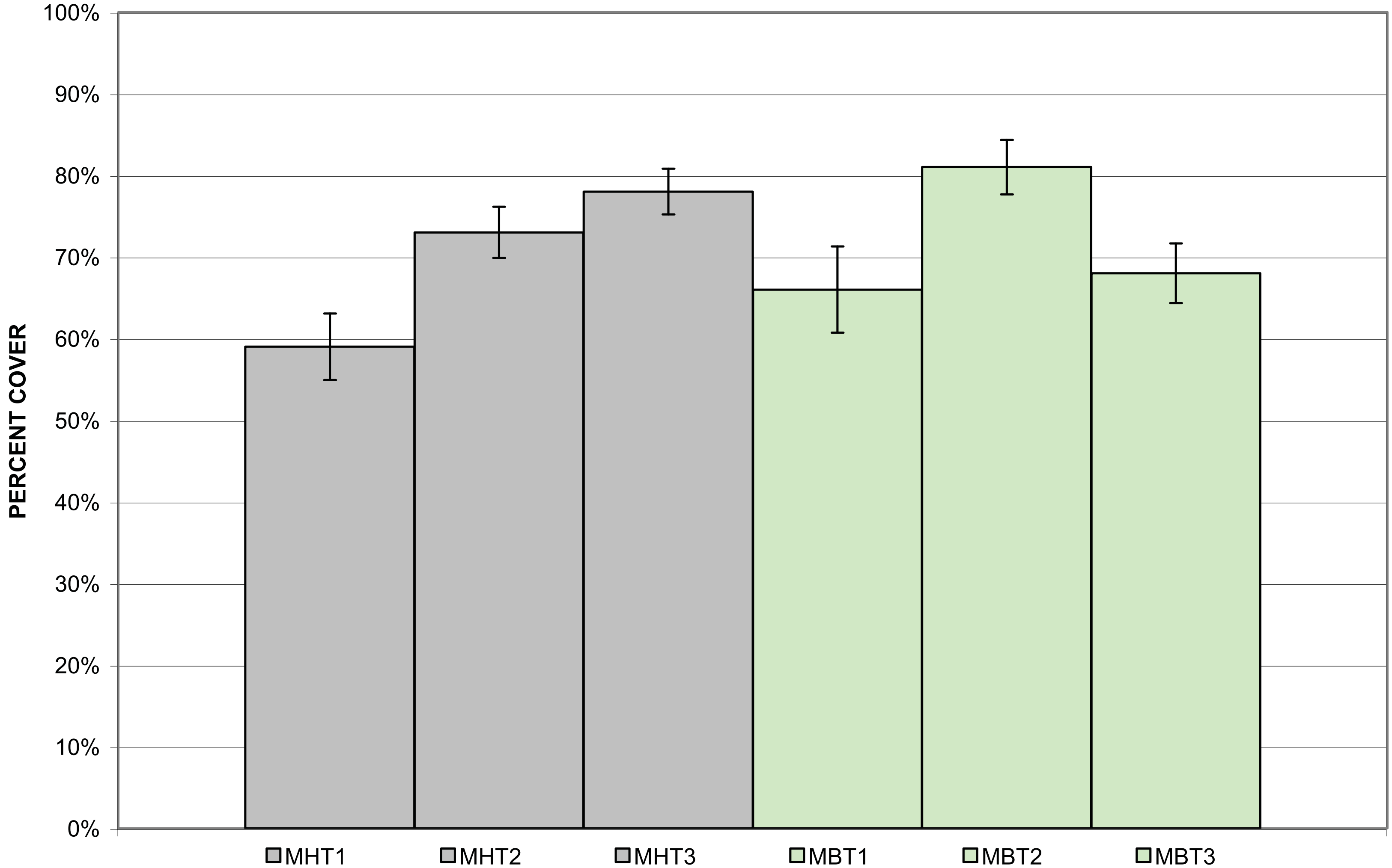
**Figure 8-12**
**Mean Live Standing Crop**
**2003 Reference Marsh Transect Data**




(a) Also includes *Spartina cynosuroides* dominated quadrats, when present.
(b) Includes quadrats dominated by *Spartina patens* , if present.
Error bar represents +/- one Standard Error of the Mean.

MH = Mad Horse Creek Reference Marsh
MB = Moores Beach Reference Marsh

**FIGURE 8-13**
**2003 MEAN PERCENT COVER by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**REFERENCE MARSHES**

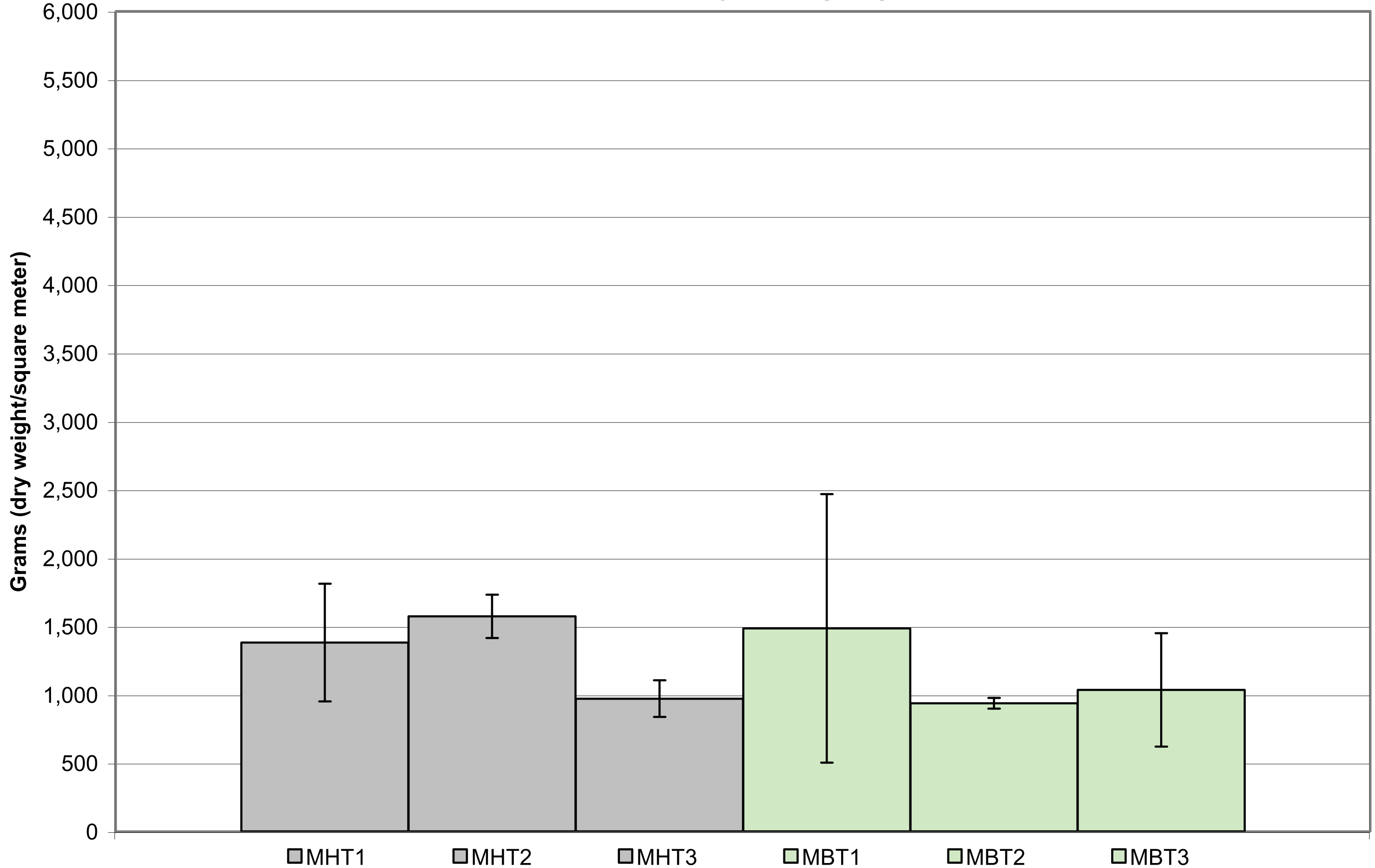



(a) Includes *S. cynosuroides* dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

MH = Mad Horse
MB = Moores Beach

T1 = Transect 1

**FIGURE 8-14**
**2003 MEAN LIVE STANDING CROP by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**REFERENCE MARSHES**

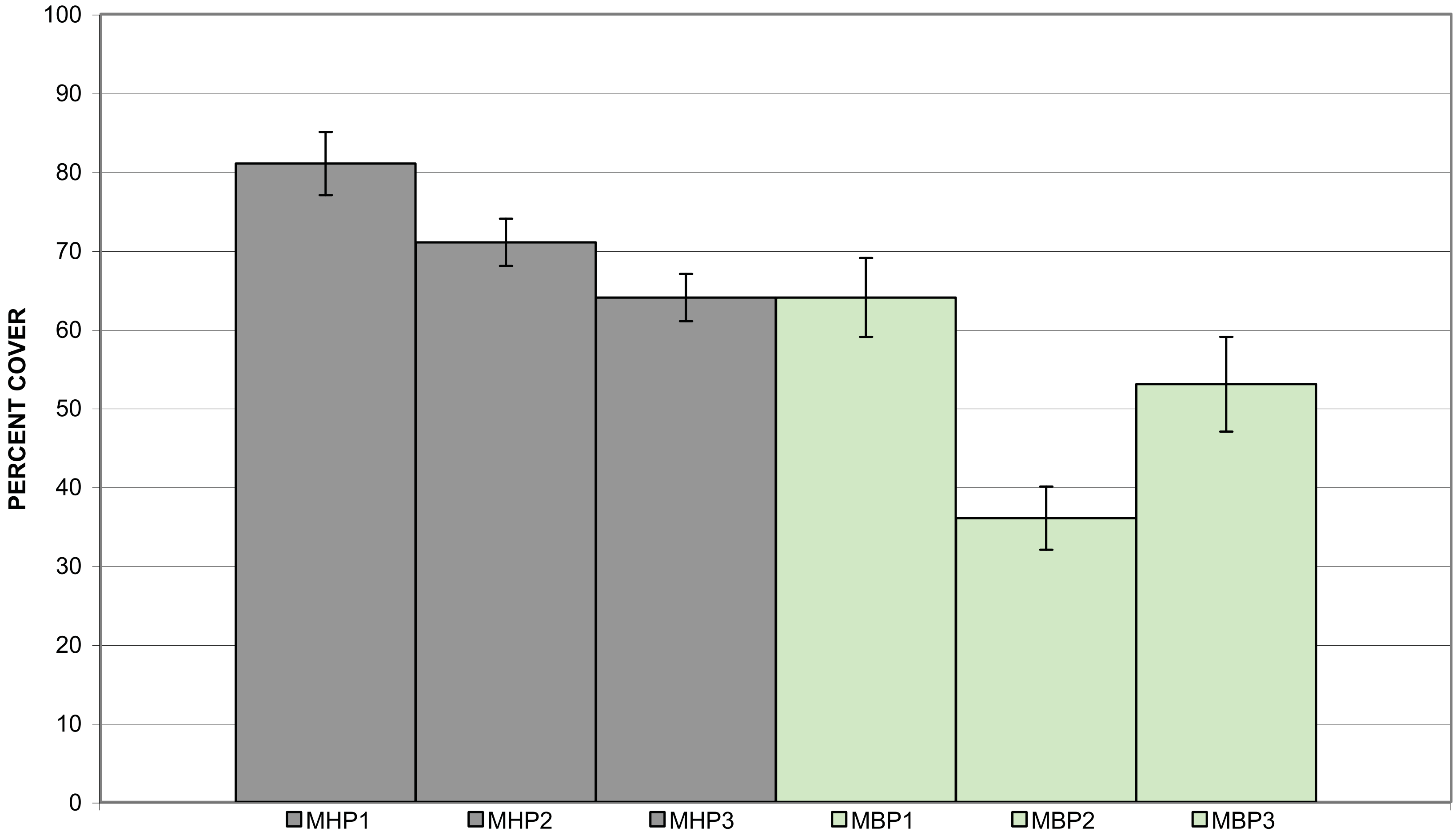



(a) Includes *S. cynosuroides* dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

MH = Mad Horse
MB = Moores Beach

T1 = Transect 1

**FIGURE 8-15**
**2003 MEAN PERCENT COVER**
***SPARTINA* - DOMINATED 60x60 METER PLOTS (a)**
**REFERENCE MARSHES**

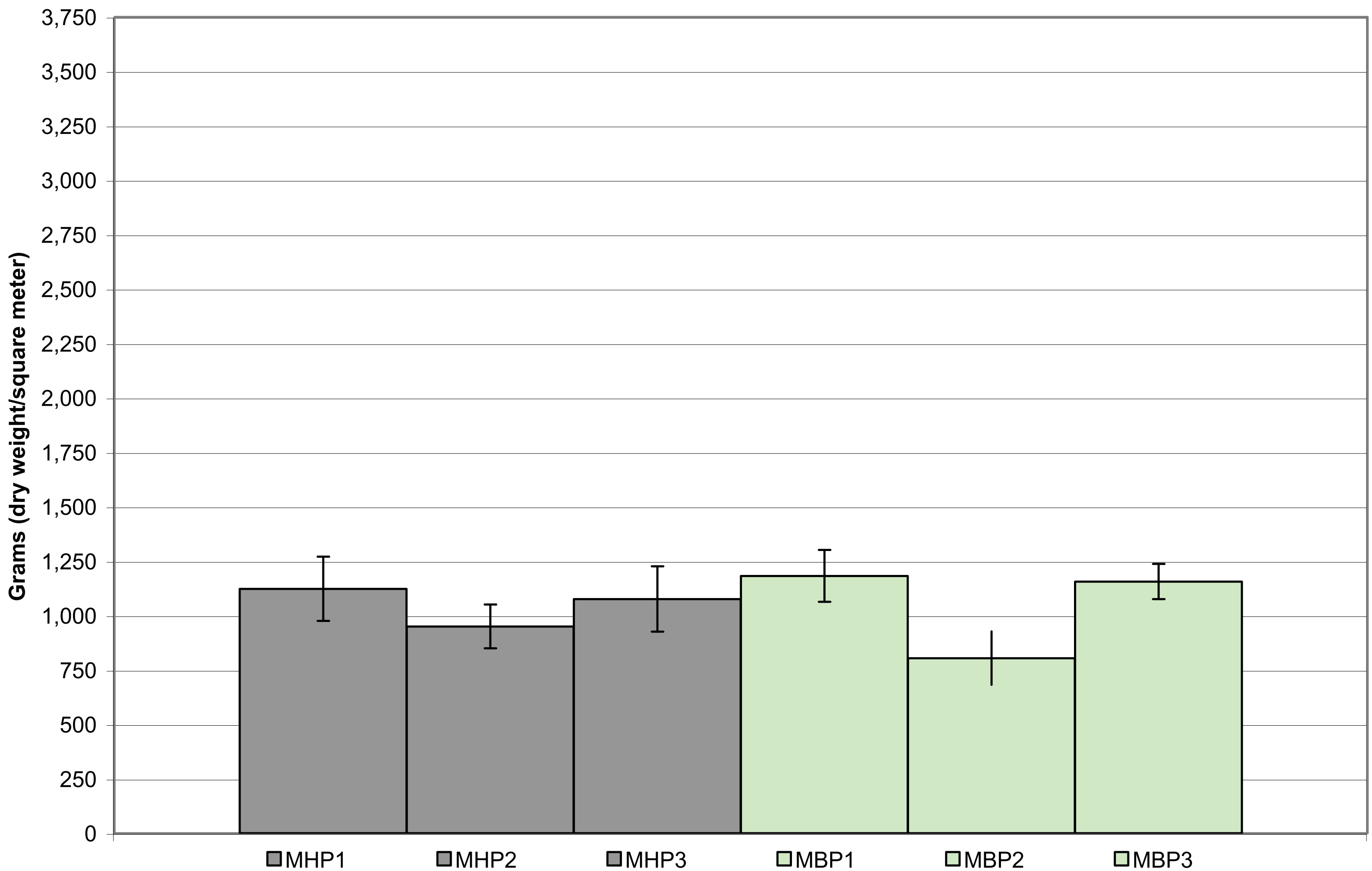



(a) Includes *S. cynosuroides* dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

MH = Mad Horse
MB = Moores Beach

P1 = Plot 1

**FIGURE 8-16**
**2003 MEAN LIVE STANDING CROP**
***SPARTINA* - DOMINATED 60x60 METER PLOTS (a)**
**REFERENCE MARSHES**

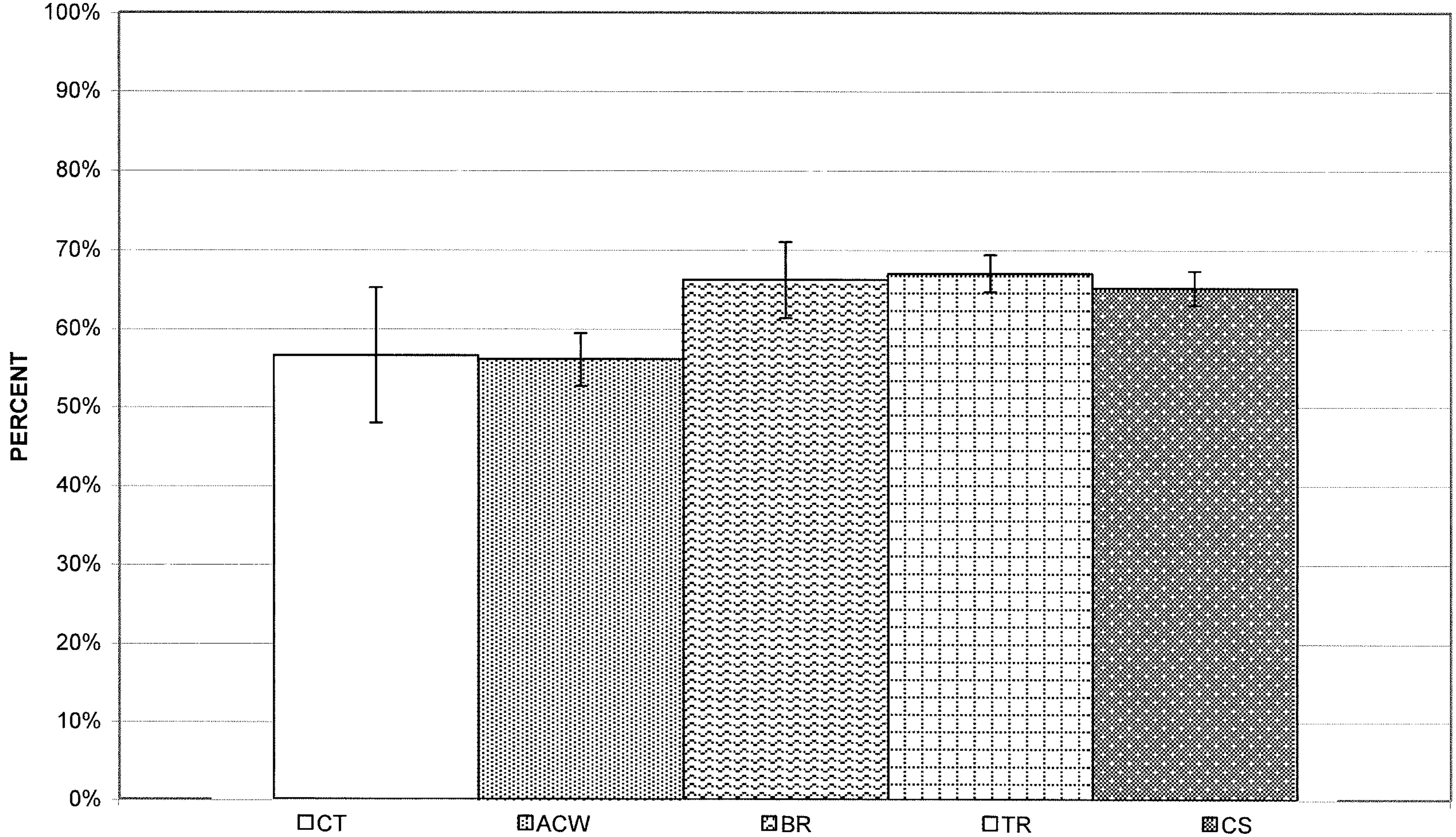



(a) Includes S. cynosuroides dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

MH = Mad Horse
MB = Moores Beach

P1 = Plot 1

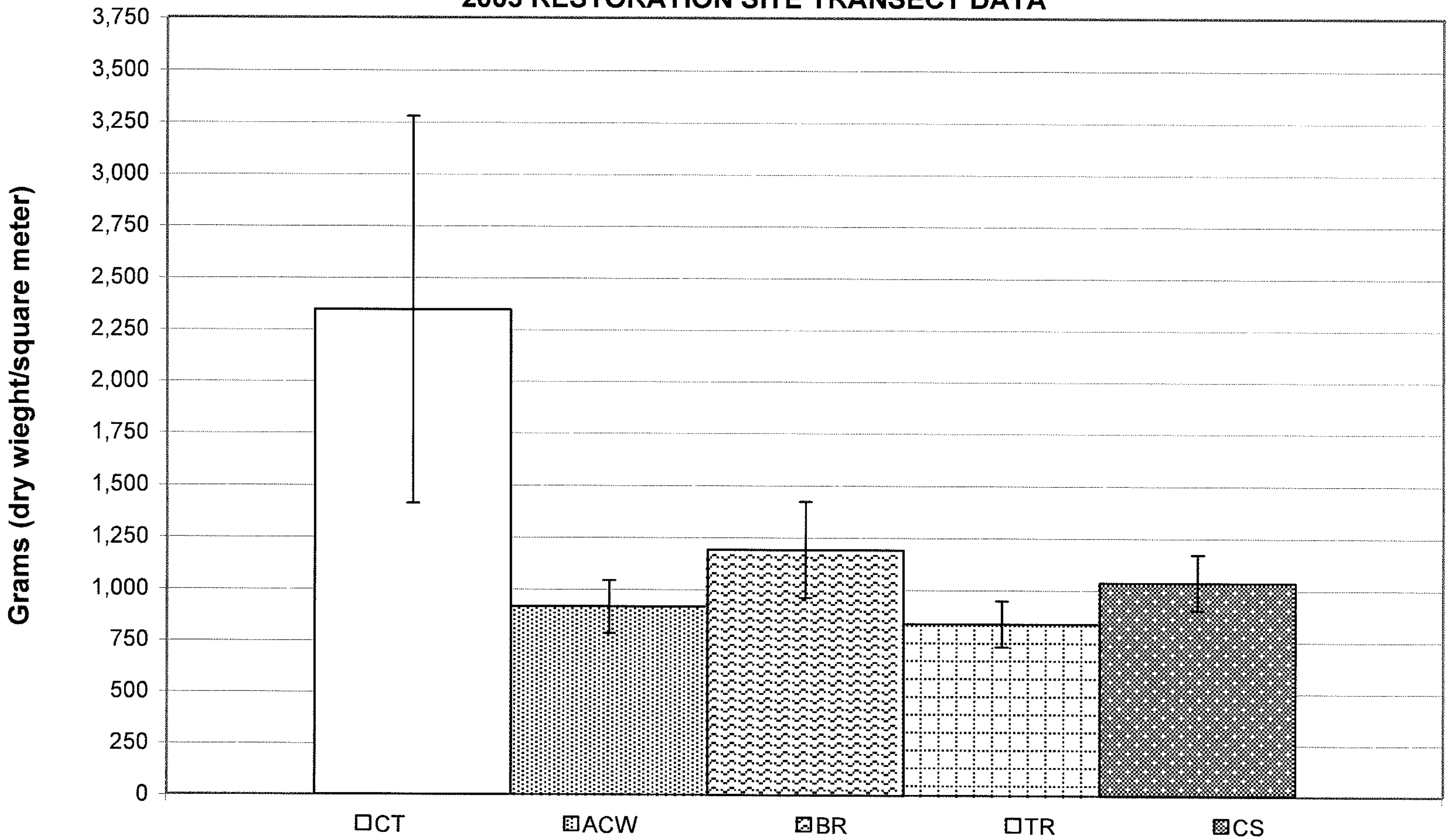
**FIGURE 8-17**
**MEAN PERCENT COVER**
**2003 RESTORATION SITE TRANSECT DATA**




CT=Commercial Township
MR=Maurice River
ACW = Alloway Creek Watershed
TR = The Rocks
CS = Cedar Swamp
BR = Browns Run-
(Cohansey River Site)

- Error bar represents +/- one Standard Error of the Mean.

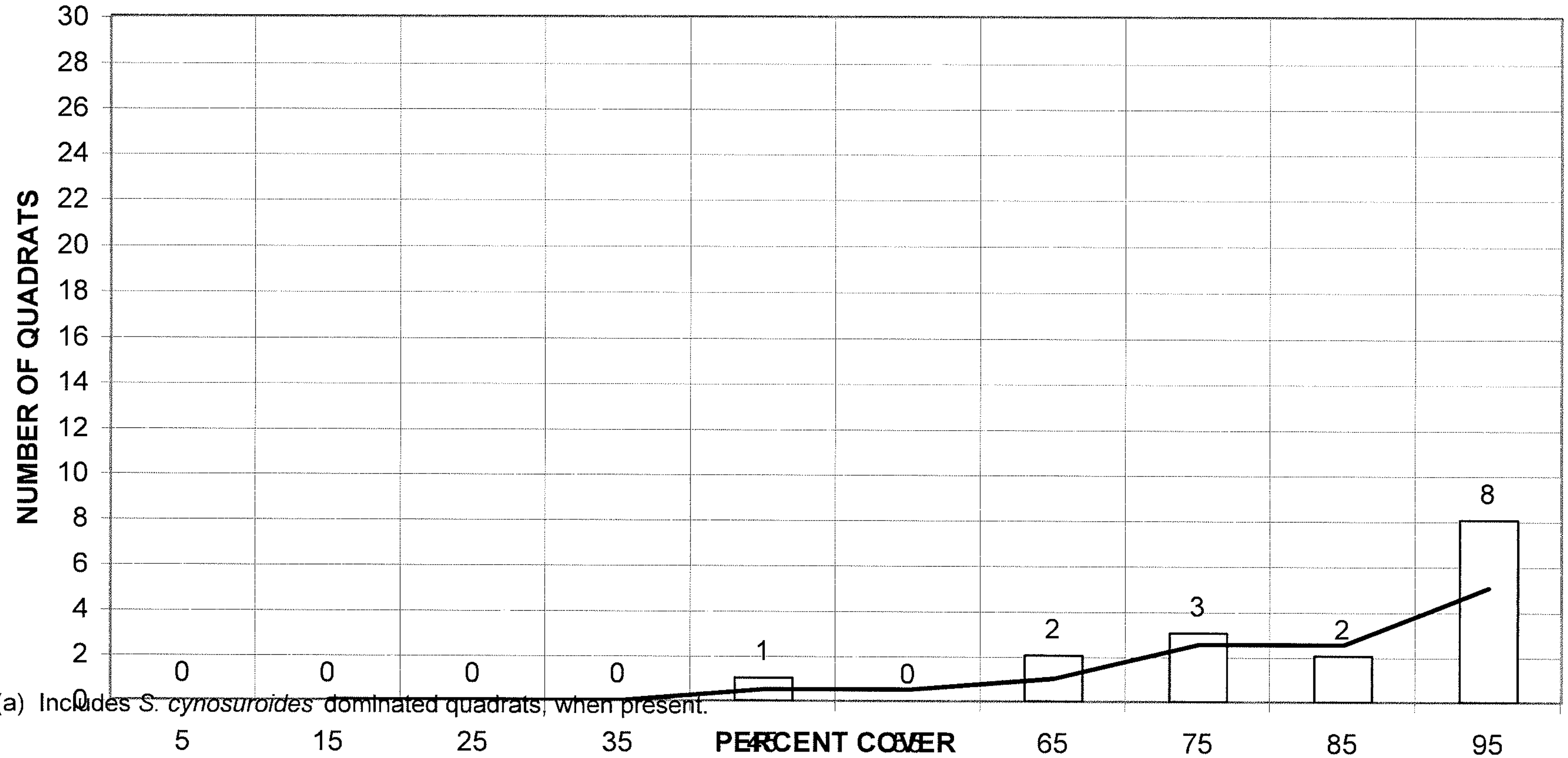
## FIGURE 8-18
## MEAN LIVE STANDING CROP
## 2003 RESTORATION SITE TRANSECT DATA




CT=Commercial Township
MR=Maurice River Site)
CS = Cedar Swamp
ACW=Alloway Creek Watershed
BR = Browns Run- (Cohansey River
TR = The Rocks

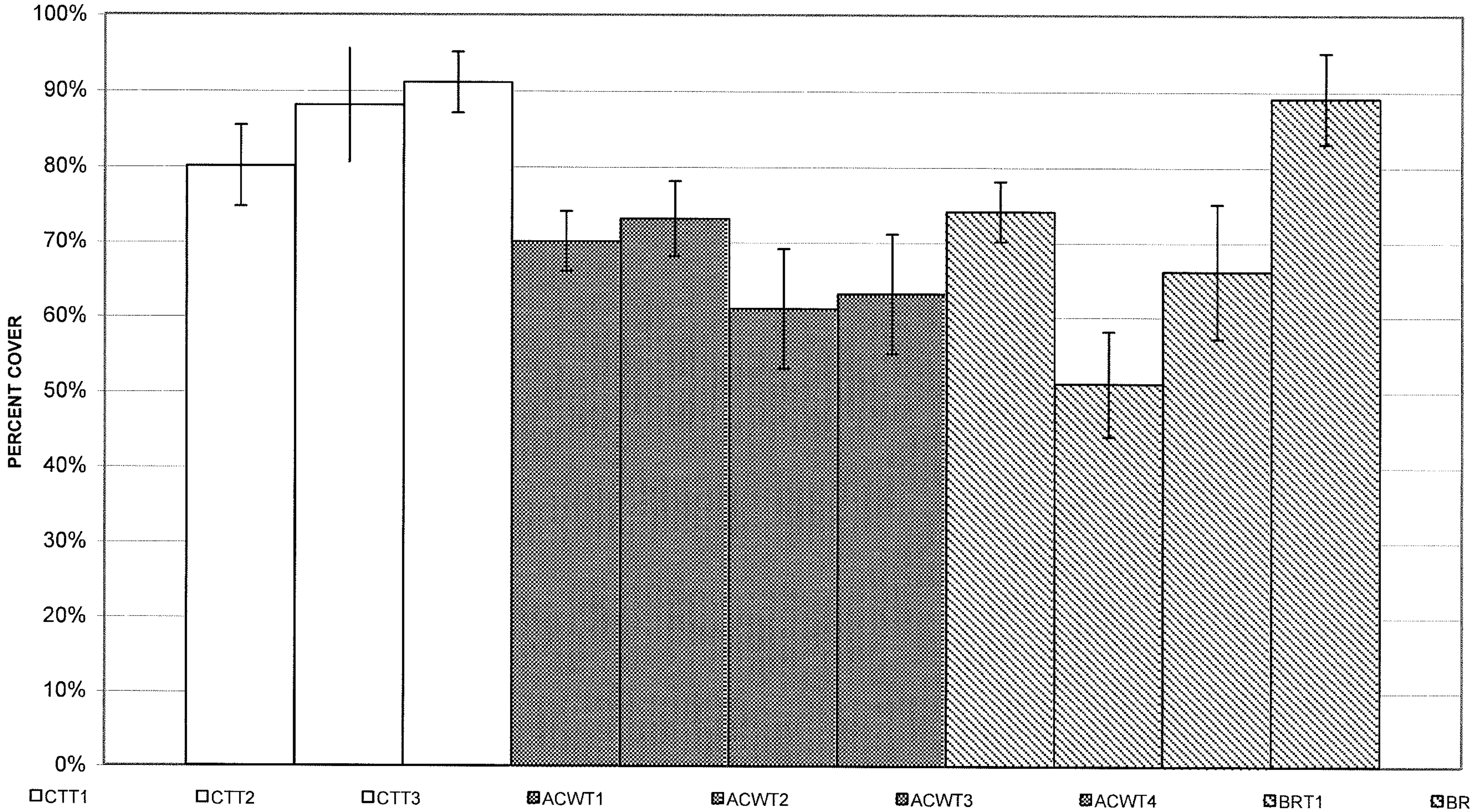
- Error bar represents +/- one Standard Error of the Mean.

**FIGURE 8-19**
**2003 PERCENT COVER GROUPINGS**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**COMMERCIAL TOWNSHIP RESTORATION SITE TRANSECTS**




(a) Includes *S. cynosuroides* dominated quadrats, when present.

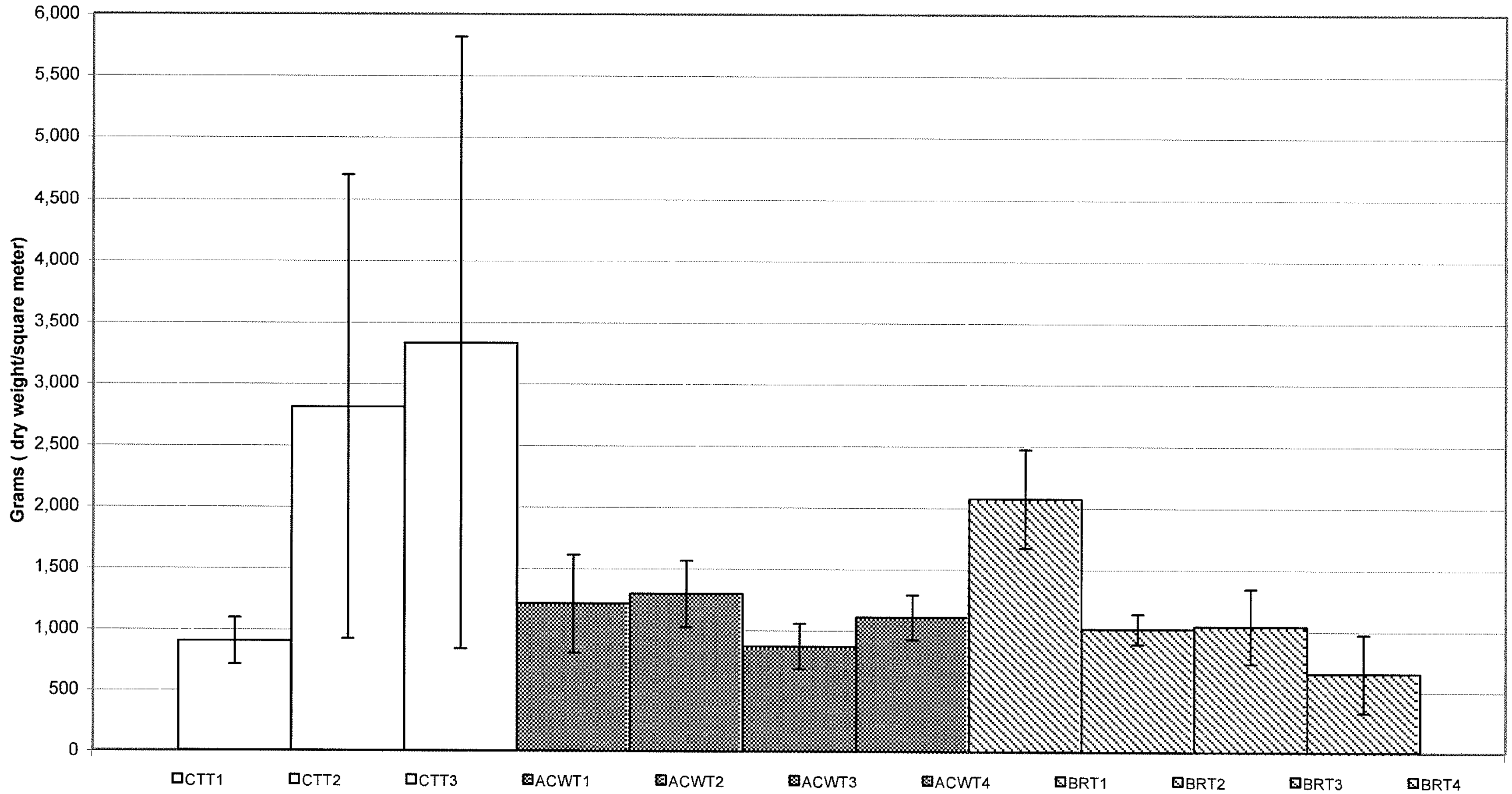
**FIGURE 8-20**
**2003 MEAN PERCENT COVER by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**NEW JERSEY WETLAND RESTORATION SITES**




(a) Includes *S. cynosuroides* dominated quadrats.
- Error bar represents +/- one Standard Error of the Mean.

CT = Commercial Township T1 = Transect 1
MRT = Maurice River Township
ACW =Alloway Creek Watershed
BR = Browns Run (Cohansey River Site)

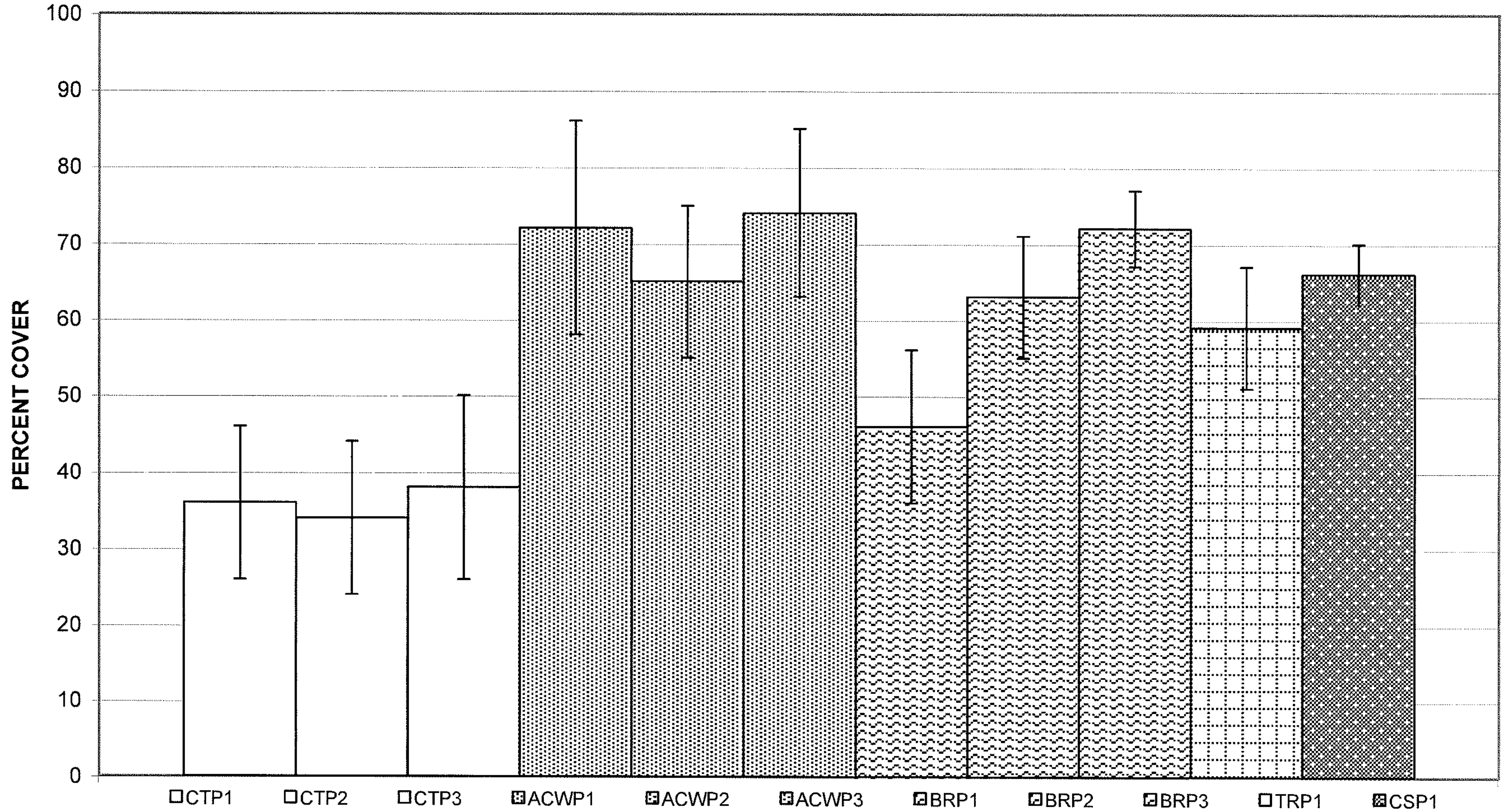
**FIGURE 8-21**
**2003 MEAN LIVE STANDING CROP by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**NEW JERSEY WETLAND RESTORATION SITES**




CT = Commercial Township T1 = Transect 1
MRT = Maurice River Township
ACW =Alloway Creek Watershed
BR = Browns Run (Cohansey River Site)

(a) Includes *S. cynosuroides* dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

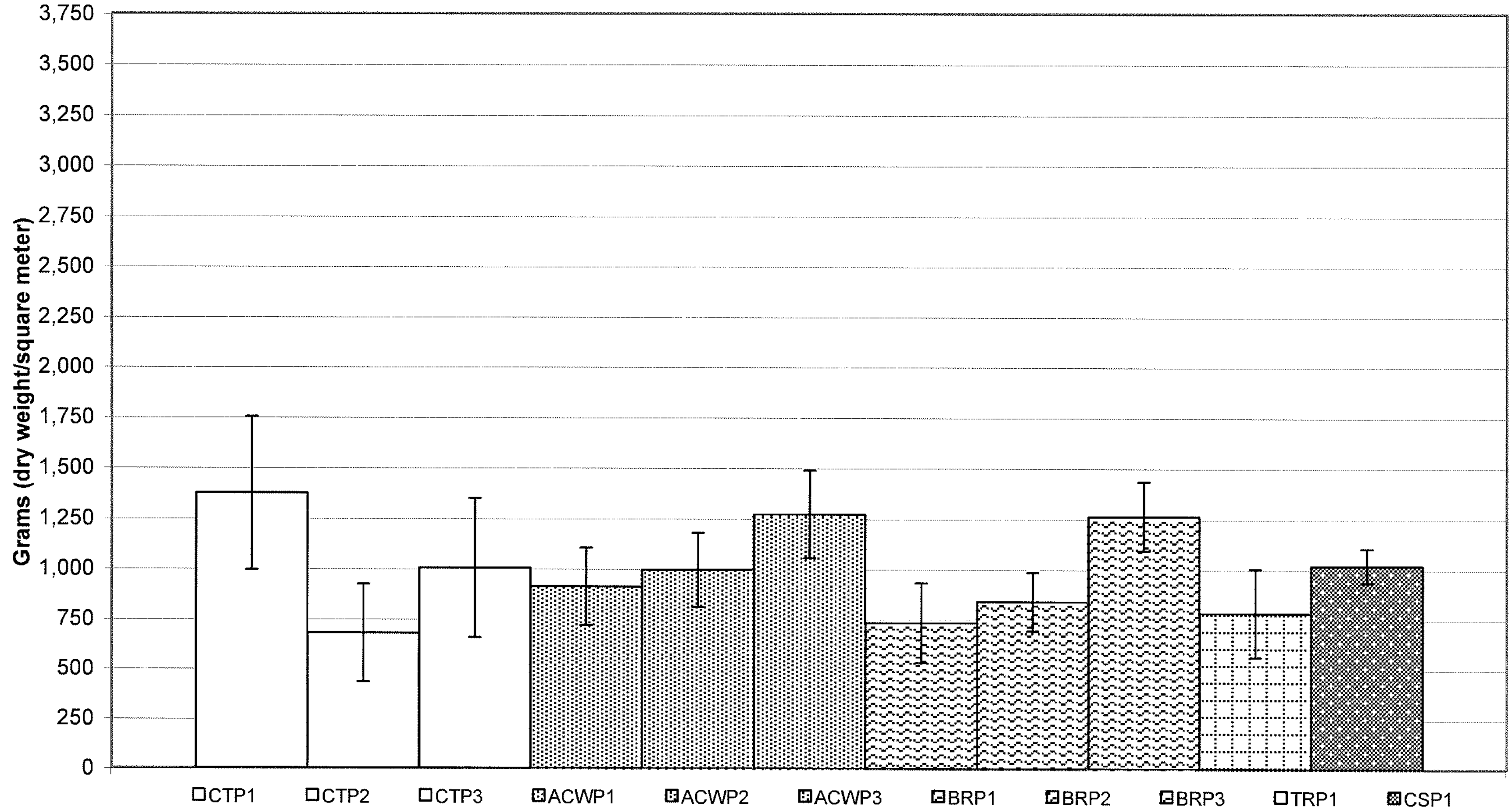
## FIGURE 8-22
## 2003 MEAN PERCENT COVER 60x60 METER PLOTS
## WETLAND RESTORATION SITES




CT=Commercial Township TR = The Rocks
CS = Cedar Swamp
ACW = Alloway Creek Watershed P1 = Plot 1
BR = Browns Run (Cohansey River Site)

Error bar represents +/- one Standard Error of the

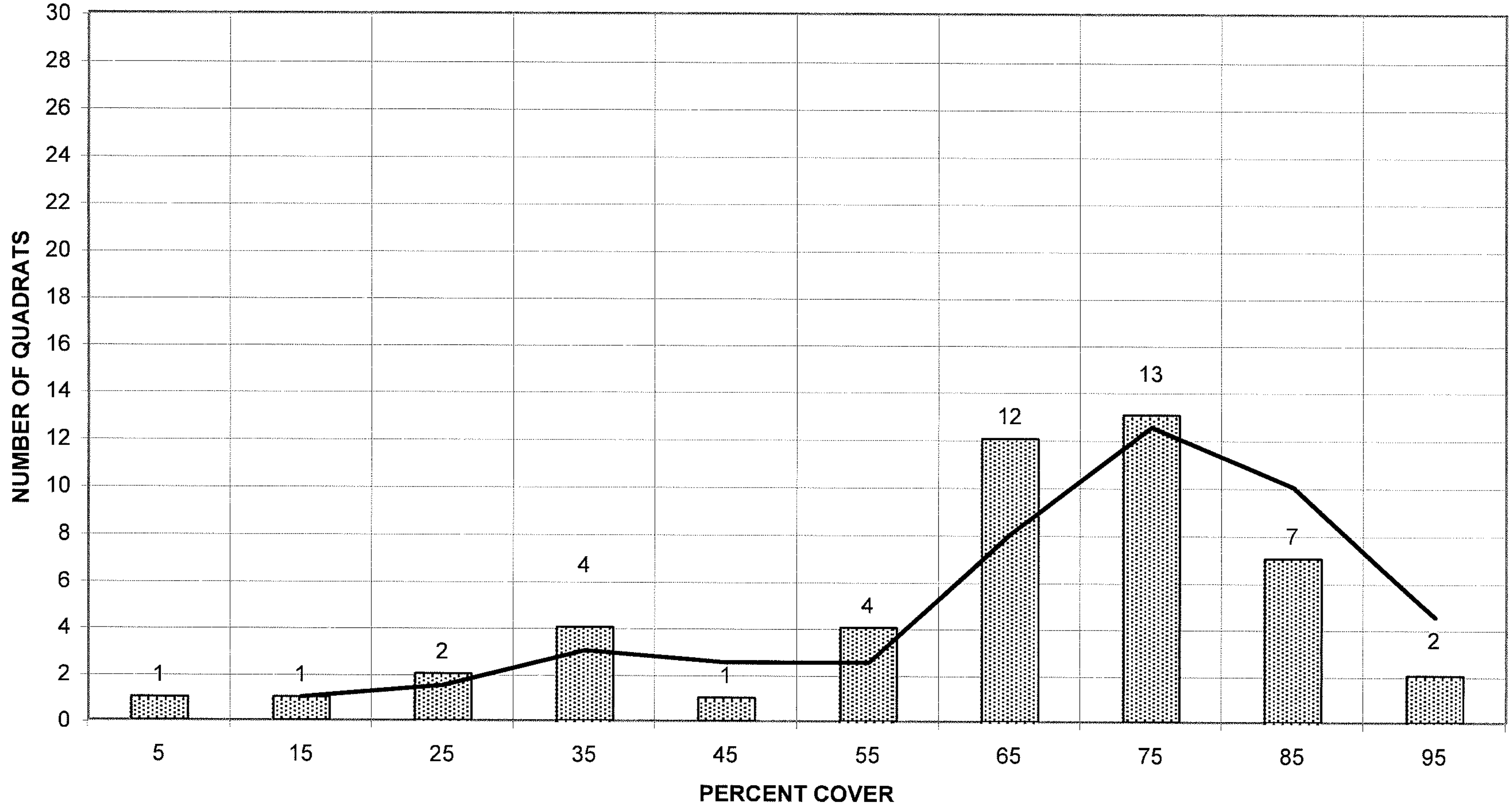
**FIGURE 8-23**
**2003 MEAN LIVE STANDING CROP 60x60 METER PLOTS**
**WETLAND RESTORATION SITES**




CT=Commercial Township TR = The Rocks
CS = Cedar Swamp
ACW = Alloway Creek Watershed P1 = Plot 1
BR = Browns Run (Cohansey River Site)

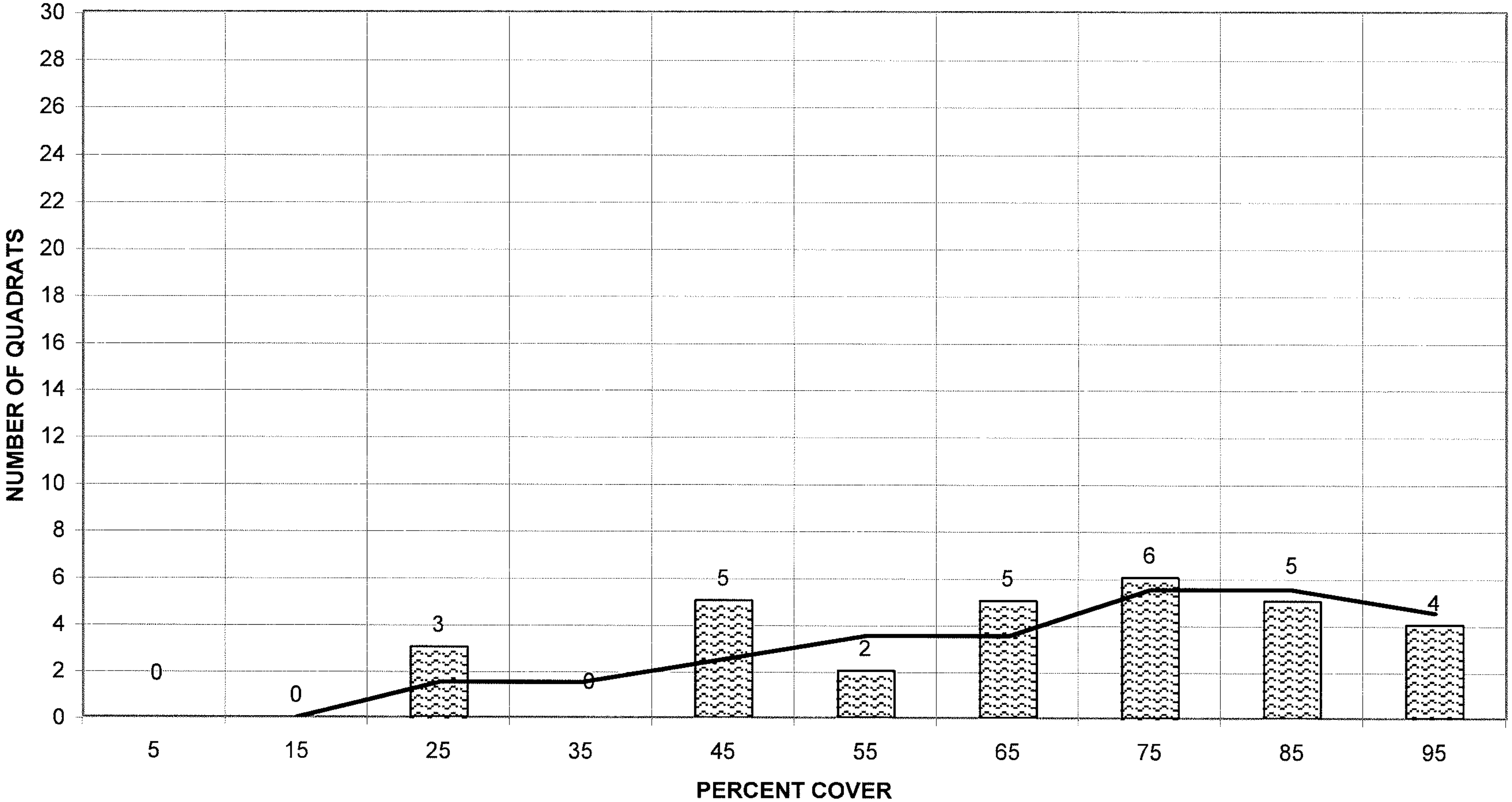
Error bar represents +/- one Standard Error of the

FIGURE 8-24
2003 PERCENT COVER GROUPINGS
*SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)
ALLOWAY CREEK WATERSHED RESTORATION AREA TRANSECTS



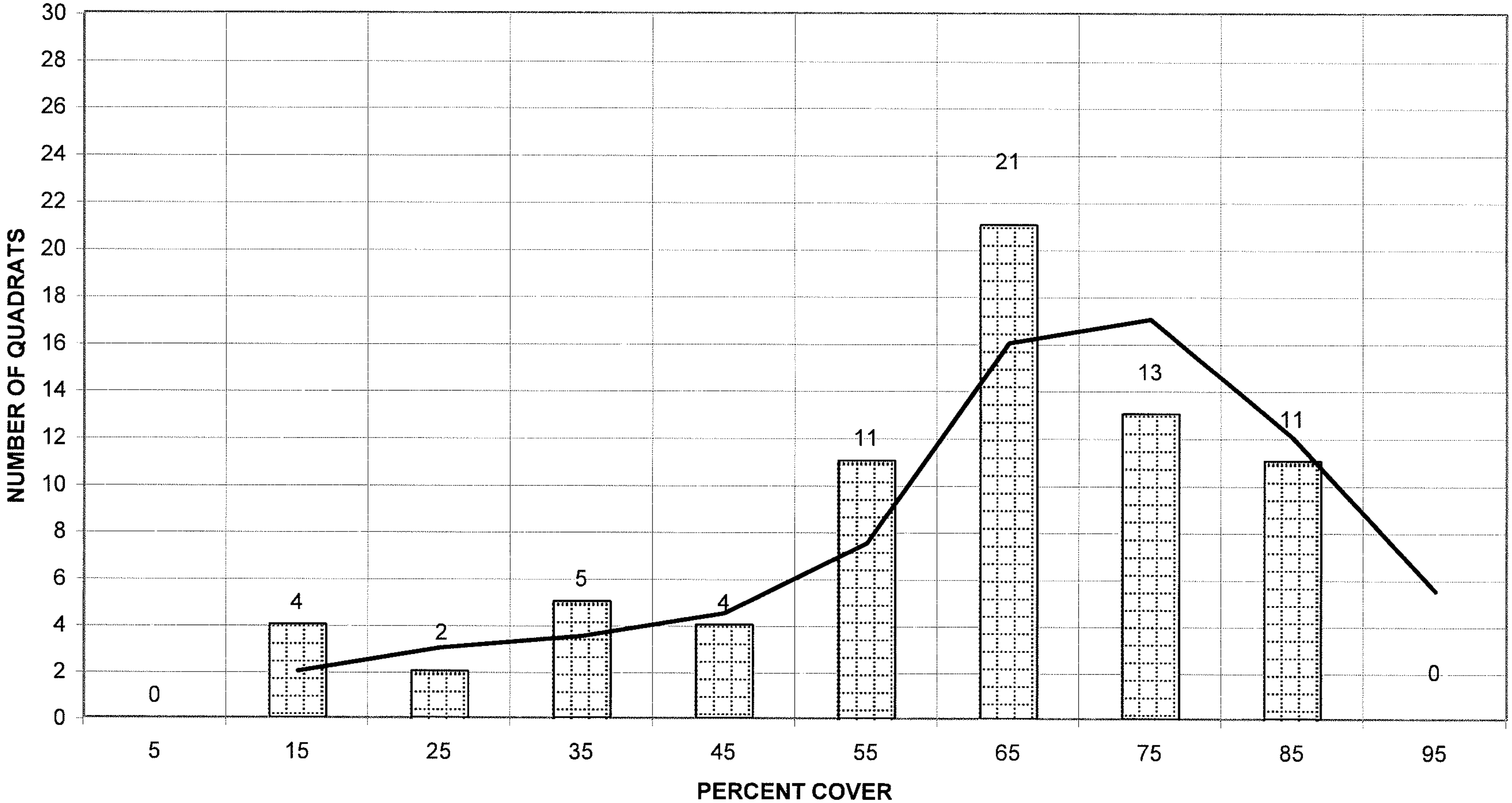

(a) Includes *S. cynosuroides* dominated quadrats, when present.

**FIGURE 8-25**
**2003 PERCENT COVER GROUPINGS**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**BROWNS RUN RESTORATION AREA TRANSECTS**



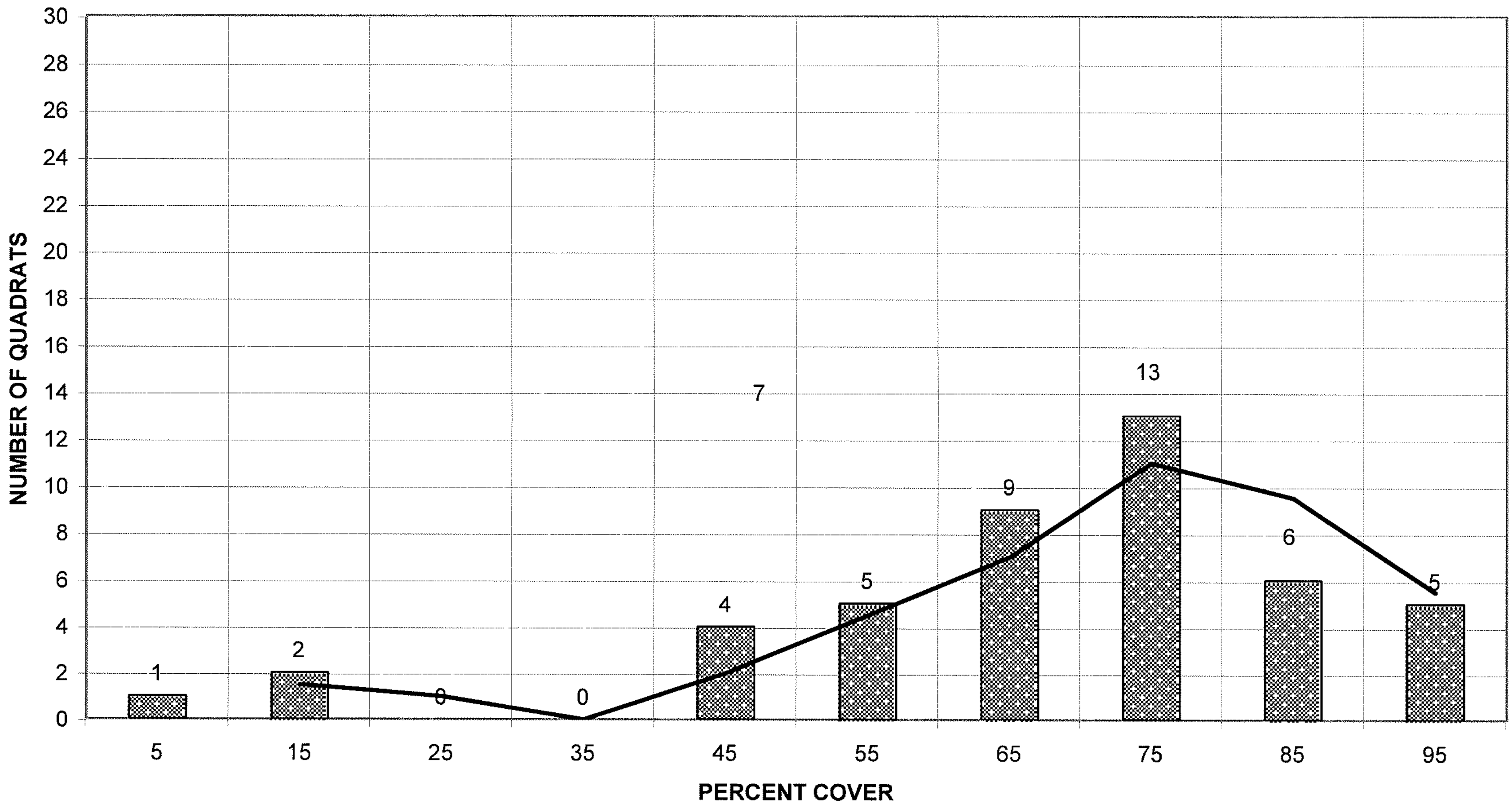

(a) Includes *S. cynosuroides* dominated quadrats, when present.

FIGURE 8-26
2003 PERCENT COVER GROUPINGS
*SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)
THE ROCKS RESTORATION SITE TRANSECTS



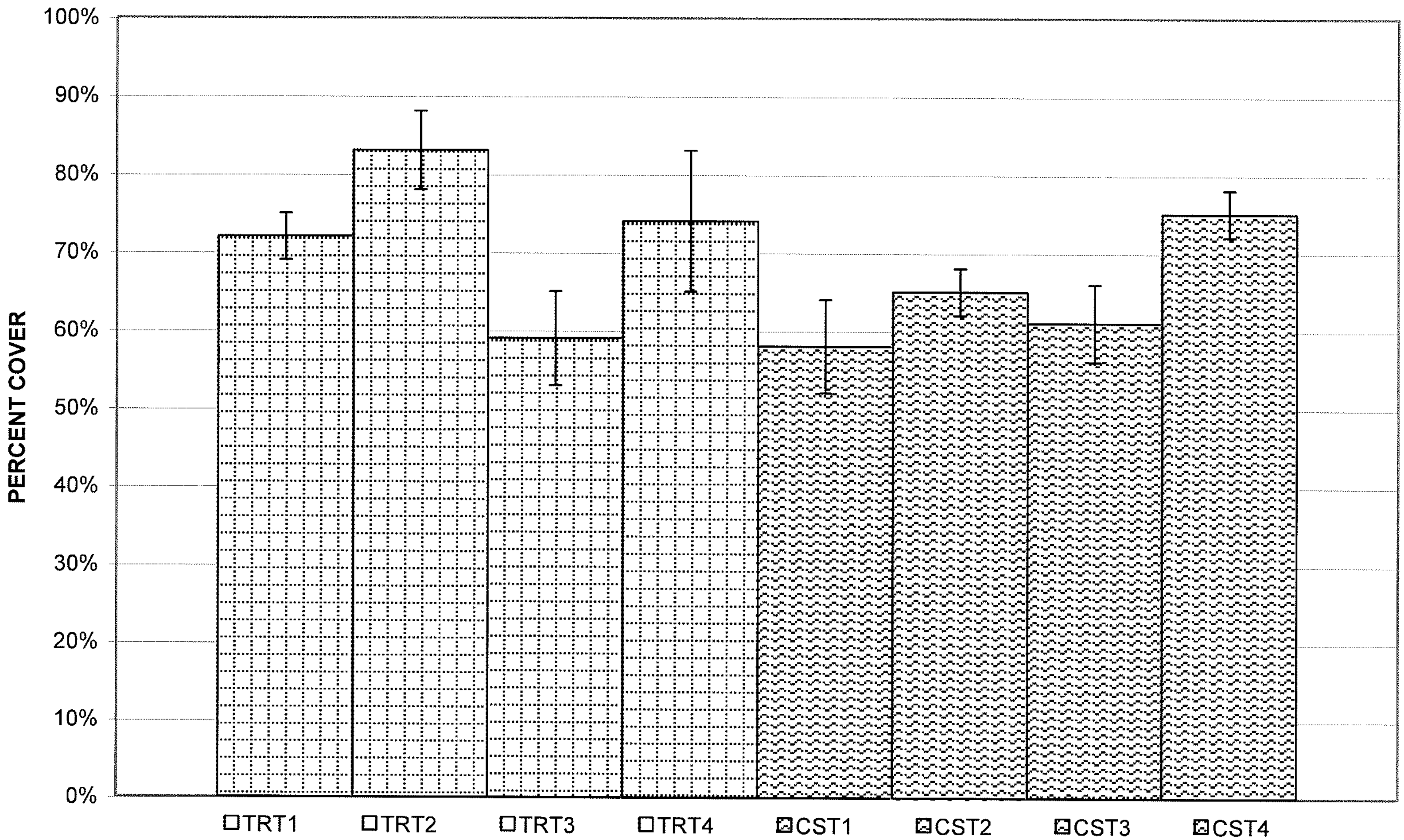

(a) Includes *S. cynosuroides* dominated quadrats, when present.

**FIGURE 8-27**
**2003 PERCENT COVER GROUPINGS**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**CEDAR SWAMP RESTORATION SITE TRANSECTS**




(a) Includes *S. cynosuroides* dominated quadrats, when present.

**FIGURE 8-28**
**2003 MEAN PERCENT COVER by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**DELAWARE WETLAND RESTORATION SITES**

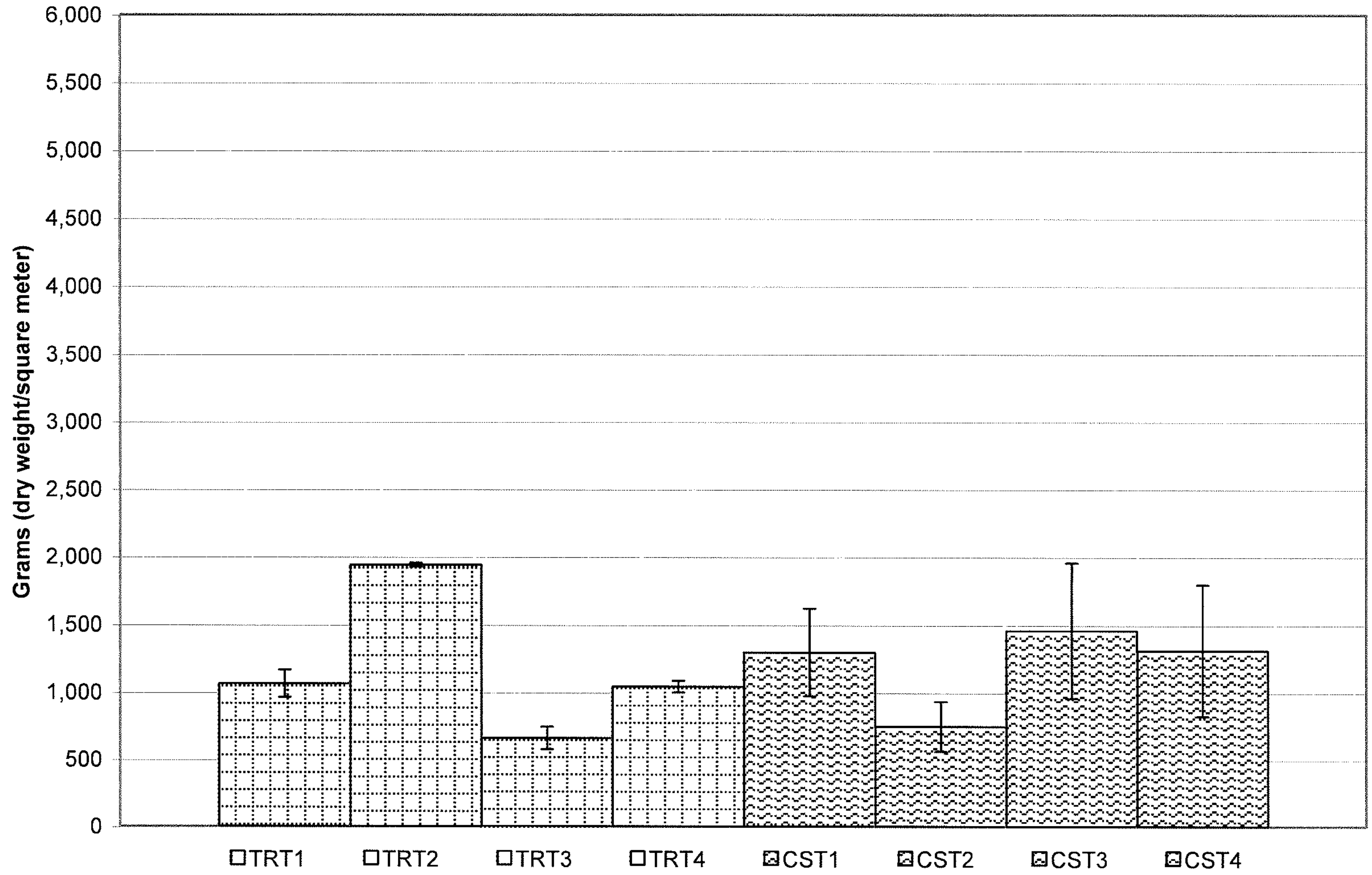



(a) Includes S. cynosuroides dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

TR = The Rocks
CS = Cedar Swamp

T1 =Transect 1

**FIGURE 8-29**
**2003 MEAN LIVE STANDING CROP by TRANSECT**
***SPARTINA ALTERNIFLORA* DOMINATED QUADRATS (a)**
**DELAWARE WETLAND RESTORATION SITES**




(a) Includes S. cynosuroides dominated quadrats.
Error bar represents +/- one Standard Error of the Mean.

TR = The Rocks
CS = Cedar Swamp
T1 =Transect 1

# APPENDIX A

# MACROPHYTE FIELD SAMPLING WORKSHEETS

# VEGETATION TRANSECT DATA SHEET
# PSEG EEP DETRITAL MONITORING

**Site**:_______________ _____________ **Transect:** ____________ **Date:** ____________

**Investigators:** ______________________________________ **Compass Reading:**____________

Weather Conditions: ______________________________________

Notes:

**Pole #1**
**Pole #2**
**Pole #3**
**Pole #4**
**Pole #5**

| Community type (No.) / Segment No. | Start - End (m) | Length (m) | Return Start - End (m) | Selected Clip Plots (dist from segment) / Selected Ocular Plots (dist from end) |
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Total number of vegetation communities = _________

Total number of 0.25 $m^2$ clip plots (number of vegetation communities X 2) = _________

Total number of 0.25 $m^2$ ocular quadrats (number of clip plots X 3; up to 22) = _________

Total transect length = ________ meters

| Dominant Plant Community | No. Community Segments | Selected Community Segment / length (m) | | Segment No. / Distance to quadrat (m) | |
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# EXHIBIT A-2
## CLIP QUADRAT DATA SHEET
## PSEG EEP DETRITAL MONITORING

**Site**:______________ ________ **Photo No.:**_________ **Date:** ______________________

**Investigators:** ____________________ Weather Conditions: ______________________

**Transect:**_____________ **Quadrat:** ___________ **Distance (m):** ____________

**Side of transect (L or R):**__________________ Water Depth (cm): ______________________

Notes:

| Species | Percent Cover | Height (cm) | Flowering (Y/N) | Number of Bags | | | |
|---|---|---|---|---|---|---|---|
| | | | | Live | Dead | Litter | Sort |
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| **Total Percent Cover** | | | | | | | |

**EXHIBIT A-3**
**OCULAR QUADRAT DATA SHEET**
**PSEG EEP VEGETATION MONITORING**

**Date:** _______________ **Site:** __________________ **Transect:** _______________ **Investigators:** _________________

| | | | Species {% cover / height (cm) / flowering (y/n)} | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quadrat No. | Distance from end (m) | Total % Cover | | | | | | | | | | | | | | | |
| | | | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ | % / ht. /__ |
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Note: Locate odd number quadrats on the left side of the transect and even number quadrats on the right side.

**EXHIBIT A-4**

**VEGETATION PLOT DATA SHEET**

**PSE&G EEP VEGETATION MONITORING**

**Site:**______________________________ **Date:** __________

**Investigators:**___________________ Weather Conditions: ______________________________

**Plot:**_____________________

Notes:

| | | |
|---|---|---|
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| Quadrat ID | Distance north (m) | Distance east (m) | Species {% cover / height (cm) / flowering (y/n)} | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | Number of Bags | | | |
| | | | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | % / ht ./__ | Live | Dead | Litter | Sort |
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# EXHIBIT A-5
## LAB DATA SHEET FOR CLIP QUADRAT VEGETATION
## PSEG EEP VEGETATION MONITORING

| Quadrat ID | Date | Species | Live (g) | Dead Standing (g) | Litter (g) |
|---|---|---|---|---|---|
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Species abbreviations

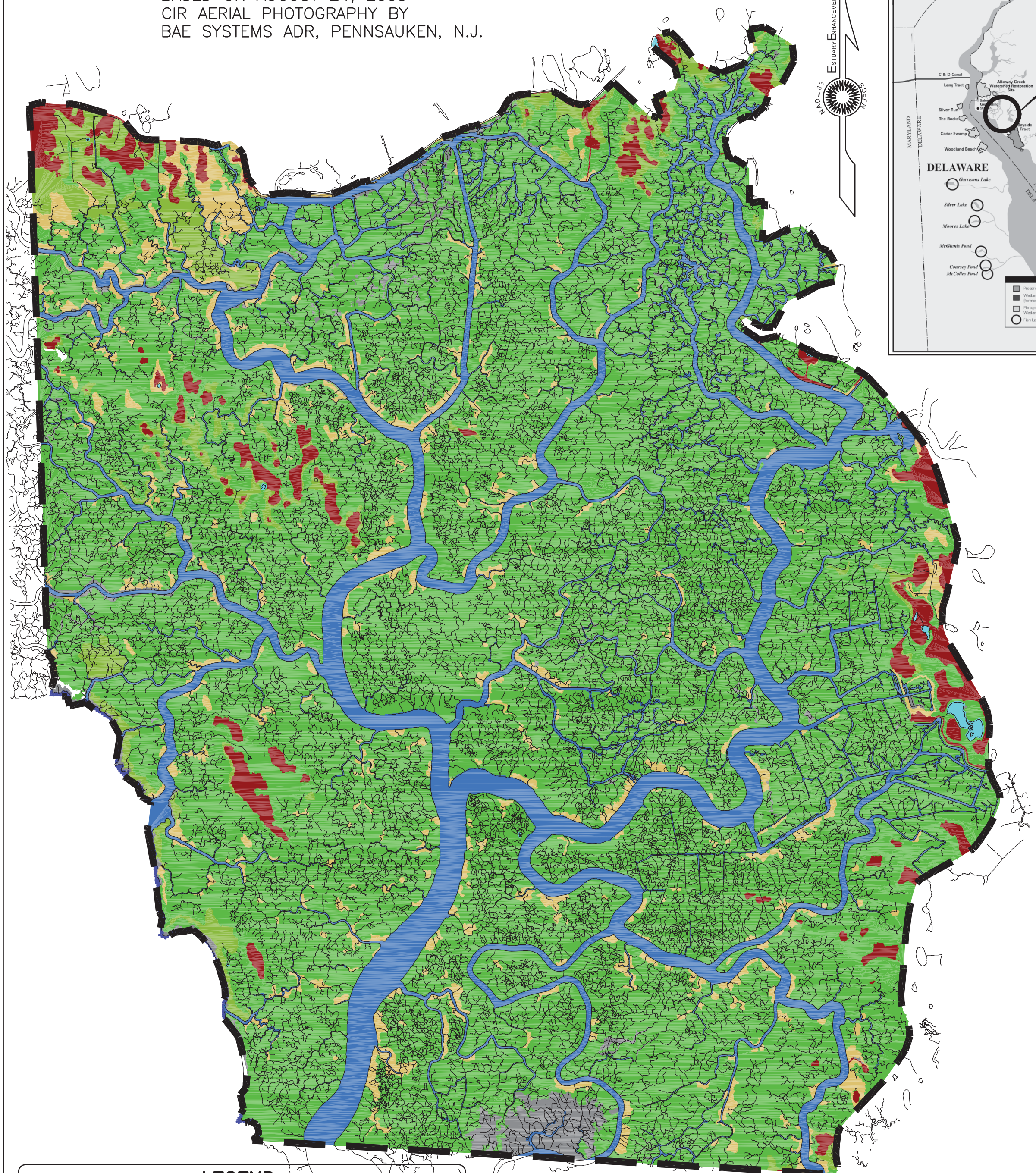
AA = arrow arum - *Pelatandra virginica*
AC = water hemp - *Amaranthus cannabinus*
BJ = Blue joint - *Calamagrostis canadenis*
DS = spike grass - *Distichlis spicata*
JG = black grass - *Juncus gerardii*
PA = common reed - *Phragmites australis*
PP = salt marsh fleabane - *Pluchea purpurascens*
PUNC = dotted smartweed - *Polygonum punctatum*
PV = Switch grass - *Panicum virgatum*
SA = smooth cordgrass - *Spartina alterniflora*
SC = big cordgrass - *Spartina cynosuroides*
SO = Three square - *Scirpus olneyi*
SP = salt hay grass - *Spartina patens*
SR = salt marsh bulrush - *Scirpus robustus*
SS = seaside goldenrod - *Solidago sempervirens*
SV = soft stem bulrush - *Scirpus validus*
TA = narrow-leaf cattail - *Typha angustifolia*
TL = broad leaf cattail - *Typha latifolia*
WM = walter's millet - *Echinochloa walteri*

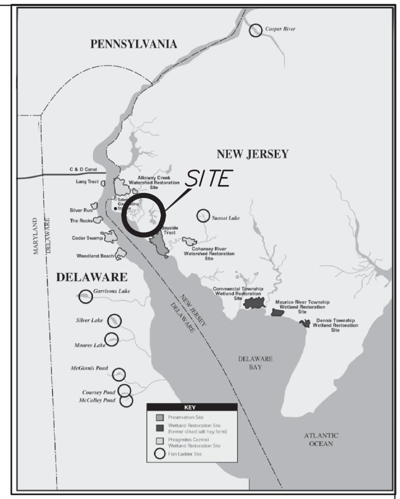
# APPENDIX B

# 2003 VEGETATION COVER CATEGORY MAPS

## MAP SOURCE:

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.




## LEGEND

SITE BOUNDARY

WETLAND RESTORATION AREA BOUNDARY

EXISTING SURFACE WATER FEATURE

EXISTING ROADS

**VEGETATIVE COVER CATEGORIES**

- *Spartina*/OTHER DESIRABLE MARSH VEGETATION
- DESIRABLE MARSH VEGETATION/*Phragmites*
- *Phragmites* DOMINATED VEGETATION
- DEAD *Phragmites australis*
- NON-VEGETATED MARSH PLAIN
- PONDED WATER
- CHANNEL
- OPEN WATER
- BUFFER AREA

FEET 0 1200 2400 3600

METERS 0 576 1152

URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

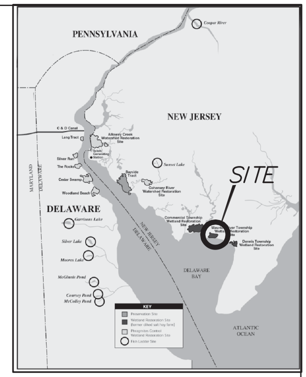
*Figure B-1*

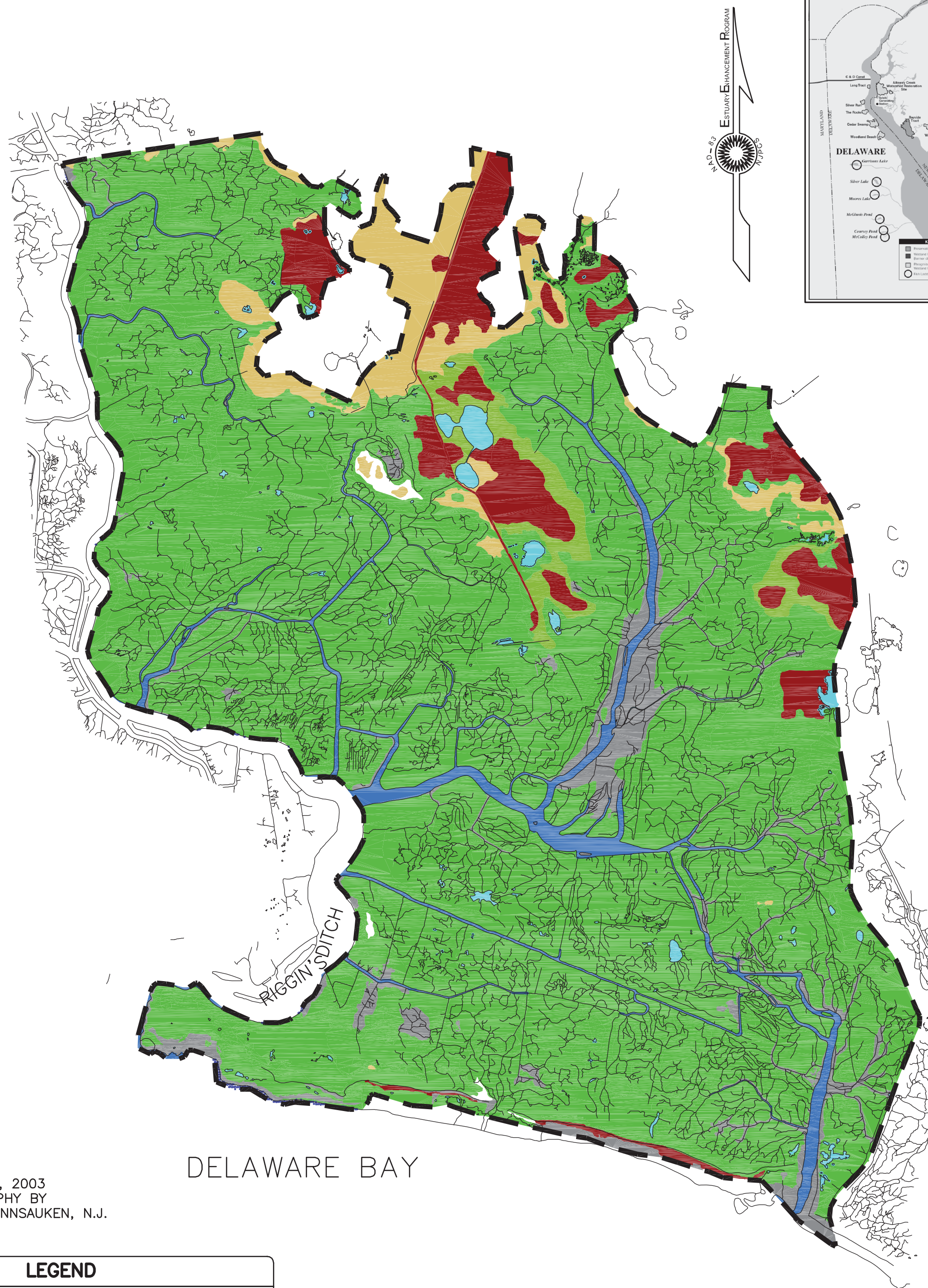
*MADHORSE CREEK REFERENCE MARSH*

*2003 VEGETATION FEATURES*

*LOWER ALLOWAYS CREEK TOWNSHIP*
*SALEM COUNTY, NEW JERSEY*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 9, 2004 | SCALE | AS SHOWN |
| FILE | 03_MH_VEG | CHECKED | RLH | EXAMINED | RLH |




**MAP SOURCE:**
BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

## LEGEND

- SITE BOUNDARY
- WETLAND RESTORATION AREA BOUNDARY
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS

**VEGETATIVE COVER CATEGORIES**

- *Spartina*/OTHER DESIRABLE MARSH VEGETATION
- DESIRABLE MARSH VEGETATION/*Phragmites*
- *Phragmites* DOMINATED VEGETATION
- Dead *Phragmites australis*
- NON-VEGETATED MARSH PLAIN
- PONDED WATER
- CHANNEL
- OPEN WATER
- BUFFER AREA
- RECOVERING DESIRABLE SPECIES AREA

FEET 0 900 1800 2700
METERS 0 432 864

URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

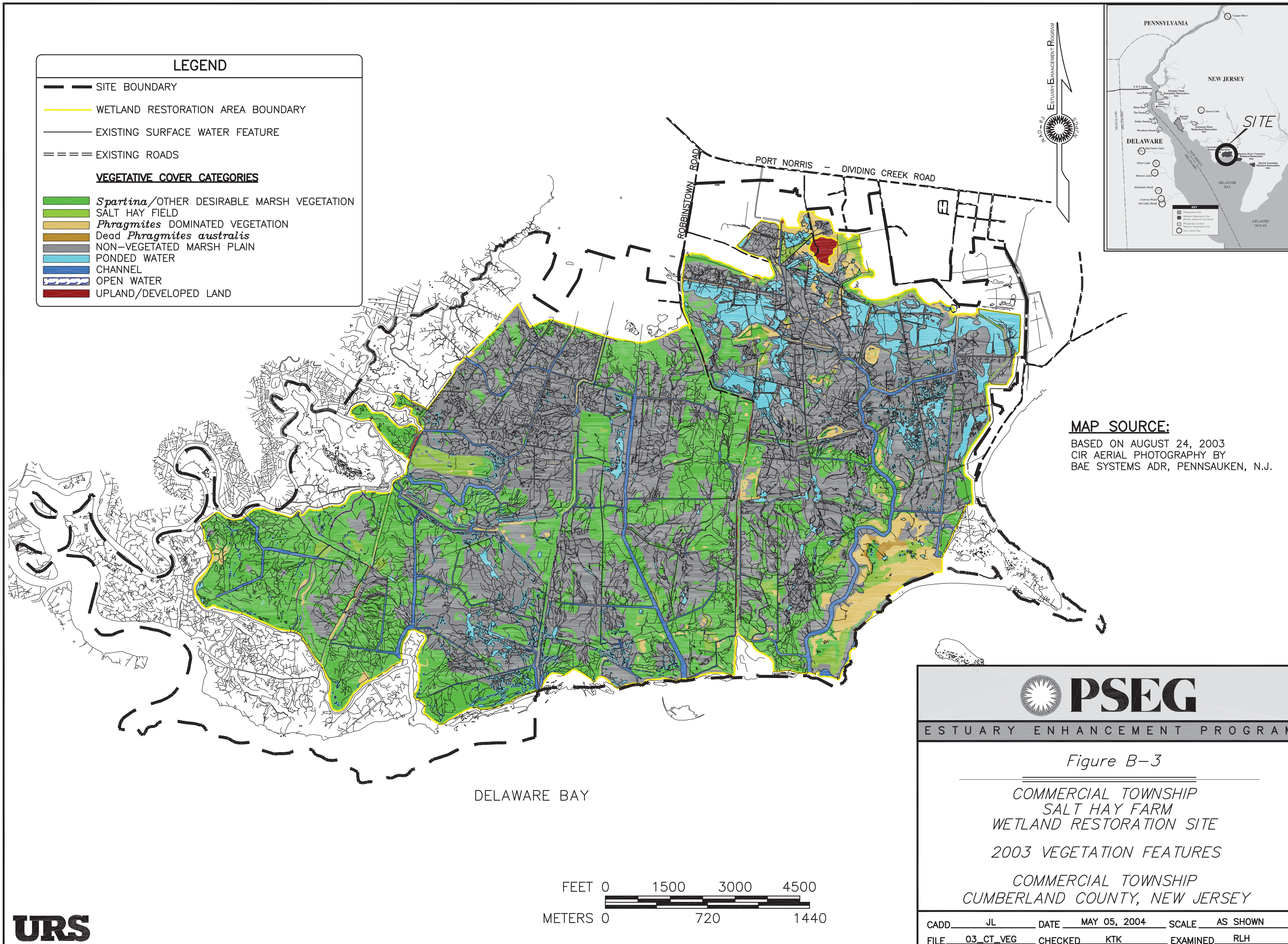
*Figure B-2*

MOORES BEACH REFERENCE MARSH

2003 HYDROLOGICAL FEATURES

MAURICE RIVER TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 9, 2004 | SCALE | AS SHOWN |
| FILE | 03_MB_HYD | CHECKED | RLH | EXAMINED | RLH |




URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

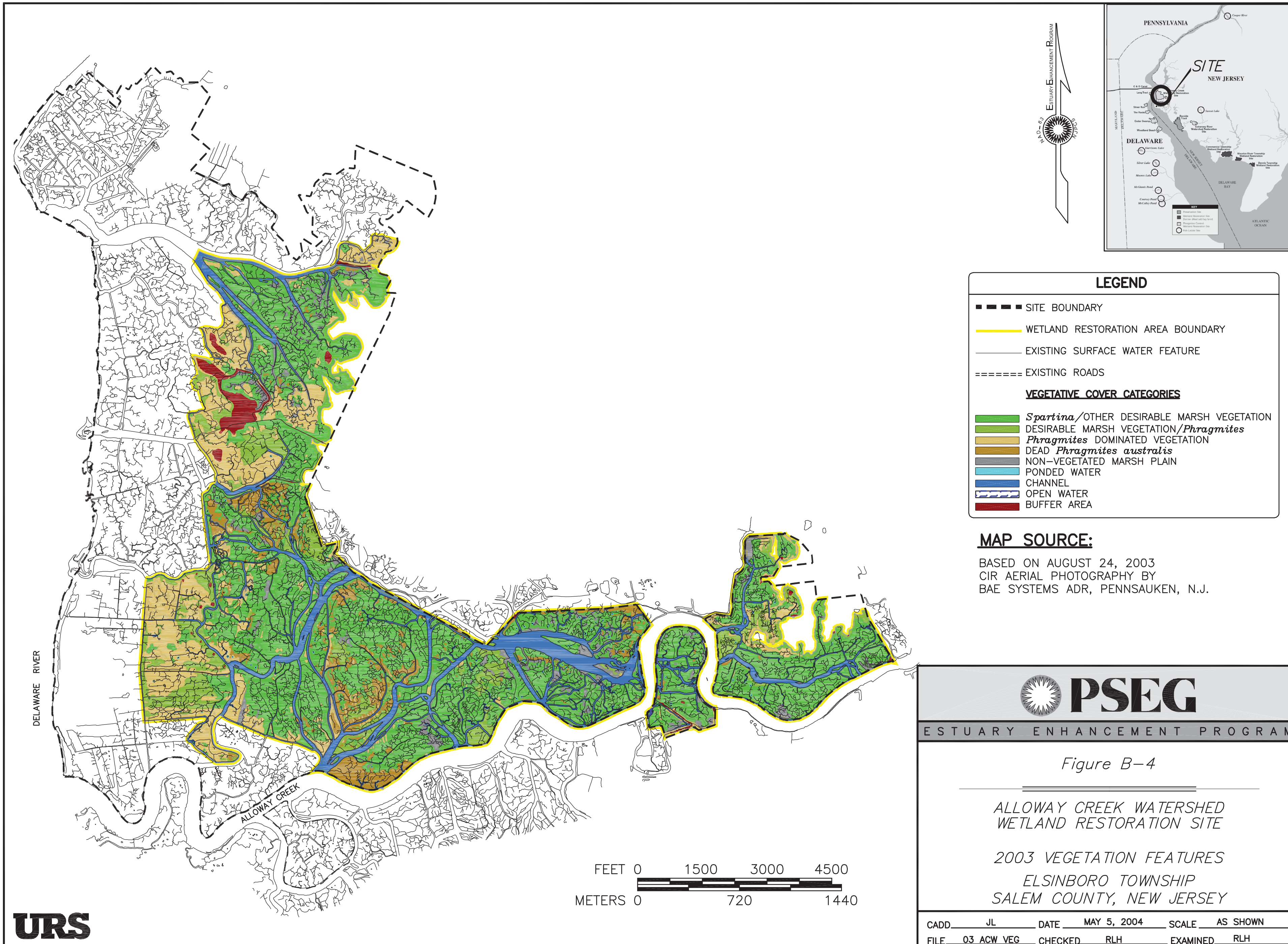
*Figure B-3*

COMMERCIAL TOWNSHIP
SALT HAY FARM
WETLAND RESTORATION SITE

2003 VEGETATION FEATURES

COMMERCIAL TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 05, 2004 | SCALE | AS SHOWN |
| FILE | 03_CT_VEG | CHECKED | KTK | EXAMINED | RLH |




## LEGEND

- SITE BOUNDARY
- WETLAND RESTORATION AREA BOUNDARY
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS

**VEGETATIVE COVER CATEGORIES**

- *Spartina*/OTHER DESIRABLE MARSH VEGETATION
- DESIRABLE MARSH VEGETATION/*Phragmites*
- *Phragmites* DOMINATED VEGETATION
- DEAD *Phragmites australis*
- NON-VEGETATED MARSH PLAIN
- PONDED WATER
- CHANNEL
- OPEN WATER
- BUFFER AREA

**MAP SOURCE:**

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

PSEG

ESTUARY ENHANCEMENT PROGRAM

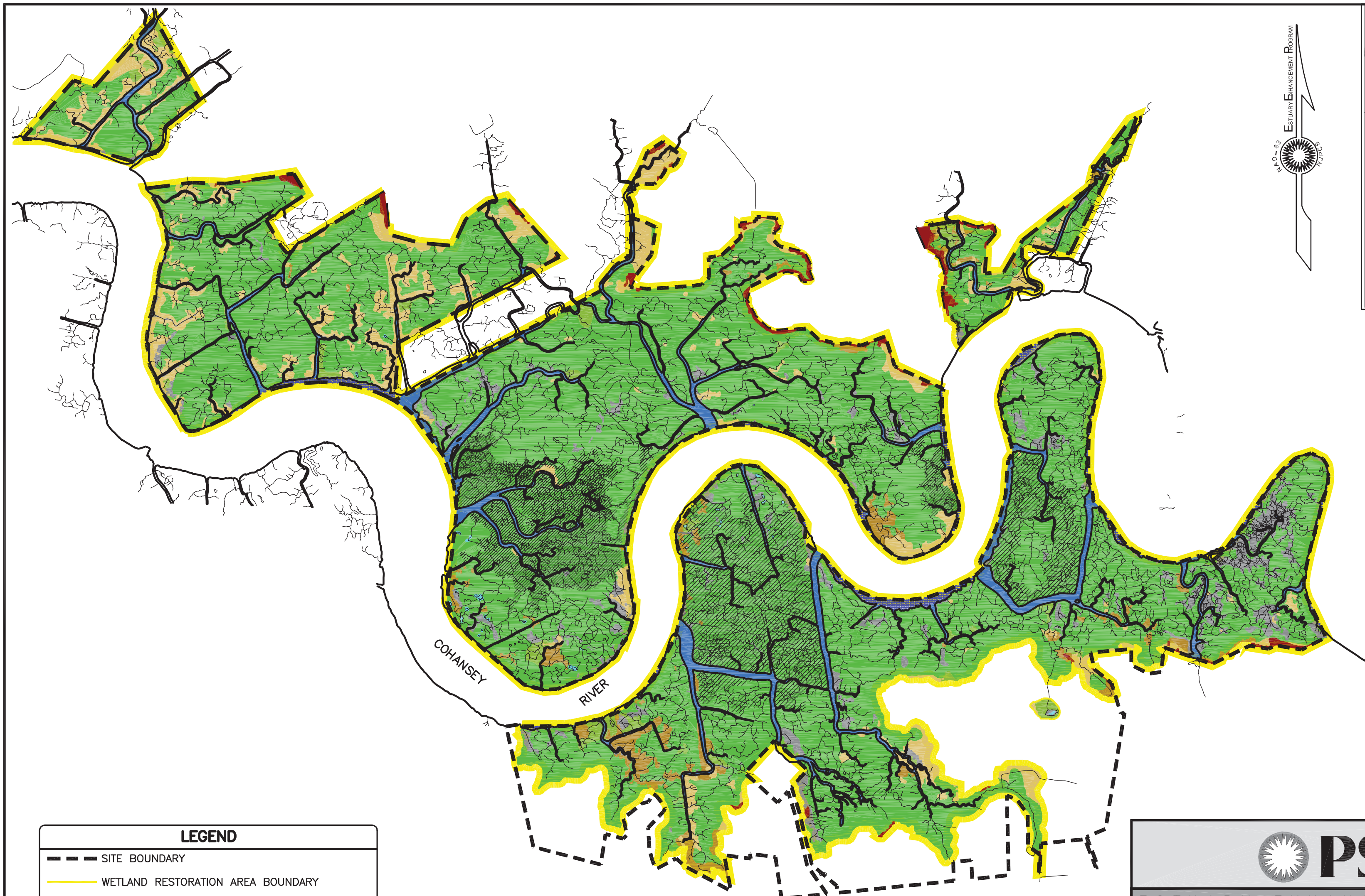
*Figure B-4*

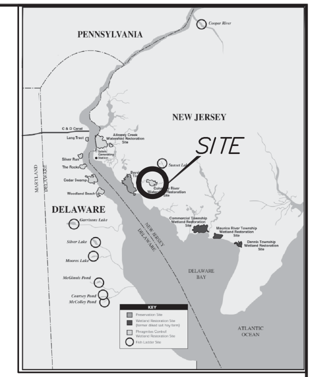
ALLOWAY CREEK WATERSHED
WETLAND RESTORATION SITE

2003 VEGETATION FEATURES

ELSINBORO TOWNSHIP
SALEM COUNTY, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 5, 2004 | SCALE | AS SHOWN |
| FILE | 03 ACW VEG | CHECKED | RLH | EXAMINED | RLH |




**MAP SOURCE:**

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

## LEGEND

- SITE BOUNDARY
- WETLAND RESTORATION AREA BOUNDARY
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS

**VEGETATIVE COVER CATEGORIES**

- *Spartina*/OTHER DESIRABLE MARSH VEGETATION
- DESIRABLE MARSH VEGETATION/*Phragmites*
- *Phragmites* DOMINATED VEGETATION
- Dead *Phragmites australis*
- NON-VEGETATED MARSH PLAIN
- PONDED WATER
- CHANNEL
- OPEN WATER
- BUFFER AREA
- RECOVERING DESIRABLE SPECIES AREA

FEET 0 850 1700 2550

METERS 0 408 816

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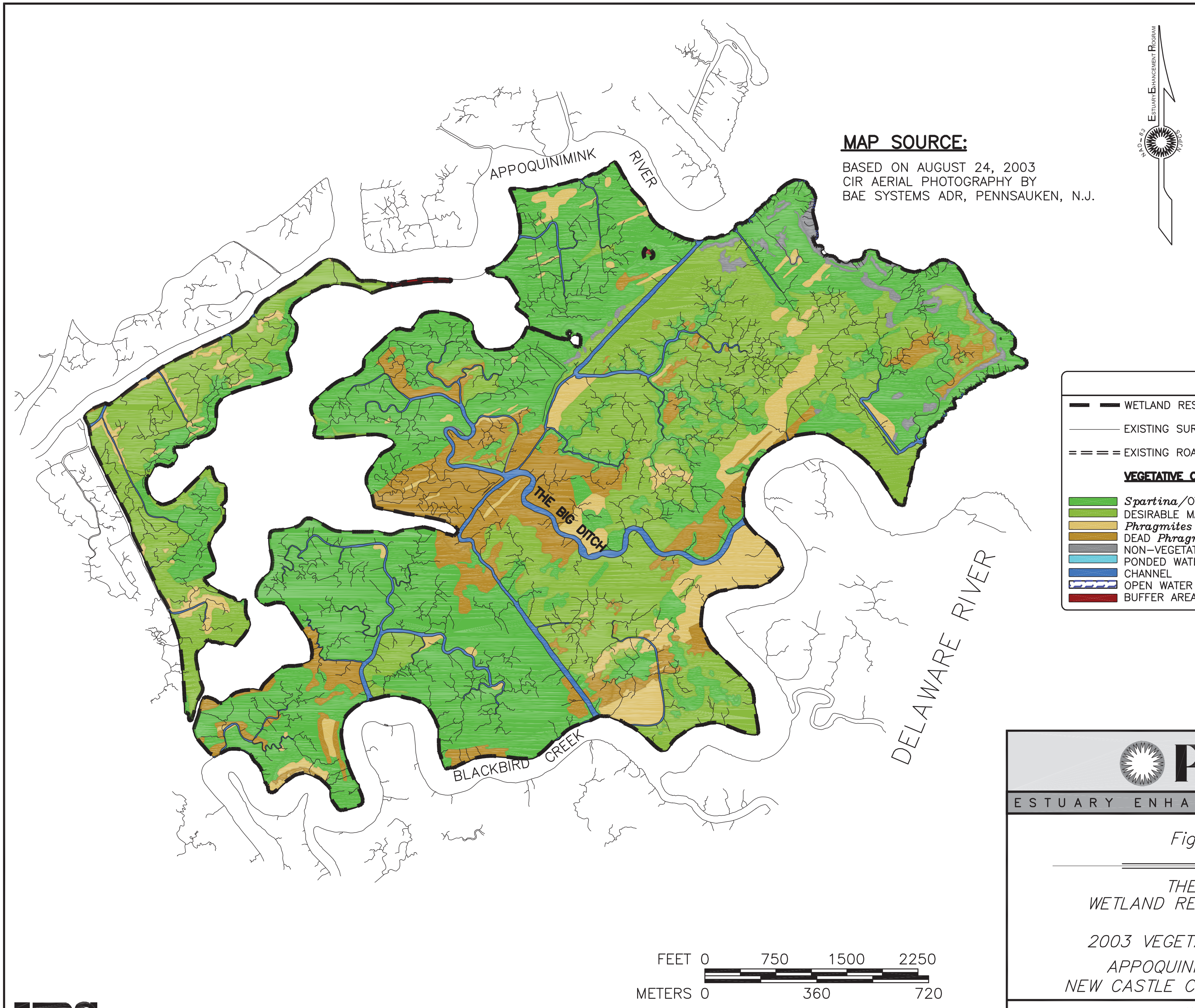
ESTUARY ENHANCEMENT PROGRAM

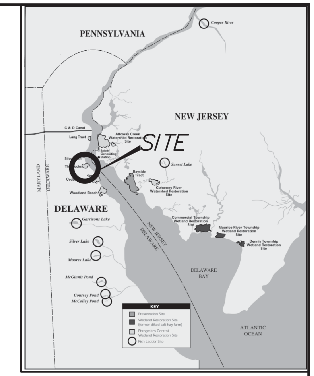
Figure B–5

COHANSEY RIVER WATERSHED
WETLAND RESTORATION SITE
2003 VEGETATION FEATURES

HOPEWELL TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 9, 2004 | SCALE | AS SHOWN |
| FILE | 03_CRW_VEG | CHECKED | RLH | EXAMINED | RLH |

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PSEG

ESTUARY ENHANCEMENT PROGRAM

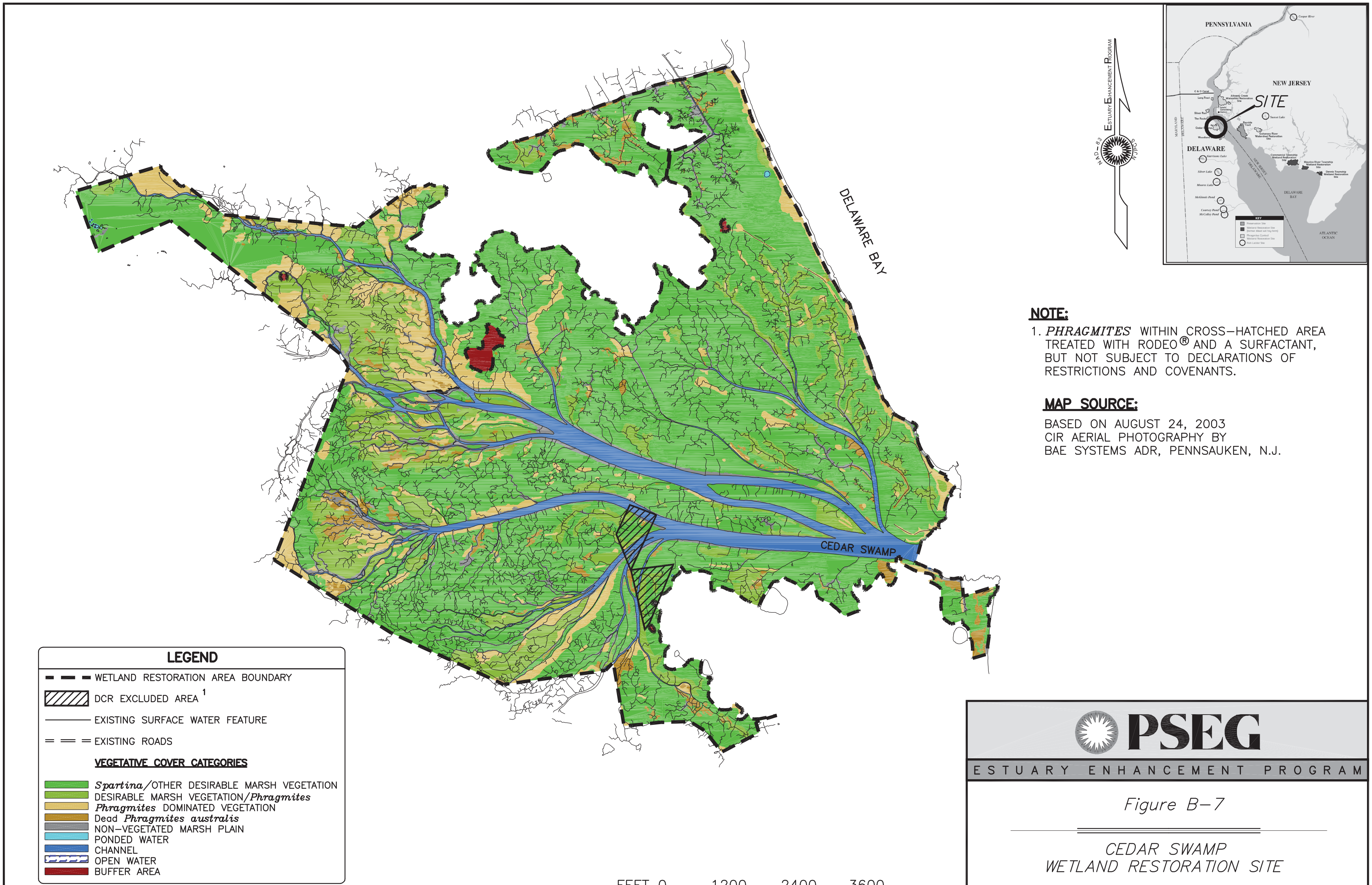
*Figure B–6*

*THE ROCKS*
*WETLAND RESTORATION SITE*

*2003 VEGETATION FEATURES*

*APPOQUINIMINK HUNDRED*
*NEW CASTLE COUNTY, DELAWARE*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 11, 2004 | SCALE | AS SHOWN |
| FILE | 03_TR_VEG | CHECKED | RLH | EXAMINED | RLH |




**NOTE:**

1. *PHRAGMITES* WITHIN CROSS-HATCHED AREA TREATED WITH RODEO® AND A SURFACTANT, BUT NOT SUBJECT TO DECLARATIONS OF RESTRICTIONS AND COVENANTS.

**MAP SOURCE:**

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

PSEG

ESTUARY ENHANCEMENT PROGRAM

*Figure B-7*

*CEDAR SWAMP*
*WETLAND RESTORATION SITE*

*2003 VEGETATION FEATURES*

*BLACKBIRD HUNDRED*
*NEW CASTLE COUNTY, DELAWARE*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 5, 2004 | SCALE | AS SHOWN |
| FILE | 03_CS-VEG | CHECKED | RLH | EXAMINED | RLH |

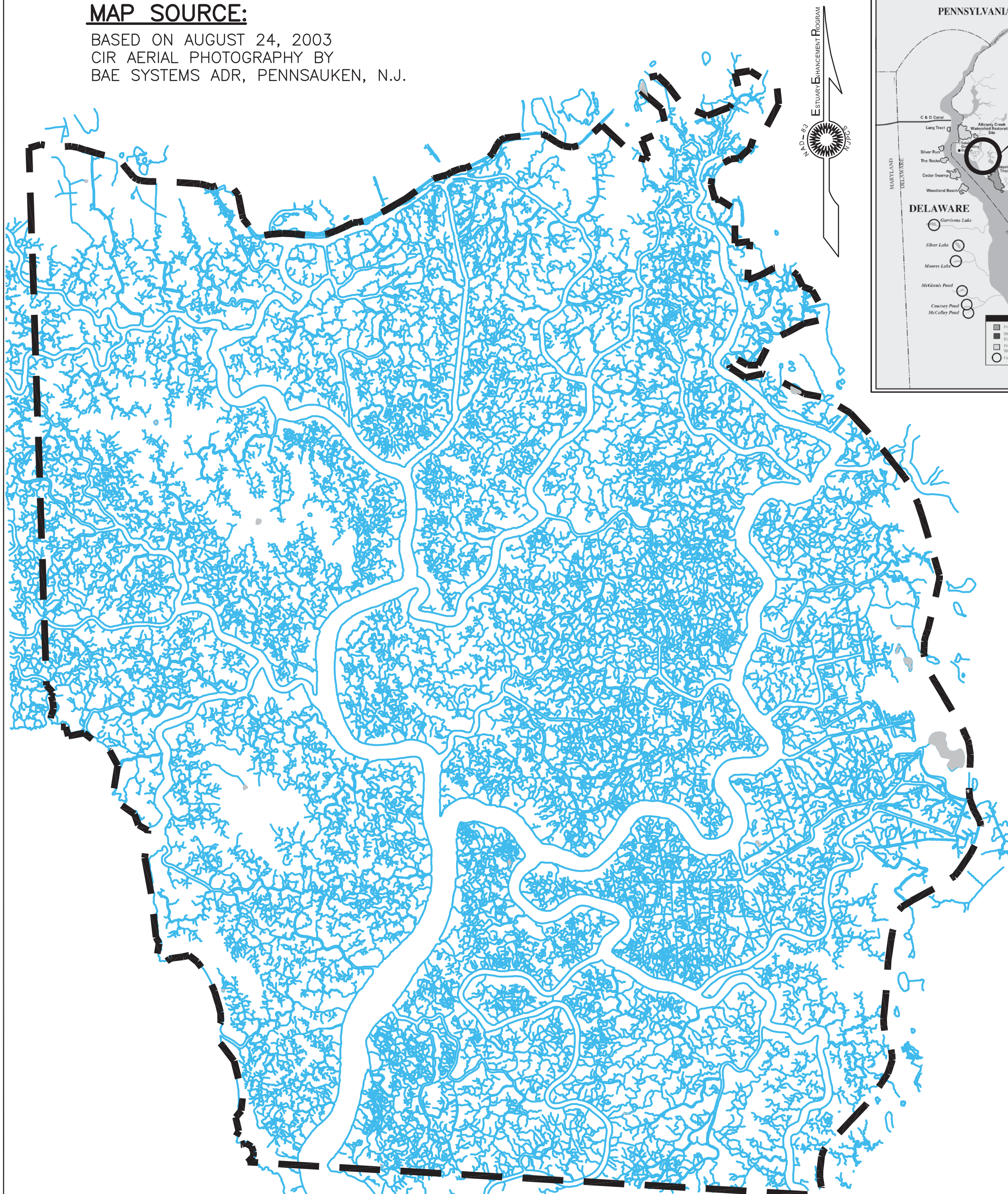
URS

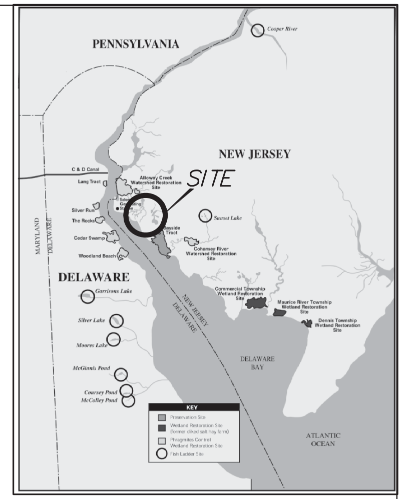
# APPENDIX C

# 2003 GEOMORPHOLOGIC MAPS

## MAP SOURCE:

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.




### LEGEND

- SITE BOUNDARY
- EXISTING SURFACE WATER FEATURE
- PONDED AREAS

FEET 0 1200 2400 3600

METERS 0 576 1152

URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

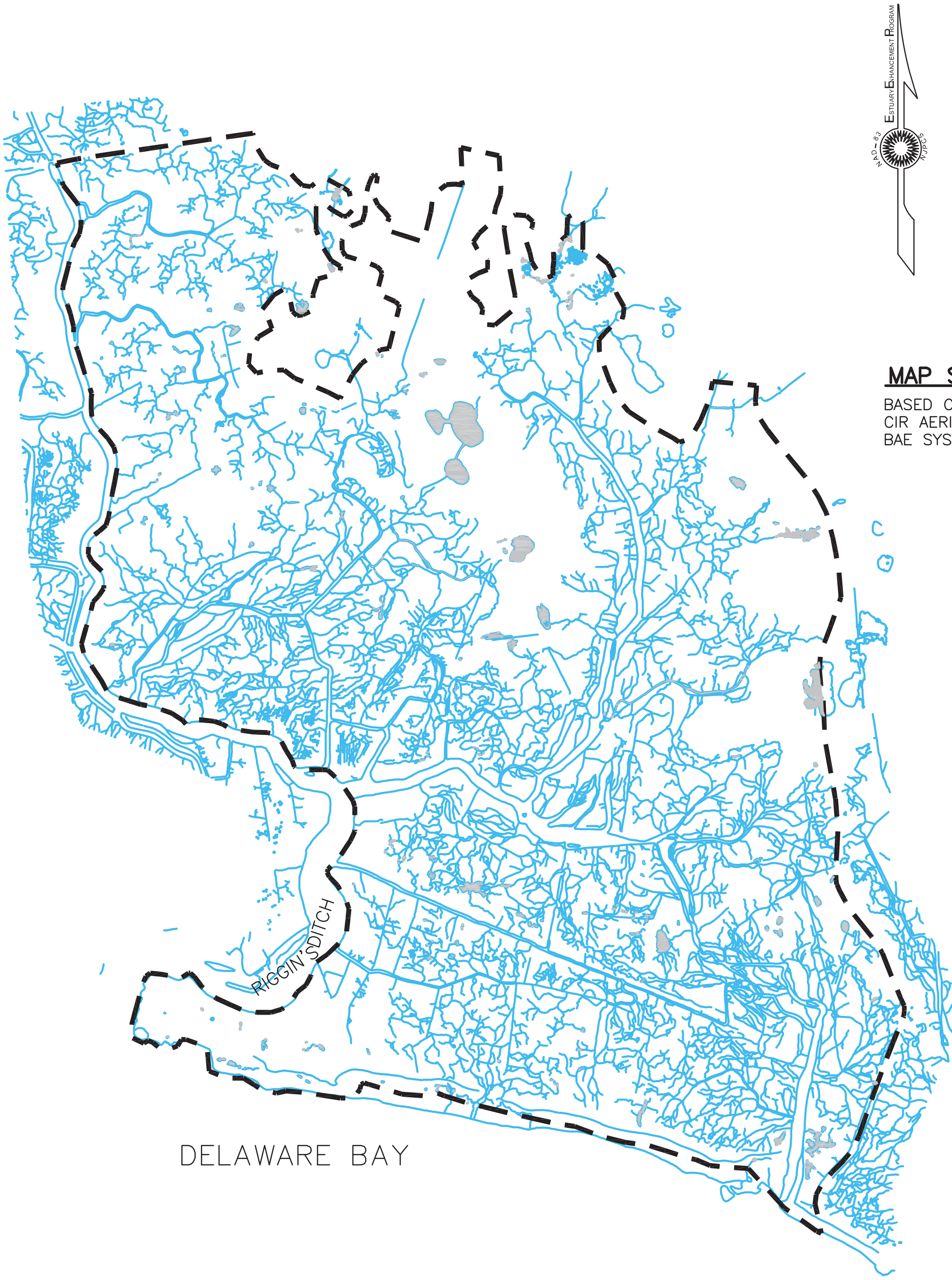
*Figure C–1*

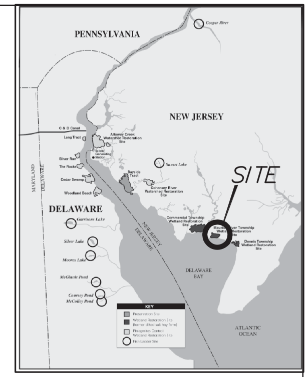
*MADHORSE CREEK REFERENCE MARSH*

*2003 HYDROLOGICAL FEATURES*

*LOWER ALLOWAYS CREEK TOWNSHIP*
*SALEM COUNTY, NEW JERSEY*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 9, 2004 | SCALE | AS SHOWN |
| FILE | 03_MH_HYD | CHECKED | RLH | EXAMINED | RLH |




## MAP SOURCE:

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

**LEGEND**

- SITE BOUNDARY
- EXISTING SURFACE WATER FEATURE
- PONDED AREAS

FEET 0 900 1800 2700
METERS 0 432 864

URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

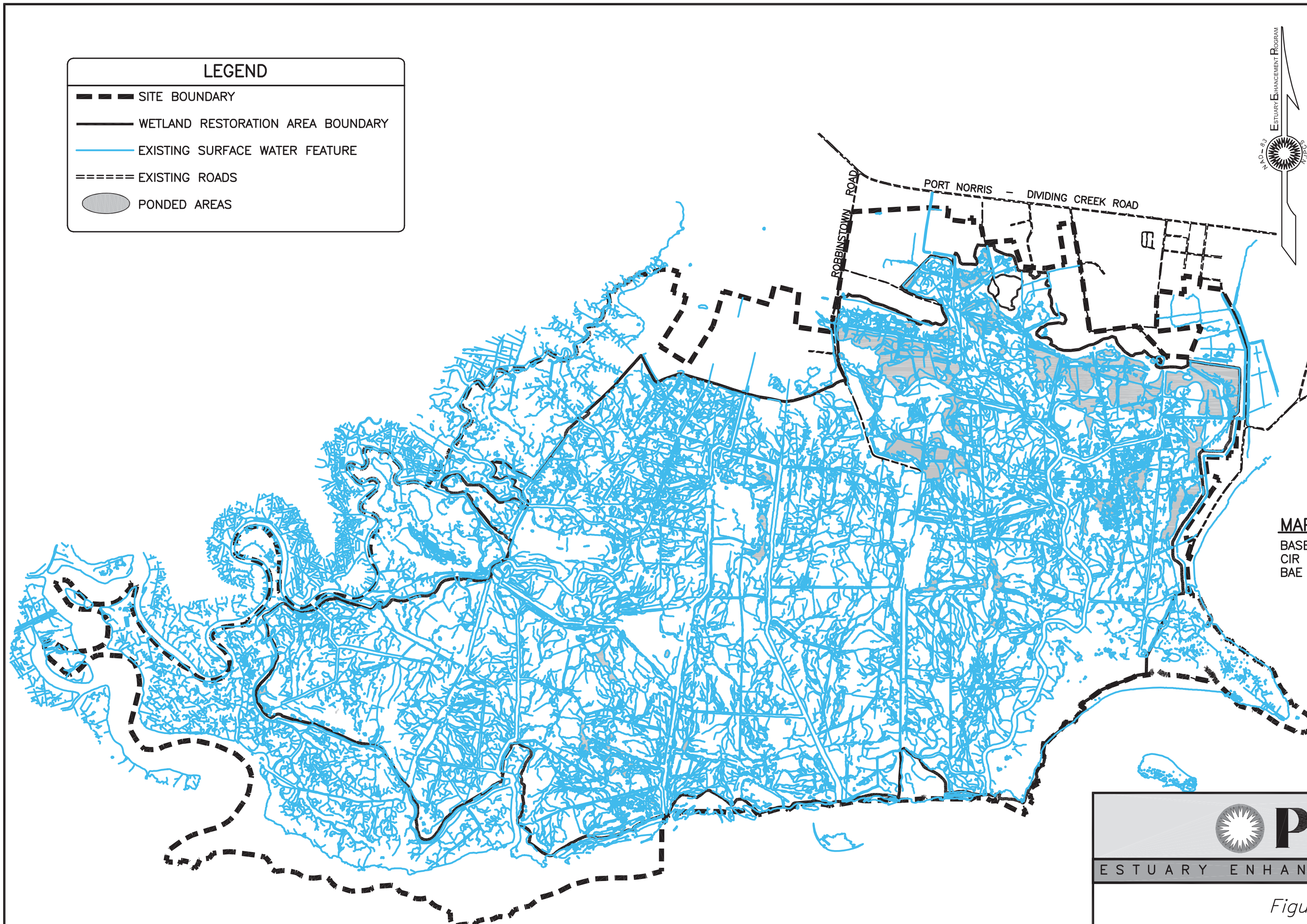
*Figure C-2*

*MOORES BEACH REFERENCE MARSH*

*2003 HYDROLOGICAL FEATURES*

*MAURICE RIVER TOWNSHIP*
*CUMBERLAND COUNTY, NEW JERSEY*

| | | |
|---|---|---|
| CADD JL | DATE MAY 9, 2004 | SCALE AS SHOWN |
| FILE 03_MB_HYD | CHECKED RLH | EXAMINED RLH |




MAP SOURCE:
BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

PSEG

ESTUARY ENHANCEMENT PROGRAM

*Figure C–3*

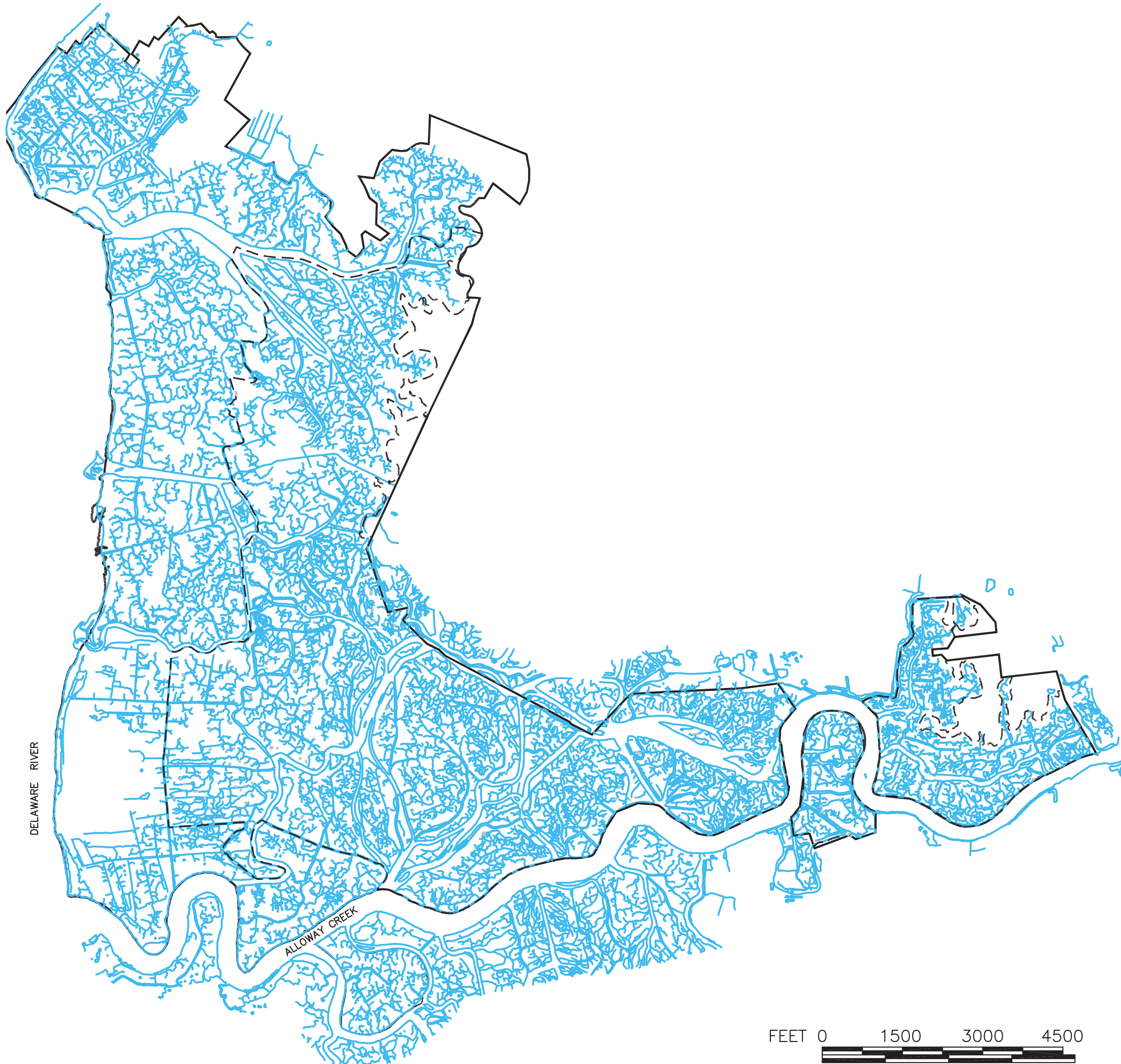
*COMMERCIAL TOWNSHIP*
*SALT HAY FARM*
*WETLAND RESTORATION SITE*

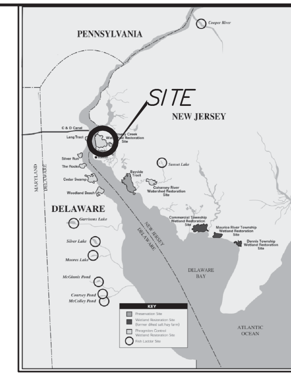
*2003 HYDROLOGICAL FEATURES*

*COMMERCIAL TOWNSHIP*
*CUMBERLAND COUNTY, NEW JERSEY*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 05, 2004 | SCALE | AS SHOWN |
| FILE | 03_CT_HYD | CHECKED | RLH | EXAMINED | RLH |

URS




ESTUARY ENHANCEMENT PROGRAM
NAD-83
NJPCS

## LEGEND

- SITE BOUNDARY
- WETLAND RESTORATION AREA BOUNDARY
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS
- PONDED AREA

**MAP SOURCE:**

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

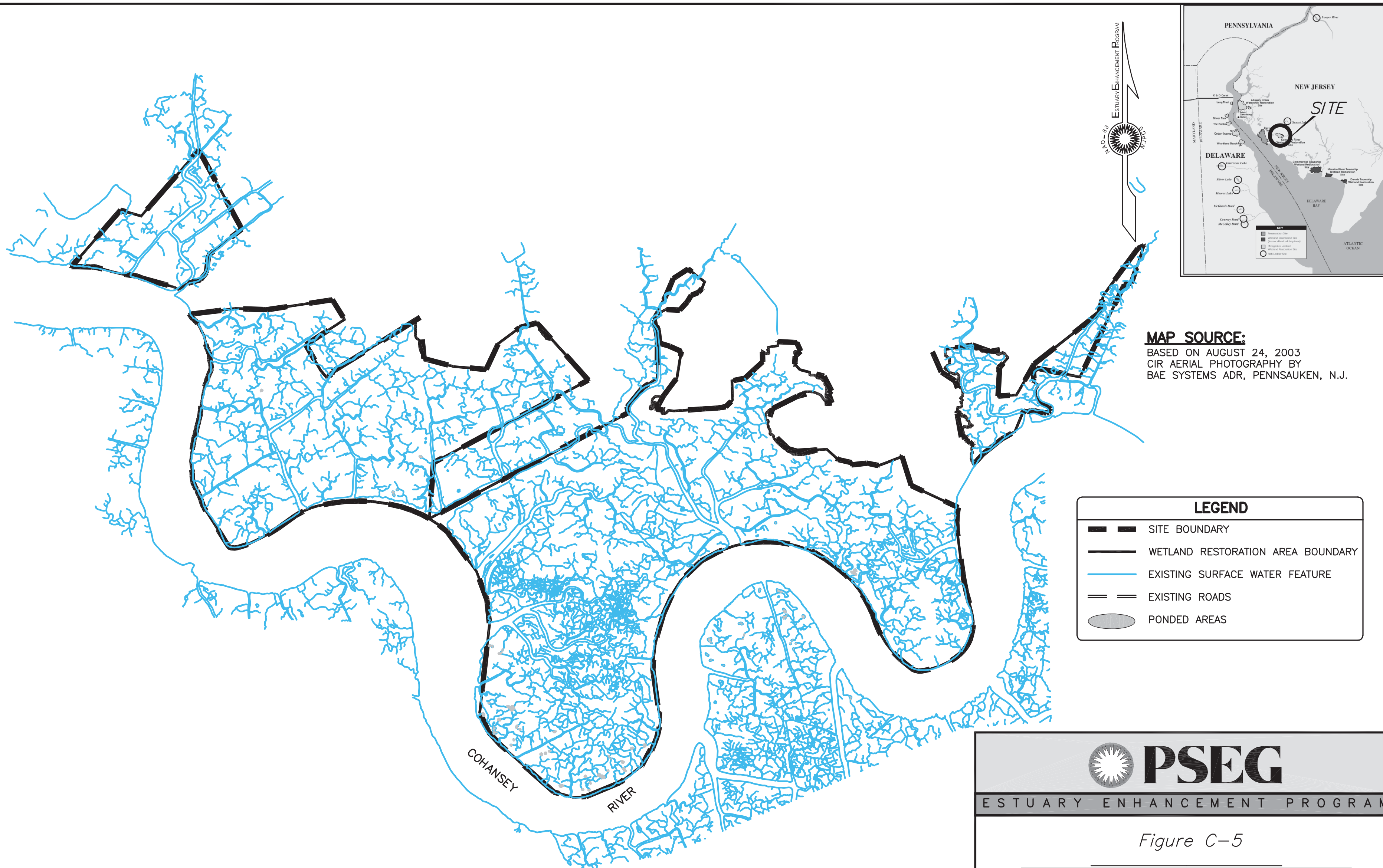
*Figure C–4*

ALLOWAY CREEK SITE
WATERSHED WETLAND RESTORATION SITE

2003 HYDROLOGICAL FEATURES

ELSINBORO TOWNSHIP
SALEM COUNTY, NEW JERSEY

| | | |
|---|---|---|
| CADD JL | DATE MAY 5, 2004 | SCALE AS SHOWN |
| FILE 03 ACW HYD | CHECKED RLH | EXAMINED RLH |




URS

PSEG

ESTUARY ENHANCEMENT PROGRAM

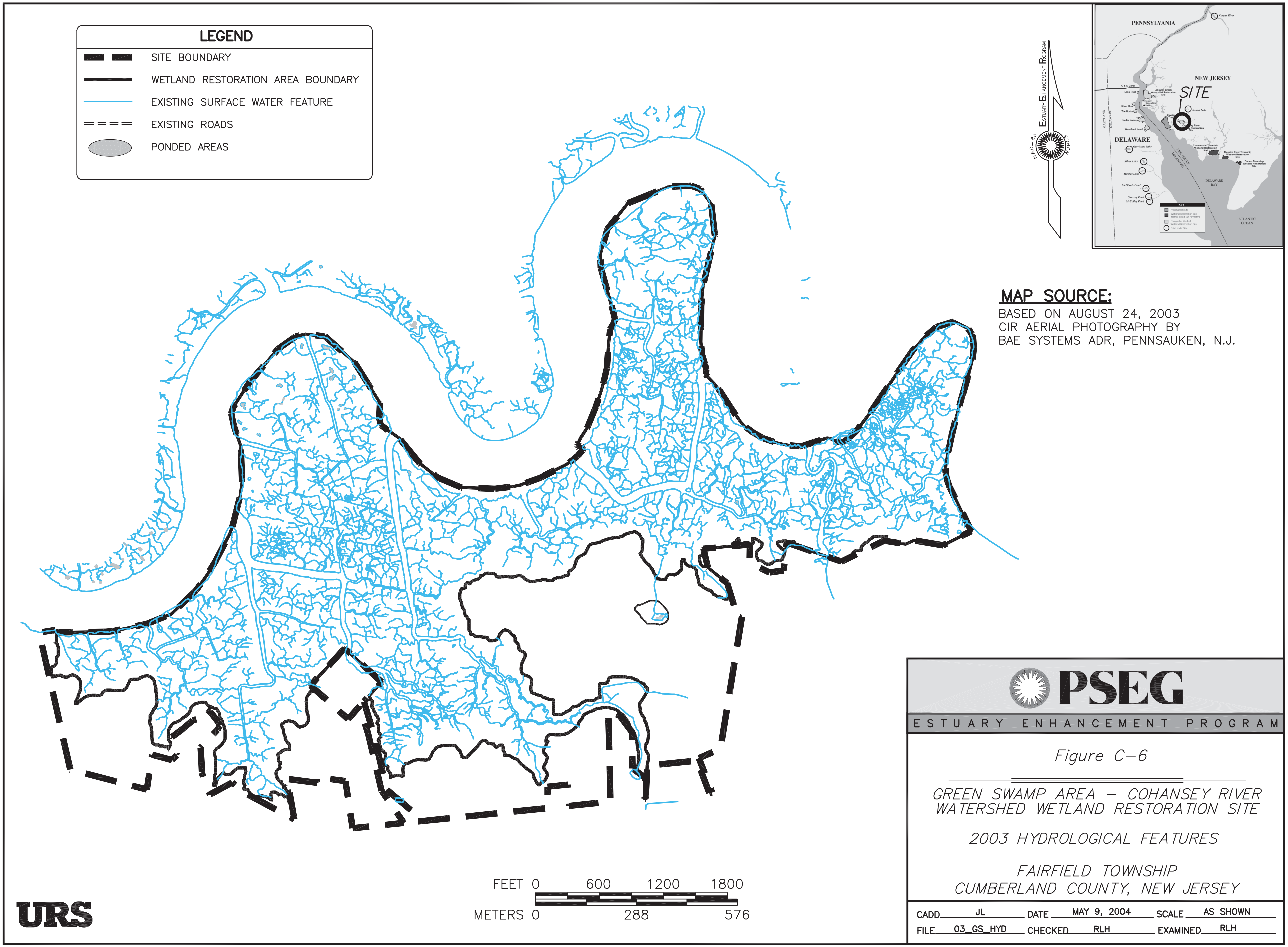
*Figure C–5*

*BROWNS RUN AREA – COHANSEY RIVER WATERSHED WETLAND RESTORATION SITE*

*2003 HYDROLOGICAL FEATURES*

*HOPEWELL TOWNSHIP*
*CUMBERLAND COUNTY, NEW JERSEY*

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 05, 2004 | SCALE | AS SHOWN |
| FILE | 03_BR_HYD | CHECKED | RLH | EXAMINED | RLH |




PSEG
ESTUARY ENHANCEMENT PROGRAM

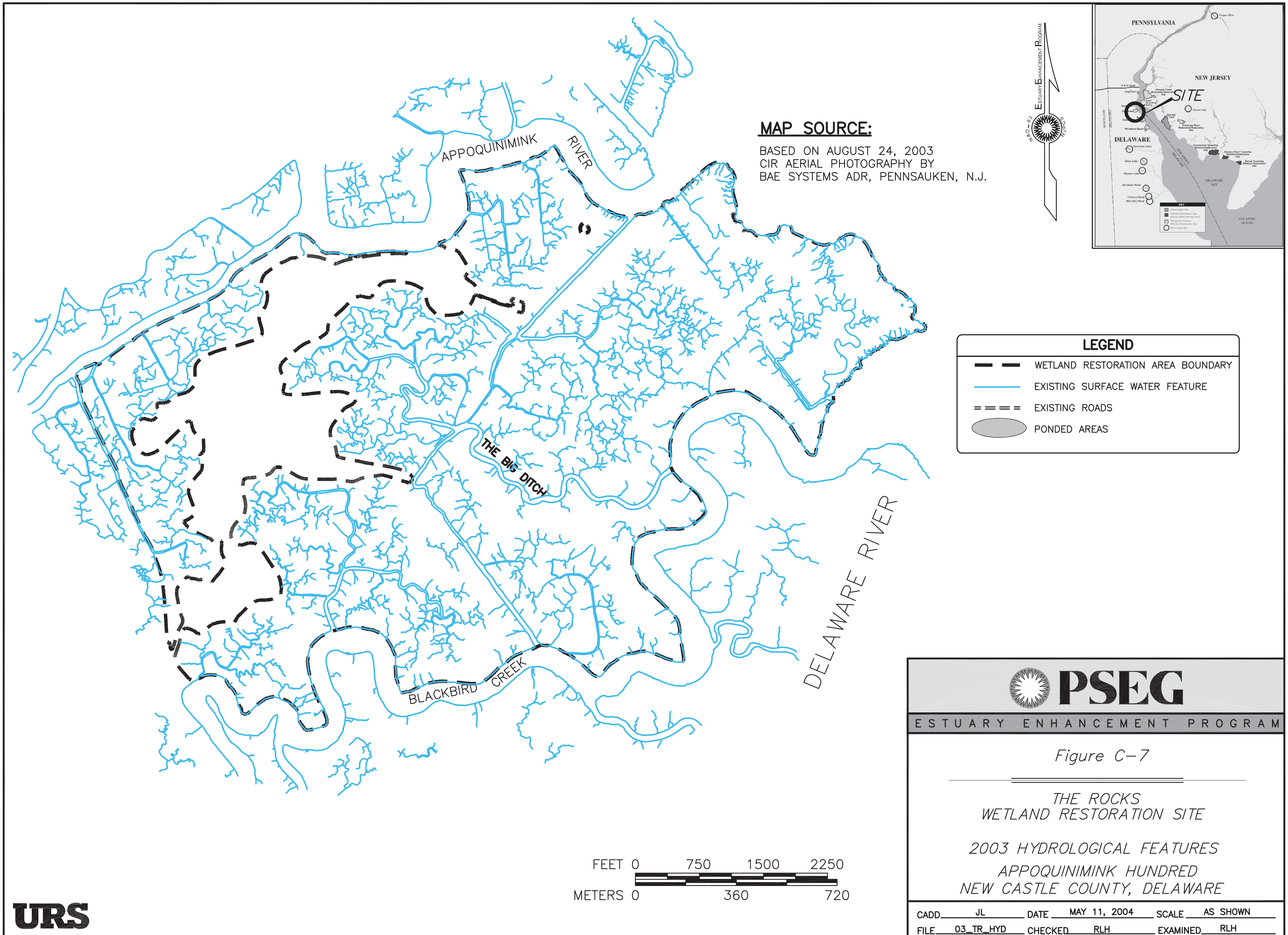
Figure C-6

GREEN SWAMP AREA – COHANSEY RIVER WATERSHED WETLAND RESTORATION SITE

2003 HYDROLOGICAL FEATURES

FAIRFIELD TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

CADD JL DATE MAY 9, 2004 SCALE AS SHOWN
FILE 03_GS_HYD CHECKED RLH EXAMINED RLH



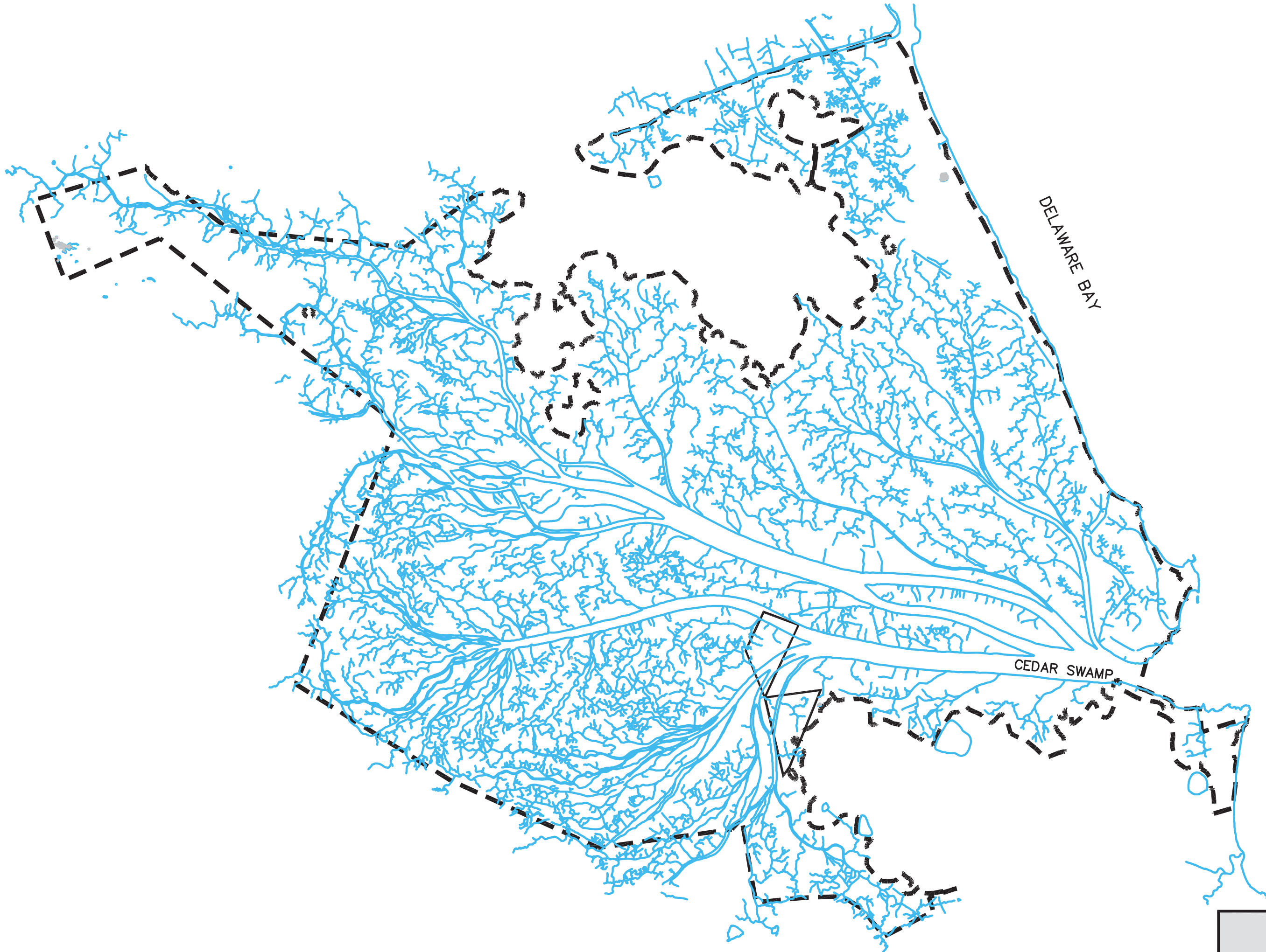

PSEG
ESTUARY ENHANCEMENT PROGRAM

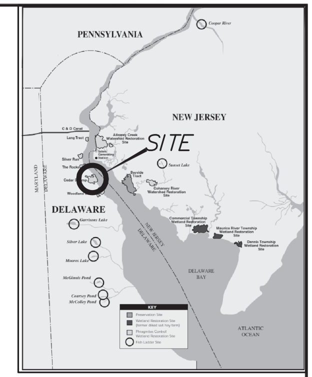
Figure C–7

THE ROCKS
WETLAND RESTORATION SITE

2003 HYDROLOGICAL FEATURES
APPOQUINIMINK HUNDRED
NEW CASTLE COUNTY, DELAWARE

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 11, 2004 | SCALE | AS SHOWN |
| FILE | 03_TR_HYD | CHECKED | RLH | EXAMINED | RLH |




**MAP SOURCE:**

BASED ON AUGUST 24, 2003
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.

**LEGEND**

- WETLAND RESTORATION AREA BOUNDARY
- DCR EXCLUDED AREA [1]
- EXISTING SURFACE WATER FEATURE
- EXISTING ROADS
- PONDED AREAS

FEET 0 1200 2400 3600
METERS 0 600 1200

URS

PSEG
ESTUARY ENHANCEMENT PROGRAM

Figure C–8

CEDAR SWAMP
WETLAND RESTORATION SITE

2003 HYDROLOGICAL FEATURES

BLACKBIRD HUNDRED
NEW CASTLE COUNTY, DELAWARE

| | | | | | |
|---|---|---|---|---|---|
| CADD | JL | DATE | MAY 5, 2004 | SCALE | AS SHOWN |
| FILE | 03_CS–HYD | CHECKED | RLH | EXAMINED | RLH |

# APPENDIX D

## 2003 MACROPHYTE QUADRAT DATA – TRANSECTS

**Table D-1**

**MAD HORSE CREEK REFERENCE MARSH**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter gdw/m² |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m² | lb/acre | gdw/m² | |
| **Mad Horse Creek - Transect 1 8/18/02** | | | | | | | | | |
| MHT1-03-OQ18 | *Spartina alterniflora* | 15% | 100% | 125 | N | | | | |
| MHT1-03-OQ17 | *S. alterniflora* | 40% | 100% | 142 | N | | | | |
| MHT1-03-OQ16 | *S. alterniflora* | 80% | 100% | 115 | Y | | | | |
| MHT1-03-OQ15 | *S. alterniflora* | 50% | 100% | 138 | N | | | | |
| MHT1-03-OQ14 | *S. alterniflora* | 30% | 100% | 119 | N | | | | |
| MHT1-03-CQ1 | *S. alterniflora* | 50% | 100% | 115 | N | 1017 | 9071 | 0 | 0 |
| MHT1-03-OQ13 | *S. alterniflora* | 50% | 100% | 123 | Y | | | | |
| MHT1-03-OQ12 | *S. alterniflora* | 70% | 100% | 117 | N | | | | |
| MHT1-03-OQ11 | *S. alterniflora* | 50% | 100% | 150 | N | | | | |
| MHT1-03-OQ10 | *S. alterniflora* | 45% | 100% | 155 | N | | | | |
| MHT1-03-OQ9 | *S. alterniflora* | 60% | 100% | 134 | N | | | | |
| MHT1-03-CQ2 | *S. alterniflora* | 80% | 100% | 173 | N | 3101 | 27667 | 48 | 69 |
| MHT1-03-OQ8 | *S. alterniflora* | 30% | 40% | 126 | N | | | | |
| | *Scirpus robustus* | 5% | 7% | 92 | Y | | | | |
| | *Spartina cynosuroides* | 40% | 53% | 216 | Y | | | | |
| MHT1-03-CQ3 | *S. cynosuroides* | 40% | 53% | 182 | Y | 612 | 5464 | 52 | 95 |
| | *S. robustus* | 5% | 7% | 131 | N | 12 | 110 | 0 | 0 |
| | *Spartina patens* | 30% | 40% | 91 | N | 353 | 3148 | 0 | 0 |
| MHT1-03-CQ4 | *S. cynosuroides* | 45% | 82% | 207 | N | 730 | 6513 | 329 | 268 |
| | *S. robustus* | 10% | 18% | 146 | N | 218 | 1946 | 139 | 0 |
| MHT1-03-OQ7 | *Phragmites australis* | 90% | 100% | 272 | Y | | | | |
| MHT1-03-OQ6 | *P. australis* | 90% | 100% | 271 | Y | | | | |
| MHT1-03-CQ5 | *P. australis* | 80% | 100% | 242 | Y | 876 | 7815 | 735 | 243 |
| MHT1-03-OQ4 | *S. alterniflora* | 30% | 43% | 133 | N | | | | |
| | *S. patens* | 40% | 57% | 83 | Y | | | | |
| MHT1-03-OQ3 | *S. alterniflora* | 80% | 100% | 166 | N | | | | |
| MHT1-03-CQ6 | *S. alterniflora* | 20% | 36% | 137 | N | 406 | 3621 | 0 | 74 |
| | *S. patens* | 35% | 64% | 189 | Y | 461 | 4113 | 0 | 0 |
| MHT1-03-OQ2 | *S. alterniflora* | 30% | 43% | 102 | N | | | | |
| | *S. patens* | 40% | 57% | 76 | N | | | | |
| MHT1-03-OQ1 | *S. alterniflora* | 50% | 63% | 106 | N | | | | |
| | *S. patens* | 30% | 38% | 74 | Y | | | | |
| MHT1 - Mean - Spartina dominated Quadrats (b) | | 59% | | 142 | | 1382 | 12331 | 113 | 101 |
| MHT1 - Mean - Non-Spartina dominated Quadrats | | 87% | | -- | | 876 | 7815 | 735 | 243 |
| MHT1 - Mean - All Quadrats | | 63% | | -- | | 1298 | 11578 | 217 | 125 |
| **Mad Horse Creek - Transect 2 8/17/02** | | | | | | | | | |
| MHT2-03-OQ6 | *S. alterniflora* | 75% | 100% | 141 | Y | | | | |
| MHT2-03-OQ5 | *S. alterniflora* | 80% | 100% | 167 | N | | | | |
| MHT2-03-CQ2 | *S. alterniflora* | 80% | 100% | 161 | N | 1415 | 12622 | 0 | 405 |
| MHT2-03-OQ4 | *S. alterniflora* | 55% | 100% | 151 | N | | | | |
| MHT2-03-OQ3 | *S. alterniflora* | 80% | 100% | 152 | N | | | | |
| MHT2-03-OQ2 | *S. alterniflora* | 75% | 100% | 141 | Y | | | | |
| MHT2-03-OQ1 | *S. alterniflora* | 65% | 100% | 126 | N | | | | |
| MHT2-03-CQ1 | *S. alterniflora* | 70% | 100% | 151 | N | 1731 | 15443 | 0 | 38 |
| MHT2 - Mean - Spartina dominated Quadrats (b) | | 73% | | 149 | | 1573 | 14032 | 0 | 222 |
| MHT2 - Mean - Non-Spartina dominated Quadrats | | 0% | | -- | | 0 | 0 | 0 | 0 |
| MHT2 - Mean - All Quadrats | | 73% | | -- | | 1573 | 14032 | 0 | 222 |

**Table D-1**

**MAD HORSE CREEK REFERENCE MARSH**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Mad Horse Creek - Transect 3A 8/17/02** | | | | | | | | | |
| MHT3A-03-OQ18 | *S. alterniflora* | 40% | 53% | 121 | N | | | | |
| | *P. australis* | 5% | 7% | 131 | N | | | | |
| | *S. patens* | 30% | 40% | 81 | N | | | | |
| MHT3A-03-OQ17 | *S. alterniflora* | 30% | 33% | 91 | N | | | | |
| | *P. australis* | 10% | 11% | 121 | N | | | | |
| | *S. patens* | 20% | 22% | 91 | N | | | | |
| | *S. cynosuroides* | 15% | 17% | 151 | N | | | | |
| | *D. spicata* | 15% | 17% | 86 | N | | | | |
| MHT3A-03-OQ16 | *S. alterniflora* | 60% | 100% | 134 | N | | | | |
| MHT3A-03-OQ15 | *S. alterniflora* | 30% | 60% | 110 | N | | | | |
| | *S. patens* | 20% | 40% | 61 | N | | | | |
| MHT3A-03-OQ14 | *S. alterniflora* | 75% | 100% | 129 | N | | | | |
| MHT3A-03-OQ13 | *S. alterniflora* | 80% | 100% | 151 | N | | | | |
| MHT3A-03-CQ6 | *S. cynosuroides* | 75% | 99% | 189 | Y | 1175 | 10481 | 0 | 0 |
| | *S. robustus* | 1% | 1% | 110 | N | 1 | 5 | 0 | 110 |
| MHT3A-03-CQ5 | *S. alterniflora* | <1% | <1% | 95 | N | 4 | 37 | 0 | 117 |
| | *S. robustus* | <1% | <1% | 81 | N | 3 | 26 | 0 | 0 |
| | *S. cynosuroides* | 85% | 94% | 151 | N | 1003 | 8950 | 148 | 0 |
| | *S. patens* | 5% | 6% | 120 | N | 13 | 119 | 0 | 0 |
| MHT3A-03-OQ12 | *S. alterniflora* | 40% | 47% | 140 | N | | | | |
| | *S. patens* | 10% | 12% | 81 | N | | | | |
| | *S. cynosuroides* | 30% | 35% | 160 | N | | | | |
| | *D. spicata* | 5% | 6% | 85 | N | | | | |
| MHT3A-03-OQ11 | *S. alterniflora* | 40% | 53% | 121 | N | | | | |
| | *S. patens* | 5% | 7% | 81 | N | | | | |
| | *S. cynosuroides* | 30% | 40% | 141 | Y | | | | |
| MHT3A-03-CQ4 | *S. alterniflora* | 50% | 56% | 130 | N | 545 | 4862 | 0 | 2 |
| | *S. patens* | 5% | 6% | 81 | N | 29 | 259 | 0 | 0 |
| | *S. robustus* | 5% | 6% | 134 | N | 34 | 300 | 0 | 0 |
| | *S. cynosuroides* | 30% | 33% | 142 | N | 277 | 2469 | 0 | 0 |
| MHT3A-03-OQ10 | *S. alterniflora* | 55% | 100% | 111 | N | | | | |
| MHT3A-03-OQ9 | *S. alterniflora* | 65% | 100% | 121 | Y | | | | |
| MHT3A-03-CQ3 | *S. alterniflora* | 60% | 100% | 130 | N | 677 | 6040 | 0 | 1 |
| MHT3A-03-OQ8 | *S. alterniflora* | 65% | 81% | 136 | N | | | | |
| | *S. patens* | 15% | 19% | 81 | N | | | | |
| MHT3A-03-OQ7 | *S. alterniflora* | 70% | 93% | 131 | N | | | | |
| | *S. patens* | 5% | 7% | 83 | N | | | | |
| MHT3A-03-OQ6 | *S. alterniflora* | 70% | 78% | 151 | N | | | | |
| | *S. patens* | 20% | 22% | 80 | Y | | | | |
| MHT3A-03-OQ5 | *S. alterniflora* | 90% | 100% | 161 | N | | | | |
| MHT3A-03-OQ4 | *S. alterniflora* | 70% | 93% | 156 | Y | | | | |
| | *S. robustus* | 5% | 7% | 91 | Y | | | | |
| MHT3A-03-OQ3 | *P. australis* | 85% | 100% | 229 | Y | | | | |
| MHT3A-03-CQ2 | *P. australis* | 85% | 100% | 228 | Y | 1352 | 12061 | 0 | 647 |
| MHT3A-03-OQ2 | *P. australis* | 85% | 100% | 231 | Y | | | | |
| MHT3A-03-OQ1 | *P. australis* | 95% | 100% | 241 | Y | | | | |
| MHT3A-03-CQ1 | *P. australis* | 95% | 100% | 239 | Y | 1501 | 13394 | 211 | 99 |
| MHT3A - Mean - Spartina dominated Quadrats (b) | | 76% | | 136 | | 940 | 8387 | 37 | 58 |
| MHT3A - Mean - Non-Spartina dominated Quadra | | 89% | | -- | | 1426 | 12727 | 105 | 373 |
| MHT3A - Mean - All Quadrats | | 78% | | -- | | 1102 | 9834 | 60 | 163 |

**Table D-1**

**MAD HORSE CREEK REFERENCE MARSH**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter $gdw/m^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | |
| **Mad Horse Creek - Transect 3B 8/17/02** | | | | | | | | | |
| MHT3B-03-OQ6 | *S. alterniflora* | 90% | 100% | 138 | Y | | | | |
| MHT3B-03-OQ5 | *S. alterniflora* | 60% | 100% | 138 | N | | | | |
| MHT3B-03-CQ2 | *S. alterniflora* | 90% | 100% | 143 | N | 1475 | 13157 | 0 | 75 |
| MHT3B-03-OQ4 | *S. alterniflora* | 100% | 100% | 142 | N | | | | |
| MHT3B-03-OQ3 | *S. alterniflora* | 60% | 60% | 164 | N | | | | |
| | *Amaranthus cannabinus* | 40% | 40% | 203 | Y | | | | |
| MHT3B-03-OQ2 | *S. alterniflora* | 80% | 100% | 160 | N | | | | |
| MHT3B-03-OQ1 | *S. alterniflora* | 90% | 100% | 165 | N | | | | |
| MHT3B-03-CQ1 | *S. alterniflora* | 50% | 100% | 118 | N | 589 | 5254 | 0 | 46 |
| MHT3B - Mean - Spartina dominated Quadrats (b) | | 83% | | 146 | | 1032 | 9205 | 0 | 61 |
| MHT3B - Mean - Non-Spartina dominated Quadra | | 0% | | -- | | 0 | 0 | 0 | 0 |
| MHT3B - Mean - All Quadrats | | 83% | | -- | | 1032 | 9205 | 0 | 61 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 70% | | 141 | | 1221 | 10898 | 61 | 112 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 88% | | -- | | 1243 | 11090 | 315 | 329 |
| Site Mean - All Quadrats | | 72% | | -- | | 1106 | 9872 | 115 | 159 |

**Table D-2**
**MOORES BEACH REFERENCE MARSH**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter gdw/m² |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m² | lb/acre | gdw/m² | |
| **Moores Beach - Transect 1 8/21/02** | | | | | | | | | |
| MBT1-03-OQ6 | *S. alterniflora* | 65% | 100% | 102 | N | | | | |
| MBT1-03-OQ5 | *S. alterniflora* | 80% | 100% | 180 | N | | | | |
| MBT1-03-OQ4 | *S. alterniflora* | 70% | 100% | 148 | N | | | | |
| MBT1-03-OQ3 | *S. alterniflora* | 50% | 100% | 212 | N | | | | |
| MBT1-03-CQ2 | *S. alterniflora* | 40% | 100% | 77 | N | 2466 | 22004 | 0 | 46 |
| MBT1-03-OQ2 | *S. alterniflora* | 80% | 100% | 108 | N | | | | |
| MBT1-03-CQ1 | *S. alterniflora* | 80% | 100% | 147 | N | 503 | 4490 | 0 | 12 |
| MBT1-03-OQ1 | *S. alterniflora* | 60% | 100% | 118 | N | | | | |
| MBT1 - Mean - Spartina dominated Quadrats (b) | | 66% | | 137 | | 1485 | 13247 | 0 | 29 |
| MBT1 - Mean - Non-Spartina dominated Quadrats | | 0% | | -- | | 0 | 0 | 0 | 0 |
| MBT1 - Mean - All Quadrats | | 66% | | -- | | 1485 | 13247 | 0 | 29 |
| **Moores Beach - Transect 2 8/21/02** | | | | | | | | | |
| MBT2-03-OQ6 | *S. alterniflora* | 70% | 100% | 143 | Y | | | | |
| MBT2-03-CQ2 | *S. alterniflora* | 80% | 100% | 103 | N | 897 | 8005 | 0 | 64 |
| MBT2-03-CQ1 | *S. alterniflora* | 85% | 100% | 120 | N | 976 | 8704 | 0 | 76 |
| MBT2-03-OQ5 | *S. alterniflora* | 80% | 100% | 131 | N | | | | |
| MBT2-03-OQ4 | *S. alterniflora* | 65% | 100% | 101 | N | | | | |
| MBT2-03-OQ3 | *S. alterniflora* | 95% | 100% | 150 | Y | | | | |
| MBT2-03-OQ2 | *S. alterniflora* | 85% | 100% | 110 | N | | | | |
| MBT2-03-OQ1 | *S. alterniflora* | 85% | 100% | 130 | Y | | | | |
| MBT2 - Mean - Spartina dominated Quadrats (b) | | 81% | | 124 | | 936 | 8354 | 0 | 70 |
| MBT2 - Mean - Non-Spartina dominated Quadrats | | 0% | | -- | | 0 | 0 | 0 | 0 |
| MBT2 - Mean - All Quadrats | | 81% | | -- | | 936 | 8354 | 0 | 70 |
| **Moores Beach - Transect 3 8/21/02** | | | | | | | | | |
| MBT3-03-CQ2 | *S. alterniflora* | 50% | 100% | 56 | N | 621 | 5541 | 0 | 17 |
| MBT3-03-OQ6 | *S. alterniflora* | 75% | 100% | 73 | N | | | | |
| MBT3-03-OQ5 | *S. alterniflora* | 55% | 100% | 121 | Y | | | | |
| MBT3-03-CQ1 | *S. alterniflora* | 80% | 100% | 71 | N | 1450 | 12933 | 115 | 51 |
| MBT3-03-OQ4 | *S. alterniflora* | 70% | 100% | 115 | Y | | | | |
| MBT3-03-OQ3 | *S. alterniflora* | 75% | 100% | 113 | Y | | | | |
| MBT3-03-OQ2 | *S. alterniflora* | 65% | 100% | 97 | N | | | | |
| MBT3-03-OQ1 | *S. alterniflora* | 70% | 100% | 91 | N | | | | |
| MBT3 - Mean - Spartina dominated Quadrats (b) | | 68% | | 92 | | 1035 | 9237 | 57 | 34 |
| MBT3 - Mean - Non-Spartina dominated Quadrats | | 0% | | -- | | 0 | 0 | 0 | 0 |
| MBT3- Mean - All Quadrats | | 68% | | -- | | 1035 | 9237 | 57 | 34 |
| Site Mean - Spartina dominated Quadrats (b) | | 71% | | 111 | | 1152 | 10280 | 19 | 44 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 0% | | -- | | 0 | 0 | 0 | 0 |
| Site Mean - All Quadrats | | 71% | | -- | | 1152 | 10280 | 19 | 44 |

**Table D-3**

**COMMERCIAL TOWNSHIP SALT HAY FARM WETLAND RESTORATION SITE**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Commercial Township - Transect 1 8/22/02** | | | | | | | | | |
| CTT1-03-CQ1 | *S. alterniflora* | 50% | 100% | 126 | N | 704 | 6285 | 0 | 477 |
| CTT1-03-OQ6 | *S. alterniflora* | 80% | 100% | 162 | N | | | | |
| CTT1-03-OQ5 | *S. alterniflora* | 75% | 100% | 151 | Y | | | | |
| CTT1-03-OQ4 | *S. alterniflora* | 85% | 100% | 160 | Y | | | | |
| CTT1-03-OQ3 | *S. alterniflora* | 90% | 100% | 163 | Y | | | | |
| CTT1-03-OQ2 | *S. alterniflora* | 95% | 100% | 180 | Y | | | | |
| CTT1-03-CQ2 | *S. alterniflora* | 70% | 100% | 164 | N | 1088 | 9703 | 0 | 293 |
| CTT1-03-OQ1 | *S. alterniflora* | 95% | 100% | 160 | Y | | | | |
| CTT1 - Mean - Spartina dominated Quadrats (b) | | 80% | | 158 | | 896 | 7994 | 0 | 385 |
| CTT1 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| CTT1- Mean - All Quadrats | | 80% | | -- | | 896 | 7994 | 0 | 385 |
| **Commercial Township - Transect 2 8/22/02** | | | | | | | | | |
| CTT2-03-CQ1 | *S. alterniflora* | 95% | 100% | 241 | Y | 4691 | 41851 | 0 | 16 |
| CTT2-03-OQ1 | *S. alterniflora* | 95% | 100% | 242 | Y | | | | |
| CTT2-03-CQ2 | *S. alterniflora* | 65% | 100% | 180 | Y | 916 | 8174 | 0 | 13 |
| CTT2-03-OQ2 | *S. alterniflora* | 95% | 100% | 238 | Y | | | | |
| CTT2-03-OQ3 | Mud Flat | 0% | 0% | | | | | | |
| CTT2-03-OQ4 | Mud Flat | 0% | 0% | | | | | | |
| CTT2-03-OQ5 | Mud Flat | 0% | 0% | | | | | | |
| CTT2-03-OQ6 | Mud Flat | 0% | 0% | | | | | | |
| CTT2 - Mean - Spartina dominated Quadrats (b) | | 88% | | 225 | | 2803 | 25013 | 0 | 15 |
| CTT2 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| CTT2- Mean - All Quadrats | | 44% | | -- | | 2803 | 25013 | 0 | 15 |
| **Commercial Township - Transect 3 8/22/02** | | | | | | | | | |
| CTT3-03-CQ1 | *S. alterniflora* | 95% | 100% | 275 | Y | 5812 | 51859 | 0 | 3 |
| CTT3-03-CQ2 | *S. alterniflora* | 80% | 100% | 191 | Y | 835 | 7449 | 0 | 11 |
| CTT3-03-OQ6 | *S. alterniflora* | 95% | 100% | 271 | Y | | | | |
| CTT3-03-OQ5 | *S. alterniflora* | 95% | 100% | 175 | Y | | | | |
| CTT3-03-OQ4 | Mud Flat | 0% | 0% | | | | | | |
| CTT3-03-OQ3 | Mud Flat | 0% | 0% | | | | | | |
| CTT3-03-OQ2 | Mud Flat | 0% | 0% | | | | | | |
| CTT3-03-OQ1 | Mud Flat | 0% | 0% | | | | | | |
| CTT3 - Mean - Spartina dominated Quadrats (b) | | 91% | | 228 | | 3324 | 29654 | 0 | 7 |
| CTT3 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| CTT3- Mean - All Quadrats | | 46% | | -- | | 3324 | 29654 | 0 | 7 |
| **Commercial Township - Transect 4 8/22/02** | | | | | | | | | |
| CTT4-02-Q | | | | | | | | | |
| CTT4 - Mean - Spartina dominated Quadrats (b) | | 0% | | 0 | | 0 | 0 | 0 | 0 |
| CTT4 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | 0 | | 0 | 0 | 0 | 0 |
| CTT4- Mean - All Quadrats | | 0% | | 0 | | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 85% | | 192 | | 2341 | 20887 | 0 | 136 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 0% | | -- | | 0 | 0 | 0 | 0 |
| Site Mean - All Quadrats | | 56% | | -- | | 2341 | 20887 | 0 | 136 |

**Table D-4**
**ALLOWAY CREEK WATERSHED WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Alloway Creek Watershed - Transect 1 8/16/02** | | | | | | | | | |
| ACWT1-03-OQ18 | *S. alterniflora* | 70% | 100% | 155 | N | | | | |
| ACWT1-03-OQ17 | *S. alterniflora* | 40% | 100% | 122 | N | | | | |
| ACWT1-03-OQ16 | *S. alterniflora* | 38% | 97% | 115 | Y | | | | |
| | *Pluchea purpurascens* | 1% | 3% | 68 | Y | | | | |
| ACWT1-03-OQ15 | *S. alterniflora* | 50% | 100% | 160 | Y | | | | |
| ACWT1-03-OQ14 | *S. alterniflora* | 75% | 88% | 124 | Y | | | | |
| | *P. australis* | 5% | 6% | 104 | N | | | | |
| | *S. robustus* | 5% | 6% | 55 | Y | | | | |
| ACWT1-03-CQ6 | *S. alterniflora* | 60% | 80% | 154 | N | 581 | 5183 | 0 | 0 |
| | *P. australis* | 15% | 20% | 110 | Y | 152 | 1355 | 0 | 0 |
| ACWT1-03-OQ13 | *S. alterniflora* | 70% | 99% | 149 | N | | | | |
| | *Peltandra virginica* | 1% | 1% | 58 | N | | | | |
| ACWT1-03-OQ12 | *S. alterniflora* | 85% | 100% | 151 | N | | | | |
| ACWT1-03-OQ11 | *S. alterniflora* | 70% | 97% | 129 | N | | | | |
| | *S. robustus* | 1% | 1% | 144 | Y | | | | |
| | *Echinochloa walteri* | 1% | 1% | 85 | Y | | | | |
| ACWT1-03-OQ10 | *S. alterniflora* | 80% | 80% | 171 | Y | | | | |
| | *P. australis* | 10% | 10% | 185 | Y | | | | |
| | *S. robustus* | 10% | 10% | 143 | Y | | | | |
| ACWT1-03-CQ5 | *S. alterniflora* | 70% | 99% | 160 | Y | 1948 | 17381 | 0 | 20 |
| | *A. cannabinus* | 1% | 1% | 154 | Y | 6 | 55 | 0 | 0 |
| ACWT1-03-CQ4 | *S. alterniflora* | 15% | 23% | 117 | N | 361 | 3221 | 0 | 184 |
| | *P. australis* | 10% | 15% | 159 | N | 146 | 1306 | 0 | 0 |
| | *Typha spp.* | 40% | 62% | 167 | N | 473 | 4222 | 68 | 0 |
| ACWT1-03-OQ9 | *S. alterniflora* | 25% | 33% | 119 | N | | | | |
| | *P. australis* | 5% | 7% | 198 | Y | | | | |
| | *Typha spp.* | 45% | 60% | 195 | N | | | | |
| ACWT1-03-OQ8 | *S. alterniflora* | 70% | 86% | 165 | N | | | | |
| | *P. australis* | 10% | 12% | 114 | Y | | | | |
| | *S. robustus* | 1% | 1% | 120 | Y | | | | |
| ACWT1-03-CQ3 | *P. australis* | 40% | 100% | 214 | Y | 932 | 8313 | 2 | 205 |
| ACWT1-03-CQ2 | *S. alterniflora* | 20% | 80% | 167 | N | 431 | 3842 | 9 | 449 |
| | *S. robustus* | 5% | 20% | 160 | N | 97 | 866 | 0 | 0 |
| ACWT1-03-OQ7 | *S. alterniflora* | 70% | 84% | 154 | Y | | | | |
| | *P. australis* | 10% | 12% | 192 | Y | | | | |
| | *Typha spp.* | 1% | 1% | 153 | N | | | | |
| | *S. robustus* | 1% | 1% | 116 | Y | | | | |
| | *E. walteri* | 1% | 1% | 140 | Y | | | | |
| ACWT1-03-OQ6 | *S. alterniflora* | 5% | 6% | 155 | N | | | | |
| | *P. australis* | 80% | 93% | 246 | Y | | | | |
| | *P. purpurascens* | 1% | 1% | 92 | Y | | | | |
| ACWT1-03-OQ5 | *S. alterniflora* | 10% | 14% | 156 | N | | | | |
| | *P. australis* | 60% | 86% | 229 | Y | | | | |
| ACWT1-03-OQ4 | *S. alterniflora* | 30% | 40% | 134 | N | | | | |
| | *P. australis* | 5% | 7% | 174 | Y | | | | |
| | *Typha spp.* | 40% | 53% | 192 | N | | | | |
| ACWT1-03-CQ1 | *S. alterniflora* | 80% | 100% | 135 | Y | 1247 | 11129 | 88 | 348 |
| ACWT1-03-OQ3 | *S. alterniflora* | 15% | 18% | 135 | N | | | | |
| | *P. australis* | 70% | 82% | 253 | Y | | | | |
| ACWT1-03-OQ2 | *S. alterniflora* | 10% | 12% | 124 | N | | | | |
| | *P. australis* | 75% | 88% | 239 | Y | | | | |
| ACWT1-03-OQ1 | *S. alterniflora* | 20% | 27% | 208 | N | | | | |
| | *P. australis* | 55% | 73% | 249 | Y | | | | |
| ACWT1 - Mean - Spartina dominated Quadrats (b) | | 70% | | 148 | | 1206 | 10758 | 24 | 250 |
| ACWT1 - Mean - Non-Spartina dominated Quadrat | | 72% | | -- | | 956 | 8531 | 35 | 194 |
| ACWT1- Mean - All Quadrats | | 70% | | -- | | 1123 | 10016 | 28 | 232 |

**Table D-4**
**ALLOWAY CREEK WATERSHED WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Alloway Creek Watershed - Transect 2 8/15/02** | | | | | | | | | |
| ACWT2-03-OQ6 | *S. alterniflora* | 85% | 100% | 163 | Y | | | | |
| ACWT2-03-OQ5 | *S. alterniflora* | 55% | 100% | 91 | N | | | | |
| ACWT2-03-OQ4 | *S. alterniflora* | 80% | 100% | 172 | Y | | | | |
| ACWT2-03-OQ3 | *S. alterniflora* | 65% | 100% | 131 | Y | | | | |
| ACWT2-03-CQ2 | *S. alterniflora* | 55% | 85% | 187 | Y | 1519 | 13555 | 18 | 264 |
| | *P. australis* | 10% | 15% | 174 | N | 37 | 334 | 0 | 0 |
| ACWT2-03-OQ2 | *S. alterniflora* | 95% | 100% | 181 | Y | | | | |
| ACWT2-03-CQ1 | *S. alterniflora* | 70% | 100% | 153 | Y | 1017 | 9074 | 0 | 60 |
| ACWT2-03-OQ1 | *S. alterniflora* | 60% | 86% | 159 | Y | | | | |
| | *P. australis* | 10% | 14% | 183 | N | | | | |
| ACWT2 - Mean - Spartina dominated Quadrats (b) | | 73% | | 154 | | 1287 | 11482 | 9 | 162 |
| ACWT2 - Mean - Non-Spartina dominated Quadrat | | 0% | | -- | | 0 | 0 | 0 | 0 |
| ACWT2- Mean - All Quadrats | | 73% | | -- | | 1287 | 11482 | 9 | 162 |
| **Alloway Creek Watershed - Transect 3 8/15/02** | | | | | | | | | |
| ACWT3-03-OQ12 | Wrack | 0% | 0% | | | | | | |
| ACWT3-03-CQ4 | *S. alterniflora* | 80% | 100% | 102 | N | 672 | 5994 | 0 | 0 |
| ACWT3-03-OQ11 | *S. alterniflora* | 80% | 94% | 121 | N | | | | |
| | *E. walteri* | 5% | 6% | 139 | Y | | | | |
| ACWT3-03-OQ10 | *S. alterniflora* | 85% | 100% | 100 | N | | | | |
| ACWT3-03-OQ9 | *S. alterniflora* | 40% | 67% | 151 | N | | | | |
| | *E. walteri* | 20% | 33% | 129 | Y | | | | |
| ACWT3-03-OQ8 | *E. walteri* | 65% | 100% | 151 | Y | | | | |
| ACWT3-03-CQ3 | *E. walteri* | 85% | 100% | 151 | Y | 1422 | 12691 | 0 | 7 |
| ACWT3-03-CQ2 | *S. alterniflora* | 85% | 100% | 131 | N | 1047 | 9340 | 2 | 60 |
| ACWT3-03-OQ7 | *S. alterniflora* | 65% | 100% | 116 | N | | | | |
| ACWT3-03-OQ6 | *E. walteri* | 20% | 95% | 115 | Y | | | | |
| | *P. australis* | 1% | 5% | 140 | N | | | | |
| ACWT3-03-OQ5 | *E. walteri* | 10% | 100% | 91 | Y | | | | |
| ACWT3-03-CQ1 | *E. walteri* | 30% | 86% | 89 | Y | 143 | 1273 | 0 | 307 |
| | Dead *P. australis* | 5% | 14% | 128 | N | 0 | 0 | 222 | 0 |
| ACWT3-03-OQ4 | *S. alterniflora* | 35% | 100% | 85 | N | | | | |
| ACWT3-03-OQ3 | *S. alterniflora* | 65% | 100% | 136 | N | | | | |
| ACWT3-03-OQ2 | *S. alterniflora* | 35% | 100% | 108 | N | | | | |
| ACWT3-03-OQ1 | *S. alterniflora* | 15% | 100% | 91 | N | | | | |
| ACWT3 - Mean - Spartina dominated Quadrats (b) | | 61% | | 114 | | 859 | 7667 | 1 | 30 |
| ACWT3 - Mean - Non-Spartina dominated Quadrat | | 36% | | -- | | 783 | 6982 | 111 | 157 |
| ACWT3- Mean - All Quadrats | | 52% | | -- | | 821 | 7324 | 56 | 94 |

**Table D-4**
**ALLOWAY CREEK WATERSHED WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Alloway Creek Watershed - Transect 4 8/18/02** | | | | | | | | | |
| ACWT4-03-CQ6 | *P. australis* | 40% | 100% | 240 | Y | 661 | 5900 | 111 | 300 |
| ACWT4-03-OQ18 | *P. australis* | 40% | 100% | 265 | Y | | | | |
| ACWT4-03-CQ5 | *P. australis* | 60% | 100% | 260 | Y | 288 | 2573 | 906 | 0 |
| ACWT4-03-OQ16 | *P. australis* | 5% | 100% | 106 | N | | | | |
| ACWT4-03-OQ17 | Wrack | 0% | 0% | | | | | | |
| ACWT4-03-OQ15 | *S. alterniflora* | 90% | 100% | 221 | Y | | | | |
| ACWT4-03-OQ14 | *S. alterniflora* | 50% | 71% | 130 | N | | | | |
| | *P. virginica* | 5% | 7% | 80 | N | | | | |
| | *S. cynosuroides* | 15% | 21% | 129 | N | | | | |
| ACWT4-03-OQ13 | *S. alterniflora* | 50% | 63% | 110 | N | | | | |
| | *S. cynosuroides* | 30% | 38% | 101 | N | | | | |
| ACWT4-03-CQ4 | *S. alterniflora* | 70% | 93% | 141 | Y | 889 | 7929 | 0 | 89 |
| | *P. virginica* | 5% | 7% | 93 | N | 27 | 245 | 0 | 0 |
| ACWT4-03-OQ12 | *S. alterniflora* | 40% | 53% | 149 | N | | | | |
| | *P. virginica* | 5% | 7% | 81 | N | | | | |
| | *S. cynosuroides* | 30% | 40% | 109 | N | | | | |
| ACWT4-03-OQ11 | *S. alterniflora* | 60% | 100% | 179 | Y | | | | |
| ACWT4-03-OQ10 | *S. alterniflora* | 55% | 100% | 195 | Y | | | | |
| ACWT4-03-CQ3 | *S. alterniflora* | 70% | 100% | 161 | N | 1284 | 11455 | 0 | 0 |
| ACWT4-03-CQ2 | *E. walteri* | 15% | 75% | 91 | Y | 140 | 1250 | 0 | 0 |
| | *Typha spp.* | 5% | 25% | 72 | N | 6 | 50 | 0 | 0 |
| ACWT4-03-OQ9 | *Typha spp.* | 25% | 83% | 155 | N | | | | |
| | *S. cynosuroides* | 5% | 17% | 61 | N | | | | |
| ACWT4-03-OQ8 | *E. walteri* | 20% | 100% | 109 | Y | | | | |
| ACWT4-03-CQ1 | *E. walteri* | 20% | 100% | 110 | Y | 506 | 4514 | 0 | 149 |
| ACWT4-03-OQ7 | *Typha spp.* | 10% | 100% | 140 | N | | | | |
| ACWT4-03-OQ6 | Mud Flat | 0% | 0% | | | | | | |
| ACWT4-03-OQ5 | Wrack | 0% | 0% | | | | | | |
| ACWT4-03-OQ4 | Wrack | 0% | 0% | | | | | | |
| ACWT4-03-OQ3 | *S. alterniflora* | 5% | 100% | 81 | N | | | | |
| ACWT4-03-OQ2 | *S. alterniflora* | 25% | 83% | 191 | Y | | | | |
| | *P. virginica* | 5% | 17% | 71 | N | | | | |
| ACWT4-03-OQ1 | *S. alterniflora* | 40% | 50% | 133 | Y | | | | |
| | *E. walteri* | 25% | 31% | 141 | Y | | | | |
| | *P. virginica* | 15% | 19% | 90 | N | | | | |
| ACWT4 - Mean - Spartina dominated Quadrats (b) | | 63% | | 145 | | 1100 | 9815 | 0 | 44 |
| ACWT4 - Mean - Non-Spartina dominated Quadrat | | 19% | | -- | | 400 | 3572 | 254 | 112 |
| ACWT4- Mean - All Quadrats | | 39% | | -- | | 634 | 5653 | 169 | 90 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 67% | | 142 | | 1132 | 10096 | 12 | 147 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 36% | | -- | | 635 | 5664 | 164 | 144 |
| Site Mean - All Quadrats | | 56% | | -- | | 911 | 0 | 79 | 146 |

**Table D-5**

**COHANSEY RIVER WATERSHED WETLAND RESTORATION SITE**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Brown's Run - Transect 1 8/19/02** | | | | | | | | | |
| BRT1-03-OQ6 | *S. alterniflora* | 50% | 83% | 95 | N | | | | |
| | *A. cannabinus* | 10% | 17% | 161 | Y | | | | |
| BRT1-03-OQ5 | *S. alterniflora* | 85% | 94% | 137 | Y | | | | |
| | *A. cannabinus* | 5% | 6% | 150 | Y | | | | |
| BRT1-03-CQ2 | *S. alterniflora* | 70% | 88% | 181 | N | 1624 | 14485 | 59 | 66 |
| | *A. cannabinus* | 10% | 13% | 150 | Y | 43 | 388 | 0 | 0 |
| BRT1-03-OQ4 | *S. alterniflora* | 70% | 100% | 175 | Y | | | | |
| BRT1-03-CQ1 | *S. alterniflora* | 70% | 100% | 202 | Y | 2464 | 21988 | 0 | 39 |
| BRT1-03-OQ3 | *S. alterniflora* | 50% | 71% | 150 | N | | | | |
| | *S. cynosuroides* | 20% | 29% | 224 | Y | | | | |
| BRT1-03-OQ2 | *S. alterniflora* | 90% | 100% | 184 | Y | | | | |
| BRT1-03-OQ1 | *S. alterniflora* | 60% | 100% | 137 | Y | | | | |
| BRT1 - Mean - Spartina dominated Quadrats (b) | | 74% | | 165 | | 2066 | 18430 | 30 | 53 |
| BRT1 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| BRT1- Mean - All Quadrats | | 74% | | -- | | 2066 | 18430 | 30 | 53 |
| **Brown's Run - Transect 2 8/19/02** | | | | | | | | | |
| BRT2-03-OQ6 | *S. alterniflora* | 70% | 100% | 101 | N | | | | |
| BRT2-03-OQ5 | *S. alterniflora* | 75% | 100% | 110 | N | | | | |
| BRT2-03-OQ4 | *S. alterniflora* | 50% | 100% | 132 | Y | | | | |
| BRT2-03-CQ2 | *S. alterniflora* | 50% | 100% | 132 | Y | 884 | 7888 | 0 | 182 |
| BRT2-03-OQ3 | *S. alterniflora* | 30% | 100% | 111 | N | | | | |
| BRT2-03-OQ2 | Mud Flat | 0% | 0% | | | | | | |
| BRT2-03-OQ1 | *S. alterniflora* | 30% | 100% | 42 | N | | | | |
| BRT2-03-CQ1 | *S. alterniflora* | 50% | 100% | 180 | Y | 1130 | 10083 | 0 | 43 |
| BRT2 - Mean - Spartina dominated Quadrats (b) | | 51% | | 115 | | 1007 | 8985 | 0 | 112 |
| BRT2 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| BRT2- Mean - All Quadrats | | 44% | | -- | | 1007 | 8985 | 0 | 75 |
| **Brown's Run - Transect 3 8/20/02** | | | | | | | | | |
| BRT3-03-OQ6 | Mud Flat | 0% | 0% | | | | | | |
| BRT3-03-CQ2 | *S. alterniflora* | 75% | 100% | 112 | N | 1335 | 11915 | 0 | 34 |
| BRT3-03-OQ5 | *S. alterniflora* | 60% | 67% | 181 | N | | | | |
| | *S. cynosuroides* | 30% | 33% | 251 | Y | | | | |
| BRT3-03-CQ1 | *S. alterniflora* | 65% | 100% | 132 | N | 723 | 6455 | 0 | 32 |
| BRT3-03-OQ4 | *S. alterniflora* | 25% | 100% | 71 | N | | | | |
| BRT3-03-OQ3 | *S. alterniflora* | 45% | 100% | 93 | N | | | | |
| BRT3-03-OQ2 | *S. alterniflora* | 80% | 100% | 152 | N | | | | |
| BRT3-03-OQ1 | *S. alterniflora* | 65% | 81% | 151 | N | | | | |
| | *S. cynosuroides* | 15% | 19% | 170 | N | | | | |
| BRT3 - Mean - Spartina dominated Quadrats (b) | | 66% | | 146 | | 1029 | 9185 | 0 | 33 |
| BRT3 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| BRT3- Mean - All Quadrats | | 58% | | -- | | 0 | 0 | 0 | 33 |
| **Brown's Run - Transect 4 8/20/02** | | | | | | | | | |
| BRT4-03-OQ1 | *S. alterniflora* | 90% | 100% | 130 | Y | | | | |
| BRT4-03-OQ2 | *S. alterniflora* | 90% | 90% | 183 | Y | | | | |
| | *S. robustus* | 10% | 10% | 146 | Y | | | | |
| BRT4-03-OQ3 | *S. alterniflora* | 100% | 100% | 167 | Y | | | | |
| BRT4-03-OQ4 | *S. alterniflora* | 100% | 100% | 222 | Y | | | | |
| BRT4-03-OQ5 | *S. alterniflora* | 80% | 100% | 153 | Y | | | | |
| BRT4-03-OQ6 | *S. alterniflora* | 50% | 56% | 220 | Y | | | | |
| | *P. virginica* | 10% | 11% | 182 | Y | | | | |
| | *S. cynosuroides* | 30% | 33% | 106 | Y | | | | |
| BRT4-03-CQ1 | *S. alterniflora* | 50% | 100% | 122 | Y | 322 | 2871 | 0 | 0 |
| BRT4-03-CQ2 | *S. alterniflora* | 90% | 90% | 202 | Y | 953 | 8503 | 0 | 76 |
| | *S. robustus* | 10% | 10% | 158 | Y | 11 | 101 | 0 | 0 |
| BRT4 - Mean - Spartina dominated Quadrats (b) | | 89% | | 167 | | 643 | 5738 | 0 | 38 |
| BRT4 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| BRT4- Mean - All Quadrats | | 89% | | -- | | 643 | 5738 | 0 | 38 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 71% | | 150 | | 1186 | 10585 | 7 | 59 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 0% | | -- | | 0 | 0 | 0 | 0 |
| Site Mean - All Quadrats | | 66% | | -- | | 1186 | 0 | 7 | 52 |

**Table D-6**
**THE ROCKS WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **The Rocks - Transect 1 8/18/03** | | | | | | | | | |
| TRT1-03-CQ4 | *S. alterniflora* | 5% | 7% | 117 | N | 13 | 113 | 0 | 0 |
| | *S. robustus* | 5% | 7% | 137 | Y | 3 | 22 | 0 | 0 |
| | *Typha spp.* | 60% | 86% | 182 | N | 1081 | 9646 | 132 | 0 |
| TRT1-03-OQ12 | *S. alterniflora* | 30% | 38% | 136 | Y | | | | |
| | *Typha spp.* | 50% | 63% | 106 | N | | | | |
| TRT1-03-CQ3 | *S. alterniflora* | 5% | 6% | 110 | N | 43 | 383 | 0 | 508 |
| | *Typha spp.* | 75% | 94% | 160 | Y | 1040 | 9275 | 92 | 0 |
| TRT1-03-OQ11 | *S. alterniflora* | 75% | 93% | 124 | Y | | | | |
| | *Polygonum punctatum* | 1% | 1% | 67 | Y | | | | |
| | *S. validus* | 5% | 6% | 148 | N | | | | |
| TRT1-03-OQ10 | *S. alterniflora* | 15% | 17% | 109 | Y | | | | |
| | *P. punctatum* | 75% | 83% | 85 | Y | | | | |
| TRT1-03-OQ9 | *S. alterniflora* | 55% | 85% | 151 | Y | | | | |
| | *P. punctatum* | 10% | 15% | 144 | Y | | | | |
| TRT1-03-OQ8 | *S. alterniflora* | 55% | 100% | 159 | Y | | | | |
| TRT1-03-CQ2 | *S. alterniflora* | 75% | 94% | 147 | Y | 946 | 8442 | 7 | 0 |
| | *S. robustus* | 5% | 6% | 89 | Y | 15 | 130 | 0 | 0 |
| TRT1-03-OQ7 | *S. alterniflora* | 75% | 100% | 151 | Y | | | | |
| TRT1-03-OQ6 | *S. alterniflora* | 15% | 23% | 142 | Y | | | | |
| | *P. punctatum* | 10% | 15% | 138 | Y | | | | |
| | *A. cannabinus* | 15% | 23% | 130 | Y | | | | |
| | *S. cynosuroides* | 25% | 38% | 145 | Y | | | | |
| TRT1-03-OQ5 | *S. alterniflora* | 20% | 24% | 175 | Y | | | | |
| | *P. punctatum* | 15% | 18% | 132 | Y | | | | |
| | *A. cannabinus* | 10% | 12% | 142 | Y | | | | |
| | *S. cynosuroides* | 40% | 47% | 201 | Y | | | | |
| TRT1-03-CQ1 | *S. alterniflora* | 40% | 53% | 108 | Y | 952 | 8492 | 0 | 29 |
| | *S. robustus* | 5% | 7% | 89 | N | 14 | 127 | 9 | 0 |
| | *P. punctatum* | 30% | 40% | 125 | Y | 198 | 1768 | 0 | 0 |
| TRT1-03-OQ4 | *S. alterniflora* | 80% | 100% | 112 | Y | | | | |
| TRT1-03-OQ3 | *S. alterniflora* | 30% | 50% | 130 | Y | | | | |
| | *P. punctatum* | 20% | 33% | 135 | Y | | | | |
| | *S. robustus* | 10% | 17% | 147 | Y | | | | |
| TRT1-03-OQ2 | *S. alterniflora* | 30% | 43% | 155 | Y | | | | |
| | *P. punctatum* | 15% | 21% | 135 | Y | | | | |
| | *A. cannabinus* | 20% | 29% | 130 | Y | | | | |
| | *S. cynosuroides* | 5% | 7% | 171 | Y | | | | |
| TRT1-03-OQ1 | *S. alterniflora* | 30% | 49% | 85 | N | | | | |
| | *Typha spp.* | 20% | 33% | 101 | N | | | | |
| | *P. punctatum* | 10% | 16% | 75 | Y | | | | |
| | *S. robustus* | 1% | 2% | 57 | Y | | | | |
| TRT1 - Mean - Spartina dominated Quadrats (b) | | 72% | | 143 | | 1063 | 9480 | 8 | 15 |
| TRT1 - Mean - Non-Spartina dominated Quadrats ( | | 80% | | -- | | 1089 | 9720 | 112 | 254 |
| TRT1- Mean - All Quadrats | | 73% | | -- | | 1076 | 9600 | 60 | 134 |

**Table D-6**
**THE ROCKS WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ |
| **The Rocks - Transect 2 8/14/02** | | | | | | | | | |
| TRT2-03-CQ1 | *Typha spp.* | 30% | 81% | 136 | N | 334 | 2980 | 0 | 0 |
| | *Scirpus olneyi* | 2% | 5% | 54 | N | 6 | 51 | 17 | 0 |
| | *S. cynosuroides* | 5% | 14% | 137 | N | 30 | 264 | 112 | 309 |
| TRT2-03-CQ2 | *Typha spp.* | 33% | 94% | 108 | N | 276 | 2459 | 0 | 70 |
| | *S. olneyi* | 1% | 3% | 84 | N | 10 | 91 | 21 | 0 |
| | Dead *P. australis* | 1% | 3% | 188 | N | 0 | 0 | 58 | 0 |
| TRT2-03-OQ1 | *S. olneyi* | 5% | 13% | 73 | N | | | | |
| | *Typha spp.* | 5% | 13% | 94 | N | | | | |
| | *P. purpurascens* | 30% | 75% | 38 | N | | | | |
| TRT2-03-OQ2 | *Typha spp.* | 40% | 100% | 149 | N | | | | |
| TRT2-03-OQ3 | *Typha spp.* | 40% | 89% | 197 | N | | | | |
| | *S. alterniflora* | 5% | 11% | 142 | N | | | | |
| TRT2-03-CQ3 | Dead *Typha spp.* | 5% | 9% | 106 | N | 0 | 0 | 80 | 0 |
| | Dead *P. australis* | 20% | 36% | 322 | N | 0 | 0 | 893 | 510 |
| | *P. purpurascens* | 30% | 55% | 56 | Y | 67 | 598 | 0 | 0 |
| TRT2-03-OQ4 | Dead *P. australis* | 40% | 100% | 292 | N | | | | |
| TRT2-03-CQ4 | Dead *P. australis* | 15% | 50% | 224 | N | 0 | 0 | 635 | 0 |
| | *Typha spp.* | 5% | 17% | 168 | N | 46 | 408 | 259 | 351 |
| | *P. purpurascens* | 10% | 33% | 53 | N | 7 | 64 | 0 | 0 |
| TRT2-03-OQ5 | *S. patens* | 80% | 89% | 92 | N | | | | |
| | *E. walteri* | 10% | 11% | 137 | Y | | | | |
| TRT2-03-OQ6 | *P. purpurascens* | 25% | 100% | 62 | Y | | | | |
| TRT2-03-CQ5 | *P. purpurascens* | 60% | 92% | 76 | Y | 113 | 1012 | 0 | 256 |
| | *P. australis* | 5% | 8% | 114 | N | 164 | 1466 | 842 | 0 |
| TRT2-03-OQ7 | *S. alterniflora* | 60% | 71% | 101 | N | | | | |
| | *P. purpurascens* | 5% | 6% | 62 | Y | | | | |
| | *S. robustus* | 20% | 24% | 152 | Y | | | | |
| TRT2-03-OQ8 | *P. purpurascens* | 10% | 11% | 84 | Y | | | | |
| | *S. alterniflora* | 10% | 11% | 116 | N | | | | |
| | *E. walteri* | 70% | 78% | 175 | Y | | | | |
| TRT2-03-OQ9 | *E. walteri* | 40% | 89% | 115 | Y | | | | |
| | *A. cannabinus* | 5% | 11% | 56 | N | | | | |
| TRT2-03-OQ10 | *P. purpurascens* | 50% | 71% | 95 | Y | | | | |
| | *E. walteri* | 20% | 29% | 103 | Y | | | | |
| TRT2-03-OQ11 | *P. purpurascens* | 80% | 94% | 84 | Y | | | | |
| | *E. walteri* | 5% | 6% | 66 | Y | | | | |
| TRT2-03-CQ6 | *S. robustus* | 20% | 29% | 122 | N | 15 | 137 | 0 | 110 |
| | Dead *P. australis* | 5% | 7% | 254 | N | 0 | 0 | 762 | 0 |
| | *Aster spp.* | 5% | 7% | 94 | Y | 168 | 1497 | 0 | 0 |
| | *E. walteri* | 40% | 57% | 214 | Y | 1081 | 9648 | 0 | 0 |
| TRT2-03-OQ12 | *P. purpurascens* | 1% | 1% | 79 | Y | | | | |
| | *E. walteri* | 70% | 99% | 184 | Y | | | | |
| TRT2-03-OQ13 | *P. purpurascens* | 5% | 6% | 82 | Y | | | | |
| | *E. walteri* | 80% | 94% | 186 | Y | | | | |
| TRT2-03-OQ14 | *P. purpurascens* | 40% | 100% | 103 | Y | | | | |
| TRT2-03-OQ15 | *S. alterniflora* | 30% | 60% | 97 | N | | | | |
| | *E. walteri* | 20% | 40% | 142 | Y | | | | |
| TRT2-03-OQ16 | *E. walteri* | 10% | 100% | 51 | N | | | | |
| TRT2-03-OQ17 | *P. purpurascens* | 25% | 100% | 57 | Y | | | | |
| TRT2-03-OQ18 | *S. alterniflora* | 90% | 100% | 89 | N | | | | |
| TRT2-03-CQ7 | *S. alterniflora* | 70% | 100% | 155 | Y | 1952 | 17412 | 0 | 0 |
| TRT2-03-OQ19 | *S. alterniflora* | 90% | 100% | 167 | Y | | | | |
| TRT2-03-CQ8 | *S. alterniflora* | 80% | 100% | 147 | Y | 1922 | 17150 | 110 | 93 |
| TRT2-03-OQ20 | *S. alterniflora* | 90% | 100% | 126 | N | | | | |
| TRT2-03-OQ21 | *S. alterniflora* | 95% | 100% | 156 | Y | | | | |
| TRT2-03-OQ22 | *S. alterniflora* | 100% | 100% | 171 | Y | | | | |
| TRT2 - Mean - Spartina dominated Quadrats (b) | | 83% | | 134 | | 1937 | 17281 | 55 | 46 |
| TRT2 - Mean - Non-Spartina dominated Quadrats ( | | 52% | | -- | | 386 | 3446 | 613 | 267 |
| TRT2- Mean - All Quadrats | | 61% | | -- | | 774 | 6905 | 474 | 212 |

**Table D-6**
**THE ROCKS WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m² | lb/acre | gdw/m² | gdw/m² |
| **The Rocks - Transect 3 8/14/02** | | | | | | | | | |
| TRT3-03-OQ22 | *S. alterniflora* | 70% | 93% | 82 | N | | | | |
| | *P. australis* | 5% | 7% | 80 | Y | | | | |
| TRT3-03-CQ10 | *S. alterniflora* | 70% | 93% | 81 | N | 442 | 3940 | 0 | 136 |
| | *P. australis* | 5% | 7% | 80 | Y | 15 | 133 | 0 | 0 |
| TRT3-03-OQ21 | *S. alterniflora* | 50% | 77% | 83 | N | | | | |
| | *P. australis* | 15% | 23% | 110 | Y | | | | |
| TRT3-03-OQ20 | *S. olneyi* | 40% | 100% | 171 | Y | | | | |
| TRT3-03-OQ19 | *S. olneyi* | 50% | 98% | 181 | Y | | | | |
| | *P. purpurascens* | 1% | 2% | 40 | N | | | | |
| TRT3-03-OQ18 | *S. olneyi* | 40% | 100% | 170 | N | | | | |
| TRT3-03-CQ9 | *S. olneyi* | 60% | 100% | 150 | N | 301 | 2687 | 9 | 230 |
| TRT3-03-OQ17 | *S. olneyi* | 60% | 92% | 161 | N | | | | |
| | *S. patens* | 5% | 8% | 80 | N | | | | |
| TRT3-03-OQ16 | *S. olneyi* | 55% | 92% | 140 | N | | | | |
| | *S. patens* | 5% | 8% | 81 | N | | | | |
| TRT3-03-OQ15 | *S. olneyi* | 70% | 100% | 150 | Y | | | | |
| TRT3-03-CQ8 | *S. olneyi* | 70% | 100% | 150 | N | 406 | 3622 | 21 | 34 |
| TRT3-03-OQ14 | *S. patens* | 90% | 90% | 71 | N | | | | |
| | *D. spicata* | 10% | 10% | 65 | Y | | | | |
| TRT3-03-CQ7 | *D. spicata* | 10% | 10% | 68 | Y | 24 | 211 | 0 | 0 |
| | *S. patens* | 90% | 90% | 72 | N | 840 | 7498 | 0 | 0 |
| TRT3-03-CQ6 | *D. spicata* | 10% | 10% | 65 | Y | 4 | 34 | 0 | 0 |
| | *S. patens* | 90% | 90% | 71 | N | 728 | 6500 | 0 | 0 |
| TRT3-03-OQ13 | *S. cynosuroides* | 20% | 100% | 185 | Y | | | | |
| TRT3-03-CQ5 | *S. olneyi* | 10% | 15% | 113 | N | 157 | 1398 | 21 | 119 |
| | *P. purpurascens* | 1% | 2% | 40 | Y | 1 | 7 | 0 | 0 |
| | *S. cynosuroides* | 55% | 83% | 171 | N | 615 | 5491 | 111 | 0 |
| TRT3-03-OQ12 | *S. cynosuroides* | 45% | 98% | 171 | N | | | | |
| | *S. olneyi* | 1% | 2% | 81 | N | | | | |
| TRT3-03-OQ11 | *S. robustus* | 30% | 100% | 140 | Y | | | | |
| TRT3-03-OQ10 | *S. cynosuroides* | 5% | 100% | 104 | N | | | | |
| TRT3-03-CQ4 | *S. cynosuroides* | 60% | 100% | 150 | N | 585 | 5219 | 90 | 41 |
| TRT3-03-OQ9 | *S. alterniflora* | 5% | 7% | 94 | N | | | | |
| | *S. cynosuroides* | 65% | 93% | 170 | N | | | | |
| TRT3-03-OQ8 | *S. alterniflora* | 5% | 7% | 80 | N | | | | |
| | *S. cynosuroides* | 70% | 93% | 201 | Y | | | | |
| TRT3-03-CQ3 | *S. alterniflora* | 75% | 99% | 120 | Y | 816 | 7278 | 0 | 251 |
| | Dead *P. australis* | 1% | 1% | 141 | N | | | | |
| TRT3-03-OQ7 | *S. alterniflora* | 70% | 100% | 171 | Y | | | | |
| TRT3-03-OQ6 | *S. alterniflora* | 65% | 100% | 125 | Y | | | | |
| TRT3-03-OQ5 | *S. alterniflora* | 60% | 100% | 145 | Y | | | | |
| TRT3-03-OQ4 | *P. australis* | 70% | 100% | 180 | Y | | | | |
| TRT3-03-OQ3 | *P. australis* | 80% | 100% | 241 | Y | | | | |
| TRT3-03-OQ2 | *P. australis* | 90% | 100% | 331 | Y | | | | |
| TRT3-03-OQ1 | *P. australis* | 80% | 100% | 305 | Y | | | | |
| TRT3-03-CQ2 | *P. australis* | 70% | 100% | 216 | Y | 492 | 4392 | 0 | 329 |
| TRT3-03-CQ1 | *P. australis* | 90% | 100% | 211 | Y | 2294 | 20471 | 0 | 539 |
| TRT3 - Mean - Spartina dominated Quadrats (b) | | 59% | | 133 | | 658 | 5866 | 56 | 137 |
| TRT3 - Mean - Non-Spartina dominated Quadrats ( | | 70% | | -- | | 848 | 7569 | 5 | 189 |
| TRT3- Mean - All Quadrats | | 65% | | -- | | 772 | 6888 | 25 | 168 |

**Table D-6**
**THE ROCKS WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ |
| **The Rocks - Transect 4 8/14/02** | | | | | | | | | |
| TRT4-03-OQ12 | *P. purpurascens* | 10% | 10% | 103 | Y | | | | |
| | *E. walteri* | 60% | 60% | 127 | Y | | | | |
| | *P. australis* | 30% | 30% | 147 | N | | | | |
| TRT4-03-CQ4 | *P. australis* | 80% | 100% | 151 | N | 598 | 5338 | 317 | 62 |
| TRT4-03-OQ11 | *P. purpurascens* | 20% | 33% | 79 | Y | | | | |
| | *E. walteri* | 20% | 33% | 89 | Y | | | | |
| | *P. australis* | 20% | 33% | 194 | Y | | | | |
| TRT4-03-OQ10 | *S. alterniflora* | 10% | 33% | 33 | N | | | | |
| | *P. purpurascens* | 10% | 33% | 89 | Y | | | | |
| | *P. australis* | 10% | 33% | 142 | N | | | | |
| TRT4-03-CQ3 | *S. cynosuroides* | 100% | 100% | 82 | N | 1084 | 9675 | 0 | 92 |
| TRT4-03-OQ9 | *P. purpurascens* | 20% | 20% | 124 | Y | | | | |
| | *E. walteri* | 40% | 40% | 169 | Y | | | | |
| | *P. australis* | 40% | 40% | 224 | N | | | | |
| TRT4-03-CQ2 | *P. australis* | 40% | 100% | 151 | N | 721 | 6430 | 214 | 125 |
| TRT4-03-OQ8 | *S. alterniflora* | 80% | 80% | 110 | N | | | | |
| | *P. purpurascens* | 20% | 20% | 106 | Y | | | | |
| TRT4-03-OQ7 | *S. alterniflora* | 50% | 63% | 110 | N | | | | |
| | *P. purpurascens* | 20% | 25% | 69 | Y | | | | |
| | *E. walteri* | 10% | 13% | 132 | Y | | | | |
| TRT4-03-OQ6 | *S. alterniflora* | 50% | 100% | 107 | N | | | | |
| TRT4-03-OQ5 | *S. alterniflora* | 20% | 100% | 106 | N | | | | |
| TRT4-03-OQ4 | *S. alterniflora* | 20% | 40% | 111 | N | | | | |
| | *P. purpurascens* | 30% | 60% | 72 | Y | | | | |
| TRT4-03-OQ3 | *D. spicata* | 100% | 100% | 54 | Y | | | | |
| TRT4-03-OQ2 | *S. alterniflora* | 80% | 100% | 114 | N | | | | |
| TRT4-03-OQ1 | *S. alterniflora* | 100% | 100% | 142 | Y | | | | |
| TRT4-03-CQ1 | *S. alterniflora* | 90% | 100% | 110 | Y | 997 | 8895 | 0 | 101 |
| TRT4 - Mean - Spartina dominated Quadrats (b) | | 74% | | 110 | | 1041 | 9285 | 0 | 97 |
| TRT4 - Mean - Non-Spartina dominated Quadrats ( | | 73% | | -- | | 660 | 5884 | 265 | 94 |
| TRT4- Mean - All Quadrats | | 74% | | -- | | 850 | 7585 | 133 | 95 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 71% | | 133 | | 1071 | 9556 | 35 | 86 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 63% | | -- | | 682 | 6081 | 279 | 215 |
| Site Mean - All Quadrats | | 67% | | -- | | 831 | 0 | 185 | 165 |

**Table D-7**

**CEDAR SWAMP WETLAND RESTORATION SITE**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ |
| **Cedar Swamp - Transect 1 8/13/02** | | | | | | 0 | 0 | 0 | 0 |
| CST1-03-OQ12 | *S. cynosuroides* | 20% | 100% | 189 | Y | | | | |
| CST1-03-CQ4 | *S. cynosuroides* | 65% | 93% | 188 | Y | 1018 | 9082 | 102 | 96 |
| | *S. alterniflora* | 5% | 7% | 130 | N | 103 | 919 | 0 | 0 |
| CST1-03-OQ11 | *S. cynosuroides* | 70% | 100% | 250 | Y | | | | |
| CST1-03-CQ3 | *S. cynosuroides* | 30% | 100% | 156 | N | 471 | 4203 | 114 | 204 |
| CST1-03-OQ10 | *S. cynosuroides* | 20% | 100% | 176 | N | | | | |
| CST1-03-OQ9 | *S. alterniflora* | 40% | 100% | 147 | Y | | | | |
| CST1-03-OQ8 | *S. alterniflora* | 20% | 100% | 168 | N | | | | |
| CST1-03-OQ7 | *S. alterniflora* | 80% | 100% | 164 | Y | | | | |
| CST1-03-CQ2 | *S. alterniflora* | 80% | 100% | 158 | N | 1940 | 17306 | 0 | 147 |
| CST1-03-OQ6 | *S. alterniflora* | 85% | 100% | 155 | Y | | | | |
| CST1-03-OQ5 | *S. alterniflora* | 80% | 100% | 141 | N | | | | |
| CST1-03-OQ4 | *S. alterniflora* | 50% | 71% | 131 | N | | | | |
| | *P. purpurascens* | 20% | 29% | 140 | N | | | | |
| CST1-03-CQ1 | *S. alterniflora* | 70% | 100% | 136 | N | 1641 | 14640 | 0 | 146 |
| CST1-03-OQ3 | *S. alterniflora* | 50% | 100% | 133 | N | | | | |
| CST1-03-OQ2 | *S. alterniflora* | 70% | 100% | 130 | N | | | | |
| CST1-03-OQ1 | *S. alterniflora* | 80% | 100% | 124 | N | | | | |
| CST1 - Mean - Spartina dominated Quadrats (b) | | 58% | | 157 | | 1293 | 11538 | 54 | 148 |
| CST1 - Mean - Non-Spartina dominated Quadrats ( | | 0% | | -- | | 0 | 0 | 0 | 0 |
| CST1- Mean - All Quadrats | | 58% | | -- | | 1293 | 11538 | 54 | 148 |

**Table D-7**
**CEDAR SWAMP WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Cedar Swamp - Transect 1 8/13/02** | | | | | | | | | |
| CST2-03-OQ18 | Dead *S. cynosuroides* | 30% | 100% | 140 | Y | | | | |
| CST2-03-OQ17 | *S. cynosuroides* | 55% | 100% | 171 | Y | | | | |
| CST2-03-OQ16 | *S. cynosuroides* | 65% | 100% | 169 | Y | | | | |
| CST2-03-OQ15 | *S. cynosuroides* | 75% | 100% | 191 | Y | | | | |
| CST2-03-OQ14 | *S. cynosuroides* | 70% | 100% | 180 | Y | | | | |
| CST2-03-CQ6 | *P. australis* | 70% | 100% | 180 | Y | 596 | 5315 | 50 | 131 |
| CST2-03-OQ13 | *S. cynosuroides* | 85% | 100% | 221 | N | | | | |
| CST2-03-OQ12 | *S. cynosuroides* | 85% | 100% | 268 | Y | | | | |
| CST2-03-OQ11 | *S. cynosuroides* | 40% | 44% | 261 | Y | | | | |
| | *P. australis* | 50% | 56% | 240 | Y | | | | |
| CST2-03-OQ10 | *P. australis* | 30% | 50% | 271 | Y | | | | |
| | *S. robustus* | 30% | 50% | 281 | Y | | | | |
| CST2-03-CQ5 | *P. australis* | 30% | 50% | 271 | Y | 217 | 1935 | 49 | 0 |
| | *S. cynosuroides* | 30% | 50% | 281 | Y | 624 | 5570 | 247 | 134 |
| CST2-03-CQ4 | *S. cynosuroides* | 35% | 100% | 224 | Y | 627 | 5592 | 0 | 36 |
| CST2-03-OQ9 | *S. cynosuroides* | 55% | 100% | 241 | Y | | | | |
| CST2-03-OQ8 | *S. cynosuroides* | 55% | 100% | 170 | Y | | | | |
| CST2-03-CQ3 | *S. cynosuroides* | 55% | 100% | 171 | Y | 582 | 5197 | 126 | 211 |
| CST2-03-OQ7 | *S. cynosuroides* | 70% | 100% | 171 | N | | | | |
| CST2-03-OQ6 | *S. cynosuroides* | 75% | 100% | 181 | N | | | | |
| CST2-03-OQ5 | *S. alterniflora* | 15% | 21% | 145 | N | | | | |
| | *S. cynosuroides* | 50% | 71% | 210 | Y | | | | |
| | *S. robustus* | 5% | 7% | 120 | N | | | | |
| CST2-03-CQ2 | *S. alterniflora* | 30% | 50% | 120 | N | 276 | 2460 | 0 | 70 |
| | *S. robustus* | 20% | 33% | 110 | N | 82 | 734 | 24 | 0 |
| | *S. cynosuroides* | 10% | 17% | 122 | N | 39 | 350 | 0 | 0 |
| CST2-03-OQ4 | *S. alterniflora* | 40% | 80% | 112 | N | | | | |
| | *S. cynosuroides* | 10% | 20% | 110 | N | | | | |
| CST2-03-OQ3 | *S. alterniflora* | 70% | 99% | 142 | Y | | | | |
| | *S. robustus* | 1% | 1% | 101 | Y | | | | |
| CST2-03-CQ1 | *S. alterniflora* | 70% | 99% | 142 | N | 634 | 5656 | 0 | 141 |
| | *S. robustus* | 1% | 1% | 101 | Y | 13 | 112 | 0 | 0 |
| CST2-03-OQ2 | *S. alterniflora* | 55% | 100% | 131 | N | | | | |
| CST2-03-OQ1 | *S. alterniflora* | 50% | 83% | 120 | N | | | | |
| | *S. robustus* | 10% | 17% | 110 | Y | | | | |
| CST2 - Mean - Spartina dominated Quadrats (b) | | 65% | | 177 | | 744 | 6639 | 89 | 125 |
| CST2 - Mean - Non-Spartina dominated Quadrats ( | | 53% | | -- | | 596 | 5315 | 50 | 131 |
| CST2- Mean - All Quadrats | | 64% | | -- | | 719 | 6419 | 83 | 126 |

**Table D-7**
**CEDAR SWAMP WETLAND RESTORATION SITE**
**PEAK SEASON 2003 TRANSECT DATA**
**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Cedar Swamp - Transect 3 8/13/02** | | | | | | | | | |
| CST3-03-OQ18 | *P. purpurascens* | 95% | 100% | 88 | Y | | | | |
| CST3-03-CQ1 | *S. cynosuroides* | 40% | 100% | 252 | Y | 1277 | 11396 | 254 | 235 |
| CST3-03-CQ2 | *S. cynosuroides* | 65% | 93% | 180 | N | 687 | 6133 | 388 | 136 |
| | *P. purpurascens* | 5% | 7% | 19 | N | 3 | 24 | 0 | 0 |
| CST3-03-OQ17 | *S. alterniflora* | 25% | 100% | 108 | N | | | | |
| CST3-03-OQ16 | *S. alterniflora* | 20% | 100% | 180 | Y | | | | |
| CST3-03-OQ15 | *S. alterniflora* | 65% | 93% | 193 | Y | | | | |
| | *P. purpurascens* | 5% | 7% | 53 | Y | | | | |
| CST3-03-OQ14 | *S. alterniflora* | 50% | 100% | 130 | Y | | | | |
| CST3-03-OQ13 | *S. alterniflora* | 60% | 100% | 156 | Y | | | | |
| CST3-03-OQ12 | *S. alterniflora* | 80% | 100% | 128 | N | | | | |
| CST3-03-OQ11 | *S. cynosuroides* | 5% | 8% | 165 | Y | | | | |
| | *S. alterniflora* | 55% | 92% | 94 | N | | | | |
| CST3-03-CQ3 | *S. alterniflora* | 80% | 100% | 157 | Y | 2391 | 21335 | 171 | 68 |
| CST3-03-OQ10 | *S. alterniflora* | 85% | 100% | 147 | N | | | | |
| CST3-03-OQ9 | *S. alterniflora* | 75% | 100% | 145 | N | | | | |
| CST3-03-OQ8 | *S. alterniflora* | 70% | 100% | 124 | N | | | | |
| CST3-03-OQ7 | *S. alterniflora* | 15% | 75% | 99 | N | | | | |
| | *P. australis* | 5% | 25% | 92 | N | | | | |
| CST3-03-OQ6 | *S. alterniflora* | 70% | 100% | 101 | N | | | | |
| CST3-03-CQ4 | *S. cynosuroides* | 10% | 13% | 144 | N | 87 | 778 | 0 | 0 |
| | *S. alterniflora* | 10% | 13% | 99 | N | 700 | 6248 | 0 | 79 |
| | Dead *S. patens* | 55% | 73% | 83 | N | 0 | 0 | 127 | 0 |
| CST3-03-OQ5 | *S. alterniflora* | 70% | 100% | 116 | N | | | | |
| CST3-03-OQ4 | *S. alterniflora* | 70% | 100% | 88 | N | | | | |
| CST3-03-OQ3 | *S. cynosuroides* | 40% | 100% | 229 | Y | | | | |
| CST3-03-OQ2 | *S. alterniflora* | 85% | 100% | 131 | N | | | | |
| CST3-03-OQ1 | *S. cynosuroides* | 35% | 88% | 260 | Y | | | | |
| | *P. purpurascens* | 5% | 13% | 23 | Y | | | | |
| CST3-03-CQ5 | *P. purpurascens* | 95% | 95% | 86 | Y | 645 | 5757 | 0 | 0 |
| | *P. australis* | 5% | 5% | 148 | Y | 37 | 330 | 82 | 427 |
| CST3-03-CQ6 | *P. purpurascens* | 95% | 95% | 75 | Y | 800 | 7137 | 0 | 389 |
| | Dead *P. australis* | 5% | 5% | 101 | N | 0 | 0 | 88 | 0 |
| CST3 - Mean - Spartina dominated Quadrats (b) | | 61% | | 154 | | 1453 | 12962 | 271 | 147 |
| CST3 - Mean - Non-Spartina dominated Quadrats ( | | 78% | | -- | | 757 | 6750 | 99 | 298 |
| CST3- Mean - All Quadrats | | 65% | | -- | | 1105 | 9856 | 185 | 222 |

**Table D-7**

**CEDAR SWAMP WETLAND RESTORATION SITE**

**PEAK SEASON 2003 TRANSECT DATA**

**PSEG EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Cedar Swamp - Transect 4 8/13/02** | | | | | | | | | |
| CST4-03-CQ4 | *S. alterniflora* | 55% | 92% | 178 | N | 361 | 3217 | 0 | 89 |
| | Dead *P. australis* | 5% | 8% | 188 | N | 0 | 0 | 525 | 0 |
| CST4-03-OQ12 | *S. alterniflora* | 20% | 44% | 139 | N | | | | |
| | *P. australis* | 25% | 56% | 135 | N | | | | |
| CST4-03-OQ11 | *S. alterniflora* | 85% | 100% | 151 | Y | | | | |
| CST4-03-OQ10 | *S. alterniflora* | 55% | 85% | 93 | N | | | | |
| | *P. australis* | 10% | 15% | 142 | N | | | | |
| CST4-03-OQ9 | *S. alterniflora* | 65% | 81% | 131 | N | | | | |
| | *S. robustus* | 15% | 19% | 144 | N | | | | |
| CST4-03-CQ3 | *S. alterniflora* | 70% | 88% | 131 | N | 1438 | 12831 | 0 | 32 |
| | *S. robustus* | 10% | 13% | 99 | N | 148 | 1317 | 0 | 0 |
| CST4-03-OQ8 | *S. alterniflora* | 65% | 100% | 100 | N | | | | |
| CST4-03-OQ7 | *S. alterniflora* | 85% | 100% | 121 | N | | | | |
| CST4-03-OQ6 | *S. alterniflora* | 80% | 89% | 136 | N | | | | |
| | *P. australis* | 10% | 11% | 152 | N | | | | |
| CST4-03-OQ5 | *S. alterniflora* | 45% | 69% | 165 | N | | | | |
| | *P. australis* | 20% | 31% | 179 | N | | | | |
| CST4-03-OQ4 | *S. alterniflora* | 75% | 100% | 121 | N | | | | |
| CST4-03-OQ3 | *S. alterniflora* | 70% | 100% | 150 | N | | | | |
| CST4-03-OQ2 | *S. alterniflora* | 85% | 100% | 144 | N | | | | |
| CST4-03-CQ1 | *S. alterniflora* | 90% | 100% | 134 | N | 1972 | 17594 | 0 | 0 |
| CST4-03-OQ1 | *S. alterniflora* | 80% | 100% | 140 | N | | | | |
| CST4-03-CQ2 | *P. australis* | 70% | 100% | 170 | Y | 610 | 5446 | 10 | 51 |
| CST4 - Mean - Spartina dominated Quadrats (b) | | 75% | | 136 | | 1306 | 11653 | 175 | 41 |
| CST4 - Mean - Non-Spartina dominated Quadrats ( | | 70% | | -- | | 610 | 5446 | 10 | 51 |
| CST4- Mean - All Quadrats | | 74% | | -- | | 1132 | 10101 | 134 | 43 |
| | | | | | | | | | |
| Site Mean - Spartina dominated Quadrats (b) | | 65% | | 159 | | 1145 | 10213 | 133 | 119 |
| Site Mean - Non-Spartina dominated Quadrats (b) | | 69% | | -- | | 695 | 6202 | 71 | 215 |
| Site Mean - All Quadrats | | 65% | | -- | | 1032 | 9210 | 118 | 143 |

(a) Quadrat numbers ending in "QQ##" indicate ocular quadrats, those ending in "CQ##" indicate clip quadrats.

(b) Spartina dominated quadrats include those dominated by S. alterniflora and/or S. cynosuroides.

# APPENDIX E

## 2003 MACROPHYTE QUADRAT DATA - PLOTS

# Table E-1
## MAD HORSE CREEK REFERENCE MARSH
## PEAK SEASON 2003 60 X 60 M PLOT DATA
## PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Mad Horse Creek - Plot 1 8/18/02** | | | | | | | | | |
| MHP1-03-VP1 | *Spartina alterniflora* | 80% | 100% | 143 | N | 907 | 8091 | 0 | 132 |
| MHP1-03-VP2 | *S. alterniflora* | 75% | 100% | 160 | N | 1437 | 12824 | 0 | 50 |
| MHP1-03-VP3 | *S. alterniflora* | 80% | 100% | 140 | N | 1057 | 9430 | 0 | 101 |
| MHP1-03-VP4 | *S. alterniflora* | 90% | 100% | 122 | N | 843 | 7519 | 0 | 30 |
| MHP1-03-VP5 | *S. alterniflora* | 85% | 100% | 157 | N | 2101 | 18745 | 0 | 28 |
| MHP1-03-VP6 | *S. alterniflora* | 50% | 100% | 91 | N | 511 | 4563 | 0 | 62 |
| MHP1-03-VP7 | *S. alterniflora* | 95% | 100% | 119 | N | 1144 | 10206 | 0 | 22 |
| MHP1-03-VP8 | *S. alterniflora* | 80% | 100% | 110 | N | 984 | 8775 | 0 | 18 |
| MHP1-03-VP9 | *S. alterniflora* | 90% | 100% | 175 | N | 1127 | 10052 | 0 | 60 |
| **Mean for Plot** | | 81% | | 135 | | 1123 | 10023 | 0 | 56 |
| **Mad Horse Creek - Plot 2 8/17/02** | | | | | | | | | |
| MHP2-03-VP1 | *S. alterniflora* | 80% | 100% | 132 | N | 999 | 8912 | 0 | 66 |
| MHP2-03-VP2 | *S. alterniflora* | 50% | 100% | 134 | N | 1509 | 13468 | 0 | 97 |
| MHP2-03-VP3 | *S. alterniflora* | 80% | 100% | 127 | N | 1292 | 11526 | 0 | 14 |
| MHP2-03-VP4 | *S. alterniflora* | 70% | 100% | 125 | N | 977 | 8715 | 0 | 21 |
| MHP2-03-VP5 | *S. alterniflora* | 70% | 100% | 80 | N | 765 | 6826 | 0 | 9 |
| MHP2-03-VP6 | *S. alterniflora* | 60% | 100% | 80 | N | 481 | 4288 | 0 | 10 |
| MHP2-03-VP7 | *S. alterniflora* | 80% | 100% | 129 | N | 821 | 7323 | 0 | 48 |
| MHP2-03-VP8 | *S. alterniflora* | 70% | 100% | 95 | N | 788 | 7032 | 0 | 16 |
| MHP2-03-VP9 | *S. alterniflora* | 65% | 87% | 119 | N | 879 | 7846 | 38 | 28 |
| MHP2-03-VP9 | *Scirpus robustus* | 10% | 13% | 83 | Y | 36 | 320 | 0 | 0 |
| **Mean for Plot** | | 71% | | 113 | | 950 | 8473 | 4 | 34 |
| **Mad Horse Creek - Plot 3 8/17/02** | | | | | | | | | |
| MHP3-03-VP1 | *S. alterniflora* | 60% | 100% | 91 | N | 489 | 4365 | 88 | 47 |
| MHP3-03-VP2 | *S. alterniflora* | 70% | 100% | 132 | N | 1258 | 11222 | 0 | 0 |
| MHP3-03-VP3 | *S. alterniflora* | 50% | 63% | 86 | N | 692 | 6176 | 0 | 12 |
| | *Spartina patens* | 30% | 38% | 63 | N | 27 | 244 | 0 | 0 |
| MHP3-03-VP4 | *S. alterniflora* | 45% | 60% | 93 | N | 1781 | 15892 | 25 | 25 |
| | *S. patens* | 30% | 40% | 53 | Y | 219 | 1956 | 0 | 0 |
| MHP3-03-VP5 | *S. alterniflora* | 60% | 100% | 128 | N | 1231 | 10983 | 0 | 86 |
| MHP3-03-VP6 | *S. alterniflora* | 50% | 100% | 82 | N | 842 | 7512 | 0 | 23 |
| MHP3-03-VP7 | *S. alterniflora* | 65% | 100% | 110 | N | 840 | 7497 | 36 | 0 |
| MHP3-03-VP8 | *S. alterniflora* | 50% | 77% | 112 | N | 781 | 6968 | 0 | 13 |
| | *S. patens* | 15% | 23% | 66 | N | 127 | 1136 | 0 | 0 |
| MHP3-03-VP9 | *S. alterniflora* | 35% | 70% | 93 | N | 1141 | 10180 | 0 | 12 |
| | *S. patens* | 15% | 30% | 57 | N | 253 | 2256 | 0 | 0 |
| **Mean for Plot** | | 64% | | 103 | | 1076 | 9599 | 17 | 24 |
| **Mean for Site** | | 72% | | 117 | | 1050 | 9365 | 7 | 38 |

**Table E-2**
**MOORES BEACH REFERENCE MARSH**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter gdw/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | |
| **Moores Beach - Plot 1** | | | | | | | | | |
| MBP1-03-VP1 | *S. alterniflora* | 70% | 100% | 154 | N | 1297 | 11569 | 0 | 52 |
| MBP1-03-VP2 | *S. alterniflora* | 50% | 100% | 142 | N | 1264 | 11278 | 0 | 73 |
| MBP1-03-VP3 | *S. alterniflora* | 80% | 100% | 134 | N | 1216 | 10845 | 0 | 87 |
| MBP1-03-VP4 | *S. alterniflora* | 40% | 100% | 114 | N | 613 | 5468 | 52 | 22 |
| MBP1-03-VP5 | *S. alterniflora* | 65% | 100% | 170 | N | 1877 | 16745 | 100 | 21 |
| MBP1-03-VP6 | *S. alterniflora* | 45% | 100% | 153 | N | 1234 | 11013 | 168 | 67 |
| MBP1-03-VP7 | *S. alterniflora* | 75% | 100% | 110 | N | 940 | 8385 | 0 | 53 |
| MBP1-03-VP8 | *S. alterniflora* | 70% | 100% | 110 | N | 853 | 7609 | 0 | 36 |
| MBP1-03-VP9 | *S. alterniflora* | 85% | 100% | 150 | Y | 1349 | 12038 | 0 | 144 |
| **Mean for Plot** | | 64% | | 137 | | 1182 | 10550 | 35 | 62 |
| **Moores Beach - Plot 2 8/21/02** | | | | | | | | | |
| MBP2-03-VP1 | *S. alterniflora* | 40% | 100% | 110 | N | 619 | 5519 | 76 | 44 |
| MBP2-03-VP2 | *S. alterniflora* | 35% | 100% | 139 | N | 1027 | 9161 | 34 | 24 |
| MBP2-03-VP3 | *S. alterniflora* | 15% | 100% | 137 | N | 728 | 6495 | 396 | 43 |
| MBP2-03-VP4 | *S. alterniflora* | 30% | 100% | 115 | N | 269 | 2401 | 15 | 74 |
| MBP2-03-VP5 | *S. alterniflora* | 35% | 100% | 143 | Y | 880 | 7848 | 77 | 56 |
| MBP2-03-VP6 | *S. alterniflora* | 40% | 100% | 113 | N | 750 | 6691 | 19 | 34 |
| MBP2-03-VP7 | *S. alterniflora* | 40% | 100% | 140 | N | 617 | 5507 | 95 | 69 |
| MBP2-03-VP8 | *S. alterniflora* | 60% | 100% | 148 | Y | 1621 | 14461 | 0 | 47 |
| MBP2-03-VP9 | *S. alterniflora* | 30% | 100% | 140 | N | 728 | 6499 | 103 | 38 |
| **Mean for Plot** | | 36% | | 132 | | 804 | 7176 | 91 | 48 |
| **Moores Beach - Plot 3 8/21/02** | | | | | | | | | |
| MBP3-03-VP1 | *S. alterniflora* | 65% | 100% | 125 | N | 1529 | 13644 | 103 | 140 |
| MBP3-03-VP2 | *S. alterniflora* | 70% | 100% | 138 | Y | 1328 | 11846 | 123 | 60 |
| MBP3-03-VP3 | *S. alterniflora* | 70% | 100% | 134 | N | 1072 | 9561 | 0 | 26 |
| MBP3-03-VP4 | *S. alterniflora* | 60% | 100% | 118 | Y | 1139 | 10161 | 0 | 27 |
| MBP3-03-VP5 | *S. alterniflora* | 20% | 100% | 158 | Y | 841 | 7505 | 102 | 40 |
| MBP3-03-VP6 | *S. alterniflora* | 35% | 100% | 172 | N | 865 | 7720 | 807 | 103 |
| MBP3-03-VP7 | *S. alterniflora* | 50% | 100% | 151 | N | 975 | 8697 | 219 | 63 |
| MBP3-03-VP8 | *S. alterniflora* | 45% | 100% | 165 | N | 1226 | 10937 | 89 | 82 |
| MBP3-03-VP9 | *S. alterniflora* | 60% | 100% | 154 | Y | 1430 | 12755 | 0 | 37 |
| **Mean for Plot** | | 53% | | 146 | | 1156 | 10314 | 160 | 64 |
| **Mean for Site** | | 51% | | 138 | | 1048 | 9347 | 95 | 58 |

**Table E-3**
**COMMERCIAL TOWNSHIP SALT HAY FARM WETLAND RESTORATION SITE**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ |
| **Commercial Township - Plot 1 8/22/02** | | | | | | | | | |
| CTP1-03-VP1 | *S. alterniflora* | 30% | 100% | 192 | N | 1823 | 16264 | 0 | 72 |
| CTP1-03-VP2 | *S. alterniflora* | 50% | 100% | 175 | Y | 1840 | 16417 | 0 | 98 |
| CTP1-03-VP3 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP1-03-VP4 | *S. alterniflora* | 65% | 100% | 264 | Y | 3294 | 29386 | 0 | 14 |
| CTP1-03-VP5 | *S. alterniflora* | 45% | 100% | 171 | Y | 1932 | 17238 | 0 | 15 |
| CTP1-03-VP6 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP1-03-VP7 | *S. alterniflora* | 60% | 100% | 60 | N | 1759 | 15697 | 0 | 31 |
| CTP1-03-VP8 | *S. alterniflora* | 75% | 100% | 75 | Y | 1688 | 15057 | 0 | 24 |
| CTP1-03-VP9 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| **Mean for Plot** | | 36% | | 156 | | 1371 | 12229 | 0 | 28 |
| **Commercial Township - Plot 2 8/22/02** | | | | | | | | | |
| CTP2-03-VP1 | *S. alterniflora* | 80% | 100% | 210 | Y | 2092 | 18664 | 0 | 0 |
| CTP2-03-VP2 | *S. alterniflora* | 50% | 100% | 216 | Y | 1510 | 13469 | 0 | 0 |
| CTP2-03-VP3 | *S. alterniflora* | 30% | 100% | 141 | Y | 224 | 2002 | 0 | 0 |
| CTP2-03-VP4 | *S. alterniflora* | 50% | 100% | 170 | Y | 823 | 7342 | 0 | 0 |
| CTP2-03-VP5 | *S. alterniflora* | 60% | 100% | 17 | Y | 663 | 5911 | 0 | 0 |
| CTP2-03-VP6 | *S. alterniflora* | 35% | 100% | 135 | Y | 785 | 7002 | 0 | 0 |
| CTP2-03-VP7 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP2-03-VP8 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP2-03-VP9 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| **Mean for Plot** | | 34% | | 148 | | 677 | 6043 | 0 | 0 |
| **Commercial Township - Plot 3 8/22/02** | | | | | | | | | |
| CTP3-03-VP1 | *S. alterniflora* | 75% | 100% | 141 | Y | 1260 | 11238 | 0 | 0 |
| CTP3-03-VP2 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP3-03-VP3 | *S. alterniflora* | 60% | 100% | 191 | Y | 1975 | 17619 | 0 | 7 |
| CTP3-03-VP4 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP3-03-VP5 | *S. alterniflora* | 85% | 100% | 157 | N | 1615 | 14411 | 0 | 0 |
| CTP3-03-VP6 | *S. alterniflora* | 65% | 100% | 181 | Y | 2728 | 24343 | 0 | 0 |
| CTP3-03-VP7 | *S. alterniflora* | 60% | 100% | 166 | Y | 1430 | 12762 | 0 | 0 |
| CTP3-03-VP8 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| CTP3-03-VP9 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| **Mean for Plot** | | 38% | | 167 | | 1001 | 8930 | 0 | 1 |
| **Mean for Site** | | 36% | | 157 | | 1016 | 9068 | 0 | 10 |

**Table E-4**
**ALLOWAY CREEK WATERSHED WETLAND RESTORATION SITE**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | $gdw/m^2$ | lb/acre | $gdw/m^2$ | $gdw/m^2$ |
| **Alloway Creek Watershed - Plot 1 8/18/02** | | | | | | | | | |
| ACWP1-03-VP1 | *Phragmites australis* | 100% | 100% | 256 | Y | 1492 | 13315 | 0 | 290 |
| ACWP1-03-VP2 | *S. alterniflora* | 90% | 90% | 150 | Y | 1229 | 10961 | 0 | 41 |
| | *Echinichloa walteri* | 10% | 10% | 170 | Y | 52 | 467 | 0 | 0 |
| ACWP1-03-VP3 | *S. alterniflora* | 30% | 75% | 130 | Y | 398 | 3553 | 0 | 120 |
| | *Typha spp.* | 10% | 25% | 109 | N | 116 | 1036 | 0 | 0 |
| ACWP1-03-VP4 | *P. australis* | 10% | 100% | 115 | N | 22 | 201 | 0 | 0 |
| ACWP1-03-VP5 | *P. australis* | 100% | 100% | 207 | Y | 1204 | 10743 | 0 | 0 |
| ACWP1-03-VP6 | *S. alterniflora* | 50% | 50% | 133 | Y | 1245 | 11104 | 0 | 68 |
| | *Spartina cynosuroides* | 40% | 40% | 109 | N | 11 | 97 | 0 | 0 |
| | *Scirpus olneyi* | 10% | 10% | 100 | Y | 18 | 157 | 0 | 0 |
| ACWP1-03-VP7 | *S. alterniflora* | 100% | 100% | 159 | Y | 1307 | 11663 | 0 | 151 |
| ACWP1-03-VP8 | Mud Flat | 0% | 0% | | | 0 | 0 | 0 | 0 |
| ACWP1-03-VP9 | *P. australis* | 100% | 100% | 209 | Y | 1087 | 9701 | 0 | 0 |
| **Mean for Plot** | | 72% | | 143 | | 909 | 8111 | 0 | 74 |
| **Alloway Creek Watershed - Plot 2 8/15/02** | | | | | | | | | |
| ACWP2-03-VP1 | *S. alterniflora* | 80% | 89% | 109 | N | 977 | 8713 | 14 | 0 |
| | *S. robustus* | 10% | 11% | 135 | Y | 46 | 411 | 0 | 0 |
| ACWP2-03-VP2 | *S. alterniflora* | 57% | 100% | 114 | N | 645 | 5758 | 110 | 0 |
| ACWP2-03-VP3 | *P. australis* | 90% | 100% | 228 | Y | 1425 | 12716 | 0 | 0 |
| ACWP2-03-VP4 | *S. alterniflora* | 20% | 20% | 101 | N | 745 | 6646 | 0 | 0 |
| | *S. olneyi* | 10% | 10% | 122 | Y | 15 | 137 | 14 | 0 |
| | *P. australis* | 70% | 70% | 108 | N | 81 | 719 | 0 | 0 |
| ACWP2-03-VP5 | *P. australis* | 5% | 100% | 184 | N | 257 | 2290 | 0 | 0 |
| ACWP2-03-VP6 | *S. alterniflora* | 50% | 71% | 142 | Y | 1204 | 10739 | 0 | 0 |
| | *P. australis* | 20% | 29% | 217 | Y | 506 | 4515 | 0 | 0 |
| ACWP2-03-VP7 | *S. alterniflora* | 15% | 33% | 115 | N | 265 | 2367 | 0 | 0 |
| | *P. australis* | 30% | 67% | 195 | Y | 695 | 6201 | 33 | 0 |
| ACWP2-03-VP8 | *S. alterniflora* | 65% | 100% | 130 | N | 1120 | 9994 | 0 | 0 |
| ACWP2-03-VP9 | *S. alterniflora* | 60% | 100% | 159 | Y | 1679 | 14980 | 0 | 0 |
| **Mean for Plot** | | 65% | | 124 | | 996 | 8887 | 15 | 0 |
| **Alloway Creek Watershed - Plot 3 8/15/02** | | | | | | | | | |
| ACWP3-03-VP1 | *S. alterniflora* | 100% | 100% | 157 | Y | 1416 | 12630 | 0 | 19 |
| ACWP3-03-VP2 | *S. alterniflora* | 90% | 95% | 166 | Y | 2327 | 20763 | 0 | 0 |
| | *Amaranthus cannabinus* | 5% | 5% | 173 | Y | 128 | 1142 | 0 | 0 |
| ACWP3-03-VP3 | *S. alterniflora* | 50% | 77% | 166 | Y | 1266 | 11293 | 0 | 0 |
| | *E. walteri* | 15% | 23% | 150 | Y | 117 | 1048 | 0 | 0 |
| ACWP3-03-VP4 | *S. alterniflora* | 75% | 100% | 153 | Y | 1459 | 13020 | 0 | 0 |
| ACWP3-03-VP5 | *S. alterniflora* | 100% | 100% | 155 | Y | 1577 | 14071 | 0 | 0 |
| ACWP3-03-VP6 | *S. alterniflora* | 70% | 100% | 157 | Y | 1062 | 9473 | 0 | 0 |
| ACWP3-03-VP7 | Wrack | 0% | 0% | | | 0 | 0 | 0 | 0 |
| ACWP3-03-VP8 | *S. alterniflora* | 90% | 90% | 136 | Y | 885 | 7898 | 0 | 0 |
| | *A. cannabinus* | 10% | 10% | 132 | Y | 15 | 131 | 0 | 0 |
| ACWP3-03-VP9 | *S. alterniflora* | 45% | 75% | 132 | Y | 1049 | 9362 | 0 | 0 |
| | *A. cannabinus* | 5% | 8% | 150 | Y | 26 | 233 | 0 | 0 |
| | *E. walteri* | 10% | 17% | 77 | Y | 84 | 749 | 0 | 0 |
| **Mean for Plot** | | 74% | | 153 | | 1268 | 11313 | 0 | 2 |
| **Mean for Site** | | 70% | | 140 | | 1058 | 9437 | 5 | 25 |

**Table E-5**
**COHANSEY RIVER WATERSHED WETLAND RESTORATION SITE**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | gdw/m$^2$ |
| **Brown's Run - Plot 1 8/19/02** | | | | | | | | | |
| BRP1-03-VP1 | *S. alterniflora* | 55% | 92% | 74 | N | 423 | 3775 | 0 | 40 |
| | *P. australis* | 5% | 8% | 86 | N | 910 | 8119 | 0 | 0 |
| BRP1-03-VP2 | *S. alterniflora* | 25% | 100% | 147 | Y | 512 | 4571 | 0 | 22 |
| BRP1-03-VP3 | *S. alterniflora* | 45% | 64% | 143 | Y | 868 | 7747 | 0 | 35 |
| | *P. australis* | 25% | 36% | 187 | Y | 317 | 2828 | 0 | 0 |
| BRP1-03-VP4 | *S. alterniflora* | 45% | 100% | 174 | Y | 763 | 6811 | 0 | 0 |
| BRP1-03-VP5 | *S. alterniflora* | 50% | 63% | 124 | Y | 1415 | 12625 | 0 | 18 |
| | *P. australis* | 30% | 38% | 177 | Y | 274 | 2442 | 0 | 0 |
| BRP1-03-VP6 | Mud Flat/Wrack | 0% | 0% | | N | 0 | 0 | 0 | 0 |
| BRP1-03-VP7 | *S. alterniflora* | 40% | 100% | 54 | N | 179 | 1596 | 0 | 36 |
| BRP1-03-VP8 | *S. alterniflora* | 80% | 100% | 120 | Y | 866 | 7726 | 32 | 31 |
| BRP1-03-VP9 | *S. alterniflora* | 10% | 100% | 96 | N | 50 | 445 | 0 | 0 |
| **Mean for Plot** | | 46% | | 117 | | 731 | 6521 | 4 | 20 |
| **Brown's Run - Plot 2 8/19/02** | | | | | | | | | |
| BRP2-03-VP1 | *P. australis* | 75% | 100% | 150 | N | 849 | 7572 | 199 | 94 |
| BRP2-03-VP2 | *S. alterniflora* | 70% | 100% | 131 | Y | 1323 | 11804 | 0 | 24 |
| BRP2-03-VP3 | *S. alterniflora* | 35% | 100% | 102 | Y | 840 | 7497 | 0 | 118 |
| BRP2-03-VP4 | *S. alterniflora* | 80% | 100% | 121 | Y | 1326 | 11827 | 0 | 21 |
| BRP2-03-VP5 | *S. alterniflora* | 75% | 100% | 141 | Y | 994 | 8865 | 0 | 75 |
| BRP2-03-VP6 | *S. alterniflora* | 85% | 100% | 130 | Y | 1118 | 9977 | 0 | 49 |
| BRP2-03-VP8 | *S. alterniflora* | 35% | 100% | 81 | Y | 154 | 1373 | 0 | 0 |
| BRP2-03-VP8 | *S. alterniflora* | 30% | 100% | 30 | N | 147 | 1311 | 0 | 0 |
| BRP2-03-VP9 | *S. alterniflora* | 80% | 100% | 112 | N | 781 | 6969 | 0 | 68 |
| **Mean for Plot** | | 63% | | 106 | | 837 | 7466 | 22 | 50 |
| **Brown's Run - Plot 3 8/20/02** | | | | | | | | | |
| BRP3-03-VP1 | *S. alterniflora* | 90% | 100% | 181 | Y | 1140 | 10167 | 0 | 70 |
| BRP3-03-VP2 | *S. alterniflora* | 85% | 100% | 170 | Y | 1067 | 9518 | 0 | 1 |
| BRP3-03-VP3 | *S. alterniflora* | 80% | 100% | 161 | N | 1270 | 11333 | 0 | 32 |
| BRP3-03-VP4 | *S. alterniflora* | 70% | 100% | 113 | Y | 1375 | 12266 | 5 | 3 |
| BRP3-03-VP5 | *S. alterniflora* | 60% | 100% | 134 | N | 864 | 7710 | 0 | 19 |
| BRP3-03-VP6 | *S. alterniflora* | 65% | 100% | 161 | N | 1952 | 17417 | 0 | 2 |
| BRP3-03-VP7 | *S. alterniflora* | 45% | 100% | 129 | N | 502 | 4478 | 32 | 110 |
| BRP3-03-VP8 | *S. alterniflora* | 75% | 100% | 147 | N | 1025 | 9147 | 0 | 73 |
| BRP3-03-VP9 | *S. alterniflora* | 75% | 100% | 161 | N | 2138 | 19072 | 0 | 24 |
| **Mean for Plot** | | 72% | | 151 | | 1259 | 11234 | 4 | 37 |
| **Mean for Site** | | 60% | | 125 | | 942 | 8407 | 10 | 36 |

**Table E-6**
**THE ROCKS WETLAND RESTORATION SITE**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter gdw/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | |
| **The Rocks - Plot 1 8/14/02** | | | | | | | | | |
| TRP1-03-VP1 | *S. alterniflora* | 75% | 100% | 101 | N | 779 | 6952 | 0 | 0 |
| TRP1-03-VP2 | *S. alterniflora* | 80% | 89% | 91 | N | 375 | 3347 | 0 | 67 |
| | *S. olneyi* | 10% | 11% | 85 | N | 8 | 71 | 52 | 0 |
| TRP1-03-VP3 | *S. cynosuroides* | 80% | 99% | 80 | N | 2326 | 20755 | 0 | 0 |
| | *Dead P. australis* | 1% | 1% | 186 | | 0 | 0 | 476 | 0 |
| TRP1-03-VP4 | *Typha spp.* | 25% | 100% | 180 | N | 432 | 3855 | 47 | 249 |
| TRP1-03-VP5 | *Distichlis spicata* | 10% | 29% | 118 | N | 36 | 323 | 0 | 0 |
| | *Typha spp.* | 25% | 71% | 186 | N | 378 | 3370 | 0 | 0 |
| TRP1-03-VP6 | *S. alterniflora* | 25% | 61% | 88 | Y | 366 | 3270 | 0 | 70 |
| | *Dead P. australis* | 1% | 2% | 150 | N | 0 | 0 | 83 | 0 |
| | *Typha spp.* | 5% | 12% | 165 | N | 61 | 547 | 0 | 0 |
| | *S. robustus* | 10% | 24% | 119 | N | 98 | 876 | 0 | 0 |
| TRP1-03-VP7 | *S. alterniflora* | 70% | 100% | 130 | Y | 861 | 7680 | 0 | 28 |
| TRP1-03-VP8 | *S. alterniflora* | 30% | 75% | 110 | N | 400 | 3571 | 0 | 37 |
| | *D. spicata* | 10% | 25% | 73 | N | 153 | 1369 | 0 | 0 |
| TRP1-03-VP9 | *S. alterniflora* | 10% | 13% | 123 | N | 19 | 173 | 0 | 137 |
| | *Typha spp.* | 1% | 1% | | | 89 | 793 | 0 | 0 |
| | *P. australis* | 5% | 7% | 152 | N | 222 | 1982 | 37 | 0 |
| | *S. patens* | 25% | 33% | 43 | N | 337 | 3002 | 0 | 0 |
| | *S. olneyi* | 35% | 46% | 126 | N | 465 | 4149 | 0 | 0 |
| **Mean for Plot** | | 59% | | 103 | | 781 | 6968 | 77 | 65 |
| **Mean for Site** | | 59% | | 103 | | 781 | 6968 | 77 | 65 |

**Table E-7**
**CEDAR SWAMP WETLAND RESTORATION SITE**
**PEAK SEASON 2003 60 X 60 M PLOT DATA**
**PSE&G EEP DETRITAL PRODUCTION MONITORING PROGRAM**

| Quadrat No. (a) | Species Identification | % Cover | | Height (cm) | Flowering (Y/N) | Biomass Live Standing | | Dead Standing | Litter gdw/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | Aerial | Relative | | | gdw/m$^2$ | lb/acre | gdw/m$^2$ | |
| **Cedar Swamp - Plot 1 8/13/02** | | | | | | | | | |
| CSP1-03-VP1 | *S. alterniflora* | 35% | 64% | 101 | N | 635 | 5665 | 0 | 111 |
| | *S. cynosuroides* | 20% | 36% | | Y | 312 | 2786 | 0 | 0 |
| CSP1-03-VP2 | *S. alterniflora* | 65% | 100% | 116 | N | 937 | 8364 | 79 | 252 |
| CSP1-03-VP3 | *S. alterniflora* | 75% | 100% | 106 | N | 858 | 7658 | 0 | 386 |
| CSP1-03-VP4 | *S. alterniflora* | 70% | 100% | 134 | N | 1509 | 13460 | 33 | 182 |
| CSP1-03-VP5 | *S. alterniflora* | 10% | 22% | 96 | N | 100 | 889 | 0 | 189 |
| | *S. cynosuroides* | 35% | 76% | 168 | Y | 821 | 7321 | 341 | 0 |
| | *S. robustus* | 1% | 2% | 54 | N | 150 | 1336 | 0 | 0 |
| CSP1-03-VP6 | *S. alterniflora* | 65% | 100% | 111 | N | 966 | 8623 | 99 | 206 |
| CSP1-03-VP7 | *S. alterniflora* | 75% | 100% | 99 | N | 1326 | 11834 | 0 | 24 |
| CSP1-03-VP8 | *S. alterniflora* | 80% | 100% | 93 | N | 820 | 7316 | 48 | 86 |
| CSP1-03-VP9 | *S. alterniflora* | 60% | 100% | 86 | N | 709 | 6328 | 75 | 128 |
| **Mean for Plot** | | 66% | | 101 | | 1016 | 9064 | 75 | 174 |
| **Mean for Site** | | 66% | | 101 | | 1016 | 9064 | 75 | 174 |

(a) Spartina dominated quadrats include those dominated by S. alterniflora and/or S. cynosuroides.