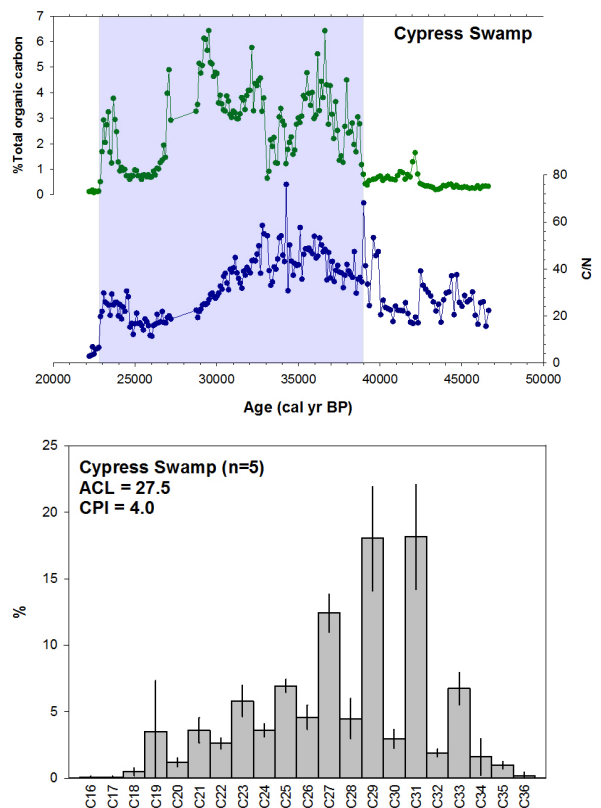**PRF# 57422**
Characterizing Organic Matter Accumulation in Freshwater Coastal Plain Wetlands
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Summary: The goal of this project is to assess the characteristics of organic matter that has accumulated in freshwater wetlands across parts of the Atlantic Coastal Plain. Through the examination of multiple sites, I am working to compare and contrast organic carbon accumulation, sources of organic matter, and the paleoenvironmental influences on characteristics of their accumulation. During this project year, work has focused on detailed analysis of sediment cores recovered from Atlantic Coastal Plain sites that include, the Cypress Swamp Formation in southern Delaware, and Great Dismal Swamp in southeastern Virginia. In addition, an investigation into a depression wetland complex in central Virginia at Maple Flatts. Cores have been recovered from each site and have been analyzed for their physical properties, bulk organic matter properties, and *n*-alkane composition. The data collected have all been generated by undergraduate research students and over the past year, and four undergraduate research students have been supported. A summary of progress on the evaluation of each site is provided below, as well as a plan for research to be conducted in the next project year.

Cypress Swamp Formation: A detailed stratigraphic analysis of two cores through the Cypress Swamp Formation has been undertaken as part of this project. This past year, my students and I have focused on analyzing high-resolution changes in total organic carbon (TOC) and organic carbon to nitrogen ratios (C/N) in core sections that contain a late Pleistocene sequence of organic matter in an otherwise sandy and organic-poor formation. The age range of these profiles are defined by six radiocarbon dates providing firm chronological control and constraining the buried organic matter unit to c. 39-23 cal ka BP. We are investigating questions about the conditions that led to this spatially extensive organic matter deposit in a coastal plain environment. Our data show that TOC values range from 1-7% and C/N values range from 20-50 at this site. There are at least two distinct intervals, one from 39-30 cal ka BP where TOC and C/N values are the highest and another from 30-23 cal ka BP where C/N values decrease. These data indicate organic matter that is dominated by terrestrial plant material and that shows changes in environmental conditions across this interval. Wet climate conditions with a high degree of variability likely persisted during this interval and affected the accumulation and preservation of organic matter. We also examined *n*-alkane concentrations. We isolated 30 samples throughout this sequence and preliminary data from 5 of the samples show that *n*-alkanes have an average chain length of 27.5, a strong odd-over-even predominance with maximum concentrations at *n*-C_{29} and *n*-C_{31} showing good preservation and a dominant source from higher plants. In the next project year we will analyze the remaining samples and examine the concentration and distribution of *n*-alkanes across this time period.

Maple Flatts: This site is a ~16 km^2 area in Augusta County, VA where depression wetlands formed during the late Quaternary as a result of dissolution of underlying carbonate-bearing coastal plain sedimentary units. These wetlands are in the form of depression basins that are 1-3 m deep. This project year, my students and I conducted ground-penetrating radar profiles across several of the wetlands, and recovered two ~3 m cores from one of them for detailed analysis. Data show extremely low sedimentation rates and a

Fig. 1. *Select data from Cypress Swamp Formation Site 2 cores, focusing on the interval from 39-23 cal ka BP. (Top) Detailed changes in total organic carbon and (C/N). (Bottom) Preliminary n-alkane distribution data from select samples.*

sequence of four radiocarbon dates that extend back 30 cal ka BP. This is a remarkable potential archive of paleoenvironmental information, however, organic geochemical results indicate <1% organic carbon for much of the

sequence showing limited preservation in this type of environment during the late Pleistocene. *n*-Alkanes were isolated from select samples, but were difficult to quantify for much of the record due to low concentrations. This year, I plan to extract more compounds from larger samples to at least better characterize the distributions of *n*-alkanes in this environment and the potential source for organic carbon.

Great Dismal Swamp: This site is located in southeastern Virginia and is a wetland that has blanketed a significant portion of the region, ~112,000-acres, since at least the late Pleistocene. This past year, samples from a core that spans the last c. 12 ka BP through one of the thickest sections of the deposit has been analyzed. Samples were collected every 10-cm and the concentration and distribution of *n*-alkanes was measured (Fig. 2). There are several interesting trends in these data, primarily defined by changes in the overall concentration of compounds, which generally
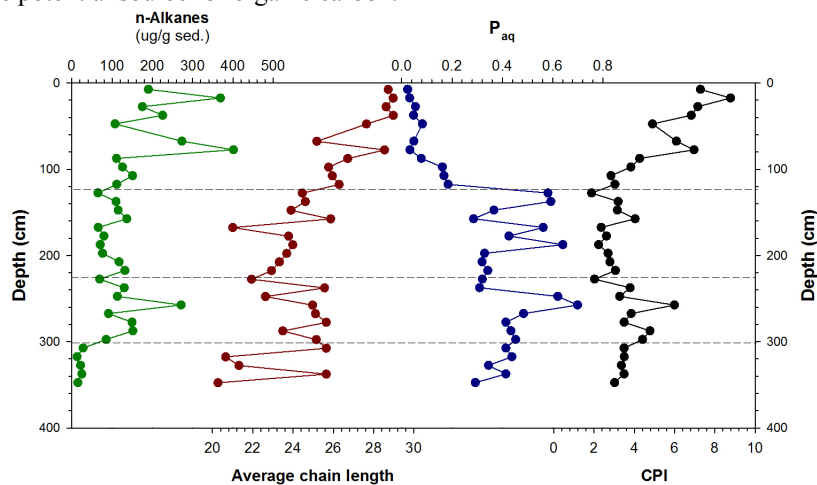

Fig. 2. Select n-alkane data from a core recovered from Great Dismal Swamp, including concentration, average chain length (ACL), P$_{aq}$, carbon preference index).

increase from the base of the record, and the changes in the average chain length. Most remarkable is a sharp change in P$_{aq}$ values, which reflect a decrease in the relative proportion of mid-chain length versus long-chain length compounds, often an indication of drier climate conditions. Further analysis is needed to establish a chronology for this site, but these data will be used to show how organic matter characteristics changed in response to Holocene climate conditions on the Coastal Plain and compare to late Pleistocene data from Cypress Swamp.

In the next project year, I plan to focus most effort on collecting additional organic geochemical data on the cores from the Cypress Swamp Formation sequences and expand our understanding of the record from the Great Dismal Swamp site with collection of additional samples and chronologic information. The depression wetland complex at Maple Flatts is also an interesting comparison and more work will be done to understand characteristics of sedimentation and if similar organic geochemical approaches will prove useful for understanding conditions that foster organic matter preservation.

Research Impact: The project has continued to help me initiate a new area of research in the mid-Atlantic region that I would have otherwise not been able to support, and to study fundamental processes regarding various influences on organic matter accumulation in coastal plain environments. As an assistant professor, this has also allowed me to gain insights into important local research questions, interact with the local scientific community, expand my research program in an undergraduate-only department, and support several students in conducting geoscience research. Furthermore, the grant has supported four undergraduate student summer research stipends and 1 undergraduate student that volunteered to work as a research student. The opportunity to teach them organic geochemical techniques that are not always available to students at the undergraduate level has been transformative for their educations. The project has also supported several other student to participate in field activities to collect sediment core samples. In total the project has resulted in three undergraduate senior theses and three presentations at regional Geological Society of America Meetings.

Publications
Childs, B., Balascio, N.L., Ramsey, K. (2019) Late Quaternary paleoenvironmental analysis of the Cypress Swamp Formation, Delaware. Geological Society of America - Southeastern Section Meeting, Charleston, S.C.
Landolt, B.W., Balascio, N.L., Bailey, C.M. (2019) Late Pleistocene sinkhole development in Maple Flats, Virginia. Geological Society of America - Southeastern Section Meeting, Charleston, S.C.
Van Hook, J.J., Balascio, N.L. (2018) Late Quaternary evolution of the Grafton Ponds Natural Area Preserve, Yorktown, Virginia. Geological Society of America - Southeastern Section Meeting, Knoxville, TN.