FACT SHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Midwest Regional Carbon Sequestration Partnership (MRCSP)

NETL Cooperative Agreement DE-FC26-05NT42589

DOE/NETL Project Manager: Traci Rodosta,
Traci.Rodosta@NETL.DOE.GOV

Submitted by Battelle

November 2009

Terrestrial Field Test: Wetlands-Blackwater Refuge

Principal Investigator	Brian Needelman	University of Maryland	bneed@umd.edu
Field Test Name	Wetlands: Carbon sequestration in restored tidal marshes at Blackwater National Wildlife Refuge.		
Test Location	Cambridge, MD		
Amount and Source of CO_2	Tons: N/A	Source: Atmospheric	
Field Test Partners (Primary Sponsors)	Maryland Department of Natural Resources Power Plant Research Program		
	Maryland Energy Administration		

Summary of Field Test Site and Operations:

The Blackwater National Wildlife Refuge is considered a wetland of international importance, has been identified as 1 of 6 priority wetland areas by the North American Waterfowl Management Plan, and is called one of the "Last Great Places" by the The Nature Conservancy. An estimated 8,000 acres of tidal marsh have been lost since the 1930's at Blackwater due to sea-level rise, subsidence, erosion, salt water intrusion, and herbivory by invasive species. Current tidal marsh loss rates are estimated at 150-400 acres per year. The Army Corps of Engineers and the U.S. Fish and Wildlife Service (USFWS) is currently developing a long-term project to use clean dredged material from the Baltimore Harbor shipping channel to restore up to 20,000 acres of tidal marsh at Blackwater and in the surrounding mid-Chesapeake Bay region.

In order to test and develop restoration methods using dredged material, a tidal marsh restoration project was undertaken in 2003. Scientists are currently monitoring these sites for elevation changes and vegetation status. The MRCSP has added data collection on C sequestration in order to use these sites as field validation tests for this technology.

Little is known about carbon sequestration rates in these systems. In natural marshes, high net primary productivity and low decomposition rates lead to high carbon concentrations. If a marsh is able to accrete with sea-level rise, exceptionally high carbon sequestration rates can occur relative to other terrestrial systems. Sequestration rates in restored marshes may be higher than in natural marshes if the ecosystem follows an increasing trend towards natural marsh carbon densities. However, rates may be lower if the restored marshes do not have the same net primary productivity of natural marshes.

Research Objectives:

- Develop estimates of C sequestration rates in restored marshes across time
- Understand influence of management practices on C sequestration rates in restored marshes
- Improve fundamental understanding of basic processes controlling C sequestration in marsh soil profiles
- Develop sampling protocol for C sequestration validation in restored marshes

Summary of Modeling and MMV Efforts:

The study is being conducted on one restored tidal marsh cell created in 2003 and one natural marsh cell. Within each cell, 45 plots have been laid out for annual soil core and vegetation data collection (Figure 1). Feldspar markers are being used to mark initial surfaces (pre-accretion), in subsequent years samples will be collected above and below the initial marked surface. Upon collection, soils are divided into horizons, and analyzed for bulk density and carbon. A subset of samples is analyzed for particle size. Equipment at each cell include a recording well, a temperature logger, and redox electrodes. Additional data being collected include porewater chemistry (salinity, nutrients, sulfides, dissolved methane) and methane emissions.

Each marsh cell has three surface elevation tables (SETs). These mechanical leveling devices are used to determine relative elevation above or below a benchmark in wetland sediments. At each SET, three transects were created beginning 3-4 m from the SET and running to the edge of the marsh. Along each transect, 4-6 marker plots (60 x 40 cm) were laid out depending on the length of the transect and the variability of the terrain and vegetation (44 plots in the restored marsh and 41 in the reference marsh). Finely ground feldspar was applied at each plot to a depth of approximately 5 cm in May–June 2006. The feldspar forms a bright white layer on the soil surface that is being tracked over time as the marsh accretes. The design allows for future sample collection within the feldspar marker plots. In addition, each cell has a datalogged well and a datalogged temperature probe.

At each plot, a soil core was collected annually using a McCauley peat auger to a depth of 50 cm. This auger removes an intact core and minimizes compaction and vertical distortions. Samples are divided by horizon (if apparent), by the presence of the feldspar marker horizon, or by 25-cm increments (if horizons were not apparent) and bagged in the field. Color and horizon designation are recorded according to standard soil description procedures. Samples were collected in 2006, 2007, and 2008.

Bulk density and total carbon content were calculated on each horizon. Each sample was weighed moist and homogenized. Then 5 g subsamples were oven dried at 105^{o}C for calculation of water content. Bulk density was then calculated as the estimated dry sample mass divided by core volume. Organic carbon and total nitrogen were measured using high temperature combustion with a Leco CHN2000 (Leco Corp., St. Joseph, MI).

Our methodology was not successful for the quantification in changes in subsurface carbon contents in tidal marsh soils. The challenge with marsh soils is that they are highly dynamic in their volume plus they are continually accumulating material near the surface. Therefore, the samples taken to a depth of 50 cm may have represented different soil layers across years such that the different in carbon contents did not necessarily reflect net carbon gains or losses. We had originally planned to address this complication through the use of marker horizons in the soil profiles; however, these horizons proved to be inconsistent and were therefore not reliable. Our proposed solution is to install an earth anchor, a metal rod with a horizontal plan at its base (similar to a screw). This would then serve as a reference plane for future sampling. If the soil layers become denser above this reference plane, then the samples will be collected to a shallower depth; if they loosen, then sampling will be deeper.

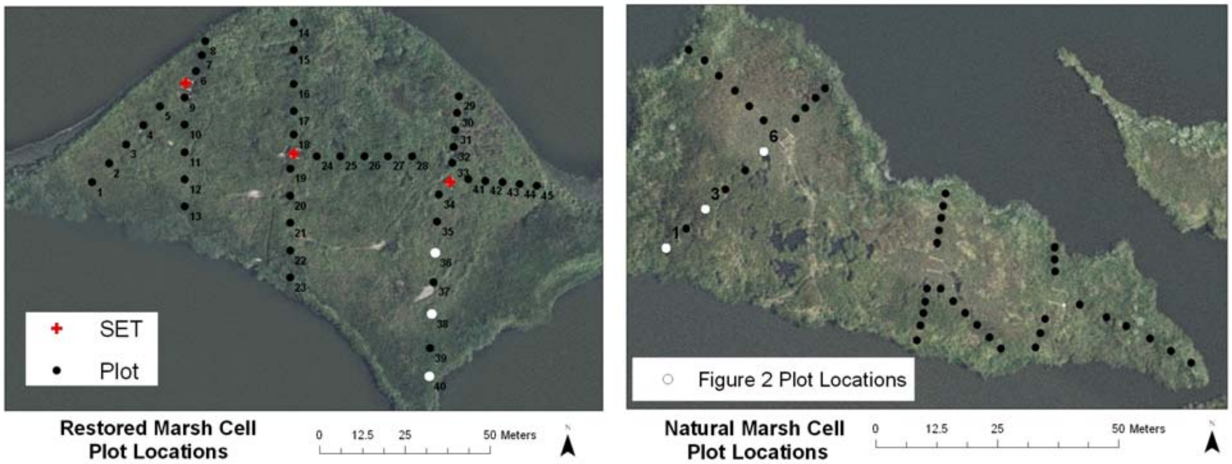

Figure 1. Surface elevation table (SET) and plot locations for the restored and natural (reference) marshes at Blackwater National Wildlife Refuge.

Accomplishments to Date:

The Phase II studies on terrestrial carbon sequestration in restored tidal marshes have resulted in the following research findings:

- The restored and natural marsh at the Blackwater National Wildlife Refuge are sequestering carbon at an above-average rate versus the national average based solely on surficial accumulation, which is probably an underestimate.
- At the rate of 3.4 Mg C ha^{-1} yr^{-1} of surficial carbon sequestration, the proposed 8,000 ha restoration would sequester about 27,000 tonnes C ha^{-1} yr^{-1} (or 110,000 tonnes CO_2 ha^{-1} yr^{-1}). The rate of carbon sequestration would likely vary across wetland types within the proposed restoration; however, this estimate is within the range typically found in this region. This estimate is conservative because it is only accounting for surficial carbon deposits.
- The earth anchor method appears to be a viable method to perform carbon accounting deeper into the soil profile.
- A significant portion of the carbon sequestration benefit in these marshes is offset through methane emissions.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

Current proposals include estimates of up to 8,000 hectares of marsh restoration in the mid-Chesapeake Bay region. Modeling work has estimated that the C sequestration rates in these marshes may range from 2.5 to 5.7 Mg C ha^{-1} yr^{-1}. Note that these estimates are approximate and are highly dependent on rates of organic matter accumulation and sea-level rise. At these values the full restoration would sequester 20,000 to 45,600 Mg C yr^{-1} or 75,000 to 170,000 Mg CO_2 yr^{-1}.

Cost*:

Total Project Cost: $26,320

DOE Share: $20,033 (76%)

Non-Doe Share: $6,287 (24%)

(*) Costs are for overall MRCSP Phase II project, reported in thousands.