JOHNS HOPKINS UNIVERSITY Zanvyl Krieger School of Arts and Sciences Advanced Academic Programs

Proposal for Independent Research Project in
Environmental Science and Policy

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Paleoecological Evidence of a Pre-Settlement Sedge Wetland in a Piedmont River Valley

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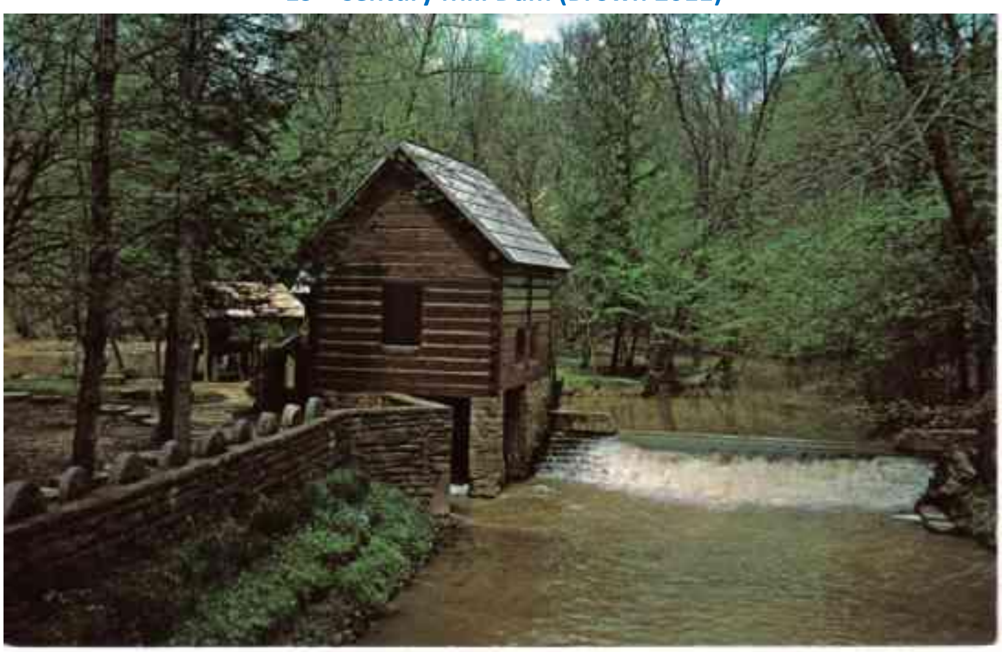
INTRODUCTION

Dark, organic layers containing fossil seeds of sedges and other obligate wetland species have been recovered from the base of numerous river banks in the Piedmont of Maryland and Pennsylvania, USA (Merritts et al 2011; Voli et al 2009; Walter and Merritts 2008). Overlying these buried organic layers are 1.0 to 6.0 meters of silt and clay sediment, referred to as Legacy Sediment, forming the primary river bank. These studies demonstrate a widespread and dramatic environmental shift during the colonial period from prehistoric low-lying open sedge meadows to post-European high-banked meandering river channels whose banks are dominated by riparian trees or agricultural fields of grasses and weedy herbaceous plants. This environmental shift was the result of burial of the prehistoric wetland by mill pond sediment behind dams constructed during the post-settlement period, particularly in the 18th and 19th centuries, combined with an influx of sedimentation from extensive deforestation.

19th Century Mill Dam (Brown 2011)



Merritts et al. (2011) and Walter and Merritts (2008) have well summarized the geomorphic processes and historic evidence so far accumulated for the above scenario. This scenario of mill pond sediment being deposited in river valleys and then incised by a meandering river channel after a dam is breached is a shift in thinking about the geomorphology of Piedmont rivers as they have been described since mid-20th century (Wolman 1955, Wolman and Leopold 1957, Leopold 1973, Jacobson and Coleman 1986). The scenario described in these earlier studies is that a river channel meanders across a valley for 100s or 1000s of years depositing sediment during overbank flow. The new evidence is that river channels as seen today are no older than 300 years, and that the high bank sediment buried the original sedge meadow wetlands that had endured since at least the mid Holocene (6,000 yr BP).

Macrofossils of obligate wetland species extracted from these pre-colonial layers indicate that the groundwater table lay near the surface and maintained saturated, anaerobic soils, favoring sedge-dominated assemblages for many centuries (Hilgartner et al 2010). These organic wetland soils can be traced across the entire valley bottom where they overlie quartz-rich gravels. The primary hydrologic control is believed to have been springs emanating from valley margins combined with slow, shallow overflow from upstream regions. There is virtually no evidence of prehistoric stream channels. Thus the typical Piedmont valley bottom appears to have been a broad hydrologic system resembling an anastomosing stream network harboring obligate wetland species in a surface level water table.

This image of Holocene prehistoric wetlands contrasts markedly with the modern river system. A single meandering river channel with high banks resting several meters above the ground water table incised into an otherwise flat valley is most characteristic. Instead of obligate wetland species the banks are lined by facultative, riparian trees like sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*) and silver maple (*Acer saccharinum*) (Hilgartner and Brush 2006; Brush et al. 1980). In some agricultural fields common grasses such as *Dactylus glomerata* and *Setaria glauca* may line higher banks with *Phalaris arundinacea* occurring in lower elevations near the channel. Much of the flat modern valley contains upland weedy vegetation, forest patches or farmland, sometimes with patches of facultative wetland species in swales or in depressions near valley margins (Hilgartner et al. pers. obs.). Analysis of the silt and clay sediment that characterizes most of the river bank and the valley surface soil indicates that this layer is not older than 300 years and is lacustrine in origin (Merritts et al 2011; Walter and Merritts 2008).

Some recent stratigraphic analyses of macrofossil seeds in buried wetlands of the Piedmont of

Maryland and southeastern Pennsylvania indicate that these prehistoric wetlands were hydro-climatically stable for several thousand years (Hilgartner et al. 2010). Scattered samples taken from many locations indicate long-term stability patterns and a recent study found consistent sedge species for 2800 years (Neugebauer 2011). However, detailed studies of these prehistoric wetlands, their lateral extent across the valley, variation in vegetation characteristics and temporal stability, and the influence of natural and anthropogenic disturbance on the wetland is still needed.

In this study, we examine a series of samples extracted from the base of a river bank in north central Maryland, USA with the base of the paleo-wetland radiocarbon-dated at ~5,000 yr BP. The samples span a distance of 0.5 km within a broad river valley. The samples will be used to supplement a study of a core from the same river (Hilgartner et al 2010) to provide a broader spatial view of the ancient wetland. Analysis of fossil seeds of local wetland species will be combined with geomorphic data of the river channel and banks and historical land use data to provide a 5000 yr history of a prehistoric wetland and post-settlement river channel. Early analysis of fossil seeds showed a dominance of tussock sedge (*Carex stricta*), an important species indicator of a saturated sedge meadow habitat, and important habitat for the endangered bog turtle (*Glyptemys muhlenbergii*). It is hypothesized that *C. stricta* covered much of the valley floor before A.D. 1700. This has important implications for stream restoration and conservation of the bog turtle.

Typical Sedge Meadow Habitat for Bog Turtles

(Lee and Norden 2011)

The macrofossils in this study will provide a record of the lateral extent of this pre-settlement wetland. It is hypothesized that a sedge meadow wetland occurred throughout the river valley between the valley margins lying at the ground water table supplemented by springs and gently flowing water. Sedge seeds in these samples could provide support for this hypothesis.

GOALS

Important aspects and goals of this independent study are to:

1. Learn to identify common wetland indicator macrofossils as a tool to analyze past environments
2. Compile the macrofossil data into a spatial framework relative to the valley dimensions
3. Analyze data using Sorenson's similarity indices
4. Collect additional samples from the field site if needed
5. Explore the importance of the Pre-settlement wetland as a habitat for the endangered bog turtle
6. Analyze the potential of a wetland restoration at this site

STUDY AREA

The study area is Little Falls, a tributary of the Gunpowder River in northern Baltimore County, near White Hall, MD. USA (76°37'30.329 W, 39°36'47.333 N).

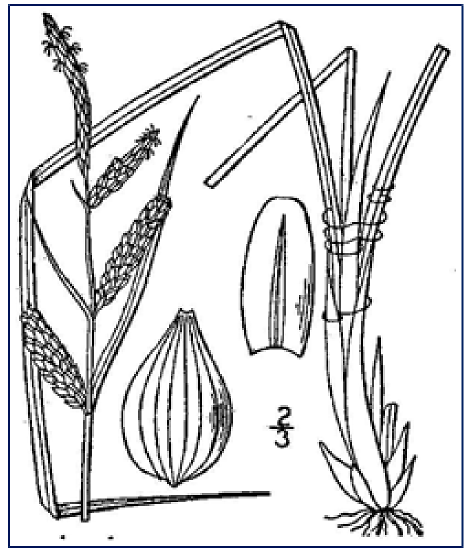
Little Falls (Google Maps 2011)

A core (LFC1) was extracted from the base of the river bank about 1.0 km south of Whitehall. The bedrock is primarily schist with chlorite and garnets and the surrounding forest is considered to be part of the Chestnut Oak Association on Grace Brush's map (Brush et al. 1980)

METHODS

Macrofossils (buried seeds) recovered from sediment samples will be identified and analyzed. Fifteen sediment samples have been collected where Carbon-14 dates varying between 2,000 and 5,000 years before present (BP) have been established. The results from these samples will be compared with a core analysis from another site along the same river bank (Hilgartner et al. 2010). The core (LFC1) revealed a 5,000-yr history of a tussock sedge (*Carex stricta*) dominated wetland that persisted from 4,300 yr BP until 300 yr BP when a millpond filled with sediment behind a downstream dam buried the sedge wetland.

Carex stricta



(Britton and Brown 1913)

A set of samples extracted from a hydric layer at the base of the bank of Little Falls over a distance of ~100 meters along a transect were collected in 2010 using a trowel and stored in plastic bags. Carbon-dating of some of these layers has been conducted. A return to the study site to examine the topography and perhaps collect additional samples from other hydric layer exposures up- and down river from these samples is expected. In the lab a portion of a sediment sample is soaked in warm water for ~2 hours and the volume of displacement is noted to determine the volume of the sediment. The sample is then sieved in two nested sieves washed with warm water, and the remainder is placed in a petrie dish with water and a grid. With forceps the sample is searched for seeds, leaves, and other macrofossils. These macrofossils are separated and placed in a separate petrie dish for identification. Identification of seeds will be undertaken with the guidance of Dr. Hilgartner, using his seed reference collection, and an assortment of identification guides and web-based identifications.

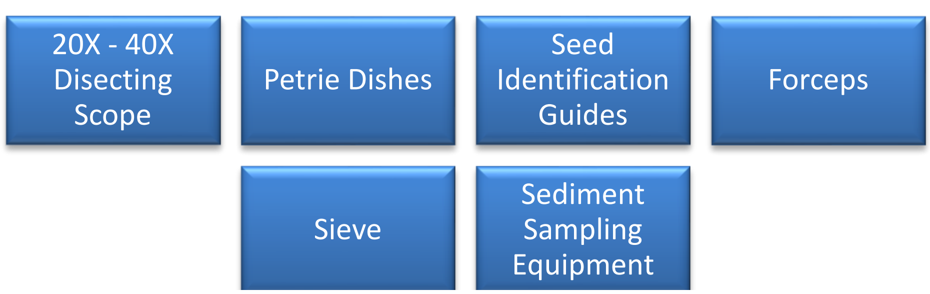
Carex stricta Seeds (USDA, NRCS 2011)

After seed identification, the abundance of each species is equilibrated relative to the volume of the sample. Seed abundance is used to determine dominant species and variation between samples. Sorenson's Index of Similarity will compare seed species composition between samples. This in turn will be compared to Sorenson's indices in previous surface sample studies (Hilgartner et al 2010, 1995), which will permit quantitative analysis of habitat variability.

ANTICIPATED OUTCOME/RESULTS

This project's investigation into the type of habitat revealed by the fossil record will be conducted to help establish the paleo-hydrology of the wetland. Numerous plant indicators can be used to provide a range of flood levels and hydroperiod. This hydrology and plant community will be compared and contrasted with the current environment. It has already been established that the modern 2-m bank at Little Falls is a channel that was incised following the breaching of a dam in the early 19th century (Hilgartner et al, 2010). The sediment had accumulated behind the mill dam following extensive deforestation and subsequent erosion between 1775 and 1830, burying the ancient wetland. So the modern riparian wetland with sycamore, black walnut, and silver maple is a result of a post-settlement impact and change. The composition and hydrology of the pre-settlement wetland will be compared with this riparian wetland. It is expected that the large difference between pre- and post-settlement wetlands will

Equipment Needed

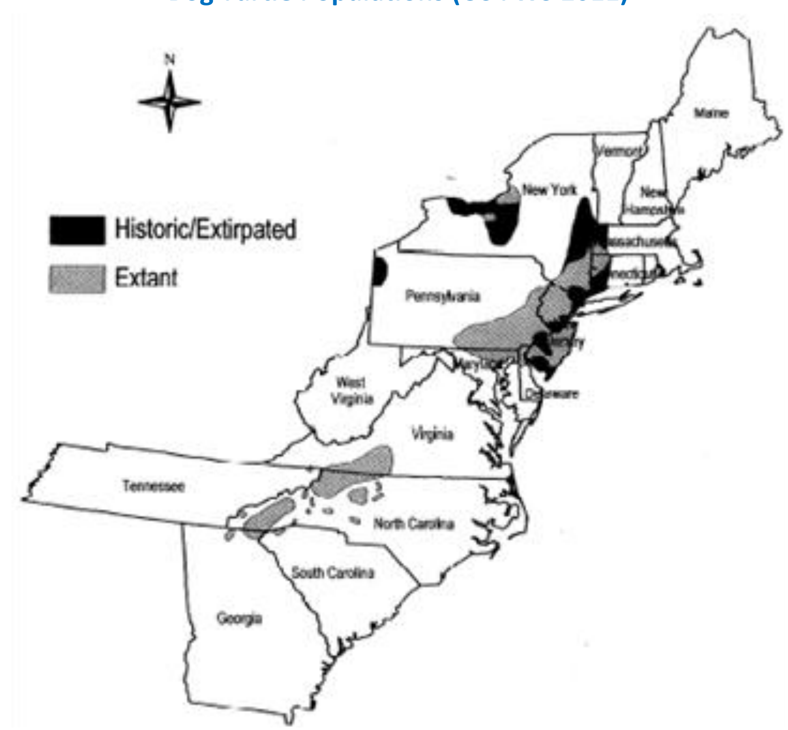


offer guidelines on potential wetland restoration goals.

Tussock sedge (*Carex stricta*) was found to be the dominant species at a coring site at Little Falls called LFC1 (Hilgartner et al, 2010). This species is the indicator species not only for a specific hydrology but as a prime habitat for the endangered bog turtle (*Glyptemys muhlenbergii*) (Morrow et al. 2001). A question to be addressed is whether this habitat was widespread across the Little Falls Valley or whether it was an isolated habitat found at the coring location. It is hypothesized that this habitat was more extensive in pre-colonial days and would have harbored a greater population of bog turtles (Lee and Norden 2011). Their disjunct distribution today may be a result of the disappearance of these more extensive wetlands so that today's populations are confined to relict habitats (Lee and Norden 2011). Knowledge of the extent of the bog turtle habitat is important information for conservation and restoration of this rare species. It is hoped that this study will provide additional light on this subject.

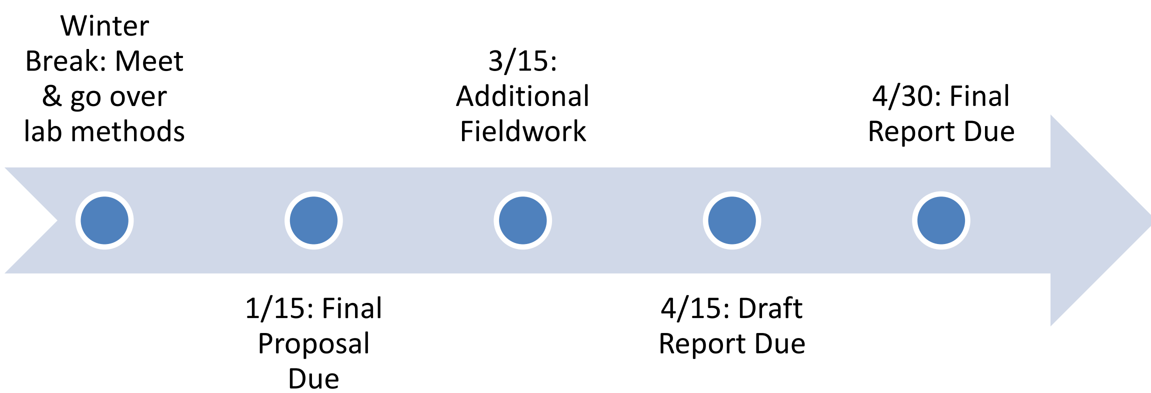
Several river valley restorations where legacy sediment has been removed to restore the prehistoric wetland and ground water table have been performed in southeastern Pennsylvania. These include Big Spring Run, Conoy River and Banta in Lancaster County, and have been considered successful in reestablishing an herbaceous wetland. While Maryland has not yet undertaken this approach it is expected that this study of Little Falls will offer a guideline on a Best Management Approach to wetand restoration in this valley and perhaps other Maryland river valleys.

Bog Turtle Populations (US FWS 2011)



TIMELINE

It is expected that the items in the goals section will be completed by the end of the spring semester, 2012. The study will begin at the start of the semester in January, 2012. A projected timeline is listed below:



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