



Monitoring Salt Marsh Vegetation at Colonial National Historical Park

2012 Summary Report

Natural Resource Data Series NPS/NCBN/NRDS—2013/444



ON THE COVER

Salt Marsh at Colonial National Historical Park (COLO).
Photograph by Robin Baranowski

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

The Northeast Coastal and Barrier Network (NCBN) began monitoring salt marsh vegetation on a biennial basis at Colonial National Historical Park (COLO) in 2008. Due to safety and logistical concerns regarding site access, new permanent sites were established in 2012. This report summarizes the third year of vegetation data collected at COLO; however, only one of the sites was monitored in all three years.

Vegetation monitoring at five sites was conducted July 23-27, 2012. The percent cover of each vegetation species and non-vegetation cover type within each 1 m² plot (n = 250) was visually estimated using a revised Braun-Blanquet method. Twenty-six vegetation species and three non-vegetation cover types (bare ground, wrack & litter, and water) were observed.

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. 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 data collected at Colonial National Historical Park (COLO), according to the protocol developed by James-Pirri et al. (In Review)—Monitoring Salt Marsh Vegetation: A Protocol for the National Park Service’s Long-Term Monitoring Program, Northeast Coastal and Barrier Network.

Methods

Permanent Site Selection

Due to time constraints and extreme difficulties accessing the monitoring sites during the 2008 and 2010 field seasons (Paternaude and Pooler 2010 a, b), a thorough field reconnaissance was conducted in May 2011. After eliminating all sites requiring extensive canoeing or hiking, five permanent, 5-8 hectare salt marsh sites were randomly selected for monitoring at COLO (Figure 1) in 2012. The number of sites chosen within the park was based on available habitat as well as the logistics and feasibility of sampling all sites within one week. Detailed information about the site selection process and sampling design can be found in *Monitoring Vegetation in Salt Marshes: A Protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network* (James-Pirri et al. In Review). Vegetation sampling is currently being conducted biennially.

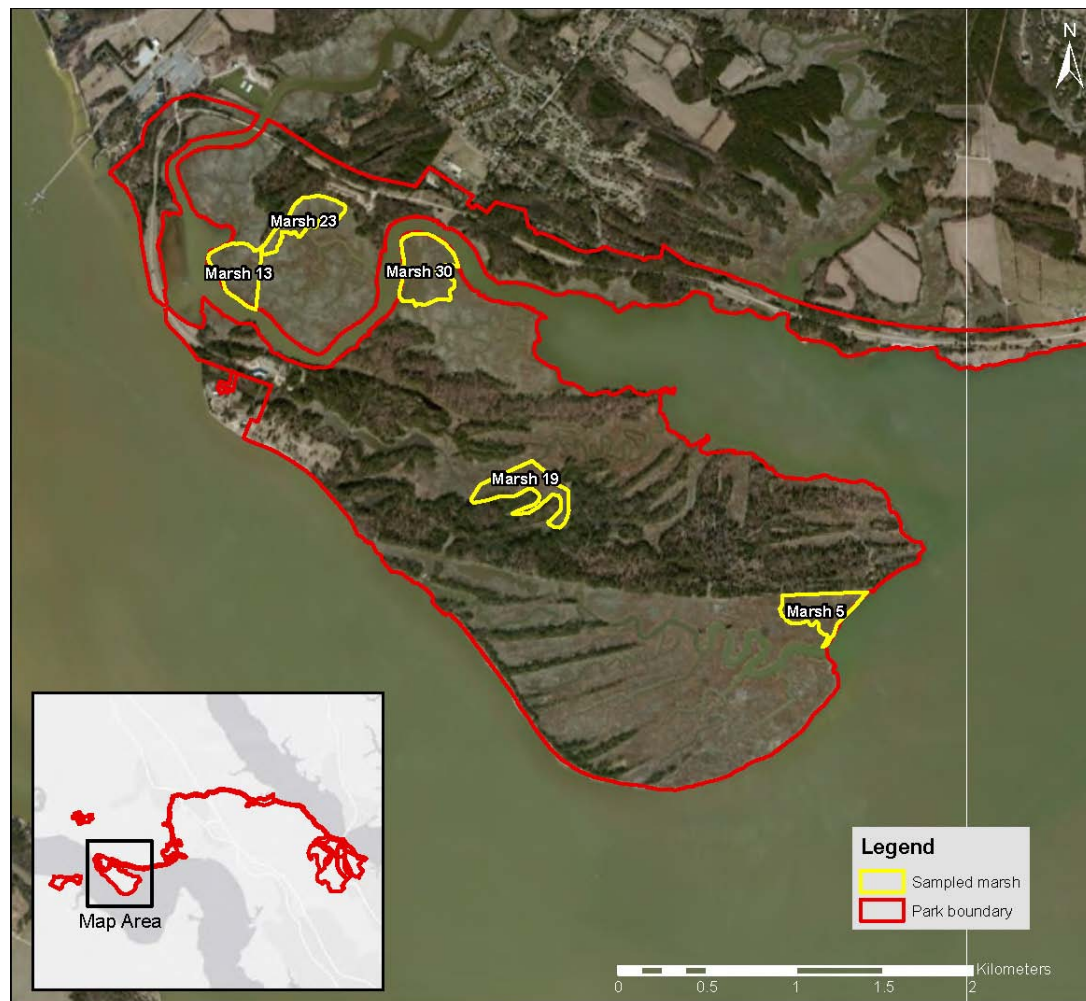


Figure 1. Locations of permanent monitoring sites established by NCBN at Colonial National Historical Park (COLO) in 2012. Vegetation monitoring will be conducted at these five sites on a biennial basis.

Vegetation Plot Selection and Data Collection

Vegetation sampling was conducted once at each of the five sites (Table 1). Ten transects extending from bay to upland were systematically placed based on a single random start. Plots were located by treating the total length of all 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 interspersed of the plots throughout the marsh study area, thus providing a representative sample of all salt marsh communities (*e.g.*, low marsh, high marsh).

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).

Table 1. Sampling dates and number of vegetation plots sampled at five marsh sites at COLO in 2012.

Site	Date	No. of Plots
5	7/23/2012	50
13	7/24/2012	50
19	7/26/2012	50
23	7/27/2012	50
30	7/25/2012	50

Table 2. 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).

Live vascular plants	Identified by species (herbaceous and shrubs).
Standing non-living vascular plants	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.
Macroalgae	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.
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

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 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%	0.50%
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, we refer to it 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, we have chosen to average these values so that relative prevalence is on a more readily interpretable percent scale. We present the relative percent prevalence for each species and non-vegetation cover type as the average of the relative percent cover and the relative percent frequency. A detailed description of the analyses and formulae are presented in the salt marsh vegetation protocol (James-Pirri et al. In Review).

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

In addition to relative percent prevalence, we report the average percent cover of each species and non-vegetation cover type for all plots combined. 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.

If any 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 data summary. Information about plants listed by each state is available online (USDA 2012). Additional information can be obtained from the Virginia Department of Conservation and Recreation (VA DCR) website (VA DCR 2009) and an online report produced by the VA DCR (Townsend 2009). If any species from one of the above categories is observed, the plots are noted in Appendix A which includes a table of all vegetation sample plots and their respective Universal Transverse Mercator (UTM) coordinates.

Results

Vegetation

Twenty-six vegetation species and three non-vegetation cover types (bare ground, wrack & litter, and water) were recorded at five monitoring sites at COLO in 2012 (Table 4). Species are grouped by salinity tolerances (USDA 2012). As explained in the Data Summary section, the relative percent prevalence combines information about how much of each site each species ‘covers’ relative to all other species present and how frequently it appears throughout the site relative to all other species present. One of the species, *Phragmites australis*, is listed by the Commonwealth of Virginia as highly invasive (VA DCR 2009). The coordinates for plots where *P. Australis* was present are provided in Appendix A. None of the vegetation species observed in 2012 are federally or state listed as threatened, endangered, or rare (USDA 2012, Townsend 2009). Tables summarizing vegetation data by site are provided in the Appendices.

Table 4. Average percent cover (Average % Cover $\pm$ SE), frequency, and relative percent prevalence of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized over all 250 plots. Percent cover was estimated using the midpoint values of Braun-Blanquet percent ranges (Table 2). (NL) indicates standing non-living vegetation. '*' species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009).

Cover Type		Avg. % Cover $\pm$ SE	Freq.	Rel. % Cover	Rel. % Freq.	Rel. % Prevalence
Salinity Tolerance						
Species	Common Name					
Vegetation		67.7 $\pm$ 1.9	236	66.8	74.7	70.8
High Salinity Tolerance		29.9 $\pm$ 2.1	167	29.5	29.1	29.3
<i>Spartina cynosuroides</i>	big cordgrass	17.9 $\pm$ 1.6	133	17.7	12.4	15.1
<i>Spartina cynosuroides</i> (NL)	big cordgrass (NL)	4.1 $\pm$ 0.6	78	4.1	7.3	5.7
<i>Schoenoplectus robustus</i>	saltmarsh bulrush	6.3 $\pm$ 0.9	73	6.2	6.8	6.5
<i>Schoenoplectus robustus</i> (NL)	saltmarsh bulrush (NL)	1.1 $\pm$ 0.3	23	1.1	2.1	1.6
<i>Spartina alterniflora</i>	saltmarsh cordgrass	0.4 $\pm$ 0.3	2	0.4	0.2	0.3
<i>Distichlis spicata</i>	spikegrass	0.1 $\pm$ 0.1	3	0.1	0.3	0.2
Medium Salinity Tolerance		9.3 $\pm$ 1.1	112	9.2	18.4	13.8
<i>Schoenoplectus pungens</i>	common threesquare	2.0 $\pm$ 0.4	46	1.9	4.3	3.1
<i>Schoenoplectus pungens</i> (NL)	common threesquare (NL)	0.3 $\pm$ 0.1	5	0.3	0.5	0.4
<i>Zizania aquatica</i>	annual wildrice	2.5 $\pm$ 0.7	40	2.4	3.7	3.0
<i>Zizania aquatica</i> (NL)	annual wildrice (NL)	0.1 $\pm$ 0.1	2	0.1	0.2	0.2
<i>Pontederia cordata</i>	pickerelweed	1.7 $\pm$ 0.3	30	1.7	2.8	2.2
<i>Pontederia cordata</i> (NL)	pickerelweed (NL)	< 0.05	1	< 0.05	0.1	< 0.05
<i>Polygonum punctatum</i>	dotted smartweed	1.0 $\pm$ 0.2	37	1.0	3.4	2.2
<i>Polygonum punctatum</i> (NL)	dotted smartweed (NL)	< 0.05	1	< 0.05	0.1	< 0.05
<i>Typha angustifolia</i>	narrowleaf cattail	0.7 $\pm$ 0.3	17	0.7	1.6	1.1
<i>Typha angustifolia</i> (NL)	narrowleaf cattail (NL)	0.3 $\pm$ 0.2	7	0.3	0.7	0.5
<i>Eleocharis parvula</i>	dwarf spikerush	0.6 $\pm$ 0.3	7	0.6	0.7	0.6
<i>Schoenoplectus americanus</i>	American bulrush	< 0.05	2	< 0.05	0.2	0.1
<i>Lythrum lineare</i>	wand lythrum	< 0.05	1	< 0.05	0.1	< 0.05
Low Salinity Tolerance		28.3 $\pm$ 1.6	193	27.9	26.7	27.3
<i>Peltandra virginica</i>	green arrow arum	21.7 $\pm$ 1.6	154	21.4	14.4	17.9

Table 4. Average percent cover (Average % Cover $\pm$ SE), frequency, and relative percent prevalence of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized over all 250 plots. Percent cover was estimated using the midpoint values of Braun-Blanquet percent ranges (Table 2). (NL) indicates standing non-living vegetation. '*' species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009) (continued).

Cover Type						
Salinity Tolerance						
Species	Common Name	Avg. % Cover $\pm$ SE	Freq.	Rel. % Cover	Rel. % Freq.	Rel. % Prevalence
<i>Peltandra virginica</i> (NL)	green arrow arum (NL)	1.1 $\pm$ 0.3	25	1.1	2.3	1.7
<i>Sagittaria lancifolia</i>	bulltongue arrowhead	2.7 $\pm$ 0.5	43	2.7	4.0	3.4
<i>Sagittaria lancifolia</i> (NL)	bulltongue arrowhead (NL)	0.1 $\pm$ 0.1	2	0.1	0.2	0.2
<i>Juncus tenuis</i>	field rush	1.0 $\pm$ 0.3	28	1.0	2.6	1.8
<i>Phragmites australis</i> *	common reed	0.8 $\pm$ 0.3	13	0.8	1.2	1.0
<i>Phragmites australis</i> (NL)*	common reed (NL)	0.1 $\pm$ 0.1	4	0.1	0.4	0.2
<i>Pluchea odorata</i>	marsh fleabane	0.6 $\pm$ 0.2	10	0.6	0.9	0.8
<i>Thelypteris palustris</i>	marsh fern	0.1 $\pm$ 0.1	2	0.1	0.2	0.2
<i>Hydrocotyle verticillata</i>	whorled marsh pennywort	0.1 $\pm$ 0.1	1	0.1	0.1	0.1
<i>Phyla lanceolata</i>	lanceleaf frogfruit	0.1 $\pm$ 0.1	1	0.1	0.1	0.1
<i>Sagittaria subulata</i>	awl-leaf arrowhead	< 0.05	2	< 0.05	0.2	0.1
<i>Hibiscus moscheutos</i>	rose mallow	< 0.05	1	< 0.05	0.1	< 0.05
No Salinity Tolerance		0.1 $\pm$ 0.1	4	0.1	0.4	0.2
<i>Leersia oryzoides</i>	rice cutgrass	0.1 $\pm$ 0.1	2	0.1	0.2	0.2
<i>Osmunda regalis</i>	royal fern	0.1 $\pm$ 0.1	1	0.1	0.1	0.1
<i>Teucrium canadense</i>	American germander	< 0.05	1	< 0.05	0.1	< 0.05
Unknown Salinity Tolerance		< 0.05	1	< 0.05	0.1	< 0.05
<i>Ptilimnium capillaceum</i>	mock bishopweed	< 0.05	1	< 0.05	0.1	< 0.05
Non-Vegetation		24.5 $\pm$ 1.9	144	24.2	14.8	19.5
<i>bare ground</i>	bare ground	13.1 $\pm$ 1.2	115	12.9	10.7	11.8
<i>water</i>	water	11.5 $\pm$ 1.8	44	11.3	4.1	7.7
Incidental Cover		9.1 $\pm$ 1.0	115	9.0	10.7	9.8
<i>Wrack & litter</i>	wrack / litter	9.1 $\pm$ 1.0	115	9.0	10.7	9.8

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Appendix A: Coordinates for vegetation plots sampled at COLO in 2012.

Table A-1. Coordinates for vegetation plots sampled at COLO site 5 in 2012, UTM, Zone 18, NAD 83, meters.

Station ID	UTM X (east)	UTM Y (north)	Station ID	UTM X (east)	UTM Y (north)
C5V1012_2012	345477	4118398	C5V3212_2012	345428	4118434
C5V1112_2012	345375	4118522	C5V3312_2012	345278	4118491
C5V112_2012	345425	4118443	C5V3412_2012	345668	4118494
C5V1212_2012	345621	4118472	C5V3512_2012	345281	4118449
C5V1312_2012	345428	4118396	C5V3612_2012	345474	4118460
C5V1412_2012	345331	4118431	C5V3712_2012	345425	4118466
C5V1512_2012	345669	4118547	C5V3812_2012	345283	4118486
C5V1612_2012	345619	4118522	C5V3912_2012	345480	4118351
C5V1712_2012	345429	4118448	C5V4012_2012	345278	4118516
C5V1812_2012	345375	4118486	C5V4112_2012	345530	4118321
C5V1912_2012	345575	4118401	C5V412_2012	345623	4118479
C5V2012_2012	345427	4118474	C5V4212_2012	345331	4118397
C5V2112_2012	345571	4118515	C5V4312_2012	345575	4118401
C5V212_2012	345621	4118446	C5V4412_2012	345328	4118535
C5V2212_2012	345281	4118444	C5V4512_2012	345480	4118322
C5V2312_2012	345615	4118546	C5V4612_2012	345328	4118438
C5V2412_2012	345277	4118529	C5V4712_2012	345283	4118423
C5V2512_2012	345475	4118381	C5V4812_2012	345325	4118523
C5V2612_2012	345277	4118496	C5V4912_2012	345482	4118329
C5V2712_2012	345476	4118476	C5V5012_2012	345326	4118493
C5V2812_2012	345573	4118471	C5V512_2012	345570	4118503
C5V2912_2012	345523	4118483	C5V612_2012	345528	4118422
C5V3012_2012	345428	4118393	C5V712_2012	345524	4118471
C5V3112_2012	345375	4118522	C5V812_2012	345619	4118534
C5V312_2012	345279	4118413	C5V912_2012	345524	4118467

Table A-2. Coordinates for vegetation plots sampled at COLO site 13 in 2012, UTM, Zone 18, NAD 83, meters. '*' indicates an invasive or exotic species was observed in the plot.

Station ID	UTM X (east)	UTM Y (north)	Station ID	UTM X (east)	UTM Y (north)
C13V1012_2012	342265	4120302	C13V3412_2012*	342230	4120414
C13V1112_2012	342028	4120435	C13V3512_2012*	342221	4120380
C13V112_2012	342124	4120355	C13V3612_2012	342177	4120349
C13V1212_2012*	342289	4120405	C13V3712_2012	342240	4120231
C13V1412_2012	342039	4120434	C13V3812_2012	342113	4120282
C13V1612_2012	342014	4120435	C13V3912_2012	342228	4120306
C13V1712_2012	342109	4120318	C13V4012_2012	342260	4120198
C13V1812_2012*	342124	4120425	C13V4112_2012	342165	4120312
C13V1912_2012	342235	4120303	C13V412_2012	342094	4120320
C13V2012_2012	342110	4120316	C13V4212_2012	342008	4120400
C13V2112_2012	342265	4120302	C13V4312_2012	342282	4120480
C13V212_2012	342095	4120429	C13V4412_2012*	342111	4120354
C13V2212_2012*	342170	4120350	C13V4512_2012	342265	4120302
C13V2312_2012	342290	4120481	C13V4612_2012	342031	4120399
C13V2412_2012	342288	4120335	C13V4712_2012	342163	4120422
C13V2512_2012	342268	4120446	C13V4812_2012	342161	4120314
C13V2612_2012	342142	4120461	C13V4912_2012*	342093	4120355
C13V2712_2012	342243	4120304	C13V5012_2012	342142	4120278
C13V2812_2012	342216	4120198	C13V512_2012	342046	4120434
C13V2913_2012	342190	4120273	C13V5512_2012	342260	4120230
C13V3012_2012	342176	4120420	C13V6012_2012	342283	4120301
C13V3112_2012	342084	4120321	C13V612_2012	342243	4120448
C13V312_2012	342265	4120302	C13V712_2012*	342142	4120390
C13V3212_2012	342109	4120318	C13V812_2012*	342188	4120383
C13V3312_2012	342242	4120229	C13V912_2012	342169	4120455

Table A-3. Coordinates for vegetation plots sampled at COLO site 19 in 2012, UTM, Zone 18, NAD 83, meters.

Station ID	UTM X (east)	UTM Y (north)	Station ID	UTM X (east)	UTM Y (north)
C19V1012_2012	343845	4119127	C19V3212_2012	343856	4119037
C19V1112_2012	343822	4119208	C19V3312_2012	343879	4119050
C19V112_2012	343970	4119141	C19V3412_2012	343854	4119177
C19V1212_2012	343822	4119026	C19V3512_2012	343803	4119016
C19V1312_2012	343757	4119219	C19V3612_2012	343781	4119008
C19V1412_2012	343747	4119127	C19V3712_2012	343840	4119033
C19V1512_2012	343660	4119131	C19V3812_2012	343551	4119129
C19V1612_2012	343726	4119116	C19V3912_2012	343846	4119129
C19V1712_2012	343908	4119201	C19V4012_2012	343788	4119146
C19V1812_2012	343820	4119248	C19V4112_2012	343537	4119081
C19V1912_2012	343504	4119060	C19V412_2012	343664	4119093
C19V2012_2012	343823	4119163	C19V4212_2012	343940	4118944
C19V2112_2012	343706	4119196	C19V4312_2012	343752	4119217
C19V212_2012	343727	4119117	C19V4412_2012	343798	4119193
C19V2212_2012	343665	4119180	C19V4512_2012	343864	4119181
C19V2312_2012	343567	4119091	C19V4619_2012	343959	4119089
C19V2412_2012	343776	4119006	C19V4712_2012	343946	4119130
C19V2512_2012	343672	4119183	C19V4812_2012	343874	4119185
C19V2612_2012	343838	4119259	C19V4912_2012	343889	4119192
C19V2712_2012	343672	4119097	C19V5012_2012	343892	4119197
C19V2812_2012	343587	4119143	C19V512_2012	343911	4119203
C19V2912_2012	343664	4119180	C19V612_2012	343713	4118974
C19V3012_2012	343875	4119185	C19V712_2012	343691	4119145
C19V3112_2012	343534	4119118	C19V812_2012	343683	4119188
C19V312_2012	343815	4119158	C19V912_2012	343975	4118924

Table A-4. Coordinates for vegetation plots sampled at COLO site 23 in 2012, UTM, Zone 18, NAD 83, meters. '*' indicates an invasive or exotic species was observed in the plot.

Station ID	UTM X (east)	UTM Y (north)	Station ID	UTM X (east)	UTM Y (north)
C23V1012_2012	342712	4120740	C23V3212_2012	342532	4120705
C23V1112_2012	342485	4120675	C23V3312_2012	342450	4120637
C23V112_2012*	342462	4120628	C23V3412_2012	342678	4120697
C23V1212_2012	342539	4120697	C23V3512_2012	342601	4120634
C23V1312_2012	342391	4120478	C23V3612_2012	342562	4120748
C23V1412_2012	342670	4120707	C23V3712_2012	342482	4120607
C23V1512_2012	342449	4120643	C23V3812_2012	342412	4120604
C23V1612_2012*	342476	4120609	C23V3912_2012	342382	4120483
C23V1712_2012	342475	4120685	C23V4012_2012	342566	4120667
C23V1812_2012	342502	4120734	C23V4112_2012	342523	4120632
C23V1912_2012	342507	4120653	C23V412_2012	342628	4120751
C23V2012_2012	342490	4120596	C23V4212_2012	342691	4120760
C23V2112_2012	342408	4120529	C23V4312_2012	342681	4120692
C23V212_2012*	342630	4120670	C23V4412_2012	342576	4120657
C23V2212_2012	342408	4120529	C23V4512_2012	342367	4120501
C23V2312_2012	342552	4120761	C23V4612_2012	342571	4120739
C23V2412_2012	342664	4120715	C23V4712_2012	342566	4120744
C23V2512_2012*	342457	4120631	C23V4812_2012	342599	4120785
C23V2612_2012	342686	4120767	C23V4912_2012	342628	4120752
C23V2712_2012	342663	4120714	C23V5012_2012	342548	4120608
C23V2812_2012	342696	4120751	C23V512_2012	342351	4120524
C23V2912_2012	342559	4120752	C23V612_2012	342475	4120686
C23V3012_2012	342382	4120559	C23V712_2012	342494	4120591
C23V3112_2012*	342512	4120649	C23V812_2012	342517	4120642
C23V312_2012	342492	4120673	C23V912_2012	342760	4120688

Table A-5. Coordinates for vegetation plots sampled at COLO site 30 in 2012, UTM, Zone 18, NAD 83, meters.

Station ID	UTM X (east)	UTM Y (north)	Station ID	UTM X (east)	UTM Y (north)
C30V1012_2012	343163	4120241	C30V3212_2012	343100	4120229
C30V1112_2012	343195	4120442	C30V3312_2012	343227	4120576
C30V112_2012	343198	4120241	C30V3412_2012	343290	4120251
C30V1212_2012	343228	4120486	C30V3512_2012	343359	4120448
C30V1312_2012	343357	4120491	C30V3612_2012	343293	4120478
C30V1412_2012	343386	4120443	C30V3712_2012	343227	4120534
C30V1512_2012	343227	4120316	C30V3812_2012	343197	4120244
C30V1612_2012	343356	4120223	C30V3912_2012	343133	4120212
C30V1712_2012	343226	4120264	C30V4012_2012	343164	4120283
C30V1812_2012	343133	4120415	C30V4112_2012	343386	4120463
C30V1912_2012	343323	4120393	C30V412_2012	343131	4120449
C30V2012_2012	343194	4120553	C30V4212_2012	343261	4120267
C30V2112_2012	343261	4120540	C30V4312_2012	343258	4120341
C30V212_2012	343164	4120344	C30V4412_2012	343195	4120400
C30V2212_2012	343132	4120544	C30V4612_2012	343325	4120221
C30V2312_2012	343356	4120427	C30V4712_2012	343102	4120277
C30V2412_2012	343294	4120351	C30V4812_2012	343324	4120266
C30V2512_2012	343258	4120299	C30V4912_2012	343260	4120553
C30V2612_2012	343196	4120297	C30V5012_2012	343293	4120414
C30V2712_2012	343196	4120285	C30V5112_2012	343261	4120292
C30V2812_2012	343133	4120375	C30V512_2012	343229	4120457
C30V2912_2012	343164	4120344	C30V612_2012	343322	4120475
C30V3012_2012	343134	4120355	C30V712_2012	343260	4120231
C30V3112_2012	343166	4120432	C30V812_2012	343195	4120248
C30V312_2012	343227	4120301	C30V912_2012	343194	4120547

Appendix B: Vegetation frequency summarized by site.

Table B-1. Frequency of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. '*' species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009).

Cover Type		Site (no. of plots)					
Salinity Tolerance		5	13	19	23	30	All
Species	Common Name	(50)	(50)	(50)	(50)	(50)	(250)
Vegetation		48	50	45	45	48	236
High Salinity Tolerance		48	31	33	32	23	167
<i>Schoenoplectus robustus</i>	saltmarsh bulrush	25	17	12	7	12	73
<i>Schoenoplectus robustus (NL)</i>	saltmarsh bulrush (NL)	11	2	3	3	4	23
<i>Spartina cynosuroides</i>	big cordgrass	42	22	28	29	12	133
<i>Spartina cynosuroides (NL)</i>	big cordgrass (NL)	37	3	16	17	5	78
<i>Spartina alterniflora</i>	saltmarsh cordgrass	--	1	--	--	1	2
<i>Distichlis spicata</i>	spikegrass	--	--	3	--	--	3
Medium Salinity Tolerance		2	27	30	24	29	112
<i>Zizania aquatica</i>	annual wildrice	--	8	4	7	21	40
<i>Zizania aquatica (NL)</i>	annual wildrice (NL)	--	--	--	--	2	2
<i>Pontederia cordata</i>	pickerelweed	--	1	9	9	11	30
<i>Pontederia cordata (NL)</i>	pickerelweed (NL)	--	--	1	--	--	1
<i>Schoenoplectus pungens</i>	common threesquare	--	12	16	9	9	46
<i>Schoenoplectus pungens (NL)</i>	common threesquare (NL)	--	1	4	--	--	5
<i>Polygonum punctatum</i>	dotted smartweed	--	9	8	15	5	37
<i>Polygonum punctatum (NL)</i>	dotted smartweed (NL)	--	--	--	1	--	1
<i>Typha angustifolia</i>	narrowleaf cattail	2	3	9	1	2	17
<i>Typha angustifolia (NL)</i>	narrowleaf cattail (NL)	1	1	4	--	1	7
<i>Eleocharis parvula</i>	dwarf spikerush	--	3	4	--	--	7
<i>Lythrum lineare</i>	wand lythrum	--	--	1	--	--	1
<i>Schoenoplectus americanus</i>	American bulrush	--	--	--	2	--	2

Table B-1. Frequency of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. '*' species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009) (continued).

Cover Type		Site (no. of plots)					
Salinity Tolerance		5	13	19	23	30	All
Species	Common Name	(50)	(50)	(50)	(50)	(50)	(250)
Low Salinity Tolerance		16	48	38	45	46	193
<i>Peltandra virginica</i>	green arrow arum	13	39	13	45	44	154
<i>Peltandra virginica</i> (NL)	green arrow arum (NL)	--	10	--	5	10	25
<i>Juncus tenuis</i>	field rush	4	7	8	5	4	28
<i>Sagittaria lancifolia</i>	bulltongue arrowhead	--	14	25	--	4	43
<i>Sagittaria lancifolia</i> (NL)	bulltongue arrowhead (NL)	--	2	--	--	--	2
<i>Hibiscus moscheutos</i>	rose mallow	--	--	--	1	--	1
<i>Hydrocotyle verticillata</i>	whorled marsh pennywort	--	--	1	--	--	1
<i>Phragmites australis</i> *	common reed	--	9	--	4	--	13
<i>Phragmites australis</i> (NL)*	common reed (NL)	--	3	--	1	--	4
<i>Phyla lanceolata</i>	lanceleaf frogfruit	--	--	1	--	--	1
<i>Pluchea odorata</i>	marsh fleabane	--	--	10	--	--	10
<i>Sagittaria subulata</i>	awl-leaf arrowhead	--	2	--	--	--	2
<i>Thelypteris palustris</i>	marsh fern	--	--	2	--	--	2
No Salinity Tolerance		1	--	3	--	--	4
<i>Leersia oryzoides</i>	rice cutgrass	--	--	2	--	--	2
<i>Osmunda regalis</i>	royal fern	--	--	1	--	--	1
<i>Teucrium canadense</i>	American germander	1	--	--	--	--	1
Unknown Salinity Tolerance		--	--	1	--	--	1
<i>Ptilimnium capillaceum</i>	mock bishopweed	--	--	1	--	--	1
Non-Vegetation		10	29	28	42	35	144
<i>bare ground</i>	bare ground	10	28	22	22	33	115
<i>water</i>	water	3	3	10	23	5	44

Table B-1. Frequency of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. '*' species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009) (continued).

Cover Type		Site (no. of plots)					
Salinity Tolerance		5	13	19	23	30	All
Species	Common Name	(50)	(50)	(50)	(50)	(50)	(250)
Incidental Cover		31	14	26	22	22	115
<i>Wrack & litter</i>	wrack / litter	31	14	26	22	22	115

Appendix C. Vegetation relative percent cover summarized by site.

Table C-1. Relative percent cover of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. “*” species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009).

Cover Type		Relative Cover %					
Salinity Tolerance		Site (No. of Plots)					
Species	Common Name	5 (50)	13 (50)	19 (50)	23 (50)	30 (50)	All (250)
Vegetation		72.6	74.1	63.6	50.2	74.6	66.8
High Salinity Tolerance		67.7	19.8	30.2	17.4	11.2	29.5
<i>Spartina cynosuroides</i>	big cordgrass	38.2	11.8	19.8	14.0	3.9	17.7
<i>Spartina cynosuroides</i> (NL)	big cordgrass (NL)	12.7	1.2	3.9	1.6	0.5	4.1
<i>Schoenoplectus robustus</i>	saltmarsh bulrush	14.4	4.9	4.8	1.3	5.4	6.2
<i>Schoenoplectus robustus</i> (NL)	saltmarsh bulrush (NL)	2.5	0.6	1.0	0.4	0.7	1.1
<i>Spartina alterniflora</i>	saltmarsh cordgrass	--	1.3	--	--	0.7	0.4
<i>Distichlis spicata</i>	spikegrass	--	--	0.7	--	--	0.1
Medium Salinity Tolerance		0.4	10.4	15.8	5.0	15.2	9.2
<i>Zizania aquatica</i>	annual wildrice	--	2.5	0.7	0.4	8.6	2.4
<i>Zizania aquatica</i> (NL)	annual wildrice (NL)	--	--	--	--	0.4	0.1
<i>Schoenoplectus pungens</i>	common threesquare	--	2.8	4.9	0.7	1.8	1.9
<i>Schoenoplectus pungens</i> (NL)	common threesquare (NL)	--	0.3	1.3	--	--	0.3
<i>Pontederia cordata</i>	pickerelweed	--	0.8	2.1	2.3	3.3	1.7
<i>Pontederia cordata</i> (NL)	pickerelweed (NL)	--	--	0.1	--	--	< 0.05
<i>Polygonum punctatum</i>	dotted smartweed	--	1.3	1.6	1.3	0.8	1.0
<i>Polygonum punctatum</i> (NL)	dotted smartweed (NL)	--	--	--	0.1	--	< 0.05
<i>Typha angustifolia</i>	narrowleaf cattail	0.3	1.2	1.8	0.1	0.4	0.7
<i>Typha angustifolia</i> (NL)	narrowleaf cattail (NL)	0.1	0.1	1.5	--	0.1	0.3
<i>Eleocharis parvula</i>	dwarf spikerush	--	1.4	1.8	--	--	0.6
<i>Lythrum lineare</i>	wand lythrum	--	--	0.1	--	--	< 0.05

Table C-1. Relative percent cover of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. “*” species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009) (continued).

Cover Type		Relative Cover %					
Salinity Tolerance		Site (No. of Plots)					
Species	Common Name	5 (50)	13 (50)	19 (50)	23 (50)	30 (50)	All (250)
<i>Schoenoplectus americanus</i>	American bulrush	--	--	--	0.1	--	< 0.05
Low Salinity Tolerance		4.4	43.8	16.8	27.8	48.1	27.9
<i>Peltandra virginica</i>	green arrow arum	4.2	27.8	3.9	26.0	44.8	21.4
<i>Peltandra virginica</i> (NL)	green arrow arum (NL)	--	3.2	--	0.5	1.8	1.1
<i>Sagittaria lancifolia</i>	bulltongue arrowhead	--	5.1	8.1	--	1.0	2.7
<i>Sagittaria lancifolia</i> (NL)	bulltongue arrowhead (NL)	--	0.4	--	--	--	0.1
<i>Juncus tenuis</i>	field rush	0.2	2.6	0.8	1.0	0.5	1.0
<i>Phragmites australis</i> *	common reed	--	3.8	--	0.2	--	0.8
<i>Phragmites australis</i> (NL)*	common reed (NL)	--	0.7	--	0.1	--	0.1
<i>Pluchea odorata</i>	marsh fleabane	--	--	2.9	--	--	0.6
<i>Hydrocotyle verticillata</i>	whorled marsh pennywort	--	--	0.3	--	--	0.1
<i>Phyla lanceolata</i>	lanceleaf frogfruit	--	--	0.3	--	--	0.1
<i>Thelypteris palustris</i>	marsh fern	--	--	0.4	--	--	0.1
<i>Hibiscus moscheutos</i>	rose mallow	--	--	--	0.1	--	< 0.05
<i>Sagittaria subulata</i>	awl-leaf arrowhead	--	0.1	--	--	--	< 0.05
No Salinity Tolerance		0.1	--	0.7	--	--	0.1
<i>Leersia oryzoides</i>	rice cutgrass	--	--	0.4	--	--	0.1
<i>Osmunda regalis</i>	royal fern	--	--	0.3	--	--	0.1
<i>Teucrium canadense</i>	American germander	0.1	--	--	--	--	< 0.05
Unknown Salinity Tolerance		--	--	0.1	--	--	< 0.05
<i>Ptilimnium capillaceum</i>	mock bishopweed	--	--	0.1	--	--	< 0.05

Table C-1. Relative percent cover of each plant species and non-vegetation cover type observed at COLO in 2012. Data were summarized for each site and over all 250 plots. (NL) indicates standing non-living vegetation. “*” species is listed as invasive by the Commonwealth of Virginia (VA DCR 2009) (continued).

Cover Type		Relative Cover %					
Salinity Tolerance		Site (No. of Plots)					
Species	Common Name	5 (50)	13 (50)	19 (50)	23 (50)	30 (50)	All (250)
Non-Vegetation		7.8	21.0	27.8	44.4	19.5	24.2
<i>bare ground</i>	bare ground	5.6	17.8	17.3	11.5	13.3	12.9
<i>water</i>	water	2.2	3.2	10.5	33.0	6.2	11.3
Incidental Cover		19.6	4.9	8.6	5.4	5.9	9.0
<i>Wrack & litter</i>	wrack / litter	19.6	4.9	8.6	5.4	5.9	9.0