

**INSIDE
 THIS ISSUE:**

**Bacterial Load-
 ings from Wild-
 life Populations
 and TMDLs** 1

**New TMDL 2
 Planning, Imple-
 mentation, and
 Policy Review
 Article Work-**

**Upcoming AEE 2
 Conference and
 Workshops at
 Virginia Tech**

**Center Delivers 3
 Workshops in
 South America**

**Updates on the 4
 Center's TMDL
 Projects**

**Recent Center 4
 Publications
 and
 Presentations**

**Contact 4
 Information**

Bacterial Loadings from Wildlife Populations and TMDLs

With the passing of the Clean Water Act and the creation of the Total Maximum Daily Load program, States have been required to evaluate pollutant loadings to their waterways. Pathogen indicators are one of the major pollutants of concern, second only to mercury, with a total of 8,526 pathogen impairments listed. When developing a TMDL it is often necessary to determine the contribution of bacterial loading from various sources within a watershed. Sources of pathogen impairments are divided into agricultural, human, and wildlife sources by TMDL developers.



Beaver impoundment monitoring site

The 1994 EPA *Water Quality Standards Handbook* included the following instructions about bacteria from wildlife. "States may apply bacteriological criteria sufficient to support primary contact recreation with a rebuttable presumption that the indicators show the presence of human fecal pollution. Rebuttal of this presumption, however, must be based on a sanitary survey that demonstrates a lack of contamination from human sources." In other words, since there had not been sufficient data to link nonhuman indicator bacteria

with human illness, states or tribes could justify a decision not to apply water quality criteria to a body of water if the bacteria were found to be from nonhuman sources.

This lenient policy regarding bacteria from wildlife sources ended when the EPA stated that "states and authorized tribes may no longer use broad exemptions from the bacteriological criteria for waters designated for primary contact recreation based on the presumption that high levels of bacteria resulting from

non-human fecal contamination present no risk to human health" in the Ambient Water Quality Criteria guidance document. While an increased knowledge of zoonotic diseases and case studies involving contamination from wildlife sources support this change in policy, even the most basic parameters to allow developers to accurately model the bacterial contributions of wildlife to waterways are lacking in the literature.

(continued on page 2)

The goal of this study, conducted by Matthew Habersack, a doctoral student in the Biological Systems Engineering department at Virginia Tech, is to collect data needed to better characterize wildlife fecal bacteria loadings to waterways and to improve the science of modeling fecal bacteria from wildlife in bacterial TMDLs and other water quality protection efforts. This is being done by examining fecal production rates and fecal coliform, *Escherichia coli*, and *Enterococcus spp.* concentrations and die-off rates in scat from raccoons (*Procyon lotor*), muskrats (*Ondatra zibethicus*), beavers (*Castor canadensis*), and snapping turtles (*Chelydra serpentina*).

Preliminary data collected for this study indicates that bacterial loadings from the species under study are typically orders of magnitude higher than what is currently being represented in TMDLs. Additionally, bacterial production rates from snapping turtles are indicating that cold-blooded animals may contribute significant bacterial loadings to waterways, at least in certain circumstances. In one freshwater pond sampled, it was estimated that fecal coliform loadings from muskrats and beavers combined would amount to less than two percent of that contributed by snapping turtles. This goes against the current thinking that warm-blooded animals are the

only significant contributors to coliform loadings.

In order to evaluate the impact of the newly determined wildlife bacteria parameters, these parameters were input into existing HSPF model data files from previously completed TMDL studies. Inclusion of the new parameters into the models results in a significant increase in modeled bacteria concentrations from wildlife. These results suggest the need for additional research to see where in the landscape wildlife fecal material is being deposited and how much of it is entering the waterway directly. The results of this study will be available in late 2008.

TMDL Planning, Implementation and Policy Review Paper Published

The Center for Watershed Studies at Virginia Tech has published a review paper for CAB Reviews, titled "Approaches to TMDL Planning and Implementation policy tools for Implementation to achieve water quality standards." CAB Reviews is a new online review publication started in 2006 by CABI International (www.cabi.org) to complement the subject coverage of their online database CAB Abstracts. CAB Reviews focuses on topics from animal science, applied plant sciences, agriculture, nutrition and food science, natural resources and environmental sciences.

The paper relied heavily on the contents of the TMDL Knowledgebase

Clearinghouse developed by the Center. The paper discusses causes of impairments and TMDL development using three main approaches: mass balance approach, statistical approach, and a computer-based modeling approach. The paper addresses how load reductions among pollutant sources can be achieved, including making allocations among nonpoint sources (NPS) after deciding how much load reduction can be obtained from permitted sources, making allocations based on uniform percentage reductions among all sources and making allocations to source(s) with lowest costs of control. The paper also includes a brief overview of the uncertainty associated with TMDL

development. A section on TMDL implementation is also included. This section provides an overview of the adaptive implementation process and touches on the importance of stakeholder engagement in implementation. Lastly, the paper discusses policy tools for TMDL implementation. The tools discussed include effluent standards (technology or water-quality based effluent limitations), incentives, education, and pollutant trading. The paper is available for download at the Center's website: www.tmdl.bse.vt.edu/research/C64/.

Upcoming AEE Conference and Workshops at Virginia Tech

The 8th American Ecological Engineering Society Annual Meeting will be at Virginia Tech in Blacksburg, VA, June 9-14, 2008. The theme of this meeting is "*Beyond Wetlands: Engineering the Landscape*" and will be structured to feature research and design on topics such as regional planning, watershed management, stream and wetland restoration, low impact development, green design, and phytoremediation. The meeting includes a combination of workshops (June 9-10), plenary sessions, concurrent sessions, and breakout sessions over a six-day period. Additional information is available at <http://www.cpe.vt.edu/aees/index.html>

Three 1.5-day workshops will be held June 9-10, 2008 at Virginia Tech in Blacksburg, VA. These workshops are designed for engineers and scientists involved in ecosystem design and restoration. The workshops topics include Ecological Design 101, Stream Restoration Design: Beyond Bankfull, and Mitigation Wetland Design. Additional information is available at <http://www.cpe.vt.edu/aees/topics.html>



Center Delivers Workshops in South America

In January, Dr. Brian Benham delivered two (2) day-long watershed management workshops to government and non-governmental agency water resources professionals with in Ecuador. These workshops were delivered as part of a project entitled "Watershed-based Natural Resource Management in Small-scale Agriculture: Sloped Areas of the Andean Region." This project includes U.S. researchers from: Virginia Tech, Penn State University, University of Denver, and Florida A&M University and international partners in Ecuador, Bolivia, and Peru.

The Andean Region and other similar projects are funded by the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP, www.oired.vt.edu/sanremcrsp/) which is, in turn, funded by the U.S. Agency for International Development (USAID). The goal of the SANREM CRSP is to promote stakeholder empowerment and improved livelihoods through knowledge-based sustainable agriculture and natural resource management systems. The program is managed by the Office of International Research, Education, and Development at Virginia Tech.

The watershed management workshops were designed to introduce participants to watershed management planning as practiced in the U.S. The workshops were developed using various resource materials including EPA's Handbook for Developing Watershed Plans to Restore and Protect Our Waters (EPA 841-B-05-005), and included specifics about selected watershed management planning examples in Virginia where the Center has been involved.

The workshops addressed six steps in watershed management planning:

1. Building Stakeholder Partnerships



Farming landscape in Chimbo River watershed near Guaranda Ecuador

2. Watershed Characterization - Approach and Data Needs
3. Developing Water Quality Goals and Identifying Possible Solutions
4. Designing a Watershed Management Implementation Program
5. Implementing a Watershed Management Plan
6. Measuring Progress and Making Adjustments

Learning objectives for participants included being able to describe the following concepts:

- The typical steps involved in conducting a watershed-scale study to assess the potential pollutants contributing to degraded water quality.
- The typical steps involved in developing a watershed-scale plan to address the offending pollutants.
- How best management practices (BMPs control nonpoint source (NPS) pollution.

- The role of watershed stakeholders in the watershed management planning process.

Forty-four people from Ecuadorian governmental and non-governmental agencies participated in the two workshops. National level Ecuadorian governmental organizations represented were: INIAP, Instituto Nacional Autónomo de Investigaciones Agropecuarias; SIGAGRO, Geographic Information Systems for the Farming Sector; MAGAP, Ministerior de Agricultura, Ganadería, Acuacultura y Pesca; and CNRH, Consejo Nacional de Recursos Hídricos. Provincial governments were represented by the Gobierno of the Province of Bolívar, an Ecuadorian province where the Andean Region SANREM project is working. Non-governmental organizations included EcoCiencia an Ecuadorian Foundation that focuses primarily on ecological and biodiversity studies, and Promoción Humana, an NGO that works directly with local stakeholders.

Updates on the Center's TMDL Projects

North Fork and South Fork Pound aquatic life (VA general standard) impairment (active and historical coal mining): Finalizing final report. Final public meeting was held on March 24th.

Hays/Moffatt Creeks bacteria TMDL: Final comments addressed, awaiting submittal to EPA.

Powhatan/Mill Creeks bacteria TMDLs (tidal influenced): Final report submitted to DEQ. Final public meeting on March 18th followed by a 30 day public comment period.

Bull Creek aquatic life TMDL (VA general standard) impairment (active and historical coal mining): Finalizing final report. Final public meeting was held on March 20th.

Lick Creek, Indian Creek and Hardware River TMDLs have been completed and are awaiting approval from EPA.

Journal Publications:

Benham, B.L., R.W. Zeckoski, and G. Yagow. 2008. Lessons Learned from TMDL Implementation Case Studies. *Water Practice*. Vol 2(1). Doi: 10.2175/193317708X281370.

Hall, K.M., R.W. Zeckoski, K.M. Brannan, and B.L. Benham. 2008. FTABLE Generation Method Effects on Instream Fecal Bacteria Concentrations Simulated with HSPF. *JAWRA*. 44(2): 489-495.

Jesiek, J.B., B.L. Benham, D.J. Bosch, and K. Stephenson. 2007. Approaches to TMDL Planning and Implementation policy tools for implementation to achieve water quality standards. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*. 2007 2, No. 084. DOI: 10.1079/PAVSNNR20072084.

Mishra, A., B.L. Benham, and S. Mostaghimi. 2008. Bacterial Transport from Agricultural Lands Fertilized with Animal Manure. *Water Air Soil Pollut.* 189:127-134.

TMDL Meetings:

Brannan, K. 2008. Final Public Meeting for the Powhatan/Mill Creeks bacteria TMDLs, March 18th, 2008, Williamsburg, Virginia.

Kline, K. 2008. Final Public Meeting for the Hays/Moffatts Creeks TMDLs, January 29, 2008, Middlebrook, Virginia.

Yagow, G. 2008. Final Public Meeting for the North and South Fork Pound Rivers TMDL, March 24th, 2008, Pound, Virginia.

Yagow, G. 2008. Final Public Meeting for the Bull Creek TMDL, March 20th, 2008, Maxie, Virginia.

Conference Presentations:

Yagow, G. 2008. A Review of Channel Erosion Modeling Techniques for Watershed Applications. Presented at the 2008 Virginia Lakes and Watersheds Conference, March 9-11, 2008. Richmond, Virginia.

Workshops:

Benham, B., et al. 2008. Virginia DCR TMDL Manager Workshop. January 15-17, 2008. Blacksburg, Virginia.

Benham, B. 2008. SANREM Watershed Management Planning Workshop. January 21-23, 2008. Quito and Guaranda, Ecuador.



The Center's mission is to conduct interdisciplinary research, teaching, and outreach to improve the integrity of the Nation's waters and watersheds by advancing the science, tools, and expertise available for developing, evaluating, and implementing watershed planning and management processes.