

***Implementing Long-Term Monitoring of Salt
Marsh Communities within the Northeast Coastal
and Barrier Network of the National Park Service***

**Year 1: Monitoring at Colonial National Historic Site,
Gateway National Recreation Area, and
Fire Island National Seashore**

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Chapter 1 . Introduction

The National Park Service has recently implemented a program to develop monitoring protocols in an effort to collect long-term data on natural and cultural resources. Cape Cod National Seashore (Massachusetts) was designated as the prototype park for the Atlantic and Gulf Coast biogeographic region where protocols were designed and tested. Two of these protocols, Monitoring Nekton in Shallow Estuarine Habitats (Raposa & Roman 2001a) and Monitoring Salt Marsh Vegetation (Roman *et al.* 2001) have been completed and are currently implemented on several US Fish and Wildlife Refuges along the Atlantic Coast (James-Pirri *et al.* 2002a, 2003, In Prep) (Fig 1-1). This is a 3 year study that will implement the salt marsh and nekton monitoring protocols at National Park Service units within the Northeast Coastal and Barrier Network as well as additional coastal Parks (Fig 1-1). This progress report summarizes the field sampling for year 1 (2003).

Study sites

The Park units within the Northeast Coastal and Barrier Network where salt marsh vegetation and nekton communities will be monitored are: Assateague Island National Seashore (ASIS, coastal Maryland and Virginia), Colonial National Historic Park (COLO, Virginia Peninsula), Fire Island National Seashore (FIIS, Long Island, NY), Gateway National Recreation Area (GATE, New York City, NY and Sandy Hook, NJ), George Washington Birthplace National Monument (GEWA, Westmoreland County, VA), Sagamore Hill National Historic Site (SAHI, Oyster Bay, NY), and Thomas Stone National Historic Site (THST, Port Tobacco, MD). Additionally, there are two coastal Parks in the Northeast Temperate Network, Acadia National Park (ACAD, Bar Harbor, ME) and Boston Harbor Island National Park Area (BOHA, Boston, MA), may also be included in this study.

Monitoring will be established at the selected Park units over a 3 year period, with an average of 3 Parks sampled each year. Due to immediate resource management needs, some parks may be added to the study [*i.e.* Saugus Iron Works NHS (SAIR) and Cape Cod NS (CACO) in 2004] while others may be dropped (*i.e.* ACAD) if it is determined that monitoring is not necessary. In 2003, monitoring of saltmarsh nekton and vegetation was conducted at COLO, FIIS, and GATE. In 2004, it is anticipated that monitoring will commence at BOHA, CACO (nekton only), SAIR (to collect data for an impending restoration of the turning basin), and SAHI. A second year of nekton data may be collected at GATE in 2004 to assist with monitoring of the restoration project at Big Egg marsh.

Methods

Nekton (Fish and Decapods)

Nekton are defined as free-swimming fish and decapod crustaceans (McIvor & Rozas 1996). They are common residents of salt marshes, utilizing the marsh surface, creeks

and ditches, and marsh pools (Able *et al.* 1996). At each study site at 15 to 25 nekton sampling locations were established. Sampling locations included both marsh pools, creeks, ditches, and shoreline areas depending on the topography of the site. Raposa & Roman (2001a) offer a detailed summary of the protocol and good overview of the spatial and temporal variability, and sample size in the nekton sampling procedure. Depending on the amount and type of open water habitat (pools, tidal creeks, shoreline, or ditches) on the marsh, two different sampling techniques (throw trap and ditch net) were employed. All pools (up to 15) within a marsh were sampled. If there were few pools on the marsh surface, then larger tidal creeks (more than 1.5m wide) and shoreline areas were also sampled with the throw trap and smaller ditches were sampled with ditch nets. All nekton sampling stations were randomly located along the perimeter of the pool, tidal creek, shoreline, or ditch.

Nekton in marsh pools, large tidal creeks, and shoreline habitats (all less than 1m deep) were sampled with a 1m² aluminum throw trap (Kushlan 1981, Sogard & Able 1991, Raposa and Roman 2001b). The throw trap is an enclosure sampler that has excellent efficiency and provides quantitative, repeatable results (Rozas & Minello 1997). The trap had an open top and bottom, was 0.5m in height and 1m square, and the sides were covered with 3mm (1/8 in) wire mesh. Each sampling location was quietly approached, and at 3m to 5m from the area that was sampled, the person throwing the trap crouched and waited a few minutes to allow any disturbed nekton to resume normal activity. The person then tossed the trap into the pool, tidal creek, or shoreline area, imbedding it in the bottom sediments and captured any nekton within the 1m² area of the trap. All nekton were collected from the trap with a 1mm mesh dip net that fit snugly within the opposite sides of the trap. The trap was considered empty when three successive attempts with the dip net produced no organisms.

Ditches (approximately 15cm to 1m wide) within the marsh were sampled using a ditch net (James-Pirri *et al.* 2002b), since the throw trap was too large to sample the narrow mosquito ditches. A ditch net is a specialized gear that has been designed to sample narrow tidal and mosquito ditches (up to 1m wide). The center body of the net (3mm or 1/8 in mesh) lines the sides and bottom of 1 linear meter (approximately) of ditch. There are two mesh (3mm or 1/8 in) doors on the open ends of the net, which when pulled, rise up to close off the ends of the net, enclosing an area of water that is approximately 1m long and as wide as the ditch. The distance between all corners of the net are recorded and the surface area of the enclosed area can be calculated as the sum of two irregular triangles. Thus a quantitative sample can be taken from the ditch habitat.

For both the throw trap and the ditch net samplers, all fish and decapods were identified and enumerated. A representative number (up to 15 individuals) of each species collected was measured for length (fish – total length; crabs – carapace width; shrimp – total length). Once identified and measured all organisms were returned to pool or ditch where they were sampled. Example data sheets for both nekton sampling methods (throw trap and ditch net) are shown in Appendix, Figs. 5-1 and 5-2.

Pools and ditches were sampled on ebbing tides, after the marsh surface had drained.

Sampling occurred twice per year, once in early summer (June-July) and once in late summer-early fall (August – October). Species composition and abundance were estimated and species richness was calculated for each site using the jack-knife method (Heltshie & Forrester 1983).

Vegetation

Permanent plots to monitor salt marsh vegetation were located according to the salt marsh vegetation protocol (Roman *et al.* 2001). At each monitoring location 15 to 20 permanent plots were established along transects to monitor salt marsh vegetation. Randomly located transects extended from the tidal creeks or shoreline to the upland and covered a representative portion of the study area. Permanent vegetation plots were located along each transect. The first plot in each transect was randomly located and all subsequent plots were systematically placed along the transect at 10m to 50m intervals depending on the size of the study area. Within each plot all species were identified and the point-intercept method (Mueller-Dombois & Ellenberg 1974) was used to estimate percent cover of herbaceous vegetation at sites except Back River marsh (COLO). At Back River it was not possible to use the point intercept method to estimate cover due to the tall vegetation canopy, therefore an estimate of percent cover was based on the Braun-Blanquet system (Braun-Blanquet cover scale (1: <5%; 2: 6-25%; 3: 26-50%; 4: 51-75%; 5: 76-100%). Percent vegetation community composition was then calculated from the average point intercept score or from the average Braun-Blanquet score for each cover type. Categories and definitions of cover types used during the vegetation monitoring are shown in Table 1-1 (taken from Roman *et al.* 2001). Example data sheets for both vegetation sampling methods (point intercept and visual cover estimation) are shown in Appendix, Figs. 5-3 and 5-4.

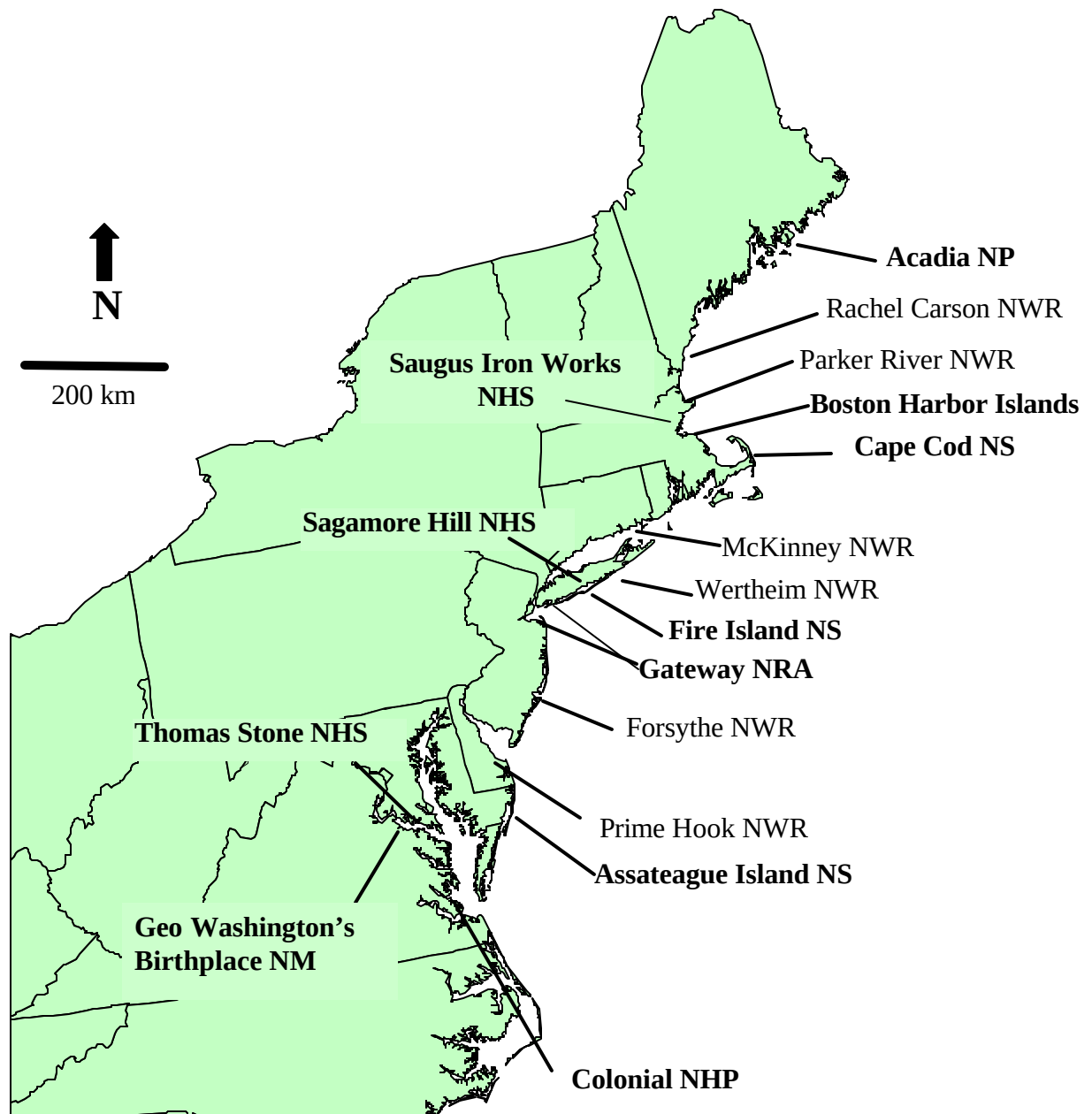


Figure 1-1 Coastal National Parks of the Northeast (in bold). Region 5 US Fish and Wildlife Refuges where salt marsh and nekton monitoring protocols are currently implemented are also shown.

Table 1-1. Definition of cover type categories used in the salt marsh vegetation monitoring program (after Roman *et al* 2001).

Live vascular plants (herbaceous and shrubs) identified by species.

Standing dead vascular plants identified by species (*e.g.*, *S. alterniflora* dead). This category only includes standing dead (attached) plants that are from a previous year's growth. There may be some dead leaves from this year's growth (*e.g.*, the ends of leaves or leaves that are being replaced by new growth, *etc.*). If you are sure these dead leaves are from the current growing season, then record as live.

Macroalgae identified by species. This category generally includes the rockweeds (*e.g.*, *Fucus*, *Ascophyllum*). Microalgae (*e.g.*, diatom mats) and fine filamentous algae are not included in this category.

Bare. Includes mud, sand, microalgae cover, *etc.* These are areas that are not flooded with water and are devoid of standing live, standing dead, or macroalgae. There can be a thin film of surface water within the bare category.

Water. Permanent standing water is identified in plots that are partly within a creek, ditch, marsh pool, or flooded panne.

Wrack/Litter. Wrack is material that has floated into the plot. This is generally dead (not attached) plant material, but could also be trash. Litter is dead plant material that is highly decomposed and is no longer attached.

Trash. Items such as logs, old piers, tires, *etc.*

Rock. Boulders or rocks can be found on the surface of northern New England marshes.

NOTES:

- If an intercept point has standing water that is covering a bare mud bottom, this point should be recorded as standing water. It is assumed that the bottom is bare and there is no need to record this.
 - If macroalgae or submerged aquatic vegetation are hit at the intercept point in a standing water habitat, then both the plant and water should be recorded.
 - If a plot is at the edge of a marsh pool (water), *Spartina* overhangs the water, and the intercept point hits the *Spartina* and water, then both *Spartina* and water should be recorded.
-

Chapter 2 . Colonial National Historical Park

Sampling and Sampling Stations

At Colonial National Historic Park (COLO) vegetation and nekton were sampled at Back River marsh (Jamestown Island) and King Creek marsh (on the York River) Fig 2-1. Monitoring took place during the summer of 2003. Nekton were sampled twice at the same station locations, once in June and once in August; vegetation was sampled in July (Table 2-1). Sampling station locations for nekton and vegetation are shown in Fig 2-2 and Fig 2-3. Table 2-2 shows the number of vegetation plots per transect and distance between plots. UTM coordinates of sampling locations are given in the Appendix, Table 5-1.

At Back River, a total of 21 nekton stations were sampled using a throw trap, with the majority of stations located along the large tidal creeks of the marsh (Fig. 2-2). Nineteen vegetation plots, oriented along four transects were sampled at Back River (Fig 2-2). At Back River it was not possible to use the point intercept method to estimate percent cover due to the tall vegetation canopy, therefore an estimate of percent cover was based on the Braun-Blanquet system (Braun-Blanquet cover scale (1: <5%; 2: 6-25%; 3: 26-50%; 4: 51-75%; 5: 76-100%). Vegetation community composition was then calculated from the average Braun-Blanquet score for each vegetation cover type.

At King Creek, a total of 28 nekton stations were sampled using throw traps, with the majority of stations located along the large tidal creeks (Fig 2-3). Seventeen vegetation plots, oriented along four transects were sampled for vegetation (Fig 2-3).

Nekton

Nekton community composition and abundance for Back River and King Creek marshes are shown in Table 2-3, and total fish and decapod density is shown in Table 2-4. Physical variables (water temperature, salinity, and dissolved oxygen) taken at nekton stations are given in Table 2-5.

At Back River, 7 species were sampled (5 fish and 2 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 9.9. The nekton community was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 93% of the species composition. *Fundulus heteroclitus* (common mummichog) was the next dominant, comprising 5% of the composition. All other species represented 1% or less of the total species composition.

At King Creek, 11 species were sampled (8 fish and 3 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 17.8. The nekton community was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 80% of the species composition. The next dominant species was *Menidia menidia* (Atlantic silversides) which comprised 14% of the community, followed by *Fundulus heteroclitus*

(common mummichog) which comprised 4% of the composition. All other species comprised 1% or less of the total nekton community.

Average lengths of dominant nekton (*Fundulus heteroclitus*, *Menidia menidia*, and *Palamonetes pugio*) sampled at both sites are presented in Fig. 2-4.

Vegetation

At Back River, the vegetation community was dominated *Peltandra virginica* (arrow arum), *Spartina cynosuroides* (giant cordgrass, live and dead), and bare ground. These cover types comprised approximately 73% of the vegetation community (Table 2-6).

At King Creek, the vegetation community was dominated by *Spartina alterniflora* (salt marsh cordgrass, live and dead) and bare ground, which comprised approximately 70% of the vegetation community (Table 2-6).

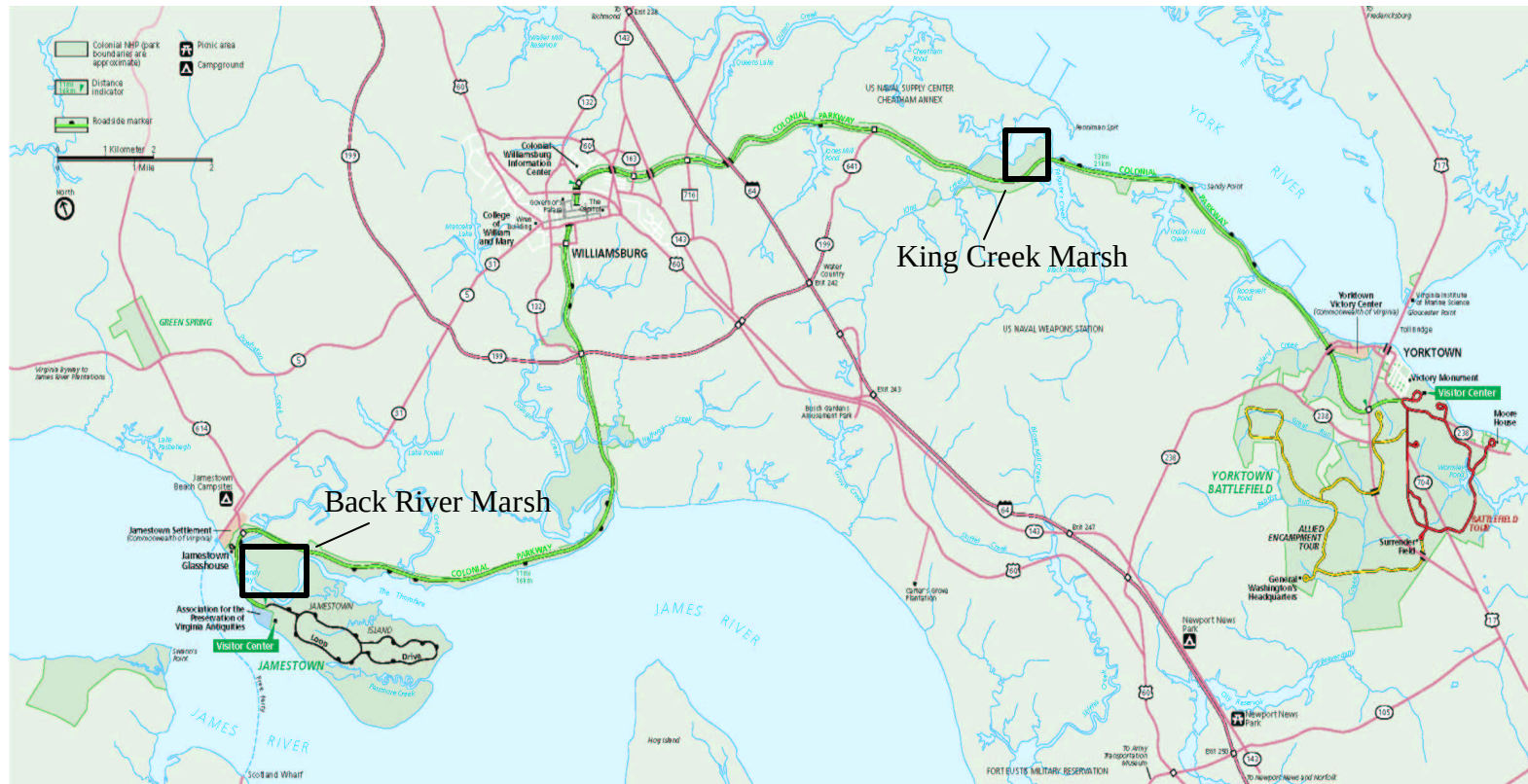


Figure 2-1. Map of COLO showing of sampling locations.

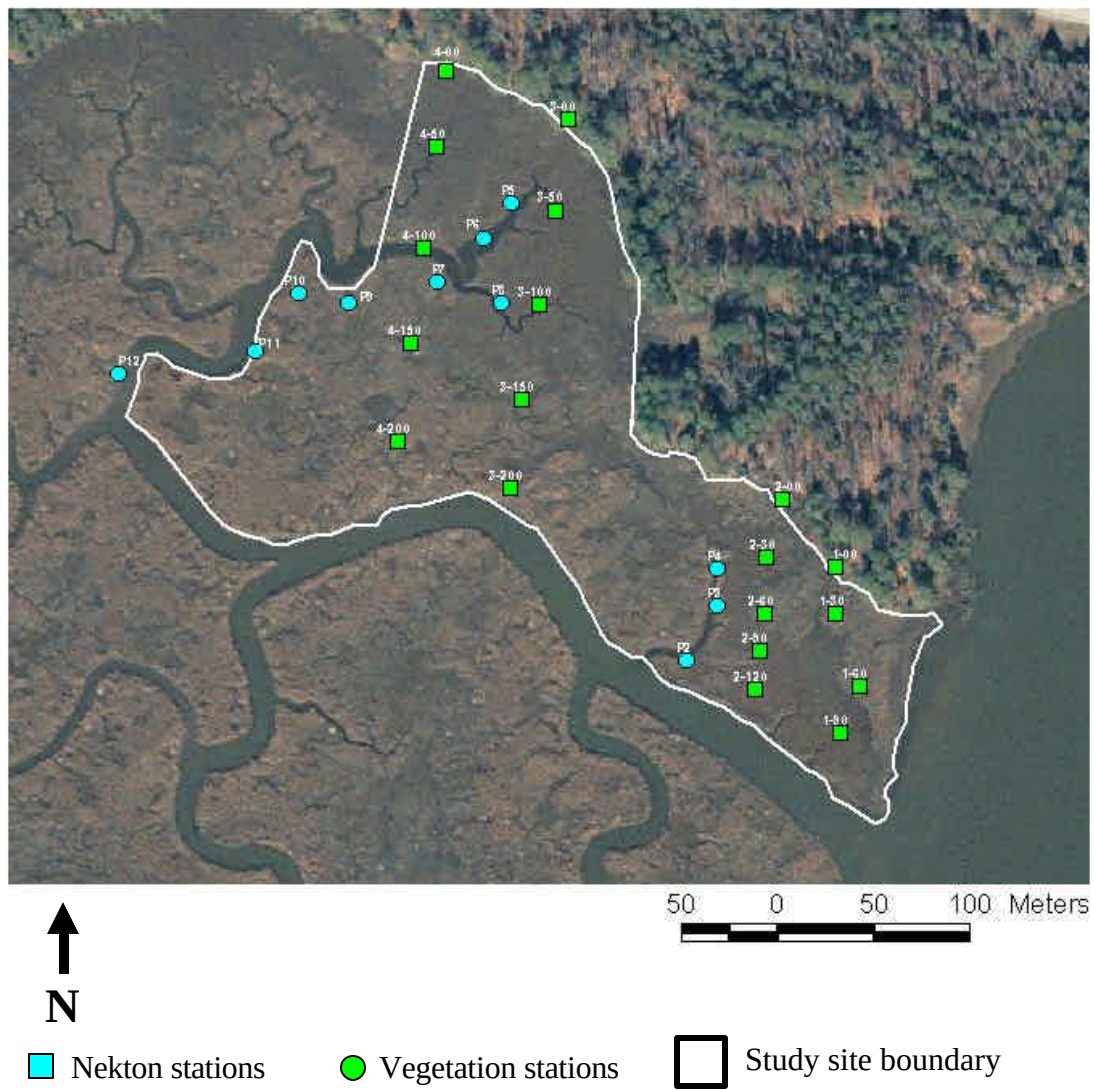


Figure 2-2. Map showing locations of stations sampled in 2003 for nekton and vegetation at Back River marsh, COLO.

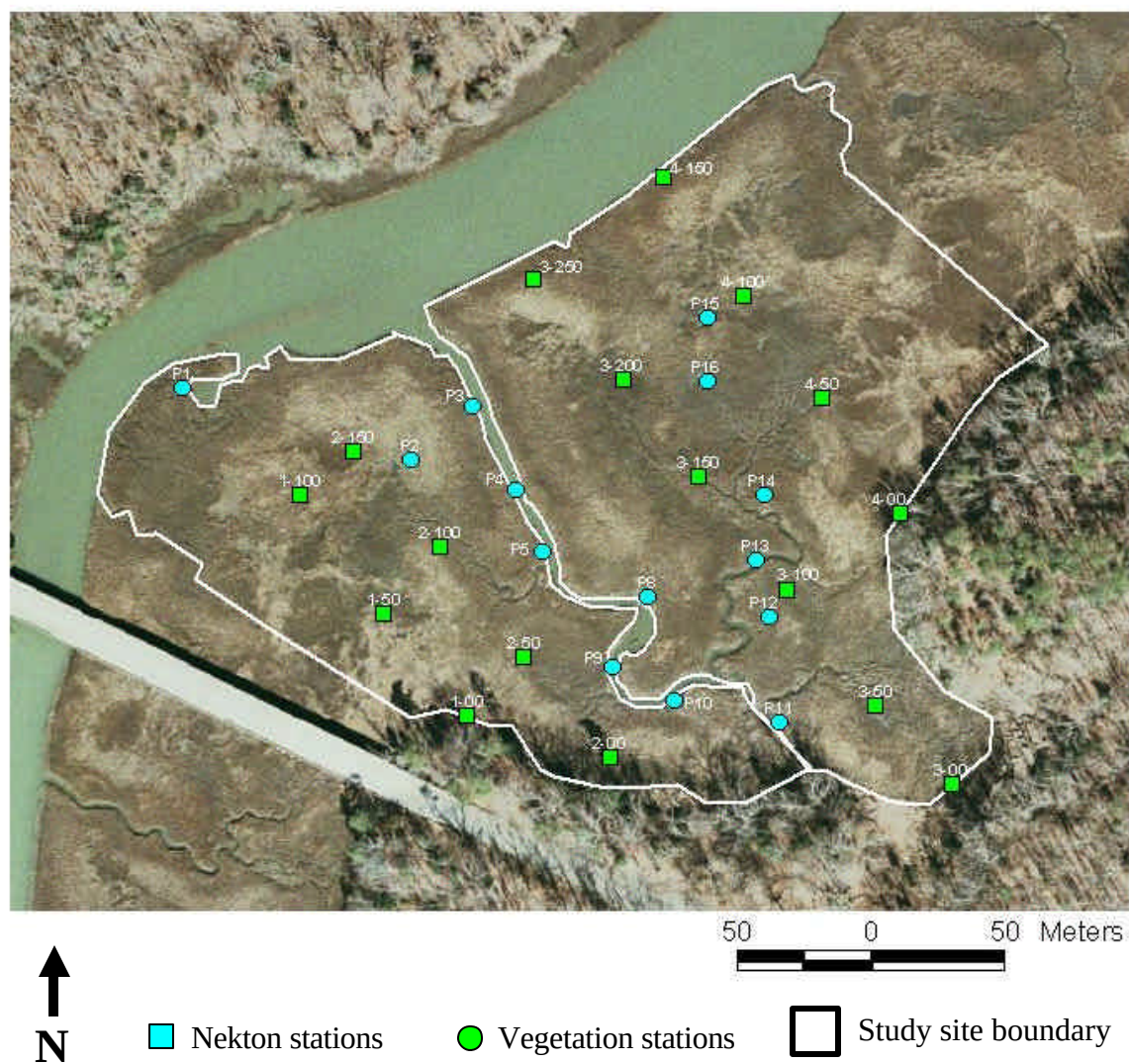


Figure 2-3. Map showing locations of stations sampled in 2003 for nekton and vegetation at King Creek marsh, COLO.

Table 2-1. Dates of nekton and vegetation sampling in 2003 at COLO.

Site	Nekton	Vegetation
Back River	June 18 & Aug 6	July 23
King Creek	June 17 & Aug 5	July 21-22

Table 2-2 Vegetation plots sampled in 2003 at COLO. UTM coordinates for each plot are listed in Appendix, Table 5-1.

Study Area	Transect	Distance between plots (m)	Plot ID and locations (m)	Total number of plots
King Creek (17 plots)	1	50	1-00 to 1-100	3
	2	50	2-00 to 2-150	4
	3	50	3-00 to 3-250	6
	4	50	4-00 to 4-150	4
Back River (19 plots)	1	30	1-00 to 1-90	4
	2	30	2-00 to 2-120	5
	3	50	3-00 to 3-200	5
	4	50	4-00 to 4-200	5

Table 2-3. Average density [number $m^{-2} \pm SD$ (total count)] of nekton sampled at Bach River and King Creek marshes in 2003. Replicate sample size is given after site name. *Note: Voucher specimens of unknown fish were lost before identification could be verified.*

Species	Common Name	Back River (21)	King Creek (28)
<i>Alosa sapidissima</i>	American shad	0	$<0.1 \pm 0.2$ (1)
<i>Anguilla rostrata</i>	American eel	<0.1 (1)	0
<i>Callinectes sapidus</i>	Blue crab	<0.1 (1)	0.1 ± 0.4 (4)
<i>Cyprinodon variegatus</i>	Sheepshead minnow	0	0.4 ± 1.9 (10)
<i>Fundulus diaphanus</i>	Banded killifish	0	<0.1 (1)
<i>Fundulus heteroclitus</i>	Mummichog	2.5 ± 5.8 (52)	2.3 ± 5.4 (64)
<i>Fundulus majalis</i>	Striped killifish	0	<0.1 (1)
<i>Fundulus species</i>	Killifish species	0	<0.1 (1)
<i>Menidia menidia</i>	Atlantic silverside	0.6 ± 2.0 (12)	6.6 ± 18.4 (185)
<i>Morone americana</i>	White perch	0.5 ± 1.5 (11)	0
<i>Palaemonetes pugio</i>	grass shrimp	50.8 ± 147.3 (1066)	38.8 ± 95.2 (1088)
<i>Palaemonetes vulgaris</i>	grass shrimp	0	<0.1
Unknown	unknown fish	<0.1 (1)	<0.1 (2)

Table 2-4. Average density [number $m^{-2} \pm SD$ (total count)] of fish, decapods, and total nekton sampled at Bach River and King Creek marshes in 2003. Replicate sample size is given after site name.

Species	Back River (21)	King Creek (28)
Total fish	3.7 ± 5.9 (77)	9.5 ± 18.3 (265)
Total decapods	50.8 ± 147.3 (1067)	39.1 ± 95.1 (1094)
Total Nekton	54.5 ± 150.6 (1144)	48.5 ± 96.3 (1359)

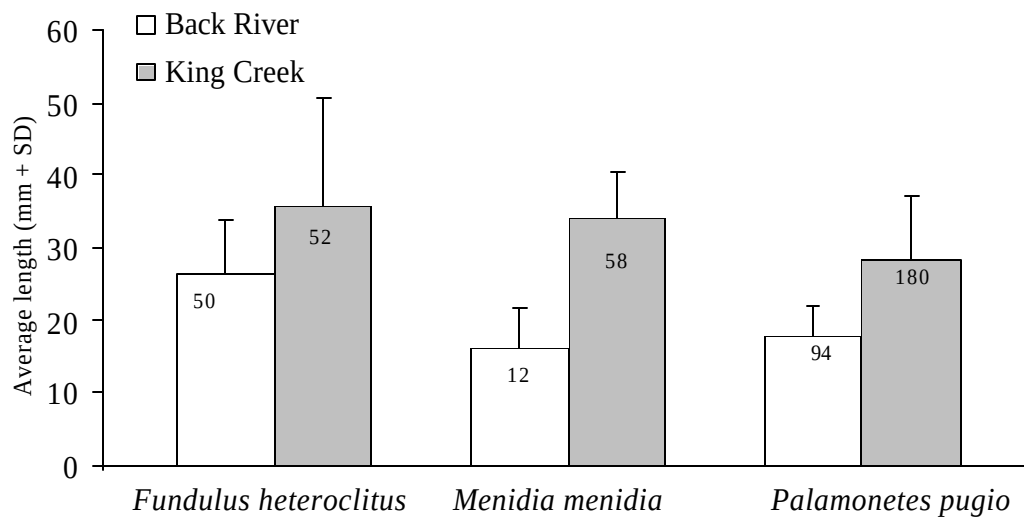


Figure 2-4. Average length (mm $\pm$ SD) of dominant nekton sampled at COLO in 2003. Number of individuals measured is indicated inside bars.

Table 2-5. Physical characteristics (average $\pm$ SD) of nekton sampling stations at COLO. Replicate sample size is given after site name.

Variable	Back River (21)	King Creek (28)
Water Temperature	25.3 $\pm$ 0.9	27.3 $\pm$ 6.0
Salinity	0.9 $\pm$ 2.1	6.4 $\pm$ 2.7
Dissolved Oxygen	3.9 $\pm$ 2.6	4.8 $\pm$ 2.7

Table 2-6. Percent composition of salt marsh communities (calculated from average cover of all plots) at Back River and King Creek marshes, COLO, in 2003. Number of vegetation plots sampled is given in parentheses after site name.

Species	Common Name	Percent Composition	
		Back River (19)	King Creek (17)
<i>Amaranthus cannabinus</i>	Tidal marsh amaranth	<1	-
Bare ground	Bare ground	14	21
<i>Distichlis spicata</i>	Spike grass	-	7
<i>Distichlis spicata</i> (dead)	Spike grass (dead)	-	5
<i>Peltandra virginica</i>	Arrow arum	28	-
<i>Peltandra virginica</i> (dead)	Arrow arum (dead)	<1	-
<i>Polygonum spp.</i>	Knotweed species	<1	-
<i>Pontederia cordata</i>	Pickernelweed	3	-
<i>Pontederia cordata</i> (dead)	Pickernelweed (dead)	<1	-
<i>Scirpus pungens</i>	Three-square bulrush	2	<1
<i>Scirpus pungens</i> (dead)	Three-square bulrush (dead)	1	<1
<i>Scirpus robustus</i>	Salt marsh bulrush	<1	-
<i>Scirpus validus</i>	Soft stem bulrush	5	-
<i>Scirpus validus</i> (dead)	Soft stem bulrush (dead)	1	-
<i>Spartina alterniflora</i>	Salt marsh cordgrass	<1	28
<i>Spartina alterniflora</i> (dead)	Salt marsh cordgrass (dead)	-	20
<i>Spartina cynosuroides</i>	Giant cordgrass	23	-
<i>Spartina cynosuroides</i> (dead)	Giant cordgrass (dead)	9	-
<i>Spartina patens</i>	Salt meadow cordgrass	-	8
<i>Spartina patens</i> (dead)	Salt meadow cordgrass (dead)	-	4
<i>Typha angustifolia</i>	Narrow leaf cattail	4	5
<i>Typha angustifolia</i> (dead)	Narrow leaf cattail (dead)	1	2
Wrack or litter	Wrack or litter	<1	-
<i>Zizania aquatica</i>	Wild rice	6	-

Chapter 3 . Gateway National Recreational Area

Sampling and Sampling Stations

At Gateway National Recreation Area (GATE) nekton were sampled within the Jamaica Bay Unit at Big Egg marsh (control and treatment sites) and at the Sandy Hook Unit at Horseshoe Cove marsh (Fig 3-1). In an effort to restore wetlands losses, the National Park Service is conducting a demonstration restoration project at the Big Egg marsh in Jamaica Bay. The project involves dredging the adjacent tidal creek and spraying sediment onto the marsh using a high-pressure apparatus (C. Roman, National Park Service, personal communication). One marsh has been sprayed (Big Egg Treatment) while an adjacent unsprayed marsh serves as a control (Big Egg Control). Only nekton were sampled at the Big Egg sites because GATE staff were already monitoring vegetation at these marshes. Nekton were sampled twice at the same station locations, once in June and once in August (Table 3-1). Vegetation at Sandy Hook was sampled once in July (Table 3-1). Locations of sampling stations are shown in Fig. 3-1 and Fig 3-2. Table 3-2 shows the number of vegetation plots per transect and distance between plots. UTM coordinates of sampling locations are given in the Appendix, Table 5-2.

At Big Egg Control, 21 nekton stations were sampled and at Big Egg Treatment 25 nekton stations were sampled (Fig. 3-2). All nekton sampling stations were located along the shoreline of the marsh and were sampled using a throw trap.

At Horseshoe Cove, 31 nekton stations were sampled using a throw trap and 21 vegetation plots were sampled using the point-intercept method (Fig. 3-3).

Nekton

Nekton community composition and abundance for Big Egg and Horseshoe Cove marshes are shown in Table 3-3, and total fish and decapod density is shown in Table 3-4. Physical variables (water temperature, salinity, and dissolved oxygen) taken at nekton stations are given in Table 3-5.

At Big Egg Control (Jamaica Bay Unit), 6 species were sampled (4 fish and 2 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 7.9. The nekton community was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 58% of the species community. The next dominant species was *Fundulus heteroclitus* (common mummichog) comprising 34% of the total nekton composition. All other species comprised 4% or less of the total species composition.

At Big Egg Treatment (Jamaica Bay Unit), 8 species were sampled (4 fish and 4 decapod) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 10.9. The nekton community was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 54% of the species community. The next dominant species were *Fundulus heteroclitus* (common mummichog) comprising 21% and *Menidia*

menidia (Atlantic silversides) comprising 18% of the total nekton composition. All other species comprised 3% or less of the total species composition.

At Horseshoe Cove (Sandy Hook Unit), 11 species were sampled (7 fish and 4 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 13.9. The nekton community was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 64% of the species community. The next dominant species was *Fundulus heteroclitus* (common mummichog) which comprised 25% of the community. All other species comprised 5% or less of the total species composition.

Average lengths of dominant nekton (*Fundulus heteroclitus*, *Menidia menidia*, and *Palaemonetes pugio*) sampled at all sites are presented in Fig. 3-4.

Vegetation

At Horseshoe Cove (Sandy Hook Unit), the vegetation community was dominated *Spartina alterniflora* (salt marsh cordgrass, live and dead), bare ground, and water. These four cover types comprised approximately 83% of the vegetation community (Table 3-6).



Figure 3-1. Map of sampling locations for GATE.

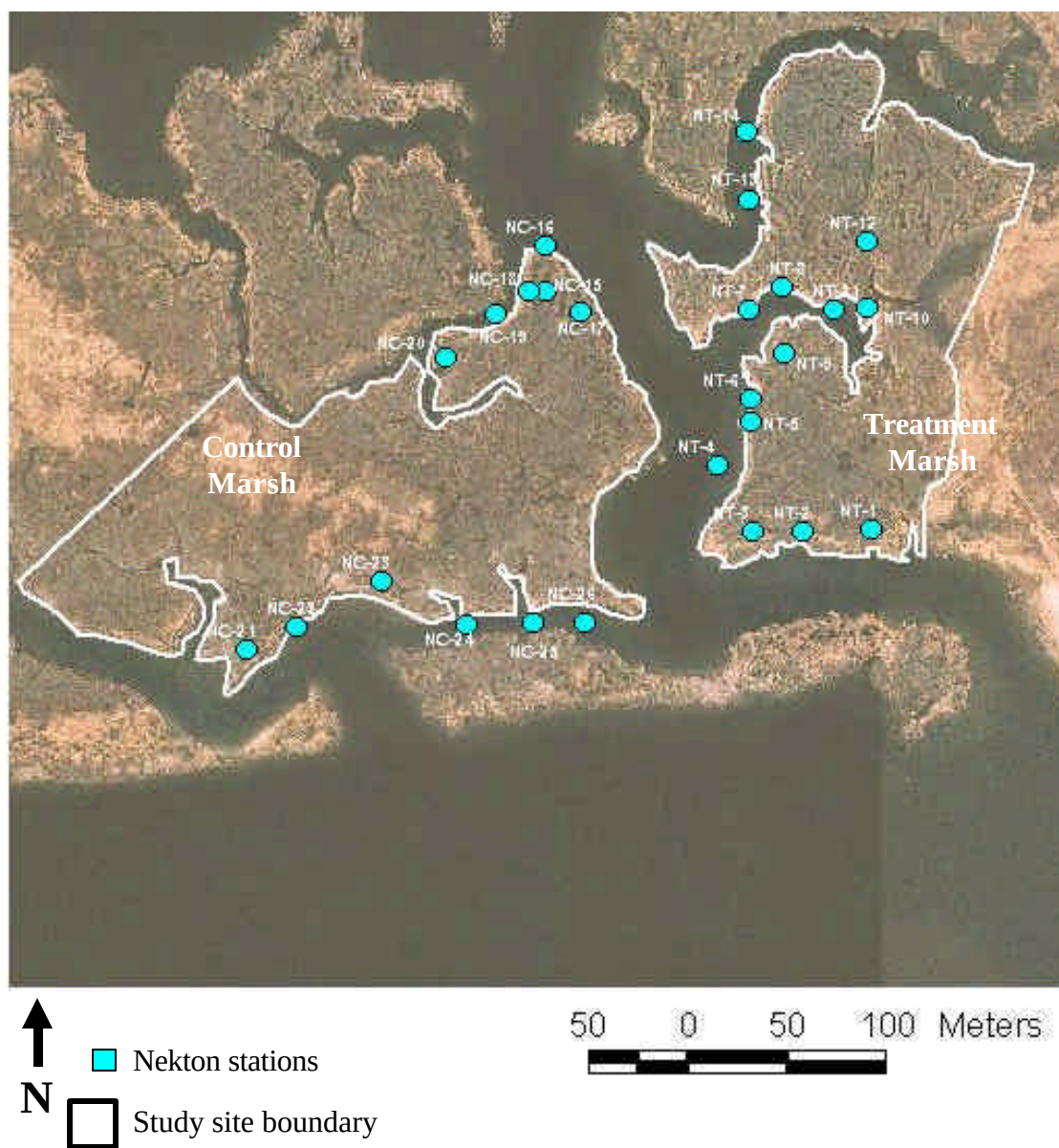


Figure 3-2. Map showing locations of nektion stations sampled in 2003 at Big Egg control and treatment marshes, Jamaica Bay Unit, GATE.

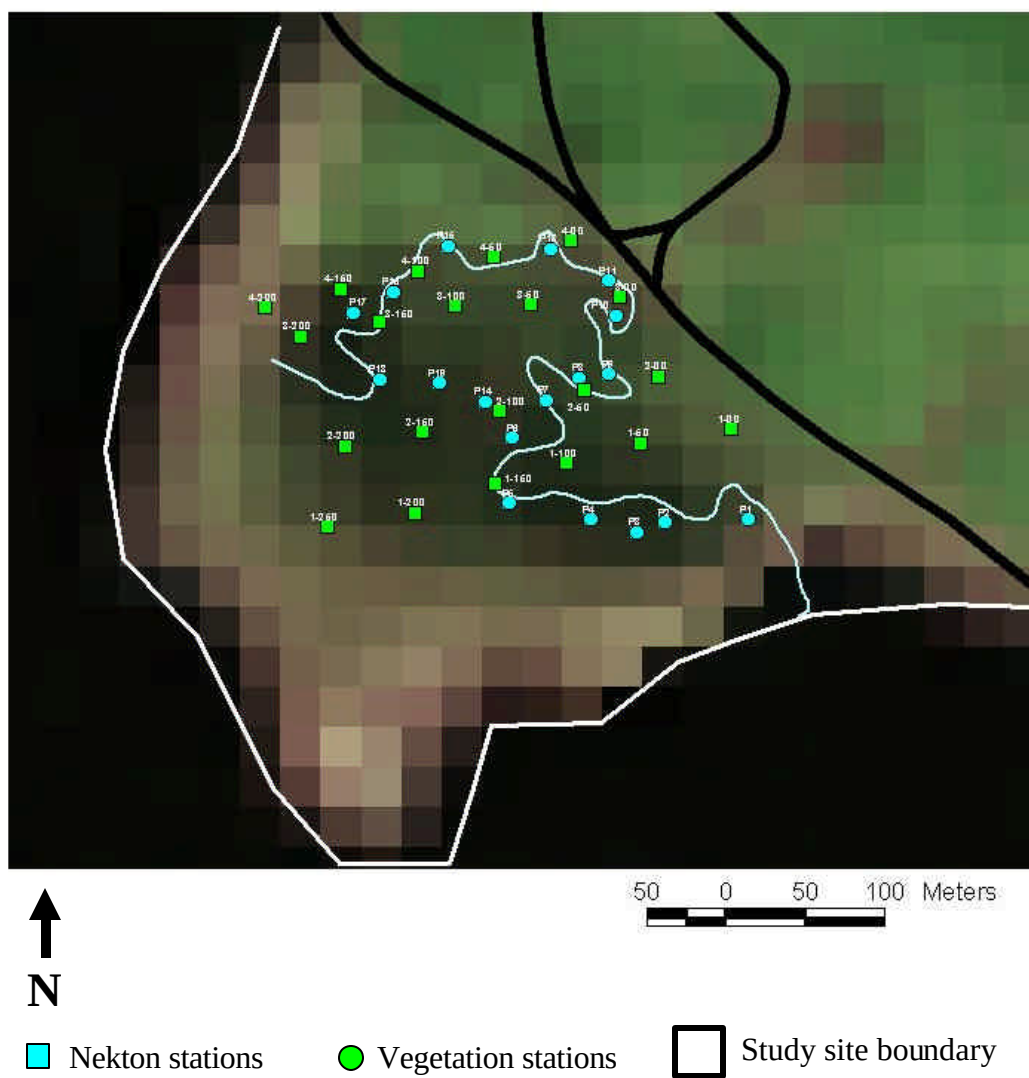


Figure 3-3. Map showing locations of stations sampled in 2003 for nekton and vegetation at Horseshoe Cove marsh, Sandy Hook Unit, GATE.

Table 3-1. Dates of nekton and vegetation sampling in 2003 at GATE. Vegetation at Big Egg marshes is currently being monitored by GATE staff.

Park Unit	Site	Vegetation	Nekton
GATE (Jamaica Bay)	Big Egg Control	-	June 4 & July 30-31
GATE (Jamaica Bay)	Big Egg Treatment	-	June 5 & July 30-31
GATE (Sandy Hook)	Horseshoe Cove	Aug 12	July 1 & Aug 13

Table 3-2. Vegetation plots sampled in 2003 at GATE. UTM coordinates for each plot are listed in Appendix, Table 5-2.

Study Area	Transect	Distance between plots (m)	Plot ID and locations (m)	Total number of plots
Horseshoe Cove (21 plots)	1	50	1-00 to 1-250	6
	2	50	2-00 to 2-200	5
	3	50	3-00 to 3-200	5
	4	50	4-00 to 4-200	5

Table 3-3. Average density [number m² ± SD (total count)] of nekton sampled at Big Egg and Horseshoe Cove Marshes in 2003. Replicate sample size is given after site name. *Note: Voucher specimens of unknown fish were lost before identification could be verified.*

Species	Common Name	Big Egg Control (21)	Big Egg Treatment (25)	Horseshoe Cove (31)
<i>Alosa sapidissima</i>	American shad	0	0	<0.1 (1)
<i>Anguilla rostrata</i>	American eel	0	0	0.2 ± 0.7 (5)
<i>Callinectes sapidus</i>	Blue crab	0	<0.1 (1)	0.2 ± 0.6 (7)
<i>Crangon septemspinosa</i>	Sevenspine bay shrimp	0	0.9 ± 4.4 (22)	0.3 ± 0.7 (8)
<i>Fundulus heteroclitus</i>	Mummichog	11.4 ± 18.7 (240)	5.8 ± 11.6 (145)	20.2 ± 39.4 (626)
<i>Fundulus majalis</i>	Striped killifish	0.6 ± 2.6 (12)	0.5 ± 1.2 (12)	4.1 ± 9.1 (128)
<i>Menidia menidia</i>	Atlantic silverside	0.8 ± 3.0 (16)	5.0 ± 9.8 (126)	3.8 ± 7.4 (117)
<i>Menidia</i> species	Silverside species	1.2 ± 5.5 (25)	<0.1 (2)	0
<i>Pagurus longicarpus</i>	Longwrist hermit crab	0	0	0.1 ± 0.4 (4)
<i>Palaemonetes pugio</i>	Grass shrimp	19.6 ± 41.3 (411)	14.8 ± 63.1 (370)	51.4 ± 147.4 (1592)
<i>Palaemonetes</i> species	Grass shrimp species	0.2 ± 0.4 (4)	0.3 ± 0.8 (8)	0
<i>Paralichthys dentatus</i>	Summer flounder	0	0	<0.1 (1)
Unknown fish	Unknown fish	0	0	<0.1 (2)

Table 3-4. Average density [number m⁻² ±SD (total count)] of fish and decapods sampled at GATE in 2003. Replicate sample size is given after site name.

Variable	Big Egg Control (21)	Big Egg Treatment (25)	Horseshoe Cove (31)
Total Fish	14.0 ± 19.6 (293)	11.4 ± 18.4 (285)	28.4 ± 42.7 (880)
Total Decapods	19.8 ± 41.2 (415)	16.0 ± 63.1 (401)	52.0 ± 147.6 (1611)
Total Nekton	33.7 ± 53.0 (708)	27.4 ± 70.8 (686)	80.4 ± 162.1 (2491)

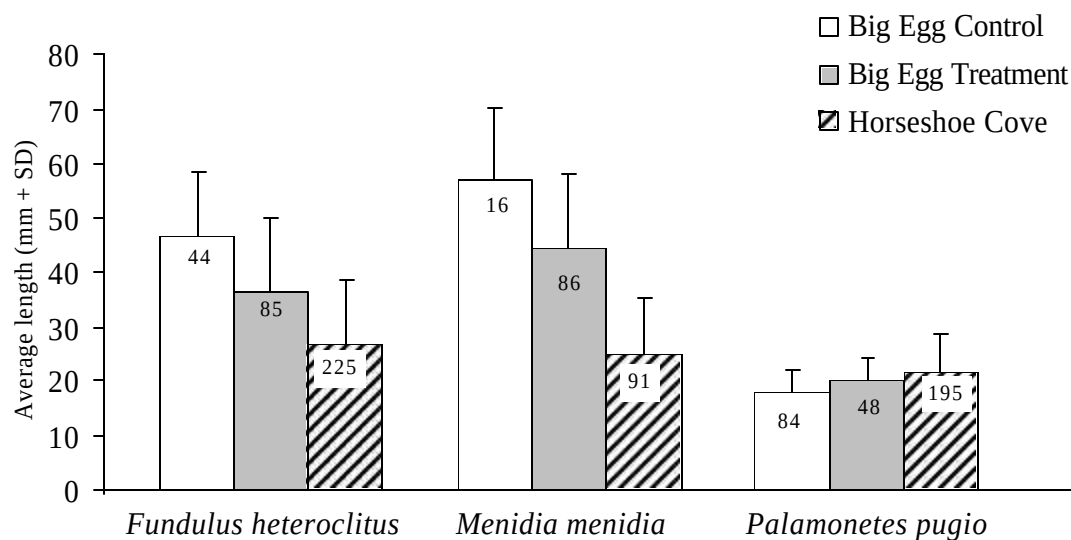


Figure 3-4. Average length (mm ±SD) of dominant nekton sampled at GATE in 2003. Number of individuals measured indicated inside bars.

Table 3-5. Physical characteristics (average ± SD) of nekton sampling stations at GATE. Replicate sample size is given after site name.

Variable	Big Egg Control (21)	Big Egg Treatment (25)	Horseshoe Cove (31)
Water Temperature	19.9 ± 5.1	21.9 ± 3.4	23.8 ± 3.4
Salinity	25.1 ± 2.1	22.6 ± 8.5	20.6 ± 4.1
Dissolved Oxygen	4.1 ± 2.7	6.3 ± 2.1	3.1 ± 2.1

Table 3-6. Percent composition of salt marsh vegetation communities (calculated from average cover of all plots) at Horseshoe Cove, Sandy Hook Unit, GATE. Twenty-one vegetation plots were sampled in 2003.

Species	Common Name	Percent Composition
<i>Atriplex patula</i>	Spreading orache	1
Bare ground	Bare ground	22
<i>Distichlis spicata</i>	Spike grass	1
<i>Distichlis spicata</i> (dead)	Spike grass (dead)	1
<i>Iva frutescens</i>	Marsh elder	4
<i>Iva frutescens</i> (dead)	Marsh elder (dead)	1
<i>Limonium carolinanum</i>	Sea lavender	<1
<i>Salicornia europea</i>	Glasswort	1
<i>Spartina alterniflora</i>	Salt marsh cordgrass	29
<i>Spartina alterniflora</i> (dead)	Salt marsh cordgrass (dead)	22
<i>Spartina patens</i>	Salt meadow cordgrass	4
<i>Spartina patens</i> (dead)	Salt meadow cordgrass (dead)	2
<i>Sueda linearis</i>	Sea blite	1
Water	Water	10
Wrack or litter	Wrack or litter	1

Chapter 4 . Fire Island National Seashore

Sampling and Sampling Stations

Nekton and vegetation were sampled within two marshes (Hospital Point and Watch Hill) at Fire Island National Seashore (FIIS) (Fig 4-1). At both these locations nekton were sampled using both throw traps (used in marsh pools and at shoreline stations) and ditch nets (used to sample ditches). Monitoring took place during the summer of 2003. Nekton were sampled twice at the same station locations, once in June and once in August; vegetation was sampled in July (Table 4-1). Sampling station locations for nekton and vegetation are shown in Fig 4-2 and Fig 4-3. Table 4-2 shows the number of vegetation plots per transect and distance between plots. UTM coordinates of sampling locations are given in the Appendix, Table 5-3.

At Hospital Point, at total of 36 nekton stations (18 ditch stations and 18 pool stations) and 30 vegetation plots were sampled in 2003 (Fig. 4-2).

At Watch Hill, at total of 29 nekton stations (20 ditches and 9 pools) and 20 vegetation plots were sampled in 2003 (Fig. 4-3).

Nekton

Nekton community composition and abundance for Hospital Point and Watch Hill marshes are shown in Table 4-3, and total fish and decapod densities are shown in Table 4-4. Physical variables (water temperature, salinity, and dissolved oxygen) taken at nekton stations are given in Table 4-5.

At Hospital Point, 8 species were sampled (6 fish and 2 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 12.9 (ditches and pools combined). The nekton community (pool and ditch samples combined) was dominated by *Palaemonetes pugio* (grass shrimp) which comprised 85% of the species community. The next dominant species were *Menidia menidia* (Atlantic silversides) and *Fundulus heteroclitus* (common mummichog) comprising 7% and 6% of the total nekton composition, respectively. All other species comprised less than 1% of the total species composition.

At Watch Hill, 11 species were sampled (9 fish and 2 decapod species) and had a species richness (jack-knife estimation, Heltshe and Forrester 1983) value of 16.8 (ditches and pools combined). The nekton community (pool and ditch samples combined) was dominated by *Fundulus heteroclitus* (common mummichog) which comprised 44% of the species community. The next dominant species were *Crangon septemspinosa* (sevenspine bay shrimp), *Palaemonetes pugio* (grass shrimp), and *Cyprinodon variegatus* (sheepshead minnow) which compromised 22%, 16%, and 15% of the total nekton composition,

respectively. All other species comprised 1% or less of the total species composition.

Average lengths of dominant nekton (*Palamonetes pugio*, *Fundulus heteroclitus*, *Crangon septemspinosa*, and *Cyprinodon variegatus*) from both sites are presented in Fig. 4-4.

Vegetation

At Hospital Point the vegetation community was dominated *Spartina alterniflora* (salt marsh cordgrass, live and dead), *S. patens* (salt meadow cordgrass, live and dead), wrack and litter, and *Distichlis spicata* (spike grass). These six cover types comprised approximately 90% of the vegetation community (Table 4-6).

At Watch Hill the vegetation community was dominated *Spartina alterniflora* (salt marsh cordgrass, live and dead), bare ground, *S. patens* (salt meadow cordgrass), and wrack and litter. These five cover types comprised approximately 92% of the vegetation community (Table 4-6).



Figure 4-1. Map of sampling locations at FIIS.

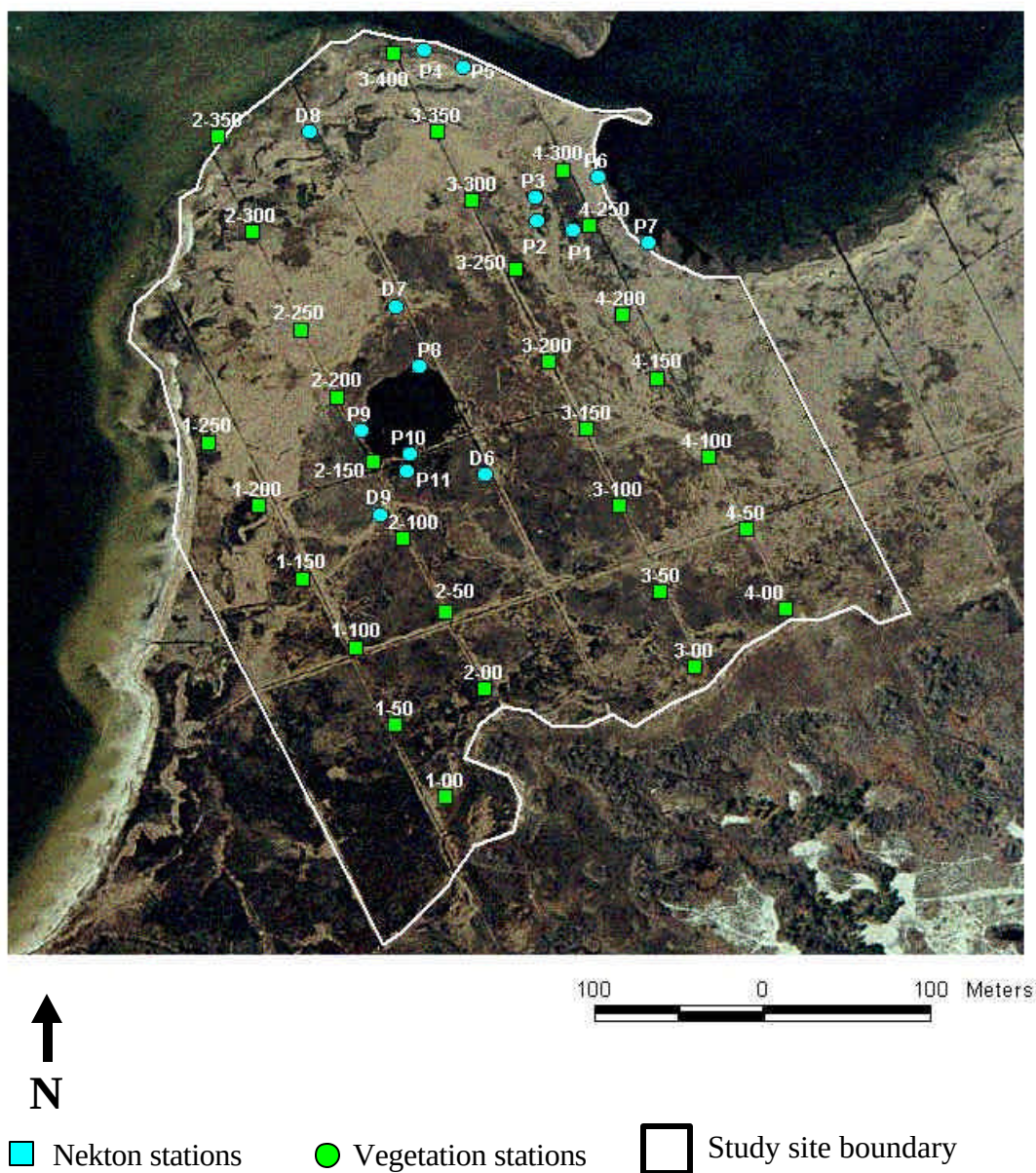


Figure 4-2. Map showing locations of stations sampled in 2003 for nekton and vegetation at Hospital Point marsh, FIIS. Coordinates of ditch stations D1-D5 were not recorded, but they were located on 2 eastern most ditches of the study area.

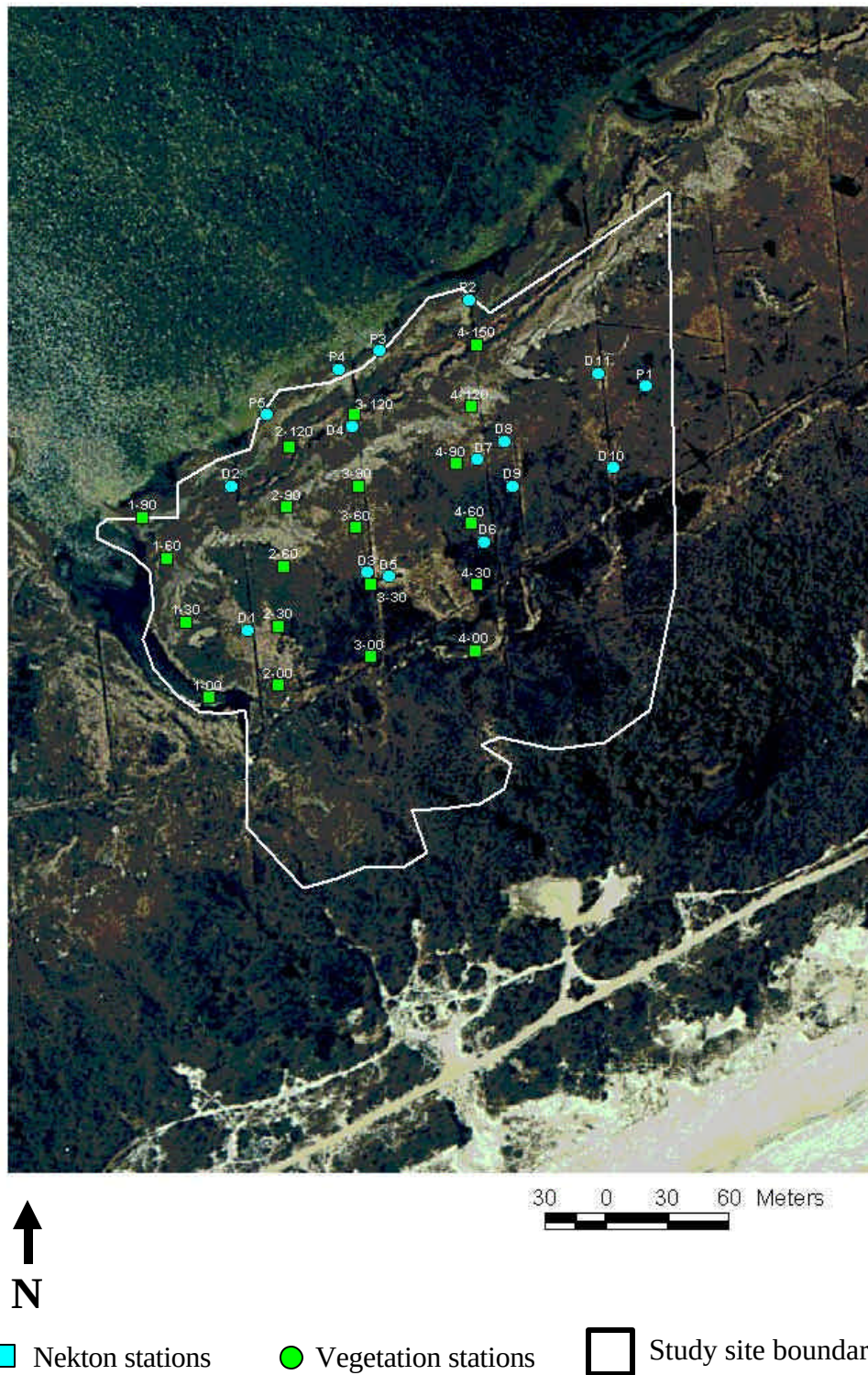


Figure 4-3. Map showing locations of stations sampled in 2003 for nekton and vegetation at Watch Hill marsh, FIIS.

Table 4-1. Dates of nekton and vegetation sampling in 2003 at FIIS

Site	Vegetation	Nekton
Hospital Point	July 8-9	June 11-12 & Aug 27
Watch Hill	July 9	June 12 & Aug 26, 27

Table 4-2. Vegetation plots sampled in 2003 at GATE. UTM coordinates for each plot are listed in Appendix, Table 5-4.

Study Area	Transect	Distance between plots (m)	Plot ID and locations (m)	Total number of plots
Hospital Point (30 plots)	1	50	1-00 to 1-250	6
	2	50	2-00 to 2-350	8
	3	50	3-00 to 3-400	9
	4	50	4-00 to 4-300	7
Watch Hill (20 plots)	1	30	1-00 to 1-90	4
	2	30	2-00 to 2-120	5
	3	30	3-00 to 3-120	5
	4	30	4-00 to 4-150	6

Table 4-3. Average density [number $\text{m}^{-2} \pm \text{SD}$ (total count)] of nekton sampled from ditches and pools at Hospital Point and Watch Hill marshes in 2003. Replicate sample size is given after site name.

Species	Common Name	Hospital Point (36)	Watch Hill (29)
Ditches			
<i>Cyprinodon variegatus</i>	Sheepshead minnow	0	6.3 ± 28.3 (28)
<i>Fundulus heteroclitus</i>	Mummichog	0.9 ± 2.2 (7)	17.3 ± 41.8 (106)
<i>Fundulus majalis</i>	Striped killifish	0	0.6 ± 2.1 (4)
<i>Lucania parva</i>	Rainwater killifish	0	0.2 ± 0.6 (1)
<i>Palaemonetes pugio</i>	Grass shrimp	0	6.1 ± 27.3 (27)
Pools			
<i>Anguilla rostrata</i>	American eel	0.1 ± 0.5 (2)	0.1 ± 0.3 (1)
<i>Apeletes quadracus</i>	4-spine stickleback	0.2 ± 0.9 (4)	0.3 ± 0.7 (3)
<i>Crangon septemspinosa</i>	Sevenspine bay shrimp	0.1 ± 0.2 (1)	20.7 ± 27.6 (186)
<i>Fundulus heteroclitus</i>	Mummichog	1.2 ± 2.5 (21)	2.6 ± 6.9 (23)
<i>Fundulus majalis</i>	Striped killifish	0.1 ± 0.2 (1)	0
<i>Fundulus</i> species	<i>Fundulus</i> species	0.1 ± 0.2 (1)	0
<i>Goby</i> species	<i>Goby</i> species	0	0.1 ± 0.3 (1)
<i>Menidia menidia</i>	Atlantic silverside	2.5 ± 7.4 (45)	0.7 ± 1.4 (6)
<i>Palaemonetes pugio</i>	Grass shrimp	30.1 ± 86.9 (541)	1.7 ± 5.0 (15)
<i>Syngnathus fuscus</i>	Northern pipefish	0	0.2 ± 0.7 (2)

Table 4-4. Average density [number $\text{m}^{-2} \pm \text{SD}$ (total count)] of fish and decapods sampled from ditches and pools at FIIS in 2003. Replicate sample size is given after site name.

Variable	Hospital Point (36)	Watch Hill (29)
Ditches		
Total Fish	0.9 ± 2.2 (7)	24.5 ± 67.0 (139)
Total Decapods	0	6.1 ± 27.3 (27)
Total Nekton	0.9 ± 2.2 (7)	30.5 ± 92.1 (166)
Pools		
Total Fish	4.2 ± 8.6 (45)	4.4 ± 10.9 (36)
Total Decapods	30.1 ± 87.1 (542)	22.3 ± 31.1 (201)
Total Nekton	34.2 ± 95.0 (587)	26.3 ± 39.5 (237)

Table 4-5. Physical characteristics (average $\pm$ SD) of nekton sampling stations (ditches and pools) at FIIS. Replicate sample size is given after site name.

Variable	Hospital Point (36)	Watch Hill (29)
Ditches		
Water Temperature	22.3 $\pm$ 3.9	23.2 $\pm$ 1.3
Salinity	14.4 $\pm$ 7.1	15.1 $\pm$ 7.6
Dissolved Oxygen	2.1 $\pm$ 2.5	4.3 $\pm$ 2.7
Pools		
Water Temperature	24.3 $\pm$ 5.8	25.3 $\pm$ 2.8
Salinity	13.8 $\pm$ 7.6	20.0 $\pm$ 7.2
Dissolved Oxygen	1.9 $\pm$ 2.0	7.8 $\pm$ 1.1

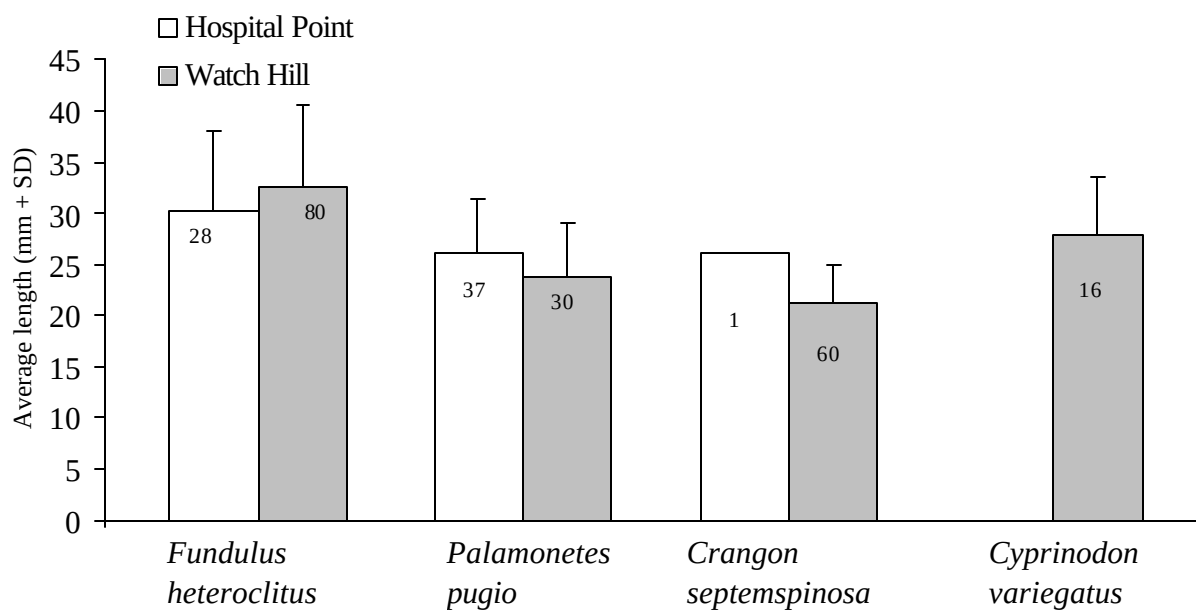


Figure 4-4. Average length (mm $\pm$ SD) of dominant nekton sampled at FIIS in 2003. Number of individuals measured indicated inside bars. Note: no *C. variegatus* were sampled at Hospital Point.

Table 4-6. Percent composition of salt marsh communities (calculated from average cover of all plots) at Hospital Point and Watch Hill, FIIS, in 2003. Number of vegetation plots sampled is given after site name.

Species	Common Name	Percent Composition	
		Hospital Point (30)	Watch Hill (20)
Bare ground	Bare ground	4	15
<i>Distichlis spicata</i>	Spike grass	5	2
<i>Distichlis spicata</i> (dead)	Spike grass (dead)	1	-
<i>Juncus gerardii</i>	Black grass	2	-
<i>Phragmites australis</i>	Common reed	<1	<1
<i>Salicornia europea</i>	Glasswort	-	<1
<i>Spartina alterniflora</i>	Salt marsh cordgrass	29	43
<i>Spartina alterniflora</i> (dead)	Salt marsh cordgrass (dead)	14	24
<i>Spartina patens</i>	Salt meadow cordgrass	27	6
<i>Spartina patens</i> (dead)	Salt meadow cordgrass (dead)	9	3
Water	Water	4	3
Wrack or litter	Wrack or litter	6	4

Literature Cited

- Able, K.W., 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, p. 335-353. In K. F. Nordstrom and C. T. Roman (eds.), *Estuarine Shores: Evolution, Environments and Human Alterations*. John Wiley & Sons, Ltd. West Sussex, England.
- Heltshe, J.F. and N.E. Forrester. 1983. Estimating species richness using the jackknife procedure. *Biometrics* 39:1-11.
- James-Pirri, M.J., R.M. Erwin, & D.J. Prosser. In Prep. US Fish and Wildlife Service (Region 5) Salt Marsh Study Year 3 Study Report. Technical report submitted to Janith Taylor, US Fish and Wildlife Service.
- James-Pirri, M.J., R.M. Erwin, & D.J. Prosser. 2003. Data Report for 2001 & 2002 US Fish and Wildlife Service (Region 5) Salt Marsh Study. Technical report submitted Janith Taylor, US Fish and Wildlife Service.
- James-Pirri, M.J., C.T. Roman & R.M. Erwin. 2002a. Final Report for the Year 1 (2001) US Fish and Wildlife Service (Region 5) Salt Marsh Study. Technical report to Janith Taylor, US Fish and Wildlife Service.
- James-Pirri, M.J., C.T. Roman & R.M. Erwin. 2002b. Field Methods Manual: US Fish and Wildlife Service (Region 5) salt marsh study. USGS Patuxent Wildlife Research Center, Coastal Research Field Station, University of Rhode Island, Narragansett, RI 02882. 62 pp.
- Kushlan, J.A. 1981. Sampling characteristics of enclosure fish traps. *Transactions of the American Fisheries Society* 110:557-562.
- McIvor, C.C. and L.P. Rozas. 1996. Direct nekton use of intertidal saltmarsh habitat and linkage with adjacent habitats: a review from the southeastern United States, p. 311-334. In K. F. Nordstrom and C. T. Roman (eds.), *Estuarine Shores: Evolution, Environments and Human Alterations*. John Wiley & Sons, Ltd. West Sussex, England.
- Mueller-Dombois, D. and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, New York. 547 pp.
- Raposa, K.B. and C.T. Roman. 2001a. Monitoring nekton in shallow estuarine habitats. Part of a series of monitoring protocols for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. USGS Patuxent Wildlife Research Center, Coastal Research Field Station, University of Rhode Island, Narragansett, RI 02882.

- Raposa, K.B. and C.T. Roman. 2001b. Seasonal habitat-use patterns of nekton in a tide-restricted and unrestricted New England salt marsh. *Wetlands* 21: 451-461.
- Roman, C.T., M.J. James-Pirri, J. F. Heltshe. 2001. Monitoring Salt Marsh Vegetation: Part of a series of monitoring protocols for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. USGS Patuxent Wildlife Research Center, Coastal Research Field Station, University of Rhode Island, Narragansett, RI 02882.
- Rozas, L.P. and T.J. Minello. 1997. Estimating densities of small fishes and decapod crustaceans in shallow estuarine habitats: a review of sampling design with focus on gear selection. *Estuaries* 20:199-213.
- Sogard, S.M. and K.W. Able. 1991. A comparison of eelgrass, sea lettuce macroalgae, and marsh creeks as habitats for epibenthic fishes and decapods. *Estuarine, Coastal and Shelf Science* 33:501-519.

Chapter 5 . Appendix

Figure 5-1. Throw trap field data sheet.

Figure 5-2. Ditch net field data sheet.

Figure 5-3. Vegetation point intercept field data sheet.

Figure 5-4. Vegetation visual cover estimate field data sheet.

Table 5-1. UTM coordinates of sampling stations at COLO.

Table 5-2. UTM coordinates of sampling stations at GATE.

Table 5-3. UTM coordinates of sampling stations at FIIS.

Throw Trap Data Sheet

SITE: _____ DATE: _____

STATION #: _____ SAMPLING CREW: _____

Coordinates: N: _____ W: _____

Habitat Type: Pool/Panne Tidal Creek Plugged Ditch Open Ditch

Time: _____

Water temp: _____ Salinity: _____ DO: _____

Water Depth: _____ Tide: Flood or Ebb

NEKTON SPECIES & MEASUREMENTS

SPECIES #1 _____ Total # of individuals: _____

Talley (include measured fish): _____

LENGTHS (15): _____

SPECIES #2 _____ Total # of individuals: _____

Talley (include measured fish): _____

LENGTHS (15): _____

SPECIES #3 _____ Total # of individuals: _____

Talley (include measured fish): _____

LENGTHS (15): _____

SPECIES #4 _____ Total # of individuals: _____

Talley (include measured fish): _____

LENGTHS (15): _____

SPECIES #5 _____ Total # of individuals: _____

Talley (include measured fish): _____

LENGTHS (15): _____

Figure 5-1. Field data sheet for nekton throw trap samples.

Ditch Net Sampler Data Sheet	
SITE: _____	DATE: _____
STATION #: _____	SAMPLING CREW: _____
Coordinates N: _____ W: _____	
Habitat Type: Tidal Creek Open Ditch Plugged Ditch	
Deployment Time: _____	Collection Time: _____
Distance: A to B: _____ B to C: _____ C to D: _____ D to A: _____ Diagonal _____	
Water temp: _____	Salinity: _____ DO: _____
Water Depth: _____ Creek/Ditch Depth: _____ Tide: Flood or Ebb	
NEKTON SPECIES & MEASUREMENTS	
SPECIES #1 _____	
Talley: _____	Total # of individuals: _____
LENGTHS (15): _____	
SPECIES #2 _____	
Talley: _____	Total # of individuals: _____
LENGTHS (15): _____	
SPECIES #3 _____	
Talley: _____	Total # of individuals: _____
LENGTHS (15): _____	
SPECIES #4 _____	
Talley: _____	Total # of individuals: _____
LENGTHS (15): _____	
SPECIES #5 _____	
Talley: _____	Total # of individuals: _____
LENGTHS (15): _____	

Figure 5-2. Field data sheet for nekton throw trap samples

VEGETATION DATA SHEET (1m² point intercept method)

Site _____ Field Crew _____ Date _____

Plot ID _____ Coordinates N: _____ W: _____

Point-- record species, first row is for points 1-25, second row is for points 26-50.

SPECIES	1 26	2 27	3 28	4 29	5 30	6 31	7 32	8 33	9 34	10 35	11 36	12 37	13 38	14 39	15 40	16 41	17 42	18 43	19 44	20 45	21 46	22 47	23 48	24 49	25 50	Total Tally	
1.																											
2																											
3																											
4																											
5																											
6																											
7																											
8.																											
9.																											

Figure 5-3. Field data sheet for vegetation samples (point intercept method).

Visual Cover Estimate for Vegetation	
SITE _____	DATE _____
PLOT ID _____	TEAM _____
Comments _____	
Coordinates: N: _____ W: _____	
Braun-Blanquet Cover Classes: In 1996, 1998, 1999 we used cover class categories ranging from 1 to 7. In the Restoration Ecology MS we converted the 1-7 classes to 1-5 (1: <1-5%, 2: 6 to 25%)	
1: <1%	4: 10% to 25%
2: 1% to 5%	5: 26% to 50%
3: 6% to 10%	6: 51% to 75%
7: 76% to 100%	
<u>Species ID</u>	<u>Cover Class</u>
#1 _____	_____
#2 _____	_____
#3 _____	_____
#4 _____	_____
#5 _____	_____
#6 _____	_____
#7 _____	_____
#8 _____	_____
#9 _____	_____
#10 _____	_____
#11 _____	_____
#12 _____	_____

Figure 5-4. Field data sheet for vegetation samples (visual cover estimate).

Table 5-1. Coordinates for sampling locations at COLO, UTM, Zone 18, NAD 83, meters. *Note: Back River P1 was not sampled because it was too deep; Back River P5 was not sampled in August because it was too shallow; King Creek, P6 and P7 do not exist. * UTM coordinates of Back River, P6 were estimated from GIS maps.*

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Back River	Nekton	P2	342860	4120447
		P3	342876	4120475
		P4	342876	4120494
		P5	342769	4120684
		P6*	342755	4120665
		P7	342731	4120643
		P8	342764	4120632
		P9	342685	4120632
		P10	342659	4120637
		P11	342636	4120607
		P12	342565	4120595
	Vegetation	1-00	342938	4120495
		1-30	342938	4120471
		1-60	342950	4120433
		1-90	342940	4120409
		2-00	342910	4120530
		2-30	342902	4120500
		2-60	342901	4120471
		2-90	342898	4120452
		2-120	342896	4120432
		3-00	342799	4120727
		3-50	342792	4120680
		3-100	342784	4120631
		3-150	342775	4120582
		3-200	342769	4120536
		4-00	342736	4120752
		4-50	342731	4120713
		4-100	342724	4120660
		4-150	342717	4120611
		4-200	342711	4120560
King Creek	Nekton	P1	357640	4126486
		P2	357725	4126459
		P3	357748	4126479

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
King Creek (continued)	Nekton (continued)	P4	357764	4126448
		P5	357774	4126425
		P8	357813	4126408
		P9	357800	4126382
		P10	357823	4126370
		P11	357862	4126362
		P12	357858	4126401
		P13	357853	4126422
		P14	357856	4126446
		P15	357835	4126512
		P16	357835	4126488
	Vegetation	1-00	357746	4126364
		1-50	357715	4126402
		1-100	357684	4126446
		2-00	357799	4126349
		2-50	357767	4126386
		2-100	357736	4126427
		2-150	357704	4126462
		3-00	357926	4126339
		3-50	357898	4126368
		3-100	357865	4126411
		3-150	357832	4126453
		3-200	357804	4126489
		3-250	357771	4126526
		4-00	357907	4126439
		4-50	357878	4126482
		4-100	357849	4126520
		4-150	357819	4126564

Table 5-2. Coordinates for sampling locations at GATE, UTM, Zone 18, NAD 83, meters. *Note: The following stations were not sampled in August because of low water: Big Egg Control: NC-18, NC-22, NC-25; Big Egg Treatment: NT-7, NT-11, NT-14; Horseshoe Cove: P4, P9, P14, P16, P19. * UTM coordinates of vegetation stations 1-150, 2-50, and 3-150 were estimated from GIS maps.*

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Big Egg Treatment	Nekton	NT-1	599311.7	4494539
		NT-2	599277.9	4494539
		NT-3	599252.5	4494539
		NT-4	599235.1	4494572
		NT-5	599251.8	4494594
		NT-6	599251.6	4494605
		NT-7	599251	4494650
		NT-8	599267.8	4494661
		NT-9	599268.3	4494628
		NT-10	599293.3	4494650
		NT-11	599310.3	4494650
		NT-12	599309.8	4494684
		NT-13	599250.3	4494705
		NT-14	599249.9	4494738
Big Egg Control	Nekton	NC-15	599166.4	4494649
		NC-16	599149.1	4494682
		NC-17	599149.3	4494659
		NC-18	599140.9	4494659
		NC-19	599124.1	4494648
		NC-20	599099	4494625
		NC-21	598999.4	4494480
		NC-22	599024.6	4494491
		NC-23	599066.7	4494514
		NC-24	599109.3	4494492
		NC-25	599143.1	4494493
		NC-26	599168.5	4494493
Horseshoe Cove	Nekton	P1	584894	4478041
		P2	584842	4478039
		P3	584824	4478033
		P4	584795	4478041

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Horseshoe Cove (continued)	Nekton (continued)	P5	584744	4478051
		P6	584746	4478092
		P19	584700	4478127
		P7	584767	4478116
		P8	584788	4478130
		P9	584807	4478132
		P10	584811	4478169
		P11	584807	4478191
		P13	584770	4478211
		P14	584729	4478115
		P15	584706	4478213
		P16	584671	4478184
		P17	584646	4478171
		P18	584663	4478129
Horseshoe Cove	Vegetation	1-00	584884	4478098
		1-50	584827	4478089
		1-100	584780	4478076
		1-150*	584735	4478063
		1-200	584685	4478045
		1-250	584630	4478036
		2-00	584838	4478131
		2-50*	584791	4478122
		2-100	584738	4478109
		2-150	584690	4478096
		2-200	584641	4478087
		3-00	584814	4478181
		3-50	584758	4478176
		3-100	584710	4478175
		3-150*	584663	4478165
		3-200	584613	4478156
		4-00	584783	4478216
		4-50	584735	4478206
		4-100	584687	4478197
		4-150	584639	4478186
		4-200	584591	4478174

Table 5-1. Coordinates for sampling locations at FIIS, UTM, Zone 18, NAD 83, meters.
 * UTM coordinates of nekton stations, Hospital Point, D1 to D5 are unavailable, however they were on the two eastern most ditches of the study site; station P8 was estimated from GIS maps. Note: Hospital Point, P4 and P5 do not exist; Watch Hill, D10, D11, and P1 were not sampled in August due to low water.

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Hospital Point	Nekton	D1*	Not recorded	Not recorded
		D2*	Not recorded	Not recorded
		D3*	Not recorded	Not recorded
		D4*	Not recorded	Not recorded
		D5*	Not recorded	Not recorded
		D6	678020	4510820
		D7	677967	4510920
		D8	677916	4511024
		D9	677958	4510796
		P1	678072	4510965
		P2	678051	4510971
		P3	678050	4510985
		P6	678087	4510997
		P7	678117	4510958
		P8*	677981	4510884
		P9	677947	4510846
		P10	677976	4510832
		P11	677974	4510822
	Vegetation	1-00	677997	4510628
		1-50	677967	4510671
		1-100	677944	4510717
		1-150	677912	4510758
		1-200	677886	4510801
		1-250	677856	4510839
		2-00	678020	4510692
		2-50	677997	4510738
		2-100	677972	4510782
		2-150	677954	4510827
		2-200	677933	4510866
		2-250	677911	4510906
		2-300	677882	4510964

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Hospital Point (continued)	Vegetation (continued)	2-350	677862	4511021
		3-00	678145	4510705
		3-50	678125	4510750
		3-100	678100	4510801
		3-150	678081	4510847
		3-200	678058	4510887
		3-250	678039	4510942*
		3-300	678013	4510983
		3-350	677992	4511024
		3-400	677966	4511070
		4-00	678199	4510740
		4-50	678176	4510787
		4-100	678153	4510830
		4-150	678123	4510877
		4-200	678102	4510915
		4-250	678083	4510968
		4-300	678067	4511001
Watch Hill	Nekton	D1	670399	4506789
		D2	670391	4506859
		D3	670457	4506817
		D4	670450	4506888
		D5	670468	4506815
		D6	670514	4506832
		D7	670511	4506872
		D8	670524	4506881
		D9	670528	4506859
		D10	670577	4506868
		D11	670570	4506914
		P1	670593	4506908
		P2	670507	4506950
		P3	670463	4506925
		P4	670443	4506916
		P5	670408	4506894
	Vegetation	1-00	670380	4506756
		1-30	670369	4506793
		1-60	670360	4506824
		1-90	670348	4506844
		2-00	670414	4506762

Marsh	Sampling Variable	Station	UTM X (west)	UTM Y (north)
Watch Hill (continued)	Vegetation (continued)	2-30	670414	4506791
		2-60	670417	4506820
		2-90	670418	4506849
		2-120	670419	4506878
		3-00	670459	4506776
		3-30	670459	4506811
		3-60	670452	4506839
		3-90	670453	4506859
		3-120	670451	4506894
		4-00	670510	4506779
		4-30	670511	4506811
		4-60	670508	4506841
		4-90	670501	4506870
		4-120	670508	4506898
		4-150	670511	4506928