May 2011, Vol. 2, No. 1

The Water bLog

a newsletter of the

Utah Center for Water Resources Research

at Utah State University

Welcome!

The Water bLog is the semi-annual newsletter of the Utah Center for Water Resources Research (UCWRR), housed at the Utah Water Research Laboratory. The center supports the development of applied research related to water resources problems in Utah and promotes instructional programs that will further the training of water resource scientists and engineers. Each issue of *The Water bLog* highlights a small selection of research from the many projects currently underway at the center. More information is available online at:

http://uwrl.usu.edu/partnerships/ucwrr/

INSIDE:

Message from the Director

Mac McKee, Director

We are always proud of the tremendous research performed here at the UCWRR, but it is particularly gratifying when recognition comes from other sources. The UCWRR at Utah State University is one of 54 water institutes and centers across the country that receive matching grants under section 104 of the Water Resources Research Act of 1984. The Act requires a periodic review of each institute/center to determine its continued eligibility under the Act. Our latest review identified the UCWRR as "an exemplary program in virtually all respects" and "of among the very best of the 54 institutes nationwide." None of this could be accomplished without the hard work and dedication of our exceptional faculty, researchers, staff, and students. Well done!

This edition of *The Water bLog* features research projects that are developing biological processes for the removal of nutrients from wastewater, including phosphorus and nitrogen, and examining the vertical ozone structure in the wintertime air in the Cache Valley and other locations in Utah. These projects, of course, are directed at serious natural resources problems in the state and are the products of partnerships with state and local resources management and regulatory agencies and stake-holders. ■

RESEARCH HIGHLIGHT

Biological Processes for the Removal of Phosphorus from Lagoon Wastewater Facilities

Recent research at the UCWRR is evaluating the use of indigenous duckweed to remove excess phosphorus and nitrogen, as well as personal care products and pharmaceuticals, from lagoon wastewater treatment facilities.

A variety of ongoing research projects at the Utah Center for Water Resources Research (UCWRR) at Utah State University are directed at developing and evaluating biological processes to remove nutrients from lagoon wastewater treatment systems. One of these efforts is a study to evaluate the effectiveness of duckweed (*Lemna minor*) as a biological technology for managing nutrients (particularly nitrogen and phosphorus)

Partial early spring duckweed coverage on the 56 acre Wellsville lagoons

UtahStateUniversity

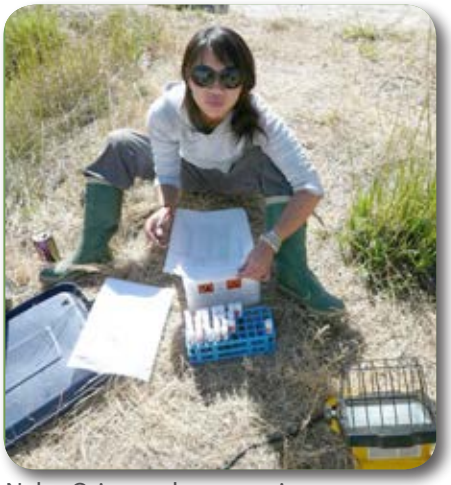
and personal care products and pharmaceutical (PCPP) contaminants in small municipal lagoon wastewater systems.

Nutrients and PCPP contaminants in municipal wastewater systems have become a growing concern to environmental regulatory agencies. Excess nutrient releases can stimulate algal blooms that reduce the oxygen content in the water (leading to fish kills) and negatively impact taste, odor, and other water quality characteristics. PCPP contaminants can also affect aquatic systems and drinking water supplies if their concentrations are not controlled. Conventional physical and biological wastewater treatment processes are not designed for nor are they effective in removing either nutrients (nitrogen/phosphorous) or PCPP contaminants, and current alternatives for their removal are prohibitively expensive, particularly for small, rural communities.

Research

Duckweed is a small, fast-growing, floating aquatic plant that is common to many ponds, reservoirs, and wastewater treatment lagoons throughout the US. These plants are known to effectively remove nitrogen and many heavy metals from wastewater, but less is known about their ability to remove phosphorous or PCPP contaminants in wastewater treatment systems.

Results from laboratory and field investigations at the Wellsville, UT lagoons indicate that a duckweed system with bi-monthly harvesting could meet



Naho Orita analyzes nutrient concentrations in the Wellsville lagoons

Researchers on Wellsville Lagoons measure duckweed growth and nutrient levels

Wellsville's phosphorus removal needs for about 20 years based on significant duckweed growth rates and high concentrations of nutrients that have been observed to accumulate in the duckweed biomass.

More than 250,000 lbs. of dried duckweed material could be harvested from the Wellsville lagoons annually.

Some potential beneficial byproducts of the harvested biomass include:

- Production of a high quality animal feed supplement that is more than twice the value of alfalfa based on digestibility and organic matter, protein, and crude fiber content.
- Anaerobic conversion of duckweed biomass to methane that could generate 1,000,000 cubic feet of methane per year.
- Fermentation of duckweed biomass to ethanol that could generate approximately 1,500 gallons of ethanol per year at observed fermentation rates.

"Results from laboratory and field investigations...indicate that a duckweed system with bi-monthly harvesting could meet Wellsville's phosphorus removal needs for about 20 years"

The effectiveness of such a system depends on efficient and cost-effective harvesting and processing of the generated biomass.

Benefits to the State

- An effective, sustainable method for water quality improvements.
- A promising nutrient removal system through harvesting of high growth rate duckweed biomass.
- A low cost system with a low or positive energy and environmental footprint.

Looking to the Future

Future efforts will continue to study harvested duckweed in order to optimize anaerobic degradability, animal feed digestibility, and ethanol production. The potential of the duckweed biomass to bioconcentrate and/or metabolize metals and hazardous PCPP contaminants that occur in municipal wastewater will be evaluated, as well as the impact of such bioconcentration on the processing steps required for the various beneficial byproducts. ■

R. Ryan Dupont, Ph.D.
Professor
Utah State University.
Phone: (435) 797-3227
E-mail: ryan.dupont@usu.edu

RESEARCH HIGHLIGHT

Cooperative Study of Ambient Ammonia Distribution and Vertical Ozone Profiles

The UCWRR is developing and testing a system for examining the vertical ozone structure in Utah's wintertime air, particularly Utah's Cache Valley, to further identify and refine the most effective remediation scenarios for the air pollutant $PM_{2.5}$

Crystal Wood prepares to deploy a tethered balloon used to measure ozone profiles

In December 2009, Cache Valley, as well as most of Utah's Wasatch Front, was officially declared non-attainment for the air pollutant $PM_{2.5}$ (particulate matter less than two and one-half microns in diameter) by the U.S. Environmental Protection Agency (EPA), which initiated a 3-year time frame for the state agencies and local stake holders to develop a State Implementation Plan (SIP) to outline a remediation plan. Significant efforts are underway to understand the complexities of Cache Valley's somewhat unique air pollutant problems.

Past research has shown available ozone to play a significant role in the atmospheric chemical reactions that create these wintertime pollutants, and test flights suggest that at least some ozone may not be locally derived. Confirmation of these findings could have significant implications on the effectiveness of any potential local remediation scenarios.

A researcher prepares to test the vertical ozone structure in Cache Valley, Utah

Research

This project has developed and tested a system that examines the vertical ozone structure in Cache Valley's wintertime air.

- The components continue to be consolidated so that the monitor is small and light enough to fly on a tethered balloon system on AggieAir Unmanned Aerial Vehicles.
- Multiple tests have been performed on the modified system under temperatures expected in Cache Valley's wintertime atmosphere.
- A workshop concerning the first phase of the SIP was presented for EPA representatives, Utah and Idaho environmental agencies, and Utah State University/UCWRR in late October 2010.
- Tethered balloons are currently measuring multiple ozone profiles under both inversion and non-inversion episodes in Cache Valley and in Vernal, Utah.

Benefits to the State

The Cache Valley air quality studies, cooperatively supported previously by the UCWRR and other local and state agencies, have established a viable and sustainable air quality research program at Utah State University.

- These studies have led to air quality research throughout the state and beyond.
- Results of this study can be extended to the entire Wasatch Front, also declared a $PM_{2.5}$ non-attainment area in Dec. 2009.

Looking to the Future

The team continues to optimize the final package and develop protocols to economically and accurately characterize particle size distribution and composition with the aim of further refining the limiting parameters to identify the most effective remediation scenarios. The PI will continue to work closely with state and local stakeholders to successfully develop the SIP following the required timeline. ■

Researchers attach the air quality monitor system to a tethered balloon

Randal S. Martin, Ph.D.
Research Associate Professor,
Utah Water Research Laboratory
Utah State University.
Phone: (435) 797-1585
E-mail: randy.martin@usu.edu

Update

Nutrients and Water Quality: A Region 8 Collaborative Workshop

Lars Christensen and Jeff Horsburgh at the workshop *(photo by Lindsey A. Knebel, Colorado Water Institute)*

In February 15-17, 2011, water management agencies, universities, and various stakeholders in the six states of EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming) came together in Salt Lake City, Utah to develop a shared understanding of the science and to better understand the challenges associated with developing and implementing nutrient controls and management while preserving other important stakeholder values. The stated goal of this three-day workshop was to provide an opportunity to build a better informed and more tightly linked community of nutrient researchers, regulators, managers, policy makers and stakeholders that would lead to collaborative approaches for developing and achieving nutrient controls and management. The Utah Center for Water Resources Research and the Utah Water Research Laboratory were pleased to participate with the Colorado Water Institute, the Northern Plains and Mountains Regional Water Program, and the US Environmental Protection Agency in co-hosting the event. Post-workshop materials are available at the following link:

http://www.cwi.colostate.edu/nutrients

Future Issues:

Research Highlights:

"Using AggieAir to Quantify the Spread of Invasive Wetland Species." (UCWRR researchers are using the multispectral imaging capabilities of the AggieAir™ UAV platform to track the spread of *Phragmites australis* in Utah wetlands.)

"New Utah Center for Hydrologic Information and Computing." (This new Center within the UCWRR is advancing the information systems and computational technology needed to support data analysis, sharing, and visualization in hydrology and water resources.)

"Phytoremediation at Hill Air Force Base in Utah." (Researchers at the UCWRR are evaluating the potential effectiveness of using phytoremediation to remove contaminants from groundwater.)

Far Afield

In recent months the UCWRR hosted a training workshop for a contingent from **Senegal**, **Guinea**, **Mauritania**, and **Mali**. In addition, UCWRR researchers have conducted research and training in numerous countries in the past six months, including:

- Hobart, Australia
- Vienna, Austria
- Brussels, Belgium
- Yangling, China
- Erbil, Iraq
- Bari, Italy
- Amman, Jordan
- Doha, Qatar
- Dakar, Senegal
- Singapore
- Taipei, Taiwan

UCWRR researcher Jeff Horsburgh (center) setting up a weather station at the Agricultural Research Center in Erbil, Iraq

The UCWRR's legacy of involvement in international water research and development has recently taken several UCWRR researchers to Erbil, Iraq, to conduct a field-based training as part of an ongoing program designed to improve water resources management in Iraq.

CONTACT INFORMATION:
Director: Dr. Mac McKee
Associate Director: Dr. William J. Doucette
Address: Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200
Phone: (435) 797-3157, Fax: (435) 797-3663
Website: http://uwrl.usu.edu/partnerships/ucwrr/

UtahStateUniversity