

WETLANDS AS BMPs AND THEIR USE IN TRADING OF NUTRIENT AND SEDIMENT REDUCTION CREDITS J. Schubauer-Berigan¹, D. Brown¹, D. Burden¹, T. Canfield¹, W. Franz², J. Kressel¹, M. Heberling³, K. Hurld⁴, C. Lane⁵, M. Morrison¹, M. Mikota⁴, C. Nietch¹, W. Sidle¹, R. Sumner⁴and H. Thurston¹

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LTG 3 Poster 06

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MYP 3 Science Questions

MYP 3. Science Question #2

What BMP's, treatment systems and restoration technologies remain as uncertain options for watershed management? For mixed land use watersheds? For habitat alteration? For priority stressors?

MYP 3 Science Question #3

How can classification schemes, modeling scenario analyses landscape classification, and economic projections be applied to provide alternatives for meeting water quality goals efficiently at multiple scales? What are the economic benefits of watershed management?

Overall Research Objectives

Research Objectives

1). To improve our understanding of how and to what extent natural and constructed wetlands capture and respond to watershed stressors so that we successfully incorporate wetlands into watershed management plans.

2). Develop approaches to optimally incorporate wetlands watershed management plans and economically implement them on the ground.

3). To evaluate novel approaches, such as utilizing market forces or "trading" that can be used to encourage wetland restoration and drive voluntary improvements in water quality. 3). Develop effective and economical tools to monitor and model wetland processing and attenuation of watershed stressors so that wetlands can be used in TMDL development and implementation.

How Research Addresses the Water Quality MYP Goals

The Office of Research and Development is conducting applied wetlands research that: 1) allows managers to more effectively design and implement wetlands as part of watershed management plan: 2) provides tools to evaluate the effectiveness of using wetlands as BMPs and 3) supports policy development and evaluation. The goal is to provide the knowledge base necessary to appropriately utilize wetlands to protect and improve the nation's water quality.

Overall Approach

A range of wetland research activities across ORD are being conducted to support the water quality research objectives. These include 4 major types of activities: 1) full scale case studies, 2) field and mesocosm experiments, 3) modeling studies and 4) synthesis and guidance development. These activities are integrated and leveraged with the watershed management research activities and objectives.

1. Case Studies (DE, IN, OH, MO, MI, IL, WI)

Approach-Case studies are being conducted to evaluate full-scale wetland design implementation and performance for removing watershed stressors in a watershed management context. Most recently this work has focused on stressors such as suspended and bedded sediments, non-point source nutrient control and pathogens. These studies also are used as an engineering "test bed" to develop and evaluate new monitoring and assessment tools for broader application.

Kankakee (IL and IN) and Shaker Wetland Studies- The studies were implemented to test the usefulness of stable isotopes to help guide the construction and restoration of wetlands. Stable isotopes were used to document and forecast the hydrodynamics of flows between the Kankakee River and the agrarian floodplain and to describe the complicated groundwater -surface water interactions at the Shaker site. Six peer reviewed journal publications have been produced as a result of this work. As a direct result of the Kankakee work, the Counties involved in the management of the constructed wetlands redesigned the wetland hydrology and significant reductions of nitrate reaching the Kankakee River have been achieved. At the Shaker site, it was possible to forecast which areas where the most appropriate for wetland restoration.

La Crosse Wetland Studies (WI)-This case study is ongoing and was initiated to evaluate the performance of both constructed and native wetlands for attenuating non-point source nutrient and sediment loads form two urbanizing watersheds along the Mississippi R. The study is designed to evaluate monitoring approaches and new tools (e.g. loads vs. concentrations: relationships between turbidity. TSS. SSC, real time sampling technology and sampling issues such as length of sampling record) for evaluating the performance of wetland BMPs. It is also a goal of the project to evaluate and perform a cost benefit analysis for the constructed wetland. Preliminary results indicate substantial removal of sediments and nutrients by the constructed wetland. It is envisioned that the results will be useful in evaluating the particular design used for the constructed wetland and lead to design improvements.

Constructed Wetland Evaluation Studies (MO, NC, WY)- Wetlands constructed for use with three types (municipal effluent, Agricultural/CAEO effluent, Industrial effluent) of source pollution are being evaluated. The studies are primarily focused on reductions of nutrients and suspended solids. The study wetlands also receive inputs of persistent pollutants. One concern is what is happening to the persistent pollutants that enter these wetlands. Through this assessment the basis for a true cost-benefit analysis will be established. The following assessments were conducted: sediment chemical analysis, surface water chemical analysis, sediment toxicity, limnology, benthic invertebrates, aquatic plants, and ground water. Sampling of all sites is complete and preliminary analysis is being conducted.

Delaware Restored Wetlands Studies- The primary objectives of these ongoing studies are: 1) to investigate the fate of nutrients and sediments in agricultural runoff entering small wetlands being constructed and used as BMPs to reduce. the amount of nutrients and suspended sediments getting into the waters of the state of Delaware from runoff water from agricultural fields and 2) Develop a guidance document on how to construct these systems, where to site these systems and how well they perform the function of reducing nutrients and sediments from the agricultural drainage. A literature review has been conducted and is currently being compiled as the basis for the guidance document. The project is in early sampling stage.

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2. Field and Mesocosm Experiments To Evaluate Mechanisms

Approach-Field and Mesocosm experiments are being conducted to provide a better understanding of the factors that control wetland mechanisms and to evaluate treatment and constructed wetland designs.

Mesocom Studies-Recently completed mesocom studies were designed to assess the effects of stormwater pond and wetland best management practice (BMP) designs on phosphorus and nitrogen concentrations in effluent. Relative difference between BMP types were evaluated with respect to several nutrient forms and in relation to untreated stormwater runoff. The mesocosms allowed for direct measurement of time integrated nutrient influent and effluent mass loading. Preliminary analysis of results show that significant nitrate removal from BMP influent was observed and appeared to be controlled by influent concentration. The studies indicate that BMP designs that optimize for organic matter production and retention would result in maximal nutrient load retention.

Field Experiments-An ongoing replicated field experiment in Grailville. OH is designed to determine the applicability wetland systems to septic wastewater treatment in mixed land use watersheds. The study is tracking wetland performance of regulatory variables (concentration and mass) for nitrogen, phosphorus, and pathogenic indicators. The goal is to relate 'treatment' processes to carbon cycle dynamics both onsite and offsite to support future watershed management decision making.

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effects of stormwater pond and wetland BMP designs

Approach- Models are tested and developed in conjunction with the wetlands research activities. These activities are closely aligned with our integrated management synthesis activities a using many of the same models (SWMM, SWAT, SUSTAIN etc. see LTG3 Poster 3-08)

Current Application- Results from the studies are used to at all scales to produce improved models that can be used for process estimation, scenario testing futures analysis and forecasting and project evaluation and verification.

New Projects-Several new projects at are in the planning stages with the regions, states and OWOW. One such projected that was recently funded has the objective of designing wetland protection/restoration scenarios for a portion of the Great Salt Lake (e.g., Farmington Bay/Tooele County). We plan to use models to evaluate the ecological consequences of different scenarios relative to the risks and their effect on wetland water quality. Study results will be reported in a way to help inform local water quality management decisions in the study area, including those affecting POTW operation and federal compensatory wetland mitigation requirements under the Section 404 Program of the Clean Water Act.



Approach- Producing capstone reports, peer reviewed publications and documents that synthesize the available research so that reliable guidance can be produced to support policy evaluation and development. is one of the our important research activities.

Recently completed - Recently these activities have resulted in the production of manual for Constructed Wetlands Treatment of Municipal Wastewaters

New Projects-ORD is trying to resolve the numerous technical issues related to wetland and ecological function, assigning economic value/credits or for estimating treatment credits and economic research related to the market formation, to evaluate the feasibility of using wetlands as a component of an effective water quality trading program. An ORD-OW team is developing active research collaborations in the area of wetlands and water quality trading. A feasibility study is underway and an expert panel meeting designed to refine critical research directions is planned for the spring of 2006. A number of new wetland and water quality trading projects (joint ORD/OW/EPA Region/State), are in the initiation or planning stages with CA, OH and UT. All of these activities support the President's goal to restore, improve and protect at least three million additional acres of wetlands

Interactions with Customers

The complex issues surrounding incorporating wetlands into a watershed management plan requires a team effort that works best when the customers and other stakeholders are included at all stages of the projects. These studies typically involve local and State agencies. EPA Regional offices and other Federal agencies. Transparency and good communication are key to the success of the projects.

How Research Contributes to Outcomes

The applied wetlands research conducted by the Office of Research and Development in collaboration with the Program Offices and the Regions and other partners and stakeholders: 1) allows managers to more effectively design and implement wetlands as part of watershed management plan: 2) provides tools to evaluate the effectiveness of using wetlands as BMPs and 3) supports policy development and evaluation.



