

**Wetland Classification Study
Cooper River, South Carolina
Final Report to the U.S. Army Corps of Engineers,
Charleston District**

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Preface

This study was performed by the Environmental Laboratory (EL) of the U.S. Army Engineer Research and Development Center (ERDC) and was funded by the U.S. Army Corps of Engineers. The report was prepared by Molly Reif, Environmental Systems Branch, ERDC-EL, Vicksburg, MS. The work described in the report was performed by Molly Reif under the general supervision of Mark Messersmith, Planning and Environmental Branch, USACE-Charleston District, Charleston, SC.

Abstract

The Charleston Harbor Post 45 feasibility study will analyze and evaluate improvements to the Charleston Harbor. The US Army Corps of Engineers (USACE) is assessing potential impacts that the project may have on the resources in and around the Harbor, including potential changes in marsh ecosystems as a function of salinity changes. In order to adequately assess potential impacts to marsh ecosystems near the Harbor, datasets illustrating wetland characterization are required. As such, recent WorldView-2 (WV-2) imagery was used to develop a wetland classification map in the designated area along the Cooper River, South Carolina to be consistent with classification schemas developed by the South Carolina Department of Health & Environmental Control's Ocean & Coastal Resource Management (SCDHEC-OCRM) and The Citadel. Two field surveys of the study area were conducted, December 3-6, 2012 and June 4-6, 2013, to collect site data for training (supervised classification) and validation (accuracy assessment) to correspond with the seasonal timeframes of the historic WV-2 imagery (December 9, 2010 and May 25, 2011). The maximum likelihood classification technique was used to identify 14 classes, 12 of which are wetland classes, ranging from freshwater (northern study area) to brackish (central study area) to saltwater (southern study area) communities. Ninety-six sites were used to validate the wetland classification in a confusion matrix with an overall accuracy of 81.25% and a Kappa Coefficient of 0.79. A total of 54,801.77 acres were mapped with 19,544.01 acres included in validated wetland classes (excluding Woody Mix, which includes both low-lying and non-wetland forest). Intertidal-Emergent Marsh (ITEM) Black Needlerush and ITEM Smooth Cordgrass and their respective Mix classes made up over half of the total mapped wetland area (54%) with a combined average Producer's Accuracy of 87.92%. ITEM Freshwater Mix and ITEM Freshwater Mix with Big Cordgrass and/or Cattail classes accounted for 31% of the wetland area with a combined average Producer's Accuracy of 87.5%. ITEM Big Cordgrass Dominant and its respective Mix class combined to form almost 5% of the wetland class area with a combined average Producer's Accuracy of 81.25%, while Submerged Aquatic Vegetation and Floating Leaf Vegetation made up 10% of the wetland area with combined Producer's Accuracies of 75%. ITEM Cattail Dominant had less than 0.05% area mapped and 0% accuracy. Some classification confusion is observed between the ITEM Freshwater Mix and ITEM Freshwater Mix with Big Cordgrass and/or Cattail classes. Additionally, there is some confusion between those two classes and ITEM Big Cordgrass Dominant and Mix classes. Some confusion generally occurs in all "Mix" classes and ITEM Cattail Dominant may not have been mapped well due to its overall lack of abundance in this study area and stand density. The Charleston District will use this data to determine the transitions from saltwater to brackish to freshwater wetlands, and the data will be combined with salinity isopleths derived from the hydrodynamic model to assist in determining potential impacts to these resources as a result of project alternatives. This study marks an important step in developing a comprehensive, detailed wetland map for the Cooper River, SC.

Introduction

The Charleston Harbor Post 45 feasibility study will analyze and evaluate improvements to the Charleston Harbor Navigation Channel. During this phase of study, the Harbor will be evaluated to identify the extent to which the array of alternatives will be applied to each reach of the Federal Navigation Channel. This process will include the appropriate level of engineering, economic, and environmental analyses to identify the possible benefits and impacts associated with the projected navigational improvements. Improvements being considered will be additional depth and other channel modifications. The US Army Corps of Engineers (USACE) is assessing potential impacts that the project may have on the resources in and around the Harbor, including potential changes in marsh ecosystems as a function of salinity changes.

In order to adequately assess potential impacts to marsh ecosystems near the Harbor, datasets illustrating wetland characterization are required. As such, existing datasets in the area were assessed especially for their use as a baseline for the prediction of project impacts and depiction of changes in wetland habitat composition. More specifically, the wetland characterization data will be used to help determine the transition from saltwater to brackish to freshwater wetlands, and will be used in conjunction with the Environmental Fluid Dynamics Code (EFDC) hydrodynamic model (a separate USACE study) to evaluate if and how channel improvements could impact these resources. The USACE determined, with guidance from their Interagency Coordination Team (ICT), that wetland mapping studies conducted by the South Carolina Department of Health & Environmental Control's Ocean & Coastal Resource Management (SCDHEC-OCRM) and The Citadel could be used to assist with baseline wetland characterization needs, extending from coastal South Carolina near Charleston, north to the freshwater impounded wetlands along the east and west branches of the Cooper River (Figure 1). However, the saltwater and freshwater systems mapped in those studies, respectively, left a section of the potentially impacted area unmapped by either study. Furthermore, evaluated datasets such as the U.S. Fish and Wildlife Service's National Wetlands Inventory and the U.S. Geological Survey's National Land Cover Data were considered inadequate by the ICT, for use as a baseline due to a variety of factors, such as spatial resolution and currentness requirements. Therefore, additional data resources were sought for wetland delineation and development of a complete, current, and thorough wetland characterization of the potentially impacted area along the Cooper River which could experience a shift in wetland structure. As such, recent WorldView-2 imagery, orthoimagery, and light detection and ranging (lidar) data were acquired and evaluated for the development of a wetland classification map in the designated area along the Cooper River, South Carolina to be consistent with classification schemas developed by the SCDHEC-OCRM and The Citadel. This report describes the data, methods, and results of the wetland classification work done to complete this task.

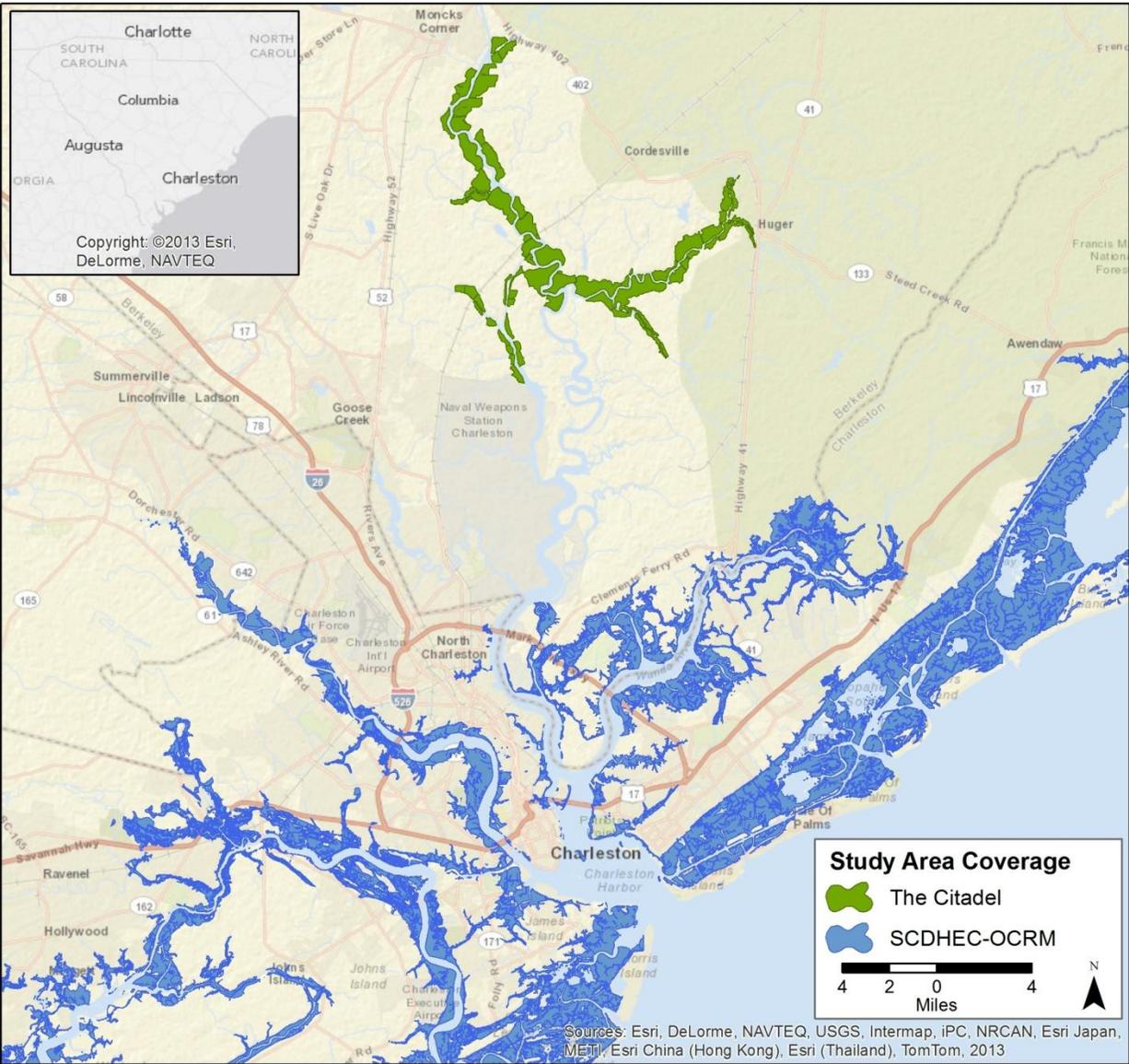


Figure 1. Coverage extent for The Citadel and South Carolina Department of Health & Environmental Control’s Ocean & Coastal Resource Management (SCDHEC-OCRM) wetland mapping studies.

Data and Study Site

Imagery and other datasets were provided by the Charleston District for evaluation and use in the development of an updated wetland classification map along the specified area of the Cooper River, SC. More specifically, the study area includes the section of the Cooper River between Goose Creek (southern limit) and the “T” (northern limit) where the east and west branches meet to form the main stem of the river (Figure 2). The datasets provided by the District for the study area included the following:

- Digital Globe WorldView-2 (WV-2) 8-band imagery (December 9, 2010 and May, 25, 2011); Figure 2

- National Agriculture Imagery Program (NAIP) orthoimagery (2011)
- U.S. Geological Survey (USGS) lidar bare earth elevation data (2011)
- SCDHEC-OCRM Critical Area Salt marsh Delineations data (2006)
- The Citadel Rice Field Study data (1989-2006)

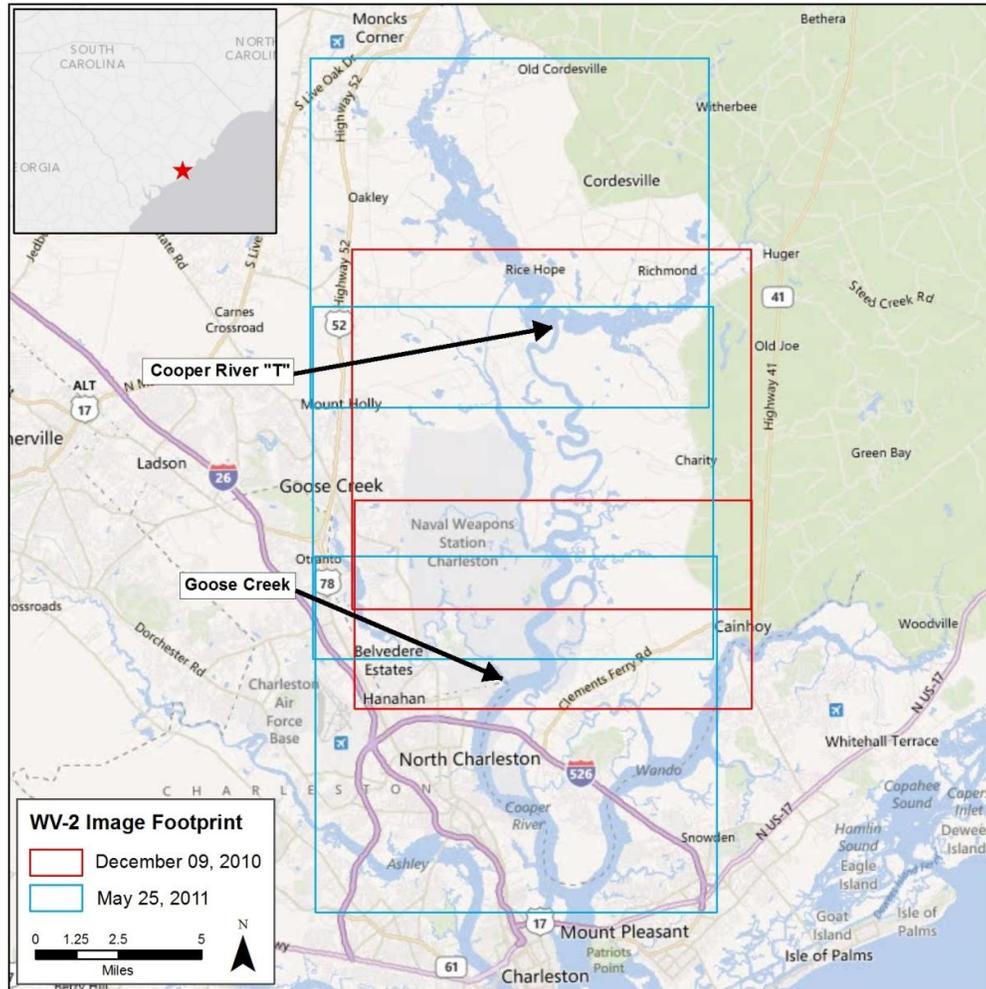


Figure 2. Location of the Cooper River study area between Goose Creek (southern limit) and the “T” (northern limit) and WV-2 image footprints.

SCDHEC-OCRM Critical Area Salt Marsh Delineations

SCDHEC-OCRM used aerial imagery (0.25-meter resolution South Carolina Department of Natural Resources’ digital orthophotography quarter-quarter quadrangle [DOQQQ]) to perform a high marsh and low marsh delineation of salt marsh habitat within designated critical areas (covering all of the Wando River, most of the Ashley River, and the lower part of the Cooper River up to Goose Creek, which is the upstream extent of the Federal Navigation Channel, Figure 1). Delineations of low and high marsh were based on visible spectral differences between the vegetation types:

- Low marsh (*Spartina alterniflora*)
- High marsh (*Juncus roemerianus*)

Citadel Rice Field Study

The Citadel study mapped tidal freshwater impounded wetlands (or rice fields) using color infrared DOQQs (1999, winter) to subset former rice fields, create community signatures for each field (groups of red-green-blue pixels within a community), and apply nearest neighbor classifications to map the extent of communities within the rest of a field. Other years were also classified for which aerial photography was available, including 1989, 1994 and 2006. The 2006 study area extended from the “T” on the Cooper River to areas along the east and west branches (Figure 1). Five communities were identified:

- Subtidal-open water submerged aquatic vegetation (SAV) (e.g., *Egeria*, *Cabomba*, *Hydrilla*, *Potamogeton*),
- Subtidal-emergent/floating leaf vegetation (FLV) (e.g., *Ludwigia*, *Eichornia*, *Polygonum*),
- Intertidal-emergent marsh (ITEM) (e.g., *Zizaniopsis*, *Pontederia*, *Scirpus*),
- Intertidal-developing swamp forest (DSF) (e.g., *Acer*, *Salix*, *Nyssa*, with ITEM), and
- Intertidal-swamp forest (SF) (e.g., *Acer*, *Salix*, *Nyssa*)

With regards to the two studies mentioned above, the new mapping study was developed such that the wetland classification schema could be easily cross-walked or translated to the schema in either study, and thus, could be combined for a seamlessly integrated wetland classification map covering the potentially impacted area along the Cooper River. For the new mapping effort, the primary data used to delineate wetland habitats were the WV-2 imagery (2010-2011). Ancillary data used to support the mapping effort included the two studies described above as well as NAIP orthoimagery (2011-2012). Lidar data were not utilized in the classification effort because classification of lidar point data for vegetation analysis was not complete at the time of this study. Only bare earth digital elevation models were complete, which do not provide information for discriminating vegetation height. The classification schema evaluated for this study was the Cowardin et al. (1979) classification system:

- Water
- Unconsolidated Bottom
 - Exposed Mudflat
 - Oyster bar
- **Marine/Estuarine** (Salinity over 5 ppt)
 - Polyhaline (18 – 35 ppt) and Mesohaline (5 – 18 ppt)
 - Non-forested low marsh
 - Tall Creekside Smooth Cordgrass (*Spartina alterniflora*)
 - Intermediate Smooth Cordgrass (*Spartina alterniflora*)
 - Non-forested high marsh
 - Black Needlerush (*Juncus roemerianus*)
 - Pickle Weed (*Salicornia*)
 - Short Smooth Cordgrass (*Spartina alterniflora*)
 - *Boricchia*, *Spartina patens*, Goldenrod, sea pink (Mark Caldwell, USFWS, personal communication 19January2012)
- **Brackish Marshes** (Salinity between 0.5 and 5.0 ppt)
 - Oligohaline (0.5 – 5.0 ppt)
 - Lowest Zones

- Big Cordgrass (*Spartina cynosuroides*)
 - Black Needlerush (*Juncus roemarianus*)
 - *Pontedaria cordata* (Statler 1973)
 - *Scirpus validus* (Statler 1973)
 - Also find *Hymenocallis crassifolia*, *Zizaniopsis miliacea*, *Alternanthera philoxeroides*, *Amaranthus cannabinus*, *Cladium jamaicense*, *Typha angustifolia*, *Eleocharis spp.*, *Pluchea spp.*, *Ludwigia spp.*, *Cicuta maculate*, *Ptilimnium capillaceum*, *Hibiscus spp.* (Statler 1973)
- **Freshwater Marshes** (Salinity less than 0.5 ppt)
 - Riverine/Lacustrine/Palustrine Wetlands
 - Forested Wetland
 - Bottomland Hardwood [Bald Cypress (*Taxiodum distichum*), Swamp Tupelo (*Nyssa Aquatica*), Red Maple (*Acer rubrum*), Oak (*Quercus spp.*), Saw Palmetto (*Serenoa*)]
 - Non-forested Wetland
 - Persistent/non-persistent emergent marsh [Cattails (*typha spp.*), waterlilies (*Nymphaeaceae spp.*)]
 - *Zizaniopsis miliacea*, *Pontedaria cordata*, *Saururus cernus*, *Alternanthera philoxeroides*, and *Ludwigia spp.* (Statler 1973)

The modified classification system developed for this study, and based on the Citadel classification scheme, is as follows:

1. **Woody Mix** (consistent with classes, Intertidal-Developing Swamp Forest [DSF] (e.g., *Acer*, *Salix*, *Nyssa*, with ITEM) and Intertidal-Swamp Forest [SF] (e.g., *Acer*, *Salix*, *Nyssa*), in The Citadel Study, and Freshwater Forested Wetlands, in Cowardin et al., (1979))
 - a. Includes low-lying wetland and non-wetland forest species and woody shrubs/small trees, such as wax myrtle (*Myrica cerifera*) and button bush (*Cephalanthus occidentalis*)
2. **Submerged Aquatic Vegetation** (consistent with class, Subtidal-Open Water Submerged Aquatic Vegetation [SAV] (e.g., *Egeria*, *Cabomba*, *Hydrilla*, *Potamogeton*), in the Citadel Study)
 - a. Primary species: *Hydrilla verticillata*, *potamogeton sp.* and *cabomba sp.*
3. **Floating Leaf Vegetation** (consistent with classes, Subtidal-Emergent/Floating Leaf Vegetation [FLV] (e.g., *Ludwigia*, *Eichornia*, *Polygonum*), and Freshwater Non-Forested Wetland Persistent/Non-Persistent Emergent Marsh, in Cowardin et al. (1979))
 - a. Primary species: water-primrose (*Ludwigia sp.*), water hyacinth (*Eichornia sp.*), pickerel weed (*Pontederia sp.*) and smartweed (*Polygonum sp.*)
4. **Intertidal-Emergent Marsh (ITEM) Freshwater Mix** (consistent with classes, Intertidal-Emergent Marsh [ITEM], in The Citadel Study, and Freshwater Non-Forested Wetland Persistent/Non-Persistent Emergent Marsh, in Cowardin et al. (1979))
 - a. Primary/Mix species: white marsh/cutgrass (*Zizaniopsis miliacea*), wild rice (*Zyzania aquatica*), sawgrass (*Cladium sp.*) and bulrush (*Scirpus sp.*)
 - b. Understory species (including but not limited to): green arrow arum (*Peltandra virginica*), water-primrose (*Ludwigia sp.*), water hyacinth (*Eichhornia sp.*), pickerel weed (*Pontederia sp.*), sensitive fern (*Onoclea sensibilis*), arrowhead/duck potato (*Sagittaria sp.*), water hemlock (*Cicuta sp.*), lizard's tail (*Saururus cernuus*), alligator weed (*Alternanthera philoxeroides*), obedient plant (*Physostegia virginiana*), spider lily (*Lycoris*)

radiata), smartweed (*Polygonum sp.*), beard grass (*Andropogon sp.*), false indigo (*Amorpha sp.*) and groundnut (*Apios americana*)

5. **Intertidal-Emergent Marsh (ITEM) Freshwater Mix with Big Cordgrass and/or Cattail** (consistent with classes, Intertidal-Emergent Marsh [ITEM], in The Citadel Study, and Freshwater Non-Forested Wetland Persistent/Non-Persistent Emergent Marsh, in Cowardin et al. (1979))
 - a. Primary/Mix species: big cordgrass (*Spartina cynosuroides*), cattail (*Typha sp.*), white marsh/cutgrass (*Zizaniopsis miliacea*), wild rice (*Zyzania aquatica*), sawgrass (*Cladium sp.*) and bulrush (*Scirpus sp.*)
 - b. Understory species (same as in ITEM Freshwater Mix)
 - c. Note: This class was distinguished from ITEM Freshwater Mix to denote the presence of salt tolerant species, big cordgrass (*Spartina cynosuroides*) and cattail (*Typha sp.*). Due to isolated areas of higher elevation and/or historic rice field diking, these species are sometimes present in primarily freshwater areas.
6. **Intertidal-Emergent Marsh (ITEM) Big Cordgrass Dominant** (consistent with class, Brackish Lowest Zones Marsh, in Cowardin et al. (1979))
 - a. Primary species: big cordgrass (*Spartina cynosuroides*)
7. **Intertidal-Emergent Marsh (ITEM) Big Cordgrass Mix** (consistent with class, Brackish Lowest Zones Marsh, in Cowardin et al. (1979))
 - a. Primary species: big cordgrass (*Spartina cynosuroides*)
 - b. Mix species (including but not limited to): white marsh/cutgrass (*Zizaniopsis miliacea*), wild rice (*Zyzania aquatica*), sawgrass (*Cladium sp.*), bulrush (*Scirpus sp.*), cattail (*Typha sp.*) and black needlerush (*Juncus roemarianus*)
 - c. Understory species (same as in ITEM Freshwater Mix)
8. **Intertidal-Emergent Marsh (ITEM) Black Needlerush Dominant** (consistent with classes, High Marsh, in the SCDHEC-OCRM Study, and Marine/Estuarine Non-Forested High Marsh and Brackish Lowest Zones Marsh, in Cowardin et al. (1979))
 - a. Primary species: black needlerush (*Juncus roemarianus*)
9. **Intertidal-Emergent Marsh (ITEM) Black Needlerush Mix** (consistent with classes, High Marsh, in the SCDHEC-OCRM Study, and Marine/Estuarine Non-Forested High Marsh and Brackish Lowest Zones Marsh, in Cowardin et al. (1979))
 - a. Primary species: black needlerush (*Juncus roemarianus*)
 - b. Mix species (including but not limited to): big cordgrass (*Spartina cynosuroides*), bulrush (*Scirpus sp.*), cattail (*Typha sp.*) and smooth cordgrass (*Spartina alterniflora*)
 - c. Understory species (same as in ITEM Freshwater Mix)
10. **Intertidal-Emergent Marsh (ITEM) Cattail Dominant** (consistent with class, Freshwater Non-forested Wetland Persistent/Non-Persistent Emergent Marsh, in Cowardin et al. (1979))
 - a. Primary species: broadleaf cattail (*Typha latifolia*) and narrowleaf cattail (*Typha angustifolia*)
 - b. Understory species (including but not limited to): black needlerush (*Juncus roemarianus*), big cordgrass (*Spartina cynosuroides*), white marsh/cutgrass (*Zizaniopsis miliacea*), sawgrass (*Cladium sp.*) and other understory species listed in ITEM Freshwater Mix
11. **Intertidal-Emergent Marsh (ITEM) Smooth Cordgrass Dominant** (consistent with classes, Low Marsh, in the SCDHEC-OCRM Study, and Marine/Estuarine Non-Forested High Marsh and Non-Forested Low Marsh, in Cowardin et al. (1979))
 - a. Primary species: smooth cordgrass (*Spartina alterniflora*)

12. **Intertidal-Emergent Marsh (ITEM) Smooth Cordgrass Mix** (consistent with classes, Low Marsh, in the SCDHEC-OCRM Study, and Marine/Estuarine Non-Forested High Marsh and Non-Forested Low Marsh, in Cowardin et al. (1979))
 - a. Primary species: smooth cordgrass (*Spartina alterniflora*)
 - b. Mix species: black needlerush (*Juncus roemarianus*), bulrush (*Scirpus sp.*) and big cordgrass (*Spartina cynosuroides*)
13. **Urban/Field/Bare Soil**
 - a. Non-vegetated areas
14. **CDF Vegetation/Common Reed**
 - a. Vegetation found in three Confined Disposal Facilities (southern end of study area), as well as common reed (*Phragmites australis*)

Field Data Collection

Two field surveys of the study area were conducted, December 3-6, 2012 and June 4-6, 2013, to collect site data for use in training (supervised classification) and validation (accuracy assessment) to correspond with the December and May seasonal timeframes of the historic WV-2 imagery. This was especially important for minimizing seasonal differences between field and image data despite the annual differences (Gilmore et al., 2008). In the December site visit, a total of 82 unique locations were visited via boat access from the main stem, and some tributaries, of the Cooper River. The majority of the sites were pre-selected to ensure that different marsh communities throughout the study area were visited. The field team consisted of USACE personnel and local plant experts. The following information was collected:

- latitude and longitude using a Trimble GeoXH 6000,
- dominant wetland plant species within a 1-meter area as determined by a local wetland plant specialist,
- spectral reflectance of the dominant plant species using an ASD FieldSpec Handheld 2 spectroradiometer (visible to near-infrared), and
- GPS tagged photographs using a Ricoh 500se camera with the SE2c GPS Antenna

Of particular importance in the field data collection was the measurement of reflectance spectra. These measurements are generally useful for supervised classification approaches in which they can be directly or indirectly used to help train the image and establish class statistics to identify pixels throughout the image displaying similar spectral characteristics as the established “regions of interest”. Field measurements were made with an ASD FieldSpec Handheld 2 spectroradiometer (Analytical Spectral Devices, Boulder, CO). The instrument measures reflectance in the wavelength range of 325 – 1075 nanometers (nm) with a spectral resolution of 3 nm and a wavelength accuracy of ± 1 nm. Two to three measurements were made at each site, focusing on various target canopy reflections, using a 10° field of view fore optic attachment. Each reflectance spectra was calibrated and normalized using the systems Optimization process and white Spectralon reference panel (to maximize the signal-to-noise ratio, reduce impacts from changing illumination conditions and create a baseline measurement). Reflectance spectra of the canopy were collected at each site in the December field campaign to establish field spectra for all of the major wetland class types (classes 2 – 12, excluding woody mix, urban/field/bare

soil, and CDF vegetation/common reed). Spectra were measured by hand-positioning the instrument's fore optic approximately 4 inches above the white reference panel (at nadir) and then collecting target canopy spectra within 1-meter of the species canopy. Targets were positioned in typical configuration, between the instrument and the sun, for full illumination and minimizing shadow. In some cases, plant height prohibited nadir viewing, so measurements were made at an oblique viewing angle. Depending on canopy density, some spectral measurements included background signatures from water and soil. Where possible, measurements were made in full sun conditions \pm 2 hours within solar noon. Understory species were minimized where possible to capture the dominant species type. To better compare field spectra to the WV-2 imagery, the spectra were post-processed in Exelis Visual Information Solutions ENVI 5.0 remote sensing software and resampled to match the 8-band configuration of the WV-2 imagery. Band intervals for WV-2 are as follows:

- band 1 (coastal): 400-450nm
- band 2 (blue): 450-510nm
- band 3 (green) 510-580nm
- band 4 (yellow): 585-625nm
- band 5 (red): 630-690nm
- band 6 (red edge): 705-745nm
- band 7 (Near-Infrared 1): 770-895nm
- band 8 (Near-Infrared 2): 860-1040nm

A second field survey was conducted June 4-6, 2013 to collect additional site data to further improve a draft classification map as well as collect site data for use in validation. The primary purpose of the field effort was to collect GPS locations, photographs and plant type at selected sites accessible by boat within the study area. The same field team conducted the field survey as in the December survey and a total of 136 unique locations were visited throughout the study area. Of those sites, 96 were set aside for validation, while the remaining sites were used to help improve the draft classification map. All points were assigned to one of the 14 classes previously described and only wetland sites were visited (classes 2 – 12, excluding woody mix, urban/field/bare soil, and CDF vegetation/common reed). Figure 3 illustrates the primary sites used for training, while Figure 4 illustrates the sites used for validation. Appendix A lists the sites visited during the two field campaigns and detailed information, such as plant species and conditions observed.

**Wetland Classification: Cooper River, South Carolina
Training Sites, December 3-6, 2012 and June 4-6, 2013**

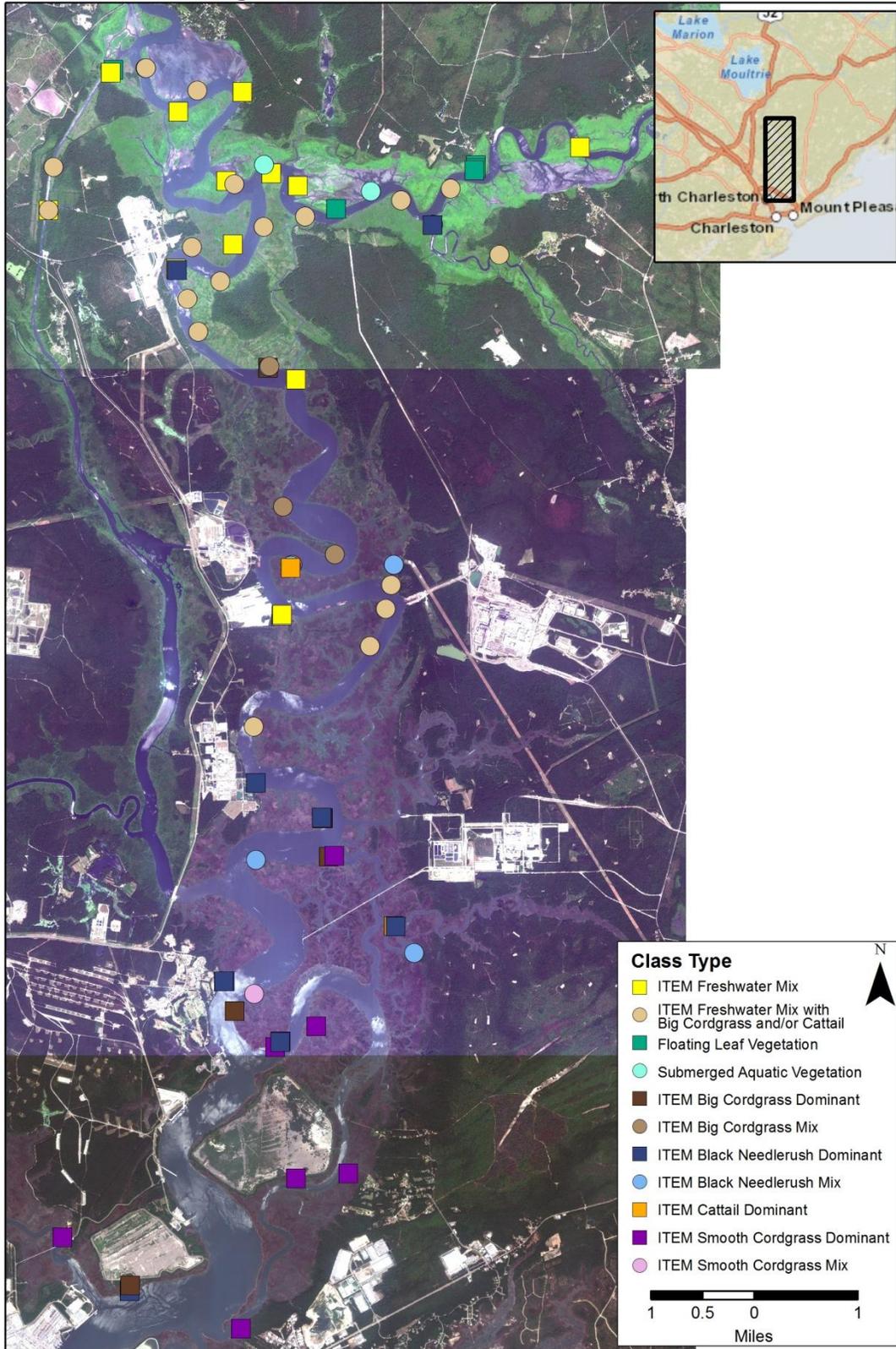


Figure 3. WV-2 image scenes and sites collected for image classification and training.

**Wetland Classification: Cooper River, South Carolina
Validation Sites, June 4-6, 2013**

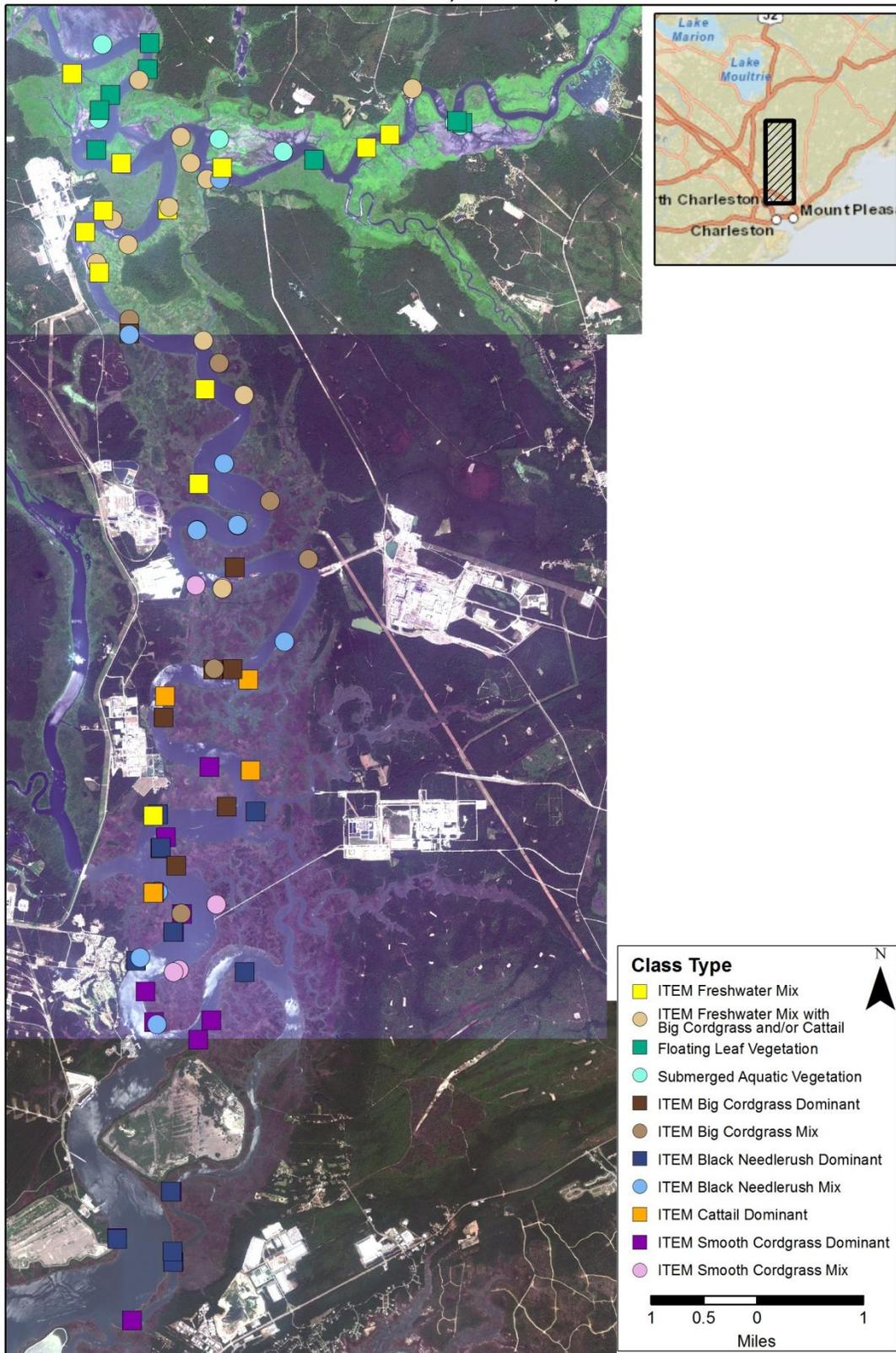


Figure 4. WV-2 image scenes and sites collected for validation.

Methods

Image Pre-Processing

High resolution, 8-band WV-2 multispectral imagery was provided by the Charleston District for the study area on 2 dates: December 9, 2010 (two scenes) and May 25, 2011 (three scenes). Scenes were delivered in geocorrected format in which individual scenes were geometrically corrected (orthorectified) to control points using the WV-2 RPC geometric model in ERDAS Imagine software using the U.S. Geological Survey's National Elevation Dataset for the elevation information. Image scenes were provided in the projection, NAD 1983 State Plane South Carolina FIPS 3900 Feet International, with 8-foot spatial resolution. Although the scenes ranged over a year time period and were acquired 2 to 3 years prior to field sampling, the seasonal timeframe (month/day) was considered more important for capturing seasonal spectral variability than interannual changes, which are noted to be minimal in the study area during this time period. However, care was taken to minimize the potential impact of interannual changes during the image analysis by comparing target field spectra to image spectra and concentrating image training to areas/pixels that exhibited minimal spectral differences.

In order to facilitate image scene comparison and comparison of field spectra, the WV-2 scenes required radiometric calibration and atmospheric processing. This is an important pre-processing step because in order to analyze surface reflectance in an image, the influence of the atmosphere collected during image acquisition must be minimized or removed. Images are delivered in raw digital number format and are converted to radiance using calibration factors provided in the WV-2 metadata files. The radiometric calibration step to convert digital numbers to radiance values attempts to remove errors and artifacts associated with sensor defects, scan angle variations, non-uniformity of digital numbers and system "noise". ENVI's Radiometric Calibration tool was used to convert the image to top-of-atmosphere spectral radiance values using the metadata file, as well as gains and offsets (or, variability in electronic response defined by "gain and offset") which were calculated for each band (gains = $\text{absCalFactor}/\text{bandwidth}$ while offsets are 0). Then, the calibrated image was converted to reflectance to further remove atmospheric effects, such as absorption and scattering. The Atmospheric Correction Module in ENVI 5.0 was used to carry out the reflectance conversion using the QUick Atmospheric Correction (QUAC) tool developed by Spectral Sciences, Inc. The QUAC is an atmospheric correction method for multi- and hyperspectral imagery that determines atmospheric compensation parameters directly from the image scene (observed pixel spectra) and bases the finding that the average reflectance of a collection of diverse material spectra is scene-dependent. Reflectance conversions were performed on all 5 image scenes to pre-process scenes for the image classification analysis.

Before a supervised classification approach was attempted, it was determined that the amount of image scene could be reduced to increase image processing efficiency (i.e. the entire scene did not require classification). Therefore, the bare earth digital elevation models (DEMs) developed by the U.S. Geological Survey and provided by the Charleston District were used to help limit the geographic extent of the study area. It was also observed in The Citadel and the SCDHEC-OCRM wetland mapping studies that their geographic extents were limited to low-lying coastal and riverine areas. Therefore, a threshold of <15ft was created to subset the DEM and make an analysis mask to clip the WV-2 image scenes,

thereby reducing the amount of scene to analyze. In addition, since only vegetated areas required classification, the scenes were further reduced to mask non-vegetated pixels using a Normalized Difference Vegetation Index (NDVI). The NDVI ratio is a commonly used band ratio to isolate healthy, green vegetation from other materials that do not reflect in the near-infrared part of the electromagnetic spectrum (Tucker, 1979). It is calculated by dividing the difference in the near-infrared (WV-2 band 8, Near-Infrared 2) and red (WV-2 band 5) bands by the sum of the NIR2 and red bands for each pixel. Values range from -1 to 1, with higher values representing vegetation. Generally, in the 5 WV-2 scenes the crude estimate of vegetation was determined by selecting NDVI values above 0.32 to 0.35, depending on the scene. By further reducing the low-lying image areas to mostly vegetation, image statistics and analysis could be further focused to the pixels of interest. Because this is a crude estimate of vegetation and a liberal threshold value was chosen (to be more inclusive of vegetated areas), some field, bare soil, and urban pixels were left in the image scenes and thus, a separate class was created to capture those non-vegetation pixels (class 13).

Classification

The purpose of a supervised classification is to rapidly identify different materials or habitat types in an image over a large area based on training sites as the basis for the classification. Specified pixels in a training site are evaluated, while remaining pixels are then assigned to a matching or corresponding class based on statistics. In the ENVI 5.0 software, a spectral library was created of all the representative target canopy spectra to compare with the WV-2 image scenes. Recall from the previous section that field spectra were resampled to match the WV-2 band configuration to facilitate comparison. Since the spectra were collected during the December field campaign, they were compared with the December WV-2 image scenes. Given that the field spectra were collected 2 years after the imagery was collected, it was decided not to use them directly in a supervised classification; however, the spectral plots were used to select appropriate pixels and groups of pixels as “regions of interest” or ROIs to help train the image classifier. More specifically, the field spectral plots were directly compared with image derived spectral plots for the same site to determine if vegetation characteristics had changed or stayed the same. In cases where the two spectral plots lined up well, the pixels for that site were determined to be a suitable ROI for that class. For example, Figure 5 shows good agreement between comparisons of field versus image spectra for site 81 (black needlerush, *Juncus roemerianus*) and site 31-1 (white marsh/cutgrass, *Zizaniopsis miliacea* and sawgrass (*Cladium sp.*)).

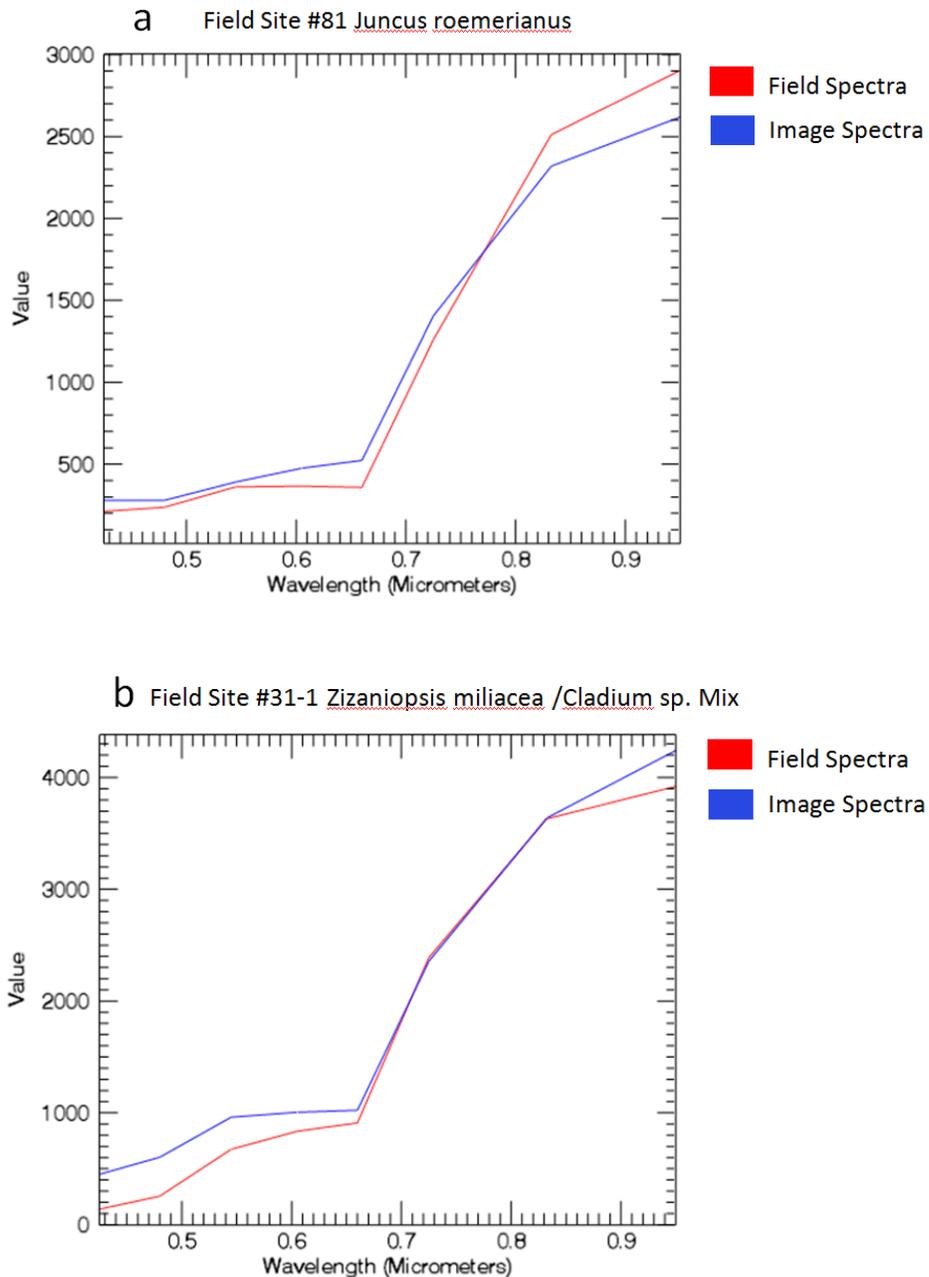


Figure 5. Spectral plot comparisons of field versus image spectra for a) site 81 (black needlerush, *Juncus roemerianus*) and b) site 31-1 (white marsh/cutgrass, *Zizaniopsis miliacea* and sawgrass, *Cladium* sp.)

ENVI's Classification Workflow tool was used to compare a variety of supervised classification techniques (Maximum Likelihood, Minimum Distance, Mahalanobis Distance and Spectral Angle Mapper). This tool also allows the user to create ROIs to train the classifier. Once field spectra were compared to the image spectra, representative groups of pixels were manually delineated in the ROI tool for each December image scene. The software recommends that at least 3 ROIs per class are delineated for a representative sample; however, given the large geographic area and variability in the WV-2 scenes, typically 10 or more ROIs were delineated throughout the image scene per class. In cases,

where there was a wide range of variability within one class, multiple classes were created to represent that class. For example, ITEM Big Cordgrass Dominant displayed a wide range of variability in a given scene, especially in the north-south direction where salinity regimes are noticeably different, and thus, the vegetation reflectance is likewise different. Therefore, more than one class was sometimes needed to spectrally separate that class from others. The Maximum Likelihood classification technique was selected for use as it is the most commonly used classification method in remote sensing image analysis (Foody, 1992). It assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a particular class (Lillesand, 2008). Therefore, the distribution of a class response pattern is described by a mean vector and thus, given those parameters a statistical probability can be computed for each pixel to determine the most suitable class with the highest probability value. Once the classification process was complete, post-processing was performed to “smooth” the result. Due to the high amount of spectral variability in an image scene, classification results often display a salt and pepper appearance. Therefore, a majority filter can be applied to remove isolated pixels and show the dominant class. In this approach, a 3x3 moving window (3x3 pixels) was passed over the classification result and in each 3x3 neighborhood the majority class was determined and when the central pixel was not the majority class, its value was changed to that class value. A draft classification map was generated using the Maximum Likelihood classifier and the two December image scenes. The results for the two scenes were merged using ESRI’s ArcGIS 10.0 software for a single classification grid file.

The draft map was reviewed by the Charleston District prior to the June field campaign and it was determined that there was some confusion between big and smooth cordgrass classes as well as some of the freshwater vegetation types. Therefore, additional sites were collected in the central and northern parts of the study area in brackish to freshwater areas to help improve the classification results. Additional field spectra were not collected; however, targeted site collection and image-derived ROIs were used to update and improve the classification result. The 3 May scenes were processed using the same classification method with new ROIs in areas that required targeted improvements as well as previously selected ROIs from the December image analysis. The final classification result is a combination of December and May image analysis with notable updates and improvements derived from the May imagery, especially in cases of class confusion.

Results

The final wetland classification result of the study area is shown in Figure 6. Appendix B includes a zoomed-in map series of the study area to show classification detail. Table 1 lists the individual classes and corresponding area statistics for each class. The table includes the class name, class code, area in square kilometers and acres, as well as percent cover (standardized by the total area classified, or 54,801.77 acres) and percent wetland cover (standardized by the total area of wetland classes, excluding woody mix, class codes 2 – 12, or 19,544.01 acres). Figure 7 graphically depicts the area distribution represented in the percent cover column in Table 1. The woody mix class made up about 46% of the mapped study area, while Urban/Field/Bare Soil and CDF Vegetation/Common Reed classes made up 12.5% and 6%, respectively. For a better illustration of the wetland class distribution (class

codes 2 – 12), the wetland class areas were standardized by the total area of wetlands mapped, excluding woody mix, which includes both low-lying wetland and non-wetland forest. Percent wetland cover in Table 1 is also graphically illustrated in Figure 8. ITEM Smooth Cordgrass Dominant and Mix classes make up 31% of the wetland area, accounting for most of the wetland area in the southern part of the study area. ITEM Black Needlerush Dominant and Mix classes combine to almost 23% as the second most prevalent class combination, again dominating the southern part of the study area as well as some central areas and illustrating the progression of species moving north from saltwater to brackish conditions. ITEM Freshwater Mix and ITEM Freshwater Mix with Big Cordgrass and/or Cattail classes made up 18% and 13% of the wetland classes, respectively, illustrating the dominance of freshwater emergent marsh in the northern part of the study area as well as some central parts of the study and representing the transition from brackish to freshwater conditions. ITEM Big Cordgrass Dominant and Mix classes combined to almost 5% of the wetland class area, generally concentrated in the central part of the study area and some parts of the southern area as well, while Floating Leaf Vegetation and Submerged Aquatic Vegetation classes made up 6% and 4%, respectively, and were generally confined to the freshwater areas in the northern area and some central parts of the study area. ITEM Cattail Dominant made up only 0.05% of the wetland class area and was the least observed wetland class in the study area.

Table 1. Area statistics for the wetland classification map, Figure 6.

Class Name	Class Code	Area Km ²	Acres	% Cover	% Wetland Cover, Non-woody
Woody Mix	1	101.48	25,075.69	45.76%	n/a
ITEM Freshwater Mix	2	14.23	3,517.46	6.42%	18.00%
ITEM Freshwater Mix w/Big Cordgrass and/or Cattail	3	10.27	2,538.23	4.63%	12.99%
Floating Leaf Vegetation	4	4.70	1,160.17	2.12%	5.94%
Submerged Aquatic Vegetation	5	3.41	841.96	1.54%	4.31%
ITEM Big Cordgrass Dominant	6	1.18	292.82	0.53%	1.50%
ITEM Big Cordgrass Mix	7	2.61	645.85	1.18%	3.30%
ITEM Black Needlerush Dominant	8	13.09	3,235.51	5.90%	16.55%
ITEM Black Needlerush Mix	9	4.90	1,210.99	2.21%	6.20%
ITEM Cattail Dominant	10	0.04	10.37	0.02%	0.05%
ITEM Smooth Cordgrass Dominant	11	23.74	5,867.19	10.71%	30.02%
ITEM Smooth Cordgrass Mix	12	0.90	223.48	0.41%	1.14%
Urban/Field/Bare Soil	13	27.68	6,839.80	12.48%	n/a
CDF Vegetation/Common Reed	14	13.53	3,342.27	6.10%	n/a
TOTAL		221.77	54,801.77	100.00%	100%

**Wetland Classification: Cooper River, South Carolina
May 25, 2011 and December 9, 2010**

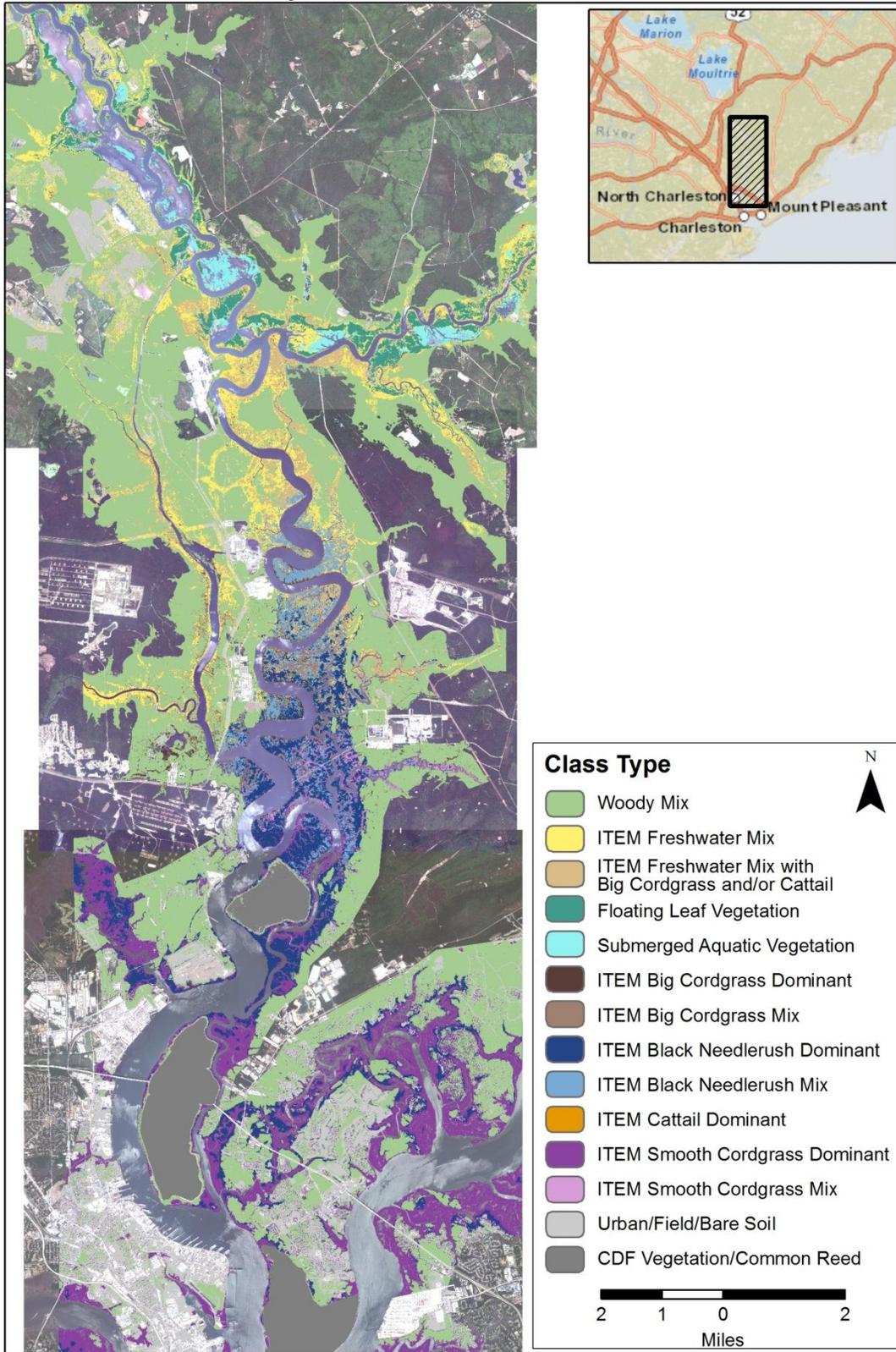


Figure 6. Final classification map using the May 2011 and December 2010 WV-2 imagery.

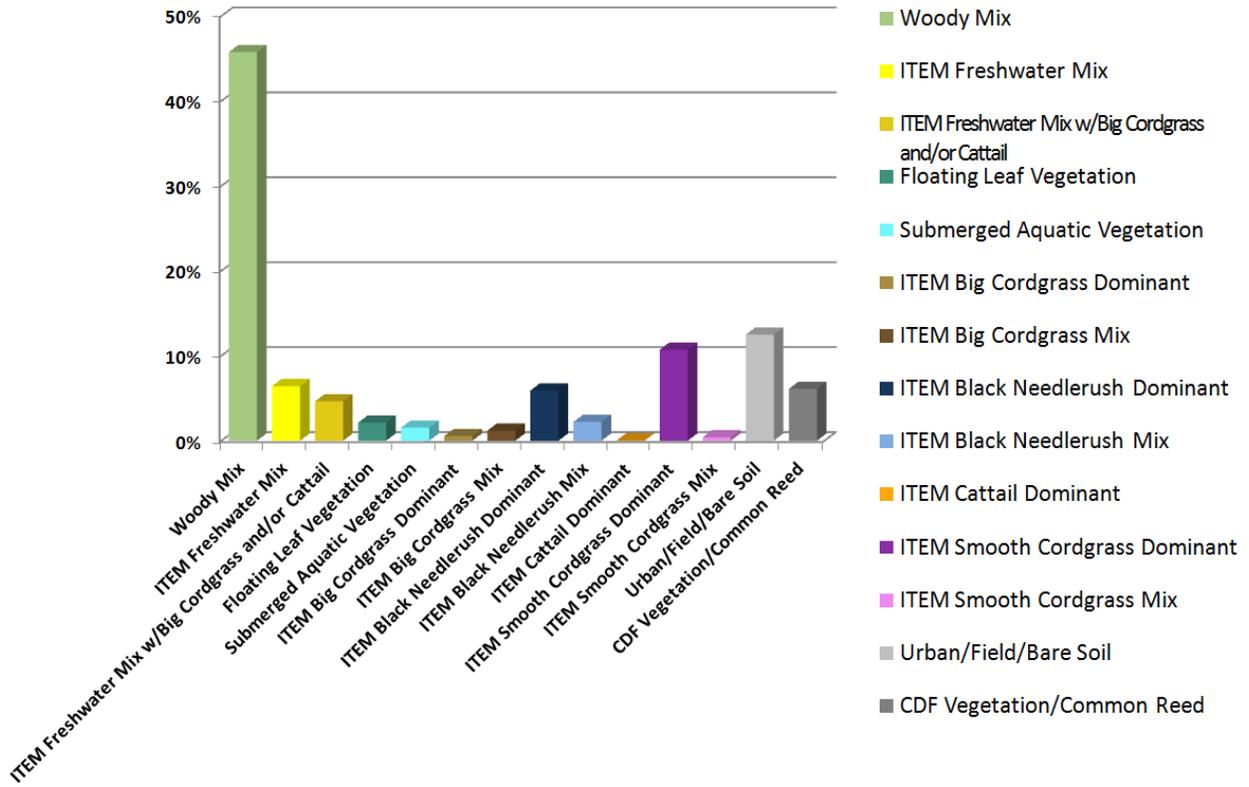


Figure 7. Area distribution per class displayed in Table 1.

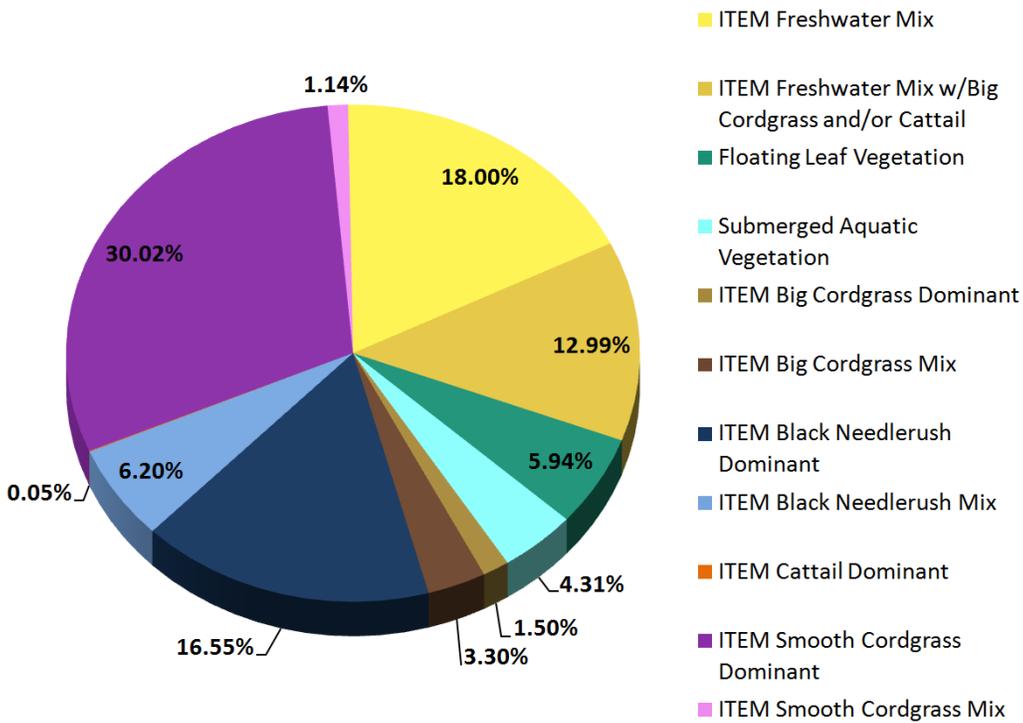


Figure 8. Area distribution of wetland classes (classes 2 – 12), excluding Woody Mix; Table 1.

Accuracy Assessment

As mentioned previously, 96 sites were set aside for validation, Figure 4. ENVI's Confusion Matrix tool was used to assess the accuracy of the wetland map results presented in Figure 6. A confusion, or error, matrix approach was used to accomplish this task. A confusion matrix compares the relationship between the classification map result to the reference or ground truth data on a class-by-class basis (Lillesand, 2008). In such a matrix, statistics for each class are reported as well as overall accuracy, producer and user accuracies, kappa coefficient and errors of commission and omission. It is particularly useful for determining how well a classification has identified a representative subset of pixels used in the training process (i.e. ROIs). Using the 96 sites set aside in the June field campaign, the wetland classification resulted in an overall accuracy of 81.25% (i.e. 78 sites out of 96 were correctly mapped) and a Kappa Coefficient of 0.79. The Kappa Coefficient is a statistical measure calculating the difference between the actual agreement between ground truth data and a classifier and the chance agreement between the two (Lillesand, 2008). Table 2 provides the pixel and percent details as determined by the confusion matrix analysis.

Table 2. Confusion matrix results.

Image Pixels (Code)	Ground Truth (Pixels)											Total
	2	3	4	5	6	7	8	9	10	11	12	
2	10	1	1	0	1	2	0	0	0	0	0	15
3	2	11	1	0	0	0	0	0	0	0	0	14
4	0	0	4	0	0	0	0	0	0	0	0	4
5	0	0	2	6	0	0	0	0	0	0	0	8
6	0	0	0	0	7	0	0	0	1	1	1	10
7	0	0	0	0	0	6	0	0	1	0	0	7
8	0	0	0	0	0	0	11	2	1	0	0	14
9	0	0	0	0	0	0	0	8	1	0	0	9
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	11	0	11
12	0	0	0	0	0	0	0	0	0	0	4	4
Total	12	12	8	6	8	8	11	10	4	12	5	96

Ground Truth (Percent)												
Image Pixels (Code)	2	3	4	5	6	7	8	9	10	11	12	Total
2	83.33	8.33	12.5	0	12.5	25	0	0	0	0	0	15.63
3	16.67	91.67	12.5	0	0	0	0	0	0	0	0	14.58
4	0	0	50	0	0	0	0	0	0	0	0	4.17
5	0	0	25	100	0	0	0	0	0	0	0	8.33
6	0	0	0	0	87.5	0	0	0	25	8.33	20	10.42
7	0	0	0	0	0	75	0	0	25	0	0	7.29
8	0	0	0	0	0	0	100	20	25	0	0	14.58
9	0	0	0	0	0	0	0	80	25	0	0	9.38
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	91.67	0	11.46
12	0	0	0	0	0	0	0	0	0	0	80	4.17
Total	100	100	100	100	100	100	100	100	100	100	100	100

Class Code	Commission (Percent)	Omission (Percent)	Commission (Pixels)	Omission (Pixels)	Producer Acc. (Percent)	User Acc. (Percent)	Producer Acc. (Pixels)	User Acc. (Pixels)
2	33.33	16.67	5/15	2/12	83.33	66.67	10/12	10/15
3	21.43	8.33	3/14	1/12	91.67	78.57	11/12	11/14
4	0	50	0/4	4/8	50	100	4/8	4/4
5	25	0	2/8	0/6	100	75	6/6	6/8
6	30	12.5	3/10	1/8	87.5	70	7/8	7/10
7	14.29	25	1/7	2/8	75	85.71	6/8	6/7
8	21.43	0	3/14	0/11	100	78.57	11/11	11/14
9	11.11	20	1/9	2/10	80	88.89	8/10	8/9
10	0	100	0/0	4/4	0	0	0/4	0/0
11	0	8.33	0/11	1/12	91.67	100	11/12	11/11
12	0	20	0/4	1/5	80	100	4/5	4/4

In Table 2, the top two segments (Ground Truth Pixels and Ground Truth Percent) report the individual class labels made by the classifier as compared to the validation sites (pixels). Note that validation site pixels that are correctly classified are located along the major diagonal of the matrix (from upper left to lower right). Likewise, the correctly mapped percents are located along the major diagonal, whereas the off-diagonal values represent errors in the classification. For example, in the Pixel table, first column (class 2), 10 sites were labeled as class 2, while 2 sites were labeled as class 3 (error or omission, or validation site pixel failing to be properly classified). In contrast, for the rows, class 2 had 10 site pixels correctly identified by the classifier as class 2, while a total of 5 site pixels were incorrectly identified or included in class 2: 1 site pixel from classes 3, 4 and 6 and 2 site pixels from class 7 (error of commission, or site pixel belonging to another class that was incorrectly labeled as belonging to that class). In the

bottom table, errors of commission and omission and producer and user's accuracies are listed for site pixels and percents. For example, as noted above, 5 site pixels were incorrectly labeled as class 2, totaling 15 sites labeled as that class; 5 divided by 15 times 100 results in a commission error of 33.33%. In contrast, the error of omission (16.67%) illustrates that 2 site pixels were incorrectly omitted from that class and assigned to class 3. Lastly, Producer Accuracy illustrates the number of correctly identified validation site pixels divided by the total number of validation site pixels for that class (class 2 had 10 of 12 validation site pixels correctly mapped and thus, a Producer Accuracy of 83.33%), while User Accuracy illustrates the number of correctly identified site pixels divided by the total number of pixels assigned to that class (class 2 had 10 of 15 total site pixels correctly mapped and thus, a User Accuracy of 66.67%).

With the exception of Floating Leaf Vegetation (class 4) and ITEM Cattail Dominant (class 10), all classes had Producer Accuracies above 75%, illustrating that the majority of validation sites were correctly mapped by the classifier. Furthermore, ITEM Freshwater Mix with Big Cordgrass and/or Cattail, Submerged Aquatic Vegetation, ITEM Black Needlerush Dominant and ITEM Smooth Cordgrass Dominant had Producer Accuracies above 90%, noting very high accuracy for those particular sites. In contrast, only 50% of Floating Leaf Vegetation (class 4) and none of the ITEM Cattail Dominant (class 10) validation sites were correctly mapped. For Floating Leaf Vegetation, the lower accuracy could be explained by the varying nature of factors that control their distribution and abundance. Recall that validation sites were collected 2 and 3 years after image acquisition. This particular class may be more variable in its distribution and abundance given the changeable nature of water depth, tides and flooding in the study area. Four of the validation sites in this class were confused with other freshwater classes, including Submerged Aquatic Vegetation, ITEM Freshwater Mix and ITEM Freshwater Mix with Big Cordgrass and/or Cattail. In contrast, the 0% accuracy for ITEM Cattail Dominant sites may be explained by a different reason. In general, this class type was not common in the study area, nor was it observed in dense stands in the field surveys as much as other class types. Thus, only 4 validation sites were collected. Typically, cattail stands were sparse enough such that understory species could have influenced spectral signatures and corresponding class labeling. For example, cattail sites were sometimes mixed with black needlerush which has a very distinct spectral signature and could be the reason why 2 of the 4 sites were labeled as ITEM Black Needlerush Dominant and Mix classes. In addition, cattail is similarly tall and often mixed with big cordgrass, which might explain why the other 2 sites were labeled as ITEM Big Cordgrass Dominant and Mix classes.

Some classification confusion is observed between the ITEM Freshwater Mix and ITEM Freshwater Mix with Big Cordgrass and/or Cattail classes. Additionally, there is some confusion between those two classes and ITEM Big Cordgrass Dominant and Mix classes, in which 3 of those sites were assigned to the Freshwater classes. This is not surprising given the somewhat arbitrary class distinction between these 4 classes. Even in the field surveys, it was sometimes difficult to distinguish between the ITEM Freshwater Mix with Big Cordgrass and/or Cattail and ITEM Big Cordgrass Mix and that is likewise reflected in the classification error. However, freshwater understory species were consistently less prevalent in the ITEM Big Cordgrass classes, which was the primary indicator for the distinction. Some confusion generally occurs in all "Mix" classes, and changes in species composition can occur especially in heterogeneous

classes. These changes can play an important factor in classification determination and were minimized through seasonal timing of imagery and field surveys. Overall, it is noted that this study area has remained stable in its habitat patterns, and this is reflected in the visual similarity between overlapping areas in this new classification mapping result and the mapping studies conducted by The Citadel and SCDHEC-OCRM.

Conclusion

This study marks an important step in developing a comprehensive, detailed wetland map for the Cooper River, SC. In addition, it illustrates how broadly applicable field and geospatial techniques can be used to develop an accurate wetland classification. Furthermore, it also illustrates how detailed wetland classes can be derived from high-resolution, 8-band WV-2 imagery with repeatable methods. The Charleston District will use this data to determine the transitions from saltwater to brackish to freshwater wetlands, and the data will be combined with salinity isopleths derived from the hydrodynamic model to assist in determining potential impacts to these resources as a result of project alternatives. The high collection frequency of WV-2 imagery facilitates its use for repeat classification, and more importantly, for future monitoring of potential impacts and changes to these critical natural resources.

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Appendix A: Field Data

December 3-6, 2012

Site_Num	Veg Species	Notes
2	wax myrtle (<i>Myrica cerifera</i>)	mix of vegetation in developing swamp forest; no dominant species
2	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	mix of vegetation in developing swamp forest; no dominant species
2	beard grass (<i>Andropogon</i> sp.)	mix of vegetation in developing swamp forest; no dominant species
2	red maple (<i>Acer rubrum</i>)	mix of vegetation in developing swamp forest; no dominant species
2	willow (<i>Salix</i> sp.)	mix of vegetation in developing swamp forest; no dominant species
2	button bush (<i>Cephalanthus occidentalis</i>)	mix of vegetation in developing swamp forest; no dominant species
2	loblolly pine (<i>Pinus taeda</i>)	mix of vegetation in developing swamp forest; no dominant species
2-1	sensitive fern (<i>Onoclea sensibilis</i>)	background of dead marsh vegetation; some veg is laying down and dead
2-1	broadleaf cattail (<i>Typha latifolia</i>)	background of dead marsh vegetation; some veg is laying down and dead
2-1	tearthumb (<i>Polygonum</i> sp.)	background of dead marsh vegetation; some veg is laying down and dead
2-1	water-primrose (<i>Ludwigia</i> sp.)	background of dead marsh vegetation; some veg is laying down and dead
2-1	false indigo (<i>Amorpha</i> sp.)	background of dead marsh vegetation; some veg is laying down and dead
2-2	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	water hyacinth (<i>Eichhornia</i> sp.)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	<i>Polygonum</i> sp.	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	<i>Aster</i> sp.	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	false indigo (<i>Amorpha</i> sp.)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	cattail (<i>Typha</i> sp.)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	wax myrtle (<i>Myrica cerifera</i>)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	climbing hempweed (<i>Mikania scandens</i>)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	green arrow arum (<i>Peltandra virginica</i>)	mixed with other types listed for 2-2 about 5ft field of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg);
2-2	groundnut (<i>Apios americana</i>)	mixed with other types listed for 2-2
31	water hyacinth (<i>Eichhornia</i> sp.)	floating emergent mix of water hyacinth and water-primrose (<i>Ludwigia</i> sp.)

31	water-primrose (<i>Ludwigia</i> sp.)	floating emergent mix of water hyacinth and water-primrose (<i>Ludwigia</i> sp.)
31-1	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	large field of dense white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg) with very little mix of other types listed for 31-1
31-1	sawgrass (<i>Cladium</i> sp.)	large field of dense white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) (dominant veg) with very little mix of other types listed for 31-1
50	<i>Hydrilla verticillata</i>	barely emergent <i>Hydrilla verticillata</i> ; just at the surface
51	sawgrass (<i>Cladium</i> sp.)	fringing bank vegetation of sawgrass (<i>Cladium</i> sp.) and water-primrose (<i>Ludwigia</i> sp.) with occasional occurrence of other types listed for 51
51	water-primrose (<i>Ludwigia</i> sp.)	fringing bank vegetation of sawgrass (<i>Cladium</i> sp.) and water-primrose (<i>Ludwigia</i> sp.) with occasional occurrence of other types listed for 51
51	big cordgrass (<i>Spartina cynosuroides</i>)	fringing bank vegetation of sawgrass (<i>Cladium</i> sp.) and water-primrose (<i>Ludwigia</i> sp.) with occasional occurrence of other types listed for 51
52	wild rice (<i>Zizania aquatica</i>)	(<i>Ludwigia</i> sp.) with occasional occurrence of other types listed for 51
29	wild rice (<i>Zizania aquatica</i>)	small, sparse patch
29	water hyacinth (<i>Eichhornia</i> sp.)	wild rice (<i>Zizania aquatica</i>) with an understory of other types listed for 29
29	water-primrose (<i>Ludwigia</i> sp.)	wild rice (<i>Zizania aquatica</i>) with an understory of other types listed for 29
29-1	big cordgrass (<i>Spartina cynosuroides</i>)	fairly sparse, small patch; picture is right after the one of the rice mill - no field sheet photo
14	water hyacinth (<i>Eichhornia</i> sp.)	mostly dominant patch mixed and surrounded by other types listed for 14
14	water-primrose (<i>Ludwigia</i> sp.)	mostly dominant patch mixed and surrounded by other types listed for 14
14	<i>Polygonum</i> sp.	mostly dominant patch mixed and surrounded by other types listed for 14
14-1	<i>Polygonum</i> sp.	small patch just to the side of a small channel
14-2	water-primrose (<i>Ludwigia</i> sp.)	small patch just to the side of a small channel
53	bulrush (<i>Scirpus</i> sp.)	bulrush (<i>Scirpus</i> sp.) with understory of other types listed for 53; cattail (<i>Typha</i> sp.) mixed in about 30ft into marsh interior
53	water hyacinth (<i>Eichhornia</i> sp.)	bulrush (<i>Scirpus</i> sp.) with understory of other types listed for 53; cattail (<i>Typha</i> sp.) mixed in about 30ft into marsh interior
53	water-primrose (<i>Ludwigia</i> sp.)	bulrush (<i>Scirpus</i> sp.) with understory of other types listed for 53; cattail (<i>Typha</i> sp.) mixed in about 30ft into marsh interior
9	dead white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	potential start of transition from fresh to a little brackish with stressed, dead white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) by the "T"; mixed with other types listed for 9
9	<i>Aster</i> sp.	potential start of transition from fresh to a little brackish with stressed, dead white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) by the "T"; mixed with other types listed for 9
9	water-primrose (<i>Ludwigia</i> sp.)	potential start of transition from fresh to a little brackish with stressed, dead white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) by the "T"; mixed with other types listed for 9
10	smooth cordgrass (<i>Spartina alterniflora</i>)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior;
		dead veg laying down with scattered mix with other types listed for 10

10	dead bulrush (<i>Scirpus</i> sp.)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
10	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
10	cattail (<i>Typha</i> sp.)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
10	wild rice (<i>Zizania aquatica</i>)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
10	water-primrose (<i>Ludwigia</i> sp.)	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
10	Aster sp.	first sign of smooth cordgrass (<i>Spartina alterniflora</i>) (moving from north, fresh, south toward potential brackish) occurs about 10ft into marsh interior; dead veg laying down with scattered mix with other types listed for 10
28	black needlerush (<i>Juncus roemerianus</i>)	mostly a mix of black needlerush (<i>Juncus roemerianus</i>) and cattail (<i>Typha</i> sp.); some big cordgrass (<i>Spartina cynosuroides</i>) but dies out as moving toward interior
28	cattail (<i>Typha</i> sp.)	mostly a mix of black needlerush (<i>Juncus roemerianus</i>) and cattail (<i>Typha</i> sp.); some big cordgrass (<i>Spartina cynosuroides</i>) but dies out as moving toward interior
28	big cordgrass (<i>Spartina cynosuroides</i>)	mostly a mix of black needlerush (<i>Juncus roemerianus</i>) and cattail (<i>Typha</i> sp.); some big cordgrass (<i>Spartina cynosuroides</i>) but dies out as moving toward interior
56	big cordgrass (<i>Spartina cynosuroides</i>)	dominant big cordgrass (<i>Spartina cynosuroides</i>) with a little cattail (<i>Typha</i> sp.)
56	cattail (<i>Typha</i> sp.)	dominant big cordgrass (<i>Spartina cynosuroides</i>) with a little cattail (<i>Typha</i> sp.)
57-1	smooth cordgrass (<i>Spartina alterniflora</i>)	fringing on the bank; cypress tree on the fringe nearby; transitional with 57-2 and 57-3
57-2	black needlerush (<i>Juncus roemerianus</i>)	behind 57-1 as moving toward marsh interior
57-3	cattail (<i>Typha</i> sp.)	behind 57-2 as moving toward marsh interior; fairly dense patch with understory of <i>Polygonum</i> sp., water-primrose (<i>Ludwigia</i> sp.), black needlerush (<i>Juncus roemerianus</i>) and <i>Amaranthus</i> sp.; band of black needlerush (<i>Juncus roemerianus</i>) about 150ft into interior
58-1	smooth cordgrass (<i>Spartina alterniflora</i>)	fringing on the bank; some laying down
58-2	big cordgrass (<i>Spartina cynosuroides</i>)	patch behind 58-1 with some black needlerush (<i>Juncus roemerianus</i>) and trace amount of sawgrass (<i>Cladium</i> sp.)
58-3	black needlerush (<i>Juncus roemerianus</i>)	dominant patch with a little sawgrass (<i>Cladium</i> sp.)
59	black needlerush (<i>Juncus roemerianus</i>)	transitional marsh grass veg surrounded by maritime forest on both sides; marsh grass = dominant black needlerush (<i>Juncus roemerianus</i>) with some smooth cordgrass (<i>Spartina alterniflora</i>), sawgrass (<i>Cladium</i> sp.) and big cordgrass (<i>Spartina cynosuroides</i>); forest = mix of red cedar, sable palmetto, cypress, loblolly pine (<i>Pinus taeda</i>), popcorn, yaupon holly, goldenrod (<i>Solidago</i> sp.), etc; GPS taken with boat

		first sign of wild rice as heading north from brackish to more freshwater;
60	wild rice (<i>Zizania aquatica</i>)	small amount on the bank; mixed with a little bit of other types in 60
		first sign of wild rice as heading north from brackish to more freshwater;
	big cordgrass (<i>Spartina cynosuroides</i>)	small amount on the bank; mixed with a little bit of other types in 60
60	smooth cordgrass (<i>Spartina alterniflora</i>)	small amount fringing on the bank
61	black needlerush (<i>Juncus roemerianus</i>)	dominant, dense vegetation with a small amount of other types in 61
61	big cordgrass (<i>Spartina cynosuroides</i>)	dominant, dense vegetation with a small amount of other types in 61
61	goldenrod (<i>Solidago</i> sp.)	dominant, dense vegetation with a small amount of other types in 61
62	bald cypress (<i>Taxodium distichum</i>)	3 bald cypress (<i>Taxodium distichum</i>) trees on the bank; brackish marsh will result in a few trees along the bank
		fringing patch that transitions to other veg types listed for 63 (same as
63	smooth cordgrass (<i>Spartina alterniflora</i>)	zonation in site 57 series) as moving toward marsh interior
		fringing patch that transitions to other veg types listed for 63 (same as
63	big cordgrass (<i>Spartina cynosuroides</i>)	zonation in site 57 series) as moving toward marsh interior
		fringing patch that transitions to other veg types listed for 63 (same as
63	cattail (<i>Typha</i> sp.)	zonation in site 57 series) as moving toward marsh interior
		fringing patch that transitions to other veg types listed for 63 (same as
63	wild rice (<i>Zizania aquatica</i>)	zonation in site 57 series) as moving toward marsh interior
64	green arrow arum (<i>Peltandra virginica</i>)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	pickerel weed (<i>Pontederia</i> sp.)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	smooth cordgrass (<i>Spartina alterniflora</i>)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	wild rice (<i>Zizania aquatica</i>)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	water hyacinth (<i>Eichhornia</i> sp.)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	cattail (<i>Typha</i> sp.)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	sawgrass (<i>Cladium</i> sp.)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
64	water-primrose (<i>Ludwigia</i> sp.)	seen for the first time as moving north to fresh water; mixed with other types listed for 64
		transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis</i>
	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	<i>miliacea</i>) as moving north to fresh water; near the bank edge mixed with
30		other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away
		transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis</i>
	water-primrose (<i>Ludwigia</i> sp.)	<i>miliacea</i>) as moving north to fresh water; near the bank edge mixed with
30		other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away
		transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis</i>
	big cordgrass (<i>Spartina cynosuroides</i>)	<i>miliacea</i>) as moving north to fresh water; near the bank edge mixed with
30		other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away

30	sawgrass (<i>Cladium</i> sp.)	transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) as moving north to fresh water; near the bank edge mixed with other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away
30	cattail (<i>Typha</i> sp.)	transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) as moving north to fresh water; near the bank edge mixed with other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away
30	water hyacinth (<i>Eichhornia</i> sp.)	transitional area with first siting of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) as moving north to fresh water; near the bank edge mixed with other types in 30; bald cypress (<i>Taxodium distichum</i>) tree about 10ft away
30-1	black needlerush (<i>Juncus roemerianus</i>)	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	big cordgrass (<i>Spartina cynosuroides</i>)	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	<i>Smilax</i> sp.	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	<i>Polygonum</i> sp.	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	arrowhead/duck potato (<i>Sagittaria</i> sp.)	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	pond gum (<i>Nyssa biflora</i>)	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
30-1	bulrush (<i>Scirpus</i> sp.)	dominant patch with other species; walked back into marsh interior; mixed with other types listed for 30-1
65	black needlerush (<i>Juncus roemerianus</i>) ?	small form of black needlerush (<i>Juncus roemerianus</i>) ? laying down with exposed mud bottom
65-1	sawgrass (<i>Cladium</i> sp.)	patch of sawgrass with trace amount of goldenrod; about 20ft from tree line
65-1	goldenrod (<i>Solidago</i> sp.)	patch of sawgrass with trace amount of goldenrod; about 20ft from tree line
65-2	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	small, dominant patch next to tree line
66	sawgrass (<i>Cladium</i> sp.)	dominant patch with a little mix of other types in 66
66	water-primrose (<i>Ludwigia</i> sp.)	dominant patch with a little mix of other types in 66
66	<i>Aster</i> sp.	dominant patch with a little mix of other types in 66
66-1	black needlerush (<i>Juncus roemerianus</i>)	dominant patch with small amount of other types in 66-1; walked into marsh interior about 30ft from site 66
66-1	<i>Polygonum</i> sp.	dominant patch with small amount of other types in 66-1; walked into marsh interior about 30ft from site 66
66-1	<i>Aster</i> sp.	dominant patch with small amount of other types in 66-1; walked into marsh interior about 30ft from site 66
67	big cordgrass (<i>Spartina cynosuroides</i>)	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	<i>Aster</i> sp.	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	water-primrose (<i>Ludwigia</i> sp.)	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	arrowhead/duck potato (<i>Sagittaria</i> sp.)	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	green arrow arum (<i>Peltandra virginica</i>)	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	wax myrtle (<i>Myrica cerifera</i>)	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior
67	swamp gum ?	dominant patch with a small mix of other types in 67; tree species are just beyond fringe in marsh interior

68	big cordgrass (<i>Spartina cynosuroides</i>)	dominant patch with a small amount of other types in 68
68	<i>Polygonum</i> sp.	dominant patch with a small amount of other types in 68
68	<i>Aster</i> sp.	dominant patch with a small amount of other types in 68
	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	2 distinct, dominant fringing patches on either side of GPS point small
69		presence of other types in 69; GPS point taken with camera
	big cordgrass (<i>Spartina cynosuroides</i>)	2 distinct, dominant fringing patches on either side of GPS point small
69		presence of other types in 69; GPS point taken with camera
70	mixed woody, marsh and shrub	other side of the bank; higher elevation; disturbed mix of vegetation more characteristic of field vegetation
27	smooth cordgrass (<i>Spartina alterniflora</i>)	small patch of fringing spartina on the bank; water background
27-1	black needlerush (<i>Juncus roemerianus</i>)	behind spartina patch at site 27; dense wide field up to a thin line of very dry big cordgrass (<i>Spartina cynosuroides</i>)
75	big cordgrass (<i>Spartina cynosuroides</i>)	small patch; fringing, dead and dry
	smooth cordgrass (<i>Spartina alterniflora</i>)	fringing strip about 20ft wide with a little mix of other types in 76; big area of
76		black needlerush (<i>Juncus roemerianus</i>) behind it
	big cordgrass (<i>Spartina cynosuroides</i>)	fringing strip about 20ft wide with a little mix of other types in 76; big area of
76	black needlerush (<i>Juncus roemerianus</i>)	black needlerush (<i>Juncus roemerianus</i>) behind it
	short form smooth cordgrass (<i>Spartina alterniflora</i>)	little mixed in with smooth cordgrass (<i>Spartina alterniflora</i>); big field of black needlerush (<i>Juncus roemerianus</i>) behind it
77	<i>Aster</i> sp.?	patch of short form spartina behind the fringe with water background and a little <i>Aster</i> sp.?
77-1	black needlerush (<i>Juncus roemerianus</i>)	Jeff will get back to us
	black needlerush (<i>Juncus roemerianus</i>)	very dense stand zoned distinctly from the fringing tall form smooth cordgrass (<i>Spartina alterniflora</i>) and slightly inland short form smooth cordgrass (<i>Spartina alterniflora</i>)
77-2	black needlerush (<i>Juncus roemerianus</i>)	very dense stand behind the zone of short form smooth cordgrass (<i>Spartina alterniflora</i>); we boated downriver from here and there's more areas of tall thin, fringing smooth cordgrass (<i>Spartina alterniflora</i>), short smooth cordgrass (<i>Spartina alterniflora</i>) with black needlerush (<i>Juncus roemerianus</i>) behind it
78	smooth cordgrass (<i>Spartina alterniflora</i>)	fringing on the bank with water background; field of black needlerush (<i>Juncus roemerianus</i>) behind the fringe; drawing on the back of field sheet
	big cordgrass (<i>Spartina cynosuroides</i>)	dead and dry patch; general area has mostly smooth cordgrass (<i>Spartina alterniflora</i>) with some small patches of big cordgrass (<i>Spartina cynosuroides</i>) mixed in; drove up the creek and saw patches of dead, dry big cordgrass (<i>Spartina cynosuroides</i>) off into the marsh interior with mostly black needlerush (<i>Juncus roemerianus</i>) behind otherwise
80	narrowleaf cattail (<i>Typha angustifolia</i>)	narrowleaf cattail (<i>Typha angustifolia</i>) patch (up creek) not far from bank mixed with some black needlerush (<i>Juncus roemerianus</i>); very dry, bright and dead looking
80	black needlerush (<i>Juncus roemerianus</i>)	narrowleaf cattail (<i>Typha angustifolia</i>) patch (up creek) not far from bank mixed with some black needlerush (<i>Juncus roemerianus</i>); very dry, bright and dead looking
80-1	black needlerush (<i>Juncus roemerianus</i>)	transition from 80 to mostly black needlerush (<i>Juncus roemerianus</i>) field; seems slightly higher in elevation with less water; very dense field

		black needlerush (<i>Juncus roemerianus</i>) along the bank with a little big
81	black needlerush (<i>Juncus roemerianus</i>)	cordgrass (<i>Spartina cynosuroides</i>) mixed in; goes all the way to tree line;
		drove farther up creek, approaching point closer to tree line
81	big cordgrass (<i>Spartina cynosuroides</i>)	big cordgrass (<i>Spartina cynosuroides</i>) ends about 10 yards from the bank
		black needlerush (<i>Juncus roemerianus</i>) mixed w/ 2 spartina species, fringing
82	black needlerush (<i>Juncus roemerianus</i>)	along the bank; farther in marsh interior = mix of black needlerush (<i>Juncus</i>
		roemerianus) and smooth cordgrass (<i>Spartina alterniflora</i>)
		black needlerush (<i>Juncus roemerianus</i>) mixed w/ 2 spartina species, fringing
82	smooth cordgrass (<i>Spartina alterniflora</i>)	along the bank; farther in marsh interior = mix of black needlerush (<i>Juncus</i>
		roemerianus) and smooth cordgrass (<i>Spartina alterniflora</i>)
		black needlerush (<i>Juncus roemerianus</i>) mixed w/ 2 spartina species, fringing
82	big cordgrass (<i>Spartina cynosuroides</i>)	along the bank; farther in marsh interior = mix of black needlerush (<i>Juncus</i>
		roemerianus) and smooth cordgrass (<i>Spartina alterniflora</i>)
		fringing black needlerush (<i>Juncus roemerianus</i>) with water background;
22	black needlerush (<i>Juncus roemerianus</i>)	slightly stressed closer to water line; lowest point on the map; first notice of
		oysters
		big field of dead big cordgrass (<i>Spartina cynosuroides</i>) with mud background
22-1	big cordgrass (<i>Spartina cynosuroides</i>)	
		that is visible; behind the dike with red cedar and baccharus
		field of short form smooth cordgrass (<i>Spartina alterniflora</i>) with mud
		background; 75% coverage, some mud will show; little bit of <i>Aster</i> sp.; near a
83	short form smooth cordgrass (<i>Spartina alterniflora</i>)	small creek lined with tall <i>alterniflora</i>
		field of short form smooth cordgrass (<i>Spartina alterniflora</i>) with mud
		background; 75% coverage, some mud will show; little bit of <i>Aster</i> sp.; near a
83	<i>Aster</i> sp.?	small creek lined with tall <i>alterniflora</i>
		fringing patch of smooth cordgrass (<i>Spartina alterniflora</i>) with area of black
		needlerush (<i>Juncus roemerianus</i>) behind it; yellow house creek, southern
		end; past the tree line up from site 20 = mix of black needlerush (<i>Juncus</i>
		roemerianus) and smooth cordgrass (<i>Spartina alterniflora</i>); smooth cordgrass
20	smooth cordgrass (<i>Spartina alterniflora</i>)	(<i>Spartina alterniflora</i>) = small fringe along the creek edge and black
		needlerush (<i>Juncus roemerianus</i>) behind; smooth cordgrass (<i>Spartina</i>
		<i>alterniflora</i>) lines creek banks going in to marsh interior
		fringing smooth cordgrass (<i>Spartina alterniflora</i>); fairly wide field with black
23	smooth cordgrass (<i>Spartina alterniflora</i>)	needlerush (<i>Juncus roemerianus</i>) behind it and big cordgrass (<i>Spartina</i>
		<i>cynosuroides</i>) fringe close to tree line
		smooth cordgrass (<i>Spartina alterniflora</i>) fringing with mix of big cordgrass
24	smooth cordgrass (<i>Spartina alterniflora</i>)	(<i>Spartina cynosuroides</i>) (greener area on the map); black needlerush (<i>Juncus</i>
		roemerianus) on the corner and fringe (see drawing)
25	smooth cordgrass (<i>Spartina alterniflora</i>)	fairly wide fringe along the bank with black needlerush (<i>Juncus roemerianus</i>)
		behind it
90	<i>Hydrilla verticillata</i>	<i>Hydrilla verticillata</i> (SAV) visible at the water surface
		floating leaf veg mix: mostly water-primrose (<i>Ludwigia</i> sp.); in the general
		area and off in the distance are patches of (purple) <i>Polygonum</i> sp., lighter
		patches of wild rice (<i>Zyania aquatica</i>) and everything else is water hyacinth
90-1	water-primrose (<i>Ludwigia</i> sp.)	(<i>Eichhornia</i> sp.) and water-primrose (<i>Ludwigia</i> sp.)

91	wild rice (<i>Zizania aquatica</i>)	mix of wild rice (<i>Zizania aquatica</i>) and white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) in a diked area; point is at the edge where its higher in elevation due to the diking; understory = water-primrose (<i>Ludwigia</i> sp.) and <i>Sagittaria</i> sp.
91	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	mix of wild rice (<i>Zizania aquatica</i>) and white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) in a diked area; point is at the edge where its higher in elevation due to the diking; understory = water-primrose (<i>Ludwigia</i> sp.) and <i>Sagittaria</i> sp.
91	water-primrose (<i>Ludwigia</i> sp.)	mix of wild rice (<i>Zizania aquatica</i>) and white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) in a diked area; point is at the edge where its higher in elevation due to the diking; understory = water-primrose (<i>Ludwigia</i> sp.) and <i>Sagittaria</i> sp.
91	arrowhead/duck potato (<i>Sagittaria</i> sp.)	mix of wild rice (<i>Zizania aquatica</i>) and white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) in a diked area; point is at the edge where its higher in elevation due to the diking; understory = water-primrose (<i>Ludwigia</i> sp.) and <i>Sagittaria</i> sp.
92	sawgrass (<i>Cladium</i> sp.)	mix of mostly sawgrass (<i>Cladium</i> sp.) with some big cordgrass (<i>Spartina cynosuroides</i>); looks greener than surrounding fringe vegetation due to the sawgrass (<i>Cladium</i> sp.); dense patch with water background
92	big cordgrass (<i>Spartina cynosuroides</i>)	mix of mostly sawgrass (<i>Cladium</i> sp.) with some big cordgrass (<i>Spartina cynosuroides</i>); looks greener than surrounding fringe vegetation due to the sawgrass (<i>Cladium</i> sp.); dense patch with water background
93	Polygonum sp.	patch of <i>Polygonum</i> sp. mixed with water-primrose (<i>Ludwigia</i> sp.); line of purple <i>Polygonum</i> sp. in the area; dense area of FLV; behind that is a creek lined with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), wild rice (<i>Zizania aquatica</i>) and big cordgrass (<i>Spartina cynosuroides</i>); about 200-300ft in (passed water hyacinth (<i>Eichhornia</i> sp.) FLV) = a field of wild rice (<i>Zizania aquatica</i>)
93	water-primrose (<i>Ludwigia</i> sp.)	patch of <i>Polygonum</i> sp. mixed with water-primrose (<i>Ludwigia</i> sp.); line of purple <i>Polygonum</i> sp. in the area; dense area of FLV; behind that is a creek lined with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), wild rice (<i>Zizania aquatica</i>) and big cordgrass (<i>Spartina cynosuroides</i>); about 200-300ft in (passed water hyacinth (<i>Eichhornia</i> sp.) FLV) = a field of wild rice (<i>Zizania aquatica</i>)
12	Hydrilla verticillata ?	SAV, could be <i>Hydrilla verticillata</i> (?); coated with algae; large area with some patches exposed at water surface
94	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	dominant stand of dead, dry white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
94	big cordgrass (<i>Spartina cynosuroides</i>)	(bright): little mix of big cordgrass (<i>Spartina cynosuroides</i>) and wild rice dominant stand of dead, dry white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
94	wild rice (<i>Zizania aquatica</i>)	(bright): little mix of big cordgrass (<i>Spartina cynosuroides</i>) and wild rice dominant stand of dead, dry white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
94-1	black needlerush (<i>Juncus roemerianus</i>)	(bright): little mix of big cordgrass (<i>Spartina cynosuroides</i>) and wild rice patch of black needlerush (<i>Juncus roemerianus</i>) behind site 94; little more stressed and dead than seen in saltier waters; can occur in fresh water areas
94-2	big cordgrass (<i>Spartina cynosuroides</i>)	especially when its exposed to saltier conditions during drought periods mix stand of dead, brown vegetation; one wax myrtle (<i>Myrica cerifera</i>) is about 20ft from site
94-2	cattail (<i>Typha</i> sp.)	mix stand of dead, brown vegetation; one wax myrtle (<i>Myrica cerifera</i>) is about 20ft from site

94-2	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	mix stand of dead, brown vegetation; one wax myrtle (<i>Myrica cerifera</i>) is about 20ft from site
94-2	sensitive fern (<i>Onoclea sensibilis</i>)	laying down and dead = understory
	big cordgrass (<i>Spartina cynosuroides</i>)	field of dry, dead, somewhat sparse big cordgrass (<i>Spartina cynosuroides</i>);
95		not healthy; maybe not getting gas much water at this site? Mix of dead veg with a bit of wild rice (<i>Zyzania aquatica</i>) mixed in
	green arrow arum (<i>Peltandra virginica</i>)	field of dry, dead, somewhat sparse big cordgrass (<i>Spartina cynosuroides</i>);
95		not healthy; maybe not getting gas much water at this site? Mix of dead veg with a bit of wild rice (<i>Zyzania aquatica</i>) mixed in
	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	field of dry, dead, somewhat sparse big cordgrass (<i>Spartina cynosuroides</i>);
95		not healthy; maybe not getting gas much water at this site? Mix of dead veg with a bit of wild rice (<i>Zyzania aquatica</i>) mixed in
	sawgrass (<i>Cladium</i> sp.)	fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96		fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96	water hyacinth (<i>Eichhornia</i> sp.)	fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96	big cordgrass (<i>Spartina cynosuroides</i>)	fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96	wild rice (<i>Zyzania aquatica</i>)	fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96	sensitive fern (<i>Onoclea sensibilis</i>)	fringing sawgrass (<i>Cladium</i> sp.) (~10-15ft wide) and water hyacinth (<i>Eichhornia</i> sp.); mix of other veg types listed for 96; single trees seen in the area
96	big cordgrass (<i>Spartina cynosuroides</i>)	fringing patch of big cordgrass (<i>Spartina cynosuroides</i>) with a little bit of FLV
97		on the outer edge of creek bank; understory = goldenrod/aster?
	black needlerush (<i>Juncus roemerianus</i>)	behind site 97, there is a patch of black needlerush (<i>Juncus roemerianus</i>)
97-1		with some big cordgrass (<i>Spartina cynosuroides</i>) mixed in
	big cordgrass (<i>Spartina cynosuroides</i>)	behind site 97, there is a patch of black needlerush (<i>Juncus roemerianus</i>)
97-1		with some big cordgrass (<i>Spartina cynosuroides</i>) mixed in
	cattail (<i>Typha</i> sp.)	behind site 97-1 = patch of cattail (<i>Typha</i> sp.) (dense, tall and dead) with a
97-2		little big cordgrass (<i>Spartina cynosuroides</i>) mixed in the patch
	big cordgrass (<i>Spartina cynosuroides</i>)	behind site 97-1 = patch of cattail (<i>Typha</i> sp.) (dense, tall and dead) with a
97-2		little big cordgrass (<i>Spartina cynosuroides</i>) mixed in the patch
	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	small patch of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) behind fringing patch of black needlerush (<i>Juncus roemerianus</i>) - fringe is about 2 - 3ft wide);
98		behind the site of white marsh = a mix of big cordgrass (<i>Spartina cynosuroides</i>) with some patches of black needlerush (<i>Juncus roemerianus</i>)
	water-primrose (<i>Ludwigia</i> sp.)	fringing water-primrose (<i>Ludwigia</i> sp.) and water hyacinth (<i>Eichhornia</i> sp.) at the water's edge; mixed and giving way to smooth cordgrass (<i>Spartina alterniflora</i>) (first sign of this = getting saltier); behind this area = little white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>) and black needlerush (<i>Juncus roemerianus</i>) mix; a few sporadic trees; site is a
99		mix

		fringing water-primrose (<i>Ludwigia</i> sp.) and water hyacinth (<i>Eichhornia</i> sp.) at the water's edge; mixed and giving way to smooth cordgrass (<i>Spartina alterniflora</i>) (first sign of this = getting saltier); behind this area = little white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>) and black needlerush (<i>Juncus roemerianus</i>) mix; a few sporadic trees; site is a mix
99	water hyacinth (<i>Eichhornia</i> sp.)	
		fringing water-primrose (<i>Ludwigia</i> sp.) and water hyacinth (<i>Eichhornia</i> sp.) at the water's edge; mixed and giving way to smooth cordgrass (<i>Spartina alterniflora</i>) (first sign of this = getting saltier); behind this area = little white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>) and black needlerush (<i>Juncus roemerianus</i>) mix; a few sporadic trees; site is a mix
99	smooth cordgrass (<i>Spartina alterniflora</i>)	
		mix of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) with a little big cordgrass (<i>Spartina cynosuroides</i>); patch of black needlerush (<i>Juncus roemerianus</i>)/big cordgrass (<i>Spartina cynosuroides</i>) behind the site to the tree line: see pic of
100	white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)	
		white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) stripe
		mix of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) with a little big cordgrass (<i>Spartina cynosuroides</i>); patch of black needlerush (<i>Juncus roemerianus</i>)/big cordgrass (<i>Spartina cynosuroides</i>) behind the site to the tree line: see pic of
100	big cordgrass (<i>Spartina cynosuroides</i>)	
		white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) stripe
		dense patch of big cordgrass (<i>Spartina cynosuroides</i>) near the bank (a little
101	big cordgrass (<i>Spartina cynosuroides</i>)	
		FLV at the waters edge); decent size, dense patch
101-1	black needlerush (<i>Juncus roemerianus</i>)	
		black needlerush (<i>Juncus roemerianus</i>) with a mix of goldenrod ? understory; behind site 101
101-1	goldenrod (<i>Solidago</i> sp.) ?	
		black needlerush (<i>Juncus roemerianus</i>) with a mix of goldenrod ? understory; behind site 101
101-2	cattail (<i>Typha</i> sp.)	
		dense , tall, dry/dead patch of cattail (<i>Typha</i> sp.) patch behind site 101-1

June 4-6, 2013

Site_Num	Class name	Notes
1	ITEM Freshwater Mix	Site dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>); FLV fringing near the water line
2	ITEM Freshwater Mix	Site dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>); FLV (<i>peltandra</i>) fringing near the water line
3	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with sporadic big cordgrass (<i>Spartina cynosuroides</i>);
4	SAV	dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>); fringing FLV SAV field; water level was high so vegetation was pulled to the surface;
5	ITEM Freshwater Mix	species are potamogeton sp., hydrilla verticillata and cabomba sp. Site mostly white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) with freshwater understory mix; fringing FLV
6	FLV	FLV field goes to tree line; water hyacinth (<i>Eichhornia</i> sp.) on the edge; water-
7	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	primrose (water-primrose (<i>Ludwigia</i> sp.) sp.) behind it Freshwater mix with bulrush (<i>Scirpus</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>), pickerel weed (<i>Pontederia</i> sp.), white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), etc; white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) is prevalent
8	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>), pickerel weed (<i>Pontederia</i> sp.), etc; patch of big cordgrass (<i>Spartina cynosuroides</i>) nearby and wild rice (<i>Zizania aquatica</i>) laying down in creek channel near bank
9	FLV	FLV field with water-primrose (<i>Ludwigia</i> sp.) and pickerel weed (<i>Pontederia</i> sp.)
10	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>), and sawgrass (<i>Cladium</i> sp.)
11	FLV	FLV with water-primrose (<i>Ludwigia</i> sp.) dominant; near edge of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
12	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>) and freshwater understory mix
13	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>), bulrush (<i>Scirpus</i> sp.), etc
14	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>) and freshwater understory mix
15	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>), cattail (<i>Typha</i> sp.), bulrush (<i>Scirpus</i> sp.) and freshwater understory mix
16	SAV	SAV in channel underwater
17	ITEM Freshwater Mix	Freshwater mix with wild rice (<i>Zizania aquatica</i>); SAV and FLV also present
18	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>) and freshwater understory mix; fringing FLV
19	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>); white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) is more prevalent; freshwater understory mix present same as in 15; fringing FLV
20	ITEM Black Needlerush Mix	Mix of black needlerush (<i>Juncus roemerianus</i>) and big cordgrass (<i>Spartina cynosuroides</i>); little bit of cattail (<i>Typha</i> sp.) present; site collected at the edge of the vegetation patch

21	FLV	FLV opening, mostly water-primrose (<i>Ludwigia</i> sp.) and water hyacinth (<i>Eichhornia</i> sp.)
22	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix
23	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>), big cordgrass (<i>Spartina</i> <i>cynosuroides</i>), bulrush (<i>Scirpus</i> sp.) and freshwater understory mix; top of canopy is largely seen to be big cordgrass (<i>Spartina</i> <i>cynosuroides</i>)
24	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with big cordgrass (<i>Spartina</i> <i>cynosuroides</i>), white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix; site is at the bank of a dike
25	FLV	FLV patch; water-primrose (<i>Ludwigia</i> sp.)
26	ITEM Freshwater Mix	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix; fringing FLV
27	FLV	FLV patch of water-primrose (<i>Ludwigia</i> sp.); white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) behind it with some big cordgrass (<i>Spartina</i> <i>cynosuroides</i>)
28	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>), big cordgrass (<i>Spartina</i> <i>cynosuroides</i>) and freshwater understory mix
29	ITEM Freshwater Mix	Freshwater mix with mostly sawgrass (<i>Cladium</i> sp.)
30	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>), big cordgrass (<i>Spartina</i> <i>cynosuroides</i>) and freshwater understory mix
31	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix
32	ITEM Freshwater Mix	Freshwater mix with wild rice (<i>Zizania</i> <i>aquatica</i>)
33	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and some big cordgrass (<i>Spartina</i> <i>cynosuroides</i>), pickerel weed (<i>Pontederia</i> sp.), black needlerush (<i>Juncus</i> <i>roemerianus</i>), bulrush (<i>Scirpus</i> sp.), etc
34	SAV	Edge of SAV field; hydrilla <i>verticillata</i> ; lots of SAV starting to be exposed due to lower tide
35	SAV	Edge of SAV field; exposed at surface
36	FLV	FLV field; water-primrose (<i>Ludwigia</i> sp.); large area
37	FLV	FLV field; water-primrose (<i>Ludwigia</i> sp.); large area
38	ITEM Freshwater Mix	Freshwater mix with sawgrass (<i>Cladium</i> sp.) and some freshwater understory mix
39	ITEM Freshwater Mix	Freshwater mix with sawgrass (<i>Cladium</i> sp.) and some freshwater understory mix
40	ITEM Freshwater Mix	Freshwater mix with sawgrass (<i>Cladium</i> sp.), white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix
41	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>), bulrush (<i>Scirpus</i> sp.), big cordgrass (<i>Spartina</i> <i>cynosuroides</i>), cattail (<i>Typha</i> sp.) and freshwater understory mix
42	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix
43	ITEM Freshwater Mix	Freshwater mix with sawgrass (<i>Cladium</i> sp.), white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>) and freshwater understory mix
44	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>); fringing FLV
45	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis</i> <i>miliacea</i>); fringing FLV

46	ITEM Black Needlerush Dominant	Small patch of black needlerush (<i>Juncus roemerianus</i>) ; may be too narrow to identify
47	FLV	FLV patch
48	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and freshwater understory mix
49	ITEM Freshwater Mix	Freshwater mix with mostly white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and freshwater understory mix
	ITEM Freshwater Mix	Freshwater mix with sawgrass (<i>Cladium</i> sp.), white marsh/cutgrass
50		(<i>Zizaniopsis miliacea</i>) and freshwater understory mix
	SAV	SAV field; site visited at high tide, which gets more exposed at low tide (potamogeton sp., hydrilla verticillata, cabomba sp., etc - same as day before)
51		SAV field; site visited at high tide, which gets more exposed at low tide (potamogeton sp., hydrilla verticillata, cabomba sp., etc - same as day before)
52	SAV	SAV field; site visited at high tide, which gets more exposed at low tide (potamogeton sp., hydrilla verticillata, cabomba sp., etc - same as day before)
53	SAV	SAV field; site visited at high tide, which gets more exposed at low tide (potamogeton sp., hydrilla verticillata, cabomba sp., etc - same as day before)
	FLV	FLV field; water-primrose (<i>Ludwigia</i> sp.); large area with some pickerel weed
54		(<i>Pontederia</i> sp.) islands which are very sporadic
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix, mostly big cordgrass (<i>Spartina cynosuroides</i>), little cattail (<i>Typha</i> sp.) and some black needlerush (<i>Juncus roemerianus</i>) about 25ft in from point; freshwater understory mix present; big cordgrass (<i>Spartina cynosuroides</i>) includes new, green, and last year's, brown mixed
55		Freshwater mix, mostly sawgrass (<i>Cladium</i> sp.) with freshwater understory
	ITEM Freshwater Mix	mix; about 40ft in from point is woody shrub mix
56	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), cattail (<i>Typha</i> sp.) and freshwater understory mix
57		Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) dominant and freshwater understory mix; wild rice (<i>Zyzzania aquatica</i>) at the water's edge
58	ITEM Freshwater Mix	Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), some white
602	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and some freshwater understory mix
	ITEM Freshwater Mix	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), bulrush (<i>Scirpus</i> sp.), and a somewhat less prevalent freshwater understory mix due
601		to high density of white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), sawgrass (<i>Cladium</i> sp.), little black needlerush (<i>Juncus roemerianus</i>), and freshwater understory mix; site transitions to large patch of black needlerush (<i>Juncus roemerianus</i>) at 30 to 40 ft further in on either side of channel
61		Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), sawgrass
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	(<i>Cladium</i> sp.) and freshwater understory mix; starting to see more big
62		cordgrass (<i>Spartina cynosuroides</i>) as moving southward; fringing FLV
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), cattail (<i>Typha</i> sp.), white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), little bulrush (<i>Scirpus</i> sp.)
63		and freshwater understory mix
	ITEM Freshwater Mix	Freshwater mix dominated by bulrush (<i>Scirpus</i> sp.) on both sides of creek; freshwater understory mix; first real dominant patch of bulrush (<i>Scirpus</i> sp.) as moving southward
64		

65	ITEM Freshwater Mix	Freshwater mix dominated by sawgrass (<i>Cladium</i> sp.) and freshwater understory mix Freshwater mix dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) with
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	big cordgrass (<i>Spartina cynosuroides</i>), cattail (<i>Typha</i> sp.) and freshwater understory mix; large patch of black needlerush (<i>Juncus roemerianus</i>) about
66		15ft farther in from point which is somewhat mixed and then dominant
67	ITEM Freshwater Mix	Freshwater mix dominated by sawgrass (<i>Cladium</i> sp.), which looked different than in previous sites
68	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix dominated by big cordgrass (<i>Spartina cynosuroides</i>) with a freshwater understory mix Freshwater mix dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
	ITEM Freshwater Mix	with freshwater understory mix; farther in the area is mixed with big
69		cordgrass (<i>Spartina cynosuroides</i>) big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with some cattail
	ITEM Big Cordgrass Mix	(<i>Typha</i> sp.) and somewhat of a freshwater understory mix that is starting to
70		become less prevalent as moving south as well as inland; fringing FLV
71	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>) with a little cattail (<i>Typha</i> sp.) and little freshwater understory mix Black needlerush (<i>Juncus roemerianus</i>) dominated mix with cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>) and a little freshwater understory
	ITEM Black Needlerush Mix	mix (understory includes <i>spartina patens</i>); denser stand of black needlerush (<i>Juncus roemerianus</i>) occurs farther inland
72		Freshwater mix with big cordgrass (<i>Spartina cynosuroides</i>), white
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	marsh/cutgrass (<i>Zizaniopsis miliacea</i>), bulrush (<i>Scirpus</i> sp.), and freshwater understory mix; about 20-30ft farther inland is ITEM big cordgrass (<i>Spartina</i>
73		<i>cynosuroides</i>) mix with some bulrush (<i>Scirpus</i> sp.)
74	ITEM Big Cordgrass Mix	Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with some bulrush (<i>Scirpus</i> sp.) and freshwater understory mix
75	ITEM Freshwater Mix	Freshwater mix dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and freshwater understory mix
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix with white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), bulrush (<i>Scirpus</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>) and freshwater understory mix
76		Black needlerush (<i>Juncus roemerianus</i>) dominated mix with big cordgrass
	ITEM Black Needlerush Mix	(<i>Spartina cynosuroides</i>) and bulrush (<i>Scirpus</i> sp.)
77		Freshwater mix with bulrush (<i>Scirpus</i> sp.), white marsh/cutgrass (<i>Zizaniopsis miliacea</i>), sawgrass (<i>Cladium</i> sp.), and freshwater understory mix (very mixed site)
78	ITEM Freshwater Mix	Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with black needlerush
	ITEM Big Cordgrass Mix	(<i>Juncus roemerianus</i>) and freshwater understory mix
79		Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with freshwater
	ITEM Big Cordgrass Mix	understory mix; black needlerush (<i>Juncus roemerianus</i>) is farther inland and
80		mixed with big cordgrass (<i>Spartina cynosuroides</i>) Black needlerush (<i>Juncus roemerianus</i>) dominated mix with some bulrush;
	ITEM Black Needlerush Mix	farther inland from site is big cordgrass (<i>Spartina cynosuroides</i>) and white
81		marsh/cutgrass (<i>Zizaniopsis miliacea</i>)

		Black needlerush (<i>Juncus roemerianus</i>) dominated mix with bulrush (<i>Scirpus</i>
82	ITEM Black Needlerush Mix	sp.) and slight freshwater understory mix; big cordgrass (<i>Spartina</i>
		<i>cynosuroides</i>) is near the bank behind fringing FLV
83	ITEM Black Needlerush Mix	Black needlerush (<i>Juncus roemerianus</i>) dominated mix with cattail (<i>Typha</i>
		sp.) and freshwater understory mix
	ITEM Smooth Cordgrass Mix	Smooth cordgrass (<i>Spartina alterniflora</i>) dominated mix with bulrush (<i>Scirpus</i>
84		sp.), pickerel weed (<i>Pontederia</i> sp.), water-primrose (<i>Ludwigia</i> sp.) and white
		marsh/cutgrass (<i>Zizaniopsis miliacea</i>); <i>spartina alterniflora</i> is isolated to the
85	ITEM Smooth Cordgrass Mix	low fringe at bank only
		Smooth cordgrass (<i>Spartina alterniflora</i>) dominated mix with freshwater mix
		just along low fringe at bank
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix dominated by bulrush (<i>Scirpus</i> sp.) with some freshwater
86		understory mix; nearby site is mixed with white marsh/cutgrass (<i>Zizaniopsis</i>
		<i>miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>) and cattail (<i>Typha</i> sp.)
		Freshwater mix with wild rice (<i>Zizania aquatica</i>) laying down, exposed at
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	lower tide near the bank; mixed with white marsh/cutgrass (<i>Zizaniopsis</i>
87		<i>miliacea</i>), big cordgrass (<i>Spartina cynosuroides</i>), bulrush (<i>Scirpus</i> sp.) and a
		little cattail (<i>Typha</i> sp.); <i>spartina alterniflora</i> patch fringing at the bank
88	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>); fringing FLV and smooth
		cordgrass (<i>Spartina alterniflora</i>) at the bank
	ITEM Freshwater Mix w/ Big Cordgrass and/or Cattail	Freshwater mix dominated by white marsh/cutgrass (<i>Zizaniopsis miliacea</i>)
89		with some bulrush (<i>Scirpus</i> sp.), cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina</i>
		<i>cynosuroides</i>) and freshwater understory mix; a little fringing smooth
		cordgrass (<i>Spartina alterniflora</i>)
	ITEM Big Cordgrass Mix	Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with bulrush (<i>Scirpus</i>
90		sp.), cattail (<i>Typha</i> sp.), white marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and a
		little freshwater understory mix; low fringing smooth cordgrass (<i>Spartina</i>
		<i>alterniflora</i>) at the bank
	ITEM Black Needlerush Mix	Black needlerush (<i>Juncus roemerianus</i>) dominated mix with big cordgrass
91		(<i>Spartina cynosuroides</i>) and a little bulrush (<i>Scirpus</i> sp.), white
		marsh/cutgrass (<i>Zizaniopsis miliacea</i>) and freshwater understory mix
	ITEM Cattail Dominant	Dominant cattail (<i>Typha</i> sp.) patch with water-primrose (<i>Ludwigia</i> sp.)
92		understory; fringing smooth cordgrass (<i>Spartina alterniflora</i>) at the bank
93	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>) on the bank with a little
		freshwater understory mix
94	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>) with very little freshwater
		understory
	ITEM Big Cordgrass Mix	Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with bulrush (<i>Scirpus</i>
95		sp.) and some black needlerush (<i>Juncus roemerianus</i>), two species of bulrush
		(<i>Scirpus</i> sp.) and a little freshwater understory mix
96	ITEM Freshwater Mix	Freshwater mix dominated by wild rice (<i>Zizania aquatica</i>); very dense stand
		near the bank
	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>); no understory; fringing
97		
		black needlerush (<i>Juncus roemerianus</i>) at the bank
98	ITEM Cattail Dominant	Dominant cattail (<i>Typha</i> sp.) with a little black needlerush (<i>Juncus</i>
		<i>roemerianus</i>) understory

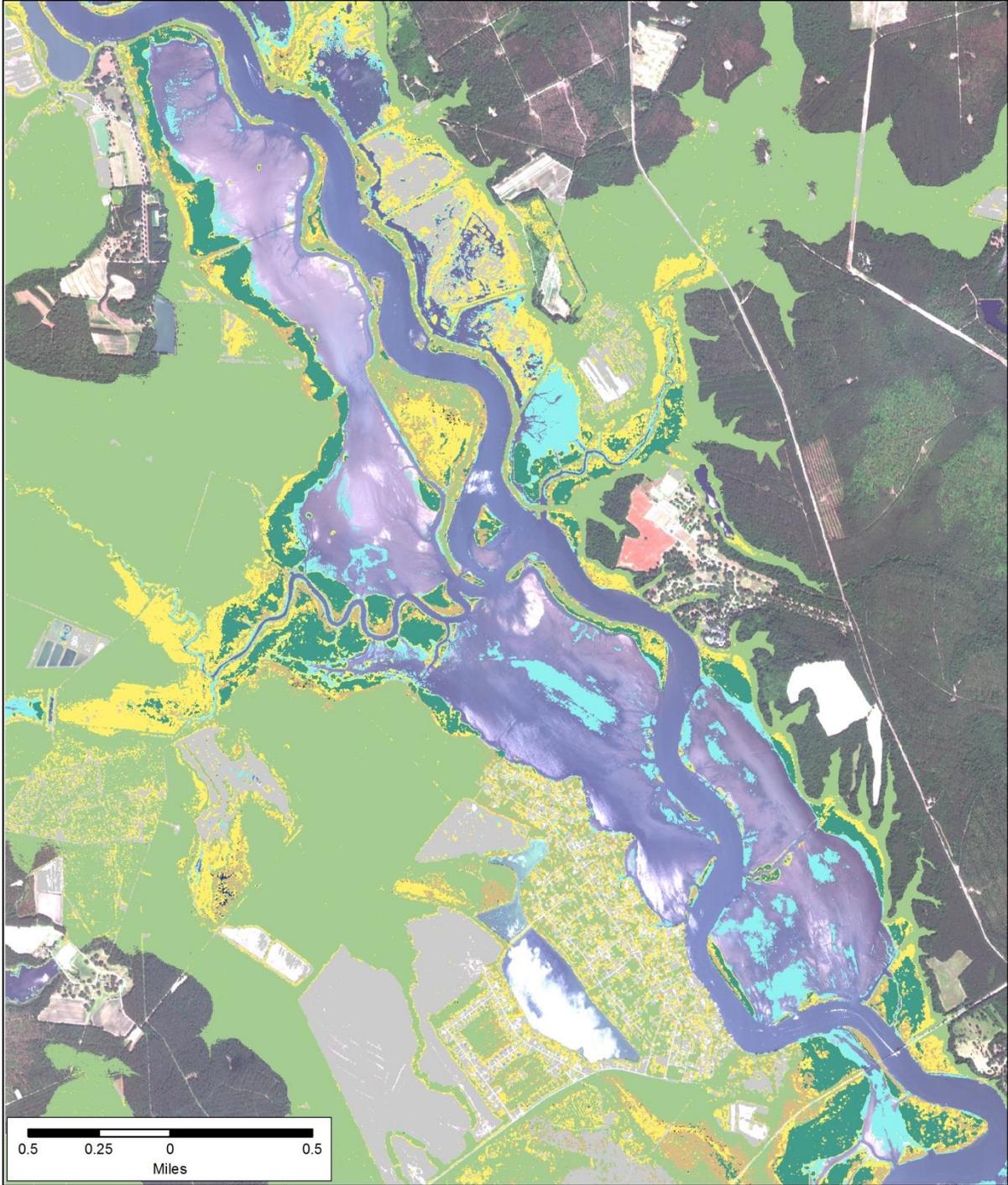
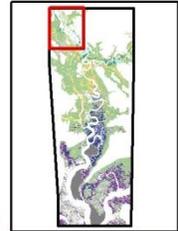
99	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>) fringing at the bank
	ITEM Cattail Dominant	Dominant cattail (<i>Typha</i> sp.) with a little understory of black needlerush (<i>Juncus roemerianus</i>), water-primrose (<i>Ludwigia</i> sp.) and polygonum sp.;
100		fringing bulrush (<i>Scirpus</i> sp.) and black needlerush (<i>Juncus roemerianus</i>)
101	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>) with a little arrowhead/duck potato (<i>Sagittaria</i> sp.) understory
102	ITEM Big Cordgrass Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>); no understory; fringing black needlerush (<i>Juncus roemerianus</i>) and smooth cordgrass (<i>Spartina alterniflora</i>) at the bank
103	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>) with a little bulrush (<i>Scirpus</i> sp.); fringing at the bank
	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>) with a little big cordgrass (<i>Spartina cynosuroides</i>) and bulrush (<i>Scirpus</i> sp.); no understory
104	ITEM Freshwater Mix	Freshwater mix dominated by sawgrass (<i>Cladium</i> sp.)
105		Dominant big cordgrass (<i>Spartina cynosuroides</i>) (thin strip); fringing smooth cordgrass (<i>Spartina alterniflora</i>) and black needlerush (<i>Juncus roemerianus</i>) at the bank; area of black needlerush (<i>Juncus roemerianus</i>) behind the big cordgrass (<i>Spartina cynosuroides</i>)
106	ITEM Big Cordgrass Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>) (behind site 106); very small amount big cordgrass (<i>Spartina cynosuroides</i>) also present
107	ITEM Black Needlerush Dominant	Dominant big cordgrass (<i>Spartina cynosuroides</i>); smooth cordgrass (<i>Spartina alterniflora</i>) fringing at the bank
108	ITEM Big Cordgrass Dominant	Big cordgrass (<i>Spartina cynosuroides</i>) dominated mix with cattail (<i>Typha</i> sp.) and freshwater understory mix; fringing smooth cordgrass (<i>Spartina alterniflora</i>) with some black needlerush (<i>Juncus roemerianus</i>)
109	ITEM Big Cordgrass Mix	Black needlerush (<i>Juncus roemerianus</i>) dominated mix with cattail (<i>Typha</i> sp.), big cordgrass (<i>Spartina cynosuroides</i>) and a little freshwater understory mix; fringing black needlerush (<i>Juncus roemerianus</i>) and big cordgrass (<i>Spartina cynosuroides</i>) at the bank
	ITEM Black Needlerush Mix	Dominant black needlerush (<i>Juncus roemerianus</i>) with very little big cordgrass (<i>Spartina cynosuroides</i>)
110	ITEM Black Needlerush Dominant	Dominant cattail (<i>Typha</i> sp.) patch
111	ITEM Cattail Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); fairly wide strip fringing at the bank with big cordgrass (<i>Spartina cynosuroides</i>) behind the site
112	ITEM Smooth Cordgrass Dominant	Big cordgrass (<i>Spartina cynosuroides</i>) on the bank mixed with bulrush (<i>Scirpus</i> sp.) and a little cattail (<i>Typha</i> sp.) and big cordgrass mixed in too
113	ITEM Big Cordgrass Mix	Dominant smooth cordgrass (<i>Spartina alterniflora</i>) fringing at the bank (big cordgrass (<i>Spartina cynosuroides</i>) mix on either side of the site)
114	ITEM Smooth Cordgrass Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>) with very little big cordgrass (<i>Spartina cynosuroides</i>)
115	ITEM Black Needlerush Dominant	Smooth cordgrass (<i>Spartina alterniflora</i>) mixed with bulrush (<i>Scirpus</i> sp.) fringing at the bank
116	ITEM Smooth Cordgrass Mix	Smooth cordgrass (<i>Spartina alterniflora</i>) mixed with bulrush (<i>Scirpus</i> sp.) fringing at the bank
117	ITEM Smooth Cordgrass Mix	Smooth cordgrass (<i>Spartina alterniflora</i>) mixed with bulrush (<i>Scirpus</i> sp.) fringing at the bank
118	ITEM Smooth Cordgrass Mix	Dominant black needlerush (<i>Juncus roemerianus</i>) from the bank to the treeline
119	ITEM Black Needlerush Dominant	

		Black needlerush (<i>Juncus roemerianus</i>) mixed with smooth cordgrass
120	ITEM Black Needlerush Mix	(<i>Spartina alterniflora</i>) and a little big cordgrass (<i>Spartina cynosuroides</i>)
121	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); fairly wide fringe at the bank
122	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); fairly wide fringe at the bank
	ITEM Black Needlerush Mix	Black needlerush (<i>Juncus roemerianus</i>) mixed with smooth cordgrass
123		(<i>Spartina alterniflora</i>) near the bank; fringing smooth cordgrass (<i>Spartina alterniflora</i>) at the bank (transitions from mix at the bank to dominant black needlerush (<i>Juncus roemerianus</i>) behind the site)
124	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); wide fringe at the bank
125	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); wide fringe at the bank
126	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>)
127	ITEM Common Reed	Dominant patch of common reed (<i>Phragmites australis</i>)
128	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>) fringing at the bank
129	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>)
130	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>) fringing at the bank
131	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>)
132	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); large patch at the site
133	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>) up to the bank
134	ITEM Smooth Cordgrass Dominant	Dominant smooth cordgrass (<i>Spartina alterniflora</i>); sandy beach at the bank
135	ITEM Black Needlerush Dominant	Dominant black needlerush (<i>Juncus roemerianus</i>)
136	ITEM Smooth Cordgrass Mix	Smooth cordgrass (<i>Spartina alterniflora</i>) dominated mix with bulrush (<i>Scirpus</i> sp.) and a little black needlerush (<i>Juncus roemerianus</i>) with big cordgrass (<i>Spartina cynosuroides</i>)

Appendix B: Zoomed-In Map Series

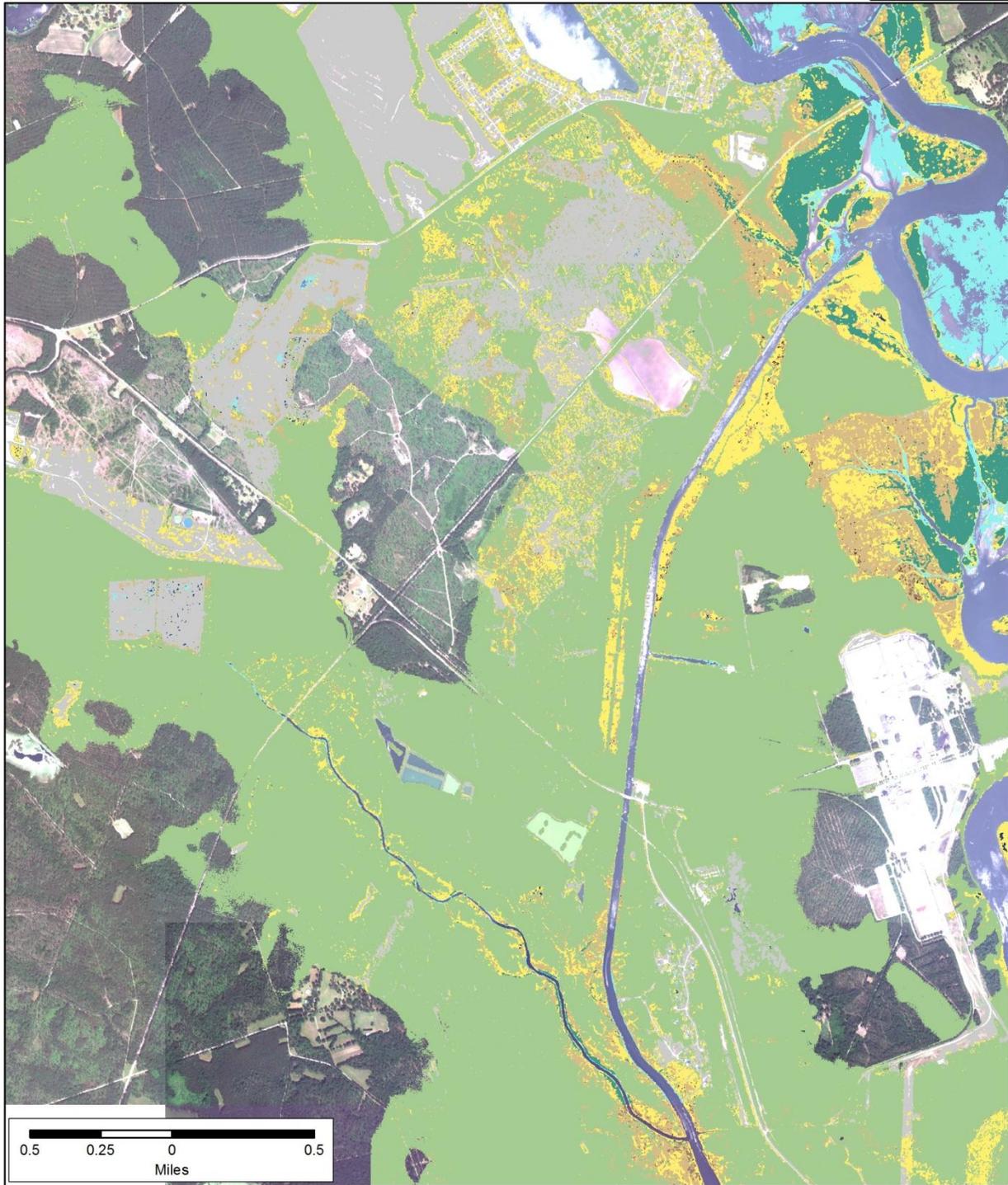
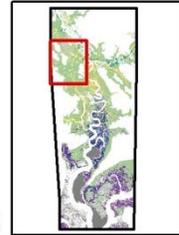
Wetland Classification: Cooper River, South Carolina, Zoom Series 1

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



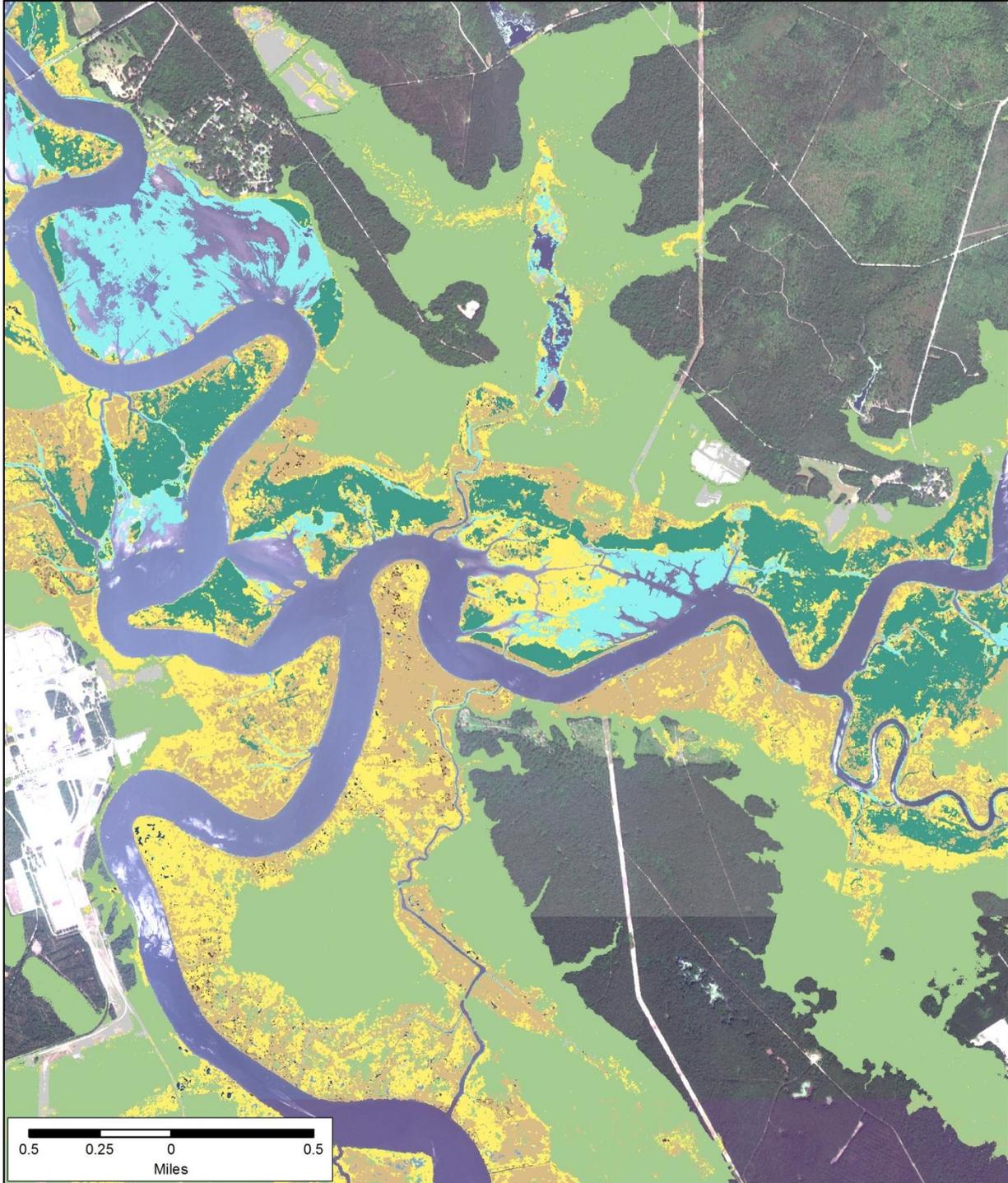
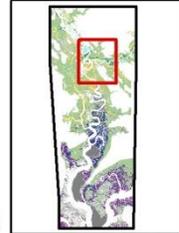
Wetland Classification: Cooper River, South Carolina, Zoom Series 2

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



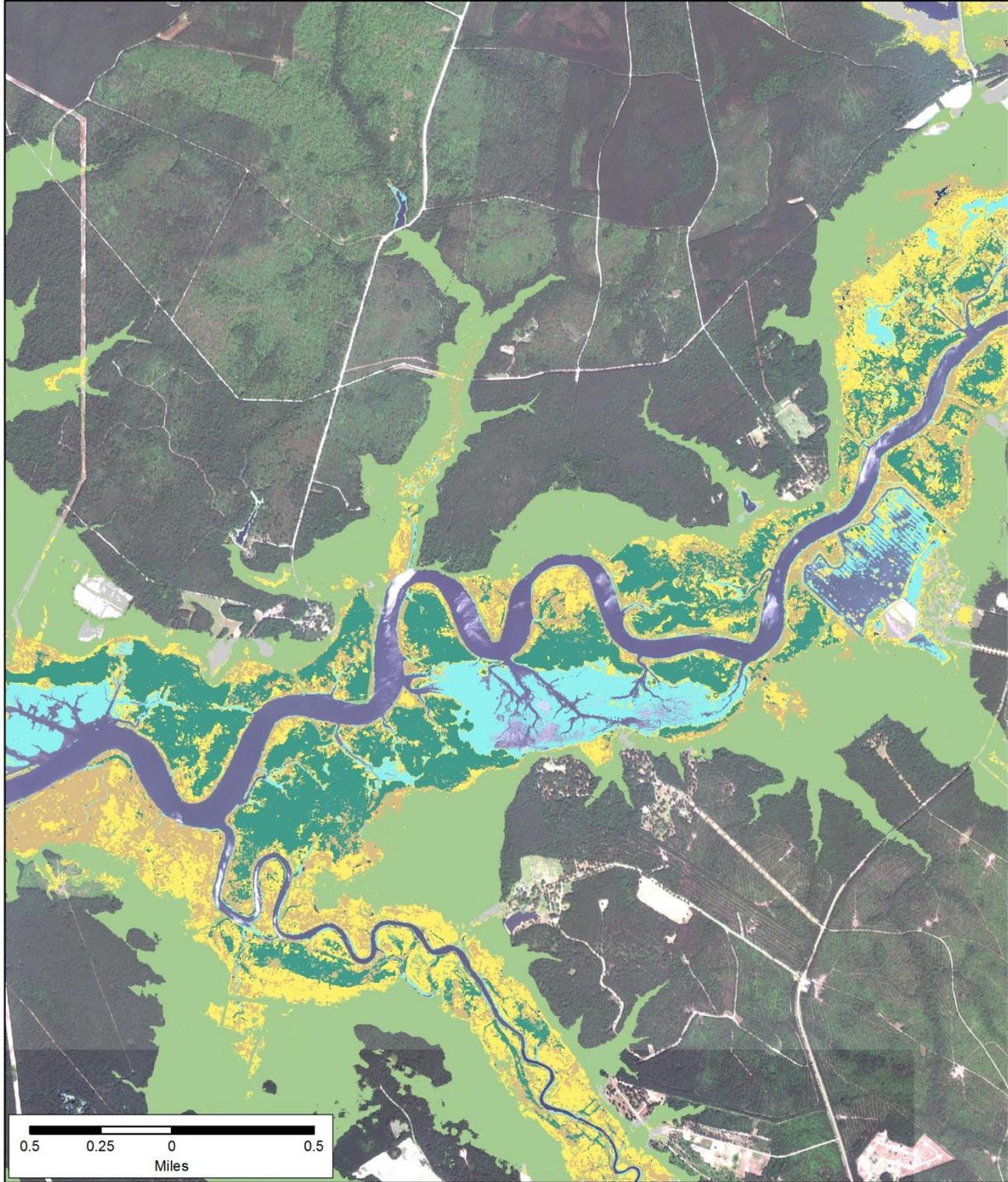
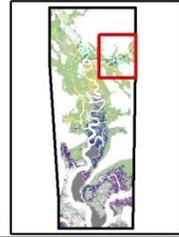
Wetland Classification: Cooper River, South Carolina, Zoom Series 3

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



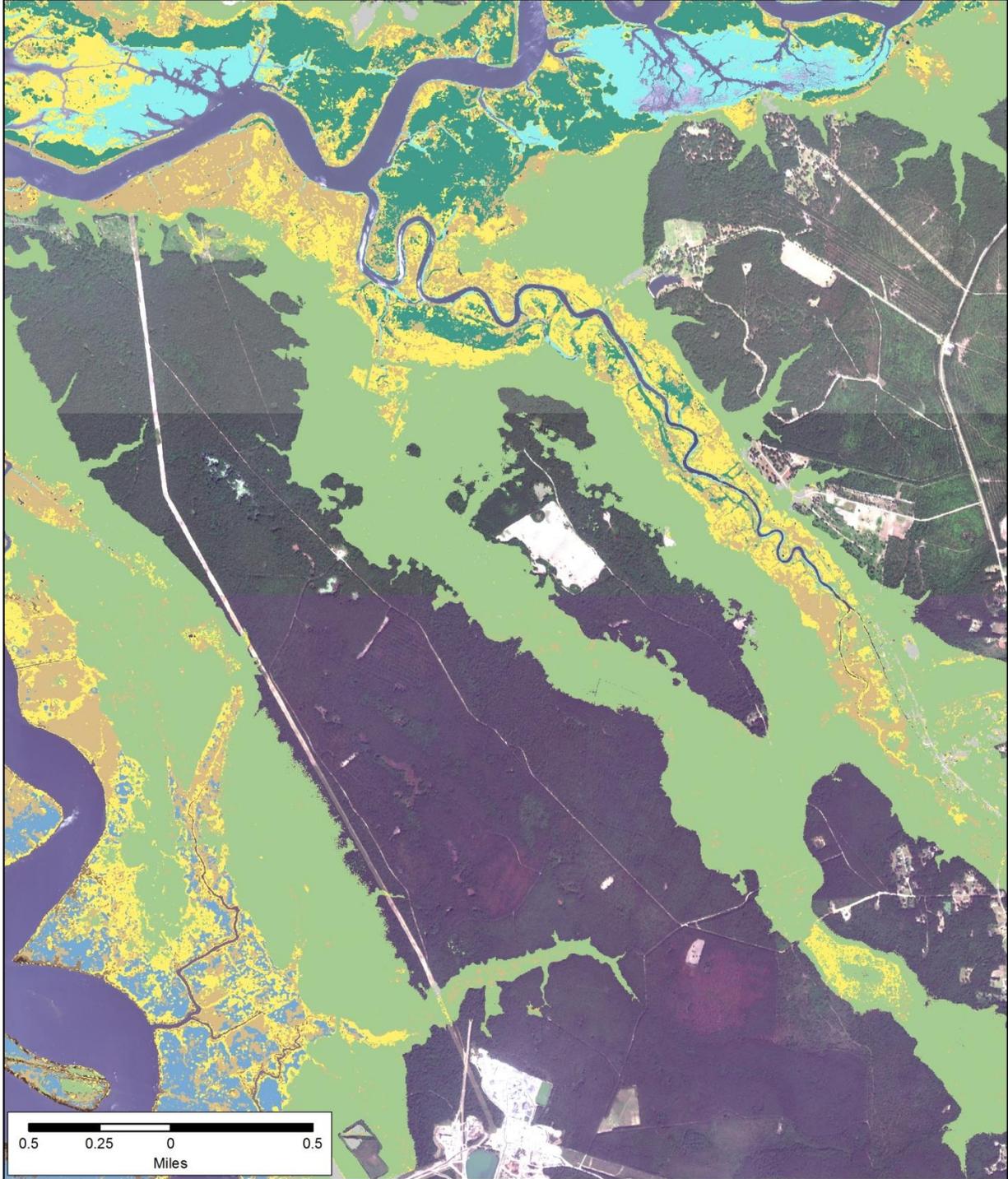
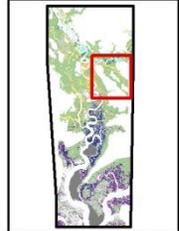
Wetland Classification: Cooper River, South Carolina, Zoom Series 4

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



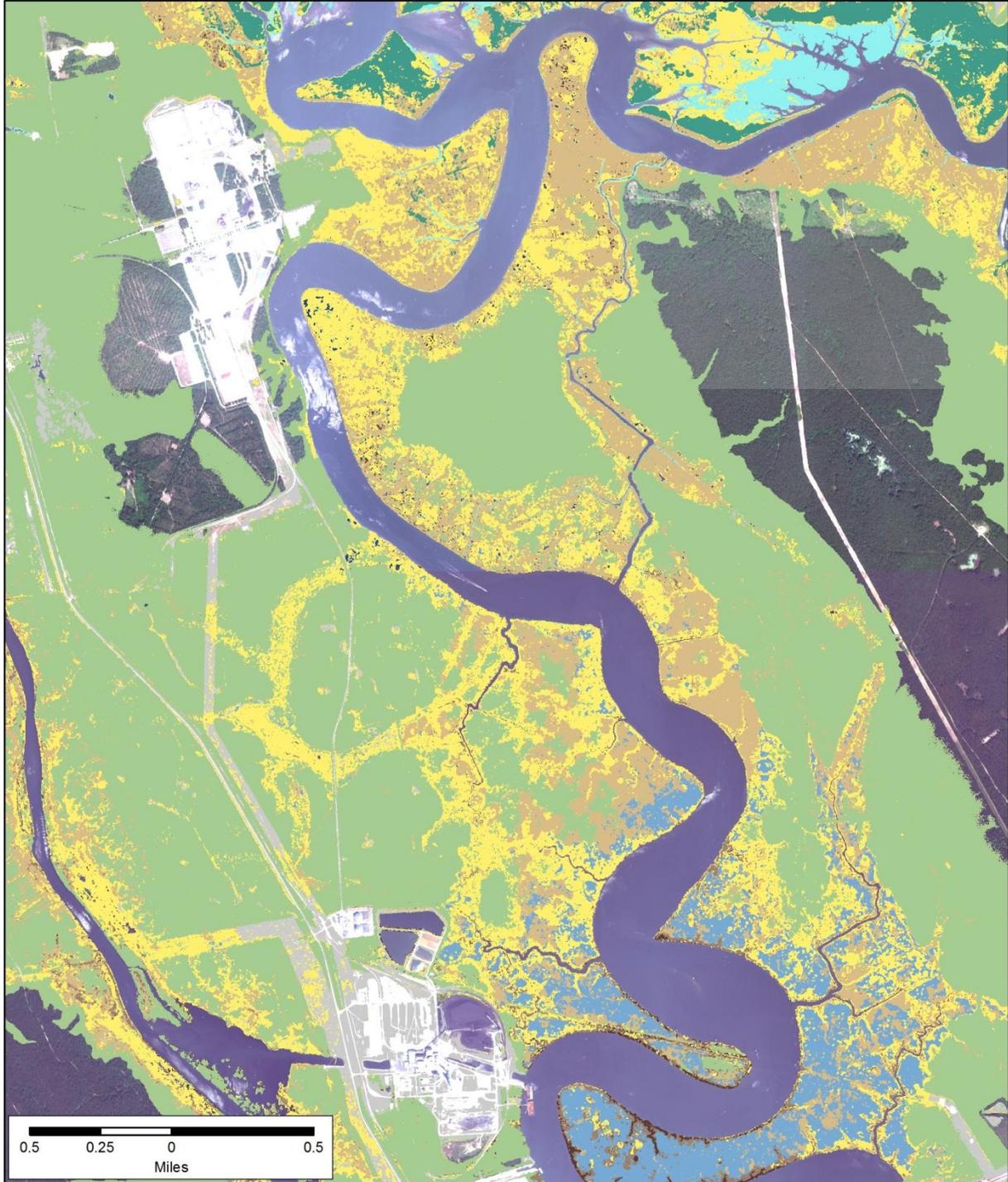
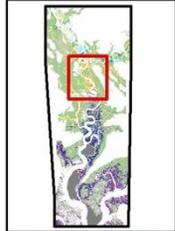
Wetland Classification: Cooper River, South Carolina, Zoom Series 5

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



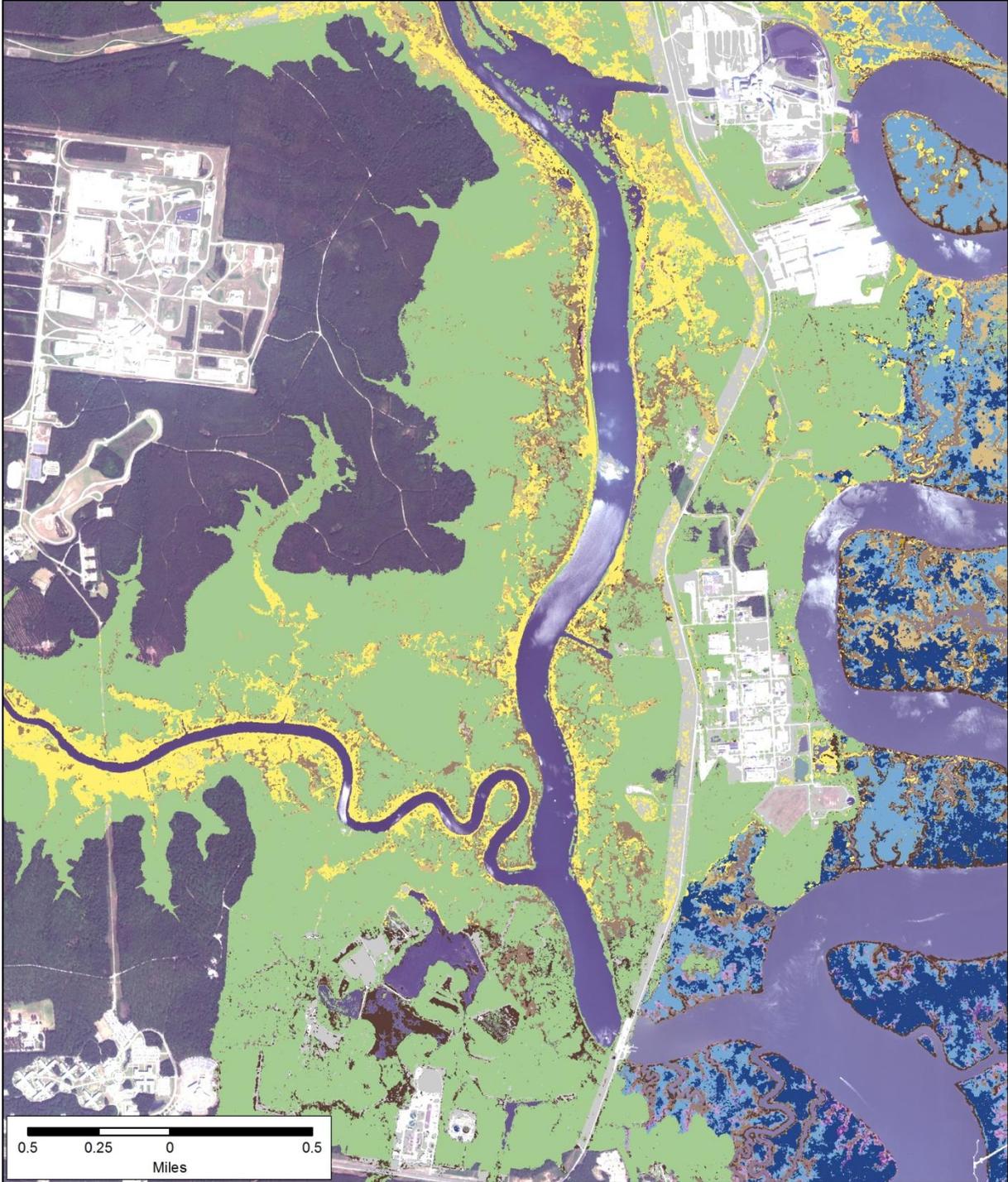
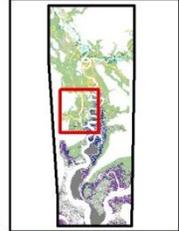
Wetland Classification: Cooper River, South Carolina, Zoom Series 6

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|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



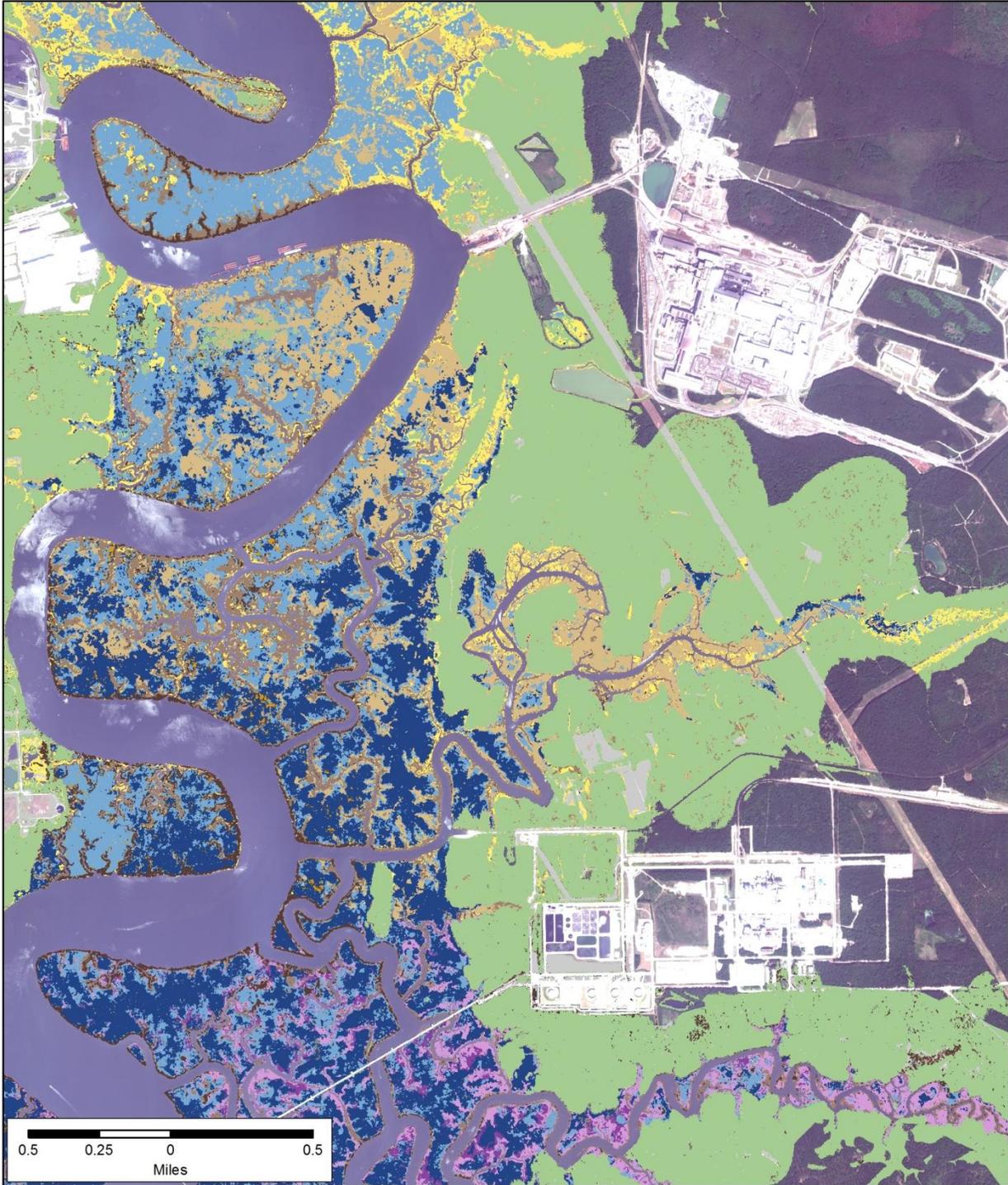
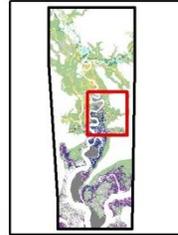
Wetland Classification: Cooper River, South Carolina, Zoom Series 7

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



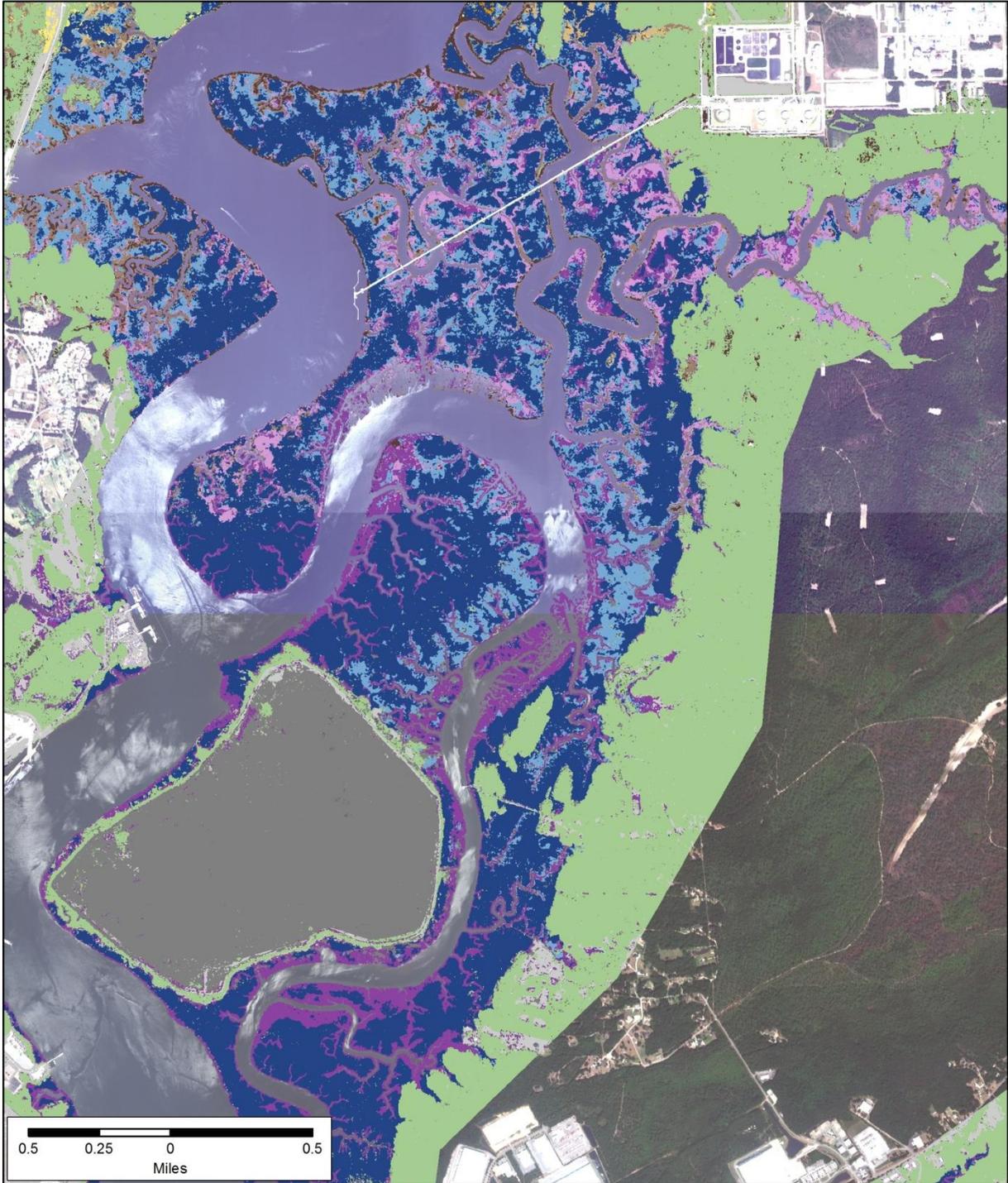
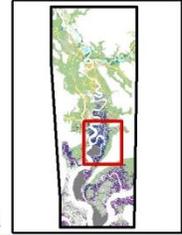
Wetland Classification: Cooper River, South Carolina, Zoom Series 8

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



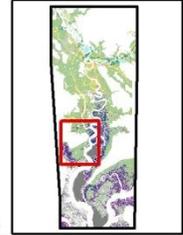
Wetland Classification: Cooper River, South Carolina, Zoom Series 9

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



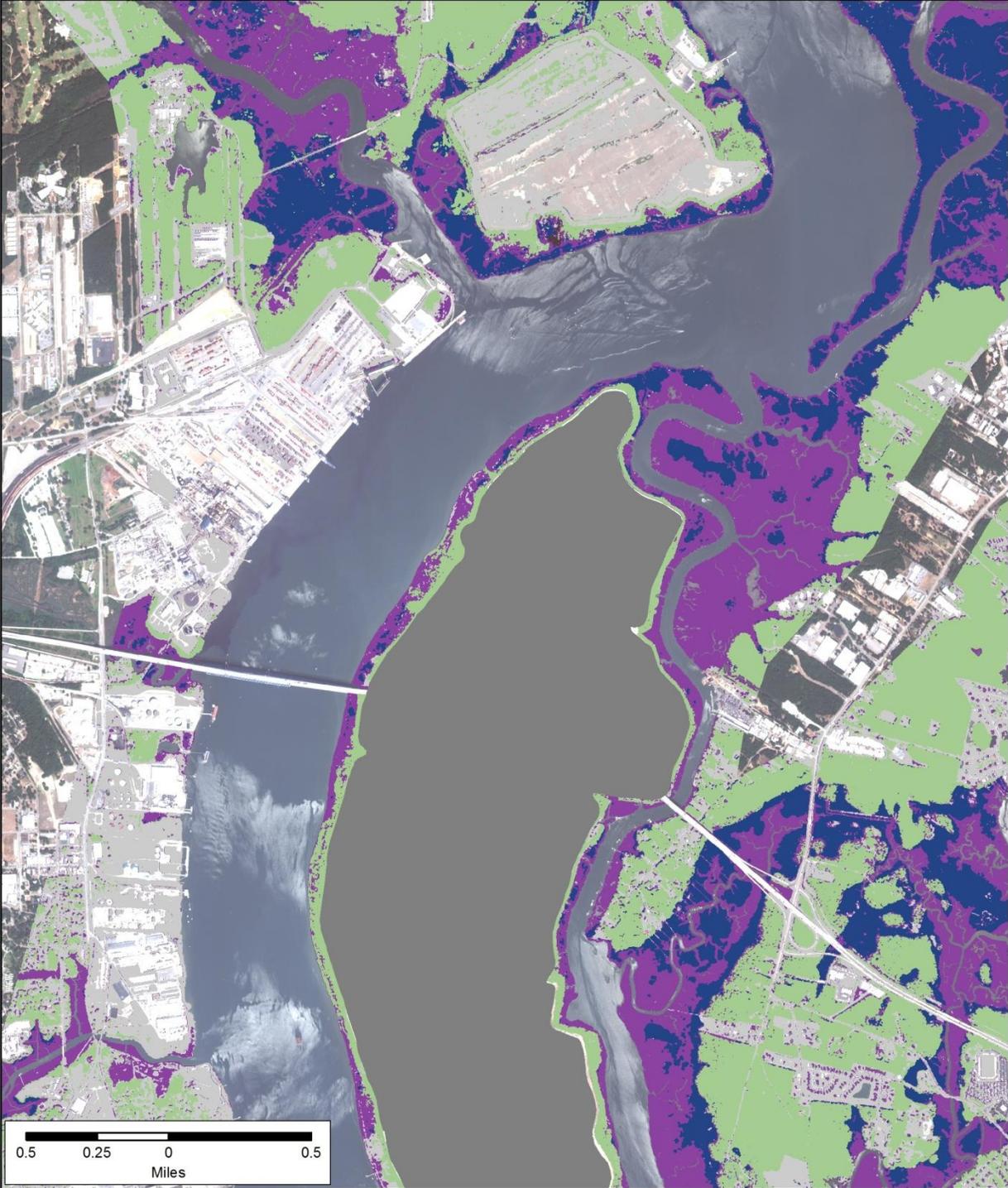
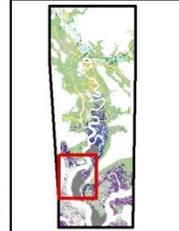
Wetland Classification: Cooper River, South Carolina, Zoom Series 10

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



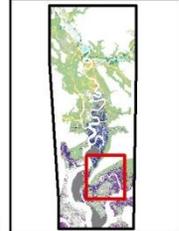
Wetland Classification: Cooper River, South Carolina, Zoom Series 11

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



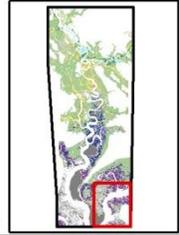
Wetland Classification: Cooper River, South Carolina, Zoom Series 12

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



Wetland Classification: Cooper River, South Carolina, Zoom Series 13

- | | | |
|---|--|--|
|  Woody Mix |  ITEM Big Cordgrass Dominant |  ITEM Smooth Cordgrass Dominant |
|  ITEM Freshwater Mix |  ITEM Big Cordgrass Mix |  ITEM Smooth Cordgrass Mix |
|  ITEM Freshwater Mix with Big Cordgrass and/or Cattail |  ITEM Black Needlerush Dominant |  Urban/Field/Bare Soil |
|  Floating Leaf Vegetation |  ITEM Black Needlerush Mix |  CDF Vegetation/Common Reed |
|  Submerged Aquatic Vegetation |  ITEM Cattail Dominant | |



Wetland Classification: Cooper River, South Carolina, Zoom Series 14

