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Salt Marsh Vegetation and Nekton Community Monitoring at George Washington Birthplace National Monument

2008 Summary Report

Natural Resource Report NPS/NCBN/NRDS—2010/069

ON THE COVER
Salt marsh at low tide at George Washington Birthplace National Monument
Photograph by: Casey Nolan

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Executive Summary

The Northeast Coastal and Barrier Network (NCBN) is one of 32 networks of parks created by the Inventory and Monitoring Program (I&M Program) of the National Park Service. The I&M Program has two components, 1) to collect baseline ecological inventory datasets and 2) to implement *Vital Signs* monitoring, a long-term ecological monitoring program, in each of the Network parks. The Northeast Coastal and Barrier Network consists of eight parks linked by geography and shared ecological characteristics along the Northeastern Atlantic Coast. As part of the Vital Signs program, each Network has developed detailed protocols for monitoring a select number of Vital Signs, or ecological indicators. Because the majority of parks in the NCBN are coastal parks, salt marsh monitoring was chosen as a high priority and a protocol was developed for collecting long-term data on salt marsh vegetation and nekton (James-Pirri In Development-a,b).

This annual report summarizes the first year of data collected at George Washington Birthplace National Monument (GEWA) located in Virginia. Forty-Four vegetation plots and a subset of creeks and shoreline were sampled for nekton at one marsh in August of 2008. Monitoring data is to be collected at this same marsh site biennially. Nekton in large tidal creeks, and shoreline habitats (all less than 1m deep) were sampled with a $1m^2$ aluminum throw trap (Kushlan 1981, Sogard & Able 1991, Raposa and Roman 2001). Vegetation was monitored using $1m^2$ plots and a revised Braun-Blanquet method (Kent and Coker 1992) to estimate percent cover of each vegetation species and non-vegetation cover type within each plot.

At the GEWA site, 35 vegetation species along with 3 non-vegetation cover types were recorded during vegetation sampling in 2008. Non-vegetation cover types recorded included wrack and litter, bare ground, and water. Six species of nekton were recorded at GEWA in 2008, including 4 fish species, 1 crab species, and 1 shrimp species. Examination of percent catch data indicates that two species account for approximately 90% of all nekton captured. The most prevalent species, common mummichog (*Fundulus heteroclitus*), accounts for approximately 54% of all nekton recorded at GEWA in 2008 and was found only at tidal creek stations. The second most common species, daggerblade grass shrimp (*Palaemonetes pugio*), accounts for approximately 36% of all nekton recorded and was found only at shoreline stations. Substantial differences in species between tidal creek and shoreline stations at GEWA have reinforced our decision to limit future nekton monitoring at GEWA to tidal creek habitat.

The information collected through this long-term monitoring program will equip park managers with scientific data to make informed decisions on both the aquatic and terrestrial resources they manage. This report summarizes the 2008 baseline data for the GEWA salt marsh selected for monitoring. Changes in salt marsh condition will be examined following data collection in 2010. By understanding the changes or trends occurring in salt marsh vegetation and nekton communities, managers will be able to better adapt and respond to these changes through their management practices.

Acknowledgments

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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 funded by Congress in 2000. 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 ecological monitoring. Networks were required to develop a monitoring plan addressing the implementation of long-term monitoring of key ecological indicators or "vital signs." 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 ecological health of park resources.

The Northeast Coastal and Barrier Network (NCBN) is made up of eight parks: Assateague Island National Seashore (ASIS, coastal Maryland and Virginia), Thomas Stone National Historic Site (THST, Charles County, MD), Cape Cod National Seashore (CACO, Cape Cod, MA), Gateway National Recreation Area (GATE, New York, NY and Sandy Hook, NJ), Fire Island National Seashore (FIIS, Long Island, NY), Sagamore Hill National Historic Site (SAHI, Oyster Bay, NY), Colonial National Historical Park (COLO, Virginia Peninsula), and George Washington Birthplace National Monument (GEWA, Westmoreland County, VA). 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 George Washington Birthplace National Monument (GEWA) in 2008 according to two protocols developed by Pirri et al., *Monitoring Nekton in Salt Marshes: A Protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network* and *Monitoring Salt Marsh Vegetation: A Protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network* (In Development-a,b).

The objective of salt marsh vegetation and nekton monitoring is to identify long-term trends in the structure of these communities, which in turn should provide a better understanding of the current status and condition of salt marsh within the parks. These data will assist park managers in making informed decisions regarding the management and continued protection of this rare and valuable coastal resource.

Methods

Permanent Site Selection

One permanent salt marsh site was selected for monitoring at GEWA (Fig. 1). This salt marsh site was the only accessible site at GEWA of appropriate size (5-8 hectares) for implementing intensive vegetation and nekton sampling. Detailed information about the site selection process and sampling design can be found in the Salt Marsh Vegetation and Nekton Protocols (James-Pirri et al. In Development-a,b). Both vegetation and nekton sampling will be conducted at this marsh every 2 years.

Nekton Sampling Station Selection and Data Collection

Based on an assessment of accessible habitat, 8 nekton sampling stations were established at the salt marsh site. Habitat types sampled included tidal creeks, and shoreline edge. All nekton sampling stations were randomly located along a tidal creek, or shoreline, so that inference can apply to all fishable water within the site and can be biologically extended to the site as a whole. Nekton stations were sampled once in August (Table 1). In future years, sampling will be conducted twice during the sampling season, once in early summer and once during late summer, and will be restricted to tidal creek habitat.

Nekton in large tidal creeks, and shoreline habitats (all less than 1m deep) were sampled with a $1m^2$ aluminum throw trap (Kushlan 1981, Sogard and Able 1991, Raposa and Roman 2001). The throw trap is an enclosure sampler that has excellent efficiency and provides quantitative, repeatable results (Rozas and Minello 1997). The trap has an open top and bottom, is 0.5m in height and 1m square, and the sides are covered with 3mm (1/8 in) wire mesh. All nekton were collected from the trap with a 1mm mesh dip net that fit snuggly within the opposite sides of the trap.

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 the location where they were collected.

Vegetation Plot Selection and Data Collection

Vegetation sampling was conducted at the permanent marsh site August 11-12. Ten transects, extending from creek bank to upland, were randomly located within the marsh and 44 $1m^2$ plots were randomly placed along these transects. Each plot was visited once during the summer sampling season.

For each plot, all vegetation species and non-vegetation cover types were recorded (Table 2), 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).

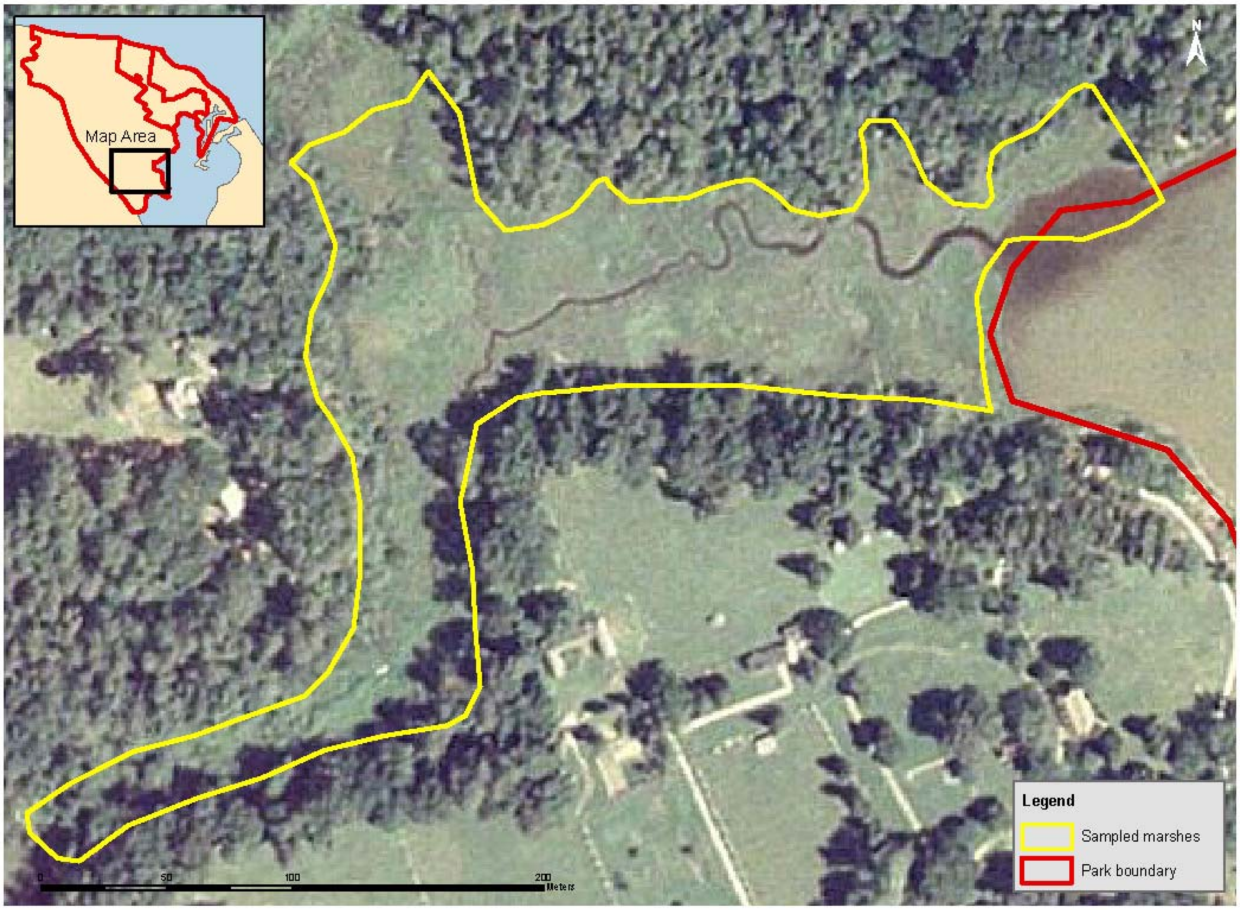

Figure 1. Aerial view and location of permanent nekton and vegetation monitoring site established by NCBN at George Washington Birthplace National Monument (GEWA) in Viginia. This site will be monitored biennially.

Table 1. Sampling dates and total number of nekton sampling stations at GEWA marsh site in 2008. Sampling stations are displayed by habitat type.

		Habitat		
Site	Dates	Tidal Creek	Shoreline	Total
1	8/13/2008	5	3	8

Table 2. Definition of standard cover type categories used in the Northeast Coastal and Barrier Network salt marsh vegetation monitoring program. (James-Pirri et al. In Development-b)

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

Standing non-living vascular plants identified by species (*e.g., S. alterniflora* 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.

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 Ground. 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.

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.

Data Summary

Nekton

Species composition, average density, average length of nekton, and standard deviations were all calculated using standard formulae. The same is true of the average values of the physical characteristics calculated for each habitat type during each visit. Details can be found in the Analysis and Reporting Standard Operating Procedure of James-Pirri et al. (In Development-a). Species richness was calculated using the algorithm described in Heltshe and Forester (1983). An explanation and example of using the algorithm is provided in the Analysis and Reporting Standard Operating Protocol of James-Pirri et al. (In Development-a).

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 in the data was converted to the midpoint of the percent range it represented (Table 3) as described in Wikum and Shanholtzer (1978).

Table 3. 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%	0.5%
2	1 - 5%	3%
3	6 - 25%	15.5%
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, we rename it a ‘relative prevalence’ value. The calculation is essentially identical to that described in Wikum and Shanholtzer’s publication. Although Wikum and Shanholtzer (1978) present their importance value as a sum of the percent frequency and percent cover values, this report takes the average of these values so that relative prevalence is on a more readily interpretable percent scale. We estimated the relative percent prevalence for each species which is the average of the relative percent cover and the relative percent frequency.

Relative percent cover is the percent of all plots that each species or cover type covers relative to all other species and non-vegetation cover types present in the marsh plots. The sum of all relative percent cover values for all species and cover types equals 100%. Relative percent frequency is the number of plots where each species or cover type is present, relative to all other species and non-vegetation cover types present. The sum of the relative percent frequency values for all species is 100%.

Taking the average of the relative percent cover and the relative percent frequency gives the relative percent prevalence for each species, or non-vegetation cover type present. Because the relative percent prevalence incorporates both percent frequency and percent cover, it is likely to differ substantially from the average percent cover for a given species or non-vegetation cover type. We also report the average percent cover of each species for all plots combined.

Lastly, if any identified vegetation species in the sample plots are listed by the United States Department of Agriculture (USDA) or the commonwealth of Virginia as exotic, invasive, threatened, endangered, or rare, these species are noted in the vegetation table. Information about plants listed by each state as exotic, invasive, threatened, endangered, or rare is available online (USDA 2010). In some cases, more specific information may be available on state websites. Information about plants listed by the commonwealth of Virginia as exotic or invasive is available online (Virginia Department of Conservation and Recreation 2009). Information about plants listed by the commonwealth of Virginia as threatened, endangered, or rare can be obtained from an online report produced by the Virginia Department of Conservation and Recreation (Townsend 2009).

If any species found in the sample plots are noted as being from one of these categories, plots with those categories of vegetation present will be noted in Appendix 2, the list of all vegetation sample plots and their respective Universal Transverse Mercator (UTM) coordinates.

Results

Nekton

Six nekton species consisting of 4 fish and 2 decapod species were captured at GEWA during the summer of 2008 on the permanent site in creeks and shoreline edge combined. Examination of nekton species composition (% catch) indicates that two species account for approximately 90% of all nekton recorded during summer sampling at GEWA in 2008 (Table 4). The most prevalent species, common mummichog (*Fundulus heteroclitus*) accounts for approximately 54% of all nekton recorded. The second most common species, daggerblade grass shrimp (*Palaemonetes pugio*) accounts for 36% of all nekton recorded. Community composition percentages show that fish comprised 100% of nekton caught in tidal creek habitat and 63% of all nekton caught.

The average density of each species and community is presented in Table 5. Common Mummichog (*F. heteroclitus)* had the highest density of all species captured in 2008, and daggerblade grass shrimp (*P. pugio*) had the second highest. It is important to note that both the species and community composition by habitat (Table 4) and average density of each species and community by habitat (Table 5) show obvious differences between tidal creek and shoreline habitat. No species where found in both habitats. The two decapod species, daggerblade grass shrimp (*P. pugio*) and blue crab (*C. sapidus*), as well as american shad (*A. sapidissima*) were found only in the shoreline stations.

Table 4. Nekton species and community composition (% catch) at GEWA in 2008. Data are shown for each visit separately and both visits combined. n = total number of nekton caught in that habitat. '-' indicates a species or community was not present.

		Community/Species Composition (%)		
Community/Species	Common Name	Tidal Creek (n = 98)	Shoreline (n = 119)	All Stations (n = 217)
Fish		**100.0**	**17.4**	**62.7**
Fundulus heteroclitus	Common Mummichog	97.5	-	53.5
Alosa sapidissima	American Shad	-	17.4	7.8
Cyprinodon variegatus	Sheepshead Minnow	1.7	-	0.9
Fundulus luciae	Spotfin Killifish	0.8	-	0.5
Decapods		**-**	**82.6**	**37.3**
Palaemonetes pugio	Daggerblade Grass Shrimp	-	80.6	36.4
Callinectes sapidus	Blue Crab	-	2.0	0.9

Table 5. Average density and standard deviation [individuals per 1 m2 ± SD (total count)] of nekton captured at GEWA in 2008. n = number of nekton stations sampled. '-' indicates a species or community was not present.

Community/Species	Common Name	Average Density [individuals per 1 m^2 ± SD (total count)] Tidal Creek (n=5)	Shoreline (n=3)	All Stations (n=8)
Fish		**23.8 ± 26.0 (119)**	**5.7 ± 9.0 (17)**	**17.0 ± 22.3 (136)**
Fundulus heteroclitus	Common Mummichog	23.2 ± 25.1 (116)	-	14.5 ± 22.5 (116)
Alosa sapidissima	American Shad	-	5.7 ± 9.0 (17)	2.1 ± 5.6 (17)
Cyprinodon variegatus	Sheepshead Minnow	0.4 ± 0.9 (2)	-	0.3 ± 0.7 (2)
Fundulus luciae	Spotfin Killifish	0.2 ± 0.4 (1)	-	0.1 ± 0.4 (1)
Decapods		**-**	**27.0 ± 46.8 (81)**	**10.1 ± 28.6 (81)**
Palaemonetes pugio	Daggerblade Grass Shrimp	-	26.3 ± 45.6 (79)	9.9 ± 27.9 (79)
Callinectes sapidus	Blue Crab	-	0.7 ± 1.2 (2)	0.3 ± 0.7 (2)
Total Nekton		**23.8 ± 26.0 (119)**	**32.7 ± 43.5 (98)**	**27.1 ± 30.8 (217)**

Another summary measure we examined for these data, species richness, provided additional information about differences in sampled habitat (Table 6). Although 3 species were found in each habitat, species richness was slightly higher in shoreline habitat, 4.3 ± 1.3, than in tidal creek habitat, 3.8 ± 0.8. This disparity is a result of there being one more unique species (species recorded at only one station) caught in shoreline habitat than in creek habitat.

Table 6. Estimated nekton species richness (Est. Species Richness ± SD) summarized by habitat at GEWA in 2008.

Habitat	No. of Stations	Observed No. of Species	Est. Species Richness ± SD
Tidal Creek	5	3	3.8 ± 0.8
Shoreline	3	3	4.3 ± 1.3
Total	8	6	8.6 ± 1.6

Average length of each species, is summarized in Table 7. These data provide a baseline for length data that will be recorded in future years. No species were found in both habitats so it is not possible to make comparisons between the habitats.

Table 7. Average length [mm ± SD (no. measured)] of nekton within each habitat at GEWA in 2008. Length data for each species was summarized over all stations sampled within each habitat. '-' indicates that a species was not present.

		Average Length [mm ± SD (no. measured)]		
Community/Species	Common Name	Tidal Creek	Shoreline	All Stations
Fish				
Alosa sapidissima	American Shad	-	26.6 ± 6.7 (16)	26.6 ± 6.7 (16)
Callinectes sapidus	Blue Crab	-	56.0 (1)	56.0 (1)
Fundulus heteroclitus	Common Mummichog	31.5 ± 12.2 (48)	-	31.5 ± 12.2 (48)
Fundulus luciae	Spotfin Killifish	39.0 (1)	-	39.0 (1)
Decapods				
Cyprinodon variegatus	Sheepshead Minnow	33.5 ± 4.9 (2)	-	33.5 ± 4.9 (2)
Palaemonetes pugio	Daggerblade Grass Shrimp	-	26.5 ± 7.2 (15)	26.5 ± 7.2 (15)

Physical characteristics of each nekton sampling station were recorded for each station. These measures provide limited insight into differences between habitats that may affect nekton (Table 8). Currently, these data are collected in a manner that may help to explain anomalies in nekton observed at a particular location during a specific visit. These parameters would need to be measured over the course of the field season in order to lend any real insight into observed changes in the nekton community.

Table 8. Average values for physical characteristics [Average ± SD (no. of stations)] at nekton sampling stations at GEWA in 2008. Data are summarized over all stations within each habitat .

	Average ± SD (no. of stations)		
Variable	Tidal Creek	Shoreline	All Stations
Water Depth (cm)	41.6 ± 17.9 (5)	38.7 ± 7.9 (3)	40.5 ± 14.2 (8)
Temperature (˚C)	22.0 ± 1.9 (5)	25.7 ± 0.6 (3)	23.4 ± 2.4 (8)
Salinity (ppt)	3.0 ± 2.6 (3)	-	3.0 ± 2.6 (3).

Vegetation

Thirty-five vegetation species along with three non-vegetation cover types were recorded at one salt marsh site during vegetation sampling at GEWA in 2008 (Table 9). None of the identified vegetation species in the sample plots are listed by the USDA or the state of Virginia as exotic, invasive, threatened, endangered, or rare. Non-vegetation cover types recorded included bare ground, water, and wrack and litter. The average percent cover and the relative percent prevalence of each species or non-vegetation cover type are also shown.

Data are sorted by average percent cover of living vegetation species. Average percent cover of non-living vegetation is also shown by species. As explained in the Data Summary section, the relative percent prevalence combines information about how much of each site each species or cover type covers relative to all other cover types present and how frequently it appears throughout the site relative to all other cover types present. The species with the highest living percent cover, *S. cynosuroides*, dwarfs the percent cover of all other species at 44.4 ± 36.1, but its relative percent prevalence, 23.3, while still high, is substantially lower. This is an indication that *S. cynosuroides* is present in large patches as opposed to being well dispersed throughout the site. In contrast, *A. patula* has a higher relative percent prevalence, 4.5, than its average cover percent, 3.8 ± 6.5 indicating that although it does not cover a large proportion of the site sampled at GEWA, it is well dispersed throughout the site (Table 9).

Table 9. Average percent cover (Average % Cover ± SD) and relative percent prevalence of each plant species and non-vegetation cover type at GEWA in 2008. Data were summarized over all 44 plots. Percent cover was estimated using the midpoint values of Braun-Blanquet percent ranges (Table 3). (NL) indicates standing non-living vegetation.

Species/Cover Type	Common Name	Average Cover % ± SD	Relative Prevalence %
Spartina cynosuroides	Big Cordgrass	44.4 ± 36.1	23.3
S. cynosuroides (NL)	Big Cordgrass (NL)	0.4 ± 1.0	1.5
Amaranthus cannabinus	Tidalmarsh Amaranth	18.1 ± 24.7	12.3
Kosteletzkya virginica	Saltmarsh Mallow	17.8 ± 28.8	10.3
K. virginica (NL)	Saltmarsh Mallow (NL)	1.1 ± 3.3	2.7
Wrack/Litter		10.1 ± 21.6	7.4
Water		7.8 ± 19.9	5.7
Typha angustifolia	Narrowleaf Cattail	4.6 ± 16.1	2.5
T. angustifolia (NL)	Narrowleaf Cattail (NL)	3.0 ± 11.3	2.0
Atriplex patula	Spear Saltbush	3.8 ± 6.5	4.5
Spartina patens	Salt Meadow Cordgrass	3.4 ± 11.5	2.3
Schoenoplectus robustus	Saltmarsh Bulrush	3.0 ± 8.7	2.9
S. robustus (NL)	Saltmarsh Bulrush (NL)	0.8 ± 3.3	1.0
Bare Ground		2.5 ± 7.1	2.7
Zizania aquatica	Annual Wildrice	2.3 ± 11.0	1.3
Myrica cerifera	Southern Wax Myrtle	2.0 ± 13.3	0.9
Quercus phellos	Willow Oak	2.0 ± 13.3	0.9
Lythrum lineare	Saltmarsh Loosestrife	1.6 ± 6.5	1.5
Polygonum punctatum	Dotted Smartweed	1.4 ± 6.1	1.6
Boehmeria cylindrica	False Nettle	1.2 ± 6.1	0.9
Impatiens capensis	Jewelweed	1.2 ± 6.1	0.9
Saururus cernuus	Lizard's Tail	1.2 ± 6.1	0.9
Rumex species	Dock Species	1.1 ± 4.0	1.3
Unidentified Plant		0.9 ± 3.3	1.5
Ilex opaca	American Holly	0.9 ± 5.7	0.5
Iva frutescens	Marsh Elder	0.9 ± 5.7	0.5
Juncus effusus	Common Rush	0.9 ± 5.7	0.5
Polygonum sagittatum	Arrowleaf Tearthumb	0.9 ± 5.7	0.5
Distichlis spicata	Spikegrass	0.5 ± 2.4	0.9
Alnus serrulata	Smooth Alder	0.4 ± 2.3	0.4
Brasenia schreberi	Watershield	0.4 ± 2.3	0.4
Decodon verticillatus	Swamp Loosestrife	0.4 ± 2.3	0.4
Elymus virginicus	Virginia Rye Grass	0.4 ± 2.3	0.4
Hibiscus moscheutos	Rose Mallow	0.4 ± 2.3	0.4
H. moscheutos (NL)	Rose Mallow (NL)	0.1 ± 0.5	0.3
Mikania Scandens	Climbing Hempvine	0.4 ± 2.3	0.4
Panicum virgatum	Switchgrass	0.4 ± 2.3	0.4
Peltandra virginica	Green Arrow Arum	0.4 ± 2.3	0.4
Gallium species	Bedstraw species	0.1 ± 0.5	0.3
Lamiacea species.	Mint Family	0.1 ± 0.5	0.3
Onoclea sensibilis	Sensitive Fern	0.1 ± 0.5	0.3
Phalaris arundinacea	Reed Canary Grass	0.1 ± 0.5	0.3
Ptilimnium capillaceum	Mock Bishopweed	0.1 ± 0.5	0.3
Smilax rotundifolia	Roundleaf Greenbriar	0.1 ± 0.5	0.3

Conclusion

Nekton

The data summarized above show that GEWA's salt marsh provides habitat for a small but thriving nekton community. One of the most notable results of the 2008 sampling season was the disparity in species between tidal creek stations and shoreline stations. These habitat differences are to be expected and reinforce the decision to limit future nekton monitoring to tidal creek stations at GEWA in future years. Given the goal of monitoring nekton with the intent of understanding salt marsh condition and how it changes over time, it is preferable to minimize the variability in the data where possible. The differences between tidal creek and shoreline stations may be attributed to the shoreline stations being more influenced by factors outside of the salt marsh boundary. Although salt marsh monitoring must take into account external factors that affect the marsh, we feel it is advisable to limit nekton data collection to stations that are within the marsh boundary to minimize variability and maximize the probability of seeing changes over time. In future years, sampling will, most likely, be limited to tidal creek stations and will occur twice during the sampling season. These changes in the GEWA sampling plan will provide more information about the nekton community within the salt marsh and the expected differences in the nekton community between early and late summer.

Annual variability will make trends in the nekton community difficult to isolate in the short term. Long term trends in sea-level rise associated with climate change, however, are likely to result in identifiable changes in the extent of seasonal difference in nekton density and species richness as well as differences in the variables themselves. With this goal in mind, the nekton data collected at GEWA in 2008 provide an informative baseline to which future data will be compared.

Vegetation

This first year of vegetation monitoring at GEWA provides essential information about the species present and how prevalent they are. These data also include information about non-vegetation cover types such as bare ground and standing water which will be important to monitor over time. Because salt marshes are located in coastal areas and many of the plant species are sensitive to subtle changes in soil salinity and saturation, changes in the spatial distribution of some species will be important primary indicators of change in salt marsh condition. Trends in the spatial distribution of vegetation species and prevalence of bare ground and water will also provide information about changes in the overall condition of the salt marsh and whether or not it may transition to mud flat due to sea-level rise and climate change.

This first year of data at GEWA establishes a baseline for monitoring trends in vegetation community structure and spatial distribution of both vegetation species and non-vegetation cover types. Long-term monitoring of salt marsh vegetation will allow us to test hypotheses about whether apparent changes are due to year to year variability or represent significant trends.

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Appendix 1: . Coordinates for nekton station locations at GEWA in 2008

Table 1. Coordinates for nekton station locations sampled at GEWA marsh site in 2008, UTM, Zone 18, NAD 83, meters.

Station ID	Habitat	UTM X (east)	UTM Y (north)
G1C_128_2008	Tidal Creek	332049	4228367
G1C_213_2008	Tidal Creek	332006	4228339
G1C_218_2008	Tidal Creek	331996	4228333
G1C_281_2008	Tidal Creek	331946	4228308
G1C_72_2008	Tidal Creek	332088	4228367
G1E_103_2008	Shoreline	332151	4228336
G1E_68_2008	Shoreline	332154	4228374
G1E_90_2008	Shoreline	332151	4228351

Appendix 2. Coordinates for vegetation plot locations at GEWA in 2008

Table 1. Coordinates for vegetation station locations sampled at GEWA site in 2008, UTM, Zone 18, NAD 83, meters.

Plot ID	UTM X (east)	UTM Y (north)
GEWA_G1_G1V108_2008	331910	4228345
GEWA_G1_G1V208_2008	331911	4228342
GEWA_G1_G1V308_2008	331922	4228326
GEWA_G1_G1V408_2008	331923	4228324
GEWA_G1_G1V508_2008	331924	4228323
GEWA_G1_G1V608_2008	331927	4228316
GEWA_G1_G1V708_2008	331936	4228314
GEWA_G1_G1V808_2008	331937	4228311
GEWA_G1_G1V908_2008	331939	4228301
GEWA_G1_G1V1008_2008	331944	4228294
GEWA_G1_G1V1108_2008	332081	4228365
GEWA_G1_G1V1208_2008	332084	4228365
GEWA_G1_G1V1308_2008	332088	4228361
GEWA_G1_G1V1408_2008	332086	4228358
GEWA_G1_G1V1508_2008	332100	4228340
GEWA_G1_G1V1608_2008	332100	4228339
GEWA_G1_G1V1708_2008	331887	4228182
GEWA_G1_G1V1808_2008	331888	4228185
GEWA_G1_G1V1908_2008	331907	4228230
GEWA_G1_G1V2008_2008	331907	4228217
GEWA_G1_G1V2108_2008	331920	4228206
GEWA_G1_G1V2208_2008	331929	4228194

Station ID	UTM X (east)	UTM Y (north)
GEWA_G1_G1V2308_2008	331931	4228182
GEWA_G1_G1V2408_2008	332010	4228351
GEWA_G1_G1V2508_2008	332017	4228347
GEWA_G1_G1V2608_2008	332022	4228339
GEWA_G1_G1V2708_2008	332021	4228334
GEWA_G1_G1V2808_2008	332024	4228328
GEWA_G1_G1V2908_2008	332037	4228326
GEWA_G1_G1V3008_2008	332043	4228323
GEWA_G1_G1V3108_2008	332159	4228390
GEWA_G1_G1V3208_2008	332129	4228381
GEWA_G1_G1V3308_2008	332137	4228383
GEWA_G1_G1V3408_2008	332135	4228381
GEWA_G1_G1V3508_2008	332144	4228371
GEWA_G1_G1V3608_2008	332147	4228366
GEWA_G1_G1V3708_2008	331804	4228163
GEWA_G1_G1V3808_2008	331809	4228152
GEWA_G1_G1V3908_2008	331991	4228365
GEWA_G1_G1V4008_2008	331993	4228362
GEWA_G1_G1V4108_2008	331998	4228356
GEWA_G1_G1V4208_2008	332005	4228352
GEWA_G1_G1V4308_2008	332008	4228338
GEWA_G1_G1V4408_2008	332014	4228323