Maryland Water Resources Research Center

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Spring 2008 **Dr. Allen P. Davis, Director** **Dr. Phil Kearney, Assoc. Dir.**

Maryland Water Issues in 2030

On October 31, 2007, the Center held a symposium on *Maryland Water Issues in 2030*. Over 100 participants attended this event. A wide array of topics were discussed, including a focus on global infectious water-borne diseases, global climate change impacts, future problems associated with limited water supplies for the Washington metropolitan area, protection of surface and ground water supplies, and evaluation and identification of contaminants of concern in drinking water. The symposium was cosponsored by the *Maryland Sea Grant College*.

Inside the Newsletter

2008 Funded Research Proposals

The Center is pleased to support two water resources research projects and two summer fellows in 2008. These projects were selected based on peer review by scientists and engineers external to the University of Maryland system. Interestingly, again, one or more have a salt or salinity focus in one way or another, suggesting that this is a topic of growing interest in the state. Summaries for these projects are presented below.

The biodiversity effect: Do plant species mixtures perform better than monocultures in runoff treatment wetlands?

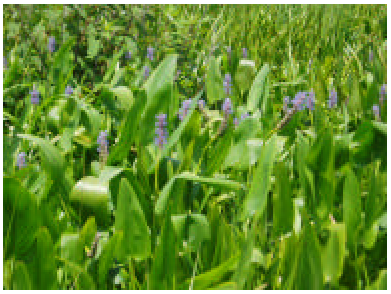
Andrew Baldwin, Environmental Science and Technology, University of Maryland, College Park

Nutrients from agricultural and urban runoff (i.e., non-point source pollution) may cause eutrophication, toxic algae blooms, and other ecological impacts in downstream waters, such as the Chesapeake Bay. Numerous studies have examined the effectiveness of constructed wetlands for removing a wide range of water constituents, and the importance of wetland vegetation for nutrient uptake and promoting microbial transformation of nitrogen is well-established. However, surprisingly little systematic research has been conducted on the role of different vegetation types in treatment effectiveness. In particular, almost nothing is known about the role of plant diversity in water treatment.

Extensive research published in the ecology literature during the last decade indicates that a number of ecosystem functions are promoted by higher numbers of coexisting plant species (higher diversity) but no one has applied this fundamental science to the engineering of constructed wetland systems, the subject of our proposed research. To our knowledge, this proposed research will be the first to apply biodiversity-ecosystem function science to ecologically-engineered water treatment systems such as runoff treatment wetlands.

The overall goal of this research is to understand how the treatment of agricultural or urban runoff using wetlands is affected by the diversity of planted species. Specific objectives are to:

1. Create experimental treatment wetland mesocosms (simulating both surface and subsurface flow wetland configurations) containing different plant diversity treatments, and relate diversity treatments to removal of nutrients from water; and
2. Develop a set of recommendations for planting wetlands to improve runoff water quality and calculate removal rate coefficients for use in designing future runoff treatment wetlands.



A diverse mixture of wetland plant species (above) may result in greater removal of nutrients from wastewater than a monoculture of a single species (below). This hypothesis will be tested using experimental wetland mesocosms planted with different species combinations in the Research Greenhouse at the University of Maryland.

Experimental greenhouse mesocosms will be planted with monocultures or mixtures of two and three plant species. There will be five replicates of each treatment in a randomized block design. Water containing dissolved nutrients (nitrate, ammonium, and phosphate) at concentrations simulating typical ranges for runoff will be pumped into the mesocosms. Vegetation will be monitored non-destructively on a monthly basis. Influent and effluent water will also be monitored on a monthly basis for ortho-phosphate, ammonium, and nitrate. Other environmental variables such as temperature, soil redox potential, and light will be monitored regularly and related to treatment effectiveness. At the end of the growing season above- and belowground biomass will be harvested, sorted by species, dried, weighed, and analyzed for total nitrogen and phosphorus. Removal rate coefficients will be calculated for each treatment, and concentration- and mass-based nutrient removal rates will be compared using analysis of variance (ANOVA) (including repeated measures and covariance analysis where appropriate).

As the first systematic study of the application of biodiversity-ecosystem function science to water quality improvement, the results of this research will be of interest to applied ecologists and environmental scientists, engineers, and managers studying or developing solutions to manage runoff water quality.

Microbial nitrogen sequestration in detrital-based streams of the Chesapeake Bay watershed under stress from road-salt runoff:

Christopher Swan, Department of Geography & Environmental Systems, University of Maryland, Baltimore County

Headwater streams are known to be sensitive to landscape disturbances, as they comprise the majority of stream miles in a watershed. These habitats are hotspots of important processes related to water quality, especially rates of organic matter decomposition and nutrient cycling. Therefore, any disturbance disrupting the ecological interactions involved in such processes is likely to be especially pronounced in these small streams, as they are in intimate contact with the landscape. Road-salt runoff has been recently identified as one such stressor and, since inputs of road-salt are expected to increase as road density increases, the subsequent effects on stream ecosystems important to understand. To date, work in my lab and others has revealed important consequences for both carbon and nitrogen dynamics as mediated by microbial communities and the invertebrates that consume them. Food webs in small forested streams rely on the annual input of leaf litter from streamside forests as a major source of energy, and the microbial community breaking down this material can serve as a sink for nitrogen from the water column. Evidence in the literature has shown that the organic matter-microbial-invertebrate pathway is one means by which excess nitrogen might be sequestered from the water column vs. being transported downstream. Given the negative effect of salt stress on carbon mineralization documented for stream microbial communities by my lab, I expect salt to also alter rates of nitrogen sequestration. As a result, road salt runoff might alter the natural ability of headwater streams to ameliorate excess nutrient delivery to larger, downstream waterbodies (e.g., the Chesapeake Bay). I propose a multi-factorial study to learn how these ecological interactions (i.e., organic matter-microbial-invertebrate) react to a gradient of salt stress currently imposed on freshwater ecosystems in the region, and how this changes the capacity for the stream community to remove nitrogen from streams.

Summer Fellowships awarded for 2008 by Maryland Water Resources Research Center

Investigating the fate and persistence of dichloroacetamide herbicide safeners in model environmental systems:

John Sivey, Department of Geography and Environmental Engineering, Johns Hopkins University, Baltimore, MD
Advisor: A. Lynn Roberts

The scientific literature is virtually silent regarding the environmental chemistry and fate of herbicide "safeners". These widely used agrochemicals are used to protect crop plants from the deleterious effects of herbicides. But, *are safeners safe*? Safeners are included among the complex mixtures of agrochemicals that perennially wash their way into surface and ground water resources around the world, including the agricultural regions of Maryland. A thorough understanding of the environmental behavior of these compounds represents an important step toward protecting our water resources while concomitantly promoting greener agricultural practices. The chemical structures of two widely used dichloroacetamide safeners, dichlormid and benoxacor, suggest the formation of potentially hazardous transformation products in environmental systems. Under reducing conditions, these safeners could be transformed to monochlorinated species, which are likely to be more potent alkylating agents (i.e., mutagens) and more persistent than the starting materials. As such, safener degradation products may be of greater toxicological concern than the parent compounds. A review of previous chloroacetamide reactivity studies reveals sizable gaps in our understanding of these highly used compounds. In response, this work seeks to systematically evaluate the persistence and abiotic reactivity of the dichloroacetamide safeners and their degradation products formed in model environmental systems. Specifically, the reactivity of dichloroacetamide safeners and selected structural analogues with reduced mineral phases (e.g., iron pyrite, mackinawite and Fe(II) adsorbed on goethite) will be determined. Hydrolysis reaction rates at near-neutral pH will also be determined. Safener transformation products will be identified using gas chromatography with mass spectrometry (for nonpolar/neutral analytes) and liquid chromatography with tandem mass spectrometry (for polar/charged analytes). These experiments simulate conditions typical of surface water, groundwater and sediment pore water environments, both of which represent important and at-risk water resources in the State of Maryland.

Integrated experimental and mathematical evaluations to improve the fate of the important groundwater contaminant tetrachloroethene (PCE) at contaminated sites:

Yen-Jung Lai, Department of Environmental Science and Technology, University of Maryland, College Park
Advisor: Jennifer G. Becker

Tetrachloroethene (PCE) is a common groundwater contaminant in the U.S. Under anaerobic conditions, some dehalorespirating bacteria strains can carry out reductive dechlorination of PCE. However, the organisms differ with respect to the extent with which they can transform PCE. Most organisms remove only one or two chlorine atoms, resulting in the formation of toxic compounds and are unacceptable from bioremediation perspective. One well-known organism, *dehalococcoides ethenogenes* strain 195, can completely dechlorinate and detoxify PCE but its performance highly depends on how much available nutrient it can obtain and if it is able to outcompete other organisms with similar niches. This purpose of my study is to evaluate the character of microbial kinetics and competition in determining whether PCE is partially or completely dechlorinated. This information is required to achieve successful bioremediation of contaminated sites.

Future Symposium

We are beginning to think about our next symposium for the Fall of 2008! These conferences take a great deal of advanced planning. As we get into the summer months, a number of decisions will have to be made. At this stage in the planning process, selecting the topic of the next conference is our most important priority. We would be pleased to hear what ideas you have for a potential topic for the 2008 Symposium. Ideas can be sent to Phil Kearney at *kearneyp@umd.edu*.

Maryland Water Issues in 2030
October 31, 2007

Dr. Robert Summers, Deputy Secretary, Maryland Department of the Environment, Baltimore, MD

Dr. Rita Colwell, Distinguished Professor, University of Maryland, College Park, and Johns Hopkins Univeristy Bloomberg School of Public Health, Senior Advisor and Chairman, Canon US Life Sciences, Inc.

Erik Hagen, Director of Operations for the Section for Cooperative Water Supply Operations at the Interstate Commission on the Potomac River Basin, Rockville

Frank Dawson, Director Aquatic Resources, Maryland Department of Natural Resources, Annapolis

Dr. Steven Prince, Professor of Geography, University of Maryland, and Director of the Regional Earth Sciences Application Center

Dr. Donald Boesch, President, University of Maryland Center for Environmental Sciences and Professor of Marine Science, Cambridge, MD

Yvette M. Selby-Mohamadu, Office of Groundwater and Drinking Water, U.S. Environmental Protection Agency, Washington, DC

Dr. Allen Davis, University of Maryland, College Park, Maryland Water Resources Research Center

Featured Scientist: Dr. Ryan Casey

Dr. Ryan Casey is an Associate Professor of Chemistry at Towson University where he also participates in the interdisciplinary Environmental Science and Studies undergraduate program and Environmental Science graduate program. Dr. Casey arrived at Towson University in 2000 after completing a PhD in Environmental Toxicology at Clemson University in 1999 and a BS in Chemistry at Virginia Tech in 1995. His dissertation research focused on mechanisms of nitrogen and phosphorus attenuation in golf course runoff entering a natural riparian wetland with emphasis on macro- and micro-scale distributions of denitrifying activity.

Since coming to Towson, Dr. Casey has expanded the scope of his work to include trace element biogeochemistry. Along with several Towson collaborators, particularly Dr. Steven Lev and Dr. Joel Snodgrass, Dr. Casey has developed a research and teaching emphasis on urban biogeochemistry that pervades the undergraduate and graduate courses in Towson's environmental curricula. In 2004 Dr. Casey served as PI on an NSF grant that established the Urban Environmental Biogeochemistry Laboratory (UEBL) at Towson University. Research in UEBL facilities involves faculty from the departments of Chemistry, Geology and Biology, making it a truly interdisciplinary endeavor. In January 2008 Dr. Casey's proposal to establish a Research Experience for Undergraduates site in urban environmental biogeochemistry was recommended for funding by NSF and is expected to commence in Summer 2008.

Dr. Casey's research efforts have both environmental chemistry and toxicology components. Recent work in his laboratory involved quantifying trace element speciation and loading into stormwater retention ponds as well as uptake into biota such as aquatic invertebrates and larval amphibians. Much of this work focuses on zinc and copper, two of the most abundant trace elements that accumulate on roadway surfaces. One of the dominant sources of zinc, tire rubber, was the focus of a bioassay in which wood frog (*Rana sylvatica*) larvae were shown to readily accumulate Zn weathered from tire debris. These larvae also experienced delayed metamorphosis which may indicate stress due to the exposure. At the watershed scale, recent research sponsored by the Maryland Water Resources Research Center demonstrated that stormwater ponds in a small suburban catchment are storing significant amounts of Zn with respect to the overall transport of Zn out of the catchment in surface flow. This suggests that while the habitat value of stormwater ponds is still uncertain due to Zn accumulation, the overall transport of Zn out of the watershed is being significantly decreased by the presence these structures. Currently, graduate student Derek Rodgers is investigating the role of algal biofilms in the uptake of Zn by grazing aquatic organisms such as larval amphibians and invertebrates. Prior work in this laboratory showed that accumulation of Cr and Ni occurred predominantly from a contaminated sediment whereas As and Se uptake occurred via ingestion of contaminated algae. Evaluation of Zn will allow us to relate these findings to urban stormwater ponds in support of our continuing efforts to evaluate habitat quality in these systems.

Current funding from the National Water Resources Institute is supporting additional research relating amphibian usage of retention ponds to potential stressors. In addition to trace elements, this work focuses on the potential impacts of road salt on amphibian reproduction and trace element availability. We have documented year-round salinization of surface and ground waters in storm water ponds and their adjacent floodplains and will be quantifying groundwater salt storage and transport to surface waters as part of this grant.

University of Maryland now has Office of Sustainability

The University of Maryland *Office of Sustainability* was formed in the summer of 2007 following the signing of the American College and University President's Climate Commitment. Sustainability at the

University began in 2002 with the completion of the University's Facilities Master Plan and the University's first national sustainability conference: *Beyond Compliance – Campus Greening Through Stewardship*. Sustainability efforts expanded over the next four years through a variety of efforts by individuals and campus departments. In 2005 and 2007, the University joined the U.S. Environmental Protection Agency and several national higher education organizations to sponsor and host the *Smart & Sustainable Campuses Conferences*. In the spring of 2007, the University issued its first Campus Sustainability Report.

The Office of Sustainability is administered by the Department of Environmental Safety and reports to the Vice President of Administrative Affairs. The Office receives direction from the Associate Director for Campus Sustainability and Environmental Affairs, Scott Lupin. Campus sustainability efforts are described at *www.sustainability.umd.edu*

Towson Scientists Receive Prestigious National Competetive Grant

The Maryland Water Resources Research Center is pleased to announce that Dr. Joel Snodgrass, Towson University, has been awarded a NIWR/USGS National Competetive Grant. The project deals with Integration of Stormwater Management Ponds into Urban Communities; Long-term Water Quality, Protection, Wildlife and Environmental Awareness.

Stormwater management ponds (SMPs) are required by most state and local governments as part of more comprehensive stormwater management practices. By intercepting and detaining runoff before it enters natural water bodies, SMPs promote biological and physical removal and detention of pollutants, dissipation of thermal pollution, and groundwater recharge, ultimately protecting hydrological and water quality characteristics of natural streams and wetlands. While SMPs are human created habitats, they superficially resemble natural wetlands and attract wildlife. SMPs may be used as mitigation for wetlands destroyed during development. SMPs pose significant threats to wildlife in urban and suburban areas. They expose wildlife to the pollutants they are designed to sequester. Preliminary studies of ponds in the Washington DC/Baltimore metropolitan region suggest that under some conditions ponds may not be effective at retaining pollutants such as zinc and road deicing salts (primarily NaCl), and may even act as ecological traps for amphibians. Ecological traps are habitats that attract wildlife only to reduce the reproductive success or survival of individuals that utilize the habitat. This work will investigate three areas: 1) longer-term storage and fate of pollutants entering storm water ponds; 2) habitat quality of storm water ponds for amphibians and their potential role as ecological traps; 3) human perceptions and interactions with storm water ponds.

The Center thanks everyone who attended the Fall 2007 Water Conference and for making it a grand success.

Maryland Water Resources Research Center

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