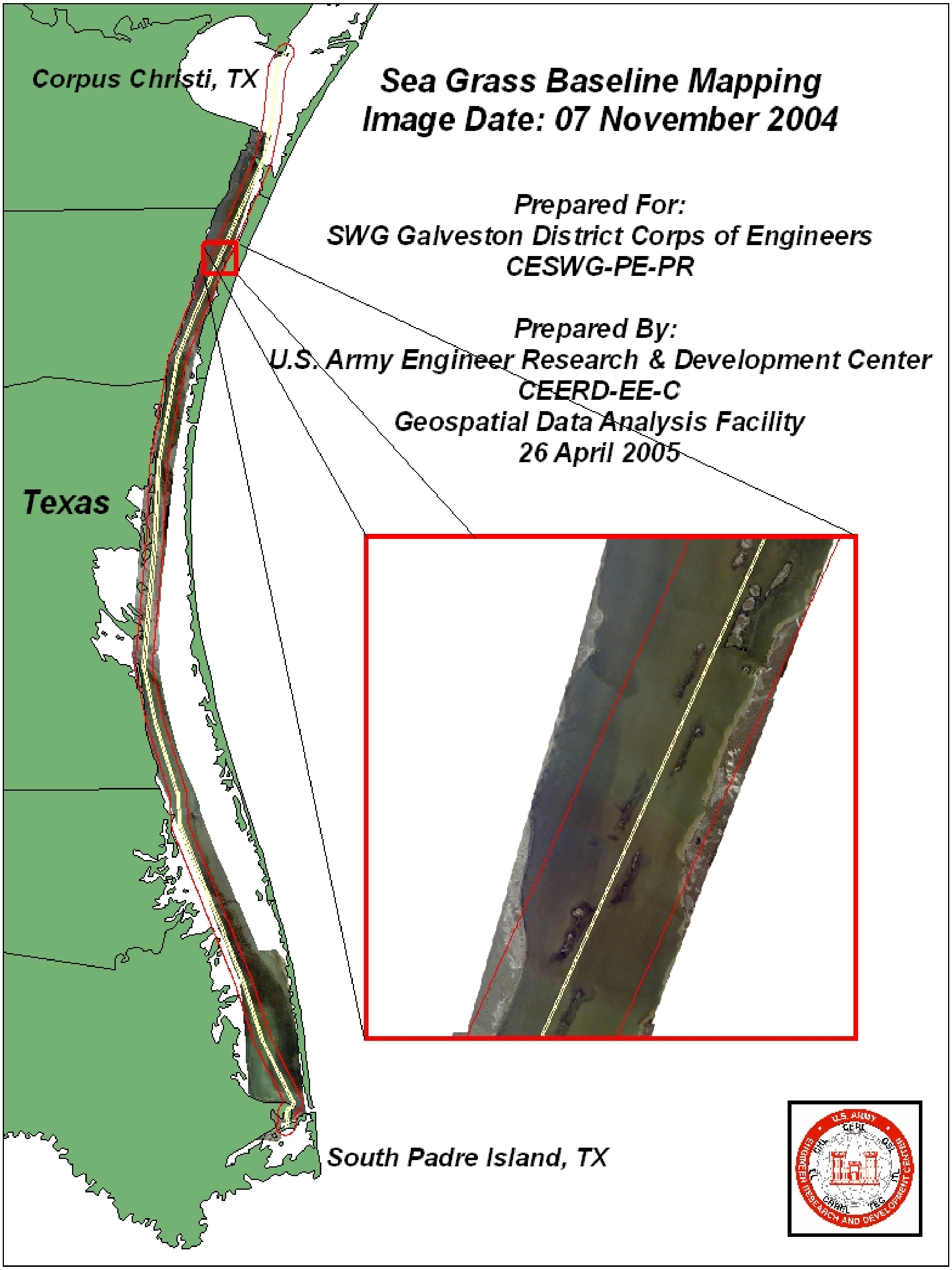
Sea Grass Baseline Mapping
Image Date: 07 November 2004
Prepared For:
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CESWG-PE-PR
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26 April 2005
Corpus Christi, TX
Texas
South Padre Island, TX

Final Report
Sea Grass Baseline Mapping
26 April 2005

Overview

This report summarizes the results of an effort to digitize and classify submersed aquatic vegetation (sea grass) within the Texas Intracoastal Waterway from Corpus Christi to South Padre Island, a distance of approximately 117 miles. The sea grass was visually interpreted and digitized on-screen from digital aerial photography. A buffer of exactly one mile was established on either side of the centerline of the waterway navigation channel. A portion (approximately 10 percent) of this buffer area was devoid of imagery due to a misalignment of the aerial flight line with the waterway channel; therefore, this area was omitted from the study area. Approximately 138,000 acres were within the project area of interest and were delineated. Areas that did not contain sea grass within this area of interest were classified as non-sea grass and consisted of land and water without visually detectable vegetation.

The baseline mapping of sea grass spatial distribution and density within the project area of interest will be used for monitoring changes in the sea grass bed habitat over time. Subsequent post-dredging surveys will be employed to assess potential changes in the sea grass distribution and density resulting from dredging and dredged material disposal operations. This analysis assesses the potential for long-term impacts to sea grasses at the landscape level.

Methods

True color aerial analog photography (Kodak Professional Supra Endura film) acquired by Aerial Viewpoint Inc. on 07 November 2004 at a nominal scale of 1:24,000, was scanned and orthorectified by Tobin International Ltd. to produce 1.2-foot resolution digital orthophotographs to be used for digitizing and classifying the sea grass beds within the area of interest. The original photograph contact prints were also used for visually depicting areas that were difficult to classify from the digital orthophotographs. Upon delivery of the digital media, the centerline of the waterway channel (obtained from Mr. David Petit, CESWG-IM) was used to establish the ±1.0-mile buffer, which constituted the geographic extent of the area of interest (less the void image area).

Before interpretation was begun a short field survey was performed. During 9-13 December 2004 a small boat acoustic-based survey of submersed vegetation was conducted near Corpus Christi, toward the north end of the area of interest, and near Port Isabel, at the south end of the area of interest. A single-beam digital echo sounder system (referred to as the Submersed Aquatic Vegetation Early Warning System [SAVEWS], see Sabol et al. 2002 for details of this equipment) was used to characterize the canopy geometry of submersed vegetation along 65 selected transects. SAVEWS outputs depth, plant height, and plant coverage at a 1-second interval (every 6-10 feet) along the transect (the system cannot presently discriminate species). A large number of rake samples were simultaneously collected with the acoustic sampling at the Port Isabel site to verify

SAVEWS outputs and to develop a species list. The purposes of this survey were to aid in training the image interpreter (interpretation done subsequent to this sampling) and to acquire data to evaluate interpretation accuracy. After processing, the output of half of the transects (randomly selected) at each site were presented to the interpreter for training and orientation.

Manual sea grass delineation was performed within this specified buffer at an image display scale of 1:4,800. The minimum mapping unit (mmu) is the smallest area that is mapped as habitat at the specified scale. In this study the mmu was set to 0.05 ac (a square 47-ft on a side, or roughly 0.1 inch on the screen at the 1:4800 scale). Digitizing at this scale enabled the interpreter to maximize the use of the digital orthophotography by “zooming in” and rendering detail not available at a scale of 1:24,000.

This mapping effort generally followed the recommendations described in the U.S. NOAA Coastal Services Center's Guidance for Benthic Habitat Mapping (Finkbeiner et al. 2001). Variances from these recommendations included interpreting the imagery at a larger scale (1:4800 as opposed to 1:24,000), use of a smaller mmu (0.05 ac as opposed to 0.25 ac), and delineation of the aquatic vegetation into more categories.

The ESRI polygon shapefile, which represents categorized sea grass beds based on their spatial distribution and apparent density, was digitized using a “heads-up” approach in an edit session of ArcMap 9.0. The analyst displayed the orthophotos on a computer screen and polygons defining the classes were digitized using a computer mouse. The display scale and mmu remained as consistent as possible during the delineation process to achieve digitizing precision and produce consistent results throughout the study area.

The sea grass beds were first segregated based on heterogeneity prior to classification. This enabled the interpreter to visualize all of the potential sea grass categories and compare them relative to one another throughout the study area to establish the baseline dataset. During the delineation process, the exterior boundary of each polygon representing a potential class was extended slightly beyond the buffer polygon boundary. This was done so that after the process was complete, the sea grass polygon shapefile could be clipped from the buffer polygon shapefile and produce clean, common arc boundaries. Following the recommendations described by Finkbeiner et al. (2001), the polygon layer was then assigned classes based on spatial distribution as either continuous or patchy. Continuous classes are defined as individual vegetation polygons having an apparent coverage above 50 percent. Patchy classes are defined as those individual polygons having an apparent coverage up to 50 percent of the total area with dominant patches being less than the mmu of 0.05 acres. Due to the large display scale used, it was sometimes difficult to extract all individual polygons that met the criteria to be classified as individual patches. Therefore, we lumped some of the individual patches into one polygon representing patchy sea grass. In addition, we merged some indistinct sea grass categories with the larger, more well-defined classes except when the class was obviously different from the neighboring sea grass bed and comprised more than approximately ten percent of the total area.

Once spatial distribution classes were established, the polygons were further subdivided into apparent density categories. These include heavy, moderate, or light sea grass for continuous and simply heavy or light for patchy. This was done to take advantage of the larger scale imagery used in this study. A continuous heavy class is defined as areas of sea grass that appear darker than nearby sea grass beds. Likewise, continuous light sea grass appears very faint and much less dense than any other continuous class. Continuous moderate is defined as sea grass beds that appear to be transitioning from heavy to light or vice versa. A patchy heavy class is defined as areas of sea grass appearing darker, more dense in clumps, than nearby sea grass beds. This class appears within continuous heavy areas where there is 50 percent sea grass cover or less and all other criteria are met for a patchy class. Patchy light sea grass beds are patches that appear lighter, less dense in clumps, than nearby sea grass beds. This class tends to appear within continuous moderate to light areas where there is 50 percent sea grass cover or less within the continuous class and all other criteria are met to be classified as patchy. A well-defined category could not be discerned for patchy moderate. Additionally, it was possible to discern areas containing drift algae at the 1:4800 scale, therefore the class ***Algae*** was added. The algae appeared as brownish red, mostly continuous in distribution, and visibly distinct areas (as opposed to sea grass) with a "flowing" or wavy pattern. The appearance suggests that the identified algae tend to be fluvial and drift about, unanchored and suspended in the water column. An example of the sea grass categories is illustrated in Figure 1. It is anticipated that the establishment of these classes will allow for a better categorization for monitoring sea grass changes over time.

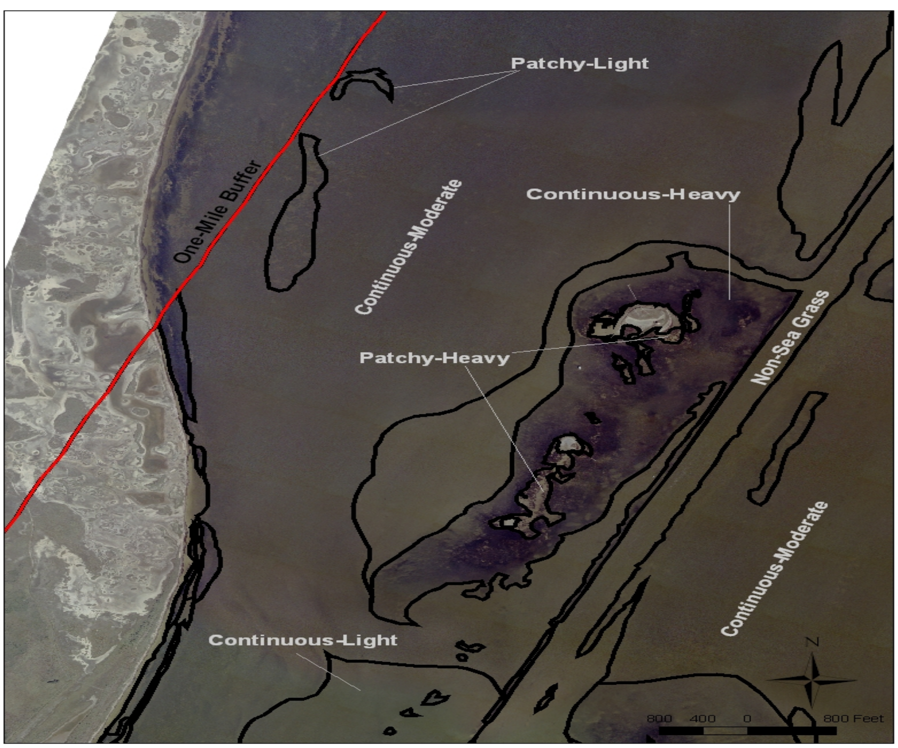

Figure 1. Snapshot of classified sea grass based on spatial distribution and density estimation.

Detailed metadata, compliant with Federal Geographic Data Committee (FGDC) guidelines, were produced for the sea grass polygon shapefile. In addition, 1:24,000 hardcopy (paper) maps depicting the sea grass categories within the study area were produced.

Results

The baseline delineation of sea grass is summarized in Table 1. It includes the number of regular, unbroken polygon features representing the class and an area summarization for each class (expressed as total per class and percent of total of the entire area of interest) along with descriptive statistics for the features within each class.

Table 1. Coverage area breakdown of sea grass classifications expressed in acres and percent of total and descriptive statistics for features within each class.

Sea Grass Classes				Polygon features within class		
Class	**Number of polygons**	**Acres**	**% Total Area**	**Minimum Acres**	**Maximum Acres**	**Average Acres**
Continuous-Heavy	474	23,607.80	17%	0.05	2,765.21	49.81
Continuous-Light	137	3,959.41	3%	0.09	1,029.72	28.90
Continuous-Moderate	225	14,628.69	11%	0.05	1,762.56	65.02
Patchy-Heavy	275	5,828.14	4%	0.08	1,576.56	21.19
Patchy-Light	148	4,015.18	3%	0.08	491.02	27.13
Algae	10	23.49	0%	0.31	6.70	2.35
Non-Sea Grass	1	85,981.47	62%	-----	-----	-----
TOTAL	**1270**	**138,044.17**	100%	-----	-----	-----
Continuous	836	42,195.90	31%	0.05	2,765.21	50.47
Patchy	423	9,843.32	7%	0.08	1,576.56	23.27
Algae	10	23.49	0%	0.31	6.70	2.35
Non-Sea Grass	1	85,981.47	62%	-----	-----	-----
TOTAL	**1270**	**138,044.17**	100%	-----	-----	-----
Heavy	749	29,435.94	21%	0.05	2,765.21	39.30
Moderate	225	14,628.69	11%	0.05	1,762.56	65.02
Light	285	7,974.59	6%	0.08	1,029.72	27.98
Algae	10	23.49	0%	0.31	6.70	2.35
Non-Sea Grass	1	85,981.47	62%	-----	-----	-----
TOTAL	**1270**	**138,044.17**	100%	-----	-----	-----

Future Considerations

Analog interpretation, as performed here, is inherently a subjective process (Finkbeiner et al. 2001). Results depend on a host of factors including image quality, scale, interpreter experience, turbidity, wind, and depth. While an accuracy analysis was not within the scope of work for this effort, we do plan to complete this analysis under separate funding sources. Results from this analysis will be made available and should lead to specific recommendations for future surveys in the waterway. Based on our experience to date several specific recommendations can be made.

Delineation was restricted to a one-mile buffer area of interest on either side of the waterway channel for the 117 miles. The acquisition flight line was positioned to maximize sea grass coverage over the habitat area, which did not necessarily align with the buffer area of interest. As a result, approximately 10 percent of the available area (15,524 acres) of interest was void of imagery. The flight line and photo acquisition should coincide with the sea grass coverage to be delineated in order to fully utilize the photography. A decision should be made prior to the next acquisition for mutual placement of the flight line and delineation area of interest, so as to maximize the available imagery and render complete results for the area of interest.

Adjusting the width of the analysis to cover the entire photograph scene instead of restricting to only within the 2-mile corridor along the channel could also be considered. However, doing this will increase the cost considerably.

Based on an internal decision, we opted to perform the interpretation and delineation at a scale of 1:4,800, a larger scale that that suggested by NOAA. While this made the task more rigorous and time-intensive it resulted in a finer level of detail, both quantitatively and qualitatively. This should prove valuable in future efforts to resolve changes over time. However, the absolute necessity of this has not been determined. If it is decided to perform future surveys at this level, it will be necessary to adjust cost estimates to cover the extra level of effort. If future surveys aerial interpretation efforts are performed at the 1:24,000 scale then results from this baseline survey can be collapsed into the coarser resolution. To cross-reference or relate the classification implemented in this study with NOAA recommendations, one would simply merge all polygon features less than 0.25 acres with the adjoining class, essentially producing a sea grass layer with a mmu of 0.25 acres. Likewise, to collapse the classes established in this study so that they coincide with Finkbeiner's suggested classes, one would simply dissolve the heavy, moderate, or light sub-category within its associated continuous or patchy class. Also, in order to establish a visual discrepancy for comparing future interpretation estimates to these baseline estimates and to better assess and monitor change over time, the November 2004 baseline sea grass layer will be superimposed with the new acquisition photography to better identify areas of change or transition.

References:

Finkbeiner, M., Stevenson, B., and Seaman, R. (2001). U.S. NOAA Coastal Services Center, "Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach." Technology Planning and Management Corporation, Charleston, SC. (NOAA/CSC/20117-PUB).

Sabol, B., Melton, R. E., Chamberlain, R., Doering, P., and Haunert, K. (2002). "Evaluation of a Digital Echo Sounder System for Detection of Submersed Aquatic Vegetation," *ESTUARIES,* Vol. 25, No.1, p. 133-141.