

The Role of the SUNY College at Oneonta Biological Field Station in the
*Upper Susquehanna River Watershed-Cooperstown Area Ecosystem
Restoration Feasibility Study And Integrated Environmental Assessment.*

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INTRODUCTION

Agricultural and urban development causes nutrients to become concentrated at upland sites (Drexler and Bedford, 2002; Detenbeck et al., 2002). The subsequent flux of these nutrients through ground and surface water flow often overwhelms the receiving waters; the ability of lakes, rivers, and streams to normally assimilate and transport these nutrients is surpassed and results abnormally high productivity (Kadlec and Knight, 1996). Historically, wetland ecosystems have occupied a position in the natural landscape between upland sites and down-slope water bodies (Mitsch and Gosselink, 2000) often putting the water table at, or very close to, the soil surface. This condition, often combined with poor drainage, gives wetlands their characteristic hydric soils, as well as making them repository of dissolved nutrients and particulate matter. However, where wetlands once occupied approximately 1 million hectares during the 18th century New York State, by the mid – 1980’s a reduction of 60% had been recorded (Dahl, 1990).

Naturally, this drastic reduction in overall area was coupled with an equally severe reduction in function. In recent decades, the scientific community has begun to identify and quantify many beneficial functions that natural wetlands provide to the surrounding landscape. Termed ‘ecosystem services’, these functions include product export, flood attenuation, wildlife habitat, and retention of sediments, nutrients, and harmful pathogens (Mitch and Gosselink, 2000). With this new appreciation and the realization of the scope of wetland destruction that has taken place over the previous century, large scale efforts at all levels of government have been initiated to replace these lost ecosystems.

In 2002, the SUNY Oneonta Biological Field Station (BFS) contracted with the U.S. Fish and Wildlife Service through the US Army Corp of Engineers (ACE) to participate in the 1.6 million dollar *Upper Susquehanna River Watershed-Cooperstown Area Ecosystem Restoration Feasibility Study And Integrated Environmental Assessment.* Authorized by the U.S. Congress, the pilot program is to “use wetland restoration, soil and water conservation practices, and non-structural measures to...improve water quality...in the Upper Susquehanna River Basin...” (ACE, 2001). Beginning in the fall of 2003, the BFS will monitor two degraded (and subsequently restored) wetlands and one reference wetland for a period of two years. Specifically, the BFS will quantify nutrient budgets (see below) for the degraded sites, using that data for comparison with that of the pristine reference site. The objective of this monitoring effort is to demonstrate the effectiveness of the restoration techniques employed by the ACE to foster the biological, physical, and chemical conditions necessary for effective nutrient retention.

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In 2001, data recovered during the reconnaissance phase of the study identified eight *Field Assessed Benefit and Design Strategy* sites (FABADS) in Otsego County (Figure 1). These are the physical locations of the “degraded” wetlands as defined by the National Resource Conservation Service (NRCS) as being wetlands subject to extensive agricultural uses within the last 100 yrs. One purpose of the FABADS restorations is to provide the data that will validate the assumptions made in the current scientific literature about the ability of wetland ecosystems to retain nutrients and thus justify the project. Additionally, the data will be used to allow for design and operation adjustments to be made before initiating additional projects in the area (ACE, 2001).

METHOD OVERVIEW

FABAD sites were surveyed, designed, and will be constructed by Ducks Unlimited, Inc. (DU). In general, the overall design for all the FABADS sites involves the creation of a berm at the outflow of the site that will serve to restrict aboveground flow. Each berm will be fitted with a flood control device that will allow water to flow once a predetermined water table level has been surpassed in the wetland. The flood control devices installed at the three wetlands to be monitored (Figure 1) will be fitted with v-notch weirs, flow meters and auto-samplers. This instrumentation will enable the BFS to calculate the amount of nutrients, nitrogen (N) and phosphorus (P), in the inflow and outflow of the wetland as well as many other physical parameters. This data will then be used in calculating the overall nutrient budget and nutrient retention ability (nutrients in minus nutrients out) for each restored wetland and the reference. Additionally, several sites along the Susquehanna River will be monitored for the identical parameters in an attempt to directly measure the effects of restoration on receiving water bodies.

Anticipated results of comparisons between the restored wetland and the reference wetland will reveal an observable shift in the restored wetlands ability to retain N and P, and reduce particulate matter suspended in solution towards the level at which the pristine reference wetland performs identical functions.

Wetland Sample Collection, Preparation, and Analysis

Flow will be measured constantly at all inflow and outflow sites. Water samples (500ml) will be hand collected weekly at the inflows and outflows of all wetlands monitored. Samples will be transferred from the field in ice-packed coolers and refrigerated immediately. Analysis of all chemical parameters will take place within 72 hours and under the maximum storage time recommended by the EPA (EPA 1984). Precipitation based events will be automatically sampled at a rate of 500mls/ hour for as long as elevated runoff conditions exists. A predetermined flow will activate the auto-sampler. Atmospheric deposition will be collected monthly by means of acid washed plastic funnel fitted with 3mm nylon mesh leading to a 1L acid washed plastic bottle. All samples collected in this manner will be collected and treated as above.

The chemical and physical parameters measured and the duration and frequency of sample collection are summarized in Table 1.

Station Description	Constituent List	Sampling Frequency
Susquehanna River 5 sites: 16, 16A, 17, 18, Oaks Creek	T, DO, pH, COND, TP, TSS, TN, NH ₃ , NO ₂ /NO ₃ , FC	Weekly from April to October – approximately 28 times/year
Wetlands Palumbo: 1 inflow, 1 outflow, and 1 down stream ¹ Daley: 1 inflow, 1 outflow, and 1 down stream ¹ Reference: 1 inflow, 1 outflow, and 1 down stream ¹	T, DO, pH, COND, TP, TSS, TN, NH ₃ , NO ₂ /NO ₃ , FC, constant flow, and hydroperiod	Weekly from April to October – approximately 28 times/year – plus during precipitation events at ~ 24 samples/day

¹ Weekly sampling only

Table 1. Monitoring protocol for the three FABAD sites and five sampling sites along the Upper Susquehanna River.

Samples collected will be analyzed at the BFS for total phosphorus (TP) using persulfate digestion followed by single reagent ascorbic acid method (APHA, 1992). Nitrate+nitrite nitrogen (NO₂/NO₃) levels will be tested using the cadmium reduction technique (APHA, 1992). Additionally, samples will be analyzed for total nitrogen (TN) using persulfate oxidation followed by colorimetric determination (phenate method) as well as ammonia (NH₃) using the phenate method (APHA, 1992).

Physical parameters, i.e. pH, temperature (T), dissolved oxygen (DO) and conductivity (COND) will be recorded on site with the use of a Hydrolab Scout 2[®] or a Surveyor 4[®] multiprobe digital microprocessor which will be calibrated according to manufacturer's instruction immediately prior to use (Hydrolab Corp., 1993). The

hydroperiod (water table fluctuations) will be monitored by weekly observations of a staff gauge mounted to the base of one flood control device in each wetland. Samples will also be tested for fecal coliform bacteria (FC) using the membrane filter technique (APHA, 1992). Total suspended solids (TSS) will be calculated as the difference of the initial and final weight of a pre-weighed standard glass-fiber filter after filtration (APHA, 1992).

Analysis of variance (ANOVA) will be performed on all parameters to detect significant differences between sites. ANOVA will also be performed to detect any significant changes at one site over time. All parameters measured will be reported as means for each data set (± 1 SE).

Wetland Processes

The nutrient budgets and the results they yield will be an indirect measurement of the collective processes that function to retain nutrients and sediment. The current state of scientific knowledge on the mechanisms involved in nutrient retention is extensive and continues to grow at a very fast pace (Mitsch and Wilson, 1996). In general, biological, chemical and physical factors (the systems *biogeochemistry*) all influence the ability of a wetland to act as a nutrient sink. This statement owes its validity to the immense complexity inherent in the processes that perform the desired nutrient removal functions.

For instance, the main mechanism responsible for P uptake is chemical adsorption - precipitation, which involves the bonding of phosphate to the ion exchange sites of elements such as iron (Fe), aluminum (Al), calcium (Ca), and clay particles found in the soil (Nichols, 1983). However this simple chemical reaction is influenced by pH, ambient P concentrations in standing water, soil organic matter (SOM), and the duration and quantity of P loading. To a lesser extent, P retention is influenced by vegetative and microbial uptake and immobilization.

Whereas P retention is dominated by physical factors, N retention is primarily biologically mediated. Many of the pools and pathways of N cycling are microbial. Plant communities serve to some degree to take up N temporarily, but mainly influence retention by their ability to resorb the nutrient to below ground biomass and in the quantity and quality of the litter they return to the soil for mineralization (Findlay et al., 1990; Windham, 2001; Meuleman et al., 2002). The main vector for N loss in wetland ecosystems is the microbial process of denitrification (Groffman and Hanson, 1997) whereby N is lost directly to the atmosphere as the result from anaerobic respiration (Nichols, 1983).

Not surprisingly, the main factor influencing all nutrient cycling in wetland ecosystems is water (Carter, 1986; Mitsch and Gosselink, 2001). The hydrology of the system reflects flood duration, water table fluctuations, retention times, redox potentials, nutrient cycling and erosion as well as being a major vector for the transportation of nutrients (Ponnamperuma, 1972; Mitsch and Gosselink, 2001; Seybold et al., 2002).

Additionally, hydrology will determine the vegetative composition by exclusion of all species not adapted to hydric soils, and influence microbial activity by limiting oxygen availability (DeLaune and Pezeshki, 1991).

Significance of Results

Success will be measured as the degree to which the restored wetlands approximate the reference site's ability to retain each nutrient fraction. Based on preliminary data, such a result will necessarily show an increase in the retention ability of the wetland over time. There is some disagreement regarding the time required for a restored wetland to reach its potential for retaining nutrients (Mitsch and Wilson, 1996; Cambell et al., 2002). Current estimates in the literature range from 5 to 20 years before the ecosystem can stabilize after the disturbance of the restoration, and to develop long term representative floral and faunal communities. Determining the appropriate timeframe can be further confounded by the natural variability inherent in these systems on a seasonal and annual basis. Nevertheless, the programs success will help reduce the threat of eutrophication of the watersheds major water bodies by 'filtering' the nutrient rich runoff associated with urban and agricultural uses. In addition to the documentation of these ecological benefits will be the demonstration that this unique collaborative effort between Federal, State, and local agencies is practical for implementation of large-scale environmental initiatives.

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