San Diego Bay Terrain Model

Progress Report (August 1, 2011 through October 31, 2011)

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Purpose of the grant:

The main goal of this project is to define the potential impacts of sea level rise due to global climate change on the habitats of San Diego Bay's wetlands and eelgrass beds.

Objectives

Key concerns include sea level rise, coastal wetland alteration, possible eelgrass habitat loss, and San Diego's adaptation to sea level rise. The IPCC (Intergovernmental Panel on Climate Change) estimates that the global average sea level will rise between 0.6 and 2 feet (0.18 to 0.59 meters) in the next century and that by 2100, sea level rise could convert as much as 33 percent of the world's coastal wetlands to open water**.** However, more recent estimates by Vermeer and Rahmstorf (2009, published in the Proceedings of the National Academy of Sciences) who based their analysis on measurements of sea level and temperature taken over the past 130 years, identified a strong link between the rate of sea level rise and global temperature and project a sea level rise of 0.75 to 1.9 meters by 2100.

Specific objectives of the San Diego Bay Terrain Model project include:

1. Couple a high-resolution LiDAR digital elevation model of San Diego Bay's watersheds (recently developed from City of San Diego LiDAR data), with the high resolution bathymetry to be developed by Dr. Neal Driscoll at SIO, to generate a relatively seamless digital map of San Diego Bay's terrain.

2. Using the seamless high resolution terrain model of San Diego Bay generated above, delineate the specific effect of sea level rise on eelgrass and wetland and benthic habitats of San Diego Bay.

3. Using the SLAMM (Sea Level Affects Marshes) Model, delineate the effect of sea level rise on San Diego Bay's 's National Wildlife Refuge including the Sweetwater Marsh Unit and the South Bay Unit. This modeling will allow prediction of wetland inundation (and associated habitat change) under the range of plausible sea level rise scenarios.

Description of Work Completed

To date, we have been making steady progress towards the goals detailed above.

Sea-level rise will have a variety of effects on eelgrass habitat. Increased water depth will restrict the amount of light reaching seagrasses, and depending on the bathymetry of the Bay and topography of the surrounding landscape, change the geographic distribution of the eelgrass habitat. In addition, changes in tidal dynamics (e.g., water current speed, circulation flow patterns, tidal range) could have a range of impacts including reductions in light, an increase in water column turbidity, and alterations of the temperature regime. Based upon our current understanding of eelgrass distribution, it does indeed seem likely that sea level rise will move the maximum depth of eelgrass growth and abundance closer to the current shoreline. The aim of the current effort is to use the seamless San Diego Bay Digital Elevation Model to better quantify this impact of sea level rise.

San Diego Bay Digital Terrain Model Mosaic

A seamless bathymetric/topographic digital elevation model (DEM) has been developed in this project for San Diego Bay (Figure 1) .The gridding and merging of the bathymetric and topographic data were accomplished using the data conversion, buffering, clipping, interpolation, mosaicking, and smoothing tools available in the ArcInfo GIS package. The resulting merged bathymetric/topographic model was output in the ArcInfo GRID format.

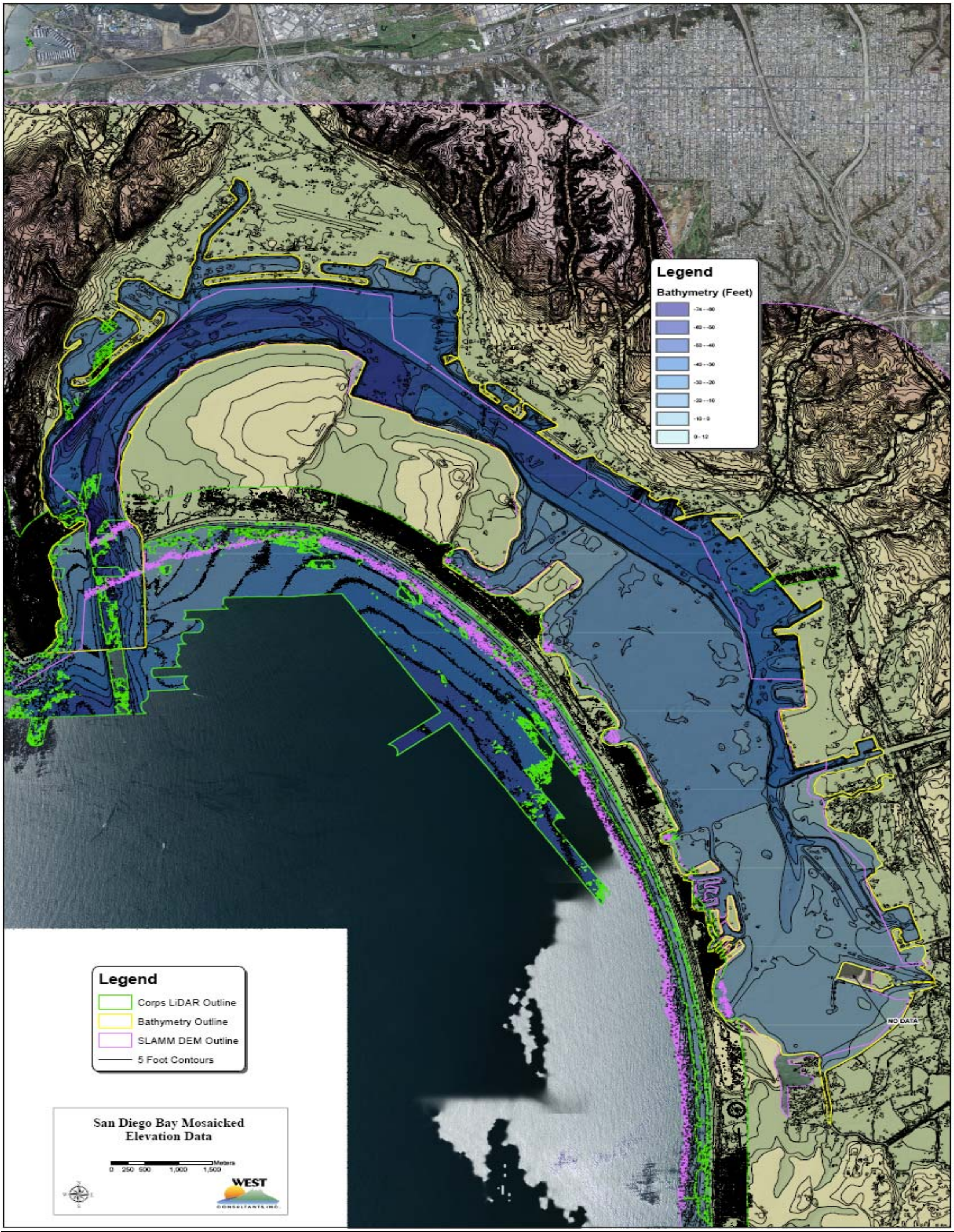

Figure 1. The Seamless San Diego Bay Terrain Model

Results

Eelgrass Analysis

The depth (elevation) distribution of Eelgrass in the southern portion of San Diego Bay was analyzed in ArcGIS. The bathymetry grid (DEM) was extracted using the Eelgrass polygons provided from the Port District from the 2008 survey (Figure2) . Descriptive statistics were determined from the resulting grid.

Minimum elevation (ft)	-18.3
Maximum elevation (ft)	4.11
Mean (ft)	-3.07
Standard deviation (ft)	1.92
Count (1-meter cell)	2,675,558 (661 acres)

Assuming a normal distribution the range of elevation for Eelgrass in this area is -6.87 feet for the lower limit and an upper limit of 0.73 feet for the 95% confidence interval.

Three sea level rise scenarios were then modeled to estimate Eelgrass loss: 1-meter, 1.5 meter, and 2-meter sea level rise. The grid derived above was reclassified using the “lower limit” values in the table below. For example, for the 1.5-meter sea level rise scenario, raster (grid) values below -1.95 were reclassified to a value of 1, and values above -1.95 were reclassified as NoData. The number of grid cells in the resulting raster were determined (Count) and compared to the count from the bathymetry/eelgrass extraction (above) to estimate the percentage loss of Eelgrass under the 1.5-meter rise scenario.

Sea level rise scenario	1-meter	1.5-meter	2-meter
Lower limit (ft)	-3.95	-1.95	-0.31
Count (1-meter cell)	985,318 (243 acres)	1,954,032 (483 acres)	2,489,196 (615 acres)
% loss	36.8	73.0	93.0

The results are mapped on the attached Figure 3.These results indicate that the loss of current eelgrass beds under the current projected sea level rise for California of about 1.5m (assuming that depth is the main controlling factor determining eelgrass occurrence) could be very significant at about 73%. At 2 m sea level rise, the loss is dramatic at 93%.

Of course, as sea level rises, previously dry or very shallow regions of San Diego Bay can become deeper and if not bulkheaded or developed already, the Bay’s eelgrass can migrate inland to these new areas. The step this next quarter will be to estimate areas for potential migration of Eelgrass under sea level rise scenarios using the seamless DEM.

Significance and Next Steps

The development of a San Diego Bay bathymetic/topographic model, has resulted in a prototype digital product that that can be employed for marine GIS and coastal zone management applications. It demonstrates how disparate spatial data can be utilized together if they are first transformed to a common reference coordinate system. Use of a merged seamless elevation model as a base data layer facilitates overlay and incorporation of other spatially referenced coastal and marine datasets. The base DEM can easily be converted to support mapping and other GIS applications, enhanced for data visualization, used for input to 2-D and 3-D environmental models, and employed in a predictive fashion to model the habitat (eelgrass and coastal wetlands) and infrastructure effects of sea level rise. Then we can make some inferences about eel grass distribution under sea level rise conditions.

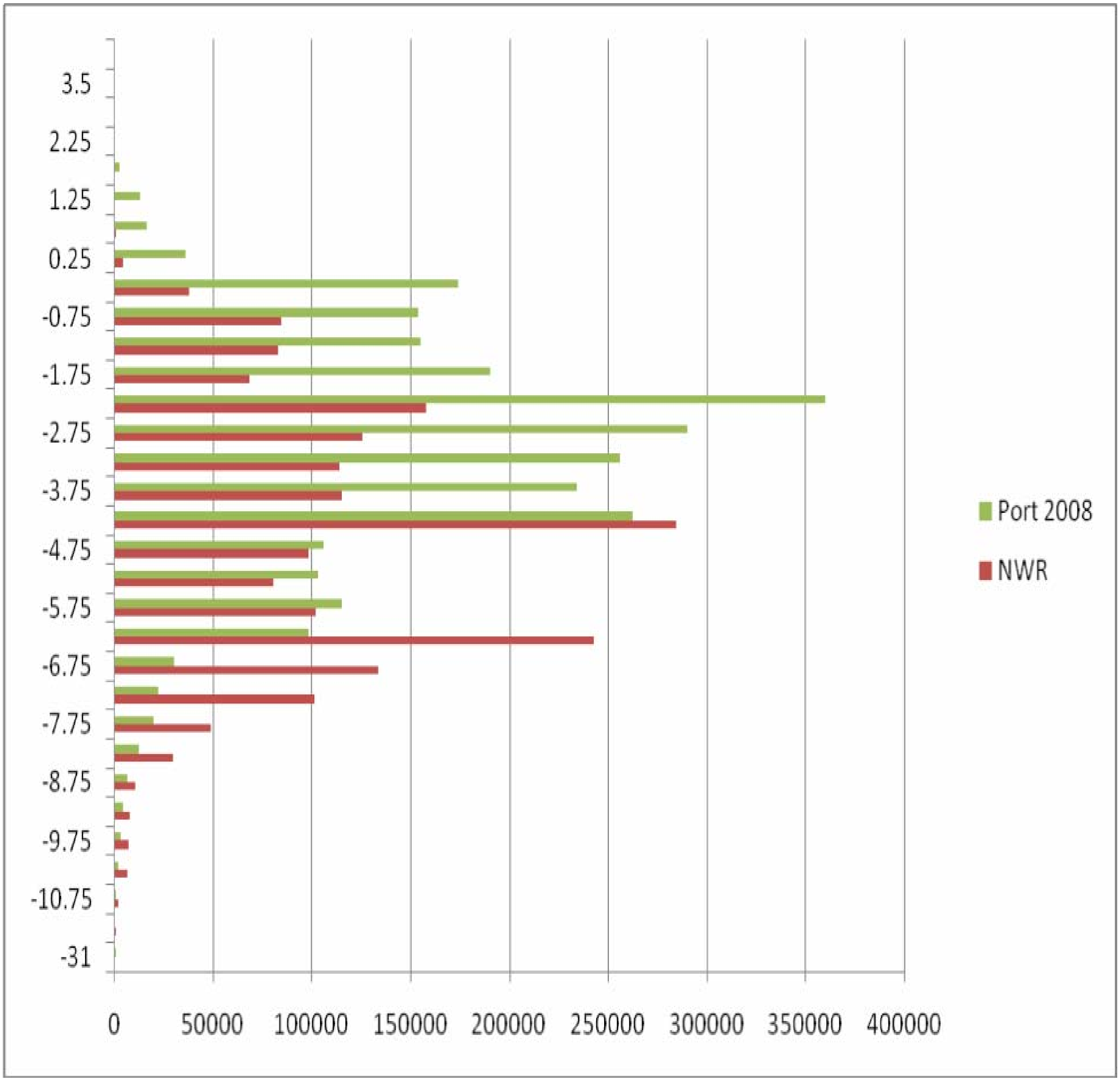

Figure 2. Same frequency distribution of eelgrass areas (as above) without DEM, and scale amplified for clarity.

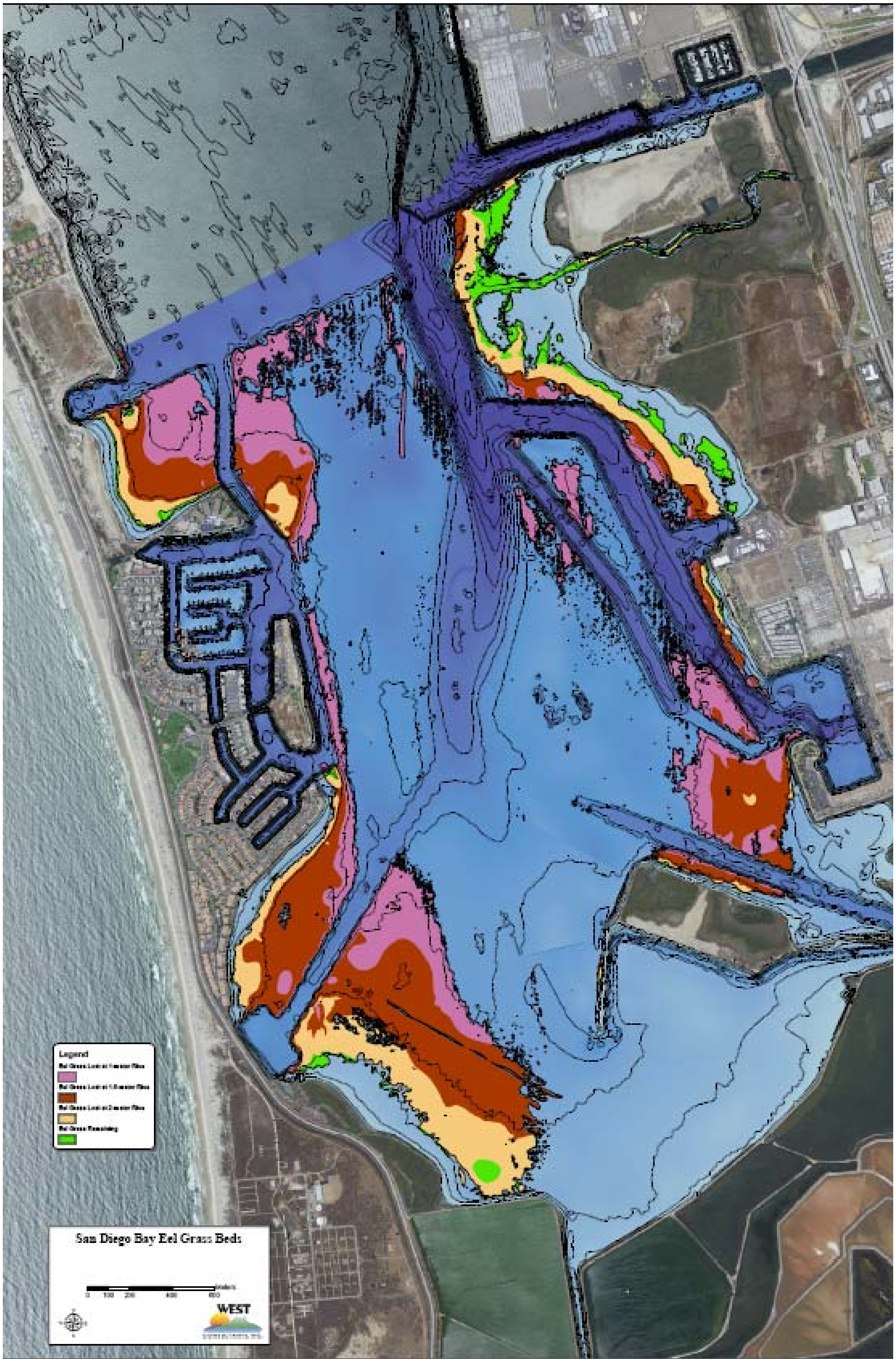

Figure 3. Predicted Loss of Eelgrass in Southern San Diego Bay as a Result of Sea Level Rise. Pink shows the area extent of eelgrass loss at 1 m SLR; reddish-brown the additive loss of eelgrass at 1.5 m SLR, and tan the additive loss at 2mSLR. Green shows the eelgrass remaining with a 2 m SLR not taking into account eelgrass migration to new flooded areas inland.

Anticipated Work for the Next Reporting Period

1. The next step will be to estimate areas for potential migration of Eelgrass under sea level rise scenarios using the seamless DEM. Such statistical frequency distributions of eelgrass abundance versus depth (added to the field verification of this with Dr. Todd Anderson) will allow us to generate a predictive capability with which to model the effect of sea level rise on eelgrass habitat.