



# Monitoring Salt Marsh Vegetation and Nekton at Gateway National Recreation Area's Sandy Hook Unit

## *2012 Summary Report*

Natural Resource Data Series NPS/NCBN/NRDS—2013/458



**ON THE COVER**

Salt marsh at Gateway National Recreation Area's Sandy Hook Unit.  
Photograph by: Robin Baranowski

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# **Monitoring Salt Marsh Vegetation and Nekton at Gateway National Recreation Area's Sandy Hook Unit**

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Erika L. Nicosia

National Park Service  
Northeast Coastal and Barrier Network  
University of Rhode Island  
1 Greenhouse Rd  
Kingston, RI 02881

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## Abstract

The Northeast Coastal and Barrier Network (NCBN) began monitoring salt marsh vegetation and nekton at Gateway National Recreation Area's Sandy Hook Unit (GATE-SHU) in 2010. This report summarizes the second year of data collected at three permanent monitoring sites during the summer of 2012. Monitoring will continue on a biennial basis.

Approximately fifty vegetation plots were sampled at each of the three marsh sites (total = 146 plots). The percent cover of each vegetation species and non-vegetation cover type within each 1 m<sup>2</sup> plot was visually estimated using a revised Braun-Blanquet method. Twenty-four vegetation species and four non-vegetation cover types (bare ground, water, wrack & litter, and trash) were recorded.

A total of 21 nekton stations were established (on creeks and pools/pannes) and sampled. Each station was sampled in late June. Normally, each station is sampled for a second time in late summer; however, in 2012 sampling during Event 2 was incomplete and only 2 of the 21 stations were sampled. Nekton stations were sampled using a 1 m<sup>2</sup> aluminum throw trap. Nine species of nekton were recorded at GATE-SHU in 2012, including six fish, two crab, and one shrimp species. Common mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), and daggerblade grass shrimp (*Palaemonetes pugio*) account for approximately 96% of all nekton captured in 2012.

## Acknowledgments

We would like to thank Gateway National Recreation Area for providing housing for the 2012 field crew.



## Introduction

National Park Service (NPS) managers need accurate information about how, when and why natural systems change over time in order to make sound management decisions. To address this need, the NPS initiated natural resource monitoring through the Natural Resource Challenge. The Inventory and Monitoring Program (I&M), the key component of this effort, organizes 270 park units into 32 networks tasked with conducting long-term ‘vital signs’ monitoring (Fancy et al. 2009). Vital signs are defined as measurable, early warning signals that may indicate change in the long-term health of natural systems. Early detection of potential problems allows park managers to take steps in restoring or maintaining the ecological health of park resources.

The Northeast Coastal and Barrier Network (NCBN) consists of eight parks extending along the Northeast Atlantic Coast. Vital Signs chosen as part of the Network’s monitoring plan include salt marsh vegetation communities, nekton communities, essential estuarine water quality parameters, and specific coastal geomorphologic features (Stevens et al. 2005). Detailed monitoring protocols have been developed and implemented in the eight parks. This annual report summarizes salt marsh vegetation and nekton community data collected at Gateway National Recreation Area’s Sandy Hook Unit (GATE-SHU) in 2012 according to two protocols—*Monitoring Nekton in Salt Marshes: A Protocol for the National Park Service’s Long-Term Monitoring Program, Northeast Coastal and Barrier Network* (James-Pirri et al. 2012) and *Monitoring Salt Marsh Vegetation: A Protocol for the National Park Service’s Long-Term Monitoring Program, Northeast Coastal and Barrier Network* (James-Pirri et al. In Review).



# Methods

## Permanent Site Selection

Three permanent monitoring sites were established for biennial monitoring at GATE-SHU in 2010 (Figure 1). Vegetation sampling is conducted at each site. Nekton sampling is conducted only at Sites 1 and 3 due to lack of appropriate habitat at Site 2. Detailed information about the site selection process and sampling design can be found in the Salt Marsh Vegetation (James-Pirri et al. In Review) and Nekton Protocols (James-Pirri et al. 2012).



**Figure 1.** Permanent salt marsh monitoring sites established by NCBN at Gateway National Recreation Area's Sandy Hook Unit (GATE-SHU) in 2010. Salt marsh monitoring is conducted biennially.

## Nekton Sampling Station Selection and Data Collection

While monitoring sites remain permanent, nekton stations within each site are re-randomized each sampling year. In 2012, six nekton sampling stations were established within pools at Site 3, and 15 nekton stations were established along the creek at Site 1. All sampling stations were randomly located on the perimeter of the pools or along the length of the creek (James-Pirri et al. 2012). Universal Transverse Mercator (UTM) coordinates for each station are provided in Appendix A. Each station was sampled in late June (Table 1). Normally, each station is sampled for a second time in late summer; however, in Event 2 sampling was incomplete (only 2 of the 21 stations were sampled).

Nekton in creeks or pools and flooded pannes were sampled using a 1 m<sup>2</sup> aluminum throw trap (Kushlan 1981, Sogard and Able 1991, Raposa and Roman 2001, James-Pirri et al. 2012). All nekton were collected from the trap using a 1 mm mesh dip net.

For each sampling station, all nekton that were captured in the throw trap were identified and enumerated. Lengths of fifteen haphazardly selected individuals of each species were measured (fish – total length; crabs – carapace width; shrimp – total length). Once identified and measured, all organisms were returned to the location where they were collected (outside the throw trap).

**Table 1.** Sampling dates and total number of unique nekton sampling stations at two marsh sites at GATE-SHU in 2012. Sampling stations are displayed by habitat type. ‘-’ Habitat not present at site. ‘\*\*’ Event 2 data collection was incomplete.

| Site | Event | Date               | Habitat            |             | Total |
|------|-------|--------------------|--------------------|-------------|-------|
|      |       |                    | Pool/Panne         | Tidal Creek |       |
| 1    | 1     | June 27-28         | --                 | 15          | 15    |
| 1    | 2*    | August 15          | --                 | 2           | 2     |
| 3    | 1     | June 27            | 6                  | --          | 6     |
| 3    | 2*    | <i>not sampled</i> | <i>not sampled</i> |             |       |

## Vegetation Plot Selection and Data Collection

Vegetation sampling was conducted once at each of the three marsh sites (Table 2). For each site, ten transects extending from bay to upland were systematically placed based on a single random start (James-Pirri et al. In Review). Plots were established by treating the total length of all ten transects as a single transect and randomly selecting points (*i.e.*, plots) along this total length. This combination of systematic transects and replicate plots is necessary to ensure interspersions of the plots throughout the marsh study area, thus providing a representative sample of all salt marsh communities (*e.g.*, low marsh, high marsh).

All vegetation species and non-vegetation cover types present in each plot were recorded (Table 3), and the estimated percent cover was determined using a modified Braun-Blanquet cover scale (0: 0%; 1: <1%; 2: 1-5%; 3: 6-25%; 4: 26-50%; 5: 51-75%; 6: 76-100%), (Kent and Coker 1992).

**Table 2.** Sampling dates and number of vegetation plots sampled at three marsh sites at GATE-SHU in 2012.

| Site | Date      | No. of plots |
|------|-----------|--------------|
| 1    | Aug 15-16 | 50           |
| 2    | Aug 16    | 46           |
| 3    | Aug 14    | 50           |

**Table 3.** Definition of standard cover type categories used in the Northeast Coastal and Barrier Network salt marsh vegetation monitoring protocol (James-Pirri et al. In Review).

|  |   |
|--|---|
| <b>Live vascular plants</b>                | Identified by species (herbaceous and shrubs).  |
| <b>Standing non-living vascular plants</b> | Identified by species (e.g., <i>S. alterniflora</i> Not Living). 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.). In cases where dead leaves are from the current growing season, plant cover is recorded as live. |
| <b>Macroalgae</b>                          | Identified by species. This category generally includes the rockweeds (e.g., <i>Fucus</i> , <i>Ascophyllum</i> ). Microalgae (e.g., diatom mats) and fine filamentous algae are not included in this category.  |
| <b>Bare ground</b>                         | 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 ground category.  |
| <b>Water</b>                               | Permanent standing water is identified in plots that are partly within a creek, ditch, marsh pool, or flooded panne.  |
| <b>Wrack/litter</b>                        | 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.   |
| <b>Trash</b>                               | Items such as logs, old piers, tires, etc.  |
| <b>Rock</b>                                | Boulders or rocks can be found on the surface of northern New England marshes.  |

## Data Summary

### *Nekton*

Nekton species composition, average density, average length, and standard error were calculated using standard formulae. The same is true of the average values of the environmental variables (water temp, salinity, and depth) calculated for each habitat type during each sampling event. Details can be found in the Analysis and Reporting Standard Operating Procedure of James-Pirri et al. (2012).

## Vegetation

Vegetation data were recorded using the modified Braun-Blanquet scale as described above (Kent and Coker 1992). For summary purposes, each Braun-Blanquet value was converted to the midpoint of the percent range it represented (Table 4) as described in Wikum and Shanholtzer (1978), and the average percent cover is calculated for each species and non-vegetation cover type using these mid-points.

**Table 4.** Modified Braun-Blanquet scale and corresponding midpoint values for determining percent cover of salt marsh vegetation.

| BB Value | Percent Cover | Midpoint |
|----------|---------------|----------|
| 0        | 0%            | 0%       |
| 1        | < 1%          | 0.50%    |
| 2        | 1 - 5%        | 3%       |
| 3        | 6 - 25%       | 15.50%   |
| 4        | 26 - 50%      | 38%      |
| 5        | 51 - 75%      | 63%      |
| 6        | 76 - 100%     | 88%      |

Wikum and Shanholtzer (1978) outline a method for calculating an importance value for each species. So as not to confuse this value with ecological importance, it is referred to here as a ‘relative prevalence’ value. Although Wikum and Shanholtzer (1978) present their ‘importance value’ as a sum of the percent frequency and percent cover values, here these values have been averaged so that relative prevalence is on a more readily interpretable percent scale. Relative percent prevalence for a species is the average of the relative percent cover and the relative percent frequency, where relative percent cover is the percentage of all plots that the species covers relative to all other species present, and relative percent frequency is the number of plots in which each species is present relative to all other species present. A detailed description of the analyses and formulae are presented in the salt marsh vegetation protocol (James-Pirri et al. In Review). Because the relative percent prevalence incorporates both percent frequency and percent cover, it provides information about how a species is distributed (*i.e.*, its ‘patchiness’) throughout the salt marsh and may differ substantially from the average percent cover for a given species.

Species are grouped by salinity tolerance (USDA 2013) to help characterize the vegetation community. Species listed by the United States Department of Agriculture (USDA), or the State of New Jersey as exotic, invasive, threatened, endangered, or rare are noted in the vegetation data summary. Information about individual plant species is available online (USDA 2013). Additional information about species listed as endangered or rare in the state of New Jersey is available on the New Jersey Natural Heritage Program website (<http://www.nj.gov/dep/parksandforests/natural/heritage/index.html>). The locations of sample plots where listed species were observed are noted in Appendix A.



## Results

### Nekton

The average nekton density at GATE-SHU is presented in Tables 5a and b. A total of nine nekton species were captured in 2012 (Table 6). Common mummichog (*F. heteroclitus*), Atlantic silverside (*M. menidia*), and daggerblade grass shrimp (*P. pugio*) account for approximately 96% of all nekton captured (Table 7). The average, maximum, and minimum lengths for each species observed in 2012 are presented in Tables 8a and b. Additional tables summarizing data by site are provided in the Appendices.

One invasive species, the European green crab (*C. maenas*) was observed during the 2012 field season. Twelve individuals were captured at Site 1 during the first sampling event. Information about the European green crab can be found on the USDA's National Invasive Species Information Center website ([Invasivespeciesinfo.gov](http://Invasivespeciesinfo.gov)).

Water temperature, depth, and salinity at each nekton sampling station were measured during each sampling event (Table 9). Currently, these data are collected in a manner that may help to explain anomalies in nekton observed at a particular location during a specific sampling event. These parameters would need to be measured continuously over the course of the field season in order to lend any real insight into observed changes in the nekton community.

**Table 5.** (a) Average density and standard error [individuals per 1 m<sup>2</sup> ± SE (total count)] of nekton captured at GATE-SHU in 2012. Data were summarized for each sampling event and both events combined. '\*\*' Event 2 data collection was incomplete for both sites. (b) Number of unique nekton stations sampled at GATE-SHU in 2012. '\*\*' Event 2 data collection was incomplete for both sites.

(a)

| Habitat     | Average Density<br>[individuals per 1 m <sup>2</sup> ± SE (total count)] |                    |                    |
|-------------|--|--------------------|--------------------|
|             | Event 1  | *Event 2           | *Events 1 & 2      |
| Pool/Panne  | 35.5 ± 11.6 (213)  | <i>not sampled</i> | 35.5 ± 11.6 (213)  |
| Tidal Creek | 52.4 ± 15.5 (786)  | 37.0 ± 32.0 (74)   | 54.4 ± 15.2 (860)  |
| All         | 47.6 ± 11.6 (999)  | 37.0 ± 32 (74)     | 49.0 ± 11.4 (1073) |

(b)

| Habitat     | No. of Stations |                    |               |
|-------------|-----------------|--------------------|---------------|
|             | Event 1         | *Event 2           | *Events 1 & 2 |
| Pool/Panne  | 6               | <i>not sampled</i> | 6             |
| Tidal Creek | 15              | 2                  | 15            |
| All         | 21              | 2                  | 21            |

**Table 6.** Nekton species richness (No. of species observed) at GATE-SHU in 2012. Data were summarized for each sampling event and both events combined. ‘\*’ Event 2 data collection was incomplete for both sites.

| Event  | No. of Stations | No. of Species Observed |
|--------|-----------------|-------------------------|
| 1      | 21              | 9                       |
| *2     | 2               | 3                       |
| *1 & 2 | 21              | 9                       |

**Table 7.** Nekton species and community composition (%) at GATE-SHU in 2012. Data were summarized for each sampling event and both events combined. n = total number of nekton captured during that event. ‘\*’ Event 2 data collection was incomplete for both sites. ‘+’ indicates exotic / invasive species.

| Life History Group/Species          | Common Name              | Group/Species Composition (%) |                   |                          |
|-------------------------------------|--------------------------|-------------------------------|-------------------|--------------------------|
|                                     |                          | Event 1 (n = 999)             | *Event 2 (n = 74) | *Events 1 & 2 (n = 1073) |
| <b>Resident Crustacean</b>          |                          | <b>1.2</b>                    | --                | <b>1.1</b>               |
| <i>Carcinus maenas</i> <sup>+</sup> | European green crab      | 1.2                           | --                | 1.1                      |
| <b>Resident Fish</b>                |                          | <b>64.2</b>                   | <b>39.2</b>       | <b>62.4</b>              |
| <i>Fundulus heteroclitus</i>        | mummichog                | 64.0                          | 39.2              | 62.3                     |
| <i>Cyprinodon variegatus</i>        | sheepshead minnow        | 0.2                           | --                | 0.2                      |
| <b>Resident Shrimp</b>              |                          | <b>14.9</b>                   | <b>58.1</b>       | <b>17.9</b>              |
| <i>Palaemonetes pugio</i>           | daggerblade grass shrimp | 14.9                          | 58.1              | 17.9                     |
| <b>Transient Crustacean</b>         |                          | <b>1.3</b>                    | <b>2.7</b>        | <b>1.4</b>               |
| <i>Callinectes sapidus</i>          | blue crab                | 1.3                           | 2.7               | 1.4                      |
| <b>Transient Fish</b>               |                          | <b>18.4</b>                   | --                | <b>17.1</b>              |
| <i>Menidia menidia</i>              | Atlantic silverside      | 16.9                          | --                | 15.8                     |
| <i>Gasterosteus aculeatus</i>       | threespine stickleback   | 1.2                           | --                | 1.1                      |
| <i>Anguilla rostrata</i>            | American eel             | 0.2                           | --                | 0.2                      |
| <i>Brevoortia tyrannus</i>          | Atlantic menhaden        | 0.1                           | --                | 0.1                      |

**Table 8.** (a) Average length [mm  $\pm$  SE (no. measured)] of nekton at GATE-SHU in 2012. Data for each species were summarized over all stations sampled during each event and both events combined. '\*' Event 2 data collection was incomplete for both sites. '+' indicates exotic / invasive species. (b) Minimum and maximum length (mm) of each nekton species at GATE-SHU 2012. '\*' Event 2 data collection was incomplete for both sites. '+' indicates exotic / invasive species.

(a)

| Life History Group/Species          | Common Name              | Average Length [mm $\pm$ SE (no. measured)] |                     |                      |
|-------------------------------------|--------------------------|---|---------------------|----------------------|
|                                     |                          | Event 1                                     | *Event 2            | *Events 1 & 2        |
| <b>Resident Crustacean</b>          |                          |   |                     |                      |
| <i>Carcinus maenas</i> <sup>+</sup> | European green crab      | 10.3 $\pm$ 1.3 (12)                         | --                  | 10.3 $\pm$ 1.3 (12)  |
| <b>Resident Fish</b>                |                          |   |                     |                      |
| <i>Cyprinodon variegatus</i>        | sheepshead minnow        | 13.0 $\pm$ 5.0 (2)                          | --                  | 13.0 $\pm$ 5.0 (2)   |
| <i>Fundulus heteroclitus</i>        | mummichog                | 22.7 $\pm$ 0.9 (213)                        | 23.2 $\pm$ 1.2 (21) | 22.8 $\pm$ 0.8 (234) |
| <b>Resident Shrimp</b>              |                          |   |                     |                      |
| <i>Palaemonetes pugio</i>           | daggerblade grass shrimp | 32.1 $\pm$ 1.1 (110)                        | 21.7 $\pm$ 0.7 (15) | 30.8 $\pm$ 1.0 (125) |
| <b>Transient Crustacean</b>         |                          |   |                     |                      |
| <i>Callinectes sapidus</i>          | blue crab                | 58.9 $\pm$ 10.4 (13)                        | 110.0 (1)           | 62.6 $\pm$ 10.3 (14) |
| <b>Transient Fish</b>               |                          |   |                     |                      |
| <i>Anguilla rostrata</i>            | American eel             | 57.0 $\pm$ 2.0 (2)                          | --                  | 57.0 $\pm$ 2.0 (2)   |
| <i>Brevoortia tyrannus</i>          | Atlantic menhaden        | 28.0 (1)                                    | --                  | 28.0 (1)             |
| <i>Gasterosteus aculeatus</i>       | threespine stickleback   | 25.2 $\pm$ 0.9 (12)                         | --                  | 25.2 $\pm$ 0.9 (12)  |
| <i>Menidia menidia</i>              | Atlantic silverside      | 21.7 $\pm$ 0.8 (60)                         | --                  | 21.7 $\pm$ 0.8 (60)  |

**Table 8.** (a) Average length [mm ± SE (no. measured)] of nekton at GATE-SHU in 2012. Data for each species were summarized over all stations sampled during each event and both events combined. ‘\*’ Event 2 data collection was incomplete for both sites. ‘+’ indicates exotic / invasive species. (b) Minimum and maximum length (mm) of each nekton species at GATE-SHU 2012. ‘\*’ Event 2 data collection was incomplete for both sites. ‘+’ indicates exotic / invasive species (continued).

(b)

| Life History Group/Species          | Common Name              | Event 1 |      | *Event 2 |      | *Events 1 & 2 |      |
|-------------------------------------|--------------------------|---------|------|----------|------|---------------|------|
|                                     |                          | Min.    | Max. | Min.     | Max. | Min.          | Max. |
| <b>Resident Crustacean</b>          |                          |         |      |          |      |               |      |
| <i>Carcinus maenas</i> <sup>+</sup> | European green crab      | 3       | 17   | --       | --   | 3             | 17   |
| <b>Resident Fish</b>                |                          |         |      |          |      |               |      |
| <i>Cyprinodon variegatus</i>        | sheepshead minnow        | 8       | 18   | --       | --   | 8             | 18   |
| <i>Fundulus heteroclitus</i>        | mummichog                | 8       | 90   | 18       | 37   | 8             | 90   |
| <b>Resident Shrimp</b>              |                          |         |      |          |      |               |      |
| <i>Palaemonetes pugio</i>           | daggerblade grass shrimp | 5       | 51   | 18       | 26   | 5             | 51   |
| <b>Transient Crustacean</b>         |                          |         |      |          |      |               |      |
| <i>Callinectes sapidus</i>          | blue crab                | 19      | 150  | 110      | 110  | 19            | 150  |
| <b>Transient Fish</b>               |                          |         |      |          |      |               |      |
| <i>Anguilla rostrata</i>            | American eel             | 55      | 59   | --       | --   | 55            | 59   |
| <i>Brevoortia tyrannus</i>          | Atlantic menhaden        | 28      | 28   | --       | --   | 28            | 28   |
| <i>Gasterosteus aculeatus</i>       | threespine stickleback   | 21      | 32   | --       | --   | 21            | 32   |
| <i>Menidia menidia</i>              | Atlantic silverside      | 12      | 41   | --       | --   | 12            | 41   |

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**Table 9.** Average water temperature, depth, and salinity [Average ± SE (no. of stations)] at nekton sampling stations at GATE-SHU in 2012. Data were summarized over all stations for each sampling event. ‘\*’ Event 2 data collection was incomplete for both sites.

| Habitat          | Average ± SE (no. of stations) |                 |             |                |
|------------------|--------------------------------|-----------------|-------------|----------------|
|                  | Event 1                        |                 | *Event 2    |                |
|                  | Pool/Panne                     | Tidal Creek     | Pool/Panne  | Tidal Creek    |
| Temperature (°C) | 19.5 ± 0.4 (6)                 | 22.3 ± 0.6 (15) |             | 29.5 ± 0.5 (2) |
| Depth (cm)       | 21.2 ± 4.5 (6)                 | 27.6 ± 3.0 (15) | not sampled | 15.4 ± 3.8 (2) |
| Salinity (ppt)   | 23.8 ± 0.9 (6)                 | 24.5 ± 0.6 (15) |             | 25.5 ± 0.5 (2) |

## Vegetation

Twenty-four vegetation species and four non-vegetation cover types (bare ground, water, wrack & litter, and trash) were observed at GATE-SHU in 2012 (Table 10). Tables summarizing vegetation data by site are provided in the Appendices.

Two species commonly considered invasive, common reed (*P. australis*) and Japanese honeysuckle (*L. japonica*) were present in vegetation plots sampled at GATE-SHU in 2012. While these two species are not federally listed as invasive, they are considered invasive in several states. An official list of invasive species is not available for the state of New Jersey (USDA 2013); however, *P. australis* and *L. japonica* are both listed on the NJ Invasive Species Strike Team's 'Do Not Plant List' (NJISST 2012). Both species were observed in plots at Site 1 (*P. australis*, 1 plot; *L. japonica*, 2 plots).

**Table 10.** Average percent cover (Average % Cover  $\pm$  SE), frequency, and relative percent prevalence of each vegetation species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized over all 146 plots. Percent cover was estimated using the midpoint values of Braun-Blanquet percent ranges (Table 4). (NL) indicates standing non-living vegetation. '\*\*' indicates invasive species (NJISST 2012).

| Cover Type                        |                            | Avg. %                           | Frequency | Rel. %      | Rel. %      | Rel. %      |
|-----------------------------------|----------------------------|----------------------------------|-----------|-------------|-------------|-------------|
| Salinity Tolerance                |                            | Cover $\pm$ SE                   |           | Cover       | Freq.       | Prevalence  |
| Species                           | Common Name                |                                  |           |             |             |             |
| <b>Vegetation</b>                 |                            | <b>47.5 <math>\pm</math> 3.7</b> | <b>97</b> | <b>45.4</b> | <b>52.4</b> | <b>48.9</b> |
| <b>High Salinity Tolerance</b>    |                            | <b>44.3 <math>\pm</math> 3.6</b> | <b>94</b> | <b>42.3</b> | <b>48.1</b> | <b>45.2</b> |
| <i>Spartina alterniflora</i>      | saltmarsh cordgrass        | 26.8 $\pm$ 3.0                   | 71        | 25.5        | 18.3        | 21.9        |
| <i>Spartina alterniflora</i> (NL) | saltmarsh cordgrass (NL)   | 4.0 $\pm$ 0.7                    | 41        | 3.8         | 10.5        | 7.2         |
| <i>Spartina patens</i>            | salt meadow cordgrass      | 5.9 $\pm$ 1.7                    | 14        | 5.7         | 3.6         | 4.7         |
| <i>Spartina patens</i> (NL)       | salt meadow cordgrass (NL) | 0.7 $\pm$ 0.3                    | 6         | 0.7         | 1.5         | 1.1         |
| <i>Iva frutescens</i>             | marsh elder                | 2.6 $\pm$ 1.0                    | 9         | 2.5         | 2.3         | 2.4         |
| <i>Suaeda maritima</i>            | herbaceous seepweed        | 0.7 $\pm$ 0.3                    | 10        | 0.7         | 2.6         | 1.6         |
| <i>Distichlis spicata</i>         | spikegrass                 | 1.2 $\pm$ 0.5                    | 6         | 1.1         | 1.5         | 1.3         |
| <i>Distichlis spicata</i> (NL)    | spikegrass (NL)            | 0.1 $\pm$ 0.1                    | 1         | 0.1         | 0.3         | 0.2         |
| <i>Solidago sempervirens</i>      | seaside goldenrod          | 0.5 $\pm$ 0.3                    | 5         | 0.5         | 1.3         | 0.9         |
| <i>Solidago sempervirens</i> (NL) | seaside goldenrod (NL)     | < 0.05                           | 1         | < 0.05      | 0.3         | 0.2         |
| <i>Limonium carolinianum</i>      | sea lavender               | 0.3 $\pm$ 0.2                    | 5         | 0.3         | 1.3         | 0.8         |
| <i>Salicornia maritima</i>        | glasswort                  | 0.4 $\pm$ 0.2                    | 5         | 0.4         | 1.3         | 0.8         |
| <i>Salicornia maritima</i> (NL)   | glasswort (NL)             | < 0.05                           | 1         | < 0.05      | 0.3         | 0.2         |
| <i>Ammophila breviligulata</i>    | American beachgrass        | 0.5 $\pm$ 0.4                    | 2         | 0.5         | 0.5         | 0.5         |
| <i>Cakile edentula</i>            | sea rocket                 | 0.2 $\pm$ 0.1                    | 2         | 0.2         | 0.5         | 0.4         |
| <i>Cakile edentula</i> (NL)       | sea rocket (NL)            | 0.1 $\pm$ 0.1                    | 2         | 0.1         | 0.5         | 0.3         |
| <i>Atriplex patula</i>            | spear saltbush             | < 0.05                           | 1         | < 0.05      | 0.3         | 0.2         |
| <i>Salsola kali</i>               | Russian thistle            | < 0.05                           | 1         | < 0.05      | 0.3         | 0.2         |
| <i>Salicornia sp.</i>             | glasswort species          | 0.1 $\pm$ 0.1                    | 1         | 0.1         | 0.3         | 0.2         |
| <i>Salicornia depressa</i>        | Virginia glasswort         | < 0.05                           | 1         | < 0.05      | 0.3         | 0.2         |
| <i>Ulva lactuca</i>               | sea lettuce                | 0.1 $\pm$ 0.1                    | 1         | 0.1         | 0.3         | 0.2         |

**Table 10.** Average percent cover (Average % Cover  $\pm$  SE), frequency, and relative percent prevalence of each vegetation species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized over all 146 plots. Percent cover was estimated using the midpoint values of Braun-Blanquet percent ranges (Table 4). (NL) indicates standing non-living vegetation. '\*\*' indicates invasive species (NJISST 2012) (continued).

| <b>Cover Type</b>                    |                      | <b>Avg. %<br/>Cover <math>\pm</math> SE</b> | <b>Frequency</b> | <b>Rel. %<br/>Cover</b> | <b>Rel. %<br/>Freq.</b> | <b>Rel. %<br/>Prevalence</b> |
|--------------------------------------|----------------------|---|------------------|-------------------------|-------------------------|------------------------------|
| <b>Species</b>                       | <b>Common Name</b>   |   |                  |                         |                         |                              |
| <b>Salinity Tolerance</b>            |                      |   |                  |                         |                         |                              |
| <b>Medium Salinity Tolerance</b>     |                      | <b>1.3 <math>\pm</math> 0.7</b>             | <b>6</b>         | <b>1.2</b>              | <b>1.9</b>              | <b>1.5</b>                   |
| <i>Toxicodendron radicans</i>        | poison ivy           | 1.1 $\pm$ 0.7                               | 5                | 1.0                     | 1.3                     | 1.1                          |
| <i>Atriplex cristata</i>             | crested saltbush     | 0.1 $\pm$ 0.1                               | 1                | 0.1                     | 0.3                     | 0.2                          |
| <i>Calystegia sepium</i>             | hedge bindweed       | 0.1 $\pm$ 0.1                               | 1                | 0.1                     | 0.3                     | 0.2                          |
| <b>Low Salinity Tolerance</b>        |                      | <b>1.2 <math>\pm</math> 0.9</b>             | <b>2</b>         | <b>1.2</b>              | <b>0.8</b>              | <b>1.0</b>                   |
| <i>Phragmites australis</i> *        | common reed          | 1.2 $\pm$ 0.8                               | 2                | 1.2                     | 0.5                     | 0.8                          |
| <i>Lonicera japonica</i> *           | Japanese honeysuckle | < 0.05                                      | 1                | < 0.05                  | 0.3                     | 0.2                          |
| <b>No Salinity Tolerance</b>         |                      | <b>0.2 <math>\pm</math> 0.1</b>             | <b>2</b>         | <b>0.2</b>              | <b>0.5</b>              | <b>0.4</b>                   |
| <i>Parthenocissus quinquefolia</i>   | Virginia creeper     | 0.2 $\pm$ 0.1                               | 2                | 0.2                     | 0.5                     | 0.4                          |
| <b>Unknown Salinity Tolerance</b>    |                      | <b>0.5 <math>\pm</math> 0.4</b>             | <b>4</b>         | <b>0.5</b>              | <b>1.1</b>              | <b>0.8</b>                   |
| <i>Bassia species</i>                | smotherweed          | 0.5 $\pm$ 0.4                               | 2                | 0.4                     | 0.5                     | 0.4                          |
| <i>Pseudognaphalium obtusifolium</i> | rabbit-tobacco       | < 0.05                                      | 1                | < 0.05                  | 0.3                     | 0.2                          |
| <i>Unknown plant</i>                 | unknown plant        | < 0.05                                      | 1                | < 0.05                  | 0.3                     | 0.2                          |
| <b>Non-Vegetation</b>                |                      | <b>40.6 <math>\pm</math> 3.4</b>            | <b>88</b>        | <b>38.8</b>             | <b>22.8</b>             | <b>30.8</b>                  |
| <i>water</i>                         | water                | 24.4 $\pm$ 3.3                              | 41               | 23.3                    | 10.5                    | 16.9                         |
| <i>bare ground</i>                   | bare ground          | 16.3 $\pm$ 2.6                              | 48               | 15.5                    | 12.3                    | 13.9                         |
| <b>Incidental Cover</b>              |                      | <b>16.6 <math>\pm</math> 2.2</b>            | <b>80</b>        | <b>15.8</b>             | <b>25.2</b>             | <b>20.5</b>                  |
| <i>Wrack &amp; litter</i>            | wrack / litter       | 15.5 $\pm$ 2.1                              | 77               | 14.8                    | 19.8                    | 17.3                         |
| <i>trash</i>                         | garbage              | 1.1 $\pm$ 0.3                               | 21               | 1.0                     | 5.4                     | 3.2                          |





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## Appendix A: Coordinates for nekton stations sampled at GATE-SHU in 2012

**Table A-1.** Coordinates for nekton stations sampled at GATE-SHU site 1 in 2012, UTM, Zone 18, NAD 83, meters. '\*\*' indicates invasive / exotic species was present (Invasivespeciesinfo.gov).

| Station ID      | UTM X (east) | UTM Y (north) |
|-----------------|--------------|---------------|
| GSH1C_15_2012   | 584894       | 4478046       |
| GSH1C_233_2012  | 584728       | 4478081       |
| GSH1C_268_2012* | 584764       | 4478101       |
| GSH1C_337_2012* | 584749       | 4478130       |
| GSH1C_36_2012   | 584882       | 4478061       |
| GSH1C_383_2012  | 584804       | 4478110       |
| GSH1C_391_2012* | 584812       | 4478114       |
| GSH1C_415_2012  | 584794       | 4478142       |
| GSH1C_518_2012  | 584820       | 4478179       |
| GSH1C_606_2012  | 584762       | 4478210       |
| GSH1C_63_2012   | 584867       | 4478058       |
| GSH1C_760_2012  | 584669       | 4478160       |
| GSH1C_792_2012  | 584660       | 4478144       |
| GSH1C_800_2012  | 584660       | 4478127       |
| GSH1C_91_2012*  | 584847       | 4478031       |

**Table A-2.** Coordinates for nekton stations sampled at GATE-SHU site 3 in 2012, UTM, Zone 18, NAD 83, meters.

| Station ID      | UTM X (east) | UTM Y (north) |
|-----------------|--------------|---------------|
| GSH3P1_124_2012 | 586623       | 4473478       |
| GSH3P1_251_2012 | 586519       | 4473475       |
| GSH3P1_38_2012  | 586577       | 4473564       |
| GSH3P2_259_2012 | 586547       | 4473262       |
| GSH3P2_51_2012  | 586661       | 4473315       |
| GSH3P2_66_2012  | 586660       | 4473298       |



## Appendix B: Coordinates for vegetation plots sampled at GATE-SHU in 2012

**Table B-1.** Coordinates for vegetation plots sampled at GATE-SHU site 1 in 2012, UTM, Zone 18, NAD 83, meters. \*\* indicates an invasive species was present (NJISST 2012).

| Station ID      | UTM X (east) | UTM Y (north) | Station ID      | UTM X (east) | UTM Y (north) |
|-----------------|--------------|---------------|-----------------|--------------|---------------|
| GSH1V1012_2012* | 584631       | 4478279       | GSH1V3712_2012  | 584739       | 4478170       |
| GSH1V1112_2012  | 584872       | 4478027       | GSH1V3812_2012  | 584695       | 4478236       |
| GSH1V112_2012   | 584617       | 4478207       | GSH1V3912_2012  | 584777       | 4478096       |
| GSH1V1212_2012  | 584833       | 4478104       | GSH1V4012_2012  | 584622       | 4478145       |
| GSH1V1312_2012  | 584791       | 4478050       | GSH1V4112_2012  | 584826       | 4478041       |
| GSH1V1512_2012  | 584768       | 4478206       | GSH1V412_2012   | 584595       | 4478056       |
| GSH1V1612_2012  | 584607       | 4478067       | GSH1V4212_2012* | 584611       | 4478256       |
| GSH1V1912_2012  | 584807       | 4478192       | GSH1V4312_2012  | 584823       | 4478033       |
| GSH1V2012_2012  | 584586       | 4478165       | GSH1V4412_2012  | 584730       | 4478039       |
| GSH1V2112_2012  | 584806       | 4478071       | GSH1V4512_2012  | 584599       | 4478118       |
| GSH1V212_2012   | 584597       | 4478176       | GSH1V4612_2012  | 584821       | 4478026       |
| GSH1V2212_2012  | 584806       | 4478071       | GSH1V4712_2012  | 584814       | 4478081       |
| GSH1V2312_2012  | 584785       | 4478110       | GSH1V4812_2012  | 584790       | 4478111       |
| GSH1V2412_2012  | 584874       | 4478094       | GSH1V4912_2012  | 584624       | 4478091       |
| GSH1V2512_2012  | 584791       | 4478173       | GSH1V5012_2012  | 584750       | 4478069       |
| GSH1V2612_2012  | 584719       | 4478087       | GSH1V5112_2012  | 584628       | 4478216       |
| GSH1V2712_2012  | 584825       | 4478037       | GSH1V512_2012   | 584831       | 4478102       |
| GSH1V2912_2012  | 584656       | 4478188       | GSH1V5212_2012  | 584757       | 4478072       |
| GSH1V3012_2012  | 584877       | 4478037       | GSH1V5312_2012  | 584610       | 4478132       |
| GSH1V3112_2012  | 584841       | 4478113       | GSH1V5412_2012  | 584747       | 4478119       |
| GSH1V3212_2012  | 584721       | 4478148       | GSH1V5512_2012  | 584768       | 4478144       |
| GSH1V3312_2012  | 584711       | 4478076       | GSH1V5712_2012  | 584742       | 4478053       |
| GSH1V3412_2012  | 584639       | 4478048       | GSH1V612_2012   | 584688       | 4478106       |
| GSH1V3512_2012  | 584867       | 4478084       | GSH1V712_2012   | 584660       | 4478070       |
| GSH1V3612_2012  | 584687       | 4478103       | GSH1V912_2012   | 584773       | 4478155       |

**Table B-2.** Coordinates for vegetation plots sampled at GATE-SHU site 2 in 2012, UTM, Zone 18, NAD 83, meters.

| <b>Station ID</b> | <b>UTM X<br/>(east)</b> | <b>UTM Y<br/>(north)</b> | <b>Station ID</b> | <b>UTM X<br/>(east)</b> | <b>UTM Y<br/>(north)</b> |
|-------------------|-------------------------|--------------------------|-------------------|-------------------------|--------------------------|
| GSH2V1012_2012    | 586028                  | 4474888                  | GSH2V3712_2012    | 585400                  | 4476109                  |
| GSH2V1112_2012    | 585639                  | 4476005                  | GSH2V3812_2012    | 585877                  | 4474816                  |
| GSH2V1312_2012    | 585594                  | 4475983                  | GSH2V3912_2012    | 585743                  | 4475838                  |
| GSH2V1412_2012    | 585583                  | 4475977                  | GSH2V4012_2012    | 585604                  | 4475988                  |
| GSH2V1512_2012    | 585882                  | 4474814                  | GSH2V4112_2012    | 585878                  | 4475683                  |
| GSH2V1712_2012    | 586115                  | 4474715                  | GSH2V412_2012     | 585860                  | 4475675                  |
| GSH2V1812_2012    | 585616                  | 4475992                  | GSH2V4212_2012    | 585839                  | 4475664                  |
| GSH2V1912_2012    | 586036                  | 4475327                  | GSH2V4312_2012    | 586137                  | 4474725                  |
| GSH2V2112_2012    | 586212                  | 4474540                  | GSH2V4412_2012    | 585638                  | 4476004                  |
| GSH2V212_2012     | 585736                  | 4475835                  | GSH2V4712_2012    | 585878                  | 4475684                  |
| GSH2V2212_2012    | 586211                  | 4474536                  | GSH2V4812_2012    | 586060                  | 4475336                  |
| GSH2V2312_2012    | 585627                  | 4476000                  | GSH2V4912_2012    | 585910                  | 4474831                  |
| GSH2V2412_2012    | 585729                  | 4475831                  | GSH2V5012_2012    | 585906                  | 4474829                  |
| GSH2V2512_2012    | 585989                  | 4475518                  | GSH2V5112_2012    | 585885                  | 4475688                  |
| GSH2V2612_2012    | 585882                  | 4474817                  | GSH2V512_2012     | 586158                  | 4474730                  |
| GSH2V2712_2012    | 585630                  | 4476001                  | GSH2V5212_2012    | 586045                  | 4475330                  |
| GSH2V2812_2012    | 585544                  | 4475958                  | GSH2V5312_2012    | 586046                  | 4475113                  |
| GSH2V2912_2012    | 585874                  | 4475679                  | GSH2V5812_2012    | 585918                  | 4474835                  |
| GSH2V3112_2012    | 586001                  | 4475526                  | GSH2V6012_2012    | 585864                  | 4475677                  |
| GSH2V312_2012     | 586097                  | 4474706                  | GSH2V612_2012     | 585361                  | 4476088                  |
| GSH2V3212_2012    | 586152                  | 4474729                  | GSH2V712_2012     | 586059                  | 4474905                  |
| GSH2V3312_2012    | 585363                  | 4476092                  | GSH2V812_2012     | 585548                  | 4475961                  |
| GSH2V3512_2012    | 585853                  | 4475671                  | GSH2V912_2012     | 585884                  | 4475687                  |

**Table B-3.** Coordinates for vegetation plots sampled at GATE-SHU site 3 in 2012, UTM, Zone 18, NAD 83, meters.

| <b>Station ID</b> | <b>UTM X<br/>(east)</b> | <b>UTM Y<br/>(north)</b> | <b>Station ID</b> | <b>UTM X<br/>(east)</b> | <b>UTM Y<br/>(north)</b> |
|-------------------|-------------------------|--------------------------|-------------------|-------------------------|--------------------------|
| GSH3V1012_2012    | 586568                  | 4473693                  | GSH3V3312_2012    | 586618                  | 4473516                  |
| GSH3V1112_2012    | 586448                  | 4473591                  | GSH3V3412_2012    | 586420                  | 4473391                  |
| GSH3V1212_2012    | 586521                  | 4473613                  | GSH3V3512_2012    | 586584                  | 4473505                  |
| GSH3V1312_2012    | 586574                  | 4473437                  | GSH3V3612_2012    | 586535                  | 4473427                  |
| GSH3V1412_2012    | 586580                  | 4473570                  | GSH3V3712_2012    | 586466                  | 4473599                  |
| GSH3V1512_2012    | 586606                  | 4473190                  | GSH3V3812_2012    | 586478                  | 4473535                  |
| GSH3V1612_2012    | 586593                  | 4473189                  | GSH3V3912_2012    | 586669                  | 4473280                  |
| GSH3V1712_2012    | 586613                  | 4473450                  | GSH3V4012_2012    | 586498                  | 4473675                  |
| GSH3V1812_2012    | 586550                  | 4473301                  | GSH3V4112_2012    | 586545                  | 4473433                  |
| GSH3V1912_2012    | 586605                  | 4473192                  | GSH3V412_2012     | 586559                  | 4473560                  |
| GSH3V2012_2012    | 586506                  | 4473608                  | GSH3V4212_2012    | 586549                  | 4473301                  |
| GSH3V2112_2012    | 586531                  | 4473743                  | GSH3V4412_2012    | 586568                  | 4473306                  |
| GSH3V212_2012     | 586468                  | 4473338                  | GSH3V4512_2012    | 586462                  | 4473334                  |
| GSH3V2212_2012    | 586586                  | 4473247                  | GSH3V4612_2012    | 586508                  | 4473673                  |
| GSH3V2312_2012    | 586611                  | 4473256                  | GSH3V4712_2012    | 586540                  | 4473554                  |
| GSH3V2412_2012    | 586546                  | 4473749                  | GSH3V4812_2012    | 586589                  | 4473187                  |
| GSH3V2512_2012    | 586459                  | 4473531                  | GSH3V4912_2012    | 586524                  | 4473549                  |
| GSH3V2612_2012    | 586571                  | 4473501                  | GSH3V5112_2012    | 586447                  | 4473334                  |
| GSH3V2712_2012    | 586460                  | 4473532                  | GSH3V512_2012     | 586617                  | 4473322                  |
| GSH3V2812_2012    | 586503                  | 4473543                  | GSH3V5212_2012    | 586547                  | 4473685                  |
| GSH3V2912_2012    | 586581                  | 4473439                  | GSH3V5312_2012    | 586415                  | 4473387                  |
| GSH3V3012_2012    | 586612                  | 4473256                  | GSH3V5812_2012    | 586552                  | 4473558                  |
| GSH3V3112_2012    | 586460                  | 4473333                  | GSH3V612_2012     | 586606                  | 4473512                  |
| GSH3V312_2012     | 586477                  | 4473339                  | GSH3V712_2012     | 586663                  | 4473269                  |
| GSH3V3212_2012    | 586659                  | 4473335                  | GSH3V912_2012     | 586565                  | 4473305                  |





## Appendix C: Nekton density summarized by site

**Table C-1.** (a) Average density and standard error [individuals per 1 m<sup>2</sup> ± SE (total count)] of nekton captured at GATE-SHU in 2012. Data were summarized for each site and sampling event as well as both events combined. ‘\*’ Event 2 data collection was incomplete for both sites. (b) Number of unique stations sampled at each site during each sampling event. ‘\*’ Event 2 data collection was incomplete for both sites.

(a)

| Site | Average Density<br>[individuals per 1 m <sup>2</sup> ± SE (total count)] |                    |                   |
|------|--|--------------------|-------------------|
|      | Event 1  | *Event 2           | Events 1 & 2      |
| 1    | 52.4 ± 15.5 (786)  | 37.0 ± 32.0 (74)   | 50.6 ± 14.0 (860) |
| 3    | 35.5 ± 11.6 (213)  | <i>not sampled</i> | 35.5 ± 11.6 (213) |

(b)

| Site | No. of Stations |                    |               |
|------|-----------------|--------------------|---------------|
|      | Event 1         | *Event 2           | *Events 1 & 2 |
| 1    | 15              | 2                  | 15            |
| 3    | 6               | <i>not sampled</i> | 6             |



## Appendix D: Nekton species richness summarized by site and sampling event

**Table D-1.** Species richness (No. of species observed) at GATE-SHU in 2012. (a) Data were summarized by site. (b) Data were summarized by site and sampling event. ‘\*’ Event 2 data collection was incomplete for both sites.

(a)

| Site | No. of Stations | No. of Species Observed |
|------|-----------------|-------------------------|
| 1    | 15              | 7                       |
| 3    | 6               | 6                       |

(b)

| Site | Event | No. of Stations | No. of Species Observed |
|------|-------|-----------------|-------------------------|
| 1    | 1     | 15              | 7                       |
| 1    | *2    | 2               | 3                       |
| 3    | 1     | 6               | 6                       |
| 3    | *2    | --not sampled-- |                         |



## Appendix E: Nekton species and community composition summarized by site and sampling event

Table E-1. Nekton species and community composition (% catch) at GATE-SHU in 2012. (a) Data were summarized by site. n = total number of nekton captured. '+' indicates invasive / exotic species (Invasivespeciesinfo.gov). '-' Species or community not present. (b) Data were summarized by site and sampling event. n = total number of nekton captured. '-' species or community not present. '\*' Event 2 data collection was incomplete for both sites. '+' indicates invasive / exotic species (Invasivespeciesinfo.gov).

(a)

| Life History Group/Species   | Common Name              | Group/Species Composition (%) |                     |
|------------------------------|--------------------------|-------------------------------|---------------------|
|                              |                          | Site 1<br>(n = 860)           | Site 3<br>(n = 213) |
| <b>Resident Crustacean</b>   |                          | <b>1.4</b>                    | <b>--</b>           |
| Carcinus maenas <sup>+</sup> | European green crab      | 1.4                           | --                  |
| <b>Resident Fish</b>         |                          | <b>61.2</b>                   | <b>67.6</b>         |
| Fundulus heteroclitus        | mummichog                | 61.2                          | 66.7                |
| Cyprinodon variegatus        | sheepshead minnow        | --                            | 0.9                 |
| <b>Resident Shrimp</b>       |                          | <b>19.7</b>                   | <b>10.8</b>         |
| Palaemonetes pugio           | daggerblade grass shrimp | 19.7                          | 10.8                |
| <b>Transient Crustacean</b>  |                          | <b>1.6</b>                    | <b>0.5</b>          |
| Callinectes sapidus          | blue crab                | 1.6                           | 0.5                 |
| <b>Transient Fish</b>        |                          | <b>16.2</b>                   | <b>21.1</b>         |
| Menidia menidia              | Atlantic silverside      | 15.8                          | 15.5                |
| Gasterosteus aculeatus       | threespine stickleback   | --                            | 5.6                 |
| Anguilla rostrata            | American eel             | 0.2                           | --                  |
| Brevoortia tyrannus          | Atlantic menhaden        | 0.1                           | --                  |

**Table E-1.** Nekton species and community composition (% catch) at GATE-SHU in 2012. (a) Data were summarized by site. n = total number of nekton captured. ‘+’ indicates invasive / exotic species (Invasivespeciesinfo.gov). ‘-’ Species or community not present. (b) Data were summarized by site and sampling event. n = total number of nekton captured. ‘-’ species or community not present. ‘\*’ Event 2 data collection was incomplete for both sites. ‘+’ indicates invasive / exotic species (Invasivespeciesinfo.gov) (continued).

(b)

| Life History Group/Species   | Common Name              | Group / Species Composition (%) |                      |                      |                     |
|------------------------------|--------------------------|---------------------------------|----------------------|----------------------|---------------------|
|                              |                          | Site 1                          |                      | Site 3               |                     |
|                              |                          | Event 1<br>(n = 786)            | *Event 2<br>(n = 74) | Event 1<br>(n = 213) | *Event 2<br>(n = 0) |
| <b>Resident Crustacean</b>   |                          | <b>1.5</b>                      | --                   | --                   | --                  |
| Carcinus maenas <sup>+</sup> | European green crab      | 1.5                             | --                   | --                   | --                  |
| <b>Resident Fish</b>         |                          | <b>63.2</b>                     | <b>39.2</b>          | <b>67.6</b>          | --                  |
| Fundulus heteroclitus        | mummichog                | 63.2                            | 39.2                 | 66.7                 | --                  |
| Cyprinodon variegatus        | sheepshead minnow        | --                              | --                   | 0.9                  | --                  |
| <b>Resident Shrimp</b>       |                          | <b>16.0</b>                     | <b>58.1</b>          | <b>10.8</b>          | --                  |
| Palaemonetes pugio           | daggerblade grass shrimp | 16.0                            | 58.1                 | 10.8                 | --                  |
| <b>Transient Crustacean</b>  |                          | <b>1.5</b>                      | <b>2.7</b>           | <b>0.5</b>           | --                  |
| Callinectes sapidus          | blue crab                | 1.5                             | 2.7                  | 0.5                  | --                  |
| <b>Transient Fish</b>        |                          | <b>17.7</b>                     | --                   | <b>21.1</b>          | --                  |
| Menidia menidia              | Atlantic silverside      | 17.3                            | --                   | 15.5                 | --                  |
| Gasterosteus aculeatus       | threespine stickleback   | --                              | --                   | 5.6                  | --                  |
| Anguilla rostrata            | American eel             | 0.3                             | --                   | --                   | --                  |
| Brevoortia tyrannus          | Atlantic menhaden        | 0.1                             | --                   | --                   | --                  |

## Appendix F: Vegetation frequency summarized by site

**Table F-1.** Frequency of each plant species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized for each site and over all 146 plots. (NL) indicates standing non-living vegetation. ‘-’ species not observed. ‘\*’ indicates an invasive species was present (NJISST 2012).

| Cover Type                         |                            | Site (no. of plots) |           |           |           |
|------------------------------------|----------------------------|---------------------|-----------|-----------|-----------|
| Salinity Tolerance                 |                            | 1                   | 2         | 3         | All       |
| Species                            | Common Name                | (50)                | (46)      | (50)      | (146)     |
| <b>Vegetation</b>                  |                            | <b>38</b>           | <b>41</b> | <b>18</b> | <b>97</b> |
| <b>High Salinity Tolerance</b>     |                            | <b>36</b>           | <b>41</b> | <b>17</b> | <b>94</b> |
| <i>Spartina alterniflora</i>       | saltmarsh cordgrass        | 30                  | 31        | 10        | 71        |
| <i>Spartina alterniflora</i> (NL)  | saltmarsh cordgrass (NL)   | 27                  | 9         | 5         | 41        |
| <i>Spartina patens</i>             | salt meadow cordgrass      | 1                   | 8         | 5         | 14        |
| <i>Spartina patens</i> (NL)        | salt meadow cordgrass (NL) | --                  | 1         | 5         | 6         |
| <i>Solidago sempervirens</i>       | seaside goldenrod          | --                  | 1         | 4         | 5         |
| <i>Solidago sempervirens</i> (NL)  | seaside goldenrod (NL)     | --                  | --        | 1         | 1         |
| <i>Suaeda maritima</i>             | herbaceous seepweed        | 5                   | 2         | 3         | 10        |
| <i>Iva frutescens</i>              | marsh elder                | 4                   | 3         | 2         | 9         |
| <i>Atriplex patula</i>             | spear saltbush             | --                  | --        | 1         | 1         |
| <i>Distichlis spicata</i>          | spikegrass                 | 3                   | 2         | 1         | 6         |
| <i>Distichlis spicata</i> (NL)     | spikegrass (NL)            | --                  | --        | 1         | 1         |
| <i>Limonium carolinianum</i>       | sea lavender               | 2                   | 2         | 1         | 5         |
| <i>Salicornia</i> sp.              | glasswort species          | --                  | --        | 1         | 1         |
| <i>Salicornia maritima</i>         | glasswort                  | 3                   | 1         | 1         | 5         |
| <i>Salicornia maritima</i> (NL)    | glasswort (NL)             | 1                   | --        | --        | 1         |
| <i>Ammophila breviligulata</i>     | American beachgrass        | --                  | 2         | --        | 2         |
| <i>Cakile edentula</i>             | sea rocket                 | --                  | 2         | --        | 2         |
| <i>Cakile edentula</i> (NL)        | sea rocket (NL)            | --                  | 2         | --        | 2         |
| <i>Salsola kali</i>                | Russian thistle            | --                  | 1         | --        | 1         |
| <i>Salicornia virginica</i>        | Virginia glasswort         | --                  | 1         | --        | 1         |
| <i>Ulva lactuca</i>                | sea lettuce                | --                  | 1         | --        | 1         |
| <b>Medium Salinity Tolerance</b>   |                            | <b>3</b>            | <b>2</b>  | <b>1</b>  | <b>6</b>  |
| <i>Toxicodendron radicans</i>      | poison ivy                 | 2                   | 2         | 1         | 5         |
| <i>Atriplex cristata</i>           | crested saltbush           | 1                   | --        | --        | 1         |
| <i>Calystegia sepium</i>           | hedge bindweed             | 1                   | --        | --        | 1         |
| <b>Low Salinity Tolerance</b>      |                            | <b>2</b>            | <b>--</b> | <b>--</b> | <b>2</b>  |
| <i>Lonicera japonica</i> *         | Japanese honeysuckle       | 1                   | --        | --        | 1         |
| <i>Phragmites australis</i> *      | common reed                | 2                   | --        | --        | 2         |
| <b>No Salinity Tolerance</b>       |                            | <b>--</b>           | <b>2</b>  | <b>--</b> | <b>2</b>  |
| <i>Parthenocissus quinquefolia</i> | Virginia creeper           | --                  | 2         | --        | 2         |

**Table F-1.** Frequency of each plant species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized for each site and over all 146 plots. (NL) indicates standing non-living vegetation. '-' species not observed. '\*\*' indicates an invasive species was present (NJISST 2012) (continued).

| <b>Cover Type</b>                    |                    | <b>Site (no. of plots)</b> |             |             |              |
|--------------------------------------|--------------------|----------------------------|-------------|-------------|--------------|
| <b>Salinity Tolerance</b>            |                    | <b>1</b>                   | <b>2</b>    | <b>3</b>    | <b>All</b>   |
| <b>Species</b>                       | <b>Common Name</b> | <b>(50)</b>                | <b>(46)</b> | <b>(50)</b> | <b>(146)</b> |
| <b>Unknown Salinity Tolerance</b>    |                    | <b>1</b>                   | <b>2</b>    | <b>1</b>    | <b>4</b>     |
| <i>Bassia species</i>                | smotherweed        | 1                          | --          | 1           | 2            |
| <i>Pseudognaphalium obtusifolium</i> | rabbit-tobacco     | --                         | 1           | --          | 1            |
| <i>Unknown plant</i>                 | unknown plant      | --                         | 1           | --          | 1            |
| <b>Non-Vegetation</b>                |                    | <b>28</b>                  | <b>23</b>   | <b>37</b>   | <b>88</b>    |
| <i>water</i>                         | water              | 9                          | 6           | 26          | 41           |
| <i>bare ground</i>                   | bare ground        | 19                         | 18          | 11          | 48           |
| <b>Incidental Cover</b>              |                    | <b>33</b>                  | <b>30</b>   | <b>17</b>   | <b>80</b>    |
| <i>Wrack &amp; litter</i>            | wrack / litter     | 32                         | 29          | 16          | 77           |
| <i>trash</i>                         | garbage            | 10                         | 6           | 5           | 21           |



## Appendix G: Vegetation relative percent cover summarized by site

**Table G-1.** Relative percent cover of each plant species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized for each site and over all 146 plots. (NL) indicates standing non-living vegetation. '\*' indicates an invasive species was present (NJISST 2012).

| Cover Type                       | Salinity Tolerance | Species                            | Common Name                | Relative % Cover    |             |             |              |
|----------------------------------|--------------------|------------------------------------|----------------------------|---------------------|-------------|-------------|--------------|
|                                  |                    |                                    |                            | Site (No. of Plots) |             |             |              |
|                                  |                    |                                    |                            | 1<br>(50)           | 2<br>(46)   | 3<br>(50)   | All<br>(146) |
| <b>Vegetation</b>                |                    |                                    |                            | <b>54.6</b>         | <b>57.3</b> | <b>23.4</b> | <b>45.4</b>  |
| <b>High Salinity Tolerance</b>   |                    |                                    |                            | <b>48.6</b>         | <b>56.2</b> | <b>21.5</b> | <b>42.3</b>  |
|                                  |                    | <i>Spartina alterniflora</i>       | saltmarsh cordgrass        | 32.1                | 36.0        | 7.9         | 25.5         |
|                                  |                    | <i>Spartina alterniflora</i> (NL)  | saltmarsh cordgrass (NL)   | 8.2                 | 2.0         | 0.6         | 3.8          |
|                                  |                    | <i>Spartina patens</i>             | salt meadow cordgrass      | 0.3                 | 10.0        | 7.4         | 5.7          |
|                                  |                    | <i>Spartina patens</i> (NL)        | salt meadow cordgrass (NL) | --                  | 0.1         | 2.0         | 0.7          |
|                                  |                    | <i>Iva frutescens</i>              | marsh elder                | 4.6                 | 1.4         | 1.1         | 2.5          |
|                                  |                    | <i>Distichlis spicata</i>          | spikegrass                 | 1.4                 | 1.6         | 0.3         | 1.1          |
|                                  |                    | <i>Distichlis spicata</i> (NL)     | spikegrass (NL)            | --                  | --          | 0.3         | 0.1          |
|                                  |                    | <i>Suaeda maritima</i>             | herbaceous seepweed        | 1.2                 | 0.3         | 0.4         | 0.7          |
|                                  |                    | <i>Ammophila breviligulata</i>     | American beachgrass        | --                  | 1.6         | --          | 0.5          |
|                                  |                    | <i>Solidago sempervirens</i>       | seaside goldenrod          | --                  | 0.8         | 0.7         | 0.5          |
|                                  |                    | <i>Solidago sempervirens</i> (NL)  | seaside goldenrod (NL)     | --                  | --          | 0.1         | < 0.05       |
|                                  |                    | <i>Salicornia maritima</i>         | glasswort                  | 0.6                 | 0.3         | 0.3         | 0.4          |
|                                  |                    | <i>Salicornia maritima</i> (NL)    | glasswort (NL)             | 0.1                 | --          | --          | 0.0          |
|                                  |                    | <i>Limonium carolinianum</i>       | sea lavender               | 0.1                 | 0.6         | 0.1         | 0.3          |
|                                  |                    | <i>Cakile edentula</i>             | sea rocket                 | --                  | 0.6         | --          | 0.2          |
|                                  |                    | <i>Cakile edentula</i> (NL)        | sea rocket (NL)            | --                  | 0.4         | --          | 0.1          |
|                                  |                    | <i>Salicornia sp.</i>              | glasswort species          | --                  | --          | 0.3         | 0.1          |
|                                  |                    | <i>Ulva lactuca</i>                | sea lettuce                | --                  | 0.3         | --          | 0.1          |
|                                  |                    | <i>Atriplex patula</i>             | spear saltbush             | --                  | --          | 0.1         | < 0.05       |
|                                  |                    | <i>Salsola kali</i>                | Russian thistle            | --                  | 0.1         | --          | < 0.05       |
|                                  |                    | <i>Salicornia virginica</i>        | Virginia glasswort         | --                  | 0.1         | --          | < 0.05       |
| <b>Medium Salinity Tolerance</b> |                    |                                    |                            | <b>1.5</b>          | <b>0.4</b>  | <b>1.8</b>  | <b>1.2</b>   |
|                                  |                    | <i>Toxicodendron radicans</i>      | poison ivy                 | 1.0                 | 0.4         | 1.8         | 1.0          |
|                                  |                    | <i>Atriplex cristata</i>           | crested saltbush           | 0.3                 | --          | --          | 0.1          |
|                                  |                    | <i>Calystegia sepium</i>           | hedge bindweed             | 0.3                 | --          | --          | 0.1          |
| <b>Low Salinity Tolerance</b>    |                    |                                    |                            | <b>3.3</b>          | <b>--</b>   | <b>--</b>   | <b>1.2</b>   |
|                                  |                    | <i>Phragmites australis</i> *      | common reed                | 3.2                 | --          | --          | 1.2          |
|                                  |                    | <i>Lonicera japonica</i> *         | Japanese honeysuckle       | 0.1                 | --          | --          | < 0.05       |
| <b>No Salinity Tolerance</b>     |                    |                                    |                            | <b>--</b>           | <b>0.6</b>  | <b>--</b>   | <b>0.2</b>   |
|                                  |                    | <i>Parthenocissus quinquefolia</i> | Virginia creeper           | --                  | 0.6         | --          | 0.2          |

Table G-1. Relative percent cover of each plant species and non-vegetation cover type observed at GATE-SHU in 2012. Data were summarized for each site and over all 146 plots. (NL) indicates standing non-living vegetation. ‘\*’ indicates an invasive species was present (NJISST 2012) (continued).

| Cover Type<br>Salinity Tolerance     |                | Relative % Cover    |             |             |              |
|--------------------------------------|----------------|---------------------|-------------|-------------|--------------|
|                                      |                | Site (No. of Plots) |             |             |              |
| Species                              | Common Name    | 1<br>(50)           | 2<br>(46)   | 3<br>(50)   | All<br>(146) |
| <i>Pseudognaphalium obtusifolium</i> | rabbit-tobacco | --                  | 0.1         | --          | < 0.05       |
| <i>Unknown plant</i>                 | unknown plant  | --                  | 0.1         | --          | < 0.05       |
| <b>Non-Vegetation</b>                |                | <b>28.5</b>         | <b>27.9</b> | <b>61.1</b> | <b>38.8</b>  |
| <i>water</i>                         | water          | 14.4                | 9.8         | 46.4        | 23.3         |
| <i>bare ground</i>                   | bare ground    | 14.1                | 18.0        | 14.7        | 15.5         |
| <b>Incidental Cover</b>              |                | <b>16.9</b>         | <b>14.8</b> | <b>15.6</b> | <b>15.8</b>  |
| <i>Wrack &amp; litter</i>            | wrack / litter | 15.8                | 13.7        | 14.8        | 14.8         |
| <i>trash</i>                         | garbage        | 1.1                 | 1.1         | 0.8         | 1.0          |