Georgia Coastal Ecosystems Long Term Ecological Research Project
Marsh Hammock Research – 2008

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The Georgia Coastal Ecosystems (GCE) Long Term Ecological Research (LTER) project (http://gce-lter.marsci.uga.edu/) is investigating the underlying mechanisms by which proximity of marshes to upland habitat drives ecosystem change along lateral gradients in the intertidal zone. Our approach to this question involves taking advantage of marsh hammocks as a natural laboratory for evaluating the influence of landscape structure and freshwater input on marsh processes. The hammock research includes basic characterization of groundwater flow as well as physical and biological characteristics at selected sites, experiments designed to understand the effects of manipulating water flow on marsh processes, and modeling. Our activities this past year included processing samples from the broad survey conducted in 2007; continuing archeological studies; and instrumenting selected hammocks for intensive study.

2007 Survey

The 2007 survey involved sampling 55 hammocks of varying sizes and origin. The work included intensive characterization of each site in terms of its geomorphology, stratigraphy, water table characteristics, and flora and fauna. Our analyses to-date suggests that there are differences in grain size, pore water salinity, and plant community in hammocks of different origin and/or size.

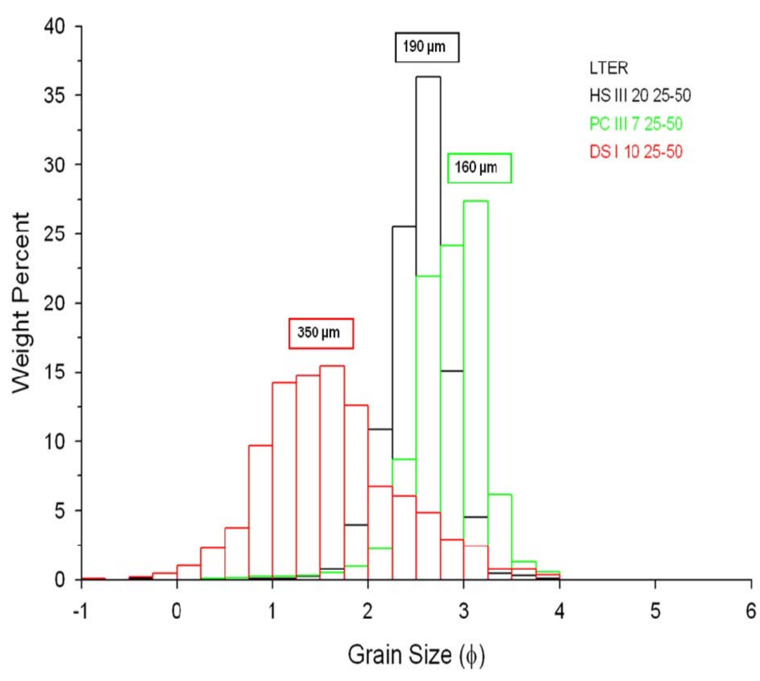

Figure 1. Grain size distribution in hammocks of Holocene (black), Pleistocene (green), and dredge spoil (red) origin.

Grain size analysis (C. Alexander) shows clear differences in the sediment associated with hammocks of different origin: the average grain size of hammocks created by dredge spoil is coarser than that of hammocks of Holocene origin, which is in turn coarser than those of Pleistocene origin. As expected, the percent sand in Holocene hammocks is greater than that in those of Pleistocene origin. An example comparing the grain size distributions of the sediments from three hammocks is shown in Figure 1. Hammocks created by ballast stone are comprised of large rocks and do not have soil suitable for grain size analysis.

Although there was variability in pore water salinity of the different hammocks sampled, there is an indication that salinities were lower on larger hammocks. This is consistent with our predictions, based on the fact that these hammocks have larger water tables. Nutrient data are still being evaluated but no statistical differences were observed in our initial analysis of pore water dissolved organic carbon and total dissolved nitrogen concentrations.

Data on the characteristics of the plant community in the high marsh adjacent to the upland area of the hammocks were collected by A. Lynes (MS student, UH) and analyzed by C. Hladik (PhD student, UGA) (Figure 2). *Borrichea frutescens* was most often the dominant plant in quadrats sampled in the high marsh bordering hammocks of ballast stone, Holocene, and Pleistocene origin. *Spartina cynosuroides* was frequently the dominant plant on dredge spoil hammocks. Ballast stone and dredge spoil hammocks tended to have fewer species appearing as dominant, while there were more species appearing as dominant on Holocene and Pleistocene hammocks. Notably, *Juncus roemerianus* was never dominant on ballast and dredge hammocks.

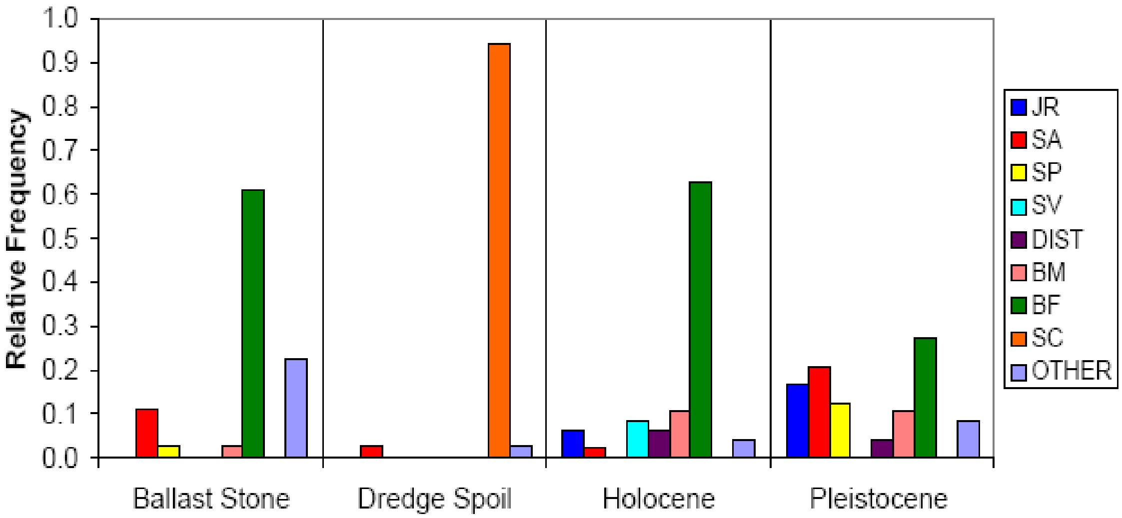

Figure 2. Dominant plants observed in quadrats sampled in the high marsh of hammocks of different origin. Plant species: *Juncus romerianus* (JR), *Spartina alterniflora* (SA), *Spartina patens* (SP), *Salicornia virginica* (SV), *Distichlis spicata* (DIST), *Batis maritima* (BM), *Borrichea frutescens* (BF), *Spartina cynosuroides* (SC).

There were also differences in the plant communities of hammocks of different size classes. Species diversity was greater on smaller hammocks and decreased with increasing hammock size, for both Holocene and Pleistocene hammocks. *B. frutescens* had the highest frequency of dominance on smaller hammocks; *J. roemerianus* was most dominant on hammocks of intermediate size; and *S. patens* had the greatest frequency of dominance on larger hammocks. Statistical analysis (non-metric multidimensional scaling) of plant community structure to evaluate differences in both hammock size and origin is ongoing.

The data collected from this effort are now being input into both GIS and Access to develop a synchronized database. The data will be used to characterize hammocks and explore relationships among a series of independent (i.e. upland physical characteristics) and dependent (i.e. marsh biodiversity, plant and animal distributions) variables.

Archeological studies

We are particularly interested in the distribution of shell deposits left by the Native American occupants, because such deposits affect soil chemistry and landform exposure, and therefore may mediate high-marsh ecosystem processes by affecting the quality and quantity of water reaching the high marsh. Other legacy effects on current ecosystems might be mediated by changes in soil nutrient structure and permeability associated with fire, latrines, and seafood processing. V. Thompson and his students and colleagues have performed archeological surveys of four hammocks to date. Surveying these areas involves shovel test probes at 20 meter intervals. All sites are mapped and drawn according to standard archaeological procedures using GPS and a total station. All observable human modification to the landscape such as existing historic structures, canals, fences indicating livestock, etc. are also included. Thompson is also currently working on a database that includes reconnaissance information on over 100 islands. Thompson, J. Turck (PhD student, UGA), and C. DePratter (USC) will deliver papers based on the hammock work in symposiums at the Southeastern Archaeological Conference and the Society for American Archaeology meeting in Atlanta (April 2009).

Intensive hammock research

The marsh/upland surveys described above are designed to evaluate how high marsh habitats are related to a range of upland characteristics, but they will not provide detailed measurements of water flow paths or biogeochemical processes, both of which we hypothesize serve to mediate the observed distributions of plants and animals. We therefore plan intensive studies designed to characterize freshwater inflow to high marsh communities in more detail, to relate it to upland characteristics, and to determine how it affects marsh community structure.

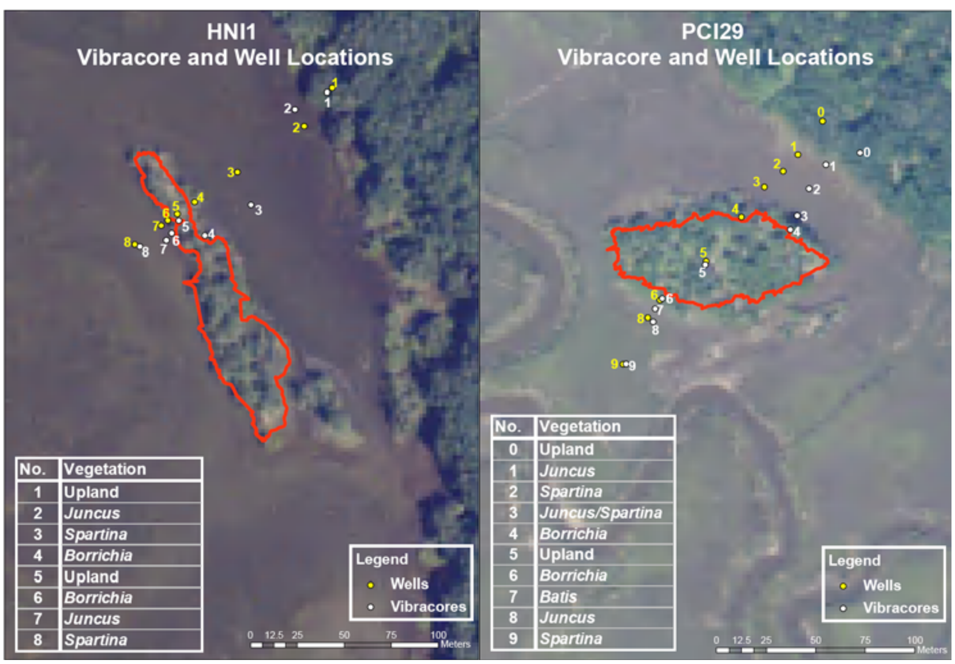

Figure 3. Locations of wells (yellow) and vibracore samples (white) on a Holocene (HNI1) and Pleistocene (PCI29) hammock. Tables show the dominant vegetation at each location.

This past year we selected two hammocks for more detailed study: HN_I_1 is of Holocene origin and is located adjacent to Blackbeard Island to the north of Sapelo; PC_I_29 is of Pleistocene origin and is located adjacent to the south end of Sapelo Island. These are of similar size, with similar vegetation zones in the high marsh. We set up transects in each hammock that run from the nearby upland (Blackbeard and Sapelo Islands, respectively), through the marsh, and up and over each hammock to the marsh adjacent to the Sound (Sapelo and Doboy, respectively) (Figure 3).

C. Alexander led a field team that took vibracore samples along the transects to get detailed information about stratigraphy. These cores show that the sedimentology of these features argues for distinctly different physical and stratigraphic processes dominating their formation. The morphology of the Holocene and Pleistocene marsh islands differs significantly, with the former being long and linear, and the latter more equidimensional. Stratigraphically, Holocene marsh islands consist of fine sand beds resting unconformably on older marsh muds, which grade downward into interbedded tidal channel deposits. Pleistocene hammock stratigraphy is more varied, exhibiting fine to medium sandy beds to marsh muds, is dominated by interbedded channel deposits, and represents a longer time over which formation and modification has occurred (Figure 4). Pleistocene hammocks also frequently exhibit an overprint of Native American habitation and usage during the past 4,000 years, in the form of shell middens. Accelerator Mass Spectrometer C-14 and Optically Stimulated Luminescence dating are being used to constrain the times over which these features formed, and grain size and x-radiography illustrate the differences in sedimentary processes important in the genesis of each.

The vibracore results were used to guide the placement of wells. Wells were placed in sand layers in order to prevent clogging and to allow sampling of a continuously connected groundwater source along the entire distance of both transects. The stratigraphy is very complicated at the Pleistocene site, however, and it is unlikely that every well is located in the same groundwater source. In addition to the vibracore stations, two additional lateral wells were installed at HN_I_1 approximately 5 meters to either side of the main transect near well #4 in order to get data on lateral inflow of groundwater. An additional upland well will be installed at this site in order to obtain a true zero salinity end member. The wells range in depth from 41 to 110 cm below a constant zero datum (99 to 232 cm below the surface). At PC_I_29, the two lateral wells are located near well #6. Well depths at this site range between 75 and 168 cm below a zero datum (130 to 247 cm below the surface).

Pressure, salinity, and temperature loggers were placed into the select wells at both sites to collect data at 10-minute intervals; these data will be used in the groundwater modeling efforts. Groundwater biogeochemistry and radium samples were collected in August and September 2008. Sample collection will continue on monthly intervals, with additional samples planned to capture spring/neap tide and storm event signals.

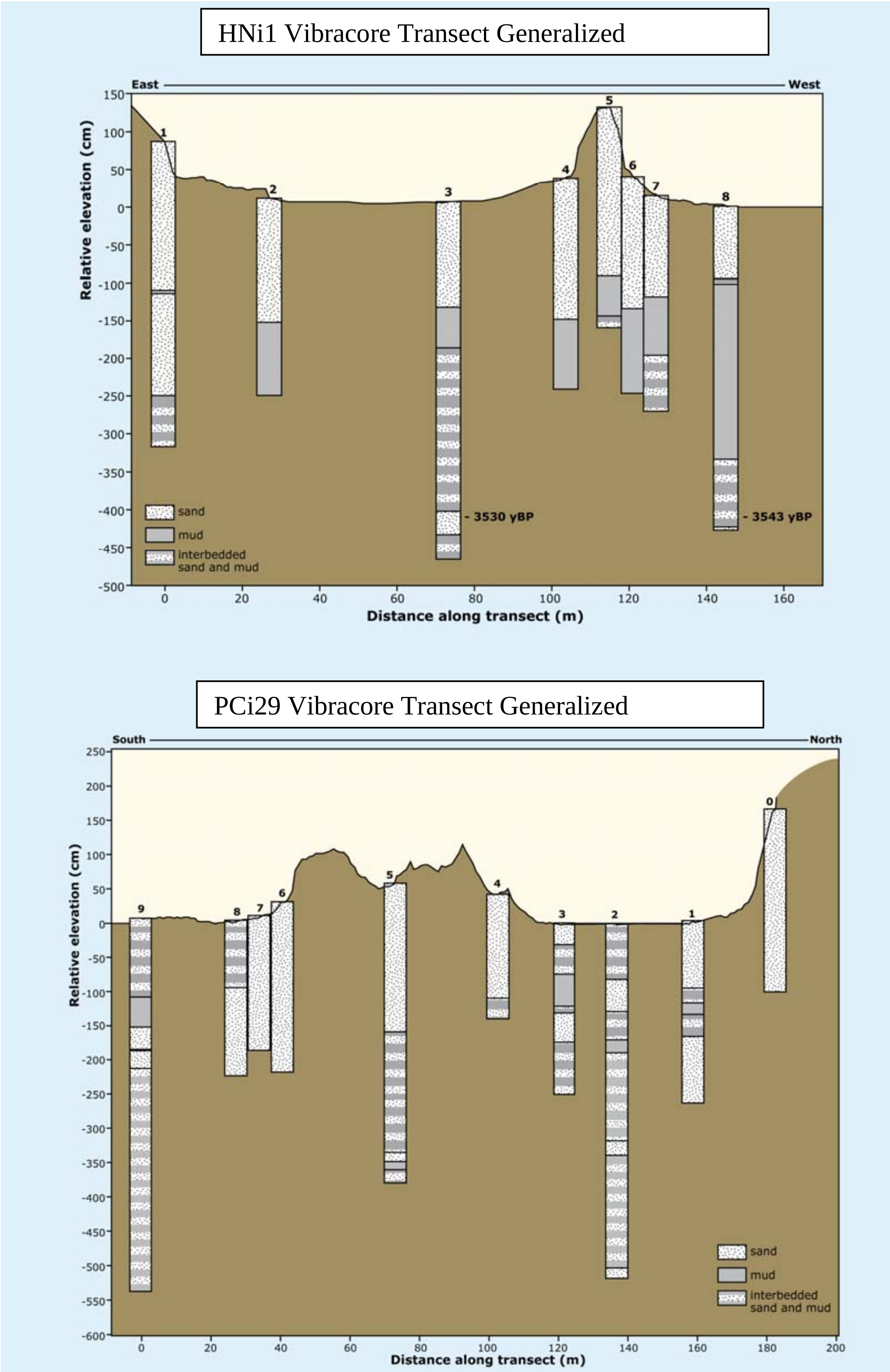

Figure 4. Stratigraphic profiles obtained from vibracore samples taken at HNI1 and PCI29. Figures show relative surface elevation along the transect.