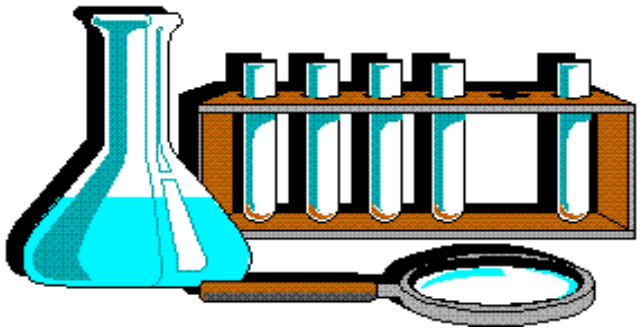


Environmental Detection News

July 2002 Vol. 1, Issue 1

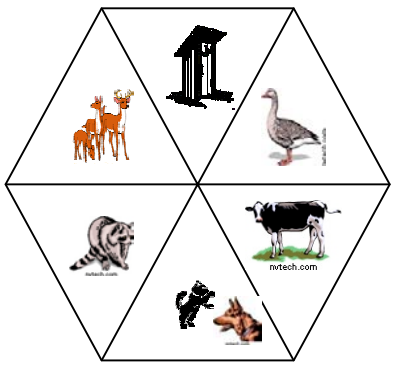
Contents

We would like to introduce this newsletter. Our initial focus is to cover discoveries, issues, events, conferences, and advance information on the entire realm of source tracking and its wide application for water quality and the Total Maximum Daily Load (TMDL) testing process. We plan to expand to carry news and information on other source tracking applications including biosafety, bioterrorism, bioremediation, and biological control. To receive the newsletter, please see the enclosed information sheet.

Feature article:

Application of Source Tracking Results to Performing TMDLs

*by Jim Kern**



All states have been required by the United States Environmental Protection Agency (USEPA) to establish Total Maximum Daily Loads (TMDLs) of pollutants in surface water-impaired areas. The TMDL is the largest loading of the pollutant that will allow water quality goals to be achieved. States use various indicators of contamination to set water quality standards (*e.g.*, fecal coliforms and *E. coli*). These indicators can originate from wildlife, human (*e.g.*, failing septic systems), pets, and livestock sources. States are only beginning to monitor for contamination from distinct sources, as Bacterial Source Tracking (BST) is an emerging field, and economical analyses have only recently become available.

MapTech, Inc. has developed numerous fecal coliform TMDLs for the state of Virginia as well as TMDL Implementation Plans for fecal coliform impairments. In each case, BST was used to assess sources, guide modeling, and improve public support of the process. Kern *et al*. (2000) described three levels of incorporating BST into TMDL development. First, BST can be used as a tool for source assessment by identifying the presence of bacteria originating from specific sources. Second, models that have been calibrated using fecal indicator enumerations can be adjusted to more accurately reflect the relative contributions of sources that have been identified during monitoring. And third, if sufficient *continued on page 2*

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♦ Huw Taylor, University of Brighton, Brighton, U.K.

from page 1

BST data is available, it can be used to calibrate the model based on measured concentrations of the fecal indicator originating from each source. Each successive level of BST use has more extensive data requirements and potentially improves model calibration and consequently public perception of the process. However, it is important not to forget the basic tenets of sampling and model development. These include consideration of sample size when drawing conclusions from sample data, modeling to the appropriate level of precision, and assessing the reasonableness of the model.

There are a variety of BST methodologies available to TMDL developers, and discussion continues as to which is most appropriate for TMDL use. However, regardless of the technique used, it is important to remember to incorporate an appropriate experimental design when developing the monitoring scheme. It is intuitively expected that the proportional contributions of the fecal indicator from different sources will change seasonally and spatially. Given this assumption, it would be advantageous to calculate relative proportions at each sample location, in each season. This implies that the number of isolates (individual bacterial colonies) analyzed from each water sample should be sufficient to assess the relative proportion of each source considered. Simple statistical methods exist for estimating the appropriate number of isolates per sample and samples per site. (Examples of how numbers of isolates per sample and numbers of samples per site can be calculated will be presented in a future issue of this newsletter.)

For most TMDLs, modeling to the species level is not warranted. TMDLs are intended to set a water quality goal and provide a solid foundation for implementation plan development. The additional expense of designing and conducting a monitoring plan that discriminates at the species level and provides enough data to estimate relative proportions typically outweighs the need. Discrimination at a management level (*e.g.*, human, livestock, and wildlife sources) is less expensive and is sufficient for most TMDL development. Higher levels of discrimination currently require more expensive analysis methodologies, combined with a monitoring design that provides the larger sample sizes needed for identifying all sources and their proportional contributions. Additionally, species-level discrimination typically results in large number of isolates being classified as "unknown" or "transient." These unrecognizable isolates, which often come from a source not being included in a known-source library, must then be reapportioned to "appropriate" sources. Management-level discrimination can be achieved with less expensive methodologies, requiring less subjectivity in applying the results to the modeling process and providing sufficient information for proceeding with the TMDL process.

Most modelers have been encouraged to visit each watershed being modeled and gain insight into the sources, loads, and delivery mechanisms of the modeled pollutants. In spite of this advice, it is all too easy to do all of the modeling without ever visiting the watershed. New technologies, such as BST, encourage this

continued on page 3

from page 2

behavior by leading modelers to believe they have more information than they could possibly gain from a simple, time-consuming site visit. However, it is perhaps more important than ever to assess water quality models for reasonableness. First, it is a simple exercise in quality assurance to back-up new technologies with tried and true methods. And second, all TMDLs are subject to public review. Inappropriately applied BST data resulting from poorly designed sampling schemes can result in analysis results which do not fit with local knowledge of the watershed. In some TMDLs conducted in Virginia, the contractors adjusted source loads based on monitored BST results. The animal populations required to produce these loads were, in some cases, orders of magnitude greater than those that could be substantiated by other methods. It is likely that the monitoring scheme did not provide sufficient data to justify making these changes to the model. This sort of methodology erodes public confidence in the modeling process and consequently in the TMDL.

Bacterial Source Tracking is a powerful and successfully applied tool in the TMDL process. With sufficient data, it can be used to improve the water quality modeling process, and consequently, public confidence in TMDLs. However, the hard-learned lessons of the past should not be forgotten. Modelers and administrators must be cautious with any new technology to assess the reasonableness of results and be certain that well established experimental design guidelines are followed.

References

Kern, J., B. Petrauskas, P. McClellan, V. O. Shanholtz, and C. Hagedorn. 2000. Bacterial source tracking: A tool for total maximum daily load development. Pp. 157-172. IN T. Younos and J. Poff, eds. *Abstracts, Virginia Water Research Symposium 2000, VWRRC Special Report SR-19-2000*,. Blacksburg, VA.

Advertising

Environmental Detection News will accept a limited number of professional level advertisements. To the left is a sample of a 1/4 page ad. **MapTech** has generously gone beyond the level of advertising support and has underwritten the costs of the (free-to-you) first issue.

All advertisements should be submitted in black and white camera-ready copy.

1/8 page ad: $125 per issue

1/4 page ad: $200 per issue

Requests for Proposals/Upcoming Meetings of Interest

2002

September 18-19 NC Coastal Nonpoint Source Management Program: "Identifying, Tracking, & Understanding the Impacts of Fecal Contamination on the Quality of N.C. Coastal Waters"
Duke University Marine Lab, Beaufort, NC, USA
Registration CLOSED, but for information on live Internet sessions September 19 afternoon:
www.coastlive.org

September 19-21 NOWRA (National Onsite Wastewater Recycling Association), 11th Annual Technical Conference & Exposition
Crown Center, Kansas City, MO, USA
For information: 1-800/966-2942

September 26 ASM (American Society for Microbiology), Special Session: International Biopreparedness Strategies
San Diego, CA, USA
For information: http://www.icaac.org

September 27-30 ASM (American Society for Microbiology), ICAAC (Interscience Conference on Antimicrobial Agents & Chemotherapy
San Diego, CA, USA
For information: http://www.asmusa.org

November 10-14 ASA (American Society of Agronomy), CSSA (Crop Science Society of America), & SSSA (Soil Science Society of America) Annual Meetings
Indiana Convention Center, Indianapolis, IN, USA
For information: http://www.asa-cssa-ssa.org/anmeet

November 13-16 WEF (Water Environment Federation) & ASIWPCA (Association of State & Interstate Water Pollution Control Administrators) Conference
National TMDL Science & Policy Conference
Phoenix, AZ, USA
For information: 1-800-666-0206

November 19-21 Biennial Conference on Agriculture & Water Quality in the Pacific North West
Yakima Convention Center, Yakima WA
For information: tami@fwaa.org

2003

May 18-22 ASM (American Society for Microbiology) 103rd General Meeting
Washington, D.C.
For information: 202/942-9228 or http://www.asmusa.org

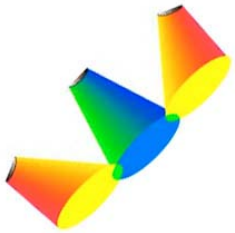
June 18-20 7th International Conference of Modeling, Measuring & Predicition of Water Pollution
Cadiz, Spain
For information: rgreen@wessex.ac.uk or http://www.wessex.ac.uk/conferences/2003/water03/

July 20-23 ASAE (American Society for Agricultural Engineers) Annual International Meeting
Riveria Hotel & Convention Center, las Vegas, NV, USA
For information: http://www.asae.org/meetings

October 11-15 WEF (Water Environment Federation) 76th Annual Technical Exhibition and Conference
Los Angeles Convention Center, Los Angeles, CA, USA
For information: http://www.weftec.org

Does your meeting or RFP belong here?

Please send information on meetings/RFPs that should appear here to:
hagedors@vt.edu
as early as possible before a meeting. Send organization/conference name, location, dates, and contact information.



(*continued from page 8*)

Spotlight on Valerie J. Harwood, Ph.d.

My postdoctoral research began in Frank Robb's lab (University of Maryland Center of Marine Biotechnology), where I continued the *Vibrio* copper detoxification work. Subsequently I worked with Harold Schreier on purification and characterization of a protease from the hyperthermophile *Pyrococcus furiosus*.

Currently, my laboratory in the Department of Biology at the University of South Florida (Tampa) focuses on several facets of bacterial water quality analysis, including bacterial source tracking (BST). We work with antibiotic resistance analysis (ARA) and ribotyping, and use both *E. coli* and *Enterococcus spp*. as indicator organisms. I'm on a team conducting a methods comparison study on the relative efficacy of ARA, ribotyping, and pulsed field gel electrophoresis for BST. One of the most compelling questions in BST for our group is the extent to which diversity of the microbial populations in environmental waters can be a useful variable. We are also ending the first year of a study that examines the survival and potential regrowth of indicator organisms in subtropical waters. The stability of antibiotic resistance and ribotype fingerprints for these organisms under environmental conditions is also being investigated.

Other areas of interest include the detection and prevalence of *Helicobacter pylori* in groundwater, environmental waters, and wastewater in the U.S. In addition to their potential impact on the validity of BST methodologies, the fate of antibiotic-resistant organisms and the genes that encode antibiotic resistance in aquatic environments are compelling public health issues.

Selected Publications

Whitlock, J. E., D. T. Jones, and **V. J. Harwood**. 2002. Identification of the sources of fecal coliforms in an urban watershed using antibiotic resistance analysis. *Water Research* 36: in press.

Pisciotta, J. M., D. F. Rath, P. A. Stanek, D. M. Flanery, and **V. J. Harwood**. 2002. Marine bacteria cause false-positive results in the Colilert-18 rapid identification test for *Escherichia coli* in Florida waters. Appl. Environ. Microbiol. 68: 539-544.

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Harwood, V. J., M. Brownell, W. Perusek, and J. E. Whitlock. 2001. Vancomycin-resistant *Enterococcus spp*. isolated from wastewater and chicken feces in the United States. *Appl. Environ. Microbiol*. 67: 4930-4933.

Harwood, V. J., J. Whitlock, and V. H. Withington. 2000. Classication of the antibiotic resistance patterns of indicator bacteria by discriminant analysis: Use in predicting the source of fecal contamination in subtropical Florida waters. *Appl. Environ. Microbiol*. 66: 3698-3704.

Harwood, V. J., J. Butler, V. Wagner, and D. Parrish. 1999. Fecal coliforms isolated from the cloaca of the diamondback terrapin (*Malaclemys terrapin centrata*) in northeast Florida. Appl. Environ. Microbiol. 65: 865-877.

On the Web *Letters* *Employment*

In future issues, we want to list helpful webpage URLs, print letters to the newsletter editor, and showcase jobs available/jobs sought. If you have any such entries for the newsletter, send them to:

hagedors@vt.edu

Introductory Editorial:

How Important is the Science?

As we present this first official issue of **Environmental Detection News (EDN)**, I would like to take this opportunity to introduce myself as **EDN**'s editor. I received my Ph.D. in Science and Technology Studies from Virginia Tech in Blacksburg, Virginia, and have over 30 years experience in science and engineering writing and editing. My main area of expertise is the public understanding of science, so I am particularly sensitive to an issue that appears to be threatening the burgeoning field of source tracking—a perceived gap between the laboratory science and the understanding and application of that science in a correct and appropriate manner. One goal of **Environmental Detection News** will be to bridge this gap.

Virtually all of the field-based source tracking studies that have been conducted recently have raised as many questions as they have answered. For example,

What role does geographic location have on source tracking?
Is different methodology more effective in different circumstances?
What are the appropriate size and representativeness for known-source libraries?
What is the best way to determine the number and size of water samples?

Practically speaking, the nation-wide mandated TMDL program will inevitably lead to legal challenges when necessary changes to reduce the pollution in water sources are implemented. If good scientific principles are sacrificed to expediency now, consequences in the future could be severe. Even with the considerations of proprietary information and budgetary constraints, the more that information is shared (such as details of methodology and known source isolates), the better science will be done by all. We applaud the local, regional, and national method comparison studies currently underway—these can only lead to stronger cross verification and compilation of data necessary to provide a solid foundation for decisions that will have to be made in the future.

However, these decisions will usually be made outside of the science laboratory, and **EDN** also aims to provide a forum for communication between the scientific community and those who will have to take the scientific results and make future political and economical decisions. Without a firm scientific foundation, those decisions will be questionable. But without comprehension of source tracking results and their implications, the science will be of little use to decision makers.

Susan Allender-Hagedorn
July, 2002

Subscription Information

At the outset, **Environmental Detection News** will be published four times a year, in July, October, January, and April. The first issue is **free**. There will be a subscription fee on subsequent issues to cover editorial, printing, and mailing costs.

There are two subscription options:

hardcopy by mail per year (4 issues)	$35
restricted on-line copy per year (4 issues)	$25

Subscription forms can be downloaded from:**http://soils1.cses.vt.edu/ch/biol_4684/bst/BST.html**

Recent Source Tracking Publications to Note

Booth, A. M., C. Hagedorn, A. K. Graves, S. C. Hagedorn, and K. H. Mentz. 2002. Sources of fecal pollution in Virginia's Blackwater River. *J. Environ. Engineering*, in press.

Graves, A. K., C. Hagedorn, A. Teetor, M. Mahal, A. M. Booth, and R. B. Reneau, Jr. 2002. Antibiotic resistance profiles to determine sources of fecal contamination in a rural Virginia watershed. *JEQ* 31:1300-1308.

Guan, S., R. Xu, S. Chen, J. Odumeru, and C. Gyles. 2002. Development of a procedure for discriminating among *Escherichia coli* isolates from animal and human sources. *Appl Environ. Microbiol*. 68.6: 2690-2698.

Hartel, P.G., J.D. Summer, J.L. Hill, J.V. Collins, J.A. Entry, and W.I. Segars. 2002. Geographic variability of *Escherichia coli* ribotypes from animals in Idaho and Georgia. *JEQ* 31:1273-1278.

Kerns, J., B. Petrauskas, P. McCllelan, V. O. Shanholtz, and C. Hagedorn. 2002. Bacterial source tracking: a tool for total maximum daily load development. Pp. 125-142. IN T. Younos, ed. Advances in Water Monitoring Research. Denver, CO: Water Resources Publications.

Malakoff, D. 2002. Microbiologists on the trail of polluting bacteria. *Science* 295.5564 (March 29): 2352-2353.

Parveen, Sdina. 2002. Sources of fecal contamination. Pp. 1256-1264. Encyclopedia of Environmental Microbiology Vol. 3.

Seveno, N. A. *et al*. 2002. Occurrence and reservoirs of antibiotic resistance genes in the environment. *Rev. Med. Microbiol.* 12.1: 15-27.

Simmons, G. E., Jr., D. F. Waye, S. Herbein, S. Myers, E. Walker. 2002. Estimating nonpoint source fecal coliform sources using DNA profile analysis. Pp. 143-168. IN T. Younos, ed. Advances in Water Monitoring Research. Denver, CO: Water Resources Publications.

Wheeler, A. L., P. G. Hartel, D. G. Godfrey, J. L. Hill, and W. I. Segars. 2002. Potential of *Enterococcus faecalis* as a human fecal indicator for microbial source tracking. *JEQ* 31:1286-1293.

Whitlock, J. E., D. T. Jones, and **V. J. Harwood**. 2002. Identification of the sources of fecal coliforms in an urban watershed using antibiotic resistance analysis. *Water Research* 36: in press.

Zhang, H. X., M. Harrington, J. T. Mauro, L. A. Fillmore, and J. Wheeler. 2002. Identity known: Using bacterial source tracking in fecal coliform TMDL development and implementation. *Water Environ. & Tech*. 14.4: 21-24.

Highlights of First National-Level Source Tracking Workshop (Irvine, California, February 2002)

On February 5-7, 2002, the Southern California Coastal Water Research Project (SCCWRP), in cooperation with the U.S. Environmental Protection Agency (EPA), the California State Water Quality Control Board, and the National Water Research Institute, hosted the first national workshop on microbiological source tracking techniques. Participants described some 16 methods that all appear to have potential in source tracking. Methods included using bacteria (*E. coli*, *Enterococcus* sp., and *Bacteroides*) or viruses (enteroviruses, coliphages, adenoviruses) as indicators, and techniques for differentiating between host sources included molecular fingerprinting, phenotypic (non-molecular) fingerprinting, amplification of species-specific gene sequences, amplification of enterotoxin genes as biomarkers, and species-specific immunoglobulins. Workshop proceedings are available online at: http://www.sccwrp.org/tools/workshops/source_tracking_workshop.html.

One outcome of the workshop has been the development of an extensive methods comparison study, funded by SCCWRP and US-EPA, that is scheduled to begin this fall. For information on this study, contact Steve Weisberg (stevew@SCCWRP.ORG).

Valerie J. Harwood, Ph.D. ("Jody")

My background is fairly eclectic; my first degree was a B.A. in French from Iowa State University. After assessing the limited range of opportunities available with this degree, I returned to the undergraduate arena and obtained a B.S. in Biology from the State University of New York, Plattsburgh.

Mary Hood's work with *Vibrio spp.* sparked my interest in environmental microbiology. Numerous moves (husband in the U.S. Navy), two children, and a stint in an environmental testing lab later, I landed in the Ph.D. program at Old Dominion University, in Andy Gordon's lab. My dissertation explored a protein-mediated mechanism of copper detoxification in *Vibrio alginolyticus* and *Vibrio parahaemolyticus*. Pathogenic *Vibrio* species and their distribution in natural waters remain a research interest.

continued on page 5

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